

FIGURE 17f

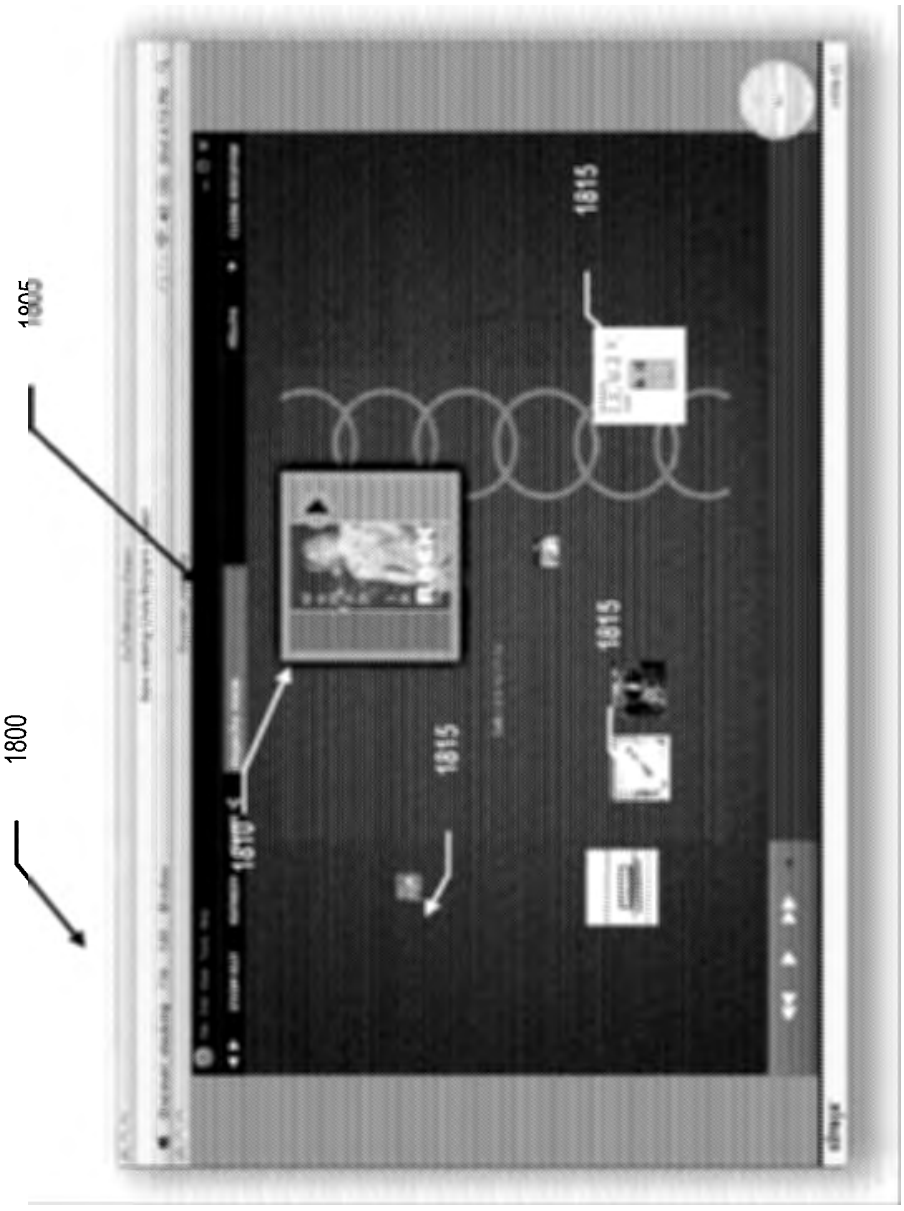


FIGURE 18a

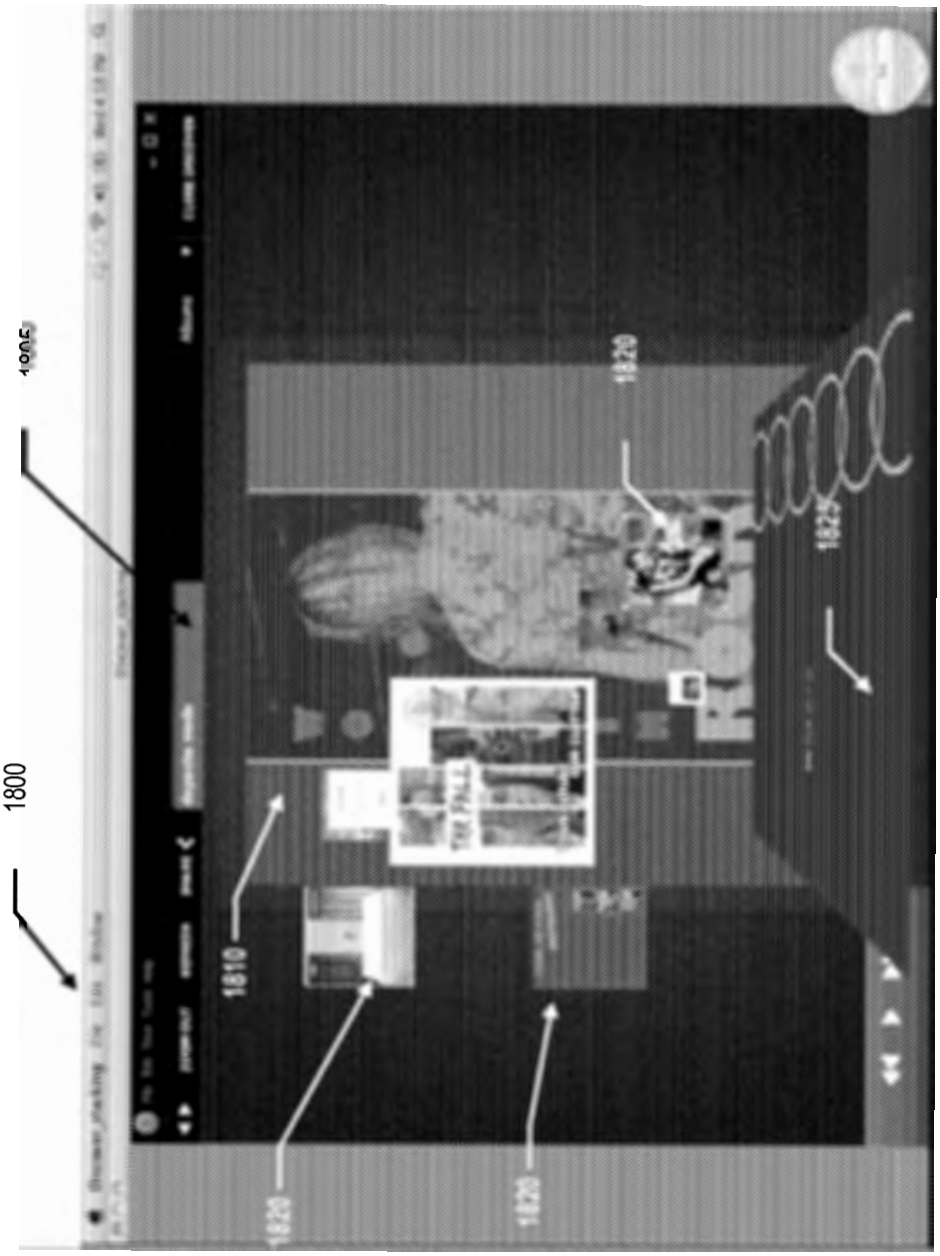


FIGURE 18b



FIGURE 18c

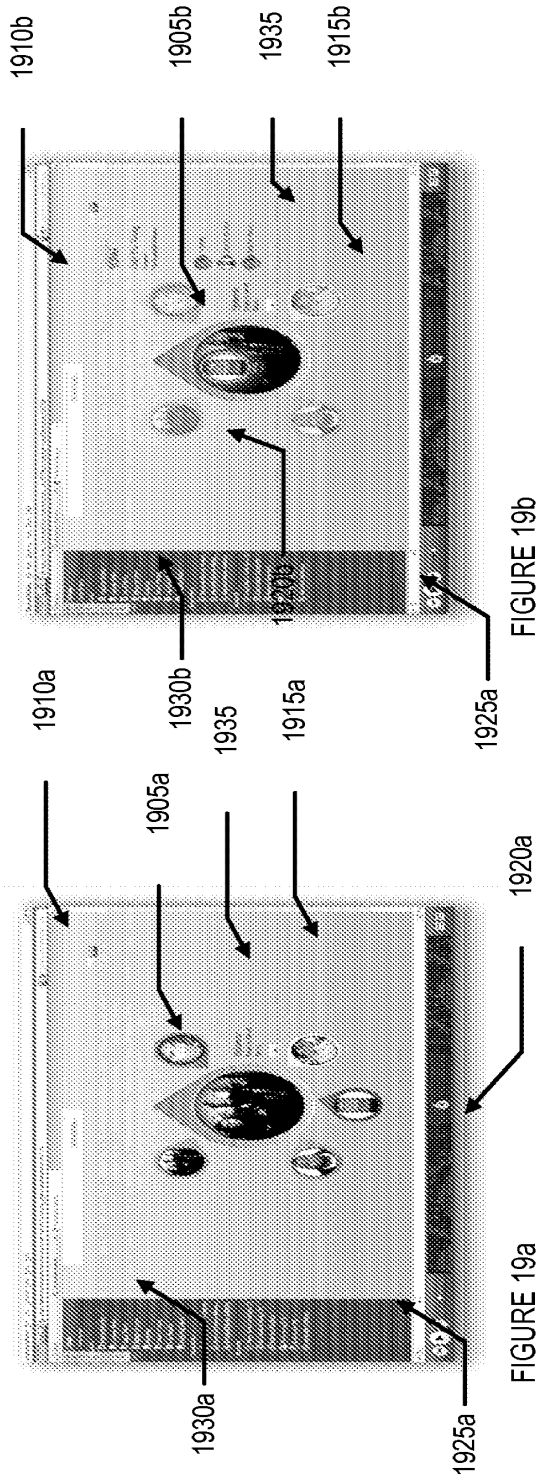


FIGURE 19a

FIGURE 19b

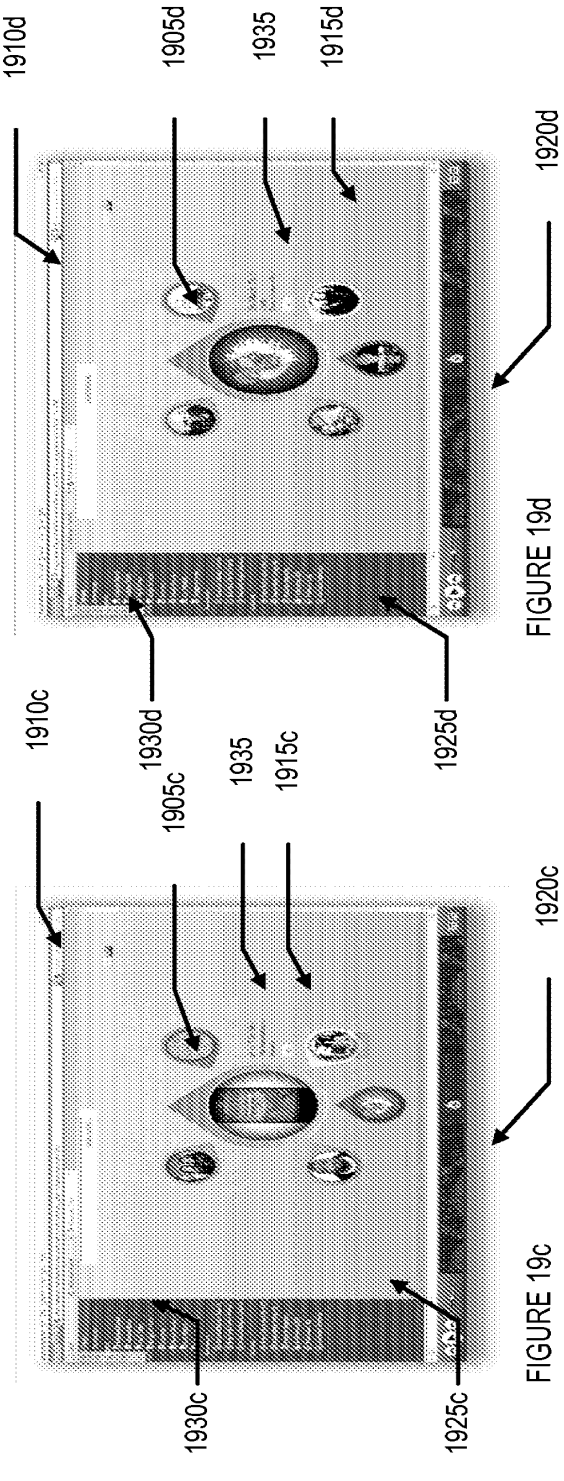


FIGURE 19c

FIGURE 19d

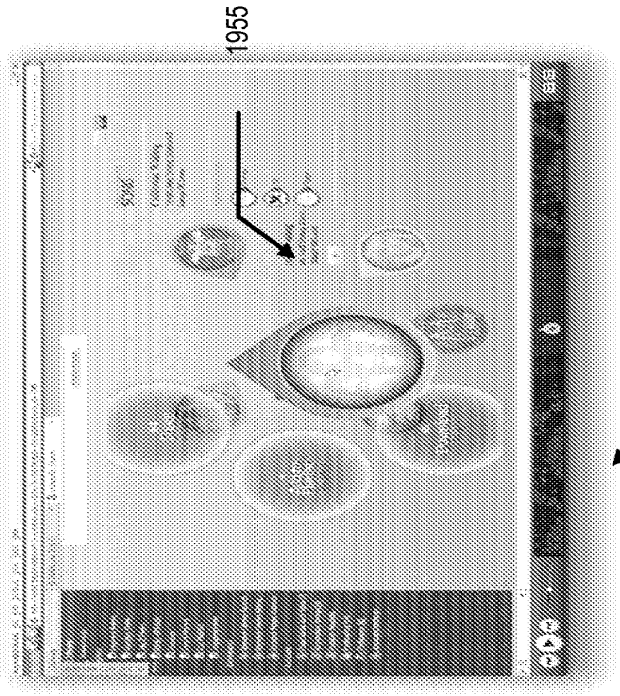


FIGURE 19f

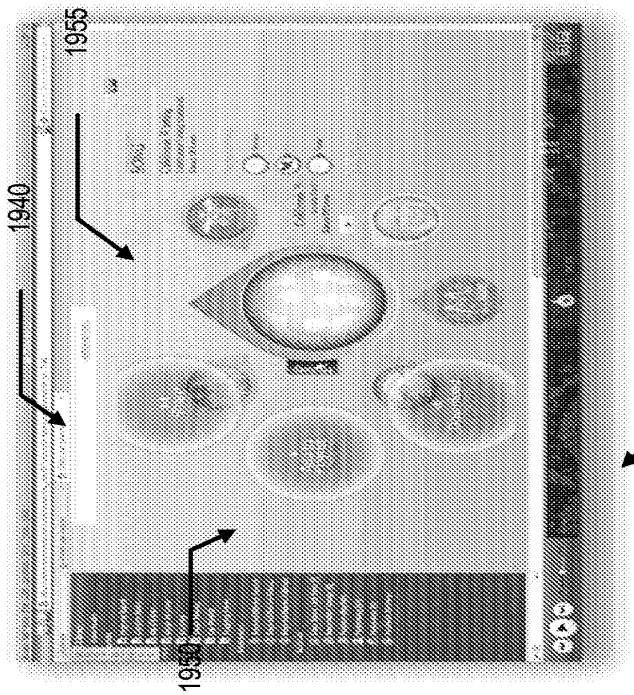


FIGURE 19e

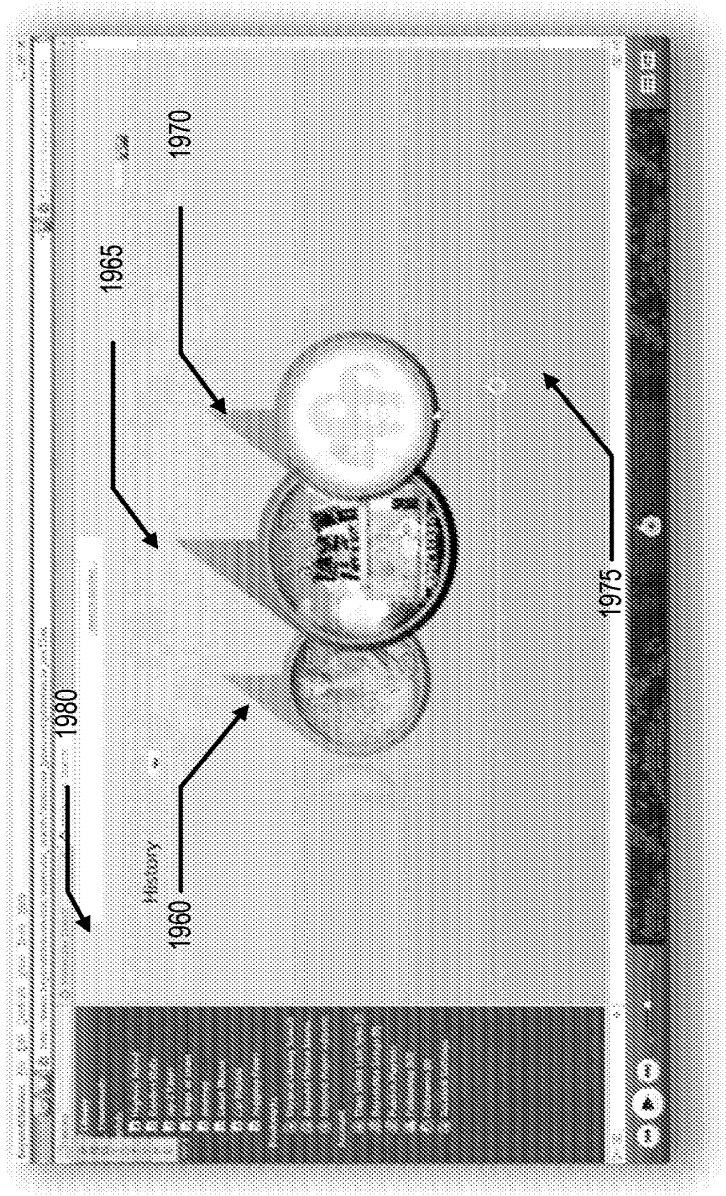


FIGURE 19g

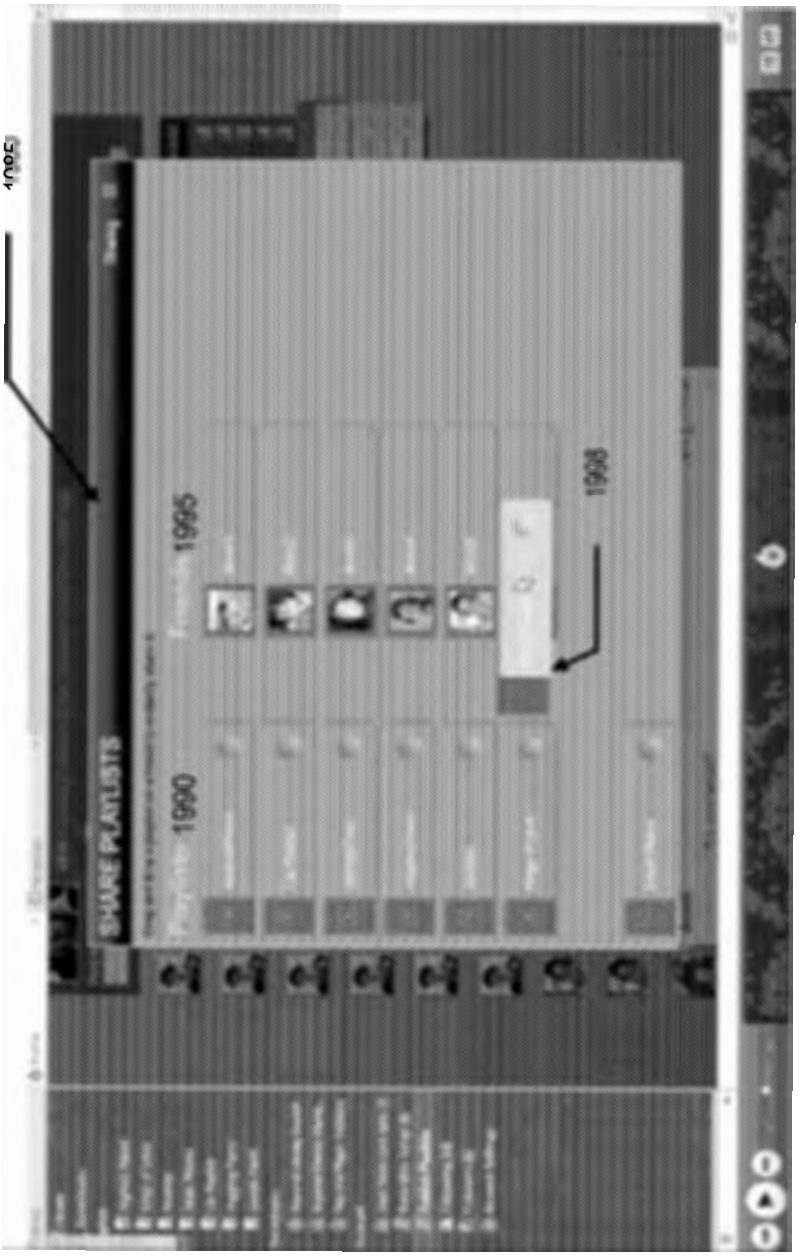


FIGURE 19h

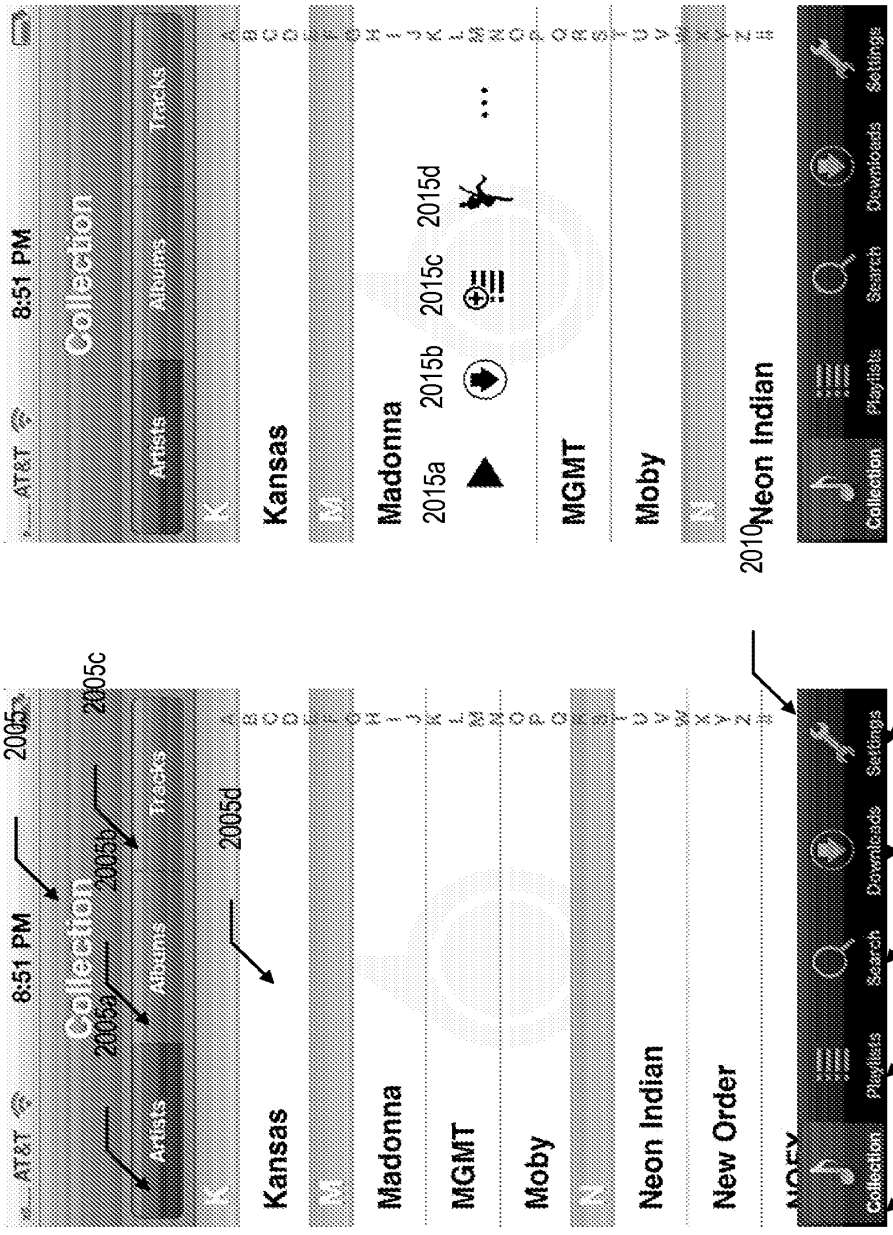


FIGURE 20a

FIGURE 20b

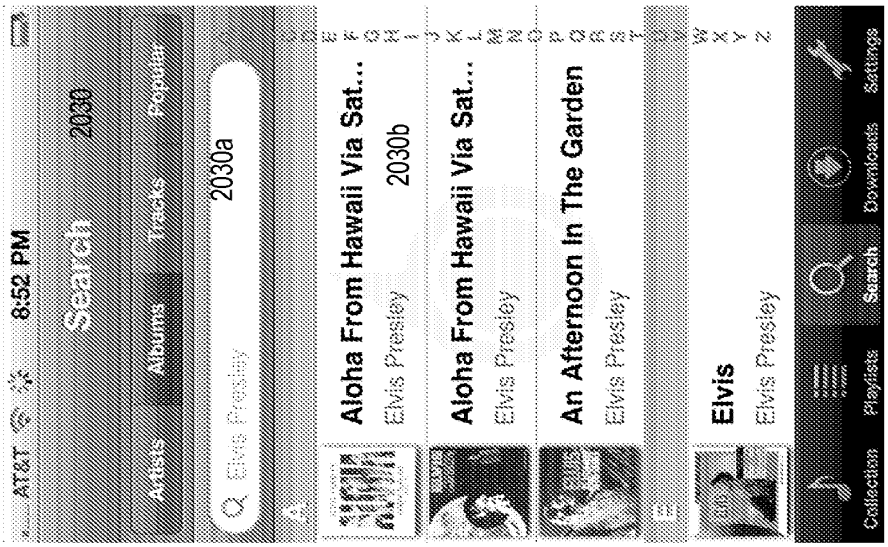


FIGURE 20d

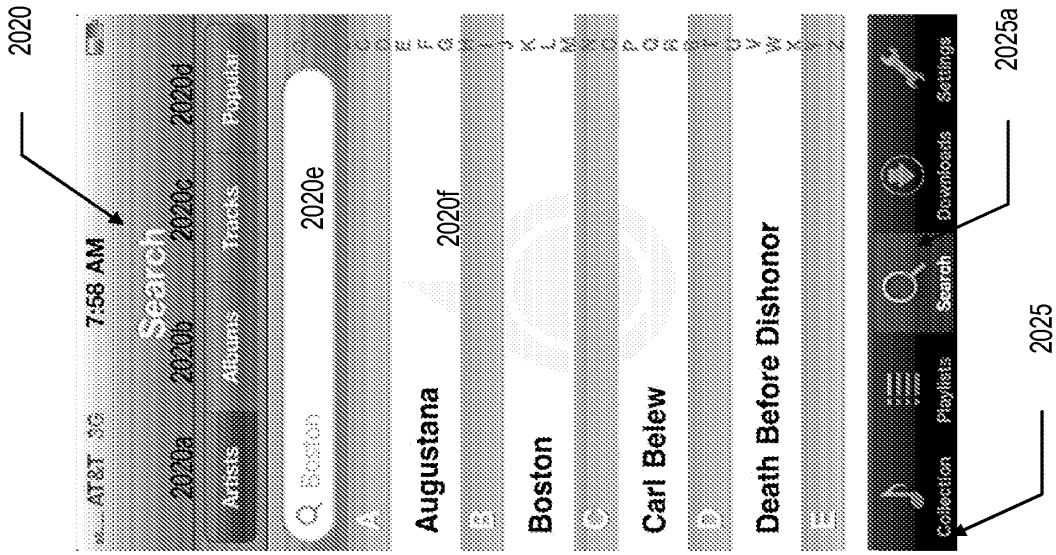


FIGURE 20c

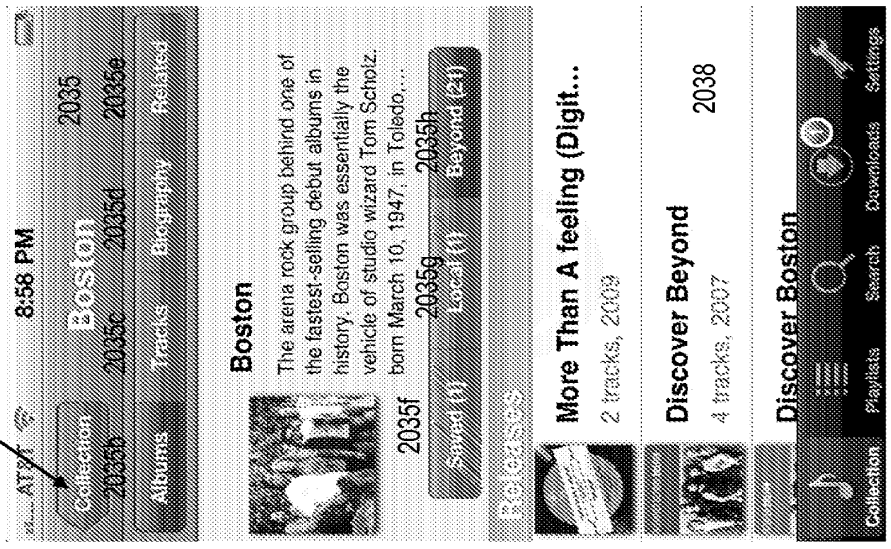


FIGURE 20e

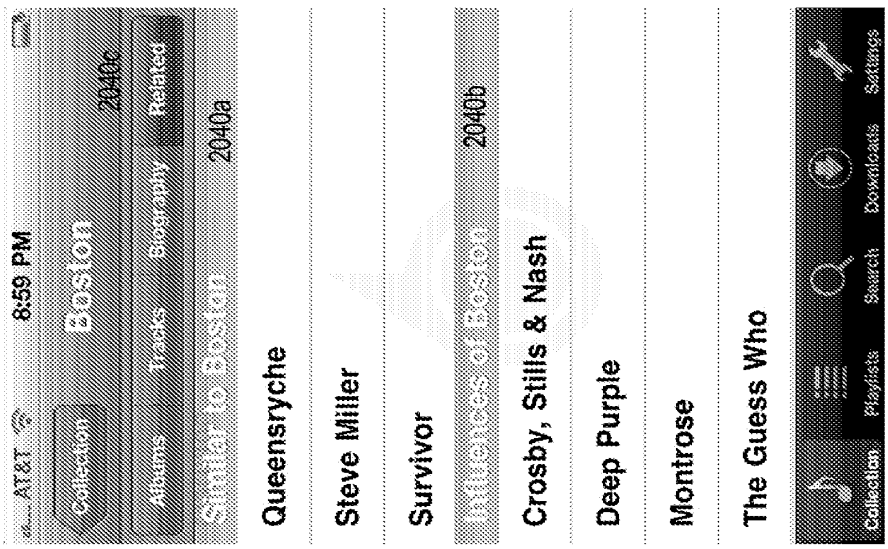


FIGURE 20f

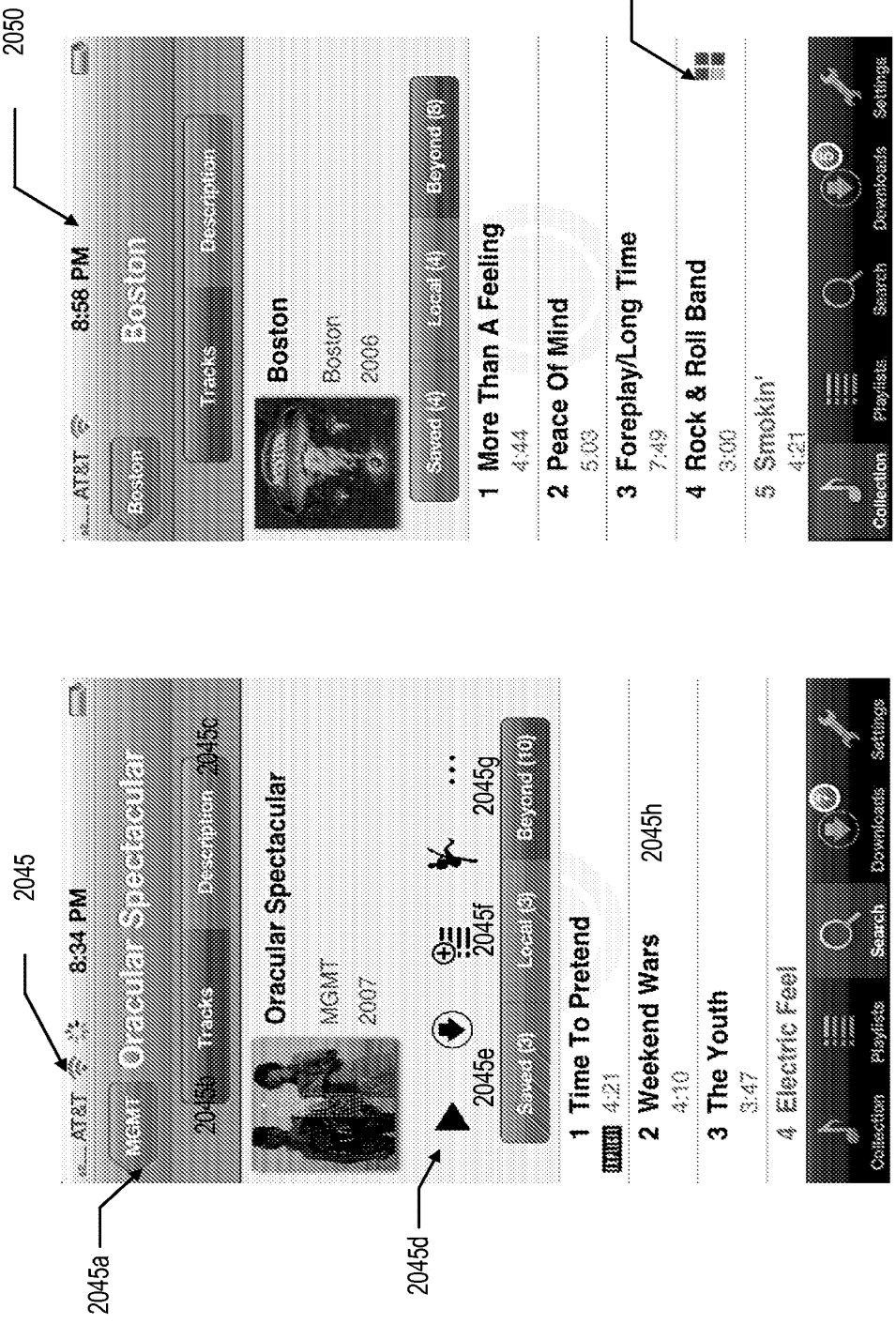


FIGURE 20g

FIGURE 20h

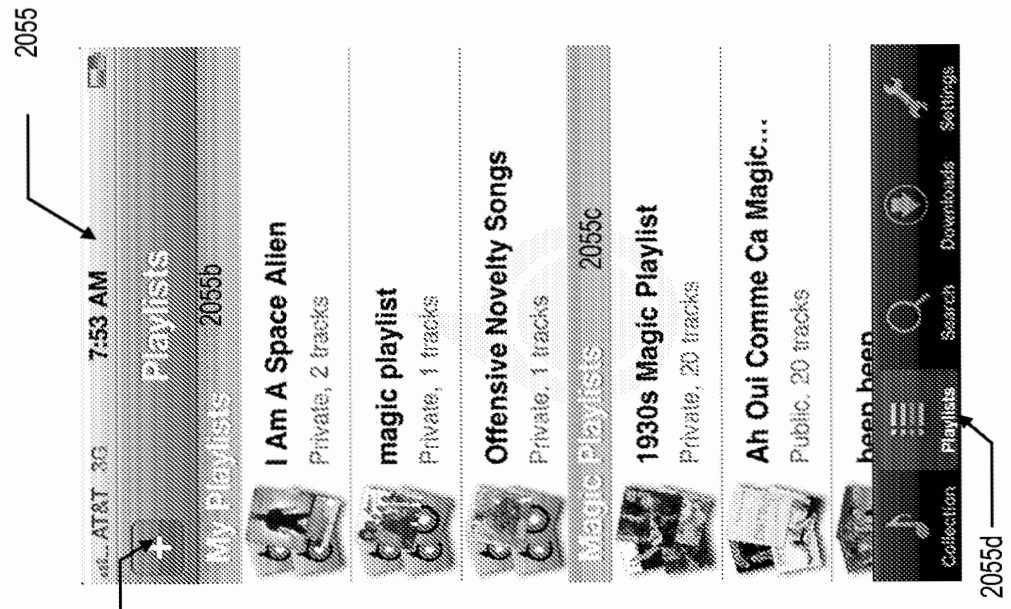


FIGURE 20i

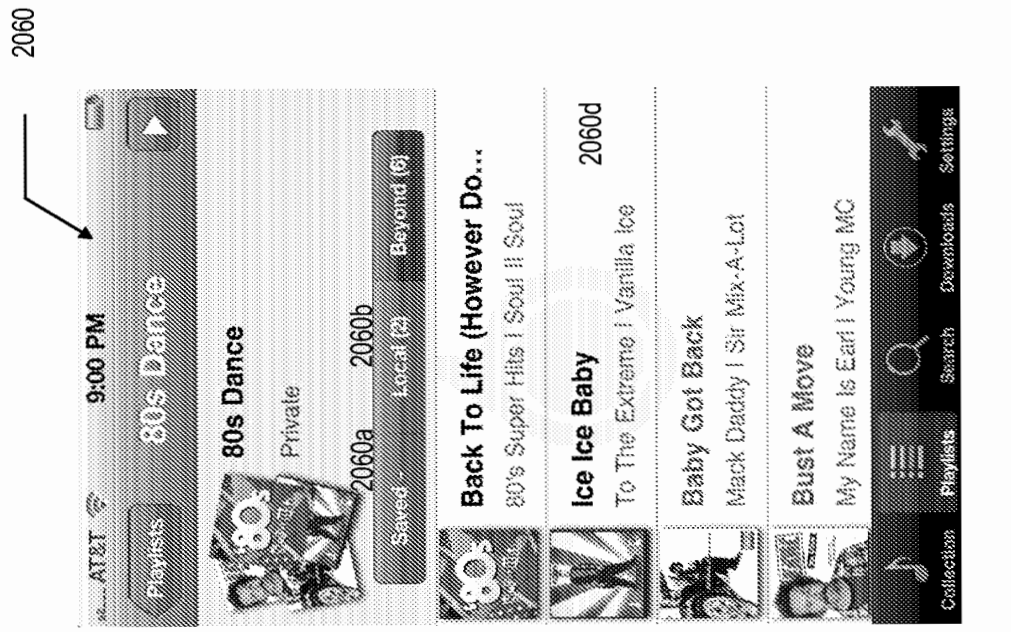


FIGURE 20j

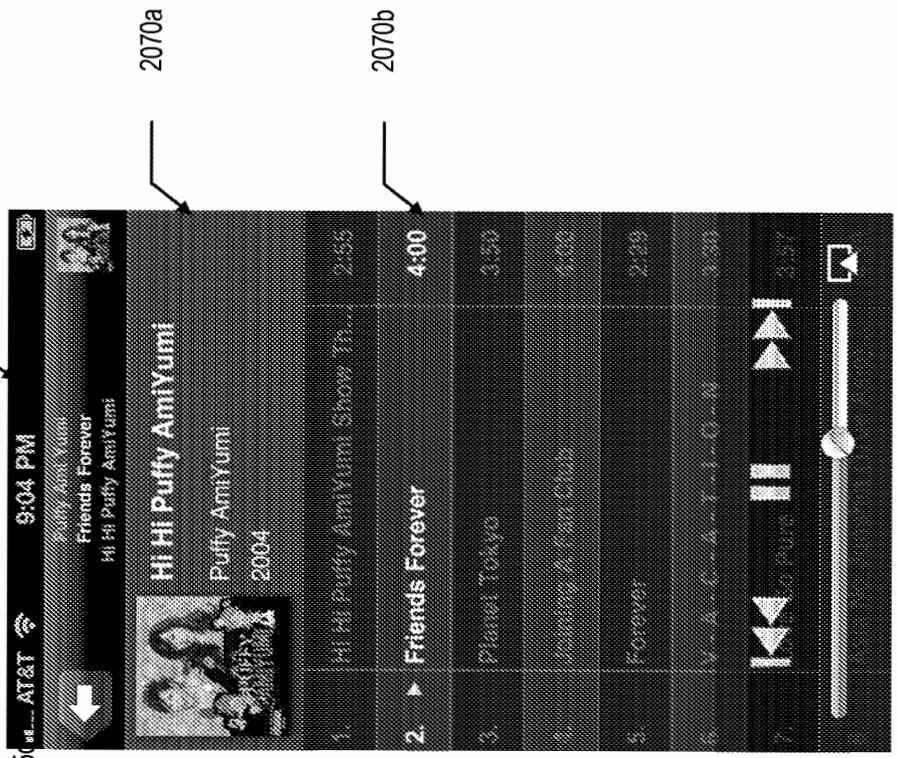
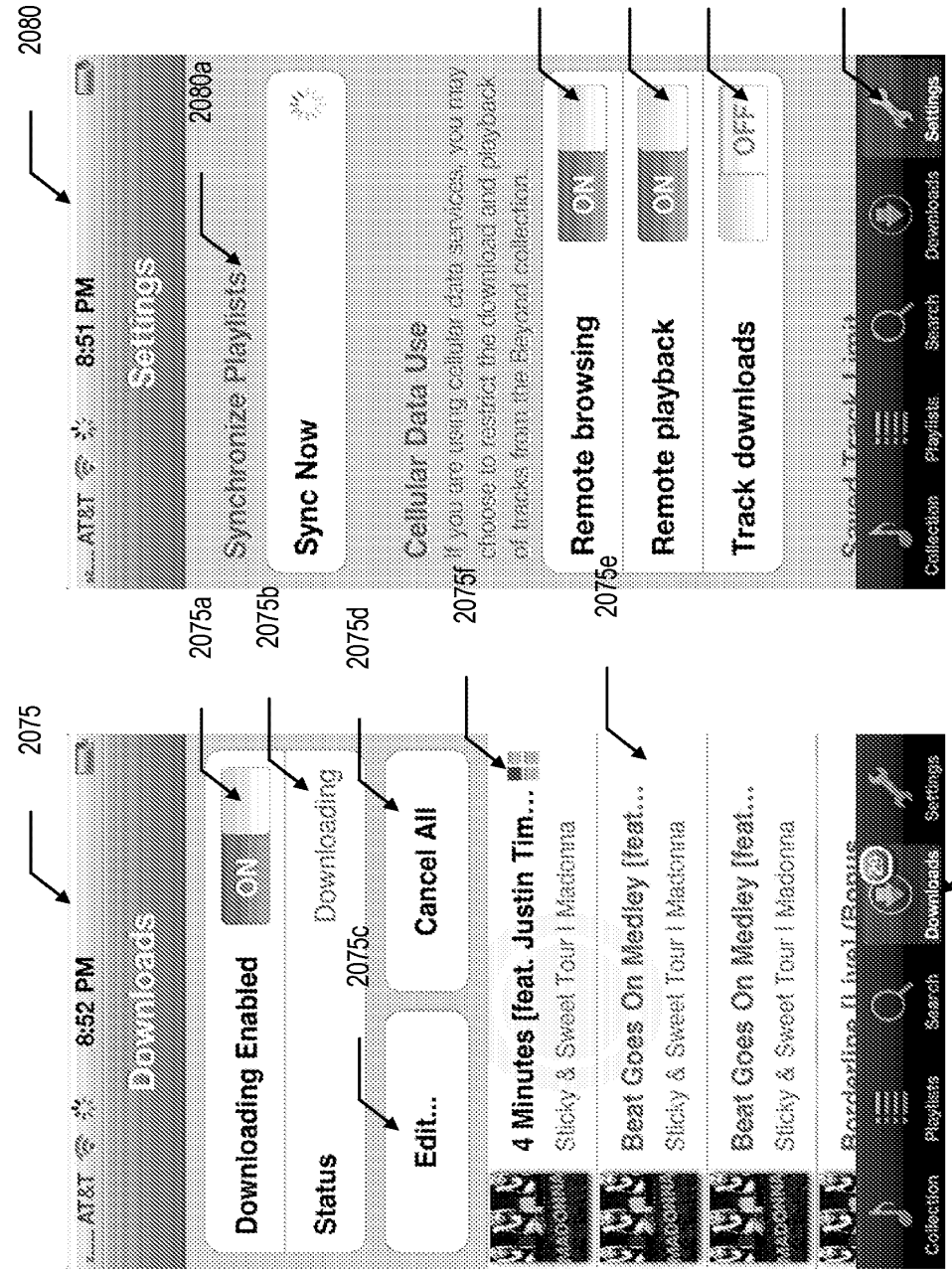


FIGURE 20l



FIGURE 20k


2080
AT&T
8:51 PM
Settings
2080a
Synchronize Playlists
Sync Now
Cellular Data Use
If you are using cellular data services, you may choose to restrict the download and playback of tracks from the Beyond collection.
Remote browsing
ON
Remote playback
ON
Track downloads
OFF
Collection
Playlists
Search
Downloads
Settings
2075a
2075b
2075d
2075f
2075e
2080b
2080c
2080d
2080e
FIGURE 20n
2075
AT&T
8:52 PM
Downloads
Downloading Enabled
ON
Status
Downloading
Edit...
Cancel All
4 Minutes (feat. Justin Tim...
Sticky & Sweet Tour | Madonna
Beat Goes On Medley (feat...
Sticky & Sweet Tour | Madonna
Beat Goes On Medley (feat...
Sticky & Sweet Tour | Madonna
Collection
Playlists
Search
Downloads
Settings
2075c
2075g
FIGURE 20m

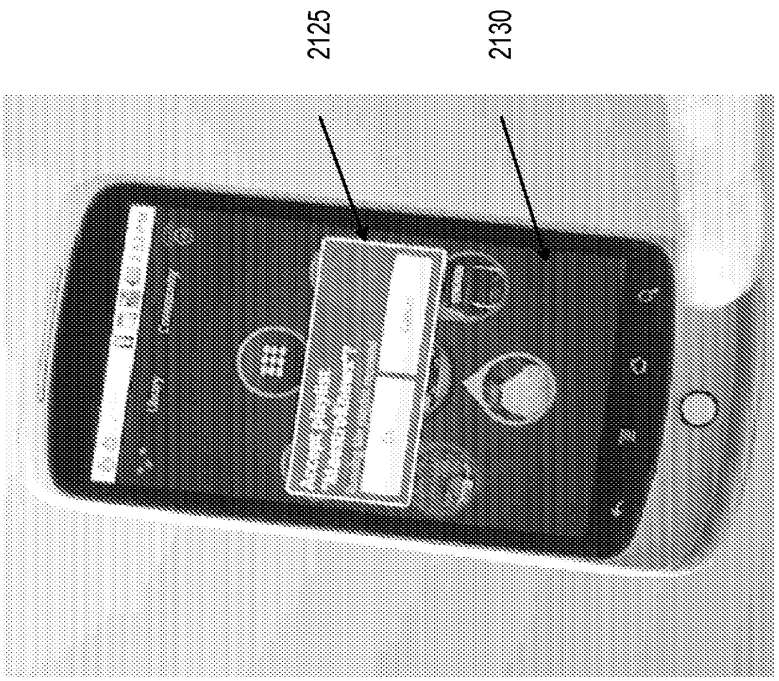


FIGURE 21b

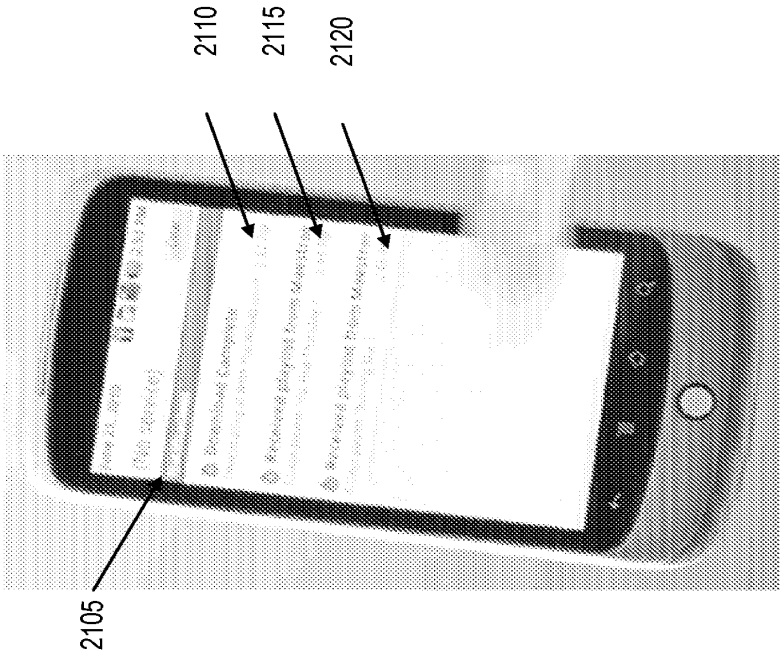


FIGURE 21a

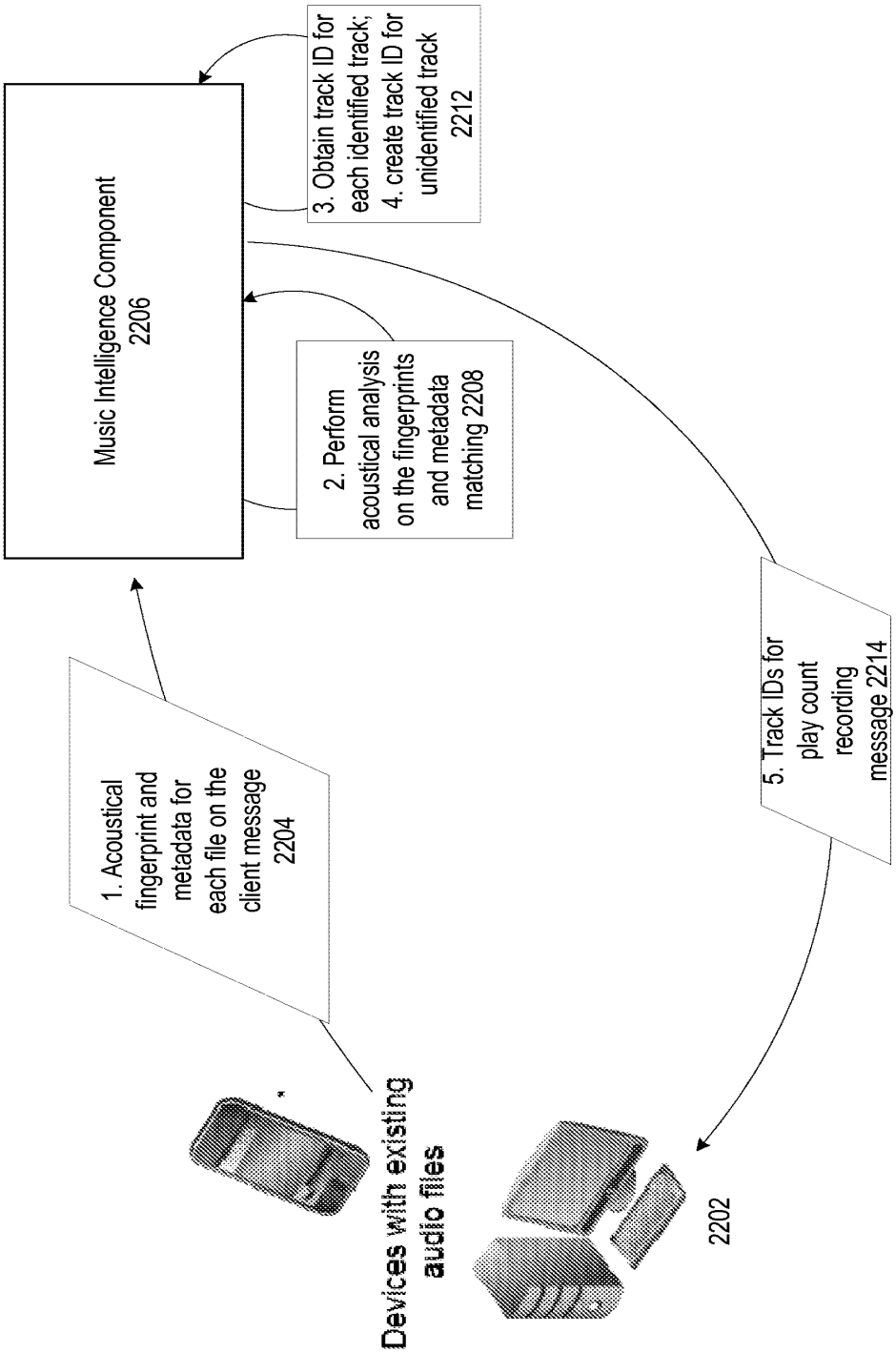

Music Intelligence Component
2206
3. Obtain track ID for each identified track; 4. create track ID for unidentified track 2212
2. Perform acoustical analysis on the fingerprints and metadata matching 2208
1. Acoustical fingerprint and metadata for each file on the client message 2204
5. Track IDs for play count recording message 2214
Devices with existing audio files
2202

FIGURE 22a

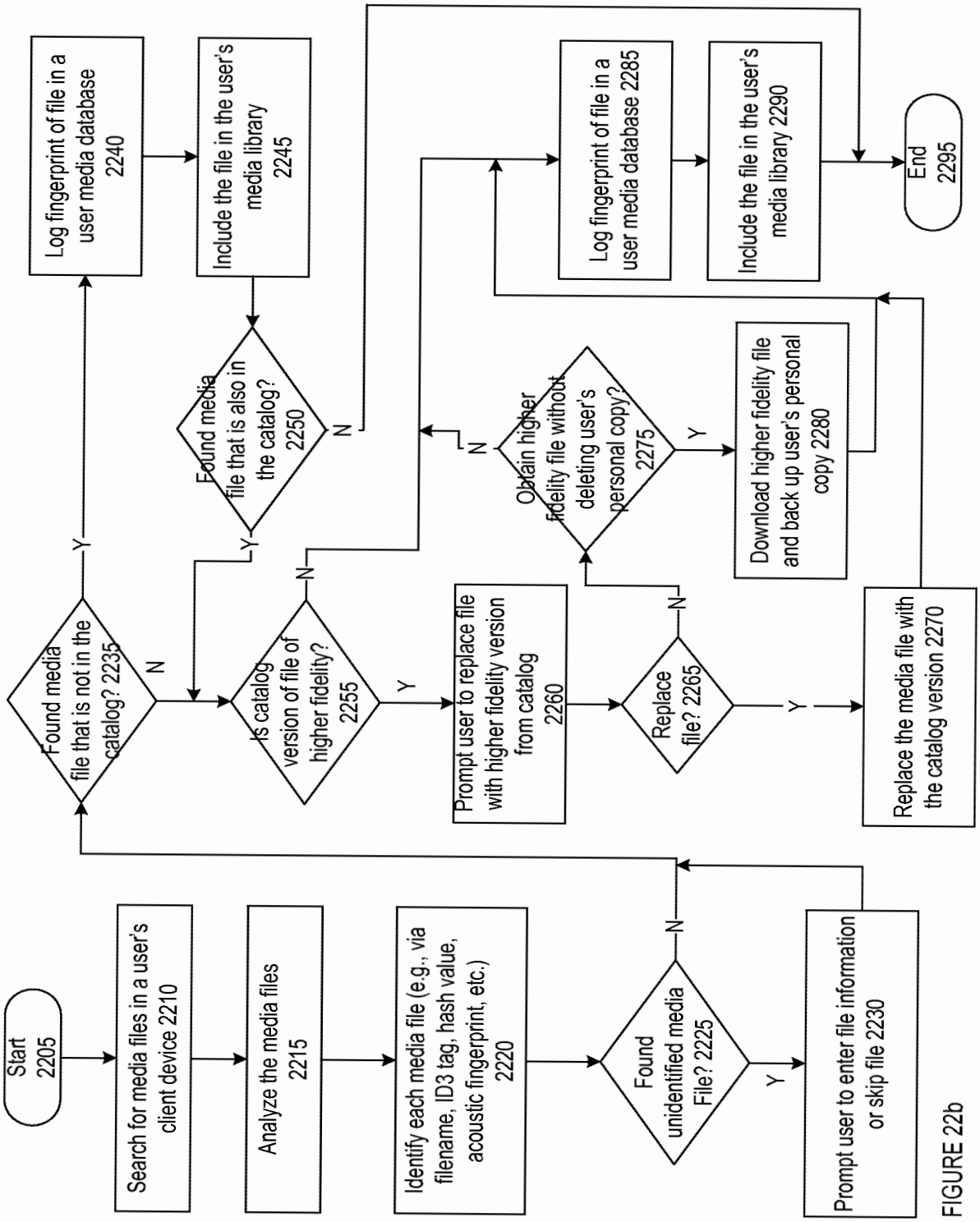

Start 2205
Search for media files in a user's client device 2210
Analyze the media files 2215
Identify each media file (e.g., via filename, ID3 tag, hash value, acoustic fingerprint, etc.) 2220
Found unidentified media File? 2225
Y
N
Prompt user to enter file information or skip file 2230
Found media file that is not in the catalog? 2235
Y
N
Log fingerprint of file in a user media database 2240
Include the file in the user's media library 2245
Found media file that is also in the catalog? 2250
Y
N
Is catalog version of file of higher fidelity? 2255
Y
N
Prompt user to replace file with higher fidelity version from catalog 2260
Replace file? 2265
Y
N
Obtain higher fidelity file without deleting user's personal copy? 2275
Y
N
Download higher fidelity file and back up user's personal copy 2280
Replace the media file with the catalog version 2270
Log fingerprint of file in a user media database 2285
Include the file in the user's media library 2290
End 2295

FIGURE 22b

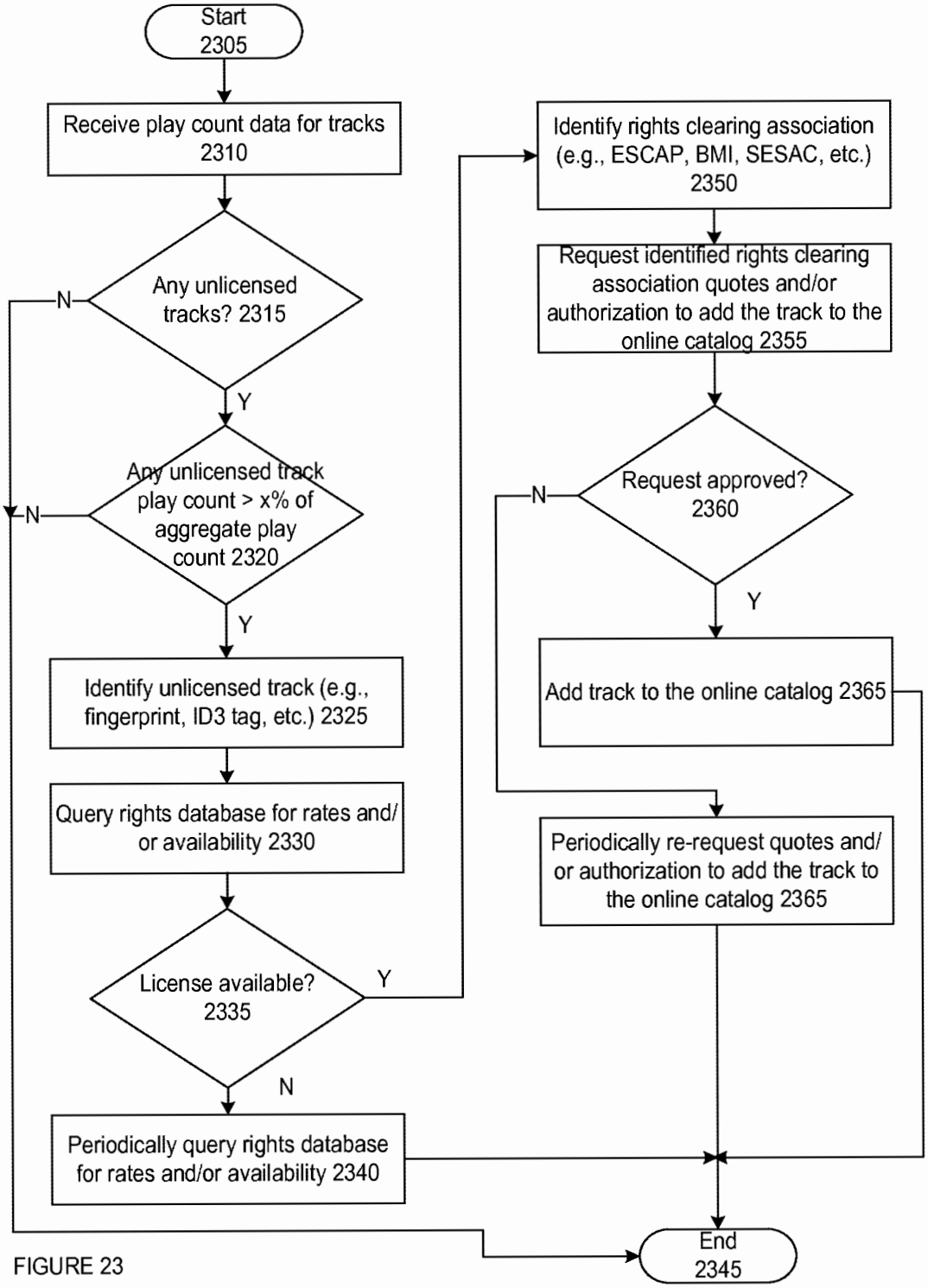

Start 2305
Receive play count data for tracks 2310
Any unlicensed tracks? 2315
N
Y
Any unlicensed track play count > x% of aggregate play count 2320
N
Y
Identify unlicensed track (e.g., fingerprint, ID3 tag, etc.) 2325
Query rights database for rates and/or availability 2330
License available? 2335
Y
N
Periodically query rights database for rates and/or availability 2340
Identify rights clearing association (e.g., ESCAP, BMI, SESAC, etc.) 2350
Request identified rights clearing association quotes and/or authorization to add the track to the online catalog 2355
Request approved? 2360
N
Y
Add track to the online catalog 2365
Periodically re-request quotes and/or authorization to add the track to the online catalog 2365
End 2345

FIGURE 23

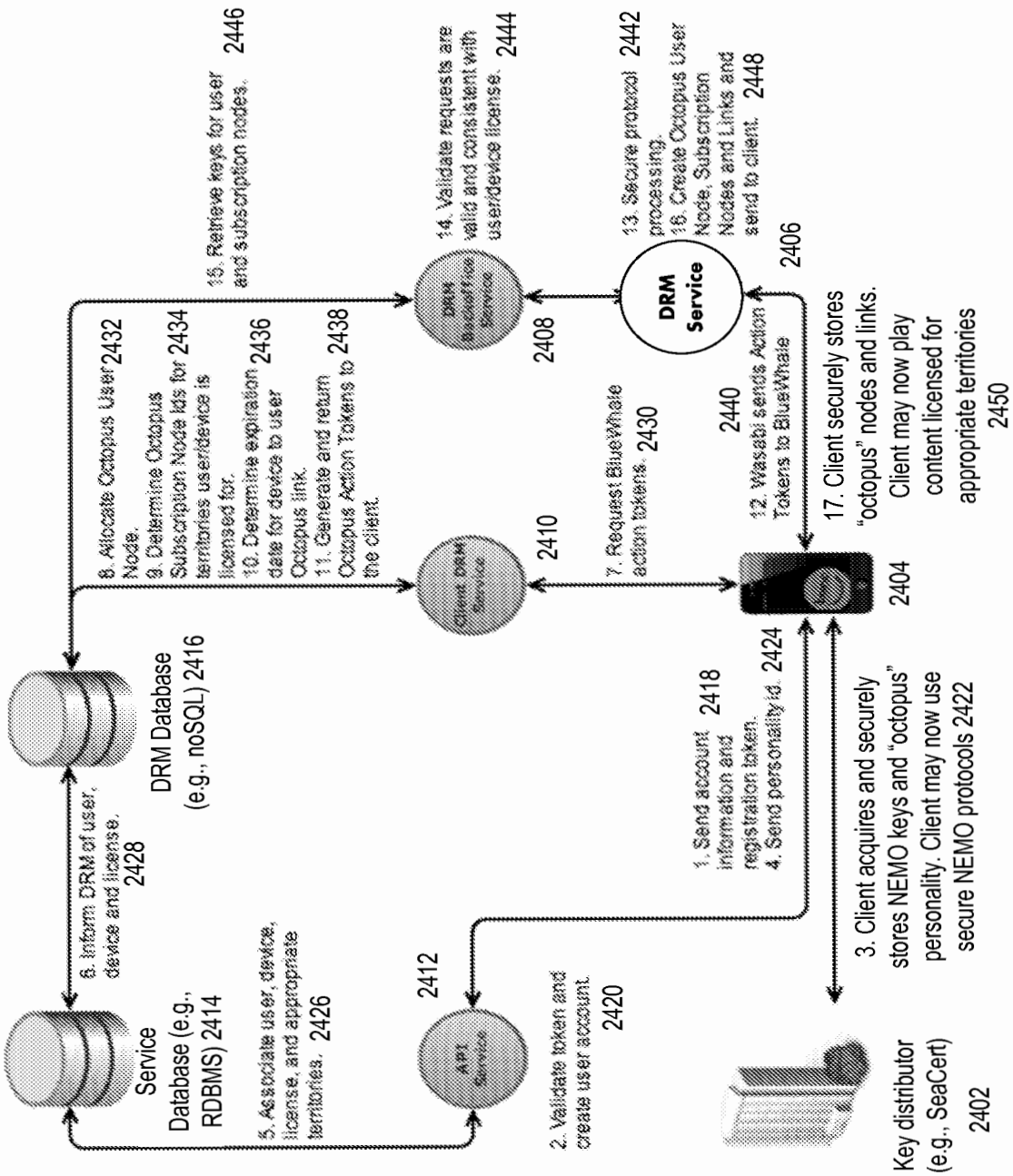

Service Database (e.g., RDBMS) 2414
DRM Database (e.g., noSQL) 2416
Key distributor (e.g., SeaCert) 2402
API Service
2412
Client DRM Service
2410
DRM Rules/Offline Service
2408
DRM Service
2406
2404
6. Inform DRM of user, device and license. 2428
5. Associate user, device, license, and appropriate territories. 2426
2. Validate token and create user account. 2420
1. Send account information and registration token. 2418
4. Send personality id. 2424
3. Client acquires and securely stores NEMO keys and "octopus" personality. Client may now use secure NEMO protocols 2422
8. Allocate Octopus User Node. 2432
9. Determine Octopus Subscription Node ids for territories user/device is licensed for. 2434
10. Determine expiration date for device to user Octopus link. 2436
11. Generate and return Octopus Action Tokens to the client. 2438
15. Retrieve keys for user and subscription nodes. 2446
14. Validate requests are valid and consistent with user/device license. 2444
7. Request BlueWhale action tokens. 2430
2440
12. Wasabi sends Action Tokens to BlueWhale
13. Secure protocol processing. 2442
16. Create Octopus User Node, Subscription Nodes and Links and send to client. 2448
17. Client securely stores "octopus" nodes and links. Client may now play content licensed for appropriate territories 2450

FIGURE 24a

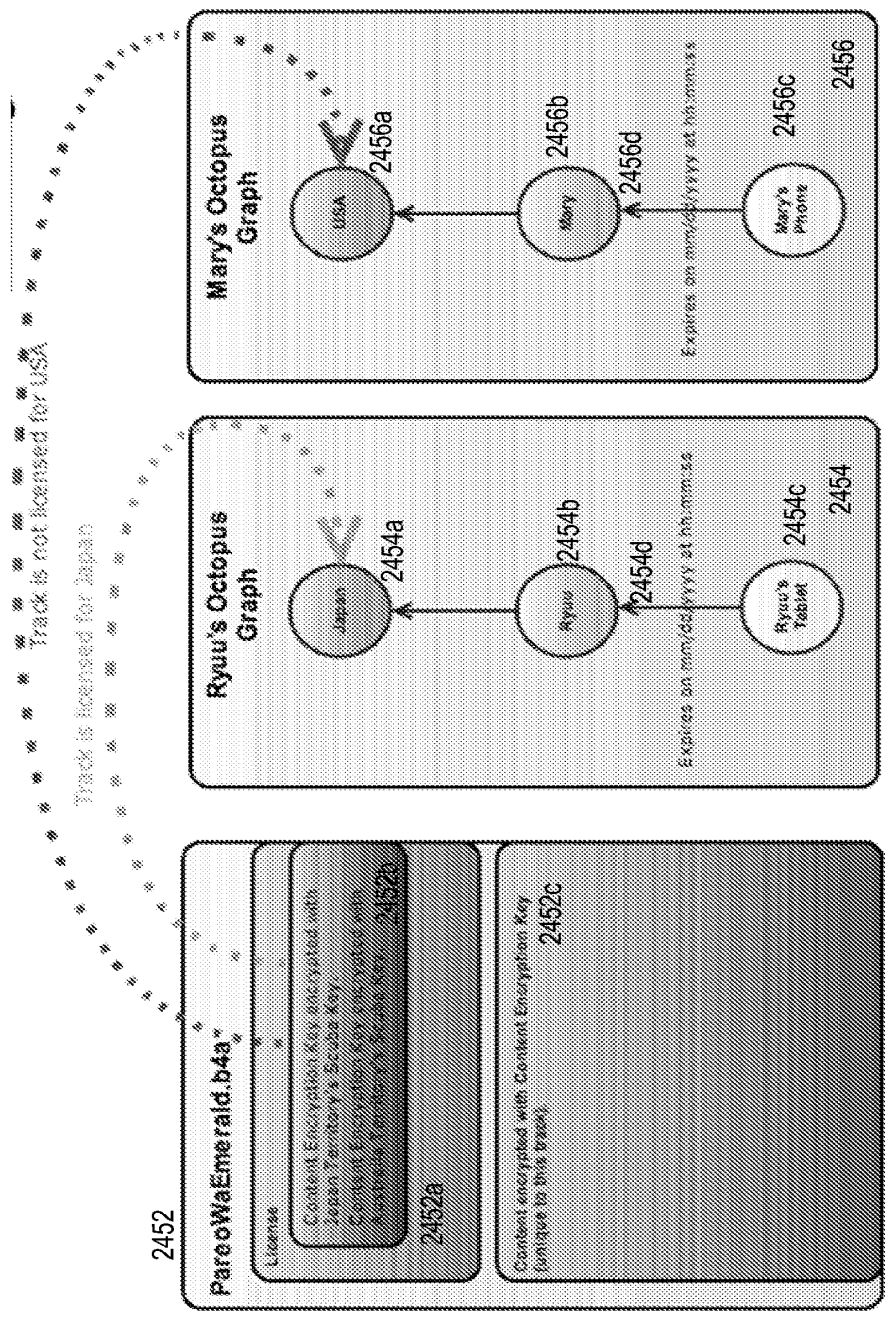

Track is not licensed for USA
Track is licensed for Japan
2452
PareoWaEmerald.b4a
License
2452a
2452b
2452c
Ryuu's Octopus Graph
Japan
2454a
Ryuu
2454b
2454d
Ryuu's Tablet
2454c
2454
Mary's Octopus Graph
USA
2456a
Mary
2456b
2456d
Mary's Phone
2456c
2456
As long as the device to user link has not expired, client on Ryuu's phone may retrieve the Japan Territory's key, decrypt the content encryption key, and decrypt the track
Client on Mary's phone may not access the keys necessary to decrypt the track

FIGURE 24b

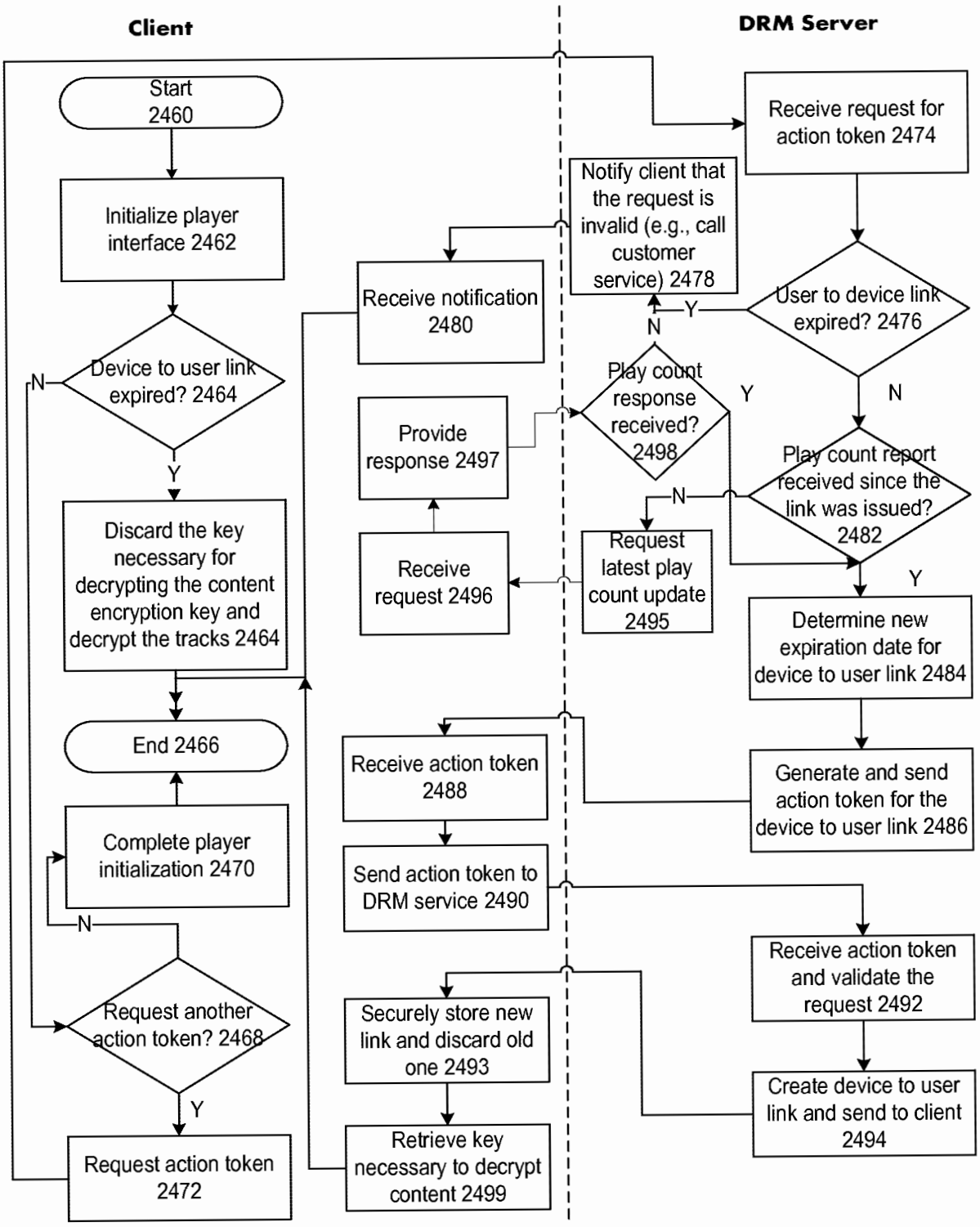

Client
DRM Server
Start 2460
Initialize player interface 2462
Device to user link expired? 2464
N
Y
Discard the key necessary for decrypting the content encryption key and decrypt the tracks 2464
End 2466
Complete player initialization 2470
N
Request another action token? 2468
Y
Request action token 2472
Receive notification 2480
Provide response 2497
Receive request 2496
Receive action token 2488
Send action token to DRM service 2490
Securely store new link and discard old one 2493
Retrieve key necessary to decrypt content 2499
Receive request for action token 2474
Notify client that the request is invalid (e.g., call customer service) 2478
User to device link expired? 2476
Y
N
Play count response received? 2498
Y
N
Request latest play count update 2495
Play count report received since the link was issued? 2482
N
Y
Determine new expiration date for device to user link 2484
Generate and send action token for the device to user link 2486
Receive action token and validate the request 2492
Create device to user link and send to client 2494

FIGURE 24c

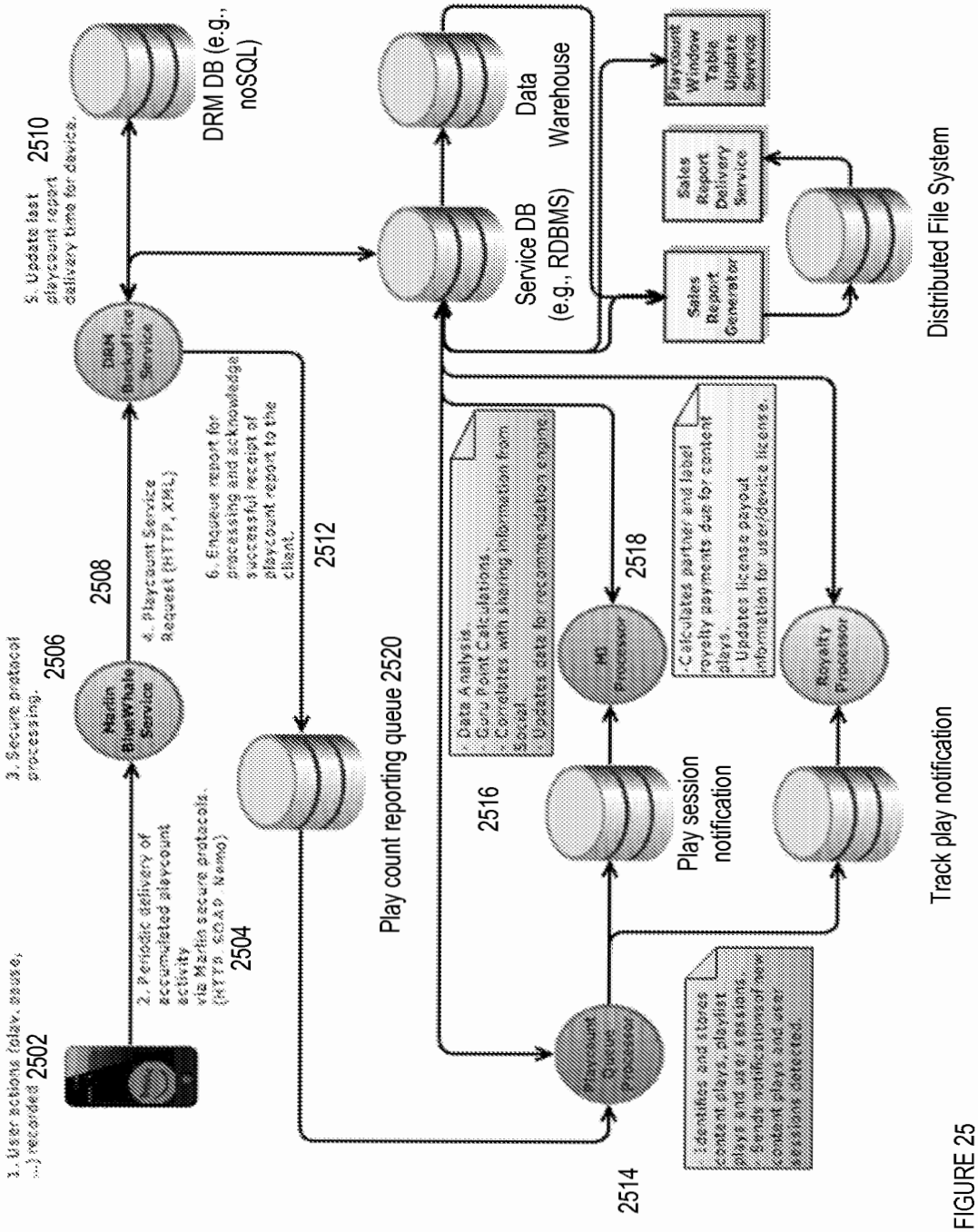

DRM DB (e.g., noSQL)
2510
Data Warehouse
Service DB (e.g., RDBMS)
Distributed File System
Sales Report Generator
Sales Report Delivery Service
Playcount Window Table Update Service
2508
2506
2504
2502
2512
2518
2516
2514
Play count reporting queue 2520
Play session notification
Track play notification
Royalty Processor

FIGURE 25

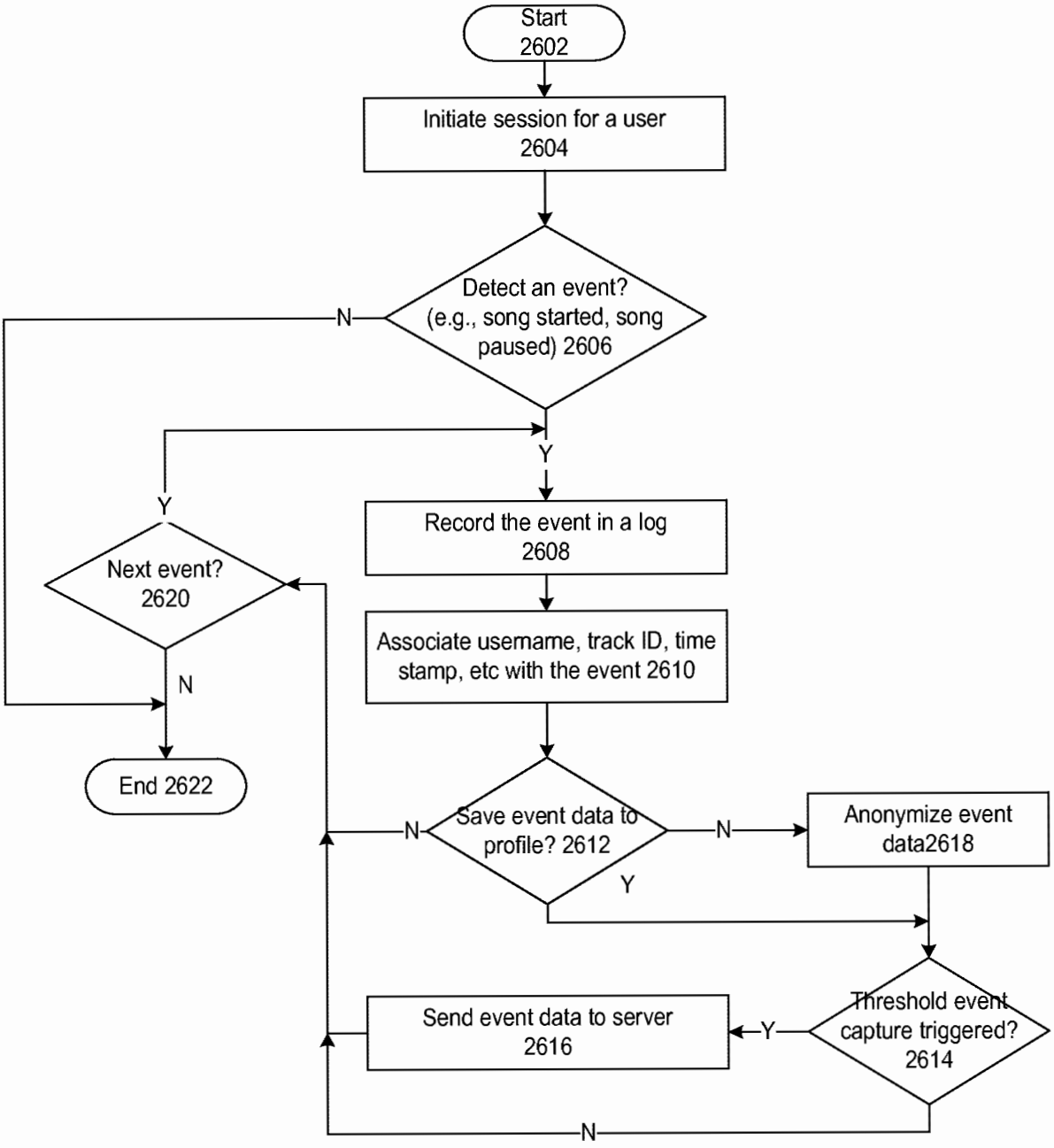

Start 2602
Initiate session for a user 2604
Detect an event? (e.g., song started, song paused) 2606
N
Y
Record the event in a log 2608
Associate username, track ID, time stamp, etc with the event 2610
Save event data to profile? 2612
N
Y
Anonymize event data2618
Threshold event capture triggered? 2614
Y
Send event data to server 2616
N
Next event? 2620
Y
N
End 2622

FIGURE 26a

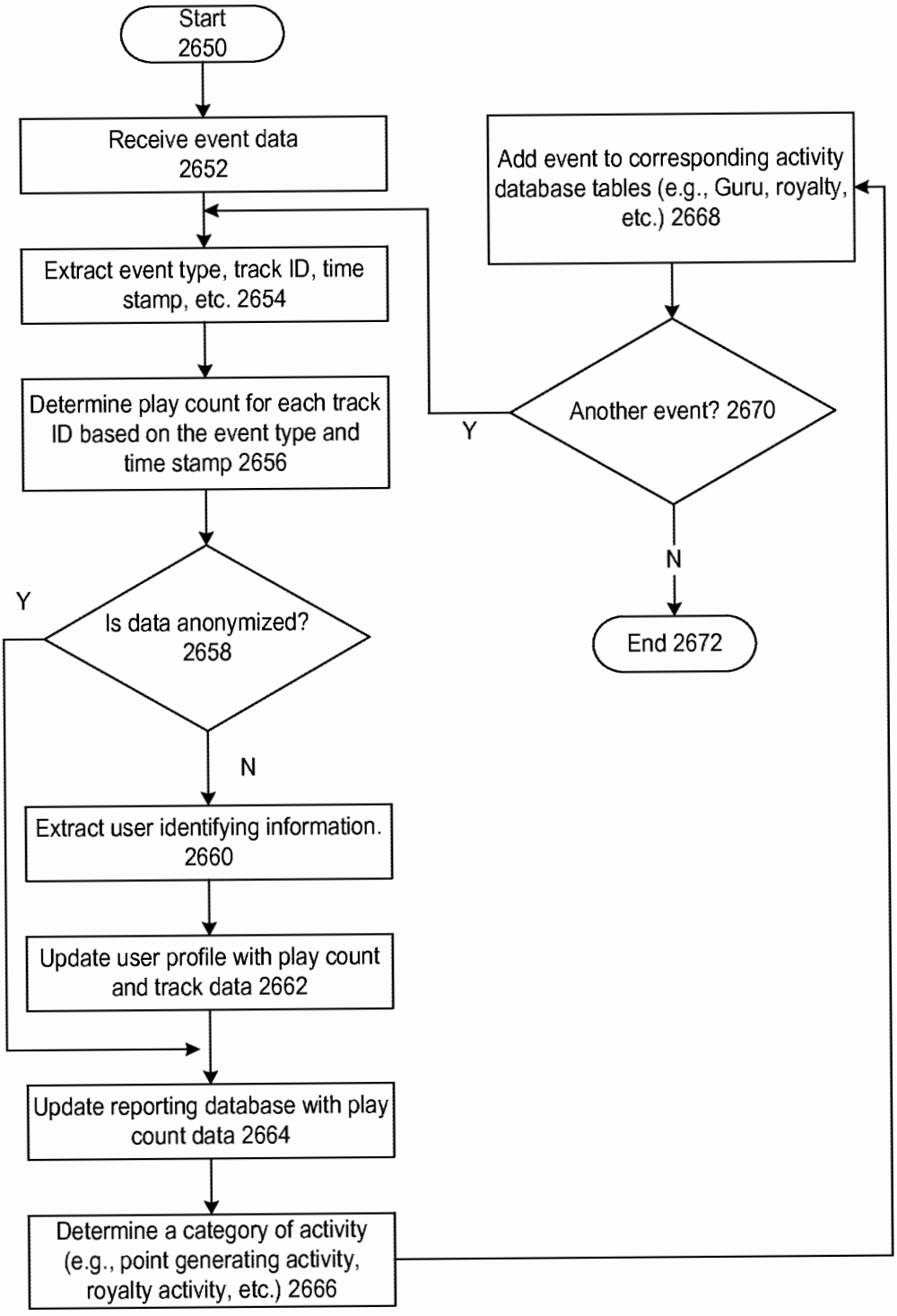

Start 2650
Receive event data 2652
Extract event type, track ID, time stamp, etc. 2654
Determine play count for each track ID based on the event type and time stamp 2656
Is data anonymized? 2658
Y
N
Extract user identifying information. 2660
Update user profile with play count and track data 2662
Update reporting database with play count data 2664
Determine a category of activity (e.g., point generating activity, royalty activity, etc.) 2666
Add event to corresponding activity database tables (e.g., Guru, royalty, etc.) 2668
Another event? 2670
Y
N
End 2672

FIGURE 26b

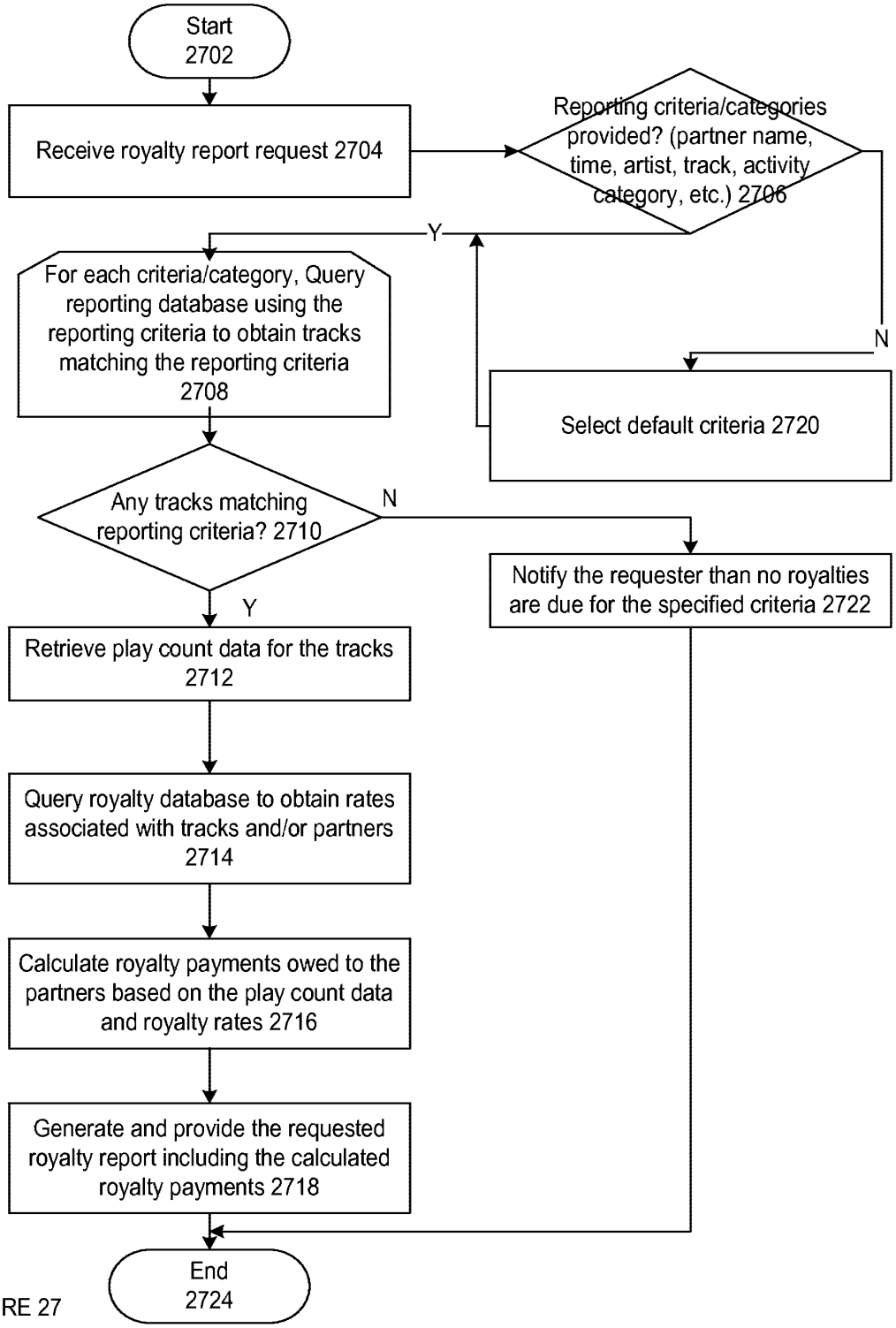
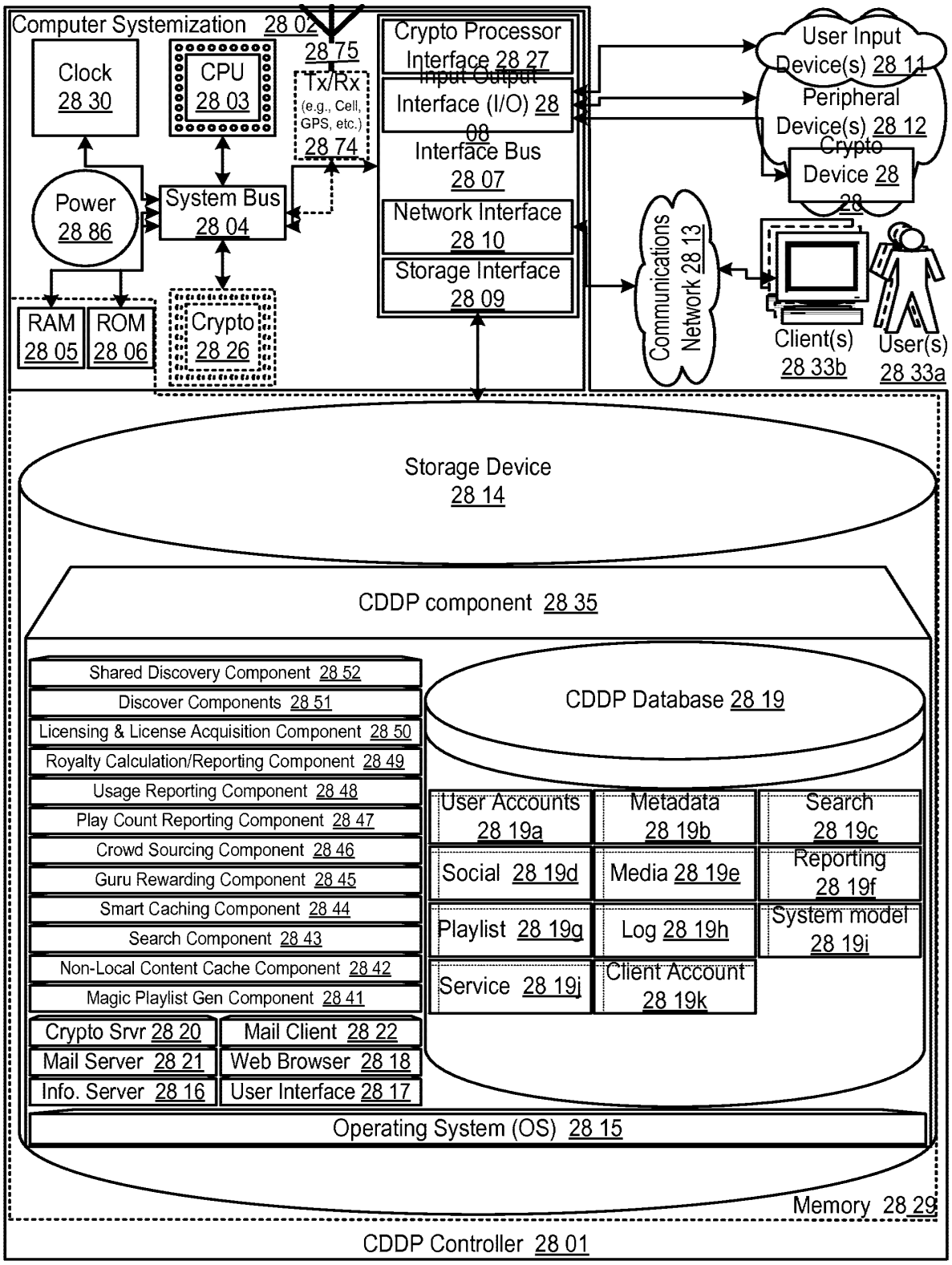

Start 2702
Receive royalty report request 2704
Reporting criteria/categories provided? (partner name, time, artist, track, activity category, etc.) 2706
Y
N
For each criteria/category, Query reporting database using the reporting criteria to obtain tracks matching the reporting criteria 2708
Select default criteria 2720
Any tracks matching reporting criteria? 2710
N
Y
Notify the requester than no royalties are due for the specified criteria 2722
Retrieve play count data for the tracks 2712
Query royalty database to obtain rates associated with tracks and/or partners 2714
Calculate royalty payments owed to the partners based on the play count data and royalty rates 2716
Generate and provide the requested royalty report including the calculated royalty payments 2718
End 2724

FIGURE 27


Computer Systemization 28 02
Clock 28 30
CPU 28 03
28 75
Tx/Rx (e.g., Cell, GPS, etc.) 28 74
Power 28 86
System Bus 28 04
RAM 28 05
ROM 28 06
Crypto 28 26
Crypto Processor Interface 28 27
Input Output Interface (I/O) 28 08
Interface Bus 28 07
Network Interface 28 10
Storage Interface 28 09
User Input Device(s) 28 11
Peripheral Device(s) 28 12
Crypto Device 28 28
Communications Network 28 13
Client(s) 28 33b
User(s) 28 33a
Storage Device 28 14
CDDP component 28 35
Shared Discovery Component 28 52
Discover Components 28 51
Licensing & License Acquisition Component 28 50
Royalty Calculation/Reporting Component 28 49
Usage Reporting Component 28 48
Play Count Reporting Component 28 47
Crowd Sourcing Component 28 46
Guru Rewarding Component 28 45
Smart Caching Component 28 44
Search Component 28 43
Non-Local Content Cache Component 28 42
Magic Playlist Gen Component 28 41
Crypto Srvr 28 20
Mail Client 28 22
Mail Server 28 21
Web Browser 28 18
Info. Server 28 16
User Interface 28 17
CDDP Database 28 19
User Accounts 28 19a
Metadata 28 19b
Search 28 19c
Social 28 19d
Media 28 19e
Reporting 28 19f
Playlist 28 19g
Log 28 19h
System model 28 19i
Service 28 19j
Client Account 28 19k
Operating System (OS) 28 15
Memory 28 29
CDDP Controller 28 01

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING TRANSMITTAL OF COPY OF INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (CHAPTER I OF THE PATENT COOPERATION TREATY)
(PCT Rule 44bis.1(c))

To:

GEORGE, Christopher N.
Hanley, Flight & Zimmerman, LLC.
150 S. Wacker Drive, Suite 2100
Chicago, Illinois 60606
ETATS-UNIS D'AMERIQUE

Date of mailing *(day/month/year)* 30 January 2014 (30.01.2014)	
Applicant's or agent's file reference 11-0501-PCT	**IMPORTANT NOTICE**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/045894	09 July 2012 (09.07.2012)	19 July 2011 (19.07.2011)

Applicant
SONOS, INC. et al

The International Bureau transmits herewith a copy of the international preliminary report on patentability (Chapter I of the Patent Cooperation Treaty)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Kihwan Moon
Facsimile No. +41 22 338 82 70	e-mail: pt01.pct@wipo.int

Form PCT/IB/326 (January 2004)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 11-0501-PCT	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2012/045894	International filing date *(day/month/year)* 09 July 2012 (09.07.2012)	Priority date *(day/month/year)* 19 July 2011 (19.07.2011)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant SONOS, INC.		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 21 January 2014 (21.01.2014)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Kihwan Moon e-mail: pt01.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
GEORGE CHRISTOPHER N.

HANLEY, FLIGHT & ZIMMERMAN, LLC. 150 S.
WACKER DRIVE, SUITE 2100 CHICAGO IL 60606 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**26 DECEMBER 2012 (26.12.2012)**
Applicant's or agent's file reference 11-0501-PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/045894	**09 JULY 2012 (09.07.2012)**	19 JULY 2011 (19.07.2011)

International Patent Classification (IPC) or both national classification and IPC

H04R 3/00(2006.01)i, H04R 5/02(2006.01)i, H04S 5/02(2006.01)i

Applicant

SONOS, INC. et al

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	26 DECEMBER 2012 (26.12.2012)	JEONG, So Yeon Telephone No.82-42-481-5656

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/045894

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/045894

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-30	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	1-30	YES
	Claims	NONE	NO
Industrial applicability (IA)	Claims	1-30	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2008-0144864 A1 (GRAEME JOHN HUON) 19 June 2008
D2: US 05553147 A (JOSEPH E.M. PINEAU) 03 September 1996
D3: US 2007-0003067 A1 (STEFAN GIERL et al.) 04 January 2007
D4: US 2002-0124097 A1 (LARSON J. ISELY et al.) 05 September 2002

1. Novelty and Inventive Step

1.1 Concerning Claims 1-10

The subject matter of claim 1 differs from these prior art documents in that a method for shaping sound comprises configuring the playback device to reproduce a stereophonic or monaural sound using a plurality of speakers based on an orientation and an audio data stream. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claim 1 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Claims 2-10 are dependent on claim 1 and therefore meet the requirements of PCT Article 33(2) and (3).

1.2 Concerning Claims 11-20

The subject matter of claim 11 differs from these prior art documents in that a tangible computer readable storage medium including a set of instructions for execution by processor when executed implement a method for shaping sound comprises a playback device reproduces a stereophonic or monaural sound using a plurality of speakers based on an orientation and an audio data stream. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claim 11 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Claims 12-20 are dependent on claim 11 and therefore meet the requirements of PCT Article 33(2) and (3).

Continued on Supplemental Box

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of :

Box V

1.3 Concerning Claims 21-30

Since the apparatus and the method of claims 21 and 1 are substantially same except the category aspect, claim 21 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Claims 22-30 are dependent on claim 21 and therefore meet the requirements of PCT Article 33(2) and (3).

2. Industrial Applicability

Claims 1-30 are industrially applicable under PCT Article 33(4).

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
11-0501-PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2012/045894	**09 JULY 2012 (09.07.2012)**	19 JULY 2011 (19.07.2011)

Applicant

SONOS, INC. et al

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the language, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.
2. ☐ Certain claims were found unsearchable (See Box No. II)
3. ☐ Unity of invention is lacking (See Box No. III)
4. With regard to the title,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the abstract,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the drawings to be published with the abstract is Figure No. 1
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/045894

A. CLASSIFICATION OF SUBJECT MATTER

H04R 3/00(2006.01)i, H04R 5/02(2006.01)i, H04S 5/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04R 3/00; G06F 15/16; H04R 5/02; H04R 5/00; H04H 5/00; H04R 29/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: speaker orientation, roll, pitch, frequency, rotation, stereophonic, monaural, shaping sound, sensor, accelerometer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008-0144864 A1 (GRAEME JOHN HUON) 19 June 2008 See abstract, paragraphs [0217],[0221],[0249],[0283], claim 165 and figures 1-10.	1-30
A	US 05553147 A (JOSEPH E.M. PINEAU) 03 September 1996 See abstract, claims 1,9 and figures 3-10.	1-30
A	US 2007-0003067 A1 (STEFAN GIERL et al.) 04 January 2007 See abstract, paragraphs [0013]-[0018] and claim 23.	1-30
A	US 2002-0124097 A1 (LARSON J. ISELY et al.) 05 September 2002 See abstract, claims 1,8 and figures 1-5.	1-30

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 DECEMBER 2012 (26.12.2012)	**26 DECEMBER 2012 (26.12.2012)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	JEONG, So Yeon Telephone No. 82-42-481-5656

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2012/045894

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008-0144864 A1	19.06.2008	AU 2004-320207 A1	08.12.2005
		EP 1749420 A1	07.02.2007
		EP 1749420 A4	15.10.2008
		WO 2005-117483 A1	08.12.2005
US 05553147 A	03.09.1996	CA 2162567 A1	24.11.1994
		CA 2162567 C	10.04.2001
		CN 1055601 C	16.08.2000
		CN 1126020 A	03.07.1996
		CN 1126020 C0	03.07.1996
		EP 0698334 A1	25.03.1998
		EP 0698334 B1	30.12.1998
		JP 02-961327 B2	06.08.1999
		JP 08-508150 A	27.08.1996
		JP 2961327 B2	12.10.1999
		KR 10-0166662 B1	01.02.1999
		WO 94-27416 A1	24.11.1994
US 2007-0003067 A1	04.01.2007	DE 10110422 A1	19.09.2002
		EP 1241797 A2	18.09.2002
		EP 1241797 A3	05.10.2005
		US 2002-0146134 A1	10.10.2002
		US 7065217 B2	20.06.2006
		US 7889871 B2	15.02.2011
US 2002-0124097 A1	05.09.2002	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
GEORGE CHRISTOPHER N.

HANLEY, FLIGHT & ZIMMERMAN, LLC. 150 S.
WACKER DRIVE, SUITE 2100 CHICAGO IL 60606 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**26 DECEMBER 2012 (26.12.2012)**
Applicant's or agent's file reference 11-0501-PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/045894	**09 JULY 2012 (09.07.2012)**	19 JULY 2011 (19.07.2011)

International Patent Classification (IPC) or both national classification and IPC

H04R 3/00(2006.01)i, H04R 5/02(2006.01)i, H04S 5/02(2006.01)i

Applicant

SONOS, INC. et al

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

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For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	26 DECEMBER 2012 (26.12.2012)	JEONG, So Yeon Telephone No.82-42-481-5656

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/045894

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

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      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/045894

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-30	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	1-30	YES
	Claims	NONE	NO
Industrial applicability (IA)	Claims	1-30	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2008-0144864 A1 (GRAEME JOHN HUON) 19 June 2008
D2: US 05553147 A (JOSEPH E.M. PINEAU) 03 September 1996
D3: US 2007-0003067 A1 (STEFAN GIERL et al.) 04 January 2007
D4: US 2002-0124097 A1 (LARSON J. ISELY et al.) 05 September 2002

1. Novelty and Inventive Step

1.1 Concerning Claims 1-10

The subject matter of claim 1 differs from these prior art documents in that a method for shaping sound comprises configuring the playback device to reproduce a stereophonic or monaural sound using a plurality of speakers based on an orientation and an audio data stream. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claim 1 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Claims 2-10 are dependent on claim 1 and therefore meet the requirements of PCT Article 33(2) and (3).

1.2 Concerning Claims 11-20

The subject matter of claim 11 differs from these prior art documents in that a tangible computer readable storage medium including a set of instructions for execution by processor when executed implement a method for shaping sound comprises a playback device reproduces a stereophonic or monaural sound using a plurality of speakers based on an orientation and an audio data stream. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claim 11 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Claims 12-20 are dependent on claim 11 and therefore meet the requirements of PCT Article 33(2) and (3).

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Box V

1.3 Concerning Claims 21-30

Since the apparatus and the method of claims 21 and 1 are substantially same except the category aspect, claim 21 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Claims 22-30 are dependent on claim 21 and therefore meet the requirements of PCT Article 33(2) and (3).

2. Industrial Applicability

Claims 1-30 are industrially applicable under PCT Article 33(4).

Electronic Acknowledgement Receipt

EFS ID:	25237444
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	18-MAR-2016
Filing Date:	17-APR-2013
Time Stamp:	15:47:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS.pdf	1055891 99a6bb720f1f388d31dc25892cacf4ce08a24c54	no	7

Warnings:	
Information:	

2	Foreign Reference	JP2002-111817_EFS.pdf	1257794 3d40587cd556374f08d7a24dce1cd5341f42768c	no	23
Warnings:					
Information:					
3	Foreign Reference	JP2002123267A.pdf	1142650 d973c970470e2f10394d4a717e65dc8a5bbbcd31	no	20
Warnings:					
Information:					
4	Foreign Reference	JP2005-136457_EFS.pdf	500771 6bd05fde776373b1e0285d145896f1c124e01ac4	no	13
Warnings:					
Information:					
5	Foreign Reference	JP2007241652A.pdf	757694 b11416f3d9a7b4362836f219a73539d2234a7da8	no	19
Warnings:					
Information:					
6	Foreign Reference	JP2009-135750_EFS.pdf	898894 56c3b9f4768ca88451df9e194ed0014a034bc1dd	no	18
Warnings:					
Information:					
7	Foreign Reference	JP2009506603.pdf	1735260 c271278bf877a4edd6299ffa3ca942efd1b82069	no	26
Warnings:					
Information:					
8	Foreign Reference	JP2009538006A.pdf	780949 58eb6213f43d027560b2f620c1b0c79f46fff66c	no	32
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Information:					
9	Foreign Reference	JP2011-130496_EFS.pdf	558338 0e00194241fac1e7fd7510c43a4b4c3704790df9	no	12
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Information:					
10	Foreign Reference	WO2007023120A1.pdf	1574651 e190d69e8ea31b006ac1311207c60121cd28b598	no	33
Warnings:					
Information:					

11	Foreign Reference	WO2008114389.pdf	1149796 504f681538790f754ba2b307b8e2fd4c7077457c	no	27
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Information:					
12	Foreign Reference	WO2012050927.pdf	21146172 0cc60d7a591c6fc5361e2caf623289fdb5939baa	no	386
Warnings:					
Information:					
13	Non Patent Literature	13871795_AA_02-10-2016.pdf	199493 eff127b44da2d4c0ad3ae2167a6d29dc0fd0f1bd	no	3
Warnings:					
Information:					
14	Non Patent Literature	EP_SearchReport_13810340_3_03-07-2016.pdf	305975 921d9e5c4cfbfe3cf521aa12e94c2763d841822c	no	9
Warnings:					
Information:					
15	Non Patent Literature	13871795_Final_OA_02-24-2016.pdf	919684 56cd03882a6726c686c523c8ec17cf5163d213ea	no	28
Warnings:					
Information:					
16	Non Patent Literature	Horwitz_Ref_2013.pdf	1041654 4c8854b087257eb517c846c07539d1e9f510ad24	no	5
Warnings:					
Information:					
17	Non Patent Literature	IPRP_PCTIB2012045894_01-30-14.PDF	203266 7f11126a42ea767ff6a1811b6b35feb0afa162ef	no	6
Warnings:					
Information:					
18	Non Patent Literature	ISR_PCTUS2012045894_12-26-12.pdf	94148 1b81a8f19df487d09e193d7b87d8badc0f7f6a52	no	3
Warnings:					
Information:					
19	Non Patent Literature	PCTUS2012045894_Written_Opinion_12-26-12.pdf	99988 b7a29f654e3f813d6d525b45740c4010bb46c87e	no	4
Warnings:					
Information:					

20	Non Patent Literature	Japanese_No_2015-520286_Office_Action_2-2-16.pdf	175340 0e47d259cd9451558c346bb95eca9c679fee7cb5	no	6
Warnings:					
Information:					
21	Non Patent Literature	Japanese_No_2014-521648_Rejection_Notice_2015-02-03.pdf	316846 0acd94225b68c056cc806c5475d31f0e956a308d	no	7
Warnings:					
Information:					
22	Non Patent Literature	Roland_Ref_2011.pdf	78782 299206975a7fa679355cd22aef307e89f51ada01	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	35994036	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13864249
Filing Date	2013-04-17
First Named Inventor	NICHOLAS; A. J. Millington
Art Unit	2442
Examiner Name	SURVILLO, OLEG
Attorney Docket Number	13-0402 (MBHB 15-518-CON)

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5533021		1996-07-02	BRANSTAD; Mark W. et al.	
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	Application Number	13864249
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	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

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(54) Audio-video synchronizing

(57) A method and apparatus for synchronizing playback of audio and video frames from a program source associates an audio presentation time stamp ("PTS") value with an output audio frame. Selected ones of audio and video data packets include respective audio and video PTS values representing desired playback times of the respective audio and data associated therewith. The selected ones of the audio data packets further include audio frame numbers representing a number of output frames of audio to be played back between the selected ones of the audio data packets. The method comprises storing the audio and video PTS values in respective audio and video PTS tables (302, 304) during an audio demultiplexing process. In addition, the audio frame numbers are stored in frame counters (309) in association with respective PTS values during the demultiplexing process. Thereafter, the process sequentially decodes the audio and video input data to produce respective frames of audio and video which are presented to the user. With the presentation of each audio and video frame, the respective audio and video frame counters (309) are selectively decremented. Upon detecting one of the audio frame counters having a zero value, the audio PTS value for that zero value audio frame counter is retrieved. Thereafter, the playback of the audio and video frames is selectively modified so that frames of audio and video are played back in synchronization.

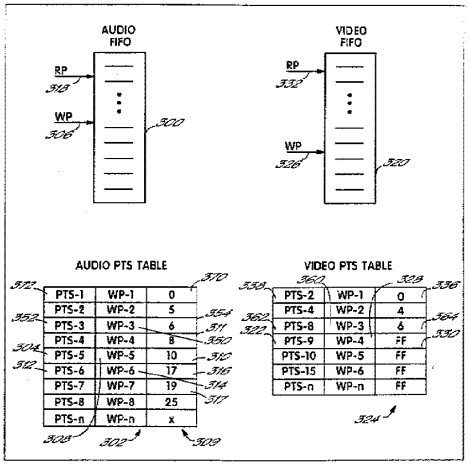


FIG. 4

EP 0 895 427 A2

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Description

[0001] This invention relates to audio-video synchronizing. A preferred form of implementation of the invention described hereinbelow relates to the digital processing of video to be displayed on a television screen and, more particularly, to digitally synchronizing the audio and video being output to a video display.

[0002] Almost all televisions manufactured today are capable of interfacing with different sources of program materials, for example a VCR, a digital versatile or video disk ("DVD") player, cable, DSS, etc., that provide audio signals for creating sounds and associated video input signals for creating screen displays. Some of those sources provide digital audio and video input signals in accordance with the Moving Picture Expert Group MPEG-2 audio/video digital compression standard. Thus, contemporary televisions and/or DVD systems preferably have the capability of processing compressed digital input signals and providing digital output signals representing the desired images. Most often, those digital signals are converted to analog signals for use by known analog television display units.

[0003] The implementation of digital signal processing for providing a video display and associated audio from an audio-video source of program material presents numerous design challenges that were not encountered in the prior processing of analog audio and video signals. For example, with digital signal processing, the audio signals are separated from the video signals; and the audio and video are processed independently. However, the playback of the audio and video must be synchronized, so that there is a coordinated and coherent reproduction of the desired audio and video provided by the source of program material.

[0004] The program source preferably provides the audio and video data in respective data packets in an "MPEG-2" format. Each of the audio and video data pockets is received from the source of video material in a continuous data stream. Each packet of video data includes a header block followed by a data block. The data block may include any number, for example one to twenty, of frames of video data that may include a full field of video data or be a coded group of pictures that includes its own header block identifying the picture type and display order. The header block for a video data packet includes control information, for example, the identity of the format of the video data, the type of compression, if used, picture size, display order, and other global parameters. The audio data packet has a header block that again identifies the format of the audio data with instructions relating to how the audio data is to be decoded and processed to provide desired enhancements, if applicable. Following the header block, the audio data packet includes an audio data block that has any number of blocks or frames of audio data, for example, from one to approximately twenty blocks.

[0005] Selected ones of the header blocks of the audio and video data packets include a presentation time stamp ("PTS") value which is a time stamp that is applicable to that data packet. The PTS value is a time reference to a system time clock that was running during the creation or recording of the audio and video data. A similar system time clock is also running during the playback of the audio and video data, and if the audio and video data are played back at the times represented by their presentation time stamps, the audio and video data will be presented to the user in the desired synchronized manner. Therefore, the PTS is used to synchronize the presentation or playback of the audio and video data.

[0006] During the decoding of the audio data, it normally must be decompressed, reconstructed and enhanced in a manner consistent with the source of program material and the capabilities of the sound reproduction system. In some applications, audio data packets may contain up to six channels of raw audio data. Depending on the number of channels the sound reproduction systems can reproduce, for example, from two to six, the sound reproduction system selectively uses the channels of raw audio data to provide a number of channels of audio which are then stored in an audio FIFO.

[0007] The decoding of the video data normally requires decompression, conversion of partial frames into full frames and the recognition of full frames. Simultaneously with the decoding process, the frames of audio and video data are being output, that is, played back to the user; and that playback must be synchronized such that the frames of audio and video present a coordinated and coherent presentation.

[0008] As will be appreciated from the foregoing, demultiplexing the audio and video data pockets is a complex process of deconstructing the data packets and storing the necessary decoding instructions as well as the content data itself to permit the decoding and playback of the data in a synchronized manner. In accordance with one known technique the audio and video content data or raw data is stored in respective audio and video first-in, first-out ("FIFO") memories. The FIFOs have write and read pointers that are controlled by a memory controller, which, in turn, is under the general control of a CPU. The write pointers are driven as a function of the requirements of the demultiplexing process, which sequentially delivers data to each of the FIFOs. The read pointers are driven as a function of independent and parallel decoding processes, which sequentially read data from the FIFOs. In addition to loading the raw data into the FIFOs, the demultiplexing process sequentially writes the associated PTS values, if present, into memory locations in respective audio and video PTS tables. To associate the PTS values with data in the FIFOs, in addition to a PTS value, the location in the respective FIFO of the first byte of data received after the PTS, is typically written into the respective audio and video PTS table.

[0009] While the audio and video data is being loaded

into the FIFO memories by the demultiplexing process, audio and video data is simultaneously and in parallel being read from the respective FIFOs during audio and video decoding and playback processes. While both are occurring, a supervisory process must monitor the time synchronization of the video and audio data being produced by the video and audio decoding processes. In the known technique described above, this is done by relating the read pointers in the FIFOs, as they are driven by the decoding processes, to the memory locations stored in the PTS tables. When the read pointer is sufficiently close to a stored location associated with a PTS, it can be determined that the PTS identifies the current time of the associated decoding process. PTS values identified in this manner may be compared to determine whether one decoding process is ahead or behind of another.

[0010] Unfortunately, this approach has distinct disadvantages which arise from the fact that, during the audio and video decoding processes, the read pointers for the respective FIFOs are automatically and continuously driven by decoding processes interacting directly with the memory controller independent of any instructions from the CPU. This must be the case because the entire process of demultiplexing audio and video data, as well as decoding and outputting the data must occur continuously in a synchronized manner.

[0011] The above-described technique for synchronizing the audio and video decoding and playback processes presents a significant challenge, due to delays inherent in the interaction of the supervisory process with the various decoding processes. Considering, for example, the decoding of audio data, assume that the audio decoder delivers a start audio frame interrupt to the CPU running the supervisory process each time decoding of an audio frame commences. At the start of an audio frame, the supervisory process must associate the data currently being read from the audio FIFO with its corresponding presentation time stamp ("PTS"), that is, the PTS value that was loaded in the audio PTS table when the data currently being read was written into the audio FIFO. Theoretically, if the location of the read pointer at the beginning of the audio frame is known, that location can be compared with the write pointer locations that were stored in the PTS table during the demultiplexing process. If a correspondence between the current read pointer location and a stored write pointer location can be found, then the PTS associated with the stored write pointer corresponds to the PTS of the audio data currently being identified by the read pointer. If the PTS value for the data being read can accurately be determined, then the decoding and playback processes may be instructed in the known manner to skip or repeat frames in order to provide a synchronized output of frames of the audio and video.

[0012] However, there are two conditions which may result in the above process, on occasion, failing to achieve synchronization in the playback of the audio and video data. The first condition arises because the CPU running the supervisory process must time share between supervision of the audio and video decoding process, and the demultiplexing process. Accordingly, the CPU must respond to each supervised process using prioritized interrupt based communication scheme. Further, the CPU communicates with the memory controller and other functional units over a shared, time multiplexed communication bus or channel. Therefore, when a start audio frame interrupt is received by the CPU, it may not be processed immediately because the CPU is processing other interrupts of an equal or higher priority. Further, even if the CPU services the start audio frame interrupt immediately, it must then communicate with the memory controller over the time multiplexed bus. Access to the bus is arbitrated and the CPU may not have the highest priority. However, during the delay in first, processing the start audio frame interrupt and second, communicating with the memory controller over the time multiplexed bus, the decoding process for the audio data FIFO continues to read audio data from the FIFO. Therefore, when the start audio frame interrupt is serviced by the CPU and the CPU is able to communicate with the memory controller, the location of the audio data FIFO read pointer obtained by the CPU will normally be different from its location when the start audio frame interrupt was initially received by the CPU. Thus, when the CPU responds to the interrupt and obtains the current read pointer for the audio FIFO from the memory controller, the read pointer will no longer have the value it had at the time the interrupt was generated. Therefore, the result of the delay is some inaccuracy in the identity of read pointer location obtained by the CPU.

[0013] The second condition of concern is that the audio packets being read may be small and processed very quickly. Therefore, the PTS table may have two PTS entries with FIFO location values that are very close. Hence, when an inaccurate read pointer location is compared to the write pointer location values in the PTS table, an incorrect PTS entry may be associated with the start of the audio frame being decoded. Thus, there will arise a small loss of synchronization between the presentation of the audio and video frames. A single occurrence of the above event might not be detectable by the user. However, if the time to service start audio frame interrupt is longer and the processing time required for the audio data packet is very short, or if several such audio data packets occur successively, the loss of synchronization may be greater. Furthermore, the loss of synchronization in the audio process is cumulative of losses of synchronization in other decoding processes. Thus, accumulated loss of synchronization can occur to the point where the loss of synchronization is disturbing or perceptible to the user.

[0014] Consequently, in a system such as that described above, there is a need to improve the association of stored PTS values (stored, for example, in PTS tables) with the audio and video data being read from

storage (for example from respective FIFO memories) during the decoding process.

[0015] First to third aspects of the present invention are set forth in claims 1, 32 and 33 hereof, respectively.

[0016] A preferred form of implementation of the present invention described hereinbelow provides a method and apparatus for improving the synchronization of the playback of the audio and video frames from a program source. The preferred form of implementation of the invention has the further advantage of providing a wide range of flexibility with respect to how the synchronization is implemented. Either the playback of the audio or the playback of the video may be used as a master to which the other is synchronized. In another embodiment, the system time counter is the master and the playback of the frames of audio and video are independently synchronized to the system time counter.

[0017] In accordance with the principles of the present invention and in accordance with the described embodiments, a method is described for associating an audio presentation time stamp ("PTS") value with an output audio frame that is a part of the sequence of audio frames that are derived from demultiplexing and decoding audio input data in respective audio data packets. The frames of audio are played back with frames of video being a part of a sequence of frames of video derived by multiplexing and decoding video data in respective video data packets. Selected ones of the audio and video data packets include respective audio and video PTS values representing desired playback times of the respective audio and data associated therewith. The selected ones of the audio data packets further include audio frame numbers representing a number of output frames of audio to be played back between the selected ones of the audio data packets. The method comprises the steps of first storing the audio and video PTS values in respective audio and video PTS tables during an audio demultiplexing process. In addition, the audio frame numbers are stored in frame counters in association with respective PTS values during the demultiplexing process. Thereafter, the method sequentially decodes the audio and video input data to produce respective frames of audio and video which are presented to the user. With the presentation of each audio frame, the audio frame counters are selectively decremented upon detecting one of the audio frame counters having a zero value, the audio PTS value for that zero value audio frame counter is retrieved. Thereafter, the playback of the audio and video frames is adjusted so that they are played back in synchronization.

[0018] In one aspect of the invention, the playback of the frames of audio is selected to be the master with which the playback of frames of video is synchronized. In that mode, the process establishes an audio clock extension for a system time counter. The audio clock extension has a value equal to the difference between audio PTS value associated with the zero audio frame counter and the current value of a system time counter. Thereafter, the current state of the system time counter is adjusted by the audio clock extension, thereby bringing the system time counter into synchronization with the playback of frames of audio.

[0019] In another aspect of the invention, video PTS values contained in selected ones of the video data packets are stored during a demultiplexing process. Thereafter, at the start of a video decoding process, a number of video frames corresponding to the duration of the video decoding process is stored in respective video frame counters. Upon presenting each of the frames of video, selected ones of the video frame counters are decremented. Upon detecting a video frame counter having a zero value, the system checks to determine whether the video PTS value associated with the zero value video frame counter is equal to the current state of the system time counter plus the audio clock extension. If there is a correspondence between the video PTS value and the value of the system time counter plus the audio clock extension, the audio and video frames are being presented in a synchronized manner.

[0020] In accordance with the further aspect of the invention, if the video PTS values is greater than the value of the current state of the system time counter plus the audio clock extension, the video frames are being presented too fast, and a frame of video is repeated to bring it into closer synchronization with the presentation of the frames of audio.

[0021] In a still further aspect of the invention, the system determines whether the video PTS value associated with the zero value frame counter is less than the value of the current state of the system time counter plus the audio clock extension. That condition indicates that the frames of video are being presented too slowly with respect to the presentation of the frames of audio, and a subsequent frame of video is skipped, thereby bringing the presentation of the frames of video into closer synchronization with the presentation of the frames of audio.

[0022] In accordance with the further embodiment of the invention, the presentation of frames of video is selected to be the master with which the presentation of the frames of audio is synchronized. In that embodiment, a video clock extension to the system time counter is determined as a function of the difference of the video PTS value associated with the video frame counter having a zero value and the current state of the system time counter. In this embodiment, in a manner similar to that described above, an audio PTS value associated with an audio frame counter having a zero value is compared to the current state of the system time counter plus the video clock extension as determined from the video PTS value. If the audio PTS value greater than the current state of the system time counter plus the video clock extension, the audio is being presented too fast with respect to the frames of video; and therefore, a frame of audio is repeated to bring the presentation of audio and video into closer synchronization.

[0023] Similarly, in a further aspect of this embodiment, if it is determined that the audio PTS value associated with the zero audio frame counter is less than the current state of the system time counter plus the video clock extension, the audio is being presented too slow with respect to the video and a subsequent frame of audio is skipped, thereby bringing the audio and video presentations into closer synchronization.

[0024] In a still further embodiment of the invention, neither the playback of audio frames or the playback of video frames is chosen as a master, and thus, no clock extension is determined. Instead the playback of audio and video is compared to the system time counter, and both the audio and the video are independently adjusted by repeating or skipping frames as required to maintain a correspondence to the system time counter. The above methods provide significant flexibility in synchronizing the playback of audio and video frames.

[0025] The invention will now be further described, by way of illustrative and nonlimiting example, with reference to the accompanying drawings, in which:

[0026] Fig. 1 is a schematic block diagram of only those portions of a television utilizing a digital audio-video processor in accordance with the principles of the present invention.

[0027] Fig. 2 is a flow chart illustrating the steps of a portion of the demultiplexing process executed by the demultiplexer in accordance with the principles of the present invention.

[0028] Fig. 3 is a flow chart illustrating the steps of a portion of the demultiplexing process executed by the CPU in accordance with the principles of the present invention.

[0029] Fig. 4 is a schematic block diagram illustrating audio and video FIFOs and tables within the memory of the processor utilized in executing the audio and video processing as illustrated in Fig. 2.

[0030] Fig. 5 is a flow chart illustrating the steps of a portion of an audio decoding process executed by the CPU in accordance with the principles of the present invention.

[0031] Fig. 6 is a flow chart illustrating the steps of a portion of a video decoding process executed by the CPU in accordance with the principles of the present invention.

[0032] Fig. 7 is a flow chart illustrating the steps of portion of a process executed by the CPU for playing back output frames of audio data in accordance with the principles of the present invention.

[0033] Fig. 8 is a flow chart illustrating the steps of a portion of a process executed by the CPU for playing back output frames of video data in accordance with the principles of the present invention.

[0034] Referring to Fig. 1, a television 18 contains a digital audio/video processor 20 that receives on input 22 a continuous serial stream of data packets containing the audio and video information required to create the desired video images. The audio and video data may be provided by any one of several devices, for example, a VCR or DVD player, cable, a DSS receiver, a menu display commanded within the television 18, etc; and the video information may be supplied in any one of several different formats. Normally, the audio and video data packets are provided in the MPEG-2 format.

[0035] The audio and video data packets are received and demultiplexed continuously in independent parallel data streams. Further, the decoding and playback of output frames of audio and video data is also performed continuously in parallel data streams independent of the demultiplexing processes. Further, demultiplexing is a process that varies significantly in real time, depending on the nature of audio and video data being received. In addition, the number of video frames to be presented and their order of presentation cannot be determined from the raw video data being received. The creation of video frames and their order of presentation is a function of the decoding process and is determined primarily by the control data in the header portion of the video data packet. Similarly, the raw audio data being received in the data packet bears little resemblance to the audio data output and presented, and the frames of audio data to be presented are created during the decoding process of the audio data.

[0036] Finally, it should be noted that output audio frames can be of any length in real time, and further, several audio frames may be associated with single video frame, or in contrast, a single audio frame may be presented during video produced by several video frames. However, it is required that the frames of audio and video be played back in a synchronized manner to provide a coordinated and coherent presentation to the user. To facilitate the coordination of the presentation of the frames of audio and video data, selected ones of the audio and video data packets contain a presentation time stamp "PTS", which is a time reference to a system counter that was running during the creation or recording of the audio and video data. A similar system time counter is running in the CPU 26 during the decoding and playback of the frames of audio and video, and audio and video PTS tables are created during the demultiplexing process. If there is perfect synchronization, when the frames of audio and video are output, their stored PTS values will be the same as the current state of the system time counter. However, the differences in the processing of the audio and video data in separate parallel bit streams does not facilitate such precise timing control. Therefore, for that and other reasons, the playback of the frames of audio and video may lose synchronization with the system time counter. The net result is a loss of synchronization in the audio and video being played back to the user.

[0037] Fig. 2 is a flow chart illustrating the general operation of the demultiplexer 19 of Fig. 1. At 202, the input 22 to the multiplexer 19 continuously receives an input bit stream of data containing in random order, audio, video and subpicture data packets. The header block of

data is extracted at 204, and video data packets are identified at 206. A video demultiplexing interrupt is provided at 208 to the CPU 26 (Fig. 1); and at 210, the video data is sequentially stored in a video data first-in, first-out ("FIFO") buffer 320 (Fig. 4) in memory 24. In a similar process, audio data packets are identified at 212, and an audio demultiplexing interrupt is provided at 214 to the CPU 26. At 216, the video data is sequentially stored in a video data FIFO buffer 300 (Fig. 4) in memory 24 (Fig. 1). Subpicture data packets are identified at 218, and a subpicture demultiplexing interrupt is provided at 220 to the CPU 26. At 222, the subpicture data is sequentially stored in a subpicture FIFO buffer (not shown) in memory 24. While the demultiplexer 19 performs other processing, it does not relate to the synchronization of the audio and video and therefore, will not be further described.

[0038] The demultiplexing process continues in the CPU 26 as illustrated in Fig. 3, and Fig. 4 is a schematic representation of how various portions of audio and video data are partitioned in the memory 24 (Fig. 1). In addition to the audio and video data FIFOs 300, 320 (Fig. 4), the memory 24 includes audio and video PTS tables 302, 324. Referring to Fig. 3, at 250, the CPU 26 services the interrupt from the demultiplexer 19 and determines at 252 whether the interrupt is for an audio PTS interrupt. If so, at 254, the PTS value in the header block of the audio data packet is loaded into audio PTS table 302, for example, at location 304. Further, the location of the write pointer 306 of the FIFO 300 associated with the location of the first byte of audio data loaded in the FIFO 300 is stored in the audio PTS table 302, for example, at location 308.

[0039] As previously mentioned, a PTS is only provided with selected audio data packets, however, those same audio data packets also contain, in their header data, a field having an audio frame number representing the number of frames of audio data to be output between the current PTS in the current audio data packet and the next audio data packet containing a PTS value. Further, the audio PTS table 302 includes frame counters, for example, memory locations at 309. And, during the demultiplexing of an audio data packet having a PTS value, that PTS value is loaded into an appropriate memory location, for example, memory location 304. Further, the number of audio frames until the next PTS value is added to the count in the corresponding frame counter, that is, frame counter 310, and the sum is written into the frame counter associated with the next PTS, that is, frame counter 316. For example, if, in the header block for the PTS loaded in memory location 304, the number of frames to the next audio data packet with a PTS is 7, that number, 7, is added to the current count, 10, in frame counter 310; and the sum, 17, is written the counter location 316 to be associated with the next audio data packet having a PTS value.

[0040] As will subsequently be explained, while the audio demultiplexing process is being executed, the process of decoding and playing back output audio frames is also running simultaneously and in parallel with the demultiplexing process. Further, with the output of each audio frame, the audio playback process decrements all of the frame counters in the audio PTS table 302. Therefore, when the count for the next PTS is loaded into location 316, the count loaded into location 310 most probably has been decremented from its original value. Consequently, as will be appreciated, the values in the frame counters 309 of the audio PTS table 302 are continuously changing as audio data packets are being demultiplexed and audio data is written into the FIFO 300, and in a simultaneously running parallel process, the audio data is also being read from the FIFO 300, decoded into output audio frames and output to the user.

[0041] If, at 256 of Fig. 3, the CPU 26 determines whether the interrupt is for a video PTS. If so, at 258, the video PTS value is sequentially stored in video PTS table 324 (Fig. 4) at, for example, location 322. Further, the location of the write pointer 326 of the video FIFO 320 when it stores the first byte of video data for that packet is written into video PTS table 324, for example, at location 328. The video PTS table 324 also has a frame counter, and during the demultiplexing process, the CPU sets a frame counter location, for example, location 330, associated with the PTS in location 322, to a non-functional value, for example, FF in hexadecimal notation.

[0042] If, at 260 of Fig. 3, the CPU determines that the interrupt is for a subpicture PTS; at 262, the CPU stores the subpicture PTS into an internal register (not shown). A PTS value is included with every subpicture data packet, and the corresponding subpicture is output when the system time clock equals the stored PTS. As subpicture synchronization is not as critical as audio/video synchronization, processing of the subpicture data will not be discussed further.

[0043] After servicing a demultiplexing interrupt, the demultiplexing process as described with respect to Figs. 1-4 continues in a similar manner. Raw audio data in the next audio data packet is sequentially loaded into the audio FIFO 300. If the next audio data packet does not have a PTS in its header block, a PTS entry is not made to the audio PTS table 302. If, however, the next audio data packet contains a PTS, that PTS is written into table 302, for example, at location 312. The write pointer location at which the write pointer 306 loads the first audio data for the current audio data packet into FIFO 300 is loaded into location 314. In addition, the number of frames of audio data between the current PTS and the next PTS is added to the count in counter location 316 and loaded into the frame counter location 317. Further, with each successive video data packet, the raw video data is sequentially loaded in the video FIFO 320; and if appropriate, PTS values are loaded in the video PTS table 324 with the respective write pointer locations. The demultiplexing process of the audio, vid-

eo and subpicture data packets proceeds in the same sequential manner to load the respective FIFOs and PTS tables with the appropriate data.

[0044] As will be appreciated, during the demultiplexing process, data is written into the respective audio and video FIFOs 300, 320 as a function of the requirements of the demultiplexing process. Further, during the demultiplexing process, the PTS values are disassociated with their respective audio and video data and stored in the respective PTS tables 302, 324. In simultaneous, independent and parallel processes, the audio and video data is read from the FIFOs 300, 320, decoded in respective audio and video decoders 25, 23 (Fig. 1) and output to the user. During the decoding process, the read pointers 318, 332 of the respective audio and video FIFOs 300, 320 are being moved automatically and continuously by a controller in the memory 24; and hence, the read pointers are not normally controlled by specific instructions from the CPU. In order to synchronize the playback of frames of audio and video data, during the decoding process, the streams of audio and video data being read from the respective FIFOs 300, 320 must be reassociated with the appropriate PTS values stored in the audio and video PTS tables 302, 324.

[0045] The audio decoding process is initiated by the audio decoder 25 (Fig. 1) detecting the extraction of the head block at 202 of Fig. 2. The audio decoder 25 then provides an audio decode interrupt to the CPU 26 and begins the process of decoding the next audio data packet. When the audio decoder 25 provides the audio decode interrupt to the CPU 26, the continuously moving read pointer 318 (Fig. 4) is identifying the current location from which the audio decoder is reading data from the FIFO 300. However, the CPU 26 must process a great number of interrupts, each having a different priority and a different real time requirement. Therefore, if the CPU 26 is processing interrupts having a higher priority than the audio decoder interrupt, there is a delay before the audio decoder interrupt can be serviced. Further, the CPU communicates with a memory controller in memory 24 and other functional units over a shared, time multiplexed communication bus or channel 29. Access to the bus is arbitrated, and the CPU may not have the highest priority. However, during the delay in first, processing the start audio frame interrupt and second, communicating with the memory controller over the time multiplexed bus 29, the audio decoder 25 is continuing to read audio data from the audio FIFO 300, and the read pointer 318 is continuously moving.

[0046] Eventually, at 400 of Fig. 5, the CPU services the audio decode interrupt; and at 402, the CPU 26 reads the current location value of the read pointer 318. However, the current location of the read pointer 318 is different from the location of the read pointer 318 when the audio decode interrupt was first provided to the CPU 26. Next, at 404, the CPU 26 scans all of the write pointer locations stored in the audio PTS table 302 to find a write pointer value that is closest to the current read pointer value, for example, at location 350 (Fig.4). The closest write pointer value is then subtracted at 408 from the current read pointer value, and the difference is tested at 410 against a maximum allowable difference value. The maximum allowable difference value is a function of the expected motion of the read pointer 318 during a maximum time delay of the CPU 26 in responding to the audio decode interrupt at 400.

[0047] If, at 410, the difference between the closest write pointer value in location 350 and the current read pointer value is equal to or greater than the maximum allowable difference value, it is concluded that there is no PTS value, including the PTS value in location 352 of table 302, associated with the audio data currently being read by the read pointer 318. If, at 410, the difference is less the maximum allowable difference value, the PTS value in location 352 associated with the identified write pointer value in location 350 is determined to be associated with the audio data being currently read by read pointer 318.

[0048] Then, at 412, the value in the frame counter 354 associated with the closest read pointer value in location 350 is evaluated to determine whether it is approximately equal to the duration or time, that is, the length, of the audio decoding process as measured in terms of number of audio frames. The real time required to decode frames of audio data can be predicted with reasonable accuracy. Further, that period of decoding time can also be calibrated or dimensioned in terms of the number of audio frames of data being decoded. Since the frame counters are decremented with each frame of audio data being output, it can be expected that the frame counter value will be equal to the number of audio frames of decoder delay. Therefore, if the value in the counter location 354 of the PTS table 302 is approximately equal to the expected delay in decoding the current audio data, at the end of that decoding process, the audio data being played back should correspond to the PTS value in the table 302 that has a zero counter value.

[0049] However, it is possible that during the decoding process a bit error occurs, and therefore, at 412, it will be determined that the counter value is not approximately equal to the number audio frames of the duration of the audio decoding process. In that event, at 414, the counter value in location 354 is modified and set to the number of audio frames of decoder delay. Hence, with each iteration through the process, any erroneous value in one of the frame counters can be detected and corrected. Alternatively, in addition to changing the value in the one frame counter, the values in the other frame counters below location 354 in the audio PTS table 302 are modified by the same incremental modification that was made to the counter location 354. In summary, during the multiplexing process, the PTS value was disassociated from the audio data in the FIFO 300; but the CPU responds to interrupts during the decoding by re-establishing the association between audio data being

read from the FIFO 300 and PTS values in the audio PTS table 302.

[0050] Referring to Fig. 6, the video decoding process runs independently, continuously and in parallel with the audio decoding process as well as the video demultiplexing process. The audio decoder 25 (Fig. 1) initiates the audio decoding process; however, in contrast, the CPU 26 initiates the video decoding process. At 500 of Fig. 6, the CPU detects video header that was extracted from the video data packet at 204 of Fig. 2. Thereafter, the video decoding process is functionally similar to the audio decoding process, and at 502, the CPU must read the current location of the read pointer 332 (Fig. 4) of the video FIFO 320. As previously described, this operation is subject to delays encountered in the CPU 26 (Fig. 1) accessing the memory controller in memory 24 over the multiplexed communication bus 29 connected therebetween. Therefore, the read pointer 332 associated with the video data FIFO 320 will have moved from the point in time at which the CPU provided an instruction to read the pointer location and the point in time at which the current read pointer is identified by the CPU. Thereafter, at 506, the CPU finds the closest write pointer in the video PTS table 324, for example, the write pointer in location 360 corresponding to the value of the read pointer location. The difference between the values of current read pointer location and closest write pointer location is determined at 508, and at 510, that difference is compared to a maximum value. As with the audio decoding process, the maximum value is a function of the delay in the CPU 26 determining the current location of the read pointer 332.

[0051] If the difference is equal to or exceeds the maximum value it is concluded that the video data associated with the current value of the read pointer does not have a corresponding PTS value stored in the video table 324. However, if the difference between the values of the closest write pointer and the current read pointer values is less than the maximum value, the PTS value in location 362 associated with the closest write pointer value in location 360 is determined to be associated with the video data being read by the read pointer 332. Further, at 512, the counter value at location 364 of the video PTS table 324 is set to a value equal to the delay in the video decoding process as measured in terms of the number of frames of video data being decoded. As with the audio data, the real time required to decode the video data is predictable with reasonable accuracy. Further, the time required to process the video data associated with the current location of the read pointer can be calibrated or dimensioned in units corresponding to the number of frames of video data Therefore, the number frames of video data expected to be processed through the video decoder 23 prior to the video data associated with the current position of the read pointer being played back from the video decoder is loaded in the counter location 364 of the video PTS table 324. Thereafter, at 514, the CPU 26 provides a command to the video decoder 23 to initiate the video decoding process.

[0052] As described above, audio and video data is being continuously read from the respective audio and video FIFOs 300, 320 (Fig. 4); and the read data is being continuously but independently processed in parallel by the respective audio and video decoders 25, 23 (Fig. 1). During the audio decoding process, the audio decoder 25 will create an audio frame that is ready to be output to the user. At that time, the audio decoder 25 provides an audio frame interrupt to the CPU 26 and thereafter, immediately proceeds to start the playback of the audio frame. Referring to Fig. 7, the CPU 26 at 600 services the audio frame interrupt, and at 602, proceeds to decrement by one all of the frame counters 309 in the audio PTS table 302 (Fig. 4). Next at 604, the CPU 26 determines whether any frame counter state is equal to zero. If a zero value is found, for example, in counter location 370, the CPU 26 then at 606 retrieves the audio PTS value associated with the zero counter value, for example, from memory location 372.

[0053] When a counter state is found to be zero, the CPU 26 at 608, then determines whether the audio has been selected to be the master. There are several different approaches to providing audio/video synchronization. As earlier described, a system time counter is running in the CPU 26 during the playback of the audio and video frames. If there is perfect synchronization, when the frames of audio and video are output, their stored PTS values will be the same as the current state of the system time counter. However, during playback, either one of the audio or video streams of output frames may lose synchronization with the system time counter and hence, with each other. One approach to synchronization is to choose the audio to be a master and synchronize the video to the audio. A second approach is to choose the video to be a master and synchronize the audio to the video. A third approach is to synchronize both the audio and video to the system time counter. There are perceived advantages and disadvantages to each approach depending on the source of program material, the format of the program material, other capabilities of the audio/video processor, etc. Normally, the selection of an audio, video or no master is a system parameter that may be selected by the manufacturer of the television unit. Alternatively, the selection could also be provided to the user. In other applications, the master could be dynamically chosen by the audio/video processor.

[0054] If at 608 of Fig. 7, the CPU 26 determines that the audio is the master, the CPU creates at 610 an extension or offset for the system time counter equal to the difference between the current value of the system time counter and the PTS value associated with the zero counter value, that is, for example, the PTS value in table location 372. This system time clock extension is used in synchronizing video, as discussed below. If at 608, the CPU determines that the audio is not the master, then at 612, the CPU determines whether the PTS

value associated with the PTS table counter having a zero value is within a certain range of the current value of the system counter added to the current system time clock extension. If video master mode is used, the video playback process will create and update values for the system time clock extension (in a manner similar to that described above at 608 with respect to the audio master). However, if neither the audio or the video is chosen as master, the system time clock extension will have a zero value. In step 612, the selected PTS is compared to the current value of the system time clock, added to the system time clock extension, plus a constant, limit factor. For the audio, the magnitude of the limit factor is approximately equal to the delay of the CPU in responding the PTS interrupt as well as the delay in communicating with the memory controller plus an acceptable degree of error in audio-video synchronization.

[0055] If at 612, the PTS value from the PTS table 302 is greater than the current value of the system time counter plus its extension and plus the limit factor, that means that the audio frames are being played back faster or ahead of when the system is expecting them to be played back. Thus, there is an apparent loss of synchronization between the audio frame and the video frame being presented. To correct that loss of synchronization, the CPU 26 at 614 provides instructions to the audio decoder 25 to repeat an audio frame. Repeating an audio frame while permitting the video frames to proceed through their natural progression permits the audio frames to slide back in time and regain their synchronization with the video frames.

[0056] If the comparison at 612 is negative, the CPU 26 then at 616 determines whether the PTS value from the PTS table 302 is less than the current value of the system time counter plus its extension and minus the limit factor. If so, that means that the audio frames are being played back slower or behind of when the system time counter is expecting them to be played back. To correct that loss of synchronization, the CPU 26 at 618 provides instructions to the audio decoder 25 to skip an audio frame. Skipping the audio frame while permitting the video frames to proceed through their natural progression permits the audio frames to slide forward in time and regain their synchronization with the video frames.

[0057] Referring to Fig. 8, except for its initiation, the video frame output process is similar to the audio frame output process of Fig. 7. At 700, the CPU 26 services an interrupt created from the raster scanning process which controls the playback of the video frames. After servicing the interrupt at 700, the CPU 26 then at 702 initializes various internal registers for video playback. Next, at 704, the CPU 26 decrements all of the frame counters, for example, frame counters 336, 364, etc.; but the CPU does not decrement the video frame counters having an FF value. Then at 708, the CPU determines whether any of those frame counters have a zero value. If a zero counter value is found, for example, at location of 336, then at 710, the CPU retrieves that video PTS value.

[0058] If at 712 of Fig. 8, the CPU 26 determines that the video is the master, the CPU creates at 714 an extension or offset for the system time counter equal to the difference between the current value of the system time counter and the video PTS value associated with the zero counter value, that is, for example, the PTS value in table location 338. If at 712, the CPU determines that the video is not the master, then at 716, the CPU determines whether the video PTS value associated with the PTS table counter having a zero value is within a certain range of the current value of the system counter. At 716, the CPU determines whether the video PTS value from the PTS table location 338 is greater than the current value of the system time counter plus its extension and plus a limit factor. In the case of video, the limit factor is chosen to be approximately equal to one-half the duration of the shortest video frame. If the comparison at step 716 is true, that means that the video frames are being played back faster or ahead of when the system is expecting them to be played back. To correct that loss of synchronization, the CPU 26 at 718 provides instructions to the video decoder 23 to repeat a video frame. Repeating the video frame while permitting the audio frames to proceed through their natural progression permits the video frames to slide back in time and regain their synchronization with the audio frames.

[0059] If the comparison at 716 is false, the CPU 26 then at 720 determines whether the PTS value from the PTS table location 338 is less than the current value of the system time counter plus its extension and minus the limit factor. If so, that means that the video frames are being played back slower or behind of when the system time counter is expecting them to be played back. To correct that loss of synchronization, the CPU 26 at 722 provides instructions to the video decoder 23 to skip a video frame. Skipping the video frame while permitting the audio frames to proceed through their natural progression permits the video frames to slide forward in time and regain their synchronization with the audio frames.

[0060] Thus, the audio and video output processes operate in parallel continuously and independently to provide synchronized audio and video presentations to the user. During that process, the PTS of the video frame being presented is compared to the PTS of the currently presented audio frame; and if any loss of synchronization is detected, a video frame is repeated or skipped to regain synchronization.

[0061] The system described above has a significant advantage over the prior system previously described herein. With the prior system, delays in servicing the audio PTS interrupt in combination with audio data packets that could be processed very quickly had the potential of selecting the wrong audio PTS value from the audio PTS table. In such a case, a wrong audio PTS value would be associated with the audio data being read from

the audio data FIFO. With the prior system, the counters in the audio PTS table 302 operate the same as the video counters described with respect to Fig. 6 herein. Thus, the audio PTS table counter locations 309 are, during the audio decoding process loaded with a number of audio frames corresponding to the audio decoder time. Therefore, in the prior system if the wrong audio PTS value were chosen from the PTS table, after the decoding delay, that erroneous choice would cause an erroneous frame counter value to be stored in table 302. Further, that erroneous PTS value would then be used in an attempt to synchronize the playback of the audio and video and might result in a perceptible loss of synchronization between the audio and video being presented to the user.

[0062] With the present system, the known number of audio frames provided in the header information of the audio data packet is used in generating the frame counters in the audio PTS table 302 along with an associated PTS value as part of the demultiplexing process. Further, during the decoding process with the output of each audio frame, the frame counter is decremented, and therefore, the number of audio frames being decoded and output with respect to each PTS value in the audio PTS table 302 is accurately tracked during the decoding process of each audio data packet. This is a far more accurate approach to associating a PTS value with decoded data being output, than the prior method of comparing memory pointers to identify a PTS value. Accordingly, with the present system, memory pointer comparisons are only used to check whether the audio PTS table counter values are approximately equal to the audio decoder delay to correct bit errors should any occur.

[0063] With the present system, by using the audio frame number from the header to lock the PTS values of the decoding process to the audio frame counter in the CPU, the coordination of the audio PTS values with demultiplexed audio data can be maintained very accurately throughout the playback process. The header portion of the video data packet does not contain similar information with respect to the number of video frames to be expected between PTS values. However, with the present system, since the audio frame presentation is very precise, adjusting the audio and video synchronization pursuant to the processes of Figs. 7 and 8 provides a highly synchronized audio and video presentation to the user that conforms very closely to the desired playback.

[0064] While the invention has been illustrated by the description of a preferred embodiment and while the embodiment has been described in considerable detail, there is no intention to restrict nor in any way limit the scope of the amended claims to such detail. Additional advantages and modifications will readily appear to those who are skilled in the art. For example, the header block of an audio data packet that has a PTS value also includes the number of bytes of audio data between successive audio PTS values, in other words, the number of bytes of audio data in the current data packet plus the number of bytes of audio data in successive audio data packets until the next data packet having an audio PTS value. This data can be stored in the write pointer location instead of storing the write pointer locations in the audio and video PTS tables 302, 324.

[0065] In Fig. 4, the frame counter values are created by adding the number of audio frames from the header block of the audio data packet to the value in the prior counter and the sum is written into the counter associated with the current PTS value. Further, all of the frame counter values are decremented by one with the output of each audio frame. Alternatively, the number of audio frames from the the header block of the audio data packet may be written into the frame counter; however in this case, only the currently active counter is decremented in response to the output of an audio frame. When that counter reaches zero, then the next counter is decremented.

[0066] As described, the audio/video synchronization is normally performed with respect to the system time counter in the system. The system time counter is a counter that, when operated in the playback of audio and video data, provides counter states that are directly related to PTS values. The synchronization may be performed using any other counter or clock that has respective counter or clock states that are correlated to the PTS values. Therefore, the invention in its broadest aspects is not limited to the specific details shown and described. Consequently, departures may be made from the details described herein without departing from the scope of the claims which follow.

Claims

1. A method for associating an audio presentation time stamp ("PTS") value with an output frame of audio being a part of a sequence of frames of audio derived by demultiplexing and decoding audio input data in respective audio data packets, the output frames of audio being played back with output frames of video being a part of a sequence of frames of video are derived by multiplexing and decoding video data in respective video data packets, selected ones of the audio and video data packets include respective audio and video PTS values representing desired playback times of the respective audio and video data associated therewith, the selected ones of the audio data packets further including audio frame numbers representing a number of output frames of audio to be played back between the selected ones of the audio data packets, the method comprising the steps of:

    storing the audio and video PTS values contained in the selected ones of the respective au-

dio and video data packets during respective audio and video demultiplexing processes;
storing audio frame numbers in respective audio frame counters during the audio demultiplexing process, each of the audio frame counters being associated with one of the stored audio PTS values;
sequentially decoding the audio and video data in the selected ones of the respective audio and video data packets to produce the frames of audio and video, respectively;
providing a simultaneous playback of the frames of audio and video to the user;
selectively decrementing the audio frame counters in response to presenting each of the frames of audio;
detecting one of the audio frame counters having a zero value; and if so,
retrieving the audio PTS value corresponding to the one of the audio frame counters; and
selectively modifying the playback of the frames of audio and video to synchronize the presentation of the audio and video to the user.

2. The method of claim 1 further comprising after the step of retrieving the audio PTS value, the steps of:

providing a audio clock extension for a system time counter approximately equal to a difference between an audio PTS value associated with the one of the audio frame counters and a current value of the system time counter; and
adjusting a current state of the system time counter by the audio clock extension, thereby bringing the system time counter in synchronization with the playback of the frames of audio.

3. The method of claim 2 further comprising the steps of:

storing at the start of a video decoding process for the selected ones of the video data packets, a number of video frames in respective video frame counters, the number of video frames representing a time duration approximately equal to a duration of the video decoding process;
decrementing all of the video frame counters in response to presenting each of the frames of video;
detecting one of the video frame counters having a zero value; and if so,
retrieving the video PTS value corresponding to the one of the video frame counters; and
determining a video PTS value associated with the one of the video frame counters to be approximately equal to the current state of the system time counter plus the audio clock extension, thereby determining that the frames of audio and video are in synchronization.

4. The method of claim 3 further comprising the steps of:

determining in response to the one of the video frame counters having a zero value that the frames of video are currently being presented to the user too fast and out of synchronization with the frames of audio currently being presented to the user; and
repeating a frame of video to bring the frames of video into closer synchronization with the presentation of the frames of audio.

5. The method of claim 4 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be greater than the current state of the system time counter plus the audio clock extension, thereby indicating that the frames of video are being presented too fast with respect to the presentation of the frames of audio.

6. The method of claim 5 further comprising the steps of:

determining in response to the one of the video frame counters having a zero value that the frames of video are currently being presented to the user too slowly and out of synchronization with the frames of audio currently being presented to the user; and
skipping a frame of video to bring the frames of video into closer synchronization with the presentation of the frames of audio.

7. The method of claim 6 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be less than the current state of the system time counter plus the audio clock extension, thereby indicating that the frames of video are being presented too slowly with respect to the presentation of the frames of audio.

8. The method of claim 7 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be less than the current state of the system time counter plus the audio clock extension minus a limit factor, the limit factor being determined as a function of the delays in decoding the audio data.

9. The method of claim 8 further comprising the step of detecting the selection of an audio master synchronization determining a synchronization of the playback of frames of video to the playback of

frames of audio.

10. The method of claim 1 further comprising the steps of:

storing at the start of a video decoding process for the selected ones of the video data packets, a number of video frames in respective video frame counters, the number of video frames representing a time duration approximately equal to a duration of the video decoding process;
decrementing all of the video frame counters in response to presenting each of the frames of video;
detecting one of the video frame counters having a zero value; and if so,
retrieving the video PTS value corresponding to the one of the video frame counters;
providing a video clock extension for the system time counter approximately equal to a difference between a video PTS value associated with the one of the video frame counters and a current value of the system time counter; and
adjusting a current state of the system time counter by the video clock extension, thereby bringing the system time counter in synchronization with the playback of the frames of video.

11. The method of claim 10 further comprising the steps of:

determining in response to the one of the audio frame counters having a zero value that the frames of audio are currently being presented to the user too fast and out of synchronization with the frames of video currently being presented to the user; and
repeating a frame of audio to bring the frames of audio into closer synchronization with the presentation of the frames of video.

12. The method of claim 11 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be greater than the current state of the system time counter plus the video clock extension, thereby indicating that the frames of audio are being presented too fast with respect to the presentation of the frames of video.

13. The method of claim 12 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be greater than the current state of the system time counter plus the video clock extension plus a limit factor, the limit factor being determined as a function of the video frame length.

14. The method of claim 13 further comprising the steps of:

determining in response to the one of the audio frame counters having a zero value that the frames of audio are currently being presented to the user too slowly and out of synchronization with the frames of video currently being presented to the user; and
skipping a frame of audio to bring the frames of audio into closer synchronization with the presentation of the frames of video.

15. The method of claim 14 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be less than the current state of the system time counter plus the video clock extension, thereby indicating that the frames of audio are being presented too slowly with respect to the presentation of the frames of video.

16. The method of claim 15 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be less than the current state of the system time counter plus the video clock extension minus a limit factor, the limit factor being determined as a function of the video frame length.

17. The method of claim 16 wherein the limit factor is approximately equal to approximately one-half of a duration of a shortest video frame.

18. The method of claim 17 further comprising the step of detecting the selection of a video master synchronization determining a synchronization of the playback of frames of audio to the playback of frames of video.

19. The method of claim 11 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be greater than the current state of the system time counter, thereby indicating that the frames of audio are being presented too fast with respect to the presentation of the frames of video.

20. The method of claim 19 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be greater than the current state of the system time counter plus a limit factor, the limit factor being determined as a function of the video frame length.

21. The method of claim 20 further comprising the steps of:

determining in response to the one of the audio

frame counters having a zero value that the frames of audio are currently being presented to the user too slowly and out of synchronization with the frames of video currently being presented to the user; and
skipping a frame of audio to bring the frames of audio into closer synchronization with the presentation of the frames of video.

22. The method of claim 21 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be less than the current state of the system time counter, thereby indicating that the frames of audio are being presented too slowly with respect to the presentation of the frames of video.

23. The method of claim 22 further comprising the step of determining an audio PTS value associated with the one of the audio frame counters to be less than the current state of the system time counter minus a limit factor, the limit factor being determined as a function of the video frame length.

24. The method of claim 23 wherein the limit factor is approximately equal to approximately one-half of a duration of a shortest video frame.

25. The method of claim 24 further comprising the steps of:

determining in response to the one of the video frame counters having a zero value that the frames of video are currently being presented to the user too fast and out of synchronization with the frames of audio currently being presented to the user; and
repeating a frame of video to bring the frames of video into closer synchronization with the presentation of the frames of audio.

26. The method of claim 25 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be greater than the current state of the system time counter, thereby indicating that the frames of video are being presented too fast with respect to the presentation of the frames of audio.

27. The method of claim 26 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be greater than the current state of the system time counter plus a limit factor, the limit factor being determined as a function of the delays in decoding the audio data.

28. The method of claim 27 further comprising the steps of:

determining in response to the one of the video frame counters having a zero value that the frames of video are currently being presented to the user too slowly and out of synchronization with the frames of audio currently being presented to the user; and
skipping a frame of video to bring the frames of video into closer synchronization with the presentation of the frames of audio.

29. The method of claim 28 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be less than the current state of the system time counter, thereby indicating that the frames of video are being presented too slowly with respect to the presentation of the frames of audio.

30. The method of claim 29 further comprising the step of determining a video PTS value associated with the one of the video frame counters to be less than the current state of the system time counter minus a limit factor, the limit factor being determined as a function of the delays in decoding the audio data.

31. The method of claim 32 further comprising the step of detecting the selection of a no master synchronization for which no clock extension is determined or used and both the video and audio are independently synchronized to the system time counter.

32. A method for synchronizing a play back of frames of audio and video output data, the frames of audio and video output data being derived from demultiplexing and decoding audio and video data contained in respective audio and video data packets, selected ones of the audio and video data packets containing presentation time stamp PTS values, and the selected ones of the audio data packets containing audio frame numbers, each of the audio frame numbers representing a number of frames of audio to be played back between the selected ones of the audio data packets, the method comprising:

sequentially storing during an audio demultiplexing process of the audio data packets containing PTS values, audio data in respective audio FIFO memory locations;
sequentially storing PTS values in first memory locations in an audio PTS memory table during the first demultiplexing process;
storing in second memory locations in the audio PTS table during the first demultiplexing process, write pointer locations associated with the data written into the video FIFO memory locations for the selected video data packets con-

taining a PTS value;
storing audio frame numbers in counter memory locations in the PTS table during the first demultiplexing process;
initiating an audio decoding process simultaneously with the a start audio frame interrupt to a CPU;
acquiring a read pointer location of the audio FIFO in response to the start audio frame interrupt;
finding a write pointer location in the audio PTS table approximately equal to the read pointer location;
decoding the audio data being read from the audio FIFO;
presenting a successive audio output frame to the user;
decrementing all of the counter memory locations in the audio PTS table by one;
detecting any of the counter locations having a zero value; and if so.
adjusting a current state of a system time counter to the PTS value in the audio PTS table associated with the counter having a zero value.

33. A digital video processor for synchronizing a play back of output frames of audio and video data derived from demultiplexing and decoding audio and video data contained in audio and video data packets and selected ones of the audio and video data packets containing a presentation time stamp value, the video processor comprising:

audio and video FIFO memories for sequentially storing the audio and video data contained the respective audio and video data packets;
an audio PTS memory table having

first memory locations for sequentially storing the PTS values in the selected ones of the audio data packets,
second memory locations for storing values representing write pointer locations associated with the data written into the audio FIFO memory location in the selected audio data packets containing a PTS value, and
third memory locations functioning as counter locations for storing audio frame numbers, each representing a number of frames of audio to be played back until an occurrence of a subsequent PTS value; and

a video PTS memory table having

first memory locations for sequentially storing the PTS values in the selected ones of the video data packets,
second memory locations for storing values representing write pointer locations associated with the data written into the video FIFO memory locations for the selected video data packets containing a PTS value, and
third memory locations functioning as counter locations for storing a value representing a number of frames of video approximately equal to a delay time required for decoding a frame of video data prior to its play back to a user.

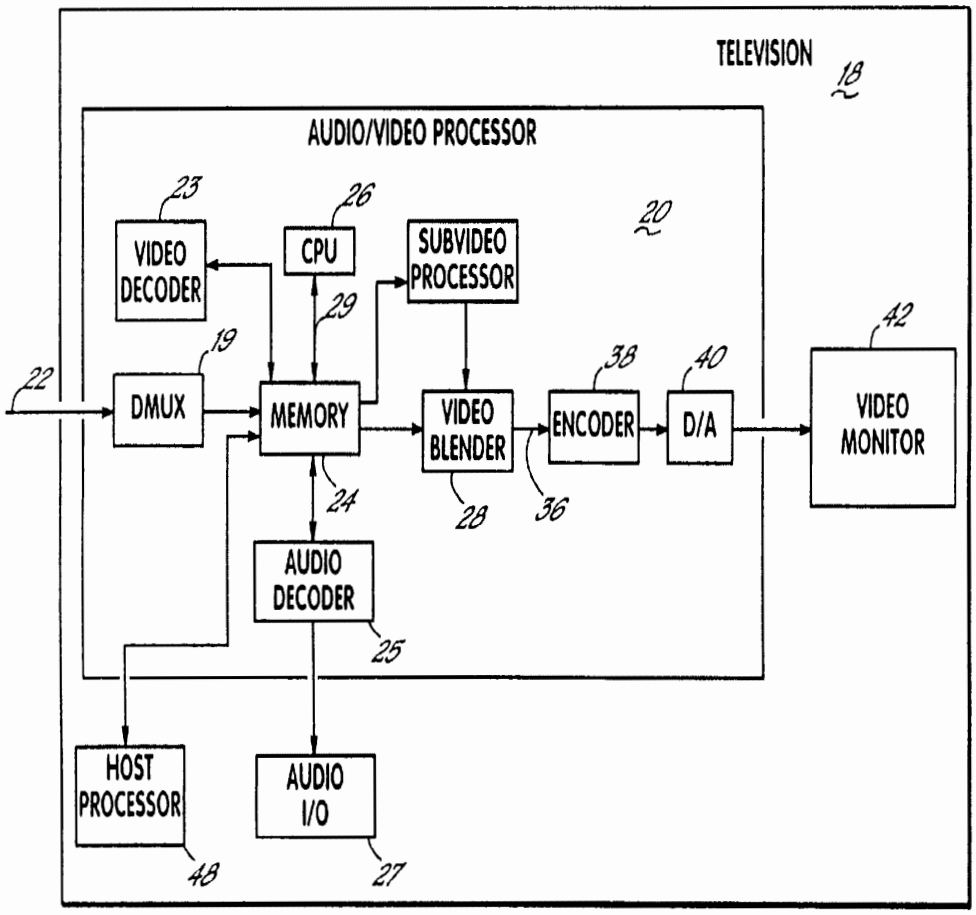


FIG. 1

EP 0 895 427 A2

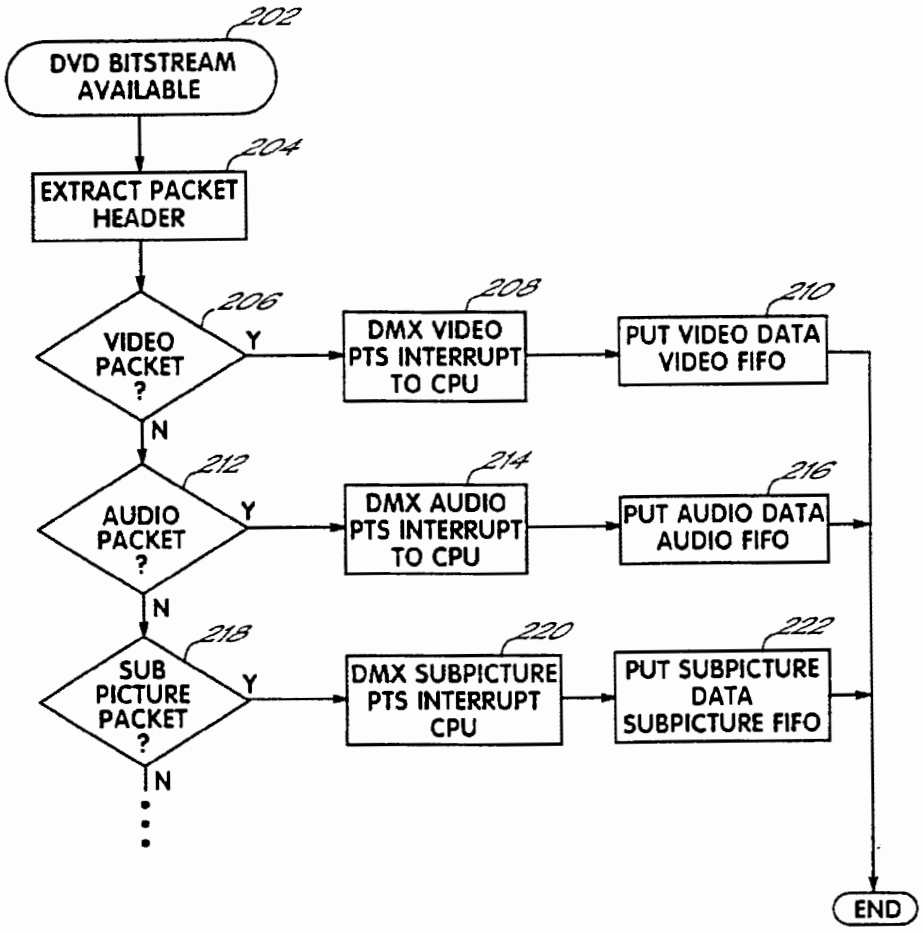

202
DVD BITSTREAM AVAILABLE
204
EXTRACT PACKET HEADER
206
VIDEO PACKET ?
Y
N
208
DMX VIDEO PTS INTERRUPT TO CPU
210
PUT VIDEO DATA VIDEO FIFO
212
AUDIO PACKET ?
Y
N
214
DMX AUDIO PTS INTERRUPT TO CPU
216
PUT AUDIO DATA AUDIO FIFO
218
SUB PICTURE PACKET ?
Y
N
220
DMX SUBPICTURE PTS INTERRUPT CPU
222
PUT SUBPICTURE DATA SUBPICTURE FIFO
END

FIG. 2

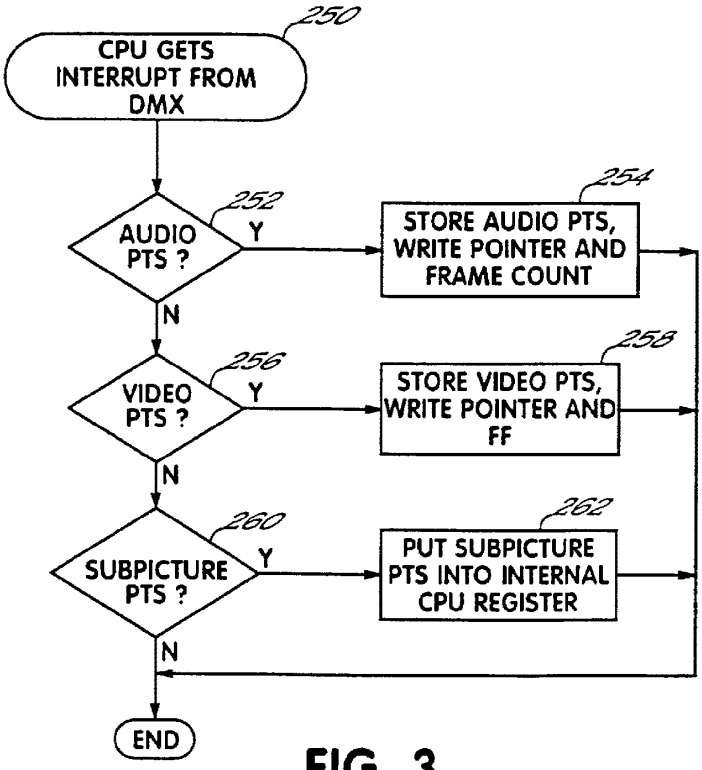

250
CPU GETS INTERRUPT FROM DMX
252
AUDIO PTS ?
Y
N
254
STORE AUDIO PTS, WRITE POINTER AND FRAME COUNT
256
VIDEO PTS ?
Y
N
258
STORE VIDEO PTS, WRITE POINTER AND FF
260
SUBPICTURE PTS ?
Y
N
262
PUT SUBPICTURE PTS INTO INTERNAL CPU REGISTER
END

FIG. 3

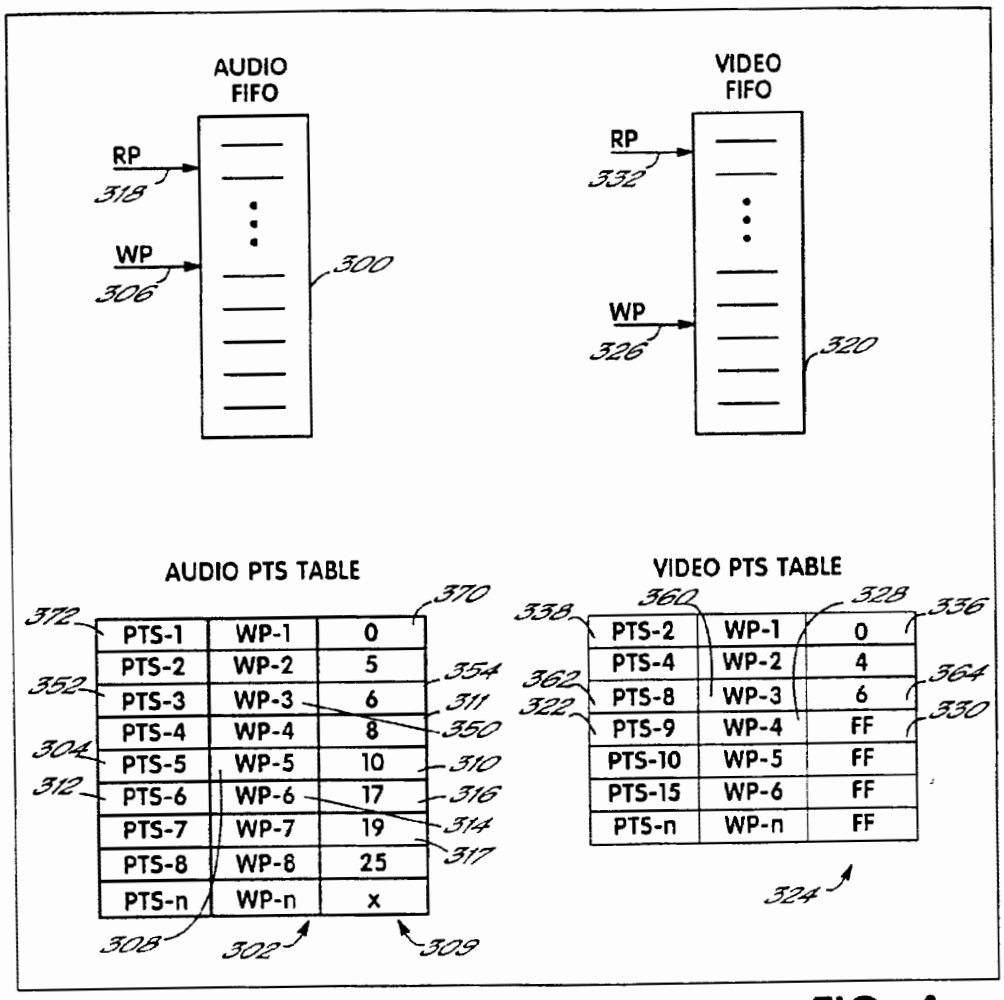

AUDIO FIFO
RP
318
WP
306
300
VIDEO FIFO
RP
332
WP
326
320
AUDIO PTS TABLE
370
372
PTS-1 WP-1 0
PTS-2 WP-2 5
352
354
PTS-3 WP-3 6
311
350
PTS-4 WP-4 8
304
PTS-5 WP-5 10
310
312
PTS-6 WP-6 17
316
PTS-7 WP-7 19
314
PTS-8 WP-8 25
317
PTS-n WP-n x
308
302
309
VIDEO PTS TABLE
360
328
338
336
PTS-2 WP-1 0
PTS-4 WP-2 4
362
364
PTS-8 WP-3 6
322
330
PTS-9 WP-4 FF
PTS-10 WP-5 FF
PTS-15 WP-6 FF
PTS-n WP-n FF
324

FIG. 4

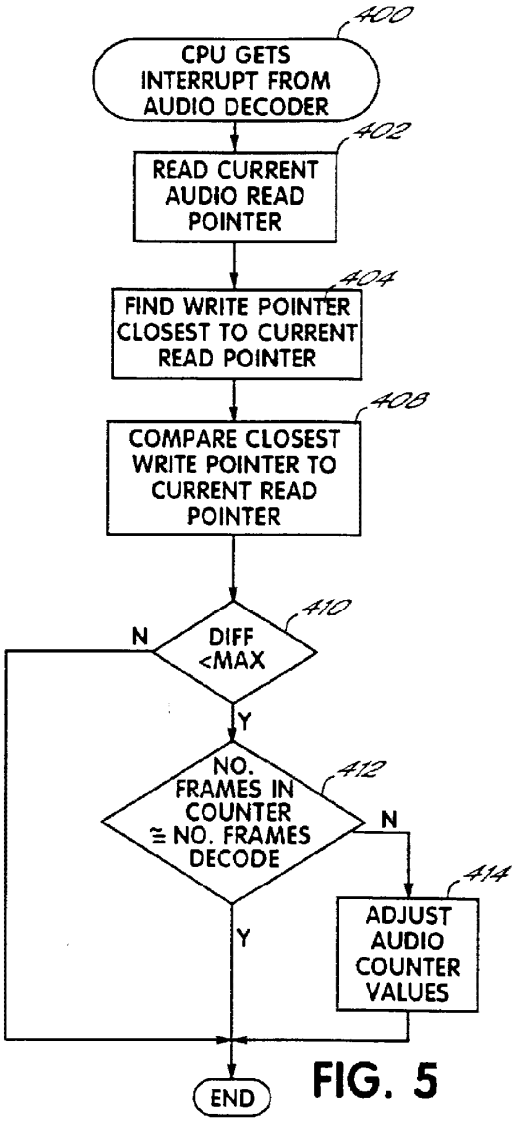

400
CPU GETS INTERRUPT FROM AUDIO DECODER
402
READ CURRENT AUDIO READ POINTER
404
FIND WRITE POINTER CLOSEST TO CURRENT READ POINTER
408
COMPARE CLOSEST WRITE POINTER TO CURRENT READ POINTER
410
DIFF <MAX
N
Y
412
NO. FRAMES IN COUNTER ≅ NO. FRAMES DECODE
N
Y
414
ADJUST AUDIO COUNTER VALUES
END

FIG. 5

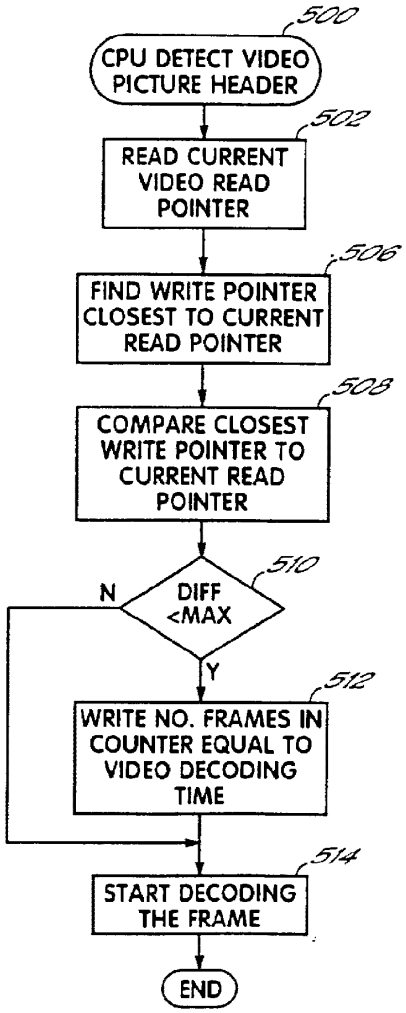

500
CPU DETECT VIDEO PICTURE HEADER
502
READ CURRENT VIDEO READ POINTER
506
FIND WRITE POINTER CLOSEST TO CURRENT READ POINTER
508
COMPARE CLOSEST WRITE POINTER TO CURRENT READ POINTER
510
DIFF <MAX
N
Y
512
WRITE NO. FRAMES IN COUNTER EQUAL TO VIDEO DECODING TIME
514
START DECODING THE FRAME
END

FIG. 6

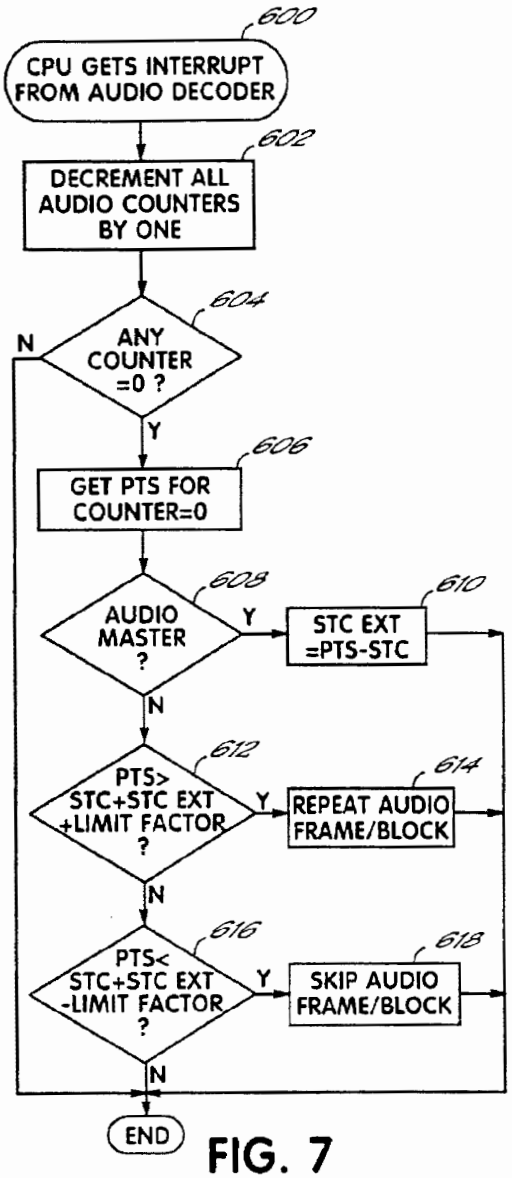

600
CPU GETS INTERRUPT FROM AUDIO DECODER
602
DECREMENT ALL AUDIO COUNTERS BY ONE
604
ANY COUNTER =0 ?
N
Y
606
GET PTS FOR COUNTER=0
608
AUDIO MASTER ?
Y
610
STC EXT =PTS-STC
N
612
PTS> STC+STC EXT +LIMIT FACTOR ?
Y
614
REPEAT AUDIO FRAME/BLOCK
N
616
PTS< STC+STC EXT -LIMIT FACTOR ?
Y
618
SKIP AUDIO FRAME/BLOCK
N
END

FIG. 7

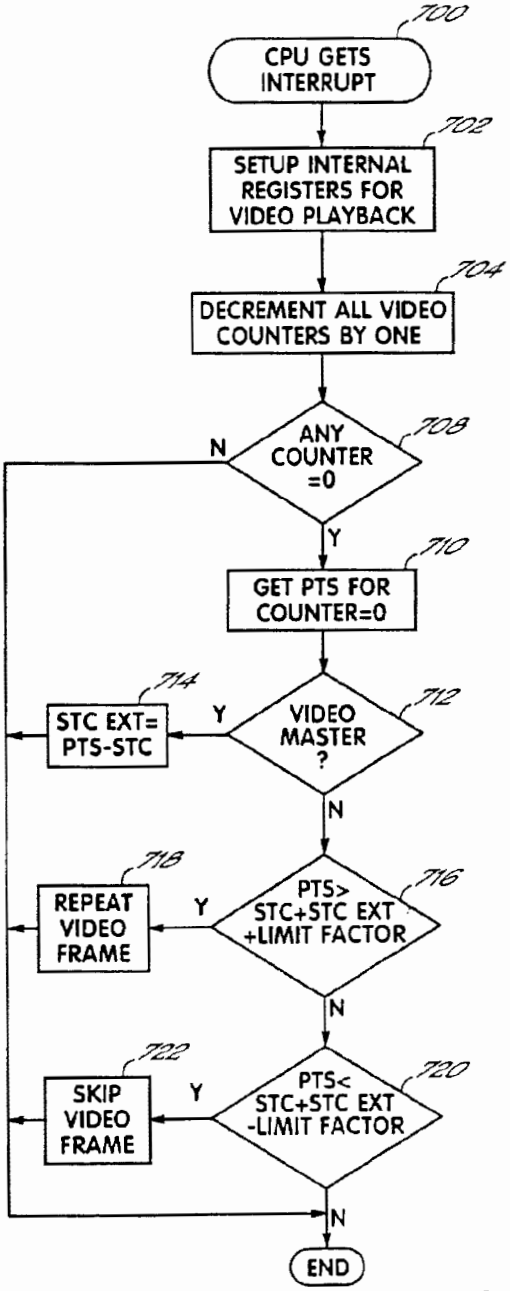

700
CPU GETS INTERRUPT
702
SETUP INTERNAL REGISTERS FOR VIDEO PLAYBACK
704
DECREMENT ALL VIDEO COUNTERS BY ONE
708
ANY COUNTER =0
N
Y
710
GET PTS FOR COUNTER=0
712
VIDEO MASTER ?
Y
714
STC EXT= PTS-STC
N
716
PTS> STC+STC EXT +LIMIT FACTOR
Y
718
REPEAT VIDEO FRAME
N
720
PTS< STC+STC EXT -LIMIT FACTOR
Y
722
SKIP VIDEO FRAME
N
END

FIG. 8

Electronic Acknowledgement Receipt

EFS ID:	24888658
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	11-FEB-2016
Filing Date:	17-APR-2013
Time Stamp:	18:41:13
Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS_Feb2016.pdf	1055384 53d066d6325a7676a4e4faa2203de272e8d50cdb	no	7

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2	Foreign Reference	EP0895427A2.pdf	1317370 9d6463482 8f09470c11e866285a88b57b44 66126	no	20
Warnings:					
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3	Non Patent Literature	13848921_AA_02-02-2016.pdf	345491 c960c063c131d2874c5edfb7a394722c330 dd8c4	no	8
Warnings:					
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4	Non Patent Literature	13864247_AA_02-01-2016.pdf	310173 a08773d30b80582719051c41d8cec943960 ff7e5	no	6
Warnings:					
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5	Non Patent Literature	13533105_Final_OA_11-18-15.pdf	2050407 3a725f3cca80e3628df2d193b84b125e1f4c 8cfd	no	56
Warnings:					
Information:					
6	Non Patent Literature	13871795_Final_OA_11-30-15.pdf	843634 27ea94cfdb19d9f83ccdb0a0ada6f93666c3 6c64	no	26
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Information:					
7	Non Patent Literature	14184528_Non-Final_OA_1-13-16.pdf	485519 765023d1ccd525051d48c39189297f272dd 05b00	no	14
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8	Non Patent Literature	14290493_Non-Final_OA_12-28-15.pdf	1024094 eb4ee16564db54fbc046df4f5251a60bf52d 3e31	no	29
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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402

	1	Creative, "Connecting Bluetooth Devices with Creative D200," http://support.creative.com/kb/ShowArticle.aspx?url=http://ask.creative.com:80/SRVS/CGI-BIN/WEBCGI.EXE/,/?St=106,E=0000000000396859016,K=9377,Sxi=8,VARSET=ws:http://us.creative.com,case=63350>, available on 11/28/2011, 2 pages	

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	Application Number	13864249
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	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-12-29
Name/Print	Benjamin M. Urban	Registration Number	71,591

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Electronic Acknowledgement Receipt

EFS ID:	24475361
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	29-DEC-2015
Filing Date:	17-APR-2013
Time Stamp:	17:57:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	Creative_ConnectingBluetooth Devices.pdf	203394 b0c5a61de0182c2a01d7fe19a965e28d90289ad3	no	2

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS_29DEC215.pdf	1054203 67d0a420569fc340cdbe69584bfd21e0553cb8ef	no	4
Warnings:					
Information:					
			Total Files Size (in bytes):	1257597	

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
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	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7158488		2007-01-02	FUJIMORI; Junichi	
	2	7319764		2008-01-15	REID; Glenn et al.	
	3	7474677		2009-01-06	TROTT; Christian A.	
	4	7483540		2009-01-27	RABINOWITZ; William M. et al.	
	5	7509181		2009-03-24	CHAMPION; Mark	
	6	7631119		2009-12-08	MOORE; Jeffrey C. et al.	
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	9	7689304		2010-03-30	SASAKI; Yoshio	
	10	7689305		2010-03-30	KREIFELDT; Richard A. et al.	
	11	7765315		2010-07-27	BATSON; James D. et al.	
	12	7827259		2010-11-02	HELLER; David et al.	
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	14	8015306		2011-09-06	BOWMAN; Timothy D.	
	15	8045721		2011-10-25	BURGAN; John M. et al.	
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	17	8090317		2012-01-03	BURGE; Benjamin D. et al.	
	18	8111132		2012-02-07	ALLEN; William A. et al.	
	19	8116476		2012-02-14	INOHARA; Yuichi	

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	20	8126172		2012-02-28	HORBACH; Ulrich et al.	
	21	8144883		2012-03-27	PDERSEN; Jan A. et al.	
	22	8148622		2012-04-03	ROTHKOPF; Fletcher R. et al.	
	23	8170260		2012-05-01	REINING; Friedrich et al.	
	24	8175297		2012-05-08	HO; Harvey et al.	
	25	8185674		2012-05-22	MOORE; Jeffrey C. et al.	
	26	8194874		2012-06-05	STAROBIN; Bradley M. et al.	
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	28	8214447		2012-07-03	DESLIPPE; Mark H. et al.	
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	30	8218790		2012-07-10	BULL; William et al.	

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	31	8233648		2012-07-31	SOREK; Noam et al.	
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	36	8316147		2012-11-20	BATSON; James D. et al.	
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	39	8345709		2013-01-01	NITZPON; Hans-Juergen et al.	
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	42	8423893		2013-04-16	RAMSAY; Max Gordon et al.	
	43	8432851		2013-04-30	XU; Guijin et al.	
	44	8433076		2013-04-30	ZUREK; Robert et al.	
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	46	8463184		2013-06-11	DUA; Robin	
	47	8463875		2013-06-11	KATZ; Hagay et al.	
	48	8509211		2013-08-13	TROTTER; John et al.	
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	52	8615091		2013-12-24	TERWAL; Remco	

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	53	8639830		2014-01-28	BOWMAN; Timothy D.	
	54	8683009		2014-03-25	NG; Stanley et al.	
	55	8731206		2014-05-20	PARK; Keun Young	
	56	8750282		2014-06-10	GELTER; Aaron et al.	
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	58	8762565		2014-06-24	TOGASHI; Ryuichiro et al.	
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	60	8819554		2014-08-26	BASSO; Andrea et al.	
	61	8843586		2014-09-23	PANTOS; Roger et al.	
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	64	8917877		2014-12-23	HAAFF; Olle et al.	
	65	8930006		2015-01-06	HAATAINEN; Niko	
	66	8954177		2015-02-10	SANDERS; Christopher John	
	67	8965544		2015-02-24	RAMSAY; Max Gordon	
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	69	9137602		2015-09-15	MAYMAN; Avrum G. et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20080212786		2008-09-04	PARK; Hae-Kwang	
	2	20080215169		2008-09-04	DEBETTENCOURT; Lisa et al.	
	3	20090017868		2009-01-15	UEDA; Joji et al.	

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	4	20090100189		2009-04-16	BAHREN; Frank et al.	
	5	20090251604		2009-10-08	IYER; Suraj C.	
	6	20110228944		2011-09-22	CROGHAN; Frank et al.	
	7	20120148075		2012-06-14	GOH; Aik Hee Daniel et al.	
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	12	20130230175		2013-09-05	BECH; Soeren et al.	
	13	20130279706		2013-10-24	MARTI; Stefan J.	
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	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	15	20140037097		2014-02-06	LABOSCO; Mark	
	16	20140064501		2014-03-06	OLSEN; Martin et al.	
	17	20140075308		2014-03-13	SANDERS; Christopher John et al.	
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	19	20140079242		2014-03-20	NGUYEN; Nam et al.	
	20	20140108929		2014-04-17	GARMARK; Sten et al.	
	21	20140123005		2014-05-01	FORSTALL; Scott J. et al.	
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	23	20140161265		2014-06-12	CHAIKIN; Peter et al.	
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	26	20140267148		2014-09-18	LUNA; Michael Edward Smith et al.	
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	33	20140344689		2014-11-20	SCOTT; Mark David et al.	
	34	20140378056		2014-12-25	LIU; Peter T.	
	35	20150026613		2015-01-22	KWON; Yunmi et al.	
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	37	20150043736		2015-02-12	OLSEN; Martin et al.	
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	42	20150256954		2015-09-10	CARLSSON; Gregory Peter et al.	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	0772374	EP	A2	1997-05-07	BANG & OLUFSEN AS.		☐
	2	2043381	EP	A2	2009-04-01	BANG & OLUFSEN AS.		☐
	3	2161950	EP	A2	2010-03-10	BANG & OLUFSEN AS.		☐

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	4	2591617	EP	B1	2014-06-18	BANG & OLUFSEN AS.		☐
	5	2486183	GB		2012-06-13	CAMBRIDGE SILICON RADIO LIMITED.		☐
	6	2014149533	WO	A2	2014-09-25	BOSE CORP [US]		☐

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	1	CANADIAN INTELLECTUAL PROPERTY OFFICE, Canadian Office Action mailed on 14 September 2015, issued in connection with Canadian Patent Application No. 2,842,342, 2 pages.	☐
	2	Notice of Allowance mailed on 07 October 2015, issued in connection with U.S. Patent Application No. 14/184526, filed on 19 February 2014, 7 pages.	☐
	3	Notice of Allowance mailed on 09 October 2015, issued in connection with U.S. Patent Application No. 13/435739, filed on 30 March 2012, 4 pages.	☐
	4	"Notice of Allowance mailed on 13 October 2015, issued in connection with U.S. Patent Application No. 13/864251, filed on 17 April 2013, 7 pages.".	☐
	5	Advisory Action mailed on 28 September 2009, issued in connection with U.S. Patent Application No. 10/816217, filed on 01 April 2004, 4 pages.	☐
	6	First Action Interview Office Action Summary mailed on 15 April 2015, issued in connection with U.S. Patent Application No. 14/505027, filed on 02 October 2014, 6 pages.	☐

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	7	Advisory Action mailed on 05 January 2012, issued in connection with U.S. Patent Application No. 12/035112, filed on 21 February 2008, 3 pages.	☐
	8	Final Office Action mailed on 13 October 2011, issued in connection with U.S. Patent Application No. 12/035112, filed on 21 February 2008, 10 pages.	☐
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	10	Non-Final Office Action mailed on 10 March 2011, issued in connection with U.S. Patent Application No. 12/035112, filed on 21 February 2008, 12 pages.	☐
	11	Non-Final Office Action mailed on 27 June 2008, issued in connection with U.S. Patent Application No. 10/861653, filed on 05 June 2004, 19 pages.	☐
	12	Notice of Allowance mailed on 14 June 2012, issued in connection with U.S. Patent Application No. 12/035112, filed on 21 February 2008, 9 pages.	☐
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Examiner Signature		Date Considered	

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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-11-23
Name/Print	Benjamin M. Urban	Registration Number	71,591

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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(54) Method and apparatus for controlling the performance of a loudspeaker in a room

(57) A method for controlling the performance of a loudspeaker in a room, by determining in a first acoustic environment suitable parameters defining a first complex transfer function based on a measurement of the resultant movement of a loudspeaker driver diaphragm and the associated force, arising from the sound field in the room, acting on it, and in a second acoustic environment the same or different parameters of a second complex transfer function by measuring the loudspeaker driver relating to the room. The ratio between the real parts of the first and second transfer functions is used to define the performance of a correcting filter, included in the signal chain to the loudspeaker driver.

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Description

The invention relates to a method and apparatus for controlling the performance of a loudspeaker in a room.

The actual performance of a loudspeaker is known to be highly dependent on the acoustics of the actual listening room and the actual loudspeaker position within this room. In particular the performance of a loudspeaker will change very noticeably when it is in proximity to the boundaries of the room. This is caused by the loading of the room on the loudspeaker as a radiator, or in other words due to the changing radiation resistance. A change of listener position changes the perceived performance of the loudspeaker, in particular due to early reflections and standing waves. However some boundary effects are universal in the room, in particular in the bass frequency range, and hence the perception of this range is less influenced by the listener position.

Loudspeaker designers experience this fact by having to make a compromise when optimizing the timbre of the loudspeaker so that the perceived sound will be acceptable under a number of different conditions, i.e. different room acoustics, loudspeaker positions, and listening positions. Even though making this compromise, the designer cannot ensure that the customer will always experience the intended quality. Thus, the listener will experience a performance of the loudspeaker that depends on the acoustic properties of the actual listening room and the position chosen for both loudspeaker and listener. There is a risk that an expensive loudspeaker which performs very well in the shop, will turn out performing badly or at least disappointingly when placed in a different environment and/or in a different position.

In order to compensate for this problem it is known to fit a switch in the cross-over filter unit in the loudspeaker in order that the bass response may be modified to suit a particular placement of the loudspeaker. At best, this must be considered a poor compromise, and if at all possible, the precise adjustment will be dependent on a measurement of the room characteristics. Some automatic systems are based on measuring the transfer function from the input of the loudspeaker to an omnidirectional microphone, placed at the preferred listening position or a number of representative positions. An equalizing filter is then inserted so that the resulting transfer function approximates a target function, which e.g. can be flat in the frequency range of interest. A major problem of such systems is the sensitivity to changes in the position of the sound source as well as the receiver. If the position of the loudspeaker or the listener is changed after calculating the equalizing filter, the effects can be severe colouration, pre-echoes, etc. Another problem of such systems is the choice of a suitable target function, where a flat function may not be found to be optimal.

It has in the present invention been realized that since all the involved acoustic phenomena's are considered to be linear, what is actually compensated through the apparently sensible procedures discussed above is the superposition of several phenomena, such as standing waves/natural frequencies of the room, early reflections, reverberation and the reduction of angular space angle due to the boundary effect, and it is considered that this is the reason why the known procedures will only function for one listening position.

It is the purpose of the invention to provide a method and apparatus for controlling the performance of a loudspeaker in a room in order that it becomes independent of the placement of the loudspeaker. This is obtained in a method according to the invention which is particular in that in a first acoustic environment the movement, e.g. velocity, of the diaphragm of the loudspeaker driver and the force, arising from the sound field, acting on it are determined by measuring suitable parameters, defining thereby a first complex transfer function, that in a second acoustic environment a second complex transfer function is determined by measuring the same or different parameters of the loudspeaker driver, relating to the room, that the ratio between the real parts of the first and second transfer functions is used to define the performance of a correcting filter, that the filter is applied in the signal chain to the loudspeaker driver.

The invention is based on the realization that there is a strong link between the way the loudspeaker sounds, in particular in the bass range, and its radiation resistance as a function of frequency, being the real part of the radiation impedance. Implementing the invention for a loudspeaker has proved to significantly increase the certainty that the customer will always experience the quality intended by the loudspeaker designer. This is achieved by measuring the radiated power output, radiation resistance or any similar physical parameter, e.g. real part of the acoustic wave impedance near the diaphragm, when the loudspeaker is placed in the actual position and comparing this to a reference measurement. More precisely this is obtained in that the loudspeaker in a first step is put in a reference room environment where it performs to a standard to be determined, and during which a reference radiated power output (real, i.e. active) or reference radiation resistance of a driver as a function of frequency is measured, and in that in a second step the loudspeaker is put in its room of usage where its attendant radiated power output or radiation resistance is measured, the ratio between the said real (active) power outputs or radiation resistances respectively being used to define the transfer function of a correcting filter in order to obtain said standard of performance determined in said reference room environment, and that in a third step said correcting filter is introduced in the electrical signal path to the driver. In principle a multi-driver loudspeaker should have each driver subjected to such a measurement, however one or several may be selected as representative. At the time of measurement of one particular driver or a group of drivers, the other drivers may either be short-circuited, disconnected or connected to the

signal.

When the loudspeaker is placed in a position which is not identical to the reference position/room, the bass performance changes. However, the method according to the invention is able to detect a major part of this change in the acoustic environment of the loudspeaker and to correct accordingly. Switching on and off an apparatus working according to the principles of the invention can lead to dramatic changes of the bass performance of the loudspeaker depending on how different the actual position and room are from the reference conditions. If a loudspeaker is designed to operate away from the walls of a room, then when placing such a loudspeaker close to a corner of the listening room, the bass performance becomes boomy, coloured, and the sound pressure level increases. In such a situation the apparatus according to the principles of the invention corrects the timbre in such a way that the perceived timbre is almost the same as in the reference position. The effect of the apparatus in this situation has been described by listeners as quite startling. The bass performance then was not plagued by the rumble which is traditionally a characteristic of a corner position, and the bass performance becomes more even and neutral without becoming "thin". In a corner position this is perceived as a dramatic improvement of the bass performance.

An advantageous embodiment is particular in that the loudspeaker is permanently fitted with measurement means, the ratio between reference and use measurements being used to define the parameters of the correcting filter. This enables a measurement to be initiated by a user or in the event that some predefined conditions are met, e.g. power up of the apparatus. This measurement cycle could be performed using a dedicated measuring signal, e.g. obtained from a particular Compact Disc.

A further advantageous embodiment of the invention is particular in that the loudspeaker is permanently fitted with measurement means, and the complex transfer function, which corresponds to the situation during usage, is continuously measured during operation of the apparatus. The ratio between reference and usage measurements being used to define the parameters of the correcting filter. This means that the loudspeaker will be automatically and continuously adaptable to any new listening room environment, e.g. using the played music as the stimuli when measuring the complex transfer functions. In this case the transfer function in the usage situation is continuously measured, and e.g. a digital signal processor in the signal chain calculates and performs the filtering which provides a sound from the loudspeaker which is very similar to the sound in the reference position/room and which presumably was judged positively during the design of the loudspeaker.

A further advantageous embodiment is particular in that the listening room is divided into zones of e.g. 30 cm by 30 cm, each having a correction filter transfer function assigned to it, and that information on the particular zone is fed to the correcting filter in the electrical signal path to the loudspeaker. By this means it is possible to accomodate a number of typical placements of a loudspeaker and to obtain a large degree of the improvement according to the invention, without having to perform a measurement.

A simpler arrangement is obtained by instructing the user to activate switches according to a schematic showing various typical placements of a loudspeaker in a room. This functions in practice, provided the loudspeaker is of the same type as the loudspeaker used in the reference environent.

An apparatus according to the invention is particular in that it comprises a filter, the transfer function of which is controllable by electronic/numerical signals, said signals being obtained from a unit which determines the ratio between a stored reference radiation resistance or active power output (real) as a function of frequency and a measured radiation resistance or active power output (real) in the usage situation. This ratio basically defines the amplitude response of the correction filter, and various filter implementations, e.g. minimum phase can be obtained from this. However various operation might be performed to modify the ratio before implementation, e.g. smoothing, convolution, frequency limiting, correction limiting, logarithm, exponential, multiplication, addition etc. and combinations of these. For instance, defining the amplitude response of the correction filter as the square root of the ratio seems to be a reasonable choice.

The invention will be further described in the following with reference to the drawing, in which

Fig. 1 shows the electrical, mechanical and acoustical signal paths associated with a loudspeaker placed in a room,

Fig. 2 shows a loudspeaker with a driver and measuring transducers, and

Fig. 3 shows a schematic of how the correction filter can be inserted in the signal chain according to one embodiment of the invention.

By way of example Fig. 1 shows the signal path and transfer functions relating to a loudspeaker in a room. The electrical signal from the source is fed to a power amplifier A which drives the loudspeaker which is designated B and comprises the electrical and mechanical parts of the loudspeaker driver unit and the acoustic influence of the cabinet enclosure. The output from the loudspeaker is transformed by the transfer function C from the acceleration of the diaphragm to the sound pressure in front of the diaphragm which may be measured by a microphone D as one example of how to obtain the force, arising from the sound field, acting on the diaphragm. An accelerometer E for example may measure the diaphragm acceleration directly. At point 1 the source signal is provided, at point 2 the electrical input signal to the loudspeaker driver is available, point 3 refers to the acceleration of the diaphragm of the loudspeaker, and at point 4 the sound pressure at some pre-

determined and fixed point in front of the driver is available. After being converted by the microphone D an electrical signal representing the sound pressure is available at point 5, and correspondingly, an electrical signal representing the membrane acceleration is available at point 6.

Fig. 2 shows one embodiment of the invention where the loudspeaker B with one of a multitude of possible placements of a microphone D and an accelerometer E.

Fig. 3 shows how a measurement of the radiation resistance of the loudspeaker is used when calculating the filter F, which is switched into the signal path. The signal processing may occur through any means available to the skilled person, the result will be a linear predistortion of the signal to the power amplifier in order that the loudspeaker provides an excitation of the listening room so that the perceived sound is a good approximation to the quality determined during the design phase. The advantage of making the measurement continuous is that the system will automatically compensate e.g. for an influx of listeners or a changed placement of furniture or the loudspeaker placement itself, which disturbs the sound distribution in the room. Such a disturbance is now compensated so that the perceived sound is essentially unchanged.

Claims

1. A method for controlling the performance of a loudspeaker in a room, **characterized in** that in a first acoustic environment the resultant movement of the loudspeaker driver diaphragm and the associated force, arising from the sound field in the room, acting on it are determined by measuring suitable parameters defining a first complex transfer function, that in a second acoustic environment a second complex transfer function is determined by measuring the same or different parameters of the loudspeaker driver relating to the room, that the ratio between the real parts of the first and second transfer functions is used to define the performance of a correcting filter, that the filter is applied in the signal chain to the loudspeaker driver.

2. A method for controlling the performance of a loudspeaker in a room, in particular in the low frequency range, according to claim 1, **characterized in** that the loudspeaker in a first step is put in a reference room environment where it performs to a standard to be determined, and during which a reference radiated power output (real, i.e. active), reference radiation resistance (acoustic or mechanical) of a driver or any similar physical parameter, e.g. real part of the acoustic wave impedance near the diaphragm of the driver, as a function of frequency is measured, and in that in a second step the loudspeaker is put in its room of use where a usage radiated power output (real, i.e. active), usage radiation resistance of the same driver or any similar physical parameter, e.g. real part of the acoustic wave impedance near the diaphragm of the same driver, is measured, the ratio between the real part of said power outputs (active), radiation resistances or any similar physical parameters, e.g. real parts of the acoustic wave impedances near the diaphragm of the driver, respectively being used to define the transfer function of a correcting filter in order to obtain said standard of performance determined in said reference room environment, and that in a third step said correcting filter is introduced in the electrical signal path to the driver.

3. A method according to claim 1 and 2 , **characterized in** that the loudspeaker is permanently fitted with measurement means, the ratio between reference and usage measurements being used to define the parameters of the correcting filter.

4. A method according to claim 1 and 2, **characterized in** that the loudspeaker is permanently fitted with measurement means and is continously measuring the second complex transfer function, the ratio between reference and usage measurements being used to define the parameters of the correcting filter.

5. A method according to claim 3, **characterized in** that the measurement means are activated by a user or in the event that some predefined conditions are met, e.g. power up of the apparatus.

6. A method according to claim 1 and 2, **characterized in** that the listening room is divided into zones of e.g. 30 cm by 30 cm, each having a correcting filter transfer function assigned to it, and that information on the particular zone is fed to the correcting filter in the electrical signal path to the loudspeaker.

7. An apparatus for performing the method according to claim 1 and 2, **characterized in** that it comprises a filter, the transfer function of which is controllable by electronic/numerical signals, said signals being obtained from a unit which determines the ratio between a stored reference radiation resistance or active power output (real) or wave resistance near the driver as a function of frequency and a measured radiation resistance or active power output (real) or wave resistance near the driver in the usage situation. This ratio basically defines the amplitude response of the correction filter, and various filter implementations, e.g. minimum phase can be obtained from this. However various operations might be performed to modify the ratio before implementation, e.g. smoothing, convolution, frequency limiting, correction limiting, logarithm, exponential, multiplication, addition etc. and combinations of these. For instance, defining the

amplitude response of the correction filter as the square root of the ratio seems to be a reasonable choice.

8. A method according to claim 3 or 4 or 5 or 6, **characterized in** that a multi-driver system, e.g. 2 woofers and 1 tweeter, should have each driver subjected to a measurement according to claim 1 and 2. However one or several may be selected as representative. At the time of measurement of one particular or a group of drivers, the other drivers may either be short-circuited, disconnected or connected to the signal. Each driver may have individual filters implemented or some groups may have a common filter implemented.

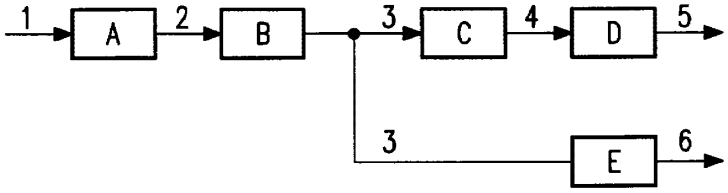


FIG. 1

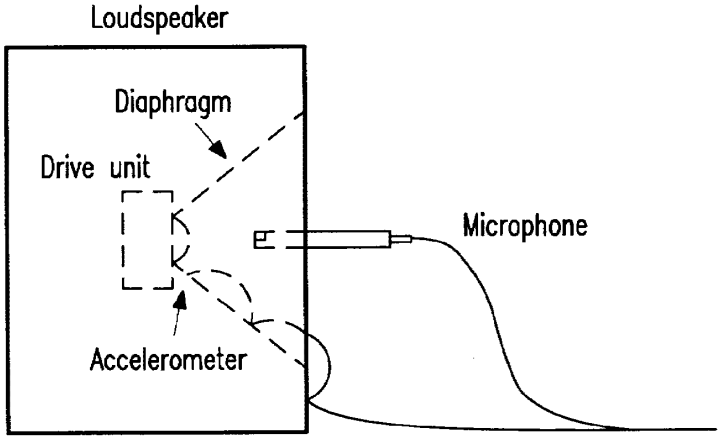


FIG. 2

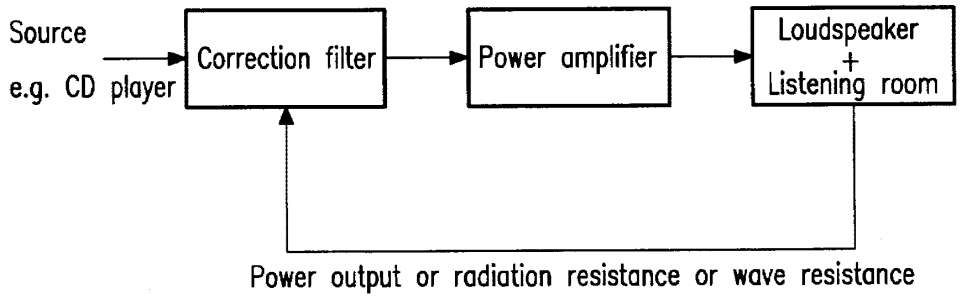


FIG. 3

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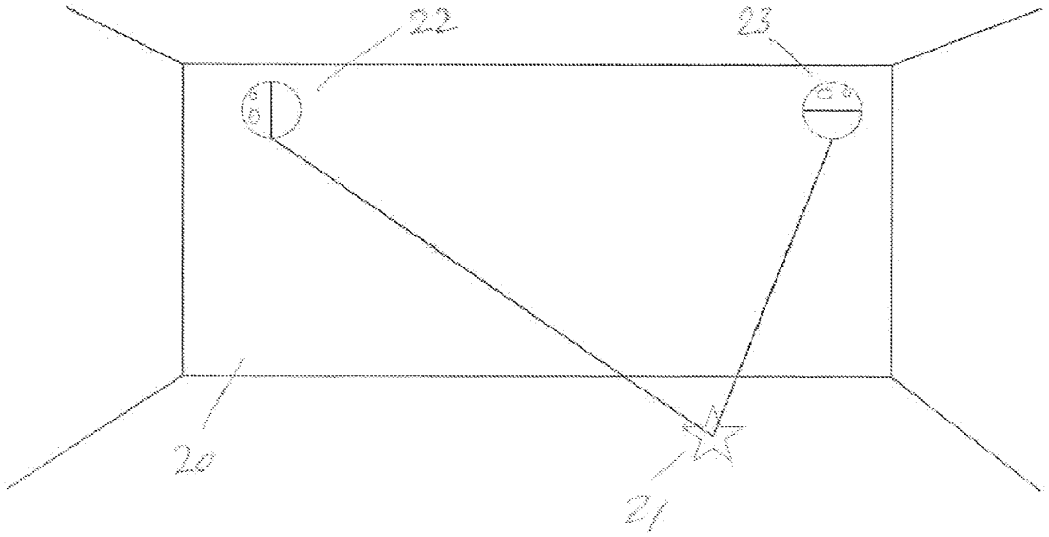
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(54) A method and a system to adjust the acoustical performance of a loudspeaker

(57) The invention relates to a method and a system for optimizing the performance of a loudspeaker system as perceived by user.

The physical part of the speaker system is adjustable which enables the speaker units to be placed in positions that imply maximal acoustical performance. This is obtained by combined means to: 1) bring the speaker in a specified position and 2) apply accordingly position dependant individual acoustical filters inserted in the signal path to each individual speaker.

Figure 5



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Description

Field of the Invention

[0001] The present invention relates to improvements in sound experience as perceived by the user in a listening room. Specifically - but not exclusively the means to obtain the increased performance is by adjusting the speaker position according to the listening position of the user and accordingly adjust individual filter means in the signal path to the loudspeaker.

Background of the Invention

[0002] When a loudspeaker is placed within an enclosed space the timbre of the loudspeaker as perceived by a listener is highly affected by the acoustical properties of the space.
Traditionally built-in loudspeaker in walls, ceiling's and floors has a very poor performance due to the difficult radiation properties out from the speaker units.
[0003] The designer of the sound reproduction system usually wishes to give the listener the same intended listening experience regardless of the acoustical properties of the listening space.
[0004] Attempts of providing systems which addresses this desire has been suggested in the art, see for example JP58218294, JP58170195 and JP57116495.
From JP58218294 is known a system where the mid and high range speaker units are arranged in a convex rotatable member relative to the loudspeakers surface. By rotating the member, the sound emitting angle due to the convex shape of the member from the mid and high range speakers, relative to the speaker's surface may be altered, in order to improve the overall sound emission.
In JP58170195 is disclosed a system where the loudspeaker type may be changed by rotating a member. The mid and high range loudspeaker units are mounted in the rotatable member. Furthermore by rotating the member a bus reflex port may be opened or closed in the front surface of the loudspeaker, thereby changing the properties of the loudspeaker.
Finally in JP57116495, the tweeter speaker unit of a loudspeaker construction, has been mounted such that it may tilt relative to a woofer speaker. In this manner it is possible to adjust the tweeters emission relative to the woofers emission, simply by directing the tweeters sound emission in a different direction.
[0005] With the current invention the loudspeaker system may adapt dynamically to the listeners position in a room.
[0006] Thus the object of the invention is to provide a loudspeaker system concept with dynamic properties such that not only the sound properties are optimised but also the listeners position is taken into account such that it is possible to create an optimum listening experience for the listener regardless of the listeners position in the room.
[0007] This object is achieved by a speaker system according to independent claim 1.
[0008] In further embodiments according to the dependent claims further advantageous objects are achieved, for example by:

- Including one or more speaker units,
- the speaker units are mounted into a frame that is rotate able and tilt able,
- individual filters may be adapted according to the individual speaker positions,
- positioning the speakers according to the listener position may be user commanded and/or automatically controlled, and
- active loudspeakers are applied for efficiency.

Description of the Invention

[0009] In the following, preferred embodiments of the invention will be described with reference to the drawing wherein

Fig. 1	illustrates a top view of the invention with the speaker units in the default position.
Fig. 2 a & b	illustrates a top view of the invention with the speaker units in two different positions.
Fig. 2 c & d	illustrates a side view of the invention with the speaker units in two different positions.
Fig. 3	illustrates the coordinate systems related to rotation- and tilt positions.
Fig. 4	illustrates the signal path including filters, amplifiers and two speaker units.
Fig. 5	illustrates how to set of speaker systems adjust according to the listing position in a room.
Fig. 6	illustrates the control system of the invention.

[0010] In a first aspect, the invention relates to:
[0011] A speaker system, where the speaker units mounted in the speaker system may be configured into different

positions to increase the acoustical performance perceived by the user, where said speaker system contains a mechanical structure consisting of four members:

- a first member(1), where said first member may have any geometrical shape, where said member has a first surface and defining a circular innermost periphery of said first member;
- a second member(2), where said second member may be arranged within the circular periphery provided on the first member(1), such that the second member may be rotate able around an axis perpendicular to, or close to being perpendicular to, the plane of the surface of the first member(1), and with the second member(2) fully or partly having a material surface;
- a third member(3) being an integrated part of the second member(2) or being a separate object mounted on top of the second member(2), and where said third member (3) includes one or more speaker units(5,6) mounted to deliver acoustical output directed away from the surface of the third member (3);
- a fourth member (4), where said fourth member is support structure including a hinge for the third member (3) and enables the third member(3) to be tilt able around an axis horizontal to, or close to being horizontal to, the plane of the surface of the second member(2) and with the fourth member (4) attached to the second member(2).

[0012] In a preferred embodiment the motorized means (31, 32, 33) control the position of the loudspeaker units (5, 6) in the speaker system. The motor means controls the rotating of the second member (2) and controls the tilting of the third member (3).

[0013] Standard means are applied to control the motors and to determine the position of each motor relative to a polar coordinate system for each of the movements, i.e. the rotation(8) of the second object(2) and the tilt(9) of the third object (3).

[0014] In one aspect the required position of the speakers are obtained by passing information of the X, Y coordinates related to the rotation of the second member to the second member motor means and by passing information of the X, Y coordinates related to the tilting of the third member to the third member motor means.

[0015] A predefined set of X, Y parameters for each of the motor means may be applied as the initial setting of the second- and third members upon start up of the speaker system. The same set of parameters may be applied as a default position that may be returned to during operation, thus to act as a Reset position for the loudspeakers.

[0016] In another aspect the rotation and the tilting of the loudspeaker units may be controlled by the user via a command from a wireless control device. Standard means (e.g. Infrared, Radio Frequency, Bluetooth or alike) may be applied for the communication from/to the remote terminal.

Specific X, Y coordinate values may be transferred to the speaker system and/or relative commands like: 'rotate left; rotate right; tilt up; tilt down; reset or similar commands.

Other functional related commands like 'bigger'; 'smaller'; 'light'; 'heavy' may be sent from a remote device for further mapping into specific X, Y parameter by the speaker system.

[0017] In the preferred embodiment this flexible addressing speaker units positions are that:

- the X, Y coordinates of the second member position may be forced to given values, and thus forced to a given position of the speaker, specified from an external control device, and
- the X, Y coordinates of the third member position may be forced to given values, and thus forced to a given position of the speaker, specified from an external control device.

[0018] In yet another aspect the position of the speaker units of one speaker system may automatically be oriented towards a detected location of a source signal in a room. This room location may be the listing position. Standard means are applied to generate the source signal; e.g. an infrared signal from a control device may be applied, and issued from the device upon a user command. The speaker system has a built in infrared receiver and detects the infrared beam. In a sequential flow of operation each of the motor means, i.e. the rotation motor means and the tilt motor means, are positioned from their respective min. to the max. positions in combinations to detect the maximum of the received IR signal. Alternatively to the IR signal and - detection method, an RF signal and - detection method or a sound signal and - detection method may be applied.

[0019] In the preferred embodiment these automated speaker units positions are where: the position of the second member and the position of the third member are determined from a detected maximum and or a detected minimum in a signal beam issued from a source located in the listening position of the user towards the speaker system.

[0020] In yet another aspect individual correction filters are applied in the signal path of every speaker according to the orientation/position of the speaker; this to maximize the sound quality as perceived by the listener. A predefined set of filter attributes are available for a set of defined X, Y positions related rotation and related to tilting of the loudspeaker units.

[0021] In the preferred embodiment these correction filter attributes may be used dynamically and consists of:

- a predefined set of filter attributes are applied as the default correction filters to be in the signal path for each of the one or more speakers, and
- a predefined plurality of individual set of filter attributes are related to different speaker positions for each of the one or more speakers, and
- a predefined set of filter attributes are selected and applied as the actual correction filter to be in the signal path for each of the one or more speakers, where the set of filter attributes are selected based on the X,Y position of the speaker.
- a predefined plurality of individual set of filter attributes related to speaker positions for each of the one or more speakers may be replaced with data from an external source.

[0022] In the preferred embodiment these correction filter attributes are related to the X, Y position of the rotation means and to the X, Y position of the tilt means in a simple index table in a discrete manner:

[0023] If X, Y position is in the interval pos1 -> pos2 Then apply filter set1

Rotate position	Tilt position	Filter	Index
Rpos1 -> Rpos2	Tpos1 -> Tpos2	Fset1	1
	Tpos2 -> Tpos3	Fset2	2
	+++	+++	//
	TposN-> TposM	FsetN	N
Rpos2 -> Rpos3	Tpos1 -> Tpos2	Fset1.1	N+1
	Tpos2 -> Tpos3	Fset2.1	N+2
	+++	+++	//
	TposN-> TposM	FsetN.1	N+N
			//
Rpos3 -> Rpos4	Tpos1 -> Tpos2	Fset1.2	2N+1
	Tpos2 -> Tpos3	Fset2.2	2N+2
	+++	+++	//
	TposN-> TposM	FsetN.2	//
+++			
RposP -> RposQ	Tpos1 -> Tpos2	Fset1.p	//
	Tpos2 -> Tpos3	Fset2.p	//
	+++	+++	//
	TposN-> TposM	FsetN.p	//

[0024] The table above illustrates the mapping of positions into filter index:

- a predefined plurality of individual set of X, Y coordinates are related to the second member position and where a predefined plurality of individual set of other X, Y coordinates are related to the third member position and where an index is related to a set of corresponding filter attributes that applies in that specific speaker position, and
- a predefined plurality of individual set of X, Y coordinates are related to the second member position and where a predefined plurality of individual set of other X, Y coordinates are related to the third member position and where an index is related to a set of corresponding filter attributes that applies in that specific speaker position and where the complete set of definitions may be replaced with data from an external source.

[0025] In figure 1 the invention is displayed with the main elements:

- The basic structure as a first element (1) may act as the fixture of other parts of the construction. The outer shape of this element is primarily determined by the requirement set up for the end user product, into which the invention will be a part of.
- A circular cavity in the first element is the room for the second (2) and the third (3) elements. Those elements are mounted so they have the freedom to rotate. According to requirements the allowed rotation may be whatever subset of the full rotation capability of 0 -> 360 deg. Preferable the axis of rotation is perpendicular to the surface of the first element(1).
- The third element (3) is attached to the rotational part of the construction (2) via a hinge (4) or alike, that allows the third member (3) to tilt. According to requirements the allowed tilting may be whatever subset of the full movement capability of 0 -> 90 deg. Preferable the axis of tilting is parallel to the surface of the second element (2).
- The loudspeaker units (5, 6) are mounted into the third element (3) such that the acoustical output is radiated away from the surface of the third element.
  One or more speaker units may be implemented according to product requirements. In a preferred embodiment two speakers are applied: one for high frequency sound radiation and one for medium frequency sound radiation.
- As part of the subsystem that detects a listening position (37) the detector of an infrared receiver (7) may be integrated into the surface of the third element. Alternative means may be implemented applying RF- or sound signal technologies.

[0026] Figure 2 illustrates different positions of the third element. The positions are examples of how the loudspeaker speaker units (5, 6) may be oriented towards a specific position in a listening room:

- In figure 2.a the second - and third element is rotated approximately - 45 deg. relative to the initial position in figure 1.
- In figure 2.b the second - and third element is rotated approximately - 90 deg. relative to the initial position in figure 1.
- In figure 2.c the second - and third element is rotated approximately - 90 deg. relative to the initial position in figure 1.
- In figure 2.d the second - and third element is rotated approximately - 90 deg., and the third element is tilted approximately - 45 deg. relative to the initial position in figure 1.

[0027] Figure 3 illustrates how ordinary X, Y coordinate systems defined the position of the speaker units (5, 6). A specific position may be defined by X, Y coordinates (8, 9) or an angle relative to the x-axis (8', 9'):

- Figure 3.a display an example of the rotation of the second - and third element into a position (8).
- Figure 3.b display an example of the tilting of the third element into a position (9).

[0028] Figure 4 illustrates how one of more speaker units is configured:

- Compensation filters (12, 12') are inserted into the signal path (11, 11'). The parameters determining the characteristics of a filter may be replaced dynamically according to an actual position of the speaker units. Individual filters are applied per speaker unit (14, 14').
- Individual amplifiers (13, 13') are applied per speaker unit (14, 14'). Active speakers may be applied. For efficiency reasons, i.e. to optimize physical size and power consumption versus output power performance, a technology like ICEpower from Bang & Olufsen may be used.

[0029] Typical applications of the speaker system as outlined may be into a stand alone loudspeaker or to be applied as an in-wall loudspeaker, or as an in-ceiling loudspeaker or as an in-floor loudspeaker, or as a loudspeaker in a home appliance and in media systems.

[0030] In figure 5 it is illustrated how two in-wall speaker systems (22, 23) are located in a room (20). One of the loudspeaker systems (22) is vertically aligned towards the listening position (21) and the other of the loudspeaker systems (23) is horizontally aligned towards the listening position (21).

[0031] In a room with a plurality of loudspeaker systems according to the invention, the filters to be applied dynamically per loud speaker unit in all systems may be configured according to different methods based on:

- Positions commanded externally from a user remote control device (36).
- A detected listener position, as deduced from an incoming source signal beam, e.g. an infrared signal (37).
- A detected position of other loudspeakers in the room, as deduced from an incoming sound signal received by the actual speaker system, e.g. a sound signal issued by another speaker unit in the room and received via a microphone (34') by the actual speaker system.

[0032] Figure 6 display the controller (30) of the loudspeaker system of one embodiment according to the invention:

- The sound signal (40, 11) is via the filters (12, 12') and the amplifiers connected to the loud speaker units (14, 14').
- The dynamic load and reload of the filter attributes is supported by data sourced in a table (39).
- The support of the filter management that is related to actual X, Y positions of the speaker units is supported by data sourced in a table (38).
- Archived filter attributes may be updated or modified by a reload af new data from an external source (35). The load may via a wired data link or via a wireless data link and sourced e.g. from a PC.
- A subsystem (37) supports the detection of the listening position by detecting the maximum of an incoming source signal e.g. infra red light beam. The system detects the maximum by analyzing different combinations of the rotation position and the tilt position.
- A subsystem (34) supports the detection of position of other loudspeakers in the room, as deduced from an incoming sound signal received via a microphone (34') by the actual speaker system.
- A subsystem (31) controls the motor that supports the rotational movement (33) and the tilt movement (33'). Standard means are applied for the control and the position of each of the motors, one to detect the X, Y position of the rotation (32) and one to detect the X,Y position of the tilt (32').

Claims

1. A speaker system, where the speaker units mounted in the speaker system may be configured into different positions to increase the acoustical performance perceived by the user, where said speaker system contains a mechanical structure consisting of four members:

   - a first member, where said first member may have any geometrical shape, where said member has a first surface and defining a circular innermost periphery of said first member;
   - a second member, where said second member may be arranged within the circular periphery provided on the first member, such that the second member may be rotate able around an axis perpendicular to, or close to being perpendicular to, the plane of the surface of the first member, and with the second member fully or partly having a material surface;
   - a third member being an integrated part of the second member or being a separate object mounted on top of the second member, and where said third member includes one or more speaker units mounted to deliver acoustical output directed away from the surface of the third member;
   - a fourth member, where said fourth member is support structure including a hinge for the third member and enables the third member to be tilt able around an axis horizontal to, or close to being horizontal to, the plane of the surface of the second member(2) and with the fourth member (4) attached to the second member(2).

2. A speaker system according to claim 1 wherein motor means controls the rotating of the second member and controls the tilting of the third member.

3. A speaker system according to claim 2 wherein the position of the speakers are obtained by passing information of X, Y coordinates related to the rotation of the second member to the second member motor means and by passing information of X, Y coordinates related to the tilting of the third member to the third member motor means.

4. A speaker system according to claim 3, wherein a predefined set of filter attributes are applied as the default correction filters to be in the signal path for each of the one or more speakers.

5. A speaker system according to claim 4, wherein one of the predefined set of X, Y coordinates defines the initial position of the second member.

6. A speaker system according to claim 4, wherein one of the predefined set of X, Y coordinates defines the initial position of the third member.

7. A speaker system according to claim 6, wherein the X, Y coordinates of the second member position may be forced to given values, and thus forced to a given position of the speaker, specified from an external control device.

8. A speaker system according to claim 6, wherein the X, Y coordinates of the third member position may be forced to given values, and thus forced to a given position of the speaker, specified from an external control device.

9. A speaker system according to claim 8, wherein a predefined plurality of individual set of X, Y coordinates are related

to the second member position and where a predefined plurality of individual set of other X, Y coordinates are related to the third member position and where an index is related to a set of corresponding filter attributes that applies in that specific speaker position.

10. A speaker system according to claim 9, wherein a predefined plurality of individual set of X, Y coordinates are related to the second member position and where a predefined plurality of individual set of other X, Y coordinates are related to the third member position and where an index is related to a set of corresponding filter attributes that applies in that specific speaker position and where the complete set of definitions may be replaced with data from an external source.

11. A speaker system according to claim 10, wherein the position of the second member and the position of the third member are determined from a detected maximum and or a detected minimum in a signal beam issued from a source located in the listening position of the user towards the speaker system.

12. A speaker system according to one or more of the claims above, wherein a predefined plurality of individual set of filter attributes are related to different speaker positions for each of the one or more speakers.

13. A speaker system according to one or more of the claims above, wherein a predefined set of filter attributes are selected and applied as the actual correction filter to be in the signal path for each of the one or more speakers, where the set of filter attributes are selected based on the X,Y position of the speaker.

14. A speaker system according to one or more of the claims above, wherein a predefined plurality of individual set of filter attributes related to speaker positions for each of the one or more speakers may be replaced with data from an external source.

15. Use of the speaker system according to any of the claims 1 to 14, implemented as a stand alone loudspeaker.

16. Use of the speaker system according to any of the claims 1 to 14, implemented as a built in loudspeaker, to be applied as in-wall loudspeaker, and/or as in-ceiling loudspeaker and/or as in-floor loudspeaker.

17. Use of the speaker system according to any of the claims 1 to 14, implemented as a loudspeaker in a home appliance and/or in media systems.

Figure 1

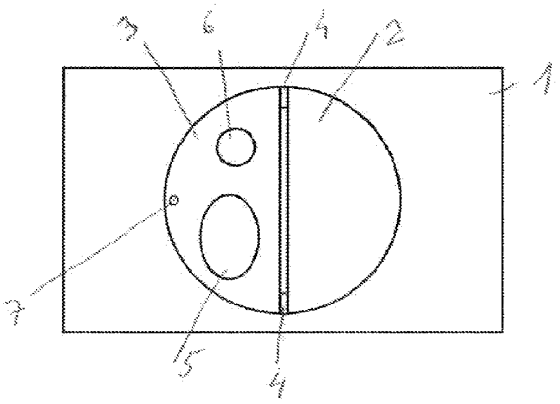


Figure 2

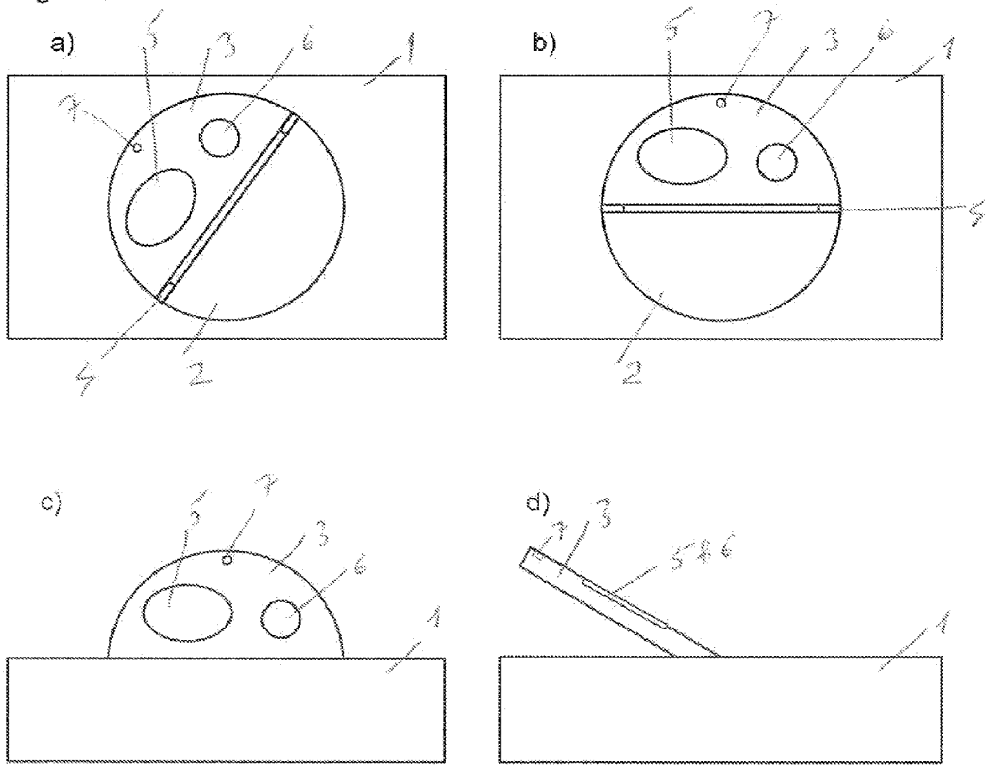


Figure 3

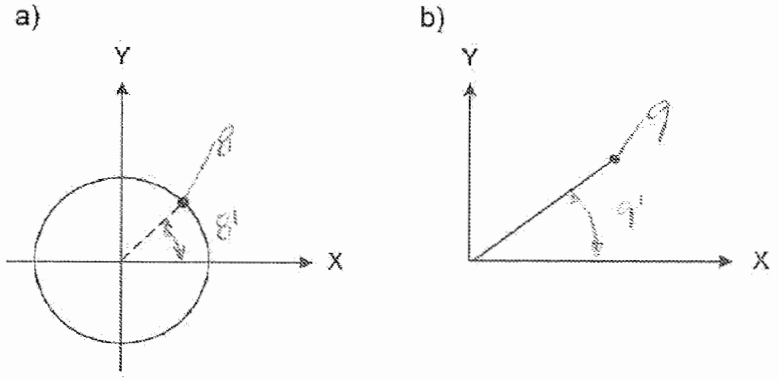


Figure 4

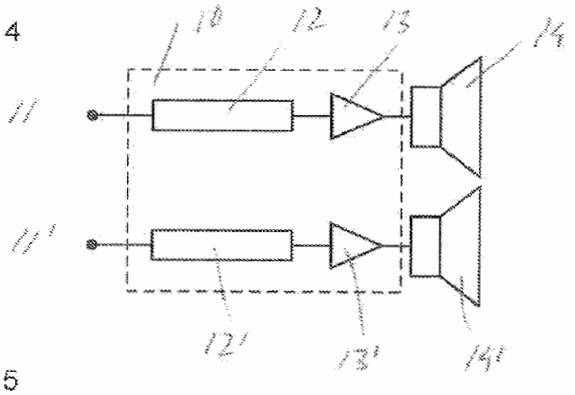


Figure 5

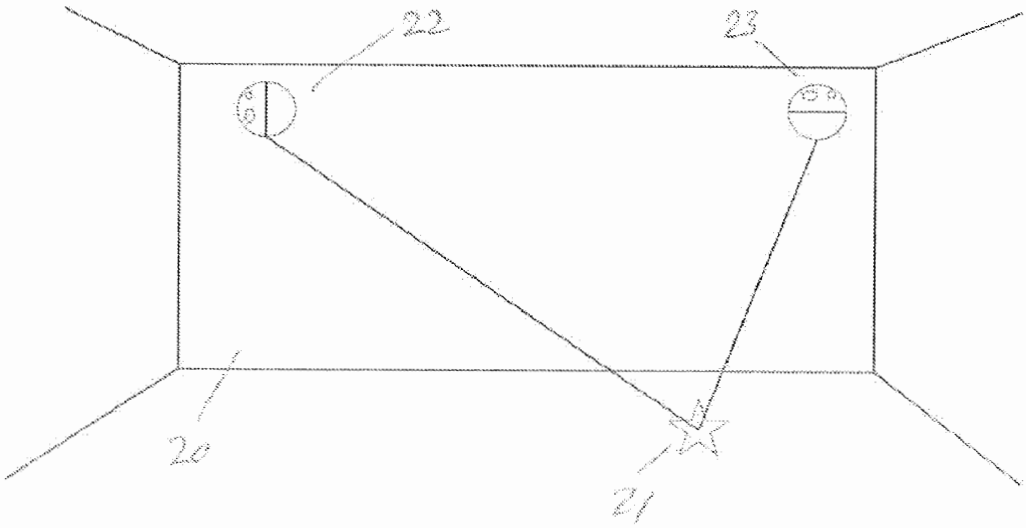
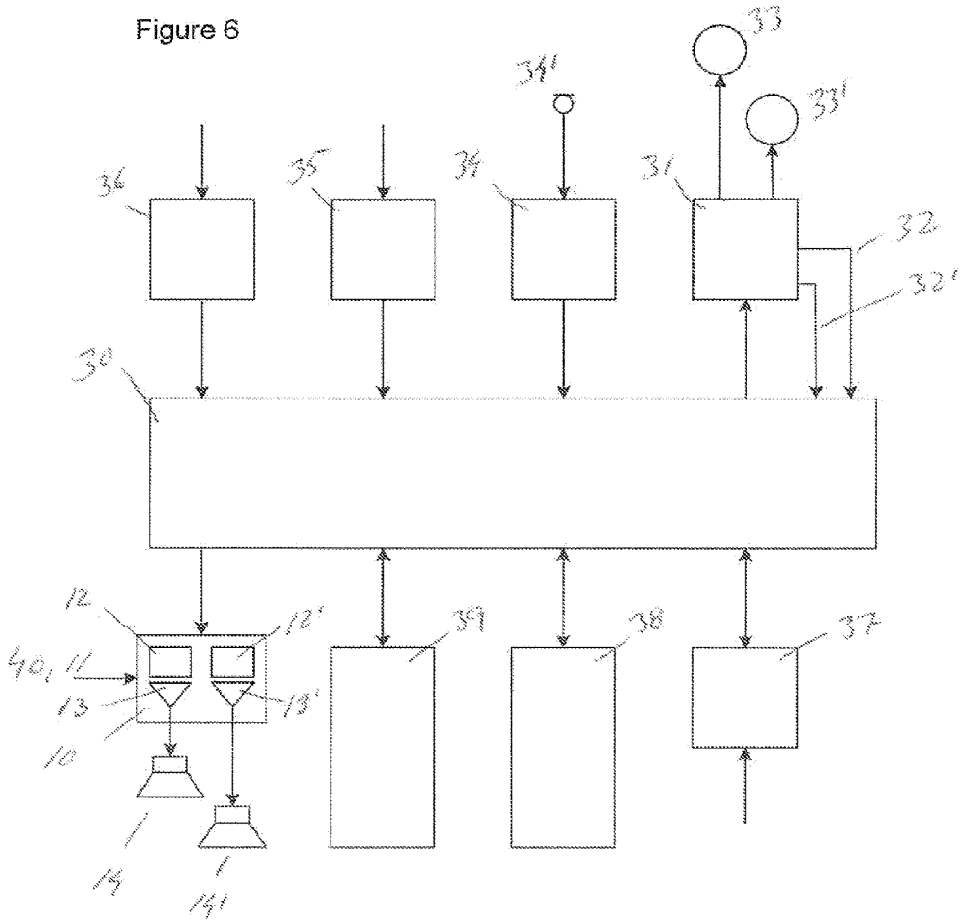


Figure 6



REFERENCES CITED IN THE DESCRIPTION

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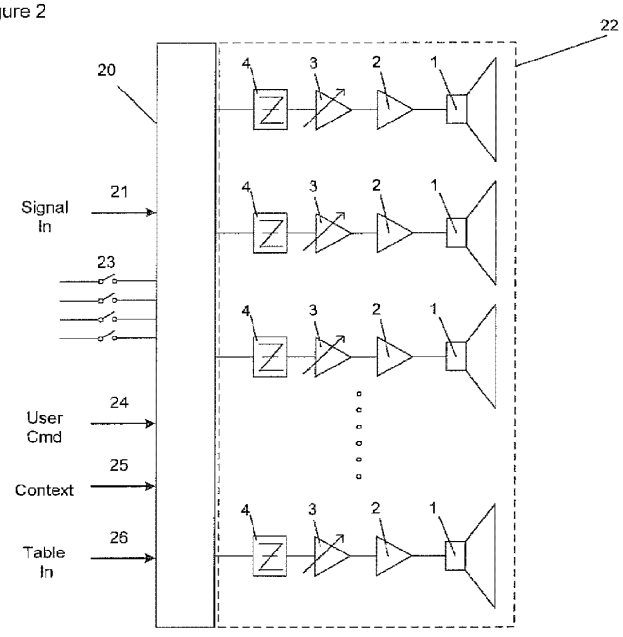
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(54) Configuring a sound field

(57) The present invention relates to a method and system for dynamic reconfiguring an audio reproduction system comprising two or more sound channels. The premises of the reconfiguring are being based on the position of one or more listeners and the one or more sound channels in the reproduction system. The feature obtained is a sound distribution into individual zones of sound fields.

The reconfiguring means are based on a digital signal processor that configures the sound channels by adjusting the equalization, the delay and the gain according to individual listener's position in a room/space.

Figure 2



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Description

Field of the Invention

[0001] The present invention relates to a method and system for dynamic reconfiguring an audio reproduction system comprising two or more sound channels. The premises of the reconfiguring are being based on the position of one or more listeners and the one or more sound channels in the reproduction system. The feature obtained is a sound distribution into individual zones of sound fields.

[0002] The invention includes digital signal processing, sound transducers, filters and amplifier configurations to be applied in surround sound systems and traditional stereophonic system, and to be applied in any domain like a home, in a vehicle, in a boat, in an airplane, in an office or in any other private or public domain, this being airports, shopping centres, sports arenas and theatres, i.e. in a PA system.

Background of the Invention

[0003] It is a well known problem in prior art loudspeaker systems operating in closed rooms/spaces e.g. a car, that the sound expired by the user may vary according to the listeners position in a space relative to the loudspeaker system transducers.

[0004] Furthermore systems have been developed for simplistic sound distribution, for example for use inside rooms or cars. The systems detect the configuration of the space and the presence of listeners, and reconfigure the sound output according to the number of listeners and their position relative to the loudspeakers. Such systems are disclosed in US2007/0211908, US2004/0240676 and DE102004022379.

Object of the Invention

[0005] Thus to obtain a certain perceived quality level of a loudspeaker system, e.g. in a car, the individual sound channels incorporating one or more loudspeaker modules must be calibrated and adjusted individually and according to the number of persons in the car, and their position in the space e.g. their seated positions.

[0006] This principle may be applied in any type of room like airplanes, boats, theatres, arenas, and shopping centres and alike.

[0007] In the public domain applications it would be a huge advantage to direct the sound fields primarily into zones where people are located and /or seated, this to avoid acoustical reflections from distributed speakers in areas where no people are located.

Description of the Invention

[0008] The invention discloses a surround sound system where different sound settings may be enabled via digital signal processing means controlling the individual sound channels parameters e.g. the equalization (filters), the delay, the gain (amplification). The premise for the control is based upon the listener's position in the listening room/space.

[0009] In a more advanced embodiment of the invention the control and sound setting may work in a contextual mode of operation to accommodate for:

- the position of the one or more listeners;
- a functional mode of operation, e.g. adjust the sound system settings to be in movie mode;
- the type of music, e.g. rock;
- the time of the day; e.g. morning/day/night/Christmas etc.

[0010] The invention discloses a solution that in an automatically mode of operation may fulfil the stated requirements and solve the related technical problems.

[0011] In summary the invention includes:

- sensor means to detect a listener position;
- a mode of operation related to a user position or a required function;
- Information available according to context (place, time and music content);
- multi channel sound system, e.g. two channels stereo, a 5.1 surround sound system;
- digital controlled sound system e,g. digital control of gain, equalization and delay;
- active speakers including amplifiers and filters for each loudspeaker transducer.

[0012] The digital control of the sound system is based on standard means for:

- gain: adjust the signal by a certain level, i.e. + /- xx dB, e.g. +0.1 dB;
- delay: the signal is delayed by a specific time, i.e. yy ms, e.g. 100 ms;
- EQ: the signal is filtered according to the Finite Impulse Response principle (FIR) or the signal is filtered according to the Infinite Impulse Response principle (IIR); a number of coefficients are specified; the number of parameters typically to be from 1 -> 1000.

[0013] The invention may be implemented in different embodiments, in which the alternative reconfiguring procedures may be implemented as:

- a traditional algorithm in terms of a sequential software program in which the values of the resulting adjustment parameters are embedded in the code itself; the algorithm validates according to a specified system structure of an actual loudspeaker configuration;
- a table based concept in which one or more tables defines the attributes to be applied per loudspeaker channel versus the mode of operation, the listener position and other context related information (e.g. time).

[0014] In a first aspect of the invention a method for automatic reconfiguring an audio reproduction system comprising two or more sound channels where the reconfiguring has the steps:

- determine the physical position of one or more listeners,
- apply the physical position as information to select a set of predefined or calculated (in situ) sound parameters, the set of parameters to include settings for equalization, gain and delay per sound channel,
- optionally apply other context related information to select a set of predefined sound parameters,
- optionally apply other user commanded information to select a set of predefined sound parameters, and
- provide the set of parameters per sound channel accordingly.

[0015] The fundamental goal of the invention is to enhance the perceived sound quality seen from a listener prospective. Regardless of the physical position of the loudspeakers, a virtual sound field may be generated and directed so it appears to be anywhere the listener may desire. This is obtained by adjusting the gain, the delay and the equalization parameters of the individual sound channels in a multichannel sound system.

[0016] In another aspect the reconfiguring process validates the position of the one or more users, and/or functional premises and/or context related premises and or content related premises as part of the reconfiguring of the one or more sound channels that constitutes the configured loudspeaker system, and where the validation prioritizes the position of one or more listeners.

[0017] According to specific requirements of a sound providing system miscellaneous features may be offered and controlled automatically and/or commanded by the user. The features may be used individually and/or mixed in a way that accommodates the user's demands. A predefined combination of sound settings per channel and the functional options supports the processing. Examples of functional options are:

- seat priority: driver, all, back, front, centre, left, right etc.;
- a persons physical position: in a room, in a car, in a PA domain etc.;
- zone priority: a zone includes one or more specific sound channels;
- mode priority: movie, music, speech;
- channel mode: stereo, surround sound 5.1, or other multi channel system of any order;
- group of people: one or more listeners in a zone;
- the time of an event.

[0018] The reconfiguring process is provided as one or more algorithms to provide the calculation of each of the values of the sound channel adjustment variables.

[0019] In a preferred embodiment the reconfiguring process is provided as a table with relations provided to be accessed by the digital signal processor to provide each of the values of the sound channel adjustment with variables.
The saved attributes and key parameters are loaded into the reconfiguring means supported by electronic means, means that is connected wirelessly or connected by wire to the audio reproduction system.

[0020] In a third aspect of the invention the reconfiguring process provides the settings of the sound parameters; gain, equalization and delay for one sound channel, to be applied in one sound field zone related to the physical position of first group of people including one or more listeners.
To accommodate for the handling of more zones including different groups of people the reconfiguring process provides

the settings of the sound parameters; gain, equalization and delay for one sound channel, to be applied in one sound field zone related to the physical position of one or more other groups of people including one or more listeners.

[0021] In yet another aspect a listener position is detected via standard sensor means like switches or infrared detectors or strain gauges or temperature sensitive detectors.

[0022] The configuring process is to be automatically executed and/or controlled by the audio amplifier means, including a digital signal processor, which drives the loudspeaker system. The reconfiguring means is embedded into an audio reproduction system.

[0023] In a preferred embodiment, the reconfiguring is controlled via a table mapping the mode of operation to adjustment parameters for each speaker in every channel or just relevant channels. The adjustment parameters are e.g. but not limited to: equalization, delay and gain.

[0024] The table may be represented as one or more data set as most appropriate to the digital controller unit. E.g. one data set may contain the relations among:

- listener position,
- loud speaker channel #,
- parameter settings (EQ, delay, and gain).

[0025] Another data set may contain the functional/mode related information like:

- functional settings (movie, audio only),
- loud speaker channel #,
- parameter settings (EQ, delay, and gain).

[0026] This table concept is considered to be a data driven control systems, and enables for easy updates of the functional behaviour of a specific system simply by loading alternative data set into the controller.

[0027] In addition, the invention includes a constraint Solver, which comprises a table with digital data representing the constraints of the passenger(s) position(s) and related acoustical adjustment, attributes and corresponding variable values.

The constraint solver processing enables an arbitrary access mode to information with no order of sequences required. This is an important advantage over prior art tree-like programming structure, where the starting point is given by the root of the tree. Especially, when finding ways from nodes within the tree-like program to a specific target location in the tree, it may be obscure with regard to which way to chose, whether backwards or forwards, and the final solution may be a new start from the root.

[0028] According to the invention, the product configuration domain table is organized as relations among variables in the general mathematical notation of 'Disjunctive Form':

AttribVariable 1.1 and AttribVariable 1.2 and AttribVariable 1.3 and Attrib Variable 1.n
Or AttribVariable 2.1 and AttribVariable 2.2 and AttribVariable 2.3 and Attrib-Variable 2.n
Or ....
Or ....
Or AttribVariable m.1 and AttribVariable m.2 and AttribVariable m.3 and AttribVariable m.n

[0029] For example, AttribVariable 1.1 may be defining a passenger seat position, AttribVariable 1.1 a speaker transducer unit, AttribVariable 1.3 a speaker system/subsystem and AttribVariable 1.n gain value for the transducer unit. In another example, AttribVariable 2.n may be a reference to another table.

[0030] An alternatively definition term is the 'Conjunctive Form':

AttribVariable 1.1 or AttribVariable 1.2 or AttribVariable 1.3 or AttribVariable 1.n
And AttribVariable 2.1 or AttribVariable 2.2 or AttribVariable 2.3 or AttribVariable 2.n
And ....
And ....
And AttribVariable m.1 or AttribVariable m.2 or AttribVariable m.3 or AttribVariable m.n

[0031] With this method of defining the problem domain, it becomes a multi-dimensional state space enabling equal and direct access to any point in the defined set of solutions. The term multidimensional has to be understood as a contrast to a tree-like programming structure, which is two-dimensional.

[0032] According to the invention, the product configuration function proceeds by finding the result of the interrogation in the set of allowed and possible combinations in one or more Configuration Constraint Tables. According to definitions

made in the configuration constraint tables, the result might be:

- a list of variables useful in the application e.g. gain, and filter setting i.e. equalization, for the one or more transducers;
- a list of variables useful in the application e.g. delay for the one or more transducers;
- a list of variables useful in the application to configure individual sound domains to related to zone of sound of targeted to one or more users.

[0033] Alternative configurations may be evaluated by the constraint solver, the alternatives being one or more of the defined set of legal combination in the constraint table.
The example illustrates alternative solutions for x, y when y is given:
[0034] The: If x Then y may be represented as x -> y
[0035] With the truth table:

x	y	x->y
0	0	1
0	1	1
1	0	0
1	1	1

Given the premise x is '1' the conclusion y is '1'.
Given the conclusion y is '1' the premises for x may be '1' or '0'.

Thus, when y is '1' the alternative for x are '1' or '0'.
[0036] Represented in a constraint table the x -> y has the legal combinations of x, y:

x	y
0	0
0	1
1	1

[0037] Table entries in a constraint table may be combined into legal/illegal combination such that all the well known logical operators known from the Boolean algebra will be included as required. The logical operators being: AND, OR, NOT, XOR, Logical Implication (->), Logical Bi-implication (=).
[0038] An example of a table definition is displayed below:

Mode or position	Speaker channel #	Other (e.g. time, content)	Equalization EQ	Delay	Gain
Driver	1		p-val-d1	q-val-d1	r-val-d1
	2		p-val-d2	q-val-d2	r-val-d2
	.....		.....	.....	.....
	n		p-val-dn	q-val-dn	r-val-dn
Front	1		p-val-f1	q-val-f1	r-val-f1
	2		p-val-f2	q-val-f2	r-val-f2
	.....		.....	.....	.....
	n		p-val-fn	q-val-fn	r-val-fn
Rear	1		p-val-r1	q-val-r1	r-val-r1
	2		p-val-r2	q-val-r2	r-val-r2

(continued)

Mode or position	Speaker channel #	Other (e.g. time, content)	Equalization EQ	Delay	Gain
	.....		.....	.....	.....
	n		p-val-rn	q-val-rn	r-val-rn
All	1		p-val-a1	q-val-a1	r-val-a1
	2		p-val-a2	q-val-a2	r-val-a2
	....		.....	.....	.....
	n		p-val-an	q-val-an	r-val-an
Movie	1		p-val-m1	q-val-m1	r-val-m1
	2		p-val-m2	q-val-m2	r-val-m2
	.....		.....	.....	.....
	n		p-val-mn	q-val-mn	r-val-mn
.....	.....				
Other	1		p-val-o1	q-val-o1	r-val-o1
	2		p-val-o2	q-val-o2	r-val-o2
	.....		.....	.....	.....
	n		p-val-on	q-val-on	r-val-on

[0039] Thus in an aspect of the invention the reconfiguring means is embedded into an audio reproduction system. Thus the system becomes the controller of the re- configuring process that provides a reconfiguration of the system itself.

Description of the Drawing

[0040] In the following, preferred embodiments of the invention will be described with reference to the drawings wherein:

Figure 1 displays components that constitute examples of loudspeaker module configurations, that represent one sound channel configuration;
Figure 2 displays an example of an embodiment of the invention displaying a plurality of sound channels;

[0041] Figure 1 display components that constitute examples of loudspeaker module configurations related to one sound channel.
A loudspeaker transducer unit (1) is the fundamental means that transforms the electrical signal to the sound waves produced by movements of the membrane of the transducer unit. Any standard transducer unit may be applied in the invention.
The characteristics of each loudspeaker transducer unit are determined by measurement and/or from specifications delivered by the supplier of the unit.
[0042] In the preferred embodiment an audio reproduction system comprising active sound transducers including an amplifier (2) is provided for each transducer unit (1). This type of amplifier is e.g. the technology ICEpower from Bang & Olufsen DK.
[0043] In a high quality audio reproduction system a dedicated filter means, an equalizer, (3) is provided per amplifier (2). The means (3) provides a frequency dependent amplification to control the overall gain, which may be regulated up or down as required. Means for down regulation may be as simple as adjustment of a resistive means serial connected to the loudspeaker module.
[0044] To control the sound distribution into individual zones of sound fields the sound delay among channels must be controlled. In a preferred embodiment the delay (4) is controlled individually per sound channel.
[0045] Figure 2 displays the example of an audio reproduction system comprising loudspeaker modules configured

in a multi channel concept e.g. a 5.1 surround sound system.
In fact any number of channels (22) may be handled; having a corresponding table complex related according to the actual functional system requirements.

[0046] The audio reproduction system may be an audio amplifier (20), including a digital signal processor, for controlling and driving the loudspeaker channels (22), and to provide a signal (21) that's amplified and filtered and delayed accordingly.

[0047] Input from sensor means (23) determines the mode and functional operation of the control system and may be of a different nature e.g. but not limited to: simple switch, accelerometer, infrared detection, thermal sensing etc.
In the preferred embodiment the sensors primarily detects the position of a user in a room/space, the position to be related to the sound field that's relevant for the one or more users /listeners.
E.g. in a vehicle the detection of a user's position is where the individual user is seated. The detection in this system may be via a simple switch in every seat, or via switches related to the security belts.

[0048] Additional control signals may be received as user commands (24), e.g. a command to 'enable automatic sound control' and a context related information (25), e.g. information about the time of the day and/or the type of music actual in play. The additional control signal information to be used as input into the digital signal processor to control mode and functional operation of the sound system.

[0049] In a preferred embodiment the reconfigure means is imbedded into the controller of the audio sound system. Thus the audio sound system is the master having the digital signal processor means (20) that initiates, controls and applies the reconfiguring process. Alternative table definitions may be loaded into the digital signal processor (20) from external means e.g. a laptop/PC (26).

[0050] The invention may be applied in relation to automatically adjusting an audio sound system to a maximum level of quality taking into account the position of individual listeners in dedicated zone of sound fields.

[0051] The invention includes sound channel configurations to be applied in surround sound systems and traditional stereophonic system, and to be applied in any domain like a home, in a vehicle, in an airplane in a boat, in an office or in any other public domain and alike.

Claims

1. A method for dynamic and automatic reconfiguring an audio reproduction system comprising two or more sound channels where the reconfiguring has the steps:

   - determine the physical position of one or more listeners,
   - apply the physical position as information to select a set of predefined or calculated sound parameters, the set of parameters to include settings for equalization, gain and delay per sound channel and/or per loudspeaker transducer,
   - optionally apply other context related information to select a set of predefined sound parameters,
   - optionally apply other user commanded information to select a set of predefined sound parameters, and
   - provide the set of parameters per sound channel and/or per loudspeaker transducer accordingly,

   and where the reconfiguring method is **characterized by** a constraint solver, which constraint solver finds one or more legal combinations among defined legal combinations predefined in a constraint table.

2. A method according to claim 1, where the reconfiguring process validates the position of the one or more users, and/or functional premises and/or context related premises and/or content related premises as part of the reconfiguring of the one or more sound channels that constitutes the configured loudspeaker system, and where the validation prioritizes the position of the one or more listeners.

3. A method according to any preceding claim where the reconfiguring process provides the settings of the sound parameters; gain, equalization and delay for one sound channel, to be applied in one sound field zone related to the physical position of a first group of people including one or more listeners.

4. A method according to claim 3 where the reconfiguring process provides the settings of the sound parameters; gain, equalization and delay for one sound channel, to be applied in one sound field zone related to the physical position of one or more other groups of people including one or more listeners.

5. A method according to claim 1, where a listener's position is detected via sensor means like switches or infrared detectors or strain gauges or temperature sensitive detectors.

6. A method according to any preceding claim, where the reconfiguring means is embedded into an audio reproduction system.

7. A method according to claim 1,**characterised in that** the constraint table comprises digital data representing the constraints of the

    1) Passenger(s) position(s), and related acoustical adjustment, attributes and corresponding variable values, and/or
    2) Passenger(s) position(s)" loud speaker channel number, parameter settings (EQ, delay, gain) and/or
    3) Functional settings, such as movie,audio only, loudspeaker channel number, parameter settings (EQ, delay, gain).

8. A method according to claim 1, **characterised in that** the constraint table is configured as a multi dimensional state space, defining relations among variables in either disjunctive form or conjunctive form.

9. A audio system comprising means for carrying out the method according to any of claims 1 to 8, **characterised in that** the automatic reconfiguring is applied on an audio reproduction system comprising two or more sound channels, each channel being active and with individual means for equalization and amplification, the system to constitute an audio reproduction equipment in a room, in a vehicle, in an airplane, in a boat, in a PA system and alike.

Figure 1

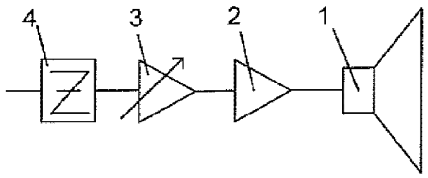
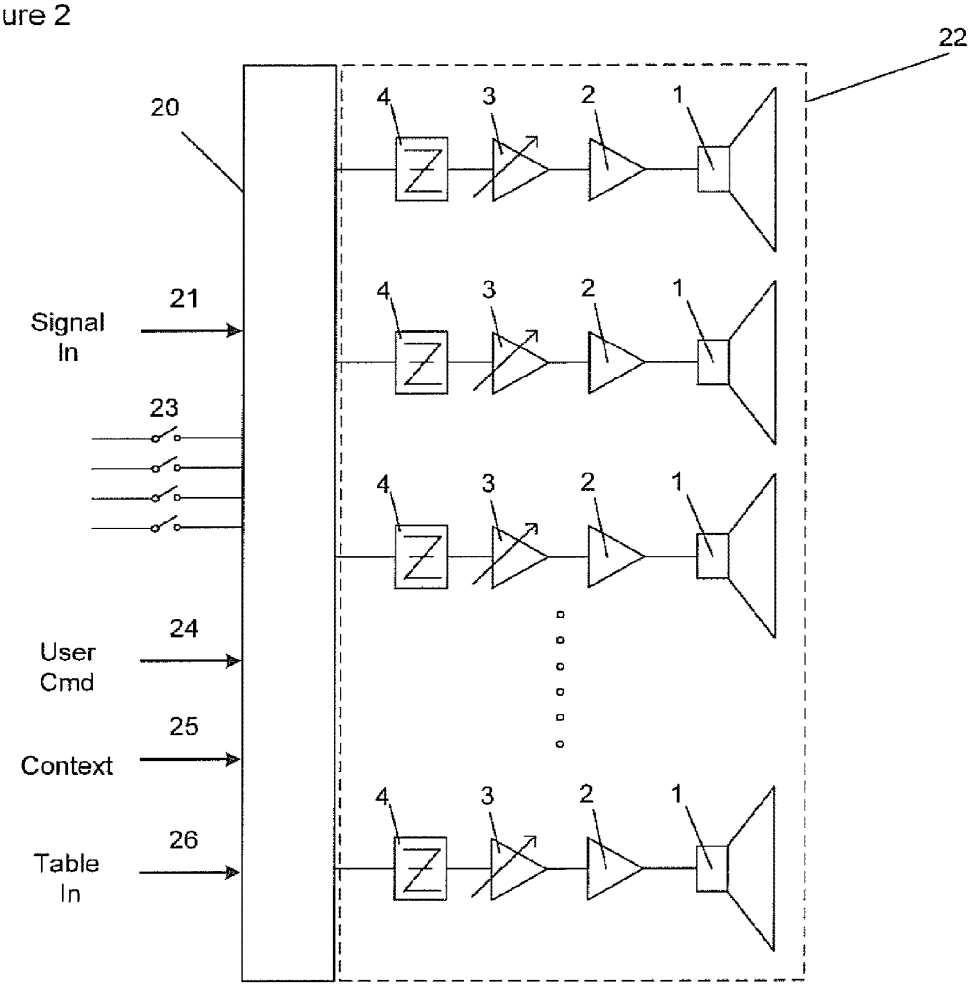


Figure 2



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(54) **ADAPTIVE SOUND FIELD CONTROL**

ADAPTIVE KLANGFELDSTEUERUNG

COMMANDE ADAPTATIVE DE CHAMP ACOUSTIQUE

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Description

TECHNICAL FIELD

[0001] The invention relates generally to a method and a system for controlling loudspeakers in a room and more specifically to such methods and systems optimised for use in small and/or closed enclosures, such as the cabin of a vehicle, for instance a car.

BACKGROUND OF THE INVENTION

[0002] Methods and systems having the capability to adjust a speaker system to its environment are known within the art. Such methods and systems comprise for instance single point room equalization, obtained by measuring sound pressure in one point near the listening position and subsequent direct inverse filtering. Another prior art procedure comprises adjusting a loudspeaker to its acoustic environment and controlling the acoustic energy in the sound field. Still another procedure comprises adjusting the loudspeaker according to the listening position.

SUMMARY OF THE INVENTION

[0003] The invention is defined by the appended claims.

[0004] The present invention differentiates from the prior art at least with respect to the following aspects:

- Adjustment of the performance in the full audible frequency range.
- According to the invention there are provided a number of individual options for adjustment, such as:
- Acoustic power output (distributed energy);
- Room gain, which may vary according to the actual room design;
- Optimal listening position;
- Listening position combined with supplemental measurements in several positions;
- Real-time adaption, by applying a subset of measurement points from the complete set of possible measurement points;
- Pre-shaped adjustments according to predefined knowledge data.

[0005] A specific embodiment of the method and system according to the invention will be described in detail in the following, but it is understood that other embodiments, for instance of the various functional entities used in the method and system would also be possible and would fall within the scope of the present invention which is defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The present invention will be better understood by reading the following detailed description of an embodiment of the invention in conjunction with the drawings, wherein:

Figure 1 shows the three main elements (the acoustic power output from the loudspeakers, the room gain and the listening position interface) of the present invention;

Figure 2 shows sampling of energy or power in a sound field in a room;

Figure 3 shows the measurement of room gain in a room or enclosure by using a special measurement loudspeaker that could be placed at any position in the room or enclosure;

Figure 4 shows an example of a special measurement loudspeaker placed in a car at one of the listening positions. The measurement loudspeaker is fitted with special means to allow easy and reproducible measurement of sound

pressure in two positions in the close near field of the loudspeaker diaphragm;

Figure 5 shows measuring the listening position interface at a particular listening position; and

Figure 6 shows real time adaptation that tracks changes of the energy or power in the sound field based on measurements of sound pressure at a subset of random positions, for instance three positions as shown in this figure.

DETAILED DESCRIPTION OF THE INVENTION

[0007] In the following, a specific embodiment of the invention will be described in detail, but it is understood that this embodiment only constitutes an example of how the general concepts of the present invention can be implemented in practice.

[0008] A basic concept of the present invention is that the total transmission path from the electrical input terminal(s) of the loudspeaker(s) to the sound pressure generated at the ears of a listener in an enclosure can be described to constitute three main elements: (i) the acoustic power emitted from the one or more loudspeakers into the enclosure when the one or more loudspeakers are provided with electrical input signals, (ii) the influence of the acoustic properties of the enclosure itself on the sound field created in the enclosure, i.e. on the distribution of sound pressure and hence on average sound pressure generated in the enclosure by the one or more loudspeakers emitting acoustic power into the enclosure, and (iii) the coupling or interface between the created sound field in the enclosure and a listener located at a given position in the enclosure. This is illustrated with reference to figure 1 that shows the three elements that participate in creating a sound field 10 in an enclosure 1 such as a listening room or automobile cabin. An example of how these three elements can be measured in practice is illustrated with reference to figures 2 through 6.

[0009] As shown in figure 1, one or more loudspeaker drive units 2, 3, 4 emit a total acoustic power into the sound field 10 depending on the coupling to the sound field 10 from each driver position and the interaction between the drive units. Depending on the acoustic properties of the listening room/enclosure, more or less power averaged sound pressure will be created in the room/enclosure for a given acoustic power output into the sound field. In order to characterize the influence of the room on the sound field generated herein, the quantity room gain is introduced. Room Gain is here defined as the ratio between the squared power averaged sound pressure in a room and the acoustic power into this room.

[0010] A listener's access to the sound field 10, i.e. his ability to receive sound energy from a sound field and at the specific place herein in which he is located, depends on the coupling to the sound field at the actual listening position. A listener is in figure 1 schematically indicated by the head 6. This coupling can be described by the radiation resistance at the listening position, for instance measured by placing a loudspeaker (14 in figures 3, 4 and 5) in the listening position and measuring the radiation resistance seen by this loudspeaker into the sound field.

[0011] Below follows a detailed description of methods for calculating the above three contributions to the total transmission path and how to determine an electronic filter for obtaining a specific target transmission from the electrical input to the loudspeakers to the ears of the listener.

[0012] Figure 2 shows how the energy or power in a sound field can be measured by power averaging a number of measured sound pressures at random positions 9 scattered across the entire space in both x, y and z directions (length, width and height directions). It is understood that although the figures represent the sound field in only two dimensions, the actual field will of course be three-dimensional, and measurement points generally should be distributed throughout the three-dimensional space. Equation I below shows how to calculate the power averaged sound pressure. The number of random positions must be higher than 1 and in a preferred embodiment it will be 9 positions, but good results can be obtained with 4 positions.

$$p_{channel\_average} = \sqrt{\frac{\sum_{i=1}^{N} \left| p_{channel\_i}(f) \right|^2}{N}} \qquad (1)$$

[0013] $p_{channel\_average}$ is the power averaged sound pressure for a given content channel, e.g. front left channel. $p_{channel\_i}$ is the measured transfer function from the input 5 to a power amplifier (not shown)to the sound pressure at the i'th random position, for instance the one designated by 9' in figure 2.

[0014] Figure 3 illustrates a method of measuring the room gain in a room/enclosure by using a special measurement loudspeaker 14 that can be placed anywhere in the room.

[0015] After placing the special measurement loudspeaker 14 at a chosen position in the room/enclosure as shown

in figure 3, sound pressure at a number of random positions I 1 is measured while emitting acoustic signals through the measurement loudspeaker 14. Equation 2 shows how to calculate the power averaged sound pressure $p_{RG\_average}$ of the sound pressures at these random positions.

$$p_{RG\_average} = \sqrt{\frac{\sum_{i=1}^{N} |p_{RG\_i}(f)|^2}{N}} \quad (2)$$

[0016] $p_{RG\_average}$ is the power averaged sound pressure when emitting acoustic signals through the special measurement loudspeaker 14 (the abbreviation RG stands for Room Gain). Figure 4 shows a practical example of such a special measurement loudspeaker mounted at a specific location in an automobile cabin. p_{RG_i} is the transfer function between the inputs to the power amplifier to the measured sound pressure at the i'th random position. (It should be noted that throughout this specification, all generated sound pressures are normalised with respect to the input voltage to the respective amplifiers. It is hence correct to designate for instance the quantity p_{RG_i} as a transfer function).

[0017] While keeping the measurement loudspeaker 14 in the same position (see figure 3), the transfer function from the input of the power amplifier to the sound pressure at two positions 12 and 13 differently spaced from the loudspeaker diaphragm but both in the very near field of the diaphragm is then measured. The distance from the diaphragm to the closest position 12, in which position the sound pressure p_1 is measured, could be e.g. 4 cm while the distance to the other position, in which position the sound pressure p_2 is measured, could be e.g. 9 cm. Equation 3 shows how to calculate the mechanical radiation resistance, $R_{m,s} = Re(Zm,r)$, from the two sound pressures p_1 and p_2 in the near field of the measurement loudspeaker 14.

$$R_{m,r} = \mathrm{Re}\left(j \cdot g \cdot f \cdot \frac{p_1}{p_1 - p_2} \right) \quad (3)$$

[0018] g is a real valued constant describing the scaling due to geometry etc. But g is unimportant in the application and can be set to 1.

[0019] Figure 4 displays one example of a special measurement loudspeaker 14 placed in a car at one of the listening positions. The measurement loudspeaker 14 is fitted with special means 15 to allow easy and reproducible measurement of sound pressure in two positions in the close near field of the loudspeaker diaphragm.

[0020] After calculating the mechanical radiation resistance from equation 3 it is possible to calculate the acoustic power output using equation 4.

$$Pa_{RG\_actual} = \frac{1}{2} \cdot R_{m,r} \cdot |v_{RG}|^2 \quad (4)$$

[0021] v_{RG} is the diaphragm velocity of the measurement loudspeaker, which can be estimated from the difference between the two near field sound pressures p_1 and p_2 as given in equation 5. As for the constant g mentioned above, h is also a real valued constant, which is a function of geometry, out which can be set to I here.

$$v_{RG} \approx h \cdot \frac{1}{j\omega} \cdot (p_1 - p_2) \quad (5)$$

[0022] The Room Gain in the actual room/enclosure can now be calculated from the definition given by equation 6.

$$Room\ Gain = \frac{p_{RG\_average}^2}{Pa_{RG\_actual}} \quad (6)$$

[0023] Figure 5 shows how the special measurement loudspeaker 14 is used to determine the listening position interface at a particular listening position. This measurement can be repeated for as many listening positions as desired. Individual filters can then be designed for each listening position or an average filter can be designed. According to a specific embodiment of the invention, the listening position interface filter is left out, whereby a global equalizing can then be designed. The listening position interface and the corresponding part of the speaker equalization filter, Listener(f), is hence to be regarded as an option.

[0024] The listening position interface is obtained from a similar measurement of two sound pressures at positions 12 and 13, respectively, in near field of the measurement loudspeaker. Again equation 3 can be used to calculate the mechanical radiation resistance from the two measured sound pressures.

Adaptive Sound Field Control Equalization Filters:

[0025] The total equalization filter is split into two main components: a speaker equalization filter and a listening position interface equalization filter as described in equation 7.

$$ASFC(f) = Speaker(f) \bullet Listener(f) \tag{7}$$

[0026] The speaker equalization filter ensures generation of a desired sound field in the room/enclosure while the listening position interface equalization filter compensates for the actual access to the generated sound field.

[0027] The total acoustic power output from the loudspeaker driver(s) for a given content channel can be calculated from the power averaged sound pressure and the measured Room Gain by using equation 8.

$$Pa_{channel\_actual} = \frac{p^2_{channel\_average}}{Room\ Gain} \tag{8}$$

[0028] Then the speaker equalization filter can be calculated from equation 9.

$$Speaker(f) = \sqrt{\frac{Pa_{Adaptive\ Target}(f)}{Pa_{channel\_actual}(f)}} \tag{9}$$

[0029] $Pa_{Adaptive\ Target}$ is a desired target function for the acoustic power output, which may be fixed, selectable or adaptive as a function of the measured total acoustic power output. This target function may also include the difference between a desired Room Gain and the actual Room Gain measured in the room/enclosure. A desired Room Gain may also be fixed, selectable or adaptive to the actual room. According to one embodiment of the invention, the desired Room Gain is equal to the actual Room Gain, i.e. preserving the natural Room Gain in the actual room. An alternative embodiment is to use a desired Room Gain equal to the Room Gain in a particular room of choice, e.g. an IEC 268-13 standard listening room.

[0030] A procedure of pre-shaping and aligning the response of the loudspeakers in the room/enclosure may precede all the measurements described in this document. This is equivalent to designing the basic loudspeaker in a particular room different or equal to the room of usage before applying this procedure for adapting to the actual room/enclosure of usage. E.g. a general trend of decreasing level with increasing frequency can be imposed onto the loudspeaker system before starting the described procedure for adapting the loudspeaker to the room/enclosure. Another example is performing dedicated equalization on a specific loudspeaker driver to correct known problems with that loudspeaker driver, which may be independent of the actual room of usage. Also specific equalization in the actual room/enclosure of usage may be applied before the room adaptation procedure is started.

[0031] Equation 10 gives the listening position interface equalization filter target.

$$Listener(f) = \sqrt{\frac{R_{m,r,reference\ listening\ position}(f)}{R_{m,r,actual\ listener\ position}(f)}} \qquad (10)$$

[0032] The radiation resistance in a reference listening position, $R_{m,r,reference\_listening\_position}$ can be measured in a listening position where the access to the sound field is considered to be optimal. E.g. a listening position where the step of pre-shaping and equalization before the procedure of adapting to the room/enclosure is optimized may be used for this reference. A preferred embodiment is, however, to use $R_{m,r,reference\_listening\_position}$ equal to the radiation resistance in free field because in free field, a listener has equal access to all frequencies. The theoretical radiation resistance in free field for a point source is frequency squared multiplied by a constant depending on geometry.

[0033] Equation 11 now gives the complete equalization filter for an Adaptive Sound Field Control (ASFC) system according to the described embodiment of the invention.

$$ASFC(f) = \sqrt{\frac{Pa_{Adaptive\ Target}(f) \bullet R_{m,r,reference\ listening\ position}(f)}{Pa_{channel\_actual}(f) \bullet R_{m,r,actual\ listener\ position}(f)}} \qquad (11)$$

[0034] A special case is when no specific listening position is considered, i.e. equalization globally valid to the whole room/enclosure. Then the total equalization filter reduces to the speaker equalization filter, as in equation 12.

$$ASFC(f) = \sqrt{\frac{Pa_{Adaptive\ Target}(f)}{Pa_{channel\_actual}(f)}} \qquad (12)$$

Real time adaptation

[0035] Another aspect of the present invention is the possibility of real time adaption to any changes of loudspeaker drivers and acoustic properties of the room/enclosure. Loudspeaker drivers are known to change as a function of aging and environment changes like temperature and humidity. Also playing loud music will heat the loudspeaker drive units and in particular the voice coils, which will also change the characteristics of the drive units,

[0036] Changing the acoustic properties of the room/enclosure can occur for numerous reasons, for instance as a consequence of how many people are present in the room/enclosure, opening or closing a window/door, opening or closing the roof in a car, fitting more or less furniture/baggage etc. into the room/enclosure. Using room adaptation according to the present invention provides a new possibility of tracking such changes in real time. The whole procedure can be repeated under different configurations, e.g. open/closed windows, and the corresponding equalization filters can be stored and selected manually or automatically when the same configuration happens during use. Alternatively, the whole or a part of the procedure can be performed during actual use in the actual configuration.

[0037] According to a preferred embodiment of the present invention, a subset of the random positions is chosen that has been proved to contain the major part of information obtained by the full set of random positions. Experiments show that a subset of 3 positions can be selected to track the changes due to changes in loudspeaker drive units and/or acoustic properties in the room/enclosure. This is shown in figure 6.

[0038] The three positions are sufficient when combining with the knowledge obtained in the full set of random positions in an initial design or calibration step. The initial or calibration step may be a collection of measurements in different configurations that can be manually selected or automatically selected when the configuration changes.

[0039] Figure 6 shows a real time adaptation tracking changes from measurement of sound pressure at a subset of random position, e.g. three positions.

[0040] In order to be able to carry out the adaptation in real time, i.e. during actual operation of for instance an automobile, those parts of the filter that are determined by means of the dedicated measurement loudspeaker 14 either located at the described position used for determining room gain RG(f) or for determining the listening position interface,

are preferably pre-recorded during an initial or calibration phase, as the measurement of p1 and p2 in front of the measurement loudspeaker and/or the use of a measurement loudspeaker at different positions in the enclosure would be difficult or in some situations even impossible to implement during actual operation. Hence, according to a preferred embodiment of the invention, in an initial or calibration phase these quantities are determined for all relevant conditions in the particular enclosure, whereas the acoustic power output from the one or more loudspeakers 2, 3, 4 can be estimated during actual operation, for instance by means of the simplified three-microphone setup shown in figure 6, which only applies three microphones, whereas a larger number of microphones (or measurement positions) is typically used in the initial or calibration phase. With reference to figures 2 and 3, respectively, nine measurement positions are used in this phase.

[0041] For instance, an event can activate the adaption procedure to take place. The event is a trigger to start the adaption algorithm and to perform the measurements, with the three microphones for instance, the calculations and the adjustments accordingly. The trigger may be of different types according to actual product requirements e.g. but not limited to: a) automatically when the car is entered or the engine is started, or b) upon a specific control command given by the user.

[0042] The command given by the user may be e.g. a pressure on button, a touch on a touch panel, a spoken command or a given gesture from a hand or the like.

[0043] The information about the mode of the adaption procedure may be displayed, with an indication of the transition from off -> initiated -> completed -> active. The type of display may e.g. be a LCD screen, an OLED panel, an LED or the like.

[0044] In the preferred embodiment, a combined key input device (switch button) and display device (an LED with multiple colour mode indications) constitute the user interface to the adaption procedure.

Claims

1. A method for determining an equalization filter for one or more loudspeakers provided in an enclosure, such as a listening room or an automobile cabin, the method comprising the steps of:

   (i) providing said one or more loudspeakers (2, 3, 4) with an audio input signal (5) whereby a sound field (10) is generated in the enclosure (1), and determining a power averaged sound pressure emitted from the one or more loudspeakers (2, 3, 4) into said enclosure (1) by power averaging a number of measured sound pressures at a first set of positions (9) in the enclosure (1);
   (ii) determining a room gain RG(f) of the enclosure (1), by

   - placing a measurement sound source (14) at a measurement position in said enclosure (1);
   - determining a power averaged sound pressure emitted by said measurement sound source (14) into said enclosure by power averaging a number of measured sound pressures at a second set of positions (11);
   - measuring sound pressures p_1 and p_2, respectively, at two positions (12) and (13), respectively, in the near field of the measurement sound source (14);
   - based on the measured sound pressures at said two positions (12, 13), calculating a mechanical radiation resistance in the near field of the measurement sound source (14);
   - based on said mechanical radiation resistance, calculating the acoustic power output from the measurement sound source (14); and
   - calculating said room gain RG(f) of the enclosure (1) to the generated sound field (10) as the ratio between the square of the power averaged sound pressure emitted by the measurement sound source (14) and said acoustic power output from the measurement sound source (14).

   (iii) forming a speaker equalization filter (Speaker(f)) as the square root of a ratio between a target acoustic power output and the actual acoustic power output from the loudspeaker driver(s), which actual acoustic power output is calculated as the square of the power averaged sound pressure divided by the room gain RG(f);
   (iv) determining said equalization filter as said speaker equalization filter (Speaker(f)).

2. The method according to claim 1, further comprising:

   - determining a listening position interface equalization filter (Listener (f)) for a specific listening position in the sound field by:

   placing a measurement sound source (14) at this specific listening position in said enclosure, and measuring sound pressures p_1 and p_2, respectively, at two positions (12) and (13), respectively, in the near

field of the measurement sound source (14)
based on the measured sound pressures at said two positions (12, 13), calculating a mechanical radiation resistance in the near field of the measurement sound source (14);
determining the listening position interface equalization filter as the square root of a ratio between the mechanical radiation resistance determined at a reference listening position and the mechanical radiation resistance determined at said specific listening position; and

- determining said equalization filter as the product of said speaker equalization filter (Speaker(f)) and said listening position interface equalization filter (Listener(f)).

3. A method according to claim 2, wherein said reference listening position is a position in free field.

4. A method according to any of the preceding claims, comprising the steps of:

(i) during an initial or calibration phase, measuring said room gain RG(f) and optionally the listening position interface equalization filter for different conditions of said enclosure and storing the measurement results in storage means;
(ii) either during said initial or calibration phase determining said power average of measured sound pressures for one or more of said different conditions of said enclosure and storing the measurement results in storage means;
or during said initial or calibration phase determining said power average of measured sound pressures for one condition, such as a reference condition, of said enclosure and storing the measurement result in storage means and during actual use of the loudspeakers (2, 3, 4) in the enclosure carrying out measurements of said sound pressures for up-dating the power averaged sound pressures, thereby to carry out up-dating of characteristics of said equalization filter to correspond to changed conditions of the enclosure.

5. A method according to claim 4, wherein the number N_u of measurement positions used for real-time updating of the filter characteristic is less than the corresponding number N of measurement positions used in the initial or calibration phase.

6. A method according to claim 5, wherein N_u is equal to 3.

7. A system for determining an equalization filter for one or more loudspeakers provided in an enclosure, such as a listening room or an automobile cabin, the system comprising:

(a) one or more microphones for measuring sound pressure at a first set of positions (9) and a second set of positions (11) in a sound field (10) in the enclosure;
(b) a measurement sound source (14) that can be placed at chosen positions in said sound field (10) in said enclosure (1);
(c) means for determining a power averaged sound pressure emitted from the one or more loudspeakers (2, 3, 4) into said enclosure (1) by power averaging a number of measured sound pressures at said first set of positions (9);
(d) means for determining a room gain RG(f) of the enclosure (1) by:

determining a power averaged sound pressure emitted by said measurement sound source (14) into said enclosure by power averaging a number of measured sound pressures at said second set of positions (11);
calculating a mechanical radiation resistance in the near field of the measurement sound source (14) based on measured sound pressures p_1 and p_2 at two positions (12, 13) in the near field of the measurement sound source (14);
calculating the acoustic power output from the measurement sound source (14) based on said mechanical radiation resistance; and
calculating said room gain RG(f) of the enclosure (1) to the generated sound field (10) as the ratio between the square of the power averaged sound pressure emitted by the measurement sound source (14) and said acoustic power output from the measurement sound source (14),

(e) means for forming a speaker equalization filter (Speaker(f)) as the square root of a ratio between a target acoustic power output and the actual acoustic power output from the loudspeaker driver(s), which actual acoustic power output is calculated as the square of the power averaged sound pressure divided by the room gain RG(f);

(f) means for determining said equalization filter characteristic as said speaker equalization filter (Speaker(f)).

8. The system in claim 7, further comprising means for determining a listening position interface equalization filter (Listener (f)) for a specific listening position in the sound field by:

calculating a mechanical radiation resistance in the near field of the measurement sound source (14) based on measured sound pressures at two positions (12, 13) in the near field of the measurement sound source (14) placed in a specific listening position in said enclosure, and
determining the listening position interface equalization filter as the square root of a ratio between the mechanical radiation resistance determined at a reference listening position and the mechanical radiation resistance determined at said specific listening position; and
wherein said means for determining said equalization filter are arranged to determine said equalization filter as the product of said speaker equalization filter (Speaker(f)) and said listening position interface equalization filter (Listener(f)).

9. A system according to claim 7 or 8, further comprising means for storing said speaker equalization filter, Speaker(f), and optionally said listening position interface equalization filter, Listener(f) corresponding to different conditions of said enclosure (1), or means for storing those quantities that are derived from measurements of said sound pressures in the enclosure and that are used for determining the speaker equalization filter, Speaker(f), and a listening position interface equalization filter, Listener(f).

10. A system according to claim 9, further comprising a set of microphones that can carry out real time measurements of sound pressure during use of the enclosure and use these measurements together with appropriately stored quantities to determine real time changes of characteristics of said equalization filter or said speaker equalization filter, Speaker(f), and optionally a listening position interface equalization filter, Listener(f).

11. A system according to claim 9 or 10 further comprising means for triggering said real time changes of equalization filter characteristics, for instance when the acoustic properties of the enclosure change, or when the acoustic properties of the loudspeakers (2, 3, 4) that create the acoustic field (10) in the enclosure (1) change.

12. A system according to claim 11, wherein said triggering is performed manually by an operator, such as by the driver or a passenger in a car.

13. A system according to claim 11, wherein said triggering is performed automatically, for instance by opening of a window in a car or when the number of persons in the cabin is changed.

14. The system according to any one of claims 7 to 13, wherein said enclosure is the cabin of vehicle, such as a car.

15. Use of the system according to any of the claims 7 to 14 for implementing the method according to any of the claims 1 to 6.

Patentansprüche

1. Verfahren zum Bestimmen eines Entzerrungsfilters für einen oder mehrere Lautsprecher, die in einer Umfassung, z.B. in einem Hörsaal oder der Kabine eines Automobils, bereitgestellt werden, wobei das Verfahren die folgenden Schritte umfasst:

(i) Versehen des einen oder der mehreren Lautsprecher (2, 3, 4) mit einem Audioeingangssignal (5), wodurch ein Klangfeld (10) in der Umfassung (1) erzeugt wird, und Bestimmen eines über die Leistung gemittelten Schalldrucks, der aus dem einen oder den mehreren Lautsprechern (2, 3, 4) in die Umfassung (1) emittiert wird, durch Mitteln einer Anzahl gemessener Schalldrücke an einer ersten Gruppe von Positionen (9) in der Umfassung (1) über die Leistung;
(ii) Bestimmen einer Raumverstärkung (Room Gain) RG(f) der Umfassung (1) durch

- Anordnen einer Messtonquelle (14) an einer Messposition in der Umfassung (1);
- Bestimmen eines über die Leistung gemittelten Schalldrucks, der aus der Messtonquelle (14) in die Umfassung emittiert wird, durch Mitteln einer Anzahl gemessener Schalldrücke an einer zweiten Gruppe von

Positionen (11) über die Leistung;
- Messen von Schalldrücken *p1* bzw. *p2* an zwei Positionen (12) bzw. (13) im Nahbereichsfeld der Messtonquelle (14);
- Berechnen eines mechanischen Strahlungswiderstands im Nahbereichsfeld der Messtonquelle (14) auf der Grundlage der gemessenen Schalldrücke an den zwei Positionen (12, 13);
- Berechnen der akustischen Leistungsausgabe aus der Messtonquelle (14) auf der Grundlage des mechanischen Strahlungswiderstands und
- Berechnen der Raumverstärkung RG(f) der Umfassung (1) für das erzeugte Klangfeld (10) als das Verhältnis zwischen dem Quadrat des über die Leistung gemittelten Schalldrucks, der aus der Messtonquelle (14) emittiert wird, und der akustischen Leistungsausgabe aus der Messtonquelle (14);

iii) Bilden eines Lautsprecher-Entzerrungsfilters (Lautsprecher(f)) als die Quadratwurzel aus einem Verhältnis zwischen einer angestrebten akustischen Leistungsausgabe und der tatsächlichen akustischen Leistungsausgabe aus dem (den) Lautsprechertreiber(n), wobei die tatsächliche akustische Leistungsausgabe als das Quadrat des über die Leistung gemittelten Schalldrucks, dividiert durch die Raumverstärkung RG(f), berechnet wird;
iv) Bestimmen des Entzerrungsfilters als der Lautsprecher-Entzerrungsfilter (Lautsprecher(f)).

2. Verfahren nach Anspruch 1, ferner umfassend:

- Bestimmen eines Hörpositions-Schnittstellen-Entzerrungsfilters (Hörer(f)) für eine spezielle Hörposition in dem Klangfeld durch:

Anordnen einer Messtonquelle (14) an dieser speziellen Hörposition in der Umfassung und
Messen von Schalldrücken *p1* bzw. *p2* an zwei Positionen (12) bzw. (13) im Nahbereichsfeld der Messtonquelle (14);
Berechnen eines mechanischen Strahlungswiderstands im Nahbereichsfeld der Messtonquelle (14) auf der Grundlage der gemessenen Schalldrücke an den zwei Positionen (12, 13);
Bestimmen des Hörpositions-Schnittstellen-Entzerrungsfilters als die Quadratwurzel eines Verhältnisses zwischen dem mechanischen Strahlungswiderstand, bestimmt an einer Referenz-Hörposition, und dem mechanischen Strahlungswiderstand, bestimmt an der speziellen Hörposition; und

- Bestimmen des Entzerrungsfilters als das Produkt aus dem Lautsprecher-Entzerrungsfilter (Lautsprecher(f)) und dem Hörpositions-Schnittstellen-Entzerrungsfilter (Hörer(f)).

3. Verfahren nach Anspruch 2, wobei die referenz-Hörposition eine Position in einem freien Feld ist.

4. Verfahren nach einem der vorhergehenden Ansprüche, welches die folgenden Schritte umfasst:

(i) Messen der Raumverstärkung RG(f) und gegebenenfalls des Hörpositions-Schnittstellen-Entzerrungsfilters für verschiedene Bedingungen der Umfassung und Speichern der Messergebnisse in einem Speichermittel während einer Anfangs- oder Kalibrierungsphase;
(ii) entweder Bestimmen des Leistungsmittelwerts gemessener Schalldrücke für eine oder mehrere der verschiedenen Bedingungen der Umfassung und Speichern der Messergebnisse in einem Speichermittel während der Anfangs- oder Kalibrierungsphase oder Bestimmen des Leistungsmittelwerts gemessener Schalldrücke für eine Bedingung, z.B. eine Referenzbedingung, der Umfassung und Speichern der Messergebnisse in einem Speichermittel während der Anfangs- oder Kalibrierungsphase und Durchführen von Messungen der Schalldrücke zum Aktualisieren der über die Leistung gemittelten Schalldrücke während der tatsächlichen Verwendung der Lautsprecher (2, 3, 4) in der Umfassung, um dadurch eine Aktualisierung von Eigenschaften des Entzerrungsfilters durchzuführen, damit diese veränderten Bedingungen der Umfassung entsprechen.

5. Verfahren nach Anspruch 4, wobei die Anzahl N_u an Messpositionen, die für die Echtzeitaktualisierung der Filtereigenschaften verwendet werden, geringer als die entsprechende Anzahl N an Messpositionen ist, die in der Anfangs- oder Kalibrierungsphase verwendet werden.

6. Verfahren nach Anspruch 5, wobei N_u gleich 3 ist.

7. System zum Bestimmen eines Entzerrungsfilters für einen oder mehrere Lautsprecher, die in einer Umfassung, z. B. einem Hörsaal oder in der Kabine eines Automobils, bereitgestellt werden, wobei das System das Folgende

umfasst:

(a) ein oder mehrere Mikrofone zum Messen des Schalldrucks an einer ersten Gruppe von Positionen (9) und einer zweiten Gruppe von Positionen (11) in einem Klangfeld (10) in der Umfassung;
(b) eine Messtonquelle (14), welche an ausgewählten Positionen in dem Klangfeld (10) in der Umfassung (1) angeordnet sein kann;
(c) ein Mittel zum Bestimmen eines über die Leistung gemittelten Schalldrucks, der aus dem einen oder den mehreren Lautsprechern (2, 3, 4) in die Umfassung (1) emittiert wird, durch Mitteln einer Anzahl gemessener Schalldrücke an der ersten Gruppe von Positionen (9) über die Leistung;
(d) ein Mittel zum Bestimmen einer Raumverstärkung RG(f) der Umfassung (1) durch:

Bestimmen eines über die Leistung gemittelten Schalldrucks, der durch die Messtonquelle (14) in die Umfassung emittiert wird, durch Mitteln einer Anzahl gemessener Schalldrücke an einer zweiten Gruppe von Positionen (11) über die Leistung;
Berechnen eines mechanischen Strahlungswiderstands im Nahbereichsfeld der Messtonquelle (14) auf der Grundlage der gemessenen Schalldrücke p_1 und p_2 an zwei Positionen (12, 13) im Nahbereichsfeld der Messtonquelle (14);
Berechnen der akustischen Leistungsausgabe aus der Messtonquelle (14) auf der Grundlage des mechanischen Strahlungswiderstands und
Berechnen der Raumverstärkung RG(f) der Umfassung (1) für das erzeugte Klangfeld (10) als das Verhältnis zwischen dem Quadrat des über die Leistung gemittelten Schalldrucks, der durch die Messtonquelle (14) emittiert wird, und der akustischen Leistungsausgabe aus der Messtonquelle (14),

(e) ein Mittel zum Bilden eines Lautsprecher-Entzerrungsfilters (Lautsprecher(f)) als die Quadratwurzel aus einem Verhältnis zwischen einer angestrebten akustischen Leistungsausgabe und der tatsächlichen akustischen Leistungsausgabe aus dem (den) Lautsprechertreiber(n), wobei die tatsächliche akustische Leistungsausgabe als das Quadrat des über die Leistung gemittelten Schalldrucks, dividiert durch die Raumverstärkung RG(f), berechnet wird;
(f) ein Mittel zum Bestimmen der Entzerrungsfiltereigenschaft als der Lautsprecher-Entzerrungsfilter (Lautsprecher(f)).

8. System nach Anspruch 7, ferner umfassend ein Mittel zum Bestimmen eines Hörpositions-Schnittstellen-Entzerrungsfilters (Hörer(f)) für eine spezielle Hörposition in dem Klangfeld durch:

Berechnen eines mechanischen Strahlungswiderstands im Nahbereichsfeld der Messtonquelle (14) auf der Grundlage von gemessenen Schalldrücken an zwei Positionen (12, 13) im Nahbereichsfeld der Messtonquelle (14), die an einer speziellen Hörposition in der Umfassung angeordnet sind; und
Bestimmen des Hörpositions-Schnittstellen-Entzerrungsfilters als die Quadratwurzel eines Verhältnisses zwischen dem mechanischen Strahlungswiderstand, bestimmt an einer Referenz-Hörposition, und
dem mechanischen Strahlungswiderstand, bestimmt an der speziellen Hörposition; und
wobei das Mittel zum Bestimmen des Entzerrungsfilters dafür eingerichtet ist, den Entzerrungsfilter als das Produkt aus dem Lautsprecher-Entzerrungsfilter (Lautsprecher(f)) und dem Hörpositions-Schnittstellen-Entzerrungsfilter (Hörer(f)) zu bestimmen.

9. System nach Anspruch 7 oder 8, ferner umfassend ein Mittel zum Speichern des Lautsprecher-Entzerrungsfilters, Lautsprecher(f), und gegebenenfalls des Hörpositions-Schnittstellen-Entzerrungsfilters, Hörer(f), entsprechend verschiedenen Bedingungen der Umfassung (1) oder ein Mittel zum Speichern jener Größen, die aus Messungen der Schalldrücke in der Umfassung abgeleitet werden und die zum Bestimmen des Lautsprecher-Entzerrungsfilters, Lautsprecher(f), und eines Hörpositions-Schnittstellen-Entzerrungsfilters, Hörer(f), verwendet werden.

10. System nach Anspruch 9, ferner umfassend eine Gruppe von Mikrofonen, welche Echtzeitmessungen des Schalldrucks während der Verwendung der Umfassung durchführen können und diese Messungen zusammen mit geeignet gespeicherten Größen verwenden können, um Echtzeitveränderungen von Eigenschaften des Entzerrungsfilters oder des Lautsprecher-Entzerrungsfilters, Lautsprecher(f), oder gegebenenfalls eines Hörpositions-Schnittstellen-Entzerrungsfilters, Hörer(f), zu bestimmen.

11. System nach Anspruch 9 oder 10, ferner umfassend ein Mittel zum Auslösen der Echtzeitveränderungen von Entzerrungsfiltereigenschaften, zum Beispiel wenn sich die akustischen Eigenschaften der Umfassung ändern oder

wenn sich die akustischen Eigenschaften der Lautsprecher (2, 3, 4) ändern, welche das Klangfeld (10) in der Umfassung (1) erzeugen.

12. System nach Anspruch 11, wobei das Auslösen manuell durch einen Operator durchgeführt wird, z.B. durch den Fahrer oder einen Passagier in einem Automobil.

13. System nach Anspruch 11, wobei das Auslösen automatisch durchgeführt wird, zum Beispiel durch Öffnen eines Fensters in einem Automobil oder wenn sich die Anzahl der Personen in der kabine ändert.

14. System nach einem der Ansprüche 7 bis 13, wobei die Umfassung die Kabine eines Fahrzeugs, z.B. eines Automobils, ist.

15. Verwendung des Systems nach einem der Ansprüche 7 bis 14 zum Realisieren des Verfahrens nach einem der Ansprüche 1 bis 6.

Revendications

1. Dispositif de détermination d'un filtre d'égalisation pour un ou plusieurs haut-parleurs fournis dans une enceinte, comme une salle d'écoute ou une cabine automobile, le procédé comprenant les étapes de :

(i) la fourniture d'un signal d'entrée audio (5) aux dits un ou plusieurs haut-parleurs (2, 3, 4) de manière à générer un champ de son (10) dans l'enceinte (1), et la détermination d'une pression de son de puissance moyenne émise à partir de l'un ou plusieurs haut-parleurs (2, 3, 4) dans ladite enceinte (1) en calculant la moyenne de puissance d'un nombre de pressions de son mesurées à un premier ensemble de positions (9) dans l'enceinte (1) ;
(ii) la détermination d'un gain de salle, RG(f), de l'enceinte (1) par

- le placement d'une source de son de mesure (14) à une position de mesure dans ladite enceinte (1) ;
- la détermination d'une pression de son de puissance moyenne émise par ladite source de son de mesure (14) dans ladite enceinte par le calcul de la moyenne de puissance d'un nombre de pressions de son mesurées à un deuxième ensemble de positions (11) ;
- la mesure de pressions de son p_1 et p_2 respectivement à deux positions (12) et (13) respectivement dans le champ proche de la source de son de mesure (14) ;
- sur la base des pressions de son mesurées aux dites deux positions (12, 13), le calcul d'une résistance de rayonnement mécanique dans le champ proche de la source de son de mesure (14) ;
- sur la base de ladite résistance de rayonnement mécanique, le calcul de la sortie de puissance acoustique de la source de son de mesure (14) ; et
- le calcul dudit gain de salle, RG(f), de l'enceinte (1) dans le champ de son généré (10) en tant que rapport entre le carré de la pression de son de puissance moyenne émise par la source de son de mesure (14) et ladite sortie de puissance acoustique de la source de son de mesure (14) ;

(iii) la formation d'un filtre d'égalisation de haut-parleurs (Speaker(f)) en tant que racine carrée d'un rapport entre une sortie de puissance acoustique cible et la sortie de puissance acoustique réelle du ou des pilotes de haut-parleurs, ladite sortie de puissance acoustique réelle étant calculée en tant que carré de la pression de son de puissance moyenne divisé par le gain de salle, RG(f) ;
(iv) la détermination dudit filtre d'égalisation en tant que ledit filtre d'égalisation de haut-parleurs (Speaker(f)).

2. Procédé selon la revendication 1, comprenant en outre :

- la détermination d'un filtre d'égalisation d'interface de position d'écoute (Listener(f)) pour une position d'écoute spécifique dans le champ de son par :

le placement d'une source de son mesure (14) à cette position d'écoute spécifique dans ladite enceinte, et la mesure de pressions de son p_1 et p_2 respectivement à deux positions (12) et (13) respectivement dans le champ proche de la source de son de mesure (14),
sur la base des pressions de son mesurées aux dites deux positions (12, 13), le calcul d'une résistance de rayonnement mécanique dans le champ proche de la source de son de mesure (14) ;

la détermination du filtre d'égalisation d'interface de position d'écoute en tant que racine carrée d'un rapport entre la résistance de rayonnement mécanique déterminée à une position d'écoute de référence et la résistance de rayonnement mécanique déterminée à ladite position d'écoute spécifique ; et

- la détermination dudit filtre d'égalisation en tant que produit dudit filtre d'égalisation de haut-parleurs (Speaker(f)) et dudit filtre d'égalisation d'interface de position d'écoute (Listener(f)).

3. Procédé selon la revendication 2, dans lequel ladite position d'écoute de référence est une position dans un champ libre.

4. Procédé selon l'une quelconque des revendications précédentes, comprenant les étapes de :

(i) au cours d'une phase initiale ou d'étalonnage, la mesure dudit gain de salle RG(f) et facultativement le filtre d'égalisation de l'interface de position d'écoute pour différentes conditions de ladite enceinte et la mémorisation des résultats de mesure dans un moyen de mémorisation ;
(ii) au cours de ladite phase initiale ou d'étalonnage, la détermination de ladite moyenne de puissance de pressions de son mesurées pour une ou plusieurs desdites conditions différentes de ladite enceinte et la mémorisation des résultats de mesure dans le moyen de mémorisation ; ou
au cours de ladite phase initiale ou d'étalonnage, la détermination de ladite moyenne de puissance de pressions de son mesurées pour une condition, comme une condition de référence, de ladite enceinte, et la mémorisation du résultat de mesure dans le moyen de mémorisation et, au cours de l'utilisation réelle des haut-parleurs (2, 3, 4) dans l'enceinte, l'exécution de mesures desdites pressions de son pour mettre à jour les pressions de son de puissance moyenne, afin d'effectuer de ce fait la mise à jour de caractéristiques dudit filtre d'égalisation pour correspondre à des conditions changées de l'enceinte.

5. Procédé selon la revendication 4, dans lequel le nombre N_u de positions de mesure utilisées pour la mise à jour en temps réel des caractéristiques de filtre est inférieur au nombre correspondant N de positions de mesure utilisées dans la phase initiale ou d'étalonnage.

6. Procédé selon la revendication 5, dans lequel N_u est égal à 3.

7. Système de détermination d'un filtre d'égalisation pour un ou plusieurs haut-parleurs fournis dans une enceinte, comme une salle d'écoute ou une cabine automobile, le système comprenant :

(a) un ou plusieurs microphones pour mesurer une pression de son à un premier ensemble de positions (9) et un deuxième ensemble de positions (11) dans un champ de son (10) dans l'enceinte ;
(b) une source de son de mesure (14) qui peut être placée à des positions choisies dans ledit champ de son (10) dans ladite enceinte (1) ;
(c) un moyen pour déterminer une pression de son de puissance moyenne émise à partir de l'un ou plusieurs haut-parleurs (2, 3, 4) dans ladite enceinte (1) en calculant la moyenne de puissance d'un nombre de pressions de son mesurées au dit premier ensemble de positions (9) ;
(d) un moyen pour déterminer un gain de salle, RG(f), de l'enceinte (1) par:

la détermination d'une pression de son de puissance moyenne émise par ladite source de son de mesure (14) dans ladite enceinte par le calcul de la moyenne de puissance d'un nombre de pressions de son mesurées au dit deuxième ensemble de positions (11) ;
le calcul d'une résistance de rayonnement mécanique dans le champ proche de la source de son de mesure (14) sur la base de pressions de son mesurées p_1 et p_2 à deux positions (12, 13) dans le champ proche de la source de son de mesure (14) ;
le calcul de la sortie de puissance acoustique de la source de son de mesure (14) sur la base de ladite résistance de rayonnement mécanique ; et
le calcul dudit gain de salle, RG(f), de l'enceinte (1) dans le champ de son généré (10) en tant que rapport entre le carré de la pression de son de puissance moyenne émise par la source de son de mesure (14) et ladite sortie de puissance acoustique de la source de son de mesure (14) ;

(e) un moyen pour former un filtre d'égalisation de haut-parleurs (Speaker(f)) en tant que racine carrée d'un rapport entre une sortie de puissance acoustique cible et la sortie de puissance acoustique réelle du ou des pilotes de haut-parleurs, ladite sortie de puissance acoustique réelle étant calculée en tant que carré de la

pression de son de puissance moyenne divisé par le gain de salle, RG(f) ;
(f) un moyen pour déterminer ladite caractéristique de filtre d'égalisation en tant que ledit filtre d'égalisation de haut-parleurs (Speaker(f)).

8. Système selon la revendication 1, comprenant un moyen pour déterminer un filtre d'égalisation d'interface de position d'écoute (Listener(f)) pour une position d'écoute spécifique dans le champ de son par :

le calcul d'une résistance de rayonnement mécanique dans le champ proche de la source de son de mesure (14) sur la base des pressions de son mesurées aux dites deux positions (12, 13) dans le champ proche de la source de son de mesure (14) placée à une position d'écoute spécifique dans ladite enceinte, et
la détermination du filtre d'égalisation d'interface de position d'écoute en tant que racine carrée d'un rapport entre la résistance de rayonnement mécanique déterminée à une position d'écoute de référence et la résistance de rayonnement mécanique déterminée à ladite position d'écoute spécifique ; et
dans lequel ledit moyen pour déterminer ledit filtre d'égalisation est agencé pour déterminer ledit filtre d'égalisation en tant que produit dudit filtre d'égalisation de haut-parleurs (Speaker(f)) et dudit filtre d'égalisation d'interface de position d'écoute (Listener(f)).

9. Système selon la revendication 7 ou 8, comprenant en outre un moyen pour mémoriser ledit filtre d'égalisation de haut-parleurs, Speaker(f), et facultativement ledit filtre d'égalisation d'interface de position d'écoute, Listener(f) correspondant à différentes conditions de ladite enceinte (1), ou un moyen pour mémoriser ces quantités qui sont dérivées de mesures desdites pressions de son dans l'enceinte et qui sont utilisées pour déterminer le filtre d'égalisation de haut-parleurs, Speaker(f), et un filtre d'égalisation d'interface de position d'écoute, Listener(f).

10. Système selon la revendication 9, comprenant en outre un ensemble de microphones qui peuvent effectuer des mesures en temps réel de pressions de son au cours d'une utilisation de l'enceinte et utiliser ces mesures avec des quantités mémorisées de manière appropriée pour déterminer des changements en temps réel de caractéristiques dudit filtre d'égalisation ou dudit filtre d'égalisation de haut-parleurs, Speaker(f), et facultativement un filtre d'égalisation d'interface de position d'écoute, Listener(f).

11. Système selon la revendication 9 ou 10, comprenant en outre un moyen pour déclencher lesdits changements en temps réel de caractéristiques de filtre d'égalisation, par exemple lorsque les propriétés acoustiques de l'enceinte changent, ou lorsque les propriétés acoustiques des haut-parleurs (2, 3, 4) qui créent le champ acoustique (10) dans l'enceinte (1) changent.

12. Système selon la revendication 11, dans lequel ledit déclenchement est effectué manuellement par un opérateur, comme par le conducteur ou un passager d'une voiture.

13. Système selon la revendication 11, dans lequel ledit déclenchement est effectué automatiquement, par exemple en ouvrant une vitre d'une voiture ou lorsque le nombre de personnes dans la cabine est changé.

14. Système selon l'une quelconque des revendications 7 à 13, dans lequel ladite enceinte est la cabine d'un véhicule, comme une voiture.

15. Utilisation du système selon l'une quelconque des revendications 7 à 14 pour mettre en oeuvre le procédé selon l'une quelconque des revendications 1 à 6.

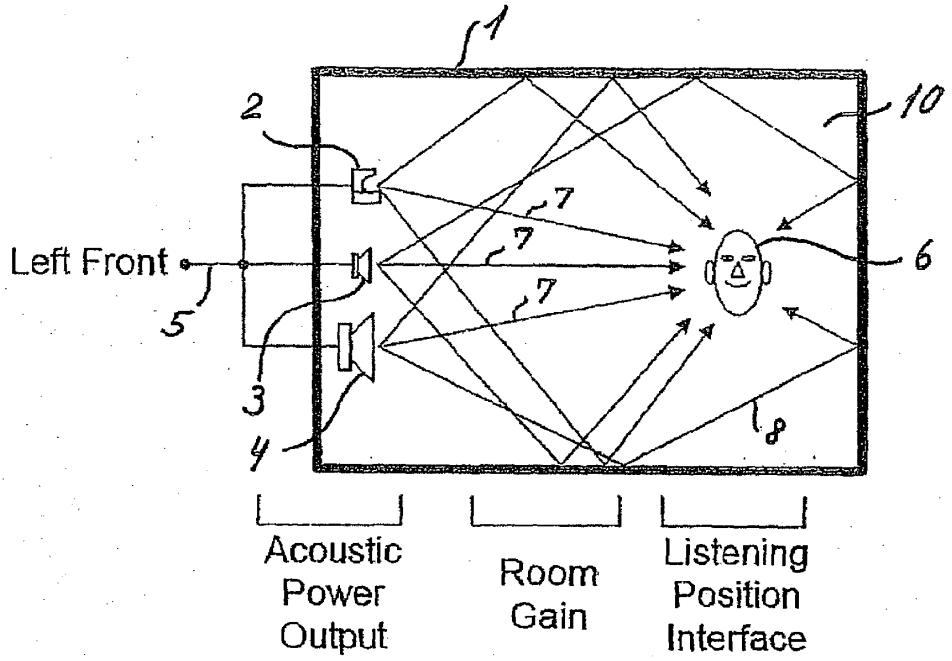

1
2
10
Left Front
5
7
7
7
6
3
4
8
Acoustic Power Output
Room Gain
Listening Position Interface

Fig. 1

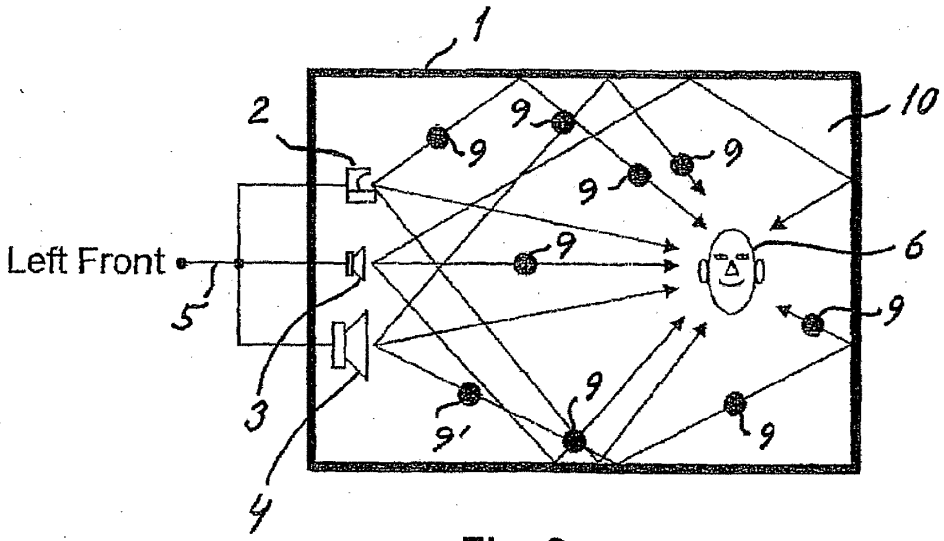

1
2
9
9
9
9
10
Left Front
5
9
6
9
3
9'
9
9
4

Fig. 2

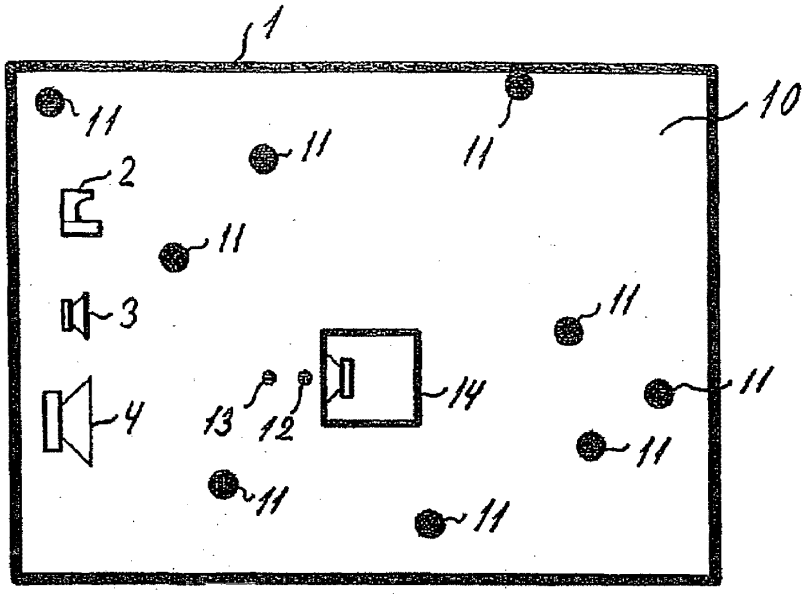


Fig. 3

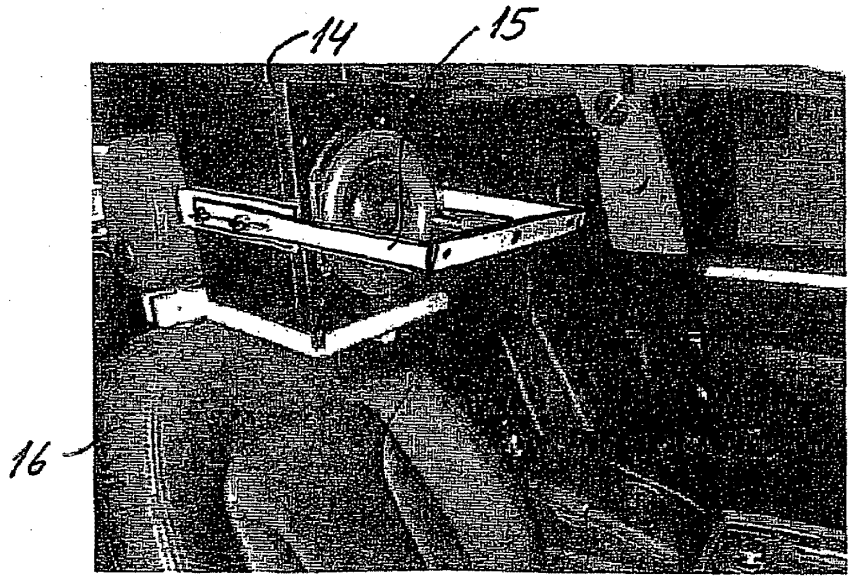


Fig. 4

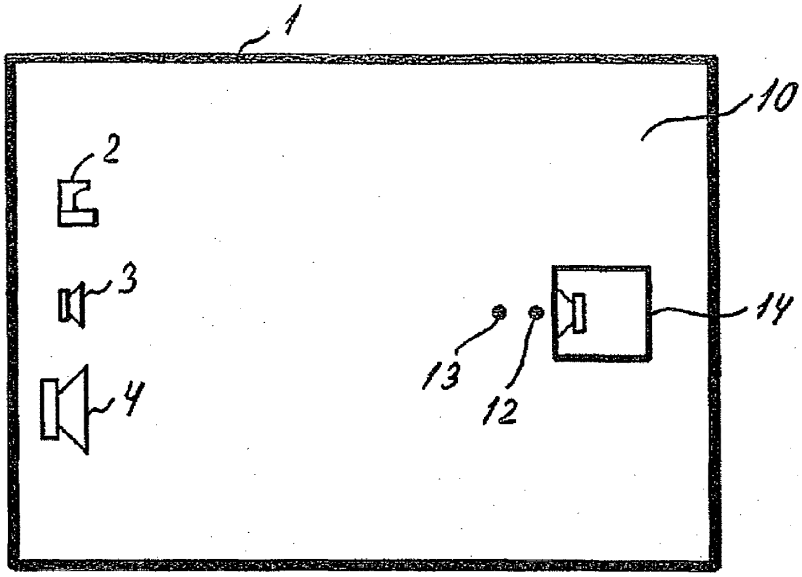


Fig. 5

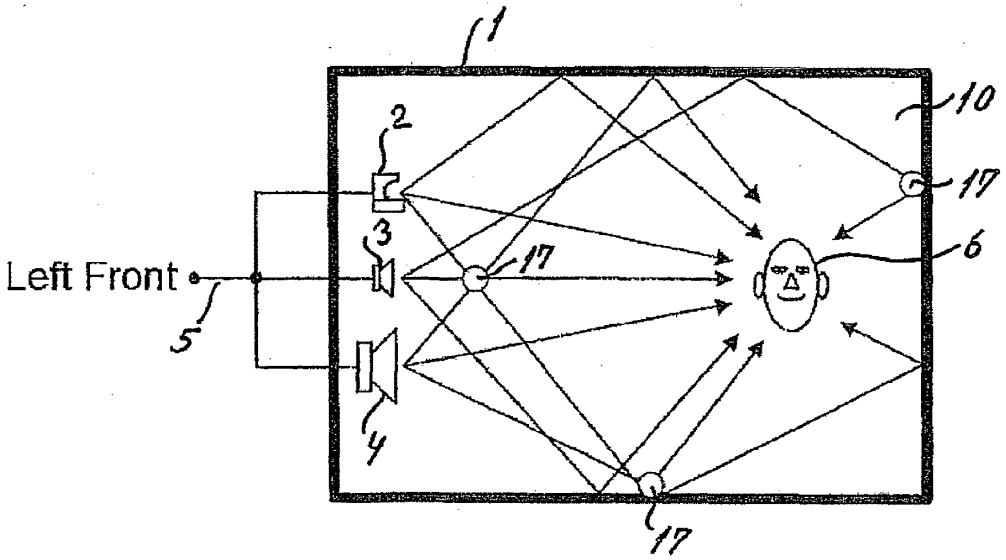


Fig. 6

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H04L 29/06 (2006.01) ***H04N 21/8547*** (2011.01)

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US 20070058762 A1 **US 20050259754 A1**
US 20040228367 A1

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INT CL **H04L, H04N**
Other: **EPODOC, WPI.**

(54) Title of the Invention: **Media distribution system**
Abstract Title: **Time stamps are added to data transmitted via Bluetooth® connections to facilitate synchronised output of the data from a plurality of devices.**

(57) A system and method for transmitting data to a plurality of output devices 401, 402 comprises: associating timing data with first and second frames of data representing media where the timing data indicates when the media should be output; the establishment first and second Bluetooth® connections 412, 413 to first and second output devices respectively; the transmission of the first and second frames of data to first and second output devices respectively; and outputting the media at a time indicated by the timing data. The media may be audio and the data encoded audio where first and second frames of data are respectively left and right channels of an audio signal. The output devices may comprise speakers 426, 427. The system may further comprise a third frame of data, Bluetooth® connection and device wherein the frames of data represent channels of a surround sound system.

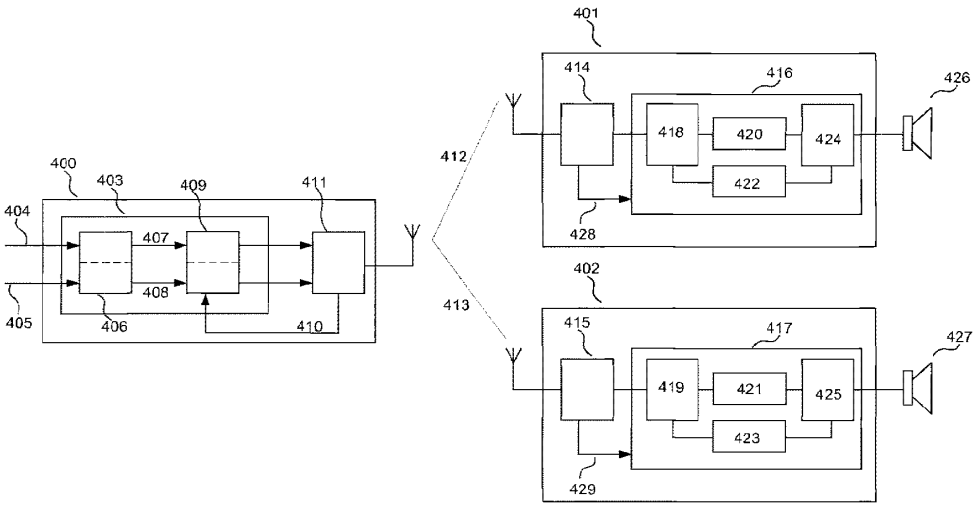


Figure 4

GB 2486183 A

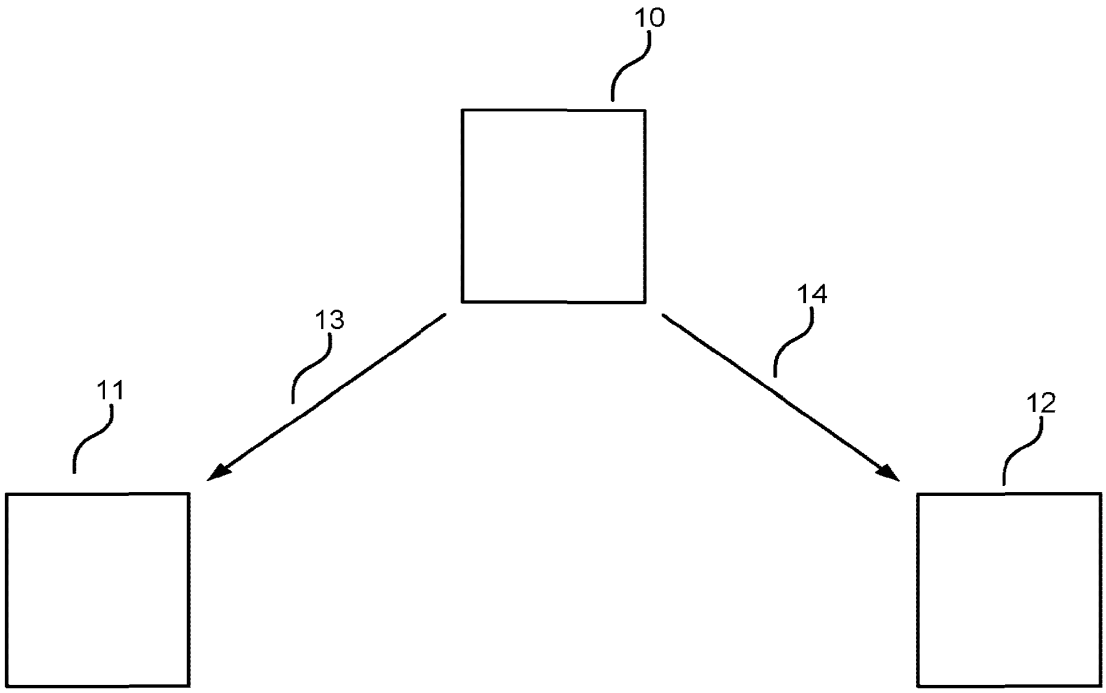


Figure 1

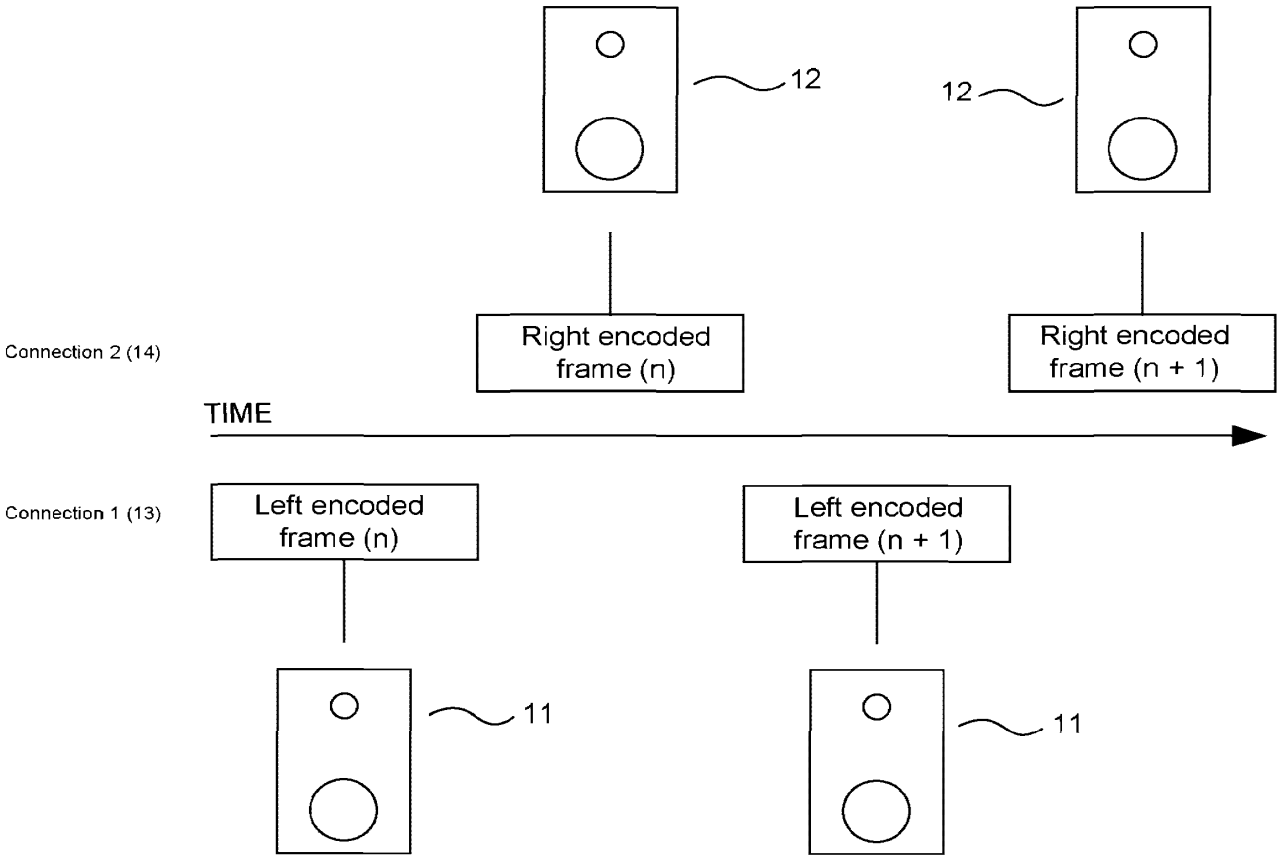

12
12
Connection 2 (14)
Right encoded frame (n)
Right encoded frame (n + 1)
TIME
Connection 1 (13)
Left encoded frame (n)
Left encoded frame (n + 1)
11
11

Figure 2

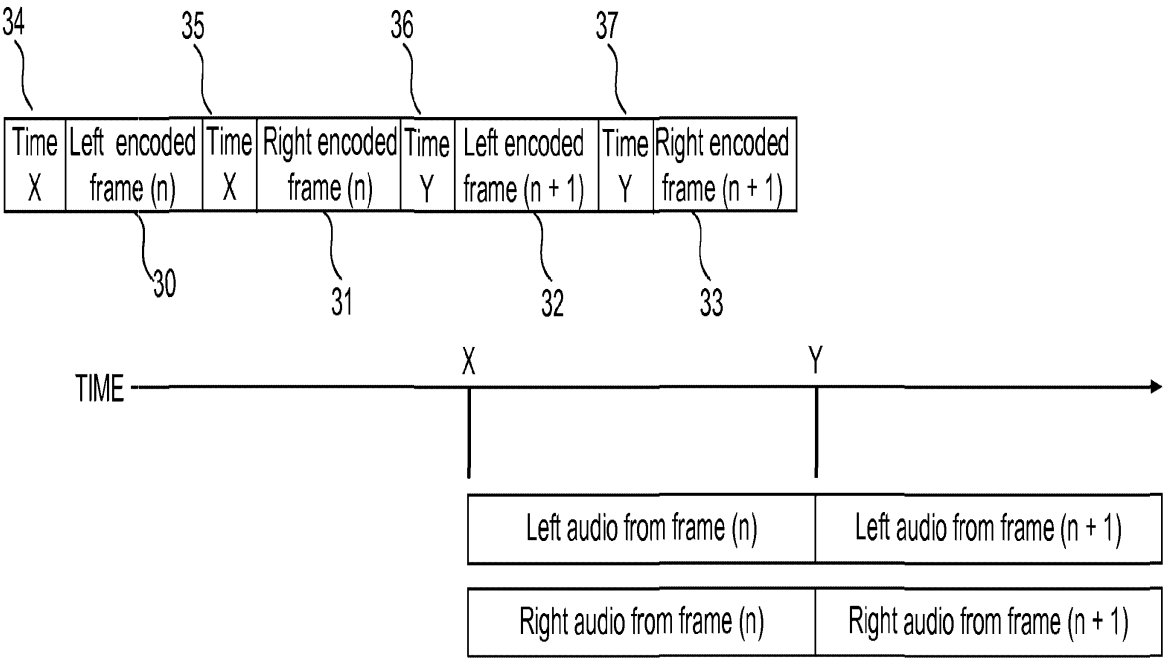

34
35
36
37
Time X
Left encoded frame (n)
Time X
Right encoded frame (n)
Time Y
Left encoded frame (n + 1)
Time Y
Right encoded frame (n + 1)
30
31
32
33
TIME
X
Y
Left audio from frame (n)
Left audio from frame (n + 1)
Right audio from frame (n)
Right audio from frame (n + 1)

Figure 3

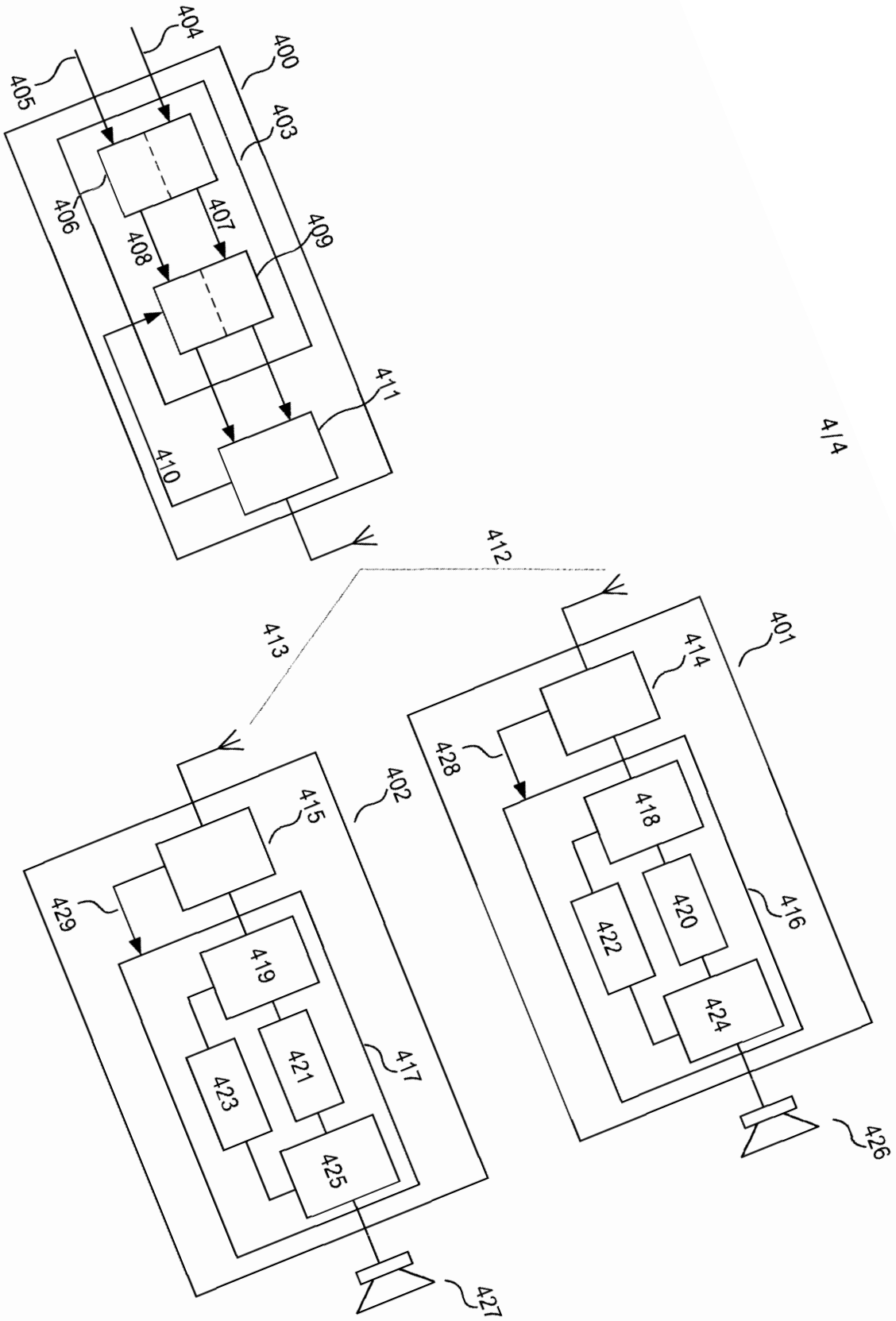

400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429

Figure 4

The following terms are registered trademarks and should be read as such wherever they occur in this document:

Bluetooth
Dolby

MEDIA DISTRIBUTION SYSTEM

BACKGROUND

[0001] Apparatus and methods for synchronising data transmitted over wireless connections, and in particular Bluetooth® connections, are disclosed.

[0002] Bluetooth® is a very widely adopted protocol for enabling wireless connections between devices. The Bluetooth® protocol is a point-to-point protocol in which two devices interact to exchange data. If a single device requires connections to two other devices, independent connections are configured for each other device. Those connections are not synchronised with each other, and may have different sample rates, data rates, and formats, as configured by the two devices. The lack of synchronisation may prevent the use of the Bluetooth® protocol where there is a need for synchronisation between data received at the two devices.

[0003] Figure 1 shows an example in which a source device 10 is connected wirelessly to a left 11 and a right 12 speaker forming a stereo pair. The output of each speaker must be aligned in time to ensure the audio is correctly replicated for the listener. Any misalignment will result in a decrease in the quality of the audio. The two speakers 11, 12 can be connected to the source device by two Bluetooth® connections 13, 14. When data is transmitted on both of these connections the frames of audio for each speaker are formed into packets for the Bluetooth® connection, which packets are interleaved on the radio link for delivery to each speaker, as per the Bluetooth® protocol and shown in Figure 2.

[0004] There is therefore a difference in the time at which the Left and Right speakers 11,12 receive the data, resulting in a delay and misalignment in the audio output. If the left speaker 11 is made aware that there is another speaker in the system, it can delay its output to account for the delay in arrival of the data at that other speaker. However, this does not provide for a robust or accurate system as the delay associated with each speaker is not known accurately, and the delay may vary dependent on the amount of data held in the buffer of each speaker. It is not therefore possible to reliably align the audio output of two speakers connected using two Bluetooth® connections.

[0005] In many applications, low-latency is an important characteristic of a wireless connection. For example in telecommunication applications low latency is vital in achieving good quality telephone connections. Low-latency is also important where an audio output must be synchronised with other outputs, for example television pictures, or pictures from a computer game.

[0006] Specific protocols for providing low-latency, or synchronised links, have been proposed, but there is a requirement for a synchronised and low-latency wireless system. In particular there is a requirement for a system to provide Bluetooth® wireless connections with these properties.

SUMMARY

[0007] The following presents a simplified summary of the disclosure in order to provide a basic understanding to the reader. This summary is not an extensive overview of the disclosure and it does not identify key/critical elements of the invention or delineate the scope of the invention. Its sole purpose is to present some concepts disclosed herein in a simplified form as a prelude to the more detailed description that is presented later.

There is provided a method of synchronising the output of media by a plurality of output devices, the method comprising the steps of associating timing data representing a time with a first frame of data representing media for output by a first output device, associating timing data representing the time with a second frame of data representing media for output by a second output device, and transmitting the first frame and the associated timing data to the first output device via a first Bluetooth connection, and transmitting the second frame and the associated timing data to the second output device via a second Bluetooth connection.

The method may further comprise the step of, at the represented time, outputting media represented by the first frame from the first output device, and outputting media represented by the second frame from the second output device.

The media may be audio.

The frames of data may be frames of encoded audio data.

The time may be indicated with respect to a common clock of the Bluetooth links.

The method may further comprise the steps of encoding the left channel of an audio signal as the first frame of data, and encoding the right channel of an audio signal as the second frame of data, wherein the first output device is a left speaker, and the second output device is a right speaker.

The steps may be repeated a plurality of times for a sequence of first and second frames, wherein the time associated with each pair of first and second frames is advanced compared to the previous pair of first and second frames.

The time associated with the first and second frames may represent a time at which the first and second output devices are expected to be able to output the media represented by those frames.

The method may further comprise the steps of associating timing data representing the time with a third frame of data representing media for output by a third output device, transmitting the third frame and the associated timing data to the third output device via a third Bluetooth connection.

The method may further comprise the step of outputting media represented by the third frame from the third output device.

The frames of data may represent channels of audio in a surround sound system, and the output devices are speakers configured to output the represented channels of audio.

The timing data may be associated with the first and/or second frame of data representing media by encoding the timing data together with the audio data.

The timing data may be associated with the first, second and/or third frame of data by appending the timing information to that frame of data

The method may further comprise the step of transmitting frames of data representing media for output by the first and/or second output device, wherein those frames of data are not associated with timing information.

There is also provided a source device for transmitting data to a plurality of output devices, comprising a processing system configured to associate timing data with first and second frames of data representing media, the timing data indicating a time at which the media represented by the first and second frames of data should be output; a Bluetooth system configured to establish a first Bluetooth connection with a first output device, and a second Bluetooth connection with a second output device, and to transmit the first frame of data and associated time stamp to the first output device, and to transmit the second frame of data and associated time stamp to the second output device.

The processing system may be further configured to encode the left channel of an audio signal as the first frame of data, and encode the right channel of an audio signal as the second frame of data.

The processing system may be further configured to associate timing data indicated the time with a third frame of data representing media, and the Bluetooth system is configured to establish a third Bluetooth connection with the third output device and to transmit the third frame of data represented media to the third output device.

There is also provided a media output device, comprising a Bluetooth system for establishing and maintaining a connection to a source device, and a processing system configured for receiving data representing media for output by the output device from the Bluetooth connection, and outputting the media at a time indicated by a time stamp associated and received with that data.

There is also provided a method of outputting media in synchronisation with the output of media from other, unconnected, devices, the method comprising the steps of receiving via a Bluetooth connection data representing the media and data indicating a time which the media should be output, and outputting the media at the indicated time.

[0008] Many of the attendant features will be more readily appreciated as the same becomes better understood by reference to the following detailed description considered in connection with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

[0009] The present description will be better understood from the following detailed description read in light of the accompanying drawings, wherein:

Figure 1 shows a schematic diagram of a source device and two output devices;

Figure 2 shows a representation of the transmission of data via two Bluetooth connections;

Figure 3 shows a representation of the transmission of data to synchronise outputs; and

Figure 4 shows a system for transmitting and outputting synchronised media.

DETAILED DESCRIPTION

[0010] The detailed description provided below in connection with the appended drawings is intended as a description of the present examples and is not intended to represent the only forms in which the present example may be constructed or utilized. The description sets forth the functions of the example and the sequence of steps for constructing and operating the example. However, the same or equivalent functions and sequences may be accomplished by different examples.

[0011] Figure 3 shows a schematic diagram of data transmission over the Bluetooth® connections described in relation to Figure 1 to provide a synchronised, low-latency, distribution of data from source device 10 to speakers 11, 12. Source device 10 is configured to encode left and right audio signals into frames 30, 31, 32, 33 for transmission to speakers 11, 12. The frames 30, 32 for the left speaker 11 are transmitted over the first Bluetooth connection 13, and the frames 31, 33 for the right speaker 12 are transmitted over the second Bluetooth connection 14.

[0012] For clarity of explanation, in this example it is assumed that the encoded frame and timing information (described below) fits into a single packet such that frames and timing data are not split between packets. In accordance with the Bluetooth® protocol packets are transmitted over the first and second Bluetooth® links alternately, and thus as shown in Figure 3 frames for the left and right speakers are transmitted alternately.

[0013] The source device 10 associates a time stamp 34, 35, 36, 37 with each encoded frame 30, 31, 32, 33 indicating the time at which the audio represented by that frame should be output by the receiving speaker. Since frames 30, 31 represent left and right audio for output at the same time, the same time stamp is associated with both frames. The time is described with reference to the Bluetooth clock that is distributed via the Bluetooth connections from the source device to the output devices.

[0014] The time indicated for each frame is selected such that both the left and right speakers will have received, and can output, the relevant frame at the indicated time.

[0015] In Figure 3, the left and right frames 30, 31 are marked for output at time X, which in this example coincides with the end of frame 31. At time X each of the speakers commence output of the audio represented by frame n. The time is indicated with reference to the Bluetooth clock distributed to each of the devices from the source device, and therefore the output from each device commences at the same time. The audio output of the left and right speakers is thus synchronised, despite the Bluetooth connections themselves being unsynchronised. As seen in Figure 3, while frames 30, 31 are being output, frames 32, 33 are being received ready for output at time Y, which falls at the end of the output of frame 33. A continuous, synchronised, audio output is thus achieved.

[0016] No modification of the Bluetooth system is required as the protocols and data formats are unchanged, the time stamp is simply transmitted as regular payload data along with the encoded audio frame.

[0017] The use of an absolute time stamp enables the speakers to recover synchronisation even if their buffers become completely empty and output stops. Output can be recommenced at any time once a frame and time stamp are successfully received. As performed in existing systems resampling and resynthesis of frames held in the buffer may be utilised to re-fill the buffer after errors in the communications link.

[0018] A small latency is introduced into the system due to the speaker receiving frames first waiting for the second speaker to receive the same frame. Frames 30, 31 are not therefore output instantly, but there is a delay to time X. This delay is dependent on, amongst other parameters, the frame size, and is generally small compared to acceptable latency times. The latency of the system may be varied depending on the configuration.

[0019] Typically output devices will include a buffer for storing frames before they are output, such that errors in frames can be accommodated by waiting for retransmission while playing data from the buffer. The use of a buffer increases latency, but also increases robustness. When a buffer is utilised the time for frames to pass through the buffer is accommodated by the time stamp being set to a suitable value. For example, in an MP3 playback system a highly robust, but higher latency system, may be provided by utilising a large buffer size. For television playback, a lower latency system may be utilised by reducing packet, frame, and buffer sizes, which may also lead to a reduction in robustness. Selection of appropriate frame and packet sizes enables efficient use of the wireless connection. For example, very small frame sizes may be utilised to minimise the proportion of frames split between packets.

[0020] Figure 4 shows a schematic diagram of a system for implementing the above method for transmitting synchronised audio data from source device 400 to two speakers 401, 402. The source device 400 comprises a processing system 403. Processing system 403 receives Left 404 and Right 405 audio data and comprises a coder 406 for coding that audio data into two coded data streams 407, 408. For example, the coder may code the audio into the SBC or MP3 formats, comprising frames of data. In alternative embodiments the audio signals may be pre-coded, or coded by a separate system, in which case processing system 403 would not provide this coding function.

[0021] Processing block 409 associates each frame of the coded data 407, 408 with a time stamp indicating the time at which the audio represented by that frame of data should be output. The time stamp is defined with respect to a Bluetooth® clock 410, which is also distributed to devices connected to the source device 400 via Bluetooth® connections maintained by Bluetooth® system 411.

[0022] As explained hereinbefore the time stamp indicates a future time at which all output devices will be in receipt of the data frame and able to output the audio represented by that frame.

[0023] Bluetooth® system 411 acts as a master and maintains two Bluetooth® connections 412, 413, one to each of the output speakers 401, 402. The Bluetooth® systems 414, 415 of the speakers are slaves in the Bluetooth® connections to the source device 400.

[0024] Bluetooth® system 411 receives the coded audio data with the applied time stamps from processing block 409 and transmits the data corresponding to the left audio channel to the left speaker 401 via Bluetooth® connection 412, and the data corresponding to the right audio channel to the right speaker 402 via Bluetooth® connection 413.

[0025] Bluetooth® systems 414, 415 receive the respective data from the source device 400, and communicate it to processing systems 416, 417. Processing blocks 418, 419 separate the time information from the encoded audio frames. The audio frames are stored in frame buffers 420, 421, and the timing information is stored in timing buffers 422, 423. The buffers are configured such that the relation between the time information and audio frames is maintained.

[0026] Decoders 424, 425 receive frames from the frame buffers 422, 423, decode the data, and output a signal to speakers 426, 427 representing the audio. Decoders 424, 425 also receive the timing information from timing buffers 422, 423, and the Bluetooth® clock 428, 429, and output the signals at the time indicated by that information. Since both speakers 401, 402 receive clock information from the source device 400, which has used that clock information to define the timing information associated with each frame, the output of each speaker is synchronised at the desired output time.

[0027] The blocks and division of functions shown in Figure 4 is for clarity only, and other divisions or processing steps are possible to provide the same functionality as that provided by Figure 4. For example, the decoding stage may be performed before the buffer stage, such that any variation in the time taken to decode the frames does not affect the output time. The time indicated by the source device may therefore be utilised as an indication of any particular step in the decoding and output process, provided each device relates the time to the same step.

[0028] The output from the decoder may be communicated to an internal or external speaker as appropriate for the particular device.

[0029] The above examples have been given by way of reference to a source device distributing data to a stereo pair of speakers. As will be appreciated, this example is not restrictive and the principles described hereinbefore may be utilised in a range of systems. For example, the output devices may be audio-visual output devices in which case the system can be utilised to synchronise a stereo audio output with a visual display. Similarly, the number of output devices may be varied for the particular system. For example the system may be utilised to distribute audio to a system of surround sound speakers comprising 5 or more speakers. For example, a surround sound system offering Dolby 5.1 sound may be connected using Bluetooth® links thereby avoiding physical connections between the speakers and source device. Such a system operates as described hereinbefore, but a Bluetooth connection is utilised between the source and each speaker, with the packets for each connection being interleaved.

[0030] In the above embodiments a time stamp is included in every frame, but in alternative embodiments a time-stamp may be included in only some of the frames. For example, in every 5th, 10th, or n^{th} frame. Such a system reduces the data overhead required for transmission of the timing information. In between the frames with the time stamp, the output device is left to free-run based on its internal clock. An indicator is provided to indicate which frames comprise timing information. The frames with which timing information is included may be selected on a dynamic basis based on performance of the connection.

[0031] The interval between frames with time stamps may be selected based on a worst-case estimation of possible changes in processing time at the output device (for example changes in buffer size or processing delay) compared to acceptable drift between the output devices. This ensures that an unacceptable variation between output devices will not occur in the time period between time stamps. The output devices may also be configured to monitor their delay and if there is a significant change to resample the available samples or stop output until the next time stamp is available for output, thereby further controlling the possible variation between output devices.

[0032] Should the buffer of an output device become empty, and the device's output thereby stop, output can only be restarted once the next frame with a time stamp is received. There is therefore a trade-off between recovery time and data overhead.

[0033] In a further variation, the timing data may be added to the audio data and encoded with that audio data by the audio encoder. This scheme removes the data overhead in the encoded frames, but leads to a small increase in distortion of the audio. Consequential changes are made to the receiving system such that the signal is decoded, and the timing information extracted from the decoded data, as will be apparent to the skilled person.

[0034] The methods and systems described herein are not restricted to particular types of Bluetooth® connections, and may be implemented, for example, using SCO or A2DP connections. References to Bluetooth® are references to the Bluetooth® family of protocols in general as promoted by the Bluetooth SIG.

[0035] The term 'processing system' is used herein to refer to any device with processing capability such that it can execute instructions. Those skilled in the art will realize that such processing capabilities are incorporated into many different devices and therefore the term includes, for example, all types of micro-processors, CPUs, GPUs, and DSPs, and multifunction chips.

[0036] The methods described herein may be performed by software in machine readable form on a tangible storage medium e.g. in the form of a program comprising program code means adapted to perform all the steps of any of the methods described herein when the program is run on a processing system and where the program may be embodied on a readable medium. Examples of tangible (or non-transitory) storage media include disks, thumb drives, memory etc and do not include propagated signals. The software can be suitable for execution on a parallel

processor or a serial processor such that the method steps may be carried out in any suitable order, or simultaneously.

[0037] This acknowledges that software can be a valuable, separately tradable commodity. It is intended to encompass software, which runs on or controls "dumb" or standard hardware, to carry out the desired functions. It is also intended to encompass software which "describes" or defines the configuration of hardware, such as HDL (hardware description language) software, as is used for designing silicon chips, or for configuring universal programmable chips, to carry out desired functions.

[0038] Any range or device value given herein may be extended or altered without losing the effect sought, as will be apparent to the skilled person.

[0039] It will be understood that the benefits and advantages described above may relate to one embodiment or may relate to several embodiments. The embodiments are not limited to those that solve any or all of the stated problems or those that have any or all of the stated benefits and advantages. It will further be understood that reference to 'an' item refers to one or more of those items. Features of each embodiment may be considered in any functioning combination.

[0040] The steps of the methods described herein may be carried out in any suitable order, or simultaneously where appropriate. Additionally, individual blocks may be deleted from any of the methods without departing from the spirit and scope of the subject matter described herein. Aspects of any of the examples described above may be combined with aspects of any of the other examples described to form further examples without losing the effect sought.

[0041] The term 'comprising' is used herein to mean including the method blocks or elements identified, but that such blocks or elements do not comprise an exclusive list and a method or apparatus may contain additional blocks or elements.

[0042] It will be understood that the above description of a preferred embodiment is given by way of example only and that various modifications may be made by those skilled in the art. The above specification, examples and data provide a complete description of the structure and use of exemplary embodiments of the invention. Although various embodiments of the invention have been described above with a certain degree of particularity, or with reference to one or more individual embodiments, those skilled in the art could make numerous alterations to the disclosed embodiments without departing from the spirit or scope of this invention, including combining features disclosed in respect of one embodiment with features disclosed in respect of a second embodiment.

CLAIMS

1. A method of synchronising the output of media by a plurality of output devices, the method comprising the steps of

associating timing data representing a time with a first frame of data representing media for output by a first output device,

associating timing data representing the time with a second frame of data representing media for output by a second output device, and

transmitting the first frame and the associated timing data to the first output device via a first Bluetooth connection, and transmitting the second frame and the associated timing data to the second output device via a second Bluetooth connection.

2. A method according to claim 1, further comprising the step of, at the represented time, outputting media represented by the first frame from the first output device, and outputting media represented by the second frame from the second output device.

3. A method according to claim 1 or 2, wherein the media is audio.

4. A method according to claim 3, wherein the frames of data are frames of encoded audio data.

5. A method according to any preceding claim, wherein the time is indicated with respect to a common clock of the Bluetooth links.

6. A method according to any preceding claim, further comprising the step of encoding the left channel of an audio signal as the first frame of data, and encoding the right channel of an audio signal as the second frame of data, wherein the first output device is a left speaker, and the second output device is a right speaker.

7. A method according to claim 1, wherein the steps of claim 1 are repeated a plurality of times for a sequence of first and second frames, wherein the time associated with each pair of first and second frames is advanced compared to the previous pair of first and second frames.

8. A method according to any preceding claim, wherein the time associated with the first and second frames represents a time at which the first and second output devices are expected to be able to output the media represented by those frames.

9. A method according to claim 1, further comprising the steps of

associating timing data representing the time with a third frame of data representing media for output by a third output device,

transmitting the third frame and the associated timing data to the third output device via a third Bluetooth connection.

10. A method according to claim 9, further comprising the step of outputting media represented by the third frame from the third output device.

11. A method according to claim 9, wherein the frames of data represent channels of audio in a surround sound system, and the output devices are speakers configured to output the represented channels of audio.

12. A method according to claim 4, wherein the timing data is associated with the first and/or second frame of data representing media by encoding the timing data together with the audio data.

13. A method according to any preceding claim, wherein the timing data is associated with the first, second and/or third frame of data by appending the timing information to that frame of data

14. A method according to any preceding claim, further comprising the step of transmitting frames of data representing media for output by the first and/or second output device, wherein those frames of data are not associated with timing information.

15. A source device for transmitting data to a plurality of output devices, comprising

a processing system configured to associate timing data with first and second frames of data representing media, the timing data indicating a time at which the media represented by the first and second frames of data should be output;

a Bluetooth system configured to establish a first Bluetooth connection with a first output device, and a second Bluetooth connection with a second output device, and to transmit the first frame of data and associated time stamp to the first output device, and to transmit the second frame of data and associated time stamp to the second output device.

16. A source device according to claim 15 wherein the processing system is further configured to encode the left channel of an audio signal as the first frame of data, and encode the right channel of an audio signal as the second frame of data.

17. A source device according to claim 15, wherein the processing system is further configured to associate timing data indicated the time with a third frame of data representing media, and the Bluetooth system is configured to establish a third Bluetooth connection with the third output device and to transmit the third frame of data represented media to the third output device.

18. A media output device, comprising

a Bluetooth system for establishing and maintaining a connection to a source device, and

a processing system configured for receiving data representing media for output by the output device from the Bluetooth connection, and outputting the media at a time indicated by a time stamp associated and received with that data.

19. A method of outputting media in synchronisation with the output of media from other, unconnected, devices, the method comprising the steps of

receiving via a Bluetooth connection data representing the media and data indicating a time which the media should be output, and

outputting the media at the indicated time.

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Claims searched: 1 to 19 **Date of search:** 12 March 2012

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Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 to 19	US2008/291863 A1 (AGREN MATTIAS PER) See whole document, particularly paragraphs 0009 and 0087.
X	1 to 19	US2004/228367 A1 (MOSIG RUDIGER) See whole document, particularly paragraphs 0047 to 0049.
X	18 at least	US2005/259754 A1 (HO JIN-MENG et al) See whole document, particularly paragraphs 0009 and 0028.
X	1, 15 and 18 at least	US2007/058762 A1 (HUDSON MICHAEL D et al) See whole document, particularly paragraphs 0012 and 0027.
X	1, 15 and 18 at least	US2007/214229 A1 (MILLINGTON NICHOLAS A J et al) See whole document, particularly paragraph 0013.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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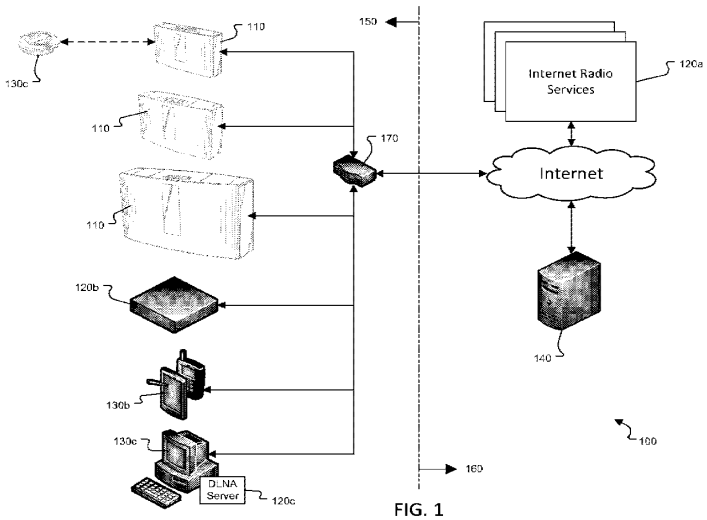


FIG. 1

(57) Abstract: A method for managing presets in an audio system is provided. The method includes syncing preset assignments on a plurality of audio playback devices such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices, and, such that, if one of the preset assignments is changed on one of the audio playback devices, each of the other audio playback devices is automatically updated such that a corresponding change is made to a corresponding preset assignment on each of the other audio playback devices. Each of the preset assignments is an assignment of an entity associated with one of a plurality of digital audio sources to one of a plurality of preset indicators on the corresponding one of the audio playback devices.

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AUDIO SYSTEMS AND RELATED DEVICES AND METHODS

BACKGROUND

[0001] This disclosure relates to audio systems and related devices and methods, and, particularly, to managing (e.g., synchronizing) presets among devices in an audio system.

SUMMARY

[0002] All examples and features mentioned below can be combined in any technically possible way.

[0003] In one aspect, a method for managing presets in an audio system is provided. The method includes syncing preset assignments on a plurality of audio playback devices such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices, and, such that, if one of the preset assignments is changed on one of the audio playback devices, each of the other audio playback devices is automatically updated such that a corresponding change is made to a corresponding preset assignment on each of the other audio playback devices. Each of the preset assignments is an assignment of an entity associated with one of a plurality of digital audio sources to one of a plurality of preset indicators on the corresponding one of the audio playback devices.

[0004] Implementations may include one of the following features, or any combination thereof.

[0005] In some implementations, the step of syncing preset assignments on a plurality of audio playback devices includes receiving information from a first audio playback device of the audio system regarding a change to one or more of a plurality of preset assignments; updating stored preset data based on the information received from the first audio playback device; and providing update information to one or more other audio playback devices of

the audio system such that the one or more other audio playback devices update their respective preset assignments to correspond to those of the first audio playback device.

[0006] In certain implementations, the step of updating stored preset data includes updating preset data stored on a remote server.

[0007] In some implementations, the step of updating stored preset data includes replacing a first set of preset assignments with a second, updated set of preset assignments.

[0008] In certain implementations, the method also includes receiving user input regarding the assignment of an entity associated with one of the digital audio sources to one of the preset indicators on a first one of the audio playback devices.

[0009] In some implementations, the user input corresponds to actuation of a hardware button on a first one of the audio playback devices.

[0010] In certain implementations, the user input is received via a controller connected to the first one of the audio playback devices via a network connection.

[0011] In some implementations, the assignable entities include at least (i) user-defined playlists of digital music and (ii) Internet radio stations.

[0012] The digital audio sources may include a plurality of Internet radio sites, and the entities may include individual radio stations provided by the Internet radio sites.

[0013] In certain implementations, the preset indicators provide access to their respectively assigned entities in the same manner irrespective of the associated digital audio source.

[0014] In some implementations, the preset indicators provide for single press access to the respectively assigned entities, irrespective of the digital audio source.

[0015] In another aspect, an audio system server includes a processor, and instructions stored on a computer-readable media that. When executed, the instructions cause the processor to: receive information from a first audio playback device of an audio system regarding a change to one or more of a plurality of preset assignments; update stored preset data based on the information received from the first device; and to provide update information to one or more other audio playback devices of the audio system such that each of the one or more other audio playback devices update their respective preset assignments to correspond to those of the first audio playback device. Each of the preset assignments represents an assignment of an entity associated with one of a plurality of digital audio sources to a corresponding preset indicator.

[0016] Implementations may include one of the above and/or below features, or any combination thereof.

[0017] In some implementations, the audio system server is a cloud-based server.

[0018] In certain implementations, the instructions, when executed, cause the processor to provide the update information to the one or more other audio playback devices in response to communication received from the one or more other audio playback devices requesting the update information.

[0019] In some implementations, the update information is an updated list of preset assignments.

[0020] In certain implementations, the instructions, when executed, cause the processor to: maintain a global recents list. The global recents list is a list of entities that is populated from content that the user has chosen to play on one or more of the audio playback devices.

[0021] In some implementations, the instructions, when executed, cause the processor to: receive information from a first audio playback device of an audio system regarding selection of a first entity for providing streamed music; update stored recent data based on

the information received from the first device; and to provide updated recents information to one or more other audio playback devices of the audio system such that each of the one or more other audio playback devices updates a locally stored recents list to correspond to a recents list stored on the first audio playback device.

[0022] In certain implementations, the instructions, when executed, cause the processor to: receive a copy of a token from a first audio playback device of an audio system, wherein the token is a unique identifier that a corresponding one of the digital audio sources recognizes and associates with a user account, thereby to provide access to the user account; store the copy of the token within the audio system server; and to provide copies of the token other audio playback devices of the audio system such that the corresponding one of the digital audio sources can recognize the other audio playback devices as being associated with the user account.

[0023] A further aspect features an audio system that includes i) a plurality of audio playback devices, and ii) a remote server. Each audio playback device is configured to operatively connect to a plurality of digital audio sources for playback of content from the digital audio sources. Each of the audio playback devices includes a set of preset indicators. Each preset indicator in the set of preset indicators is configured to have assigned to it an entity associated with one of the plurality of digital audio sources. The remote server is configured to receive information from one of the audio playback devices regarding changes to preset assignments. Each of the preset assignments represents an assignment of an entity associated with one of the digital audio sources to a corresponding one of the preset indicators. The remote server is further configured to update a stored set of global preset assignments based on the information received; and to distribute update information to the other ones of the audio playback devices regarding changes to the global preset assignments. The other ones of the audio playback devices are configured to update their respective preset assignments based on the update information distributed from the remote server such that, following the update, all of the audio playback devices of the plurality of audio playback devices have the same preset assignments.

[0024] Implementations may include one of the above and/or below features, or any combination thereof.

[0025] In some implementations, the information received from the one of the audio playback devices is an updated set of global preset assignments.

[0026] In certain implementations, the remote server is configured to update the stored set of global preset assignments by replacing the stored set of global preset assignments with the updated set of global preset assignments.

[0027] In some implementations, the remote server is configured to distribute the update information to the other ones of the audio playback devices in response to requests for update information received from the other ones of the audio playback devices.

[0028] In certain implementations, the set of preset indicators are hardware buttons.

[0029] The preset indicators may include numerical identifiers.

[0030] Yet another aspect provides an audio playback device that is configured to operably connect to a plurality of digital audio sources. The audio playback device includes a digital-to-analog converter that is configured to receive a digital representation of content from the digital audio sources and convert to analog form; an electro-acoustic transducer; a set of user-selectable preset indicators. Each indicator in the set of preset indicators is configured to have assigned to it an entity associated with the plurality of digital audio sources. The audio playback device also includes a processor and instructions stored on a computer-readable media. The instructions, when executed, cause the processor to: update one or more preset assignments based on user input, and to cause the processor to send information regarding the update to the one or more preset assignments to a remote server. Each of the preset assignments represents an assignment of an entity associated with one of the digital audio sources to a corresponding one of the preset indicators.

[0031] Implementations may include one of the above and/or below features, or any combination thereof.

[0032] In some implementations, the audio playback device also includes an enclosure. The digital-to-analog converter and the electro-acoustic transducer are located within the enclosure and the set of user-selectable present indicators is located on the enclosure.

[0033] In certain implementations, the digital audio sources include at least (i) one or more libraries of user-defined playlists of digital music files and (ii) Internet radio sites.

[0034] In some implementations, the instructions, when executed, cause the processor to: notify one or more other audio playback devices within an audio system regarding the update to the one or more preset assignments.

[0035] In certain implementations, the instructions, when executed, cause the processor to: receive notification from an other audio playback device within an audio system regarding changes to preset assignments on the other audio playback device; and, in response to receiving the notification regarding changes to the preset assignments on the other audio playback device, to contact a remote server for the audio system to request update information; and to update one or more preset assignments on the audio playback device based on the update information received from the remote server such that preset assignments on the audio playback devices correspond to respective preset assignments on the other audio playback device.

[0036] According to another aspect, an audio playback device is configured to operably connect to a plurality of digital audio sources. The audio playback device includes a digital-to-analog converter configured to receive a digital representation of content from the digital audio sources and convert to analog form; an electro-acoustic transducer; and a set of user-selectable preset indicators. Each indicator in the set of preset indicators is configured to have assigned to it an entity associated with the plurality of digital audio sources. The audio playback device also includes a processor and instructions stored on a computer-readable media. The instructions, when executed, cause the processor to:

update one or more preset assignments based on user input; and to notify one or more other audio playback devices within an audio system regarding the update to the one or more preset assignments. Each of the preset assignments represents an assignment of an entity associated with one of the digital audio sources to a corresponding one of the preset indicators.

[0037] Implementations may include one of the above and/or below features, or any combination thereof.

[0038] In some implementations, the digital audio sources include at least (i) one or more libraries of user-defined playlists of digital music files and (ii) Internet radio sites.

[0039] In certain implementations, the assignable entities include at least individual Internet radio stations and particular user-defined playlists of digital music files.

[0040] In some implementations, the digital audio sources include a plurality of Internet radio sites, and the entities include individual radio stations provided by the Internet radio sites.

[0041] In certain implementations, the instructions, when executed, cause the processor to: receive notification from an other audio playback device within an audio system regarding changes to preset assignments on the other audio playback device; and, in response to receiving the notification regarding changes to the preset assignments on the other audio playback device, to contact a remote server for the audio system to request update information; and to update one or more preset assignments on the audio playback device based on the update information received from the remote server such that preset assignments on the audio playback devices correspond to respective preset assignments on the other audio playback device.

[0042] In a further aspect, an audio playback device is configured to operably connect to a plurality of digital audio sources. The audio playback device includes a digital-to-analog converter configured to receive a digital representation of content from the digital

audio sources and convert to analog form; an electro-acoustic transducer; and a set of user-selectable preset indicators. Each indicator in the set of preset indicators is configured to have assigned to it an entity associated with the plurality of digital audio sources. The audio playback device also includes a processor and instructions stored on a computer-readable media. The instructions, when executed, cause the processor to receive notification from an other audio playback device within an audio system regarding changes to preset assignments on the other audio playback device; and, in response to receiving the notification regarding changes to the preset assignments on the other audio playback device, to contact a remote server for the audio system to request update information; and to update one or more preset assignments on the audio playback device based on the update information received from the remote server such that preset assignments on the audio playback devices correspond to respective preset assignments on the other audio playback device. Each of the preset assignments represents an assignment of an entity associated with one of the digital music sources to a corresponding one of the preset indicators.

[0043] In yet another aspect, an audio system includes i) a plurality of audio playback devices, and ii) a software program configured to run on a separate device (e.g., a separate computer, smartphone, tablet, etc.). Each audio playback device is configured to operatively connect to a plurality of digital audio sources for playback of content from the digital audio sources. Each of the audio playback devices includes a set of preset indicators. Each preset indicator in the set of preset indicators is configured to have assigned to it an entity associated with one of the plurality of digital audio sources. The software program provides a user interface configured to present an audio playback device selection region that enables user to select one of the audio playback devices to control with the separate computer. The user interface is further configured to present a set of preset indicators that corresponds to the set of preset indicators of the selected one of the audio playback devices, and to present a source selection region that enables a user to select an entity to assign to one of the preset indicators of the selected one of the audio playback devices.

[0044] Implementations may include one of the above and/or below features, or any combination thereof.

[0045] In some implementations, the source selection region also enables a user to select an entity to provide audio content to the selected one of the audio playback devices for playback of the audio content.

[0046] In certain implementations, the user interface is further configured to present a global recents. The global recents list is a list of entities that is populated from audio content that the user has chosen to play on one or more of the audio playback devices.

[0047] In some implementations, the software program includes instructions to procure the global recents list from data stored on the selected one of the audio playback devices.

[0048] In certain implementations, the user interface is further configured to enable a user to select whether the preset assignments are to be global or local. The global preset assignments are synchronized across the plurality of audio playback devices such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices, and, such that, if one of the preset assignments is changed on one of the audio playback devices, each of the other audio playback devices is updated such that a corresponding change is made to a corresponding preset assignment on each of the other audio playback devices. The local preset assignments are device-specific such that each of the audio playback devices can have a unique set of preset assignments and such that the preset assignments on any one of the audio playback devices do not necessarily correspond to the preset assignments on any of the other audio playback devices.

[0049] Another aspect features a computer-implemented method that includes storing a set of local preset assignments for each of a plurality of audio playback devices of an audio system. The local preset assignments are device-specific such that the local preset assignments for any one of the audio playback devices do not necessarily correspond to the local preset assignments for any of the other audio playback devices. The method also

includes receiving input regarding a change from a local setting to a global setting; receiving input regarding selection of one of the audio playback devices to serve as a master audio playback device; setting the set of stored local preset assignments associated with the selected, master audio playback device as a set of global preset assignments; and providing the global preset assignments to the other playback devices of the audio system so as to synchronize the preset assignments across the audio system, such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] FIG. 1 is a schematic view of an audio system that facilitates synchronization of presets among various system devices.

[0051] FIG. 2 is a swim lane diagram showing steps of managing/synchronizing "global" presets within the audio system of FIG. 1.

[0052] FIG. 3 is a swim lane diagram showing steps of managing "local" presets within the audio system of FIG. 1.

[0053] FIG. 4 is a screen shot of a user interface provided by a controller which displays a recents list within the audio system of FIG. 1.

[0054] FIG. 5 is a swim lane diagram showing steps of managing/synchronizing "global" recents within the audio system of FIG. 1.

[0055] FIG. 6 is a swim lane diagram showing steps for management of "local" recents within the audio system of FIG. 1.

[0056] FIG. 7A and 7B are perspective and top plan views, respectively, of an exemplary audio playback device from the audio system of FIG. 1.

[0057] FIG. 7C is a block diagram of the audio playback device of FIG. 7A.

[0058] FIG. 8 is a swim lane diagram showing steps for browsing entities associated with one of the digital audio sources within the audio system of FIG. 1.

[0059] FIG. 9 is a block diagram of another implementation of an audio playback device that can be utilized in the audio system of FIG. 1.

[0060] FIG. 10 is a block diagram of an exemplary controller from the audio system of FIG. 1.

[0061] FIG. 11 is a block diagram of a software program for the controller of FIG. 10.

[0062] FIG. 12 is a state interaction diagram that shows an overview of four user interface states of a user application of the controller software program of FIG. 11.

[0063] FIG. 13 illustrates a high-level workflow for a setup state from the state interaction diagram of FIG. 12.

[0064] FIG. 14A is a swim lane diagram showing steps for music setup for an Internet music service within the audio system of FIG. 1.

[0065] FIG. 14B is a swim lane diagram showing steps for distribution of tokens for accessing account based digital audio sources such as certain Internet music services within the audio system of FIG. 1.

[0066] FIG. 15A and 15B show a graphical user interface for a main application state, from the state interaction diagram of FIG. 12, in a "Now Playing" mode and an "Explore" mode, respectively, which may be suitable for a controller in the form of a desktop or laptop computer.

[0067] FIG. 15C is the user interface of FIG. 15B showing a sub-list of entities associated with an audio source named "Global Internet Radio".

[0068] FIG. 16A, 16B, and 16C show an alternative implementation of a user interface for the main application state in a "Preset" mode, a "Now Playing" mode, and an "Explore" mode, respectively, which may be suitable for a controller in the form of mobile device such as a smart phone.

[0069] FIG. 17 illustrates a process flow for setting preset from a controller within the audio system of FIG. 1.

[0070] FIGS. 18A and 18B show a sequence of screen displays illustrating the setting of a preset assignment, by selecting and holding a preset indicator, in the "Now Playing" mode on a desktop or laptop computer.

[0071] FIGS. 19A and 19B show a sequence of screen displays illustrating the setting of a preset assignment, by right-clicking on one the preset indicators and selecting "Set Preset" from a right-click menu, in the "Now Playing" mode on a desktop or laptop computer.

[0072] FIGS. 20A and 20B show a sequence of screen displays illustrating the setting of a preset assignment, by selecting a preset indicator from a preset menu, in the "Now Playing" mode on a desktop or laptop computer.

[0073] FIGS. 21A through 21C show a sequence of screen displays illustrating the setting of a preset assignment, by drag and drop, in the "Now Playing" mode on a desktop or laptop computer.

[0074] FIGS. 22A and 22B show a sequence of screen displays illustrating the setting of a preset assignment, by drag and drop, in the "Explore" mode on a desktop or laptop computer.

[0075] FIG. 23 is a block diagram of a computing device that can be used to implement the server of the audio system of FIG. 1.

DETAILED DESCRIPTION

[0076] This disclosure is based, at least in part, on the realization that it can be beneficial to synchronize presets among various devices within an audio system. It may be further beneficial to curate a list of recently access entities for providing audio content which can be shared among various devices within an audio system. Such features can help to facilitate quick and easy access to a user's preferred audio content.

[0077] SYSTEM OVERVIEW

[0078] Referring to FIG. 1, an audio system 100 for the delivery of digital audio (e.g., digital music) provides for easy, quick access to a variety of digital audio sources through the use of preset assignments. At a very high level, there are four main categories of devices in the audio system 100: (i) audio playback devices 110; (ii) digital audio sources 120a, 120b, 120c (collectively referenced as 120); controllers 130a, 130b, 130c (collectively referenced as 130); and a server 140.

[0079] The audio playback devices 110 are electronic devices which are capable of rendering audio content. These devices can access stored audio content (e.g., remotely stored audio content) and stream it for playback. In some cases, the audio playback devices 110 may also be capable of playing locally stored content. These devices render audio with the help of audio codecs and digital signal processors (DSPs) available within.

[0080] The audio playback devices 110 can communicate with each other. For example, each audio playback device 100 can communicate with the other audio playback devices 110 within the audio system 100 for synchronization. This can be a synchronization of device settings, such as synchronization of preset assignments, or, for synchronization of playback (e.g., such that all or a subset of the audio playback devices 110 play the same content simultaneously and synchronously).

[0081] The digital audio sources 120 are devices and/or services that provide access to one or more associated entities for supplying content (e.g., audio streams) to the audio playback devices 110, and which can be located remotely from the audio playback devices

110. An "entity," as used herein, refers to a grouping or collection of content for playback. Exemplary entities include Internet radio stations and user defined playlists. "Content" is data (e.g., an audio track) for playback. "Associated entity" refers to an entity that is associated with a particular audio source. For example, if the digital audio source 120 is an Internet music service such as Pandora®, an example associated entity would be a radio station provided by Pandora®.

[0082] For the purposes of the audio system 100, audio streams are considered to be data. They are processed as digital information that is converted to analog before presentation. Data streaming is the method by which data is moved from an audio source 120 to an audio playback device 110. Typically, there are two models for this data movement, push and pull. The audio system 100 is capable of managing this audio (data) streaming in both fashions; descriptions of these processes are as follows.

[0083] In a push model, the digital audio source 120 will move the data to the audio playback device 110 at a pace that it desires. The recipient (e.g., one of the audio playback devices 110) of the data will acknowledge the data and the digital audio source 120 will provide more data. This model requires the digital audio source 120 to be managing the throughput characteristics of the audio system 100. In a pull model, the audio playback device 110 will request data from the digital audio source 120 at a rate it desires. This allows the audio playback device 110 to read ahead if data is available.

[0084] The digital audio sources 120 each maintain a repository of audio content which can be chosen by the user to play. The digital audio sources 120 can be based on the Digital Living Network Alliance® (DLNA) or other Web based protocols similar to the Hypertext Transfer Protocol (HTTP). Some of the devices and services in this category include Internet based music services 120a such as Pandora®, Spotify®, and vTuner®; network-attached storage (NAS) devices 120b, and a media server daemon 120c (e.g., provided as a component of a computer-based controller).

[0085] The digital audio sources 120 include user defined playlists of digital music files available from network audio sources such as network-attached storage (NAS) devices

120b, and a DLNA server 120c which may be accessible to the audio playback devices 110 over a local area network such as a wireless (Wi-Fi) or wired (Ethernet) home network 150, as well as Internet radio sites 120a such as Pandora®, vTuner®, Spotify®, etc., which are accessible to the audio playback devices 110 over a wide area network 160 such as the Internet.

[0086] The controllers 130 are responsible for controlling the audio playback devices 110 and for browsing the audio sources 120 in the audio system 100. Some of the devices in this category include desktop computers, laptop computers, and mobile devices such as smart phones and tablets. These devices control the audio playback devices 110 via a wireless communication interface (e.g., IEEE 802.11 b /g, Bluetooth LE, infrared, etc.). The controllers 130 serve as an online management tool for a user's network enabled audio playback devices 110. The controllers 130 provide interfaces which enable to the user to perform one or more of the following: setup a connection to a Wi-Fi network; create an audio system account for the user, sign into a user's audio system account and retrieve information; add or remove an audio playback device 110 on a user's audio system account; edit an audio playback device's name, and update software; access the audio sources (via the audio playback devices 110); assign an entity (e.g., a playlist or radio station) associated with one of the audio sources 120 to a preset indicator; browse and select recents, where "recents" refers to recently accessed entities; use transport controls (play/pause, next/skip, previous), view "Now Playing" (i.e., content currently playing on an audio playback device 110) and album art; and adjust volume levels.

[0087] In some cases, the controllers 130 may include network controllers 130a, 130b and auxiliary controllers 130c. The network controllers 130a, 130b are controllers that communicate with the audio playback devices 110 over a wireless (Wi-Fi) network connection. The network controllers can include primary network controllers 130a and secondary network controllers 130b. The primary network controllers 130a can be utilized for: connecting an audio playback device 110 to a Wi-Fi network (via a USB connection between the audio playback device 110 and the primary network controller 130a); creating a system account for the user; setting up music services; browsing of content for playback;

setting preset assignments on the audio playback devices 110; transport control (e.g., play/pause, fast forward/rewind, etc.) for the audio playback devices 110; and selecting audio playback devices 110 for content playback (e.g., single room playback or synchronized multi-room playback). Devices in the primary network controller category can include desktop and laptop computers.

[0088] The secondary network controllers 130b may offer some, but not all, of the functions of the primary network controllers 130a. For example, the secondary network controllers 130b may not provide for all of the account setup and account management functions that are offered by the primary network controllers 130a. The secondary network controllers 130b may be used for: music services setup; browsing of content; setting preset assignments on the audio playback devices; transport control of the audio playback devices; and selecting audio playback devices 110 for content playback: single room or synchronized multi-room playback. Devices in the secondary network controller category can include mobile devices such as smart phones and tablets.

[0089] The auxiliary controllers 130c communicate wirelessly (e.g., via Bluetooth low energy (BTLE) or IR) with an associated (e.g., paired) one of the audio playback devices (item 110, FIG. 1). The auxiliary controllers 130c may offer limited functionality. The auxiliary controllers 130c may be used for: browsing of content; setting of preset assignments on the associated one of the audio playback devices 110; and transport control (play/pause, etc.) of the associated audio playback device.

[0090] The server 140 is a cloud-based server which contains (e.g., within an account database) information related to a user's audio system account. This includes user account information such as the list of the audio playback devices 110 within the system 100, device diagnostic information, preset assignments, etc. The server 140 will be connected to by the audio playback devices 140 and by the controllers 130 (e.g., by primary network controllers) for the purpose of preset management, as well as management of audio sources 120 and management of the user's audio system account.

Generally, the controllers 130 (e.g., network controllers 130a, 130b) will login to the server 140 with a user's login details and 'sync down' the required information to work with.

[0091] The audio playback devices 110 and one or more of the controllers 130 are coupled to a local area network (LAN) 150. Other devices such as one or more of the digital audio sources (e.g., a network-attached storage (NAS) device 120b) may also be coupled to the LAN 150. The LAN 150 may be a wired network, a wireless network, or a combination thereof. In one example, the devices (e.g., audio playback devices 110 and controllers 130 (e.g., primary and secondary controllers 130a, 130b)) within the LAN 150 are wirelessly coupled to the LAN 150 based on an industry standard such as IEEE 802.11 b/g. The LAN 150 may represent a network within a home, an office, or a vehicle. In the case of a residential home, the audio playback devices 110 may be arranged in different rooms (e.g., kitchen, dining room, basement, etc.) within the home. The devices within the LAN 150 connect to a user supplied access point 170 (e.g., a router) and subsequently to a wide area network (WAN) 160 (e.g., the Internet) for communication with the other digital audio sources 120 (Internet based music services 120a) and the server 140.

[0092] Notably, the audio system 100 can provide for the management of presets (a/k/a preset assignments) and recents. Presets are a set of (e.g., six) user-defined shortcuts to content, intended to provide quick access to entities associated with the digital music sources 120 from (1 of 6) preset indicators present on each of the audio playback devices 110. In some cases, the preset indicators can be hardware buttons. Alternatively, the preset indicators may be virtual buttons defined by regions on a touch sensitive display. The individual preset indicators can be denoted with numerical identifiers.

[0093] The preset indicators the audio playback devices 110 provide access to their respectively assigned entities irrespective of the associated digital audio source. More specifically, the preset indicators can provide for single press access to the respectively assigned entities, irrespective of the digital audio source. That is, a single press of a preset indicator will start the streaming and rendering of content from an entity assigned to that preset indicator regardless of the audio source providing that entity. In that regard, the

presets are said to be source agnostic in that they behave in the same manner regardless of the audio source. In some cases, the single press access can be facilitated with the distribution of tokens for accessing account based audio sources which normally require a user to login with account credentials.

[0094] The presets can be global or local at the user's option. The user can select the global or local option, e.g., during set up of the user's system account. If the user's account is set to provide for global presets, the preset assignments will be synchronized on all the audio playback devices 110 across the audio system 100 such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices (e.g., such that preset indicator "1" on a first one of the audio playback devices is assigned to the same entity as preset indicator "1" on all of the other audio playback devices 110 in the audio system 100), and, such that, if one of the preset assignments is changed on one of the audio playback devices 110, each of the other audio playback devices 110 is automatically updated such that a corresponding change is made to a corresponding preset assignment on each of the other audio playback devices. The synchronization of the preset assignments is managed through a combination of communications between the audio playback devices 110 with the server 140, and communications among the audio playback devices 110 themselves. A copy of the global preset assignments is stored locally on each audio playback device 110 associated with the user's account, and a copy of the global preset assignments is also maintained on the server 140.

[0095] FIG. 2 is a swim lane diagram 200 showing steps of managing/synchronizing "global" presets. "Swim lane" diagrams may be used to show the relationship between the various "actors" in the processes and to define the steps involved in the processes. FIG. 2 (and all other swim lane Figures) may equally represent a high-level block diagram of components of the invention implementing the steps thereof. The steps of FIG. 2 (and all the other FIGS. employing swim lane diagrams) may be implemented on computer program code in combination with the appropriate hardware. This computer program code may be stored on storage media such as a diskette, hard disk, CD-ROM, DVD-ROM or

tape, as well as a memory storage device or collection of memory storage devices such as read-only memory (ROM) or random access memory (RAM). Additionally, the computer program code can be transferred to a workstation over the Internet or some other type of network.

[0096] Referring to FIG. 2, four swim lanes are shown including a lane for one of the controllers 210, a lane for a first one of the audio playback devices 212, a lane for the other audio playback devices 214, and a lane for the server 216. At step 220, a first audio playback device (i.e., a first one of the audio playback devices 110, FIG. 1) receives user input regarding the assignment of an entity associated with one of the digital audio sources to one of the preset indicators on the audio playback device. In some cases, the user provides input directly to the audio playback devices, such as by pressing one of the preset indicators on the audio playback device. Alternatively, the user may provide input via a user interface on a selected one of the controllers (218), and the controller communicates the user input to the first audio playback device (219).

[0097] At step 222, the first audio playback device updates one or more preset assignments based on the user input. Updating can include updating data corresponding to the preset assignments stored locally (e.g., within memory) on the audio playback device.

[0098] At step 224, the first audio playback device sends information regarding the update to the one or more preset assignments to the remote server for updating a set preset assignments stored on the server. The update information may include an updated set of preset assignments. The audio playback devices may communicate with the server via a hypertext transfer protocol. The first audio playback device may, for example, upload the update information to the server via an HTTP POST command.

[0099] The server receives the update information from the first audio playback device (226), and updates a set of preset assignments stored on the server (228). Updating the set of preset assignments can include replacing previously stored data (e.g., a previously

stored set of presets) with the updated information (e.g., an updated set of preset assignments).

[00100] At step 230, the first audio playback device sends a communication to each of the other audio playback devices (e.g., a separate notification to each of the other audio playback devices) in the audio system notifying the other playback devices that there has been a change to one or more preset assignments.

[00101] At step 232, the other audio playback devices receive the notification from the first audio playback device. In response to receiving the notification of change to the preset assignments, the other audio playback devices synchronize their preset assignments with the server. To achieve this synchronization, each of the audio playback devices sends a communication (e.g., an HTTP GET request) to the server requesting update information corresponding to the changes to the preset assignments (234).

[00102] At step 236, the server receives the requests from the other audio playback devices. In response to the requests received from the other audio playback devices, the server responds by providing update information (which may consist of an updated set of preset assignments) to the each of the other audio playback devices (238).

[00103] At step 240, the other playback devices receive the update information from the server. Upon receipt of the update information, the other playback devices update their respective preset assignments (i.e., by updating preset data) (242). Updating can include removing (deleting) old data and replacing with new, updated data. For example, updating can include replacing a previously stored set of preset assignments and replacing with an updated set of preset assignments. Following these steps all of the audio playback devices will have the same preset assignments, and the server will have a copy of the preset assignments.

[00104] Alternatively, if the user elects to set the user's system account to provide for local presets, the preset assignments will be device-specific such that the preset assignments on any one of the audio playback devices 110 will not necessarily correspond

to the preset assignments on any of the other audio playback devices 110. A copy of the respective local preset assignments is stored locally on each audio playback device 110 associated with the user's account, and a copy of the local preset assignments for each audio playback device 110 is also maintained on the server 140.

[00105] FIG. 3 is a swim lane diagram 300 illustrating steps for managing local presets. Three swim lanes are shown including a lane for one of the controllers 310, a lane for a first one of the audio playback devices 312, and a lane for the server 316. At step 320, a selected audio playback device (i.e., a selected one of the audio playback devices 110, FIG. 1) receives user input regarding the assignment of an entity associated with one of the digital audio sources to one of the preset indicators on the audio playback device. In some cases, the user provides input directly to the audio playback devices, such as by pressing one of the preset indicators. Alternatively, the user may provide input via a user interface on one of the controllers (318), and the controller communicates the user input to the selected audio playback device (319).

[00106] At step 322, the selected audio playback device updates one or more preset assignments based on the user input. Updating can include updating data corresponding to the preset assignments stored locally (e.g., within memory) on the selected audio playback device.

[00107] At step 324, the selected audio playback device sends information regarding the update to the one or more preset assignments to the remote server for updating a set of preset assignments stored on the server. The update information may include an updated set of preset assignments. The audio playback devices may communicate with the server via a hypertext transfer protocol. The first audio playback device may, for example, upload the update information to the server via an HTTP POST command.

[00108] The server receives the update information from the selected audio playback device (326), and updates a set of preset assignments stored on the server (328). Updating the set of preset assignments can include replacing previously stored data (e.g., a previously stored set of presets) with the updated information (e.g., an updated set of

preset assignments). When the presets are set to local, the server will maintain (store and update) a separate set of presets for each audio playback device in the audio system.

[00109] The maintenance of a copy of the respective preset assignments for each of the audio playback devices on the server can be beneficial, for example, where the user elects to change from a local setting to a global setting after the individual devices have already been programed with respective preset assignments. In such a situation, the server will prompt the user (e.g., via one of the controllers) to select one of the audio playback devices to serve as a master device. The server can then set the preset assignments for the selected master audio playback device as a set of global preset assignments and can provide the global preset assignments to the other audio playback devices in the audio system so as to synchronize the presets across the audio system.

[00110] The "recents list" (a/k/a "recents") is a list of entities that is populated from content that the user has chosen to play. Recent entities can include Internet radio stations (e.g., for Pandora® and vTuner®), and a "group of tracks" selected for Spotify® and stored music. The "group of tracks" is a "parent" of a currently playing track, based on whatever the user either browsed to or searched for (e.g., Album, Playlist, Genre > All, Artist > All, etc.). The controllers 130, and, in some cases, the audio playback devices 110, can provide access to the recents by displaying the recents list to the user and allowing the user to browse the recents list and select entities therefrom.

[00111] The recents can be limited to a predetermined number of entities (e.g., 50-100 entities). Alternatively or additionally, the recents may be limited by date. For example, the recents may be limited to entities accessed by the user within the last day, month, year, etc., with older entries being purged from the list.

[00112] FIG. 4 is an exemplary user interface 400 which may be provided by one of the controllers 130 (FIG. 1), and which displays the recents list 410. The recents entries can be presented in reverse chronological order. "Now playing" (currently playing) tracks, if any, can be presented at the top of the list when the recents are displayed to the user

(412), and may include an indication of where (i.e., on which of the audio playback devices) they are playing.

[00113] Other entities included in the recents list can be displayed along with an indication of the time since they were last started. Within the same day this can take the format of "X hours" + "Y minutes" + "ago" (414). For one day ago (e.g., between 24 and 48 hours ago), "Yesterday" is displayed (416). For more than one day ago (e.g., 48 hours or more) the time can be display in the format of "X days" + "ago" (418).

[00114] As described below, the controllers 130 can be utilized to control the music selection on the audio playback devices 110 on a device-by-device (i.e., audio playback device by audio playback device) basis. Selecting a "Now Playing" entity from the recents list joins the corresponding music stream if it is not already joined.

[00115] As with the presets, the recents can be global (applied to all audio playback devices associated with a user's account) or local (device-specific) at the user's option. The same local/global toggle can be leveraged for both the presets and the recents. That is, one "global/local" setting can dictate whether the presets and recents are global or local. In some cases, the default setting is "global."

[00116] FIG. 5 is a swim lane diagram 500 showing steps for managing global recents. Four swim lanes are shown in FIG. 5 including a lane for a selected one of the controllers 510, a lane for a first one of the audio playback devices 512, a lane for the other audio playback devices 514, and a lane for the server 516. At step 520, a first audio playback device (i.e., a first one of the audio playback devices 110, FIG. 1) receives user input regarding the selection of an entity associated with one of the audio sources for providing streamed audio. In this regard, the user may provide input via one of the controllers (518), and the controller can communicate the user input to the first audio playback device (519).

[00117] At step 522, the first audio playback device updates a recents list stored locally (e.g., within memory) on that audio playback device to include the recently selected entity.

[00118] At step 524, the first audio playback device sends information regarding the update to the recents list to the remote server for updating a recents list stored on the server. The update information may include an updated recents list. The audio playback devices may communicate with the server via a hypertext transfer protocol. The first audio playback device may, for example, upload the update information to the server via an HTTP POST command.

[00119] The server receives the update information from the first audio playback device (526), and updates a recents list stored on the server (528). Updating the recents list can include replacing previously stored data (e.g., a previously stored recents list) with the updated information (e.g., an updated recents list).

[00120] At step 530, the first audio playback device sends a communication to each of the other audio playback devices (e.g., a separate notification to each of the other audio playback devices) in the audio system notifying the other playback devices that there has been a change to the recents list.

[00121] At step 532, the other audio playback devices receive the notification from the first audio playback device. In response to receiving the notification of change to the recents list, the other audio playback devices synchronize their locally stored copies of the recents list with the server. To achieve this synchronization, each of the audio playback devices sends a communication (e.g., an HTTP GET request) to the server requesting update information corresponding to the changes to the recents list (534).

[00122] At step 536, the server receives the requests from the other audio playback devices. In response to the requests received from the other audio playback devices, the server responds by providing update information (which may consist of an updated recents list) to each of the other audio playback devices (538).

[00123] At step 540, the other playback devices receive the update information from the server. Upon receipt of the update information, the other playback devices update their respective copies of the recents list (i.e., by updating recent data) (542). Updating can

include removing (deleting) old data and replacing with new, updated data. For example, updating can include replacing a previously stored recents list and replacing with an updated recents list. Following these steps all of the audio playback devices will have the same recents list, and the server will have a copy of the recents list.

[00124] When a user browses recents using one of the controllers, the controller will retrieve the recents list stored locally on a selected one of the audio playback devices for display to the user. Thus, when recents are set to global, the user will be presented with the same list of entities regardless of which one of the audio playback devices the user selects to control though the controller.

[00125] FIG. 6 is a swim lane diagram 600 showing steps for managing local recents. Three swim lanes are shown including a lane for one of the controllers 610, a lane for a selected one of the audio playback devices 612, and a lane for the server 616. At step 520, a selected audio playback device (i.e., a selected one of the audio playback devices 110, FIG. 1) receives user input regarding the selection of an entity associated with one of the audio sources for providing streamed audio. In this regard, the user may provide input via one of the controllers (518), and the controller can communicate the user input to the first audio playback device (519).

[00126] At step 522, the selected audio playback device updates a recents list stored locally (e.g., within memory) on that audio playback device to include the recently selected entity.

[00127] At step 524, the selected audio playback device sends information regarding the update to the recents list to the remote server for updating a recents list stored on the server. The update information may include an updated recents list. The audio playback devices may communicate with the server via a hypertext transfer protocol. The first audio playback device may, for example, upload the update information to the server via an HTTP POST command.

[00128] The server receives the update information from the selected audio playback device (526), and updates a recents list stored on the server (528). Updating the recents list can include replacing previously stored data (e.g., a previously stored recents list) with the updated information (e.g., an updated recents list). Thus, when recents are set to local, the user will be presented with the a device specific list of entities that corresponds to the entities that had been most recently accessed by the audio playback device that the user selects to control though the controller. The server will maintain a separate recents list for each audio playback device in the audio system.

[00129] The maintenance of a copy of the respective recents lists for each of the audio playback devices on the server can be beneficial, for example, where the user elects to change from a local setting to a global setting after the individual devices have already curated their respective recents lists. In such a situation, the server can prompt the user (e.g., via one of the controllers) to select one of the audio playback devices to serve as a master device. The server can then set the recents list for the selected master audio playback device as a global recents list and can provide the global recents list to the other audio playback devices in the audio system so as to synchronize the recents list across the audio system.

[00130] AUDIO PLAYBACK DEVICES

[00131] An exemplary audio playback device 110 will now be described in greater detail with reference to FIGS. 7A through 7C. Referring to FIG. 7A, an audio playback device 110 includes an enclosure 710 and on the enclosure 710 there resides a graphical interface 712 (e.g., an OLED display) which can provide the user with information regarding currently playing ("Now Playing") music and information regarding the presets. A screen 714 conceals one or more electro-acoustic transducers 715 (FIG. 7C). The audio playback device 110 also includes a user input interface 716. As shown in FIG. 7B, the user input interface 716 includes a plurality of preset indicators 718, which are hardware buttons in the illustrated example. The preset indicators 718 (numbered 1-6) provide the user with easy, one press access to entities assigned to those buttons. That is, a single

press of a selected one of the preset indicators 718 will initiate streaming and rendering of content from the assigned entity.

[00132] The assigned entities can be associated with different ones of the digital audio sources (items 120a, 120b, 120c, FIG. 1) such that a single audio playback device 110 can provide for single press access to various different digital audio sources. In one example, the assigned entities include at least (i) user-defined playlists of digital music and (ii) Internet radio stations. In another example, the digital audio sources include a plurality of Internet radio sites, and the assigned entities include individual radio stations provided by those Internet radio sites.

[00133] Notably, the preset indicators 718 operate in the same manner, at least from the user's perspective, regardless of which entities are assigned and which of the digital audio sources provide the assigned entities. That is, each preset indicator 718 can provide for single press access to its assigned entity whether that entity is a user-defined playlist of digital music provided by an NAS device or an Internet radio station provided by an Internet music service.

[00134] With reference to FIG. 7C, the audio playback device 110 also includes a network interface 720, a processor 722, audio hardware 724, power supplies 726 for powering the various audio playback device components, and memory 728. Each of the processor 722, the graphical interface 712, the network interface 720, the processor 722, the audio hardware 724, the power supplies 726, and the memory 728 are interconnected using various buses, and several of the components may be mounted on a common motherboard or in other manners as appropriate.

[00135] The network interface 720 provides for communication between the audio playback device 110 and the controller (e.g., items 130a-c, FIG.1), the server (item 140, FIG. 1), the audio sources (items 120, FIG. 1) and other audio playback devices 110 via one or more communications protocols. The network interface 720 may provide either or both of a wireless interface 730 and a wired interface 732. The wireless interface 730 allows the audio playback device 110 to communicate wirelessly with other devices in

accordance with a communication protocol such as such as IEEE 802.11 b/g. The wired interface 732 provides network interface functions via a wired (e.g., Ethernet) connection.

[00136] In some cases, the network interface 720 may also include a network media processor 734 for supporting Apple AirPlay® (a proprietary protocol stack/suite developed by Apple Inc., with headquarters in Cupertino, California, that allows wireless streaming of audio, video, and photos, together with related metadata between devices). For example, if a user connects an AirPlay® enabled device, such as an iPhone or iPad device, to the LAN 150, the user can then stream music to the network connected audio playback devices 110 via Apple AirPlay®. A suitable network media processor is the DM870 processor available from SMSC of Hauppauge, New York. The network media processor 734 provides network access (i.e., the Wi-Fi network and/or Ethernet connection can be provided through the network media processor 734) and AirPlay® audio. AirPlay® audio signals are passed to the processor 722, using the I^2S protocol (an electrical serial bus interface standard used for connecting digital audio devices), for downstream processing and playback. Notably, the audio playback device 110 can support audio-streaming via AirPlay® and/or DLNA's UPnP protocols, and all integrated within one device.

[00137] All other digital audio coming from network packets comes straight from the network media processor 734 through a USB bridge 736 to the processor 722 and runs into the decoders, DSP, and eventually is played back (rendered) via the electro-acoustic transducer(s) 715.

[00138] The network interface 710 can also include a Bluetooth low energy (BTLE) system-on-chip (SoC) 738 for Bluetooth low energy applications (e.g., for wireless communication with a Bluetooth enabled controller (item 130c, FIG. 1)). A suitable BTLE SoC is the CC2540 available from Texas Instruments, with headquarters in Dallas, Texas.

[00139] Streamed data pass from the network interface 720 to the processor 722. The processor 722 can execute instructions within the audio playback device (e.g., for performing, among other things, digital signal processing, decoding, and equalization functions), including instructions stored in the memory 728. The processor 722 may be

implemented as a chipset of chips that include separate and multiple analog and digital processors. The processor 722 may provide, for example, for coordination of other components of the audio playback device 110, such as control of user interfaces, applications run by the audio playback device 110. A suitable processor is the DA921 available from Texas Instruments.

[00140] The processor 722 provides a processed digital audio signal to the audio hardware 724 which includes one or more digital-to-analog (D/A) converters for converting the digital audio signal to an analog audio signal. The audio hardware 724 also includes one or more amplifiers which provide amplified analog audio signals to the electroacoustic transducer(s) 715 for playback. In addition, the audio hardware 724 may include circuitry for processing analog input signals to provide digital audio signals for sharing with other devices in the acoustic system 100.

[00141] The memory 728 stores information within the audio playback device 110. In this regard, the memory 728 may store account information, such as the preset and recent information discussed above. The memory 728 may also provide storage for "tokens" for facilitating single press access to the digital audio sources 120 (e.g., the Internet radio services of FIG. 1). A token, as used herein, is a unique identifier that may be provided by the digital audio source 120 and which allows the digital audio source 120 to recognize the audio playback device 110 as being associated with a user's account with the digital audio source 120 and without requiring the user to enter credentials (e.g., user name, password, etc.) each time the audio playback device 110 attempts to access the digital audio source 120.

[00142] The memory 728 may include, for example, flash memory and/or non-volatile random access memory (NVRAM). In some implementations, instructions (e.g., software) are stored in an information carrier. The instructions, when executed by one or more processing devices (e.g., the processor 722), perform one or more processes, such as those described above (e.g., with respect to FIGS. 2, 3, 5, and 6). The instructions can also be stored by one or more storage devices, such as one or more computer- or

machine-readable mediums (for example, the memory 728, or memory on the processor). The instructions may include instructions for performing decoding (i.e., the software modules include the audio codecs for decoding the digital audio streams), as well as digital signal processing and equalization.

[00143] The instructions may also include instructions for enabling certain "browsing" functionality. That is, at least in some cases, the controllers (items 130a-c, FIG. 1) serve as graphical remote controls for the audio playback devices 110 and do not communicate with the digital audio sources 120 (FIG. 1) directly, but, instead, communicate with the digital audio sources 120 via the audio playback devices 110.

[00144] FIG. 8 is a swim lane diagram 800 showing steps for browsing entities (e.g., stations) associated with one of the digital audio sources (items 120a-c, FIG. 1). Three swim lanes are shown in FIG. 8 including a lane for a selected one of the controllers 810, a lane for a selected one of the audio playback devices 812, and a lane for a selected one of the digital audio sources 813.

[00145] At step 820, the controller receives input from a user requesting a list of stations (entities) from a selected one of the digital audio sources (i.e., a digital audio source, within the audio system, that is selected by the user via a user interface provided by the controller). At step 822, the controller sends the request to a selected one of the audio playback devices (i.e., an audio playback device, within the audio system, that is selected by the user via a user interface provided by the controller).

[00146] At step 824, the selected one of the audio playback devices receives the request from the controller. In response, the audio playback device connects to the selected digital audio source via the router and Internet connection and requests a list of entities (e.g., stations) associated with that source (826).

[00147] At step 828, the selected one of the digital audio sources receives the request from the audio playback device. In response to the request from the audio playback device, the audio source sends a list of available entities to the audio playback device

(830). The audio playback device receives the list of available entities (832) and the audio playback device sends the list of available entities along to the controller (834).

[00148] The controller receives the list of available entities from the audio playback device (836) and displays the list to the user (838).

[00149] FIG. 9 illustrates another implementation of an audio playback device 110' in which the audio playback device hardware is divided between the enclosure 710 and a separate device ("dongle 900"). The dongle 900 can be connected to the enclosure 710 via a wired connection 902. In the illustrated example of FIG. 9, the network interface 720, the processor 722, the audio hardware 724, and the power supplies 726 are located within a housing 904 of the dongle 900. The graphical interface 712 and the user input interface 716 are located on the enclosure 710. The enclosure 710 encloses the electro-acoustic transducer(s) 715 and may also include additional electronics 906 (e.g., processors, amplifiers, D/A converters, A/D converters, power supplies, etc.) for processing, converting and amplifying audio content from local audio sources (e.g., audio content stored in memory within the enclosure 710, a CD connected to the audio playback device, a portable music device such as an IPod connected to the audio playback device 110', etc.).

[00150] CONTROLLERS

[00151] Referring to FIG. 10, an exemplary controller 130 includes a processor 1000, a memory 1010, a display 1012, a user input interface 1014, and a network interface 1016, among other components. The controller 130 may also be provided with a mass storage device 1018, such as a hard drive, a micro-drive, or other device, to provide additional storage. Each of the processor 1000, the memory 1010, the display 1012, and the network interface 1016 are interconnected using various buses, and several of the components may be mounted on a common motherboard or in other manners as appropriate.

[00152] The processor 1000 can execute instructions (e.g., software) within the controller 130, including instructions stored in the memory 1010 or in a secondary storage device (e.g., mass storage device 1018). The processor 1000 may be implemented as a chipset

of chips that include separate and multiple analog and digital processors. The processor 1000 may provide, for example, for coordination of other components of the controller 130, such as control of user interfaces, applications run by the controller 130, and network communication by the controller 130. The processor 1000 may communication with a user through the display 1012 and the user input interface 1014.

[00153] The processor 1000 may communicate with the user through a display interface 1020 coupled to the display 1012. The display 1012 may include an LCD monitor, or a touch sensitive display (e.g., in the case of a mobile device). The display interface 1020 may comprise appropriate circuitry for driving the display 1012 to preset graphical and other information to the user.

[00154] The user input interface 1014 may include one or more user input devices such as a keyboard, a pointer device such as a mouse, and/or a touch sensitive display. In some cases, the same device (e.g., a touch sensitive display) may be utilized to provide the functions of the display 1012 and the user input interface 1014.

[00155] The network interface 1016 facilitates wireless communication (e.g., Wi-Fi, Bluetooth, IR, etc.) with one or more of the audio playback devices (item 110, FIG. 1) via a corresponding network interface (item 720, FIG. 7C) on the audio playback device 110.

[00156] The memory 1010 stores information within the controller 130. In some implementations, the memory 1010 is a volatile memory unit or units. In some implementations, the memory 1010 is a non-volatile memory unit or units. The memory 1010 may also be another form of computer-readable medium, such as magnetic or optical disk.

[00157] The mass storage device 1018 is capable of providing mass storage for the controller 130. In some implementations, the mass storage device 1018 may be or contain a computer readable medium, such as a floppy disk device, a hard disk device, an optical disk device, or a tape device, a flash memory or other similar solid state memory device, or an array of devices.

[00158] Instructions (e.g., software) can be stored in an information carrier. The instructions, when executed by one or more processing devices (e.g., the processor 1000), perform one or more processes, such as those described above (e.g., with reference to FIGS. 2, 3, 5, 6 and 8). The instructions can also be stored by one or more storage devices such as computer- or machine-readable mediums (for example, the memory 1010, the storage device 1018, or memory in the processor 1000).

[00159] Referring to FIG. 11, the controller software can include a user application 1100, a DLNA server daemon 1110, and a USB driver 1112. The user application 1100 is run by the user and can be started from a daemon in response to a Region Icon command. The user application 1100 includes computer-executable instructions (e.g., software modules) for system account creation and management (i.e., creating and managing a user's system account) (1114); audio playback device registration and configuration (1116); network management (1118); preset/recent management (1120); transport control (e.g., play/pause, rewind/forward, etc.) for the audio playback devices (1122); initiating firmware updates for the audio playback devices (1124); music services setup (1126); and context sensitive help (1128). Each of these functions can be provided by a corresponding software module.

[00160] The DLNA server daemon 1110 serves music from the user's computer (e.g., iTunes, Windows Media Player, or files in a folder) to audio playback devices 110. The DLNA server 1110 is installed as a system service and always runs when the computer (controller 130) is booted. The DLNA server daemon 1110 shows as a tray icon when running in the background and can continue to serve music even when the user application 1100 is shut down. The DLNA server daemon 1110 can provide the user with the options for enabling and disabling the serving of the selected music library.

[00161] The USB driver 1112 defines how the audio playback device 110 communicates with the controller 130 over a local USB connection. The USB driver 1112 is installed as a device driver. In some cases, the USB driver 1112 is just an .INF file (i.e., a plain text information file) that points to a standard USB driver. The USB driver 1112 can be loaded

by the controllers 130 operating system when the audio playback device 110 is connected via USB.

[00162] FIG. 12 is a state interaction diagram that shows an overview of various user interface states of the user application 1100. Referring to FIG. 12, the user application consists of four primary user interface (UI) states: a setup state 1210; a tutorial state 1212; a main application state 1214; and a settings state 1216.

[00163] A first run of the user application 1100 initiates the setup state 1210. The setup state 1210 performs network (e.g., Wi-Fi/Ethernet) setup, system account creation, and music services setup via the corresponding software modules (FIG. 11). After a first run of the user application 1100, the Wi-Fi setup is automatically triggered when an audio playback device 110 (FIG. 1) is connected to a controller 130 (FIG. 1) via USB.

[00164] When the setup state 1210 is completed, the user is shown a pop-up 1218 that gives him/her the option to view a tutorial, or to skip it and go directly to the main application state 1214. If the user elects to view the tutorial, the tutorial state 1212 runs and provides a step-by-step overview of how to use the main application UI state. As mentioned above, the secondary network controllers 130b (FIG. 1) may not offer all of the functionality of the primary network controllers 103a (FIG. 1). More specifically, the secondary network controllers 130b may not provide the setup functions offered by the primary network controllers 130a, and, consequently, the secondary network controllers 130b may start at step 1218.

[00165] When the tutorial 1212 is complete, or if the user elects to skip the tutorial, the main application state 1214 runs. The main application state 1214 is the primary application view that the user interfaces with.

[00166] The user can access the settings state 1216 via the main application state 1214 (e.g., settings can be a menu item that is selectable from the main application state 1214. The settings state 1216 is an interface for adjusting system settings. The settings state 1216 can be used to: (i) adjust account settings (e.g., change an account password, delete

an audio system account, etc.); (ii) adjust device settings (e.g., update software, change a device name, etc.); (iii) adjust presets and recents settings (e.g., change between local and global settings); (iv) adjust music services settings (e.g., add a music service, change location for local Internet radio, edit a Pandora® account, connect another Pandora® account); and adjust stored music settings (e.g., add or remove a music library).

[00167] FIG. 13 illustrates a high-level workflow for the setup state. The setup state 1210 consists of four main steps: Adding devices (e.g., audio playback devices and auxiliary controllers) to a user's system network (1310); audio playback device software update (1312); system account creation (1314); and music setup (1316).

[00168] The setup state 1210 is generally initiated when an audio playback device 110 is connected to the controller 130 via a USB connection. This starts the step of adding devices to an audio system network LAN 150 (FIG. 1), which will begin by prompting the user to select how the USB connected audio playback device 110 will connect to the LAN (item 150, FIG. 1) (e.g., via Wi-Fi connection or via Ethernet connection) (1320). Once the user selects the network connection type, the user will be prompted to setup the network connection (1322). This can include entering network credentials (e.g., entering a network name or selecting from a list of available networks and entering a password if the network is password protected).

[00169] Once a network connection is established, the user interface on the controller 130 can prompt the user to disconnect the audio playback device 110 from the controller 130 (i.e., disconnect the USB connection) and connect the audio playback device 110 to power where the user intends to use it, and then return to complete setup.

[00170] Next, the user interface can prompt the user to pair an auxiliary controller (BTLE controller) and can walk the user through the pairing process (1324). Then, the user can be prompted to setup additional devices (1326). Additional devices can be added by connecting via USB and going through the aforementioned steps for each subsequently added device.

[00171] In the next step (1328) of the setup process, device software is updated. The controller sends a command to the network connected audio playback devices to check for software updates (the software updates may be made available through the server and/or via a separate Internet service). The controller will prompt the user to update the audio playback devices if any updates are available and sends a command to the audio playback devices for update. The controller can indicate the software update progress via the user interface and can display a popup window in case of any errors.

[00172] Once updates are completed, the controller will guide the user through creating an audio system account or will prompt the user to sign in to an existing account (1330). The system account will be created on the server via direct interaction between the controller and the server.

[00173] Next, the controller guides the user through music setup (1316) which includes setting up the user's stored music sources including PC stored music, NAS devices, etc. (1332) as well as setting up Internet based audio sources (e.g., Pandora®, vTuner®, etc.) (1334).

[00174] In some cases, when setting up the digital audio sources, the user may be prompted to enter account credentials. For example, when adding a user's Pandora® account to the user's system account, the Pandora® Internet service may request account credentials from the user. In return, Pandora® will return a unique identifier ("token") that can be stored on the server and in memory on each of the audio playback devices and which will allow the audio playback devices subsequent access to the remote audio source without requiring login each time.

[00175] FIG. 14A is a swim lane diagram showing steps for music setup for a digital audio source such as an Internet music service. Three swim lanes are shown in FIG. 14A including a lane for one of the controllers 1410, a lane for a selected one of the audio playback devices 1412, and a lane for a selected one of the digital audio sources (e.g., an Internet music service such as Pandora®) 1414.

[00176] At step 1420, the controller receives user input requesting access to an Internet music service, and, at step 1422, sends the request to a selected one of the audio playback devices.

[00177] The selected audio playback device receives the request from the controller (1424) and sends the request to the Internet music source (1426). Internet music source receives request (1428) and responds with a request for login credentials (1430).

[00178] The selected audio playback device receives the request for credentials (1432) and sends the request to the controller (1434). At step 1436, the controller receives the request for login credentials, and, at step 1438, the controller displays the request for login credentials to the user.

[00179] At step 1440, the controller receives login credentials from the user, and, at step 1442, the controller sends the login credentials to the selected audio playback device. The selected audio playback device receives the login credentials (1444) and sends the credentials to the Internet music service (1446).

[00180] At step 1448, the Internet music service receives the login credentials, and, at step 1450, authenticates the user's account. If the user's account is authenticated, the Internet music service will grant access and return a token to the selected audio playback device (1452). As discussed above, the token allows the Internet music service to identify and associate the device with a user's Internet music service account, thus obviating the need for login credentials after music services setup.

[00181] The selected audio playback device receives the token (1454), and stores the token within memory in the selected audio playback device (1456). The token can then be distributed to other devices within the audio system to allow those other devices to similarly access the Internet music service.

[00182] FIG. 14B is a swim lane diagram showing steps for for distribution of tokens for accessing account based digital audio sources such as certain Internet music services.

Three swim lanes are shown in FIG. 14B including a lane for a first one of the audio playback devices 1460, a lane for the other audio playback devices in the audio system 1462, and a lane for the remote server 1464. The first one of the audio playback devices (the first audio playback device) corresponds to the selected one of the audio playback devices that was utilized by the selected one of the controllers to setup the Internet music service as described above with respect to FIG. 14A.

[00183] At step 1466, the first audio playback device sends a copy of the token received from the Internet music service to the server. The server receives the token from the first audio playback device (1468), and stores a copy of the token locally (e.g., within memory) on the server (1470).

[00184] At step 1472, the first audio playback device sends a communication to each of the other audio playback devices (e.g., a separate notification to each of the other audio playback devices) in the audio system notifying the other playback devices that there have been changes to the user's account (i.e., a new digital audio source has been added to the audio system).

[00185] At step 1474, the other audio playback devices receive the notification from the first audio playback device. In response to receiving the notification, each of the audio playback devices sends a communication to the server requesting information corresponding to the changes to the user's account (1476).

[00186] At step 1478, the server receives the requests from the other audio playback devices. In response to the requests received from the other audio playback devices, the server responds by providing the new account information (which may consist of a copy of the token for the recently added Internet music service) to each of the other audio playback devices (1480).

[00187] At step 1482, the other playback devices receive the new account information (e.g., a copy of the token) from the server. Upon receipt of the update information, the

other playback devices update their locally stored copies of the user's account information (i.e., by adding the token to stored data) (1483).

[00188] The distribution of "tokens" can help to facilitate single press access to the sources (e.g., via the preset indicators on the audio playback devices) to provide for source agnostic operation (i.e., the audio playback devices behave the same regardless of the source). This can help to allow the preset indicators on the audio playback devices to provide access to their respectively assigned entities irrespective of the associated digital audio source.

[00189] Referring to FIG. 15A, the user interface 1500 for the main application state includes: an audio playback device region 1510, a preset region 1512, and a source region 1514. The audio playback device region 1510 lists audio playback devices 1516 on the LAN (150, FIG. 1) that are available for control. User can select the audio playback device 1516 from the list of available devices. The device that is currently selected is centered in the region. This is the device for which now playing information, presets, and recents are shown. The audio playback device region 1510 includes a volume slider 1518 which can be used to control the volume of the selected device.

[00190] The preset region provides a list of preset indicators 1520 (in the form of virtual buttons) which correspond to the preset indicators (item 718, FIG. 7B) on the selected audio playback device. The list can include a description of the corresponding entity assigned to the preset indicator along with a numerical identifier for the preset indicator. Users can select a preset (e.g., by double-clicking) play content associated with the selected preset with the selected audio playback device. Or, as discussed below, the user can use the interface to assign entities to the presets.

[00191] The source region 1514 displays one of two modes of the main application. The two modes of the main application include a "Now Playing" mode (FIG. 15A) and an "Explore" mode (FIG. 15B). In the Now Playing mode, the source region 1514 displays album art 1522 for content being played by the selected audio playback device. The source region 1514 includes an identification of the audio source 1524 for the playing

content, as well as source specific now playing information 1526 such as Artist Name/Album Name/Track name. In Now Playing mode, the source region 1514 also includes source specific buttons 1528, which may include transport functions such as play, pause, skip forward, etc. Also displays an "Explore" button 1530 which allows the user to navigate to the Explore mode.

[00192] Referring to FIG. 15B, the Explore mode allows the user to browse available content and features. In the Explore mode, the source region 1514 displays one of a plurality of lists that the user can navigate through to select content to play, to select an entity to assign to a preset, to access Help content, and/or to manage settings.

[00193] A top-level Explore list (FIG. 15B) will include links 1532 to: digital audio sources (e.g., global and/or local Internet radio provided by vTuner®, stored music, Pandora®, etc.), recents list, help content, and the settings UI state. Audio sources with multiple accounts (e.g., multiple Pandora® accounts all associated with the user's system account) may be listed by date, with the first one set up listed first.

[00194] Selection of an audio source opens a sub-list of entities (FIG. 15C, showing sub-list of entities) associated with the selected source (the "Global Internet Radio" source (e.g., provided by vTuner®)) in the source region 1514. The sub-list of entities is generated via communication between the controller, the selected audio playback device, and the selected audio source as discussed above. A "Now Playing" button 1534 allows the user to navigate to the Now Playing mode.

[00195] FIGS. 16A through 16C illustrate another implementation of a graphical user interface 1600 for the main application that may be utilized for mobile devices. In the implementation of FIGS. 16A-16C, the main application can be in one of three modes: Presets mode (FIG. 16A), Now Playing mode (FIG. 16B), or Explore mode (FIG. 16C). The user can navigate between Presets, Now Playing, and Explore modes by swiping/navigating left/right amongst these modes.

[00196] Referring to FIG. 16A, the user interface 1600 for the main application includes: an audio playback device region 1612, a presets region 1614, and a source region 1616. The audio playback device region 1612 lists audio playback devices on the LAN (item 150, FIG. 1) that are available for control. User can select the audio playback device from the list of available devices. The Audio playback device region 1612 includes a volume slider 1616 which can be used to control the volume of the selected device.

[00197] The presets region 1614 includes a list of preset indicators 1620 (in the form of virtual buttons) which correspond to the preset indicators on the selected audio playback device. The preset indicators (item 718, FIG. 7B) are identified by corresponding numerical identifiers for each preset indicator. Users can select a preset (e.g., by double-clicking) play content associated with the selected preset with the selected audio playback device.

[00198] The source region 1616 displays the Presets mode, the Now Playing mode, or the Explore mode of the main application. In the Preset mode, shown FIG. 16A, the source region 1616 displays additional information for the device presets. The additional information can include a description of the corresponding entity assigned to the preset along with a numerical identifier for the preset button.

[00199] In the Now Playing mode (FIG. 16B), the source region 1616 displays album art 1618 for content being played by the selected audio playback device. The source region 1616 also includes an identification of the audio source 1620 for the playing content, as well as source specific now playing information 1622 such as Artist Name/Album Name/Track name. In the Now Playing mode, the source region 1616 also includes source specific buttons 1624, which may include transport functions such as play, pause, skip forward, etc.

[00200] The Explore mode (FIG. 16C) allows the user to browse available content and features. In the Explore mode, the source window displays one of a plurality of menus that the user can navigate through to select content to play, to select an entity to assign to a preset, to access Help content, and/or to manage settings.

[00201] A top-level Explore list will include links to: available audio sources, recents, help content, and the settings UI state. Audio sources with multiple accounts (e.g., multiple Pandora® accounts all associated with the user's system account) may be listed by date, with the first one set up listed first.

[00202] Selection of an audio source opens a sub-list of entities associated with the selected source in the source window. The sub-list of entities is generated via communication between the controller, the selected audio playback device, and the selected audio source as discussed above.

[00203] FIG. 17 illustrates a process 1700 for setting preset from a controller. The process 1700 includes selecting an audio playback device from the audio playback device region of the user interface (1710). The selected audio playback device will be the device that the controller utilizes to communicate with the digital audio sources. The process 1700 also includes assigning an entity to a preset indicator on the selected audio playback device (1712).

[00204] In this regard, preset assignments can be set from either the "Now Playing" mode or the "Explore" mode of the main application. Assigning from the Now Playing mode will assign entity associated with currently playing content to the selected preset.

[00205] FIGS. 18A and 18B show a sequence of screen displays illustrating the setting of a preset assignment from the Now Playing mode on a desktop or laptop computer. Referring to FIGS. 18A and 18B, the user selects (e.g., by clicking with pointing device (mouse) or tapping in the case of a touch sensitive screen) and holds one of the preset indicators 1800 to cause the preset indicator to be highlighted (FIG. 18A). After the selected preset indicator 1800 is held for a predetermined amount of time, the preset indicator 1800 will be assigned to the "Now Playing" entity. This may be indicated by a change in the text associated with the preset indicator 1800 (e.g., the text may be updated to reflect the newly associated entity's name, as shown in FIG. 18B). The new or updated preset assignment will take effect on the selected audio playback device 1810 (i.e., the device selected in the audio playback region) which is being controlled by the controller.

[00206] Alternatively, as illustrated in FIGS. 19A and 19B, the user can right-click on one the preset indicators 1900 and select "Set Preset" from a right-click menu 1910 to assign the entity associated with the currently playing content to be assigned to the selected preset indicator 1900.

[00207] Alternatively, Referring to FIGS. 20A and 20B, the main application state may include a menu bar 2000 with a "Set Preset" button 2010. The user can set a preset assignment by clicking on the "Set Preset" button 2010 to display a Preset menu 2012. The user can choose a preset from the preset menu 2012 to assign the entity (e.g., Internet radio station) associated with the "Now Playing" content to. Preset changes may be indicated by text changes to the station name associated with the preset indicator (FIG. 18B).

[00208] FIGS. 21A through 21C illustrate yet another method of setting a preset from the "Now Playing" mode. The user can click/tap 2100 and hold within the source region (FIG. 19A). The entity to be assigned to a preset appears in a pop-up 2110 in the clicked/tapped area (FIG. 19B). And the entity is dragged and dropped on the destination preset indicator 2112 (FIG. 19C).

[00209] FIGS. 22A and 22B illustrate a method of assigning a preset in the Browse mode. The user selects an entity 2200 from a list of entities 2210 and drags the selected entity to the preset indicator 2212 (FIG. 20A). The preset assignment is updated to reflect the change. This can be reflected by a text update on the preset indicator 2212 (FIG. 20B).

[00210] Alternatively, the preset assignment can be set or changed on the audio playback device itself by pressing and holding one of the preset indicators on the device's enclosure. This will assign an entity associated with currently plating content to the selected preset indicator.

[00211] Once a preset assignment is set for the first time or changed on one of the audio playback devices, the preset assignments can be synchronized across the audio system as described above with respect to FIG. 2.

[00212] SERVER

[00213] FIG. 23 illustrates an exemplary computing device 2300 that can be utilized to implement the server (item 140, FIG. 1). The computing device 2300 is intended to represent various forms of digital computers, such as servers, blade servers, mainframes, and other appropriate computers. The components shown here, their connections and relationships, and their functions, are meant to be examples only, and are not meant to be limiting.

[00214] The computing device 2300 includes a processor 2310, a memory 2312, a storage device 2314, a high-speed interface 2316 connecting to the memory 2312 and multiple high-speed expansion ports 2318, and a low-speed interface 2320 connecting to a low-speed expansion port 2322 and the storage device 2314. Each of the processor 2310, the memory 2312, the storage device 2314, the high-speed interface 2316, the high-speed expansion ports 2318, and the low-speed interface 2320 are interconnected using various busses, and may be mounted on a common motherboard or in other manners as appropriate. The processor 2310 can process instructions (e.g., a software program) for execution within the computing device 2300, including instructions stored in the memory 2312 or on the storage device 2314 to display graphical information for a GUI on an external input/output device, such as a display 2324 coupled to the high-speed interface 2316. In other implementations, multiple processors and/or multiple buses may be used, as appropriate, along with multiple memories and types of memory. Also, multiple computing devices may be connected, with each device providing portions of the necessary operations (e.g., as a server bank, a group of blade servers, or a multi-processor system).

[00215] The memory 2312 stores information within the computing device 2300. In some implementations, the memory 2312 is a volatile memory unit or units. In some implementations, the memory 2312 is a non-volatile memory unit or units. The memory 2312 may also be another form of computer-readable medium, such as a magnetic or optical disk.

[00216] The storage device 2314 is capable of providing mass storage for the computing device 2300. In some implementations, the storage device 2314 may be or contain a computer-readable medium, such as a floppy disk device, a hard disk device, an optical disk device, or a tape device, a flash memory or other similar solid state memory device, or an array of devices, including devices in a storage area network or other configurations. Instructions can be stored in an information carrier. The instructions, when executed by one or more processing devices (for example, processor 2310), perform one or more processes, such as those described above (e.g., with reference to FIGS. 2, 3, 5, 6, 14B). The instructions can also be stored by one or more storage devices such as computer- readable mediums (for example, the memory 2312, the storage device 2314, or memory on the processor 2310). The storage device 2314 may provide storage for a database 2324. The database can be used to store audio system account information.

[00217] The high-speed interface 2316 manages bandwidth-intensive operations for the computing device 2300, while the low-speed interface 2320 manages lower bandwidth-intensive operations. Such allocation of functions is an example only. In some implementations, the high-speed interface 2316 is coupled to the memory 2312, the display 2322 (e.g., through a graphics processor or accelerator), and to the high-speed expansion ports 2318, which may accept various expansion cards (not shown). In the implementation, the low-speed interface 2320 is coupled to the storage device 2314 and the low-speed expansion port 2322. The low-speed expansion port 2322, which may include various communication ports (e.g., USB, Bluetooth, Ethernet, wireless Ethernet) may be coupled to one or more input/output devices, such as a keyboard, a pointing device, a scanner, or a networking device such as a switch or router, e.g., through a network adapter.

[00218] The computing device 2300 may be implemented in a number of different forms, as shown in the figure. For example, it may be implemented as a standard server 2330, or multiple times in a group of such servers 2332. It may also be implemented as part of a rack server system.

[00219] Implementations of the systems and methods described above comprise computer components and computer-implemented steps that will be apparent to those skilled in the art. For example, it should be understood by one of skill in the art that the computer-implemented steps may be stored as computer-executable instructions on a computer-readable medium such as, for example, floppy disks, hard disks, optical disks, Flash ROMS, nonvolatile ROM, and RAM. Furthermore, it should be understood by one of skill in the art that the computer-executable instructions may be executed on a variety of processors such as, for example, microprocessors, digital signal processors, gate arrays, etc. In addition, the instructions may be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. For ease of exposition, not every step or element of the systems and methods described above is described herein as part of a computer system, but those skilled in the art will recognize that each step or element may have a corresponding computer system or software component. Such computer system and/or software components are therefore enabled by describing their corresponding steps or elements (that is, their functionality), and are within the scope of the disclosure.

[00220] A number of implementations have been described. Nevertheless, it will be understood that additional modifications may be made without departing from the scope of the inventive concepts described herein, and, accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. A method for managing presets in an audio system, the method comprising:

syncing preset assignments on a plurality of audio playback devices such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices, and, such that, if one of the preset assignments is changed on one of the audio playback devices, each of the other audio playback devices is automatically updated such that a corresponding change is made to a corresponding preset assignment on each of the other audio playback devices,

wherein each of the preset assignments is an assignment of an entity associated with one of a plurality of digital audio sources to one of a plurality of preset indicators on the corresponding one of the audio playback devices.

2. The method of claim 1, wherein the step of syncing preset assignments on a plurality of audio playback devices comprises:

receiving information from a first audio playback device of the audio system regarding a change to one or more of a plurality of preset assignments;

updating stored preset data based on the information received from the first audio playback device; and

providing update information to one or more other audio playback devices of the audio system such that the one or more other audio playback devices update their respective preset assignments to correspond to those of the first audio playback device.

3. The method of claim 2, wherein the step of updating stored preset data comprises updating preset data stored on a remote server.

4. The method of claim 2, wherein the step of updating stored preset data comprises replacing a first set of preset assignments with a second, updated set of preset assignments.

5. The method of claim 1, further comprising receiving user input regarding the assignment of an entity associated with one of the digital audio sources to one of the preset indicators on a first one of the audio playback devices.

6. The method of claim 5, wherein the user input corresponds to actuation of a hardware button on a first one of the audio playback devices.

7. The method of claim 5, wherein the user input is received via a controller connected to the first one of the audio playback devices via a network connection.

8. The method of claim 1, wherein the assignable entities include at least (i) user-defined playlists of digital music and (ii) Internet radio stations.

9. The method of claim 1, wherein the digital audio sources include a plurality of Internet radio sites, and the entities include individual radio stations provided by the Internet radio sites.

10. The method of claim 1, wherein the preset indicators provide access to their respectively assigned entities in the same manner irrespective of the associated digital audio source.

11. The method of claim 10, wherein the preset indicators provide for single press access to the respectively assigned entities, irrespective of the digital audio source.

12. An audio system server comprising:

a processor; and

instructions stored on a computer-readable media that, when executed, cause the processor to:

receive information from a first audio playback device of an audio system regarding a change to one or more of a plurality of preset assignments, each of the preset

assignments representing an assignment of an entity associated with one of a plurality of digital audio sources to a corresponding preset indicator;

update stored preset data based on the information received from the first device; and to

provide update information to one or more other audio playback devices of the audio system such that each of the one or more other audio playback devices update their respective preset assignments to correspond to those of the first audio playback device.

13. The audio system server of claim 12, wherein the audio system server is a cloud-based server.

14. The audio system server of claim 12, wherein the instructions, when executed, cause the processor to provide the update information to the one or more other audio playback devices in response to communication received from the one or more other audio playback devices requesting the update information.

15. The audio system server of claim 12, wherein the update information is an updated list of preset assignments.

16. The audio system server of claim 12, wherein the instructions, when executed, cause the processor to:

maintain a global recents list, wherein the global recents list is a list of entities that is populated from content that the user has chosen to play on one or more of the audio playback devices.

17. The audio system server of claim 16, wherein the instructions, when executed, cause the processor to:

receive information from a first audio playback device of an audio system regarding selection of a first entity for providing streamed music;

update stored recent data based on the information received from the first device; and to

provide updated recents information to one or more other audio playback devices of the audio system such that each of the one or more other audio playback devices updates a locally stored recents list to correspond to a recents list stored on the first audio playback device.

18. The audio system server of claim 12, wherein the instructions, when executed, cause the processor to:

receive a copy of a token from a first audio playback device of an audio system, wherein the token is a unique identifier that a corresponding one of the digital audio sources recognizes and associates with a user account, thereby to provide access to the user account;

store the copy of the token within the audio system server; and to

provide copies of the token other audio playback devices of the audio system such that the corresponding one of the digital audio sources can recognize the other audio playback devices as being associated with the user account.

19. An audio system comprising:

i) a plurality of audio playback devices, each audio playback device being configured to operatively connect to a plurality of digital audio sources for playback of content from the digital audio sources and each of the audio playback devices comprising:

a set of preset indicators, wherein each preset indicator in the set of preset indicators is configured to have assigned to it an entity associated with one of the plurality of digital audio sources; and

ii) a remote server configured to:

receive information from one of the audio playback devices regarding changes to preset assignments, each of the preset assignments representing an assignment of an entity associated with one of the digital audio sources to a corresponding one of the preset indicators;

update a stored set of global preset assignments based on the information received; and to

distribute update information to the other ones of the audio playback devices regarding changes to the global preset assignments,

wherein the other ones of the audio playback devices are configured to update their respective preset assignments based on the update information distributed from the remote server such that, following the update, all of the audio playback devices of the plurality of audio playback devices have the same preset assignments.

20. The audio system of claim 19, wherein the information received from the one of the audio playback devices is an updated set of global preset assignments.

21. The audio system of claim 19, wherein the remote server is configured to update the stored set of global preset assignments by replacing the stored set of global preset assignments with the updated set of global preset assignments.

22. The audio system of claim 19, wherein the remote server is configured to distribute the update information to the other ones of the audio playback devices in response to requests for update information received from the other ones of the audio playback devices.

23. The audio system of claim 19, wherein the assignable entities include at least individual Internet radio stations and particular user-defined playlists of digital music files.

24. The audio system of claim 19, wherein the set of preset indicators comprise hardware buttons.

25. The audio system of claim 19, wherein the preset indicators include numerical identifiers.

26. The audio system of claim 19, wherein the digital audio sources include a plurality of Internet radio sites, and the entities include individual radio stations provided by the Internet radio sites.

27. The audio system of claim 19, wherein the preset indicators provide access to their respectively assigned entities in the same manner irrespective of the associated digital audio source.

28. The audio system of claim 19, wherein the preset indicators provide for single press access to the respectively assigned entities, irrespective of the digital audio source.

29. An audio playback device configured to operably connect to a plurality of digital audio sources, the audio playback device comprising:

a digital-to-analog converter configured to receive a digital representation of content from the digital audio sources and convert to analog form;

an electro-acoustic transducer;

a set of user-selectable preset indicators, wherein each indicator in the set of preset indicators is configured to have assigned to it an entity associated with the plurality of digital audio sources;

a processor; and

instructions stored on a computer-readable media that, when executed, cause the processor to:

update one or more preset assignments based on user input, each of the preset assignments representing an assignment of an entity associated with one of the digital audio sources to a corresponding one of the preset indicators; and to

send information regarding the update to the one or more preset assignments to a remote server.

30. The audio playback device of claim 29, further comprising an enclosure, wherein the digital-to-analog converter and the electro-acoustic transducer are located within the enclosure and the set of user-selectable present indicators is located on the enclosure.

31. The audio playback device of claim 29, wherein the digital audio sources comprise at least (i) one or more libraries of user-defined playlists of digital music files and (ii) Internet radio sites.

32. The audio playback device of claim 31, wherein the assignable entities include at least individual Internet radio stations and particular user-defined playlists of digital music files.

33. The audio playback device of claim 29, wherein the set of preset indicators comprise hardware buttons.

34. The audio playback device of claim 29, wherein the preset indicators include numerical identifiers.

35. The audio playback device of claim 29, wherein the digital audio sources include a plurality of Internet radio sites, and the entities include individual radio stations provided by the Internet radio sites.

36. The audio playback device of cl aim 29, wherein the preset indicators provide access to the respectively assigned entities in the same manner irrespective of the associated digital audio source.

37. The audio playback device of claim 36, wherein the preset indicators provide for single press access to the respectively assigned entities irrespective of the digital audio source.

38. The audio playback device of claim 29, wherein the instructions, when executed, cause the processor to:

notify one or more other audio playback devices within an audio system regarding the update to the one or more preset assignments.

39. The audio playback device of claim 29, wherein the instructions, when executed, cause the processor to:

receive notification from an other audio playback device within an audio system regarding changes to preset assignments on the other audio playback device;

and, in response to receiving the notification regarding changes to the preset assignments on the other audio playback device, to contact a remote server for the audio system to request update information; and to

update one or more preset assignments on the audio playback device based on the update information received from the remote server such that preset assignments on the audio playback devices correspond to respective preset assignments on the other audio playback device.

40. An audio playback device configured to operably connect to a plurality of digital audio sources, the audio playback device comprising:

a digital-to-analog converter configured to receive a digital representation of content from the digital audio sources and convert to analog form;

an electro-acoustic transducer;

a set of user-selectable preset indicators, wherein each indicator in the set of preset indicators is configured to have assigned to it an entity associated with the plurality of digital audio sources; and

a processor; and

instructions stored on a computer-readable media that, when executed,

cause the processor to:

update one or more preset assignments based on user input, each of the preset assignments representing an assignment of an entity associated with one of the digital audio sources to a corresponding one of the preset indicators; and to

notify one or more other audio playback devices within an audio system regarding the update to the one or more preset assignments.

41. The audio playback device of claim 40, further comprising an enclosure, wherein the digital-to-analog converter and the electro-acoustic transducer are located within the enclosure and the set of user-selectable present indicators is located on the enclosure.

42. The audio playback device of claim 40, wherein the digital audio sources comprise at least (i) one or more libraries of user-defined playlists of digital music files and (ii) Internet radio sites.

43. The audio playback device of claim 40, wherein the assignable entities include at least individual Internet radio stations and particular user-defined playlists of digital music files.

44. The audio playback device of claim 40, wherein the set of preset indicators comprise hardware buttons.

45. The audio playback device of claim 40, wherein the preset indicators include numerical identifiers.

46. The audio playback device of claim 40, wherein the digital audio sources include a plurality of Internet radio sites, and the entities include individual radio stations provided by the Internet radio sites.

47. The audio playback device of claim 40, wherein the preset indicators provide access to the respectively assigned entities in the same manner irrespective of the associated digital audio source.

48. The audio playback device of claim 47, wherein the preset indicators provide for single press access to the respectively assigned entities irrespective of the digital audio source.

49. The audio playback device of claim 40, wherein the instructions, when executed, cause the processor to:

receive notification from an other audio playback device within an audio system regarding changes to preset assignments on the other audio playback device;

and, in response to receiving the notification regarding changes to the preset assignments on the other audio playback device, to contact a remote server for the audio system to request update information; and to

update one or more preset assignments on the audio playback device based on the update information received from the remote server such that preset assignments on the audio playback devices correspond to respective preset assignments on the other audio playback device.

50. An audio playback device configured to operably connect to a plurality of digital audio sources, the audio playback device comprising:

a digital-to-analog converter configured to receive a digital representation of content from the digital audio sources and convert to analog form;

an electro-acoustic transducer;

a set of user-selectable preset indicators, wherein each indicator in the set of preset indicators is configured to have assigned to it an entity associated with the plurality of digital audio sources;

a processor; and

instructions stored on a computer-readable media that, when executed, cause the processor to:

receive notification from an other audio playback device within an audio system regarding changes to preset assignments on the other audio playback device;

and, in response to receiving the notification regarding changes to the preset assignments on the other audio playback device, to contact a remote server for the audio system to request update information; and to

update one or more preset assignments on the audio playback device based on the update information received from the remote server such that preset assignments on the audio playback devices correspond to respective preset assignments on the other audio playback device, each of the preset assignments representing an assignment of an entity associated with one of the digital music sources to a corresponding one of the preset indicators.

51. The audio playback device of claim 50, further comprising an enclosure, wherein the digital-to-analog converter and the electro-acoustic transducer are located within the enclosure and the set of user-selectable present indicators is located on the enclosure.

52. The audio playback device of claim 50, wherein the digital audio sources comprising at least (i) one or more libraries of user-defined playlists of digital music files and (ii) Internet radio sites.

53. The audio playback device of claim 50, wherein the assignable entities include at least individual Internet radio stations and particular user-defined playlists of digital music files.

54. The audio playback device of claim 50, wherein the set of preset indicators comprise hardware buttons.

55. The audio playback device of claim 50, wherein the preset indicators include numerical identifiers.

56. The audio playback device of claim 50, wherein the digital audio sources include a plurality of Internet radio sites, and the entities include individual radio stations provided by the Internet radio sites.

57. The audio playback device of claim 50, wherein the preset indicators provide access to the respectively assigned entities in the same manner irrespective of the associated digital audio source.

58. The audio playback device of claim 57, wherein the preset indicators provide for single press access to the respectively assigned entities irrespective of the digital audio source.

59. An audio system comprising:

i) a plurality of audio playback devices, each audio playback device being configured to operatively connect to a plurality of digital audio sources for playback of content from the digital audio sources and each of the audio playback devices comprising:

a set of preset indicators, wherein each preset indicator in the set of preset indicators is configured to have assigned to it an entity associated with one of the plurality of digital audio sources; and

ii) a software program configured to run on a separate device, wherein the software program provides a user interface configured to present an audio playback device selection region that enables user to select one of the audio playback devices to control with the separate computer,

wherein the user interface is further configured to present a set of preset indicators that corresponds to the set of preset indicators of the selected one of the audio playback devices, and to

present a source selection region that enables a user to select an entity to assign to one of the preset indicators of the selected one of the audio playback devices.

60. The audio system of claim 59, wherein the source selection region also enables a user to select an entity to provide audio content to the selected one of the audio playback devices for playback of the audio content.

61. The audio system of claim 59, wherein the user interface is further configured to present a global recents list, wherein the global recents list is a list of entities that is populated from audio content that the user has chosen to play on one or more of the audio playback devices.

62. The audio system of claim 59, wherein the software program includes instructions to procure the global recents list from data stored on the selected one of the audio playback devices.

63. The audio system of claim 59, wherein the user interface is further configured to enable a user to select whether the preset assignments are to be global or local,

wherein global preset assignments are synchronized across the plurality of audio playback devices such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices, and, such that, if one of the preset assignments is changed on one of the audio playback devices, each of the other audio playback devices is updated such that a corresponding change is made to a corresponding preset assignment on each of the other audio playback devices, and

wherein local preset assignments are device-specific such that each of the audio playback devices can have a unique set of preset assignments and such that the preset assignments on any one of the audio playback devices do not necessarily correspond to the preset assignments on any of the other audio playback devices.

64. A computer-implemented method comprising:

storing a set of local preset assignments for each of a plurality of audio playback devices of an audio system, wherein the local preset assignments are device-specific such that the local preset assignments for any one of the audio playback devices do not necessarily correspond to the local preset assignments for any of the other audio playback devices;

receiving input regarding a change from a local setting to a global setting;

receiving input regarding selection of one of the audio playback devices to serve as a master audio playback device;

setting the set of stored local preset assignments associated with the selected, master audio playback device as a set of global preset assignments; and

providing the global preset assignments to the other playback devices of the audio system so as to synchronize the preset assignments across the audio system, such that preset assignments on any one of the audio playback devices correspond to respective preset assignments on each of the other audio playback devices.

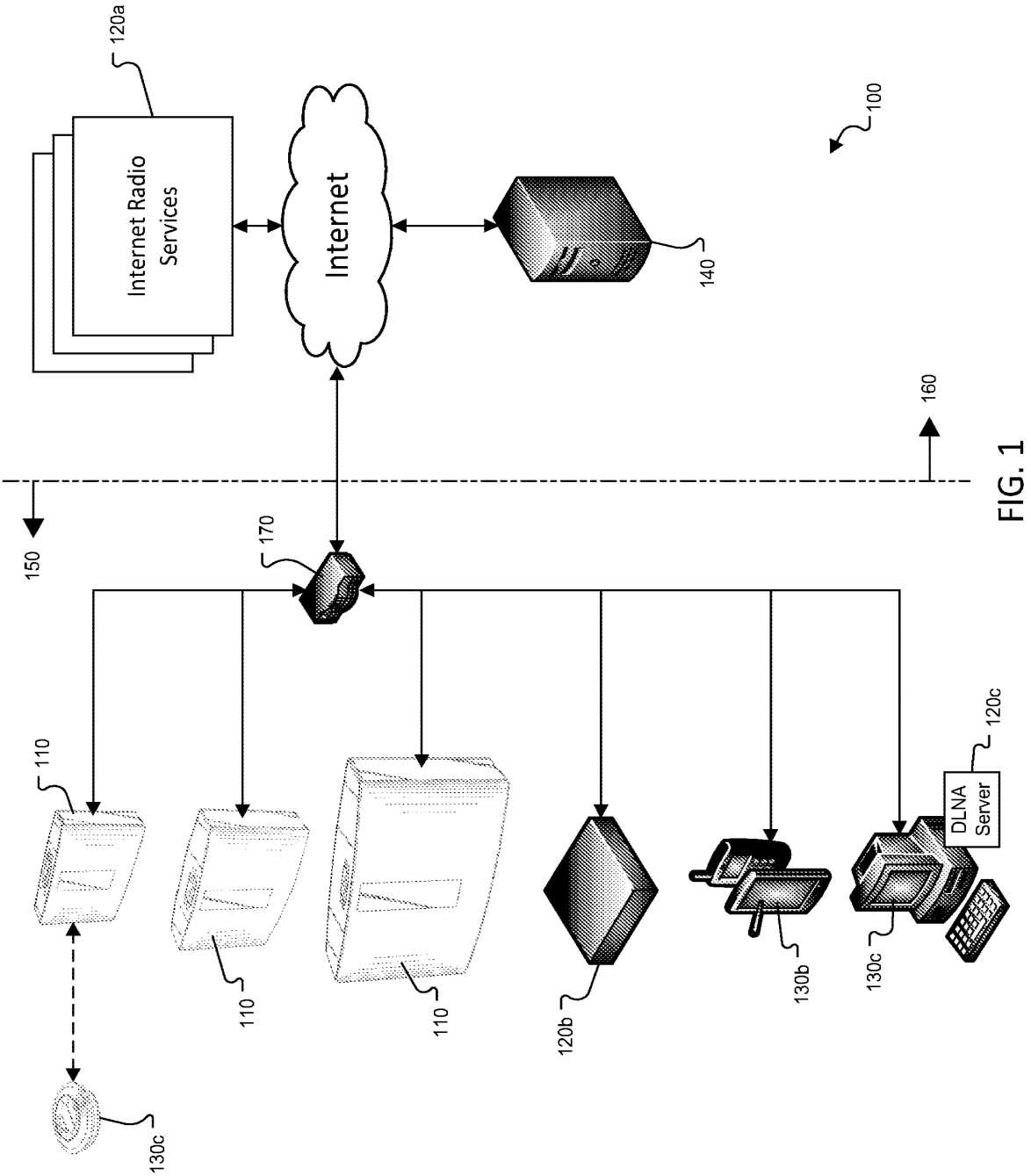

120a
Internet Radio Services
Internet
100
140
160
150
170
110
110
110
120b
130b
130c
120c
DLNA Server
130c

FIG. 1

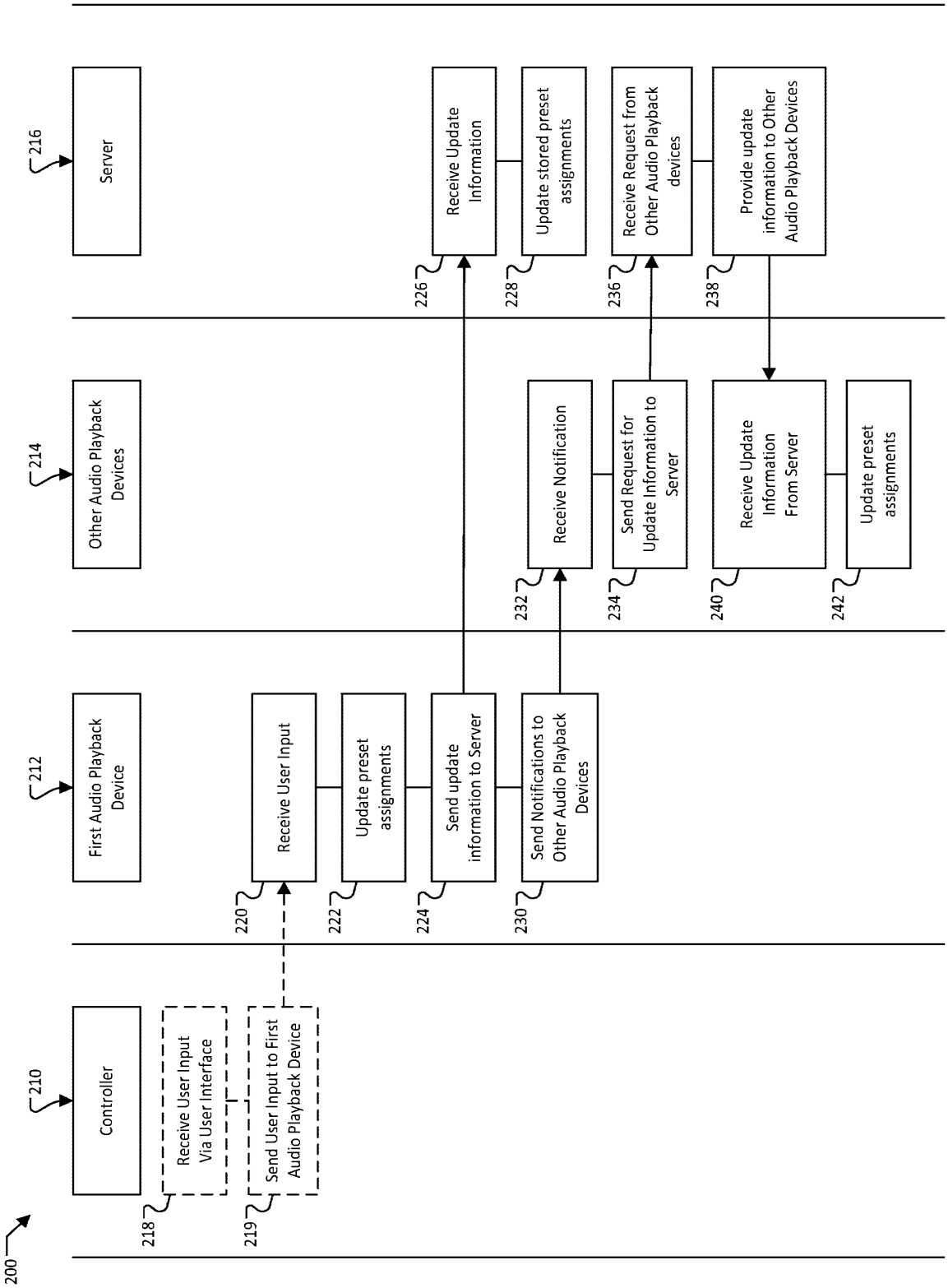

200
210
Controller
216
Server
214
Other Audio Playback Devices
212
First Audio Playback Device
218
Receive User Input Via User Interface
219
Send User Input to First Audio Playback Device
220
Receive User Input
222
Update preset assignments
224
Send update information to Server
226
Receive Update Information
228
Update stored preset assignments
230
Send Notifications to Other Audio Playback Devices
232
Receive Notification
234
Send Request for Update Information to Server
236
Receive Request from Other Audio Playback devices
238
Provide update information to Other Audio Playback Devices
240
Receive Update Information From Server
242
Update preset assignments

FIG. 2

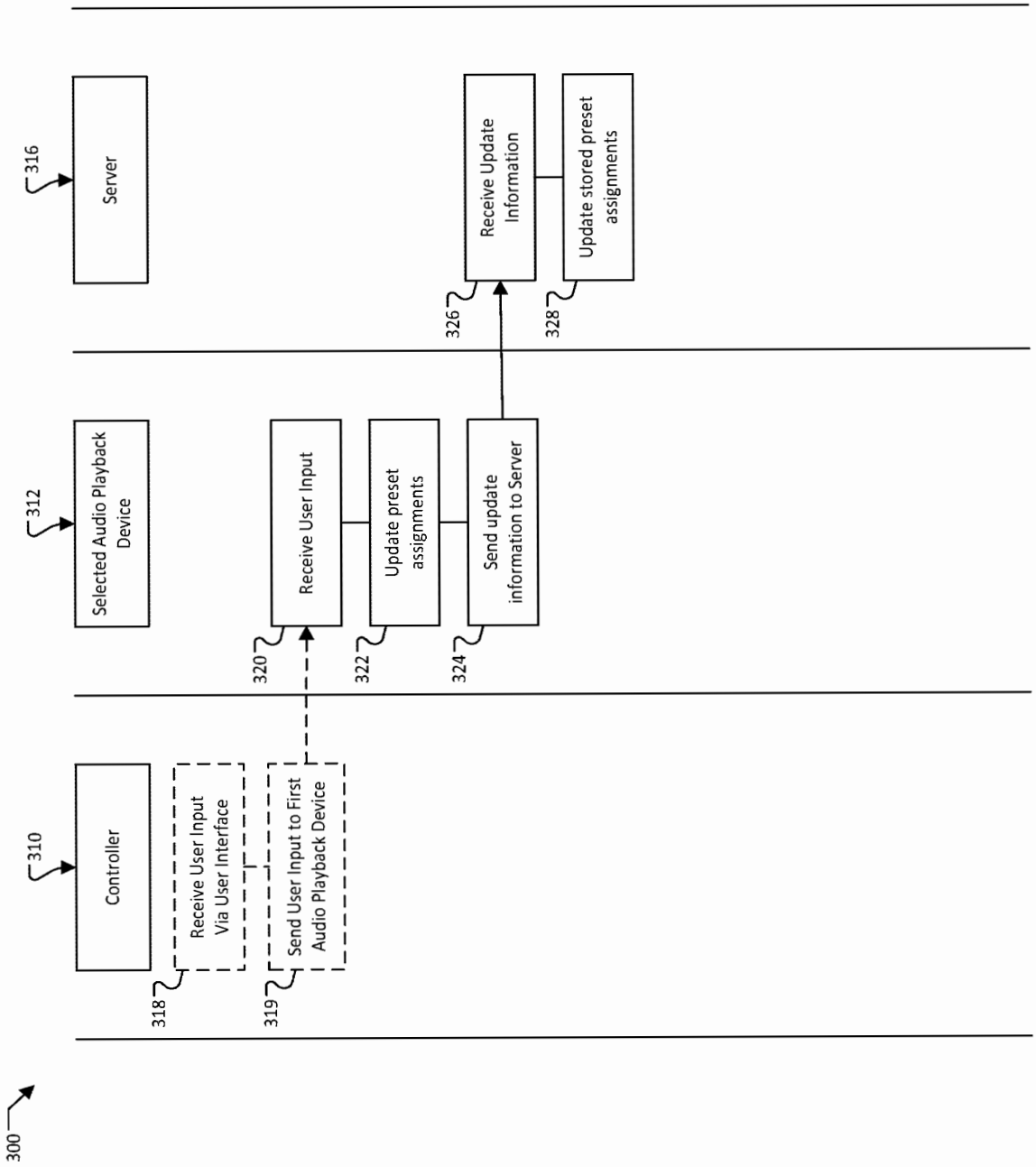

300
310
Controller
312
Selected Audio Playback Device
316
Server
318
Receive User Input Via User Interface
319
Send User Input to First Audio Playback Device
320
Receive User Input
322
Update preset assignments
324
Send update information to Server
326
Receive Update Information
328
Update stored preset assignments

FIG. 3

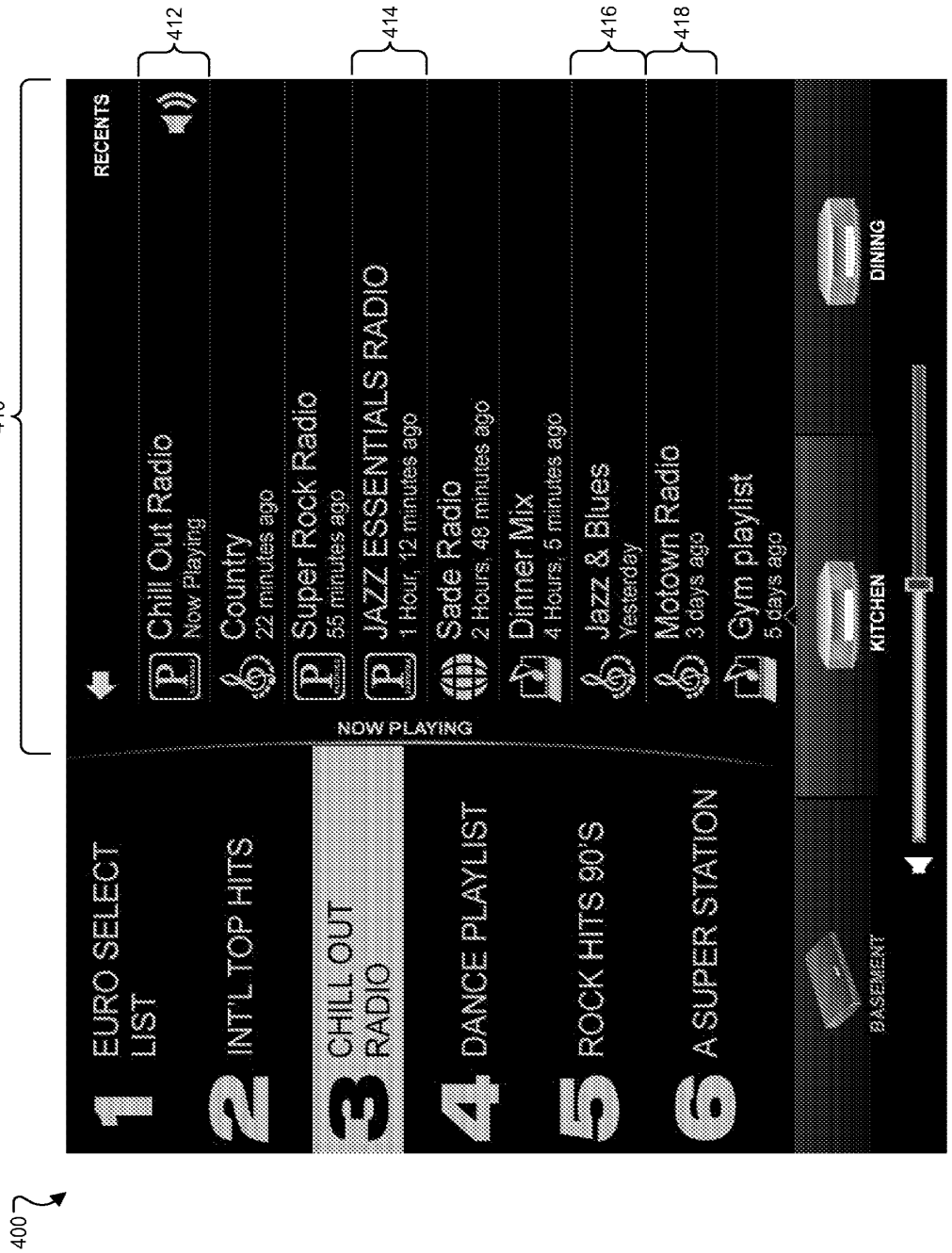

400
410
412
414
416
418
RECENTS
Chill Out Radio
Now Playing
Country
22 minutes ago
Super Rock Radio
55 minutes ago
JAZZ ESSENTIALS RADIO
1 Hour, 12 minutes ago
Sade Radio
2 Hours, 48 minutes ago
Dinner Mix
4 Hours, 5 minutes ago
Jazz & Blues
Yesterday
Motown Radio
3 days ago
Gym playlist
5 days ago
NOW PLAYING
1 EURO SELECT LIST
2 INT'L TOP HITS
3 CHILL OUT RADIO
4 DANCE PLAYLIST
5 ROCK HITS 90'S
6 A SUPER STATION
DINING
KITCHEN
BASEMENT

FIG. 4

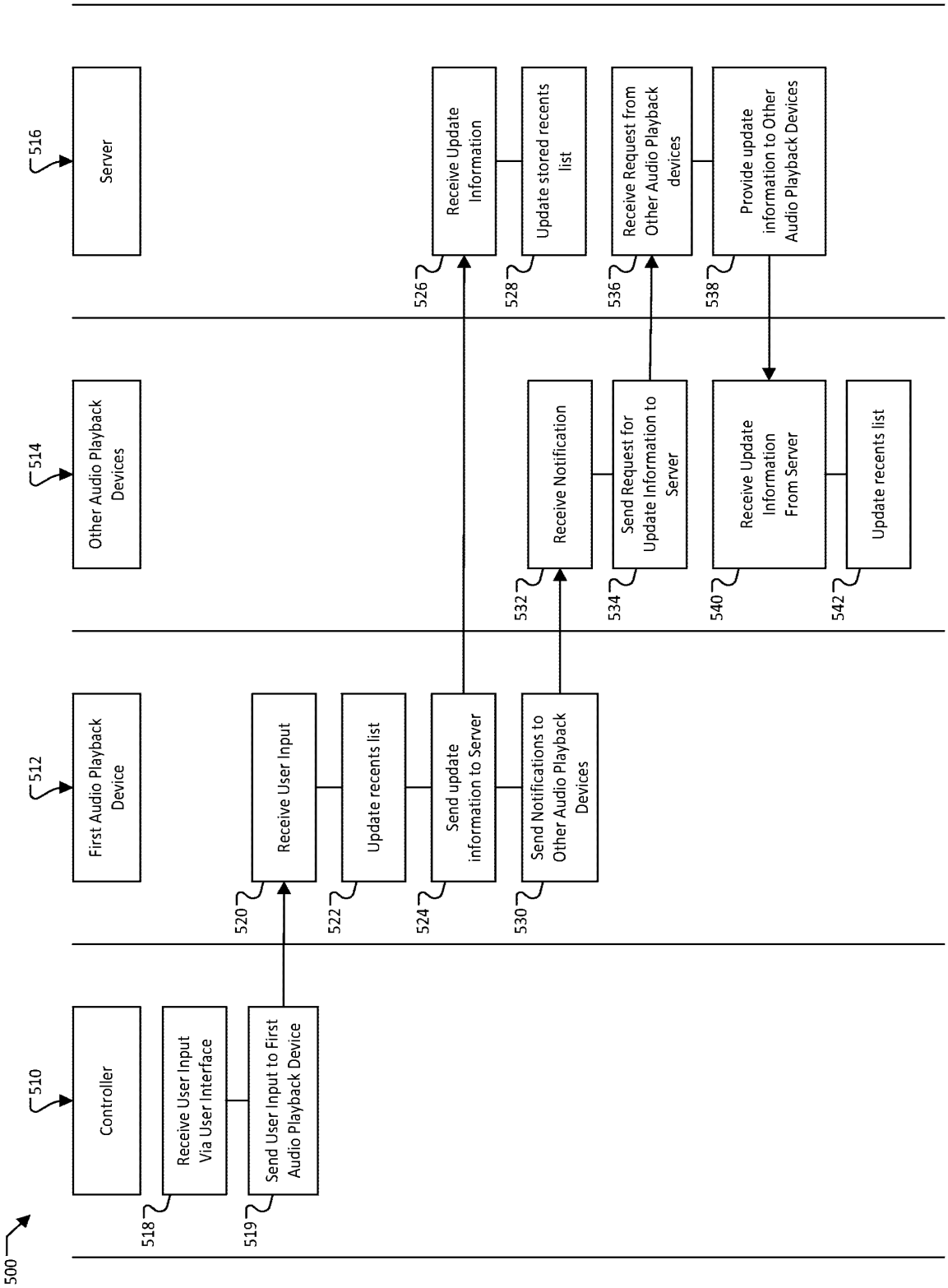

500
510
Controller
518
Receive User Input Via User Interface
519
Send User Input to First Audio Playback Device
512
First Audio Playback Device
520
Receive User Input
522
Update recents list
524
Send update information to Server
530
Send Notifications to Other Audio Playback Devices
514
Other Audio Playback Devices
532
Receive Notification
534
Send Request for Update Information to Server
540
Receive Update Information From Server
542
Update recents list
516
Server
526
Receive Update Information
528
Update stored recents list
536
Receive Request from Other Audio Playback devices
538
Provide update information to Other Audio Playback Devices

FIG. 5

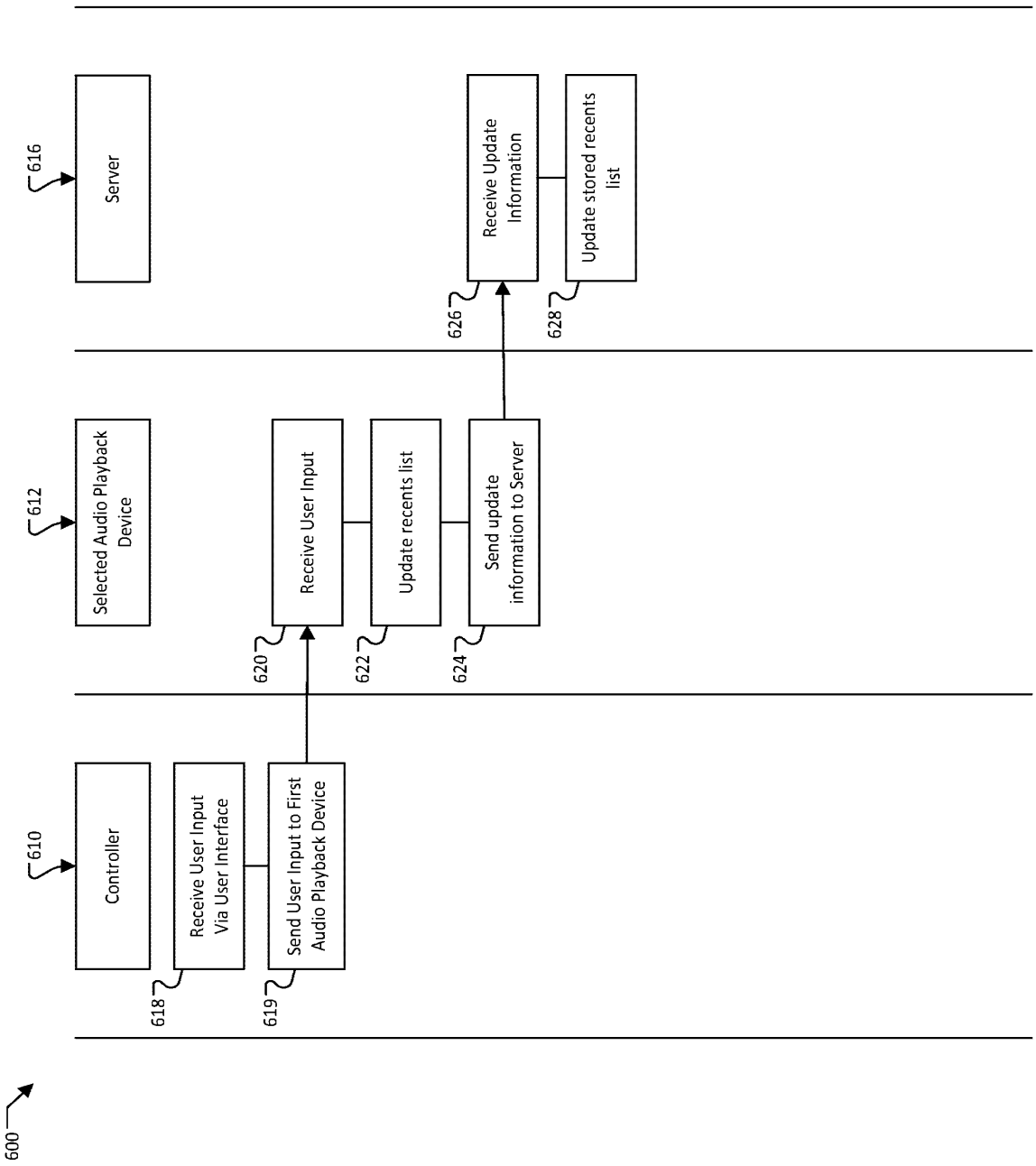

600
610
Controller
618
Receive User Input Via User Interface
619
Send User Input to First Audio Playback Device
612
Selected Audio Playback Device
620
Receive User Input
622
Update recents list
624
Send update information to Server
616
Server
626
Receive Update Information
628
Update stored recents list

FIG. 6

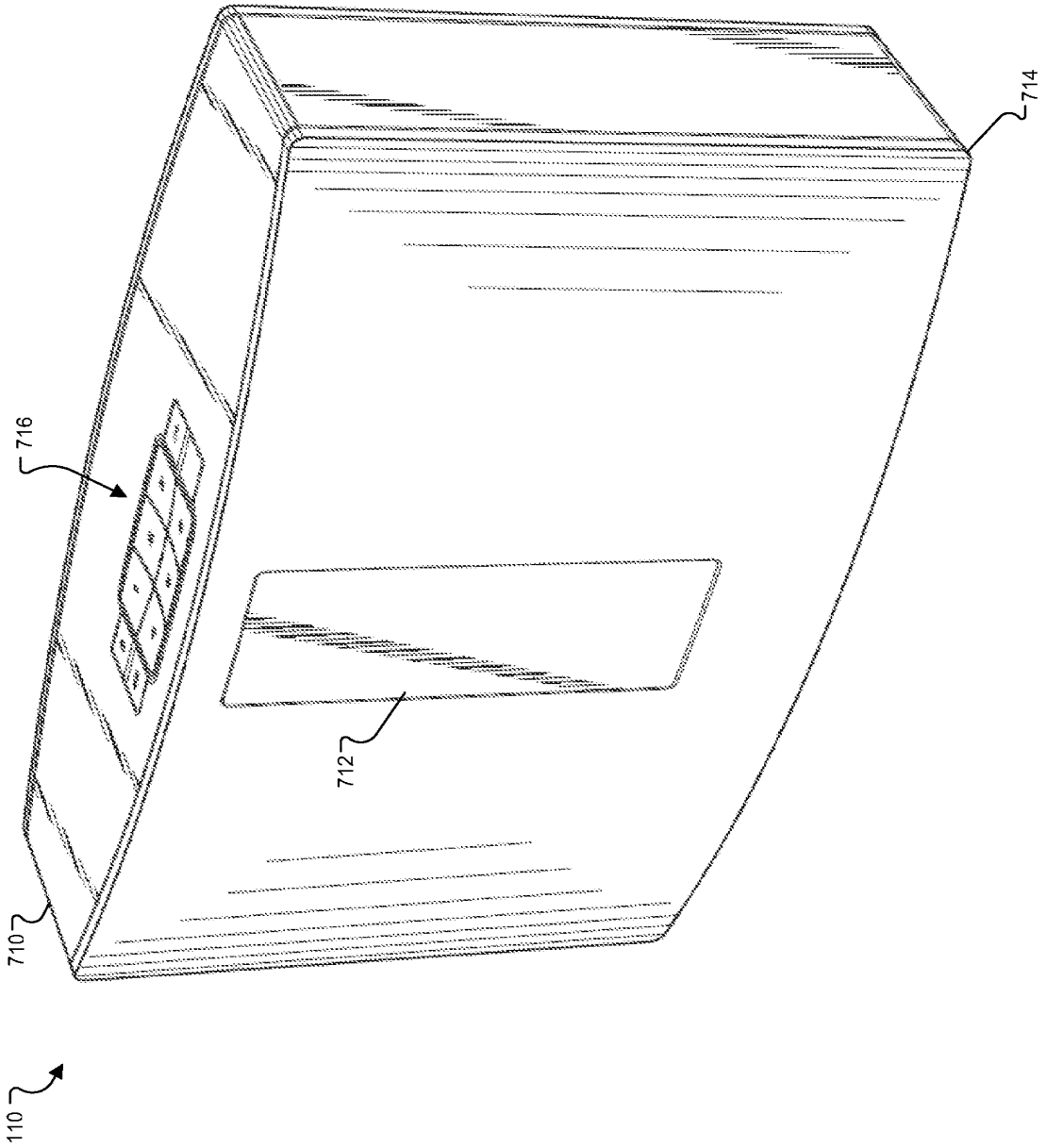


FIG. 7A

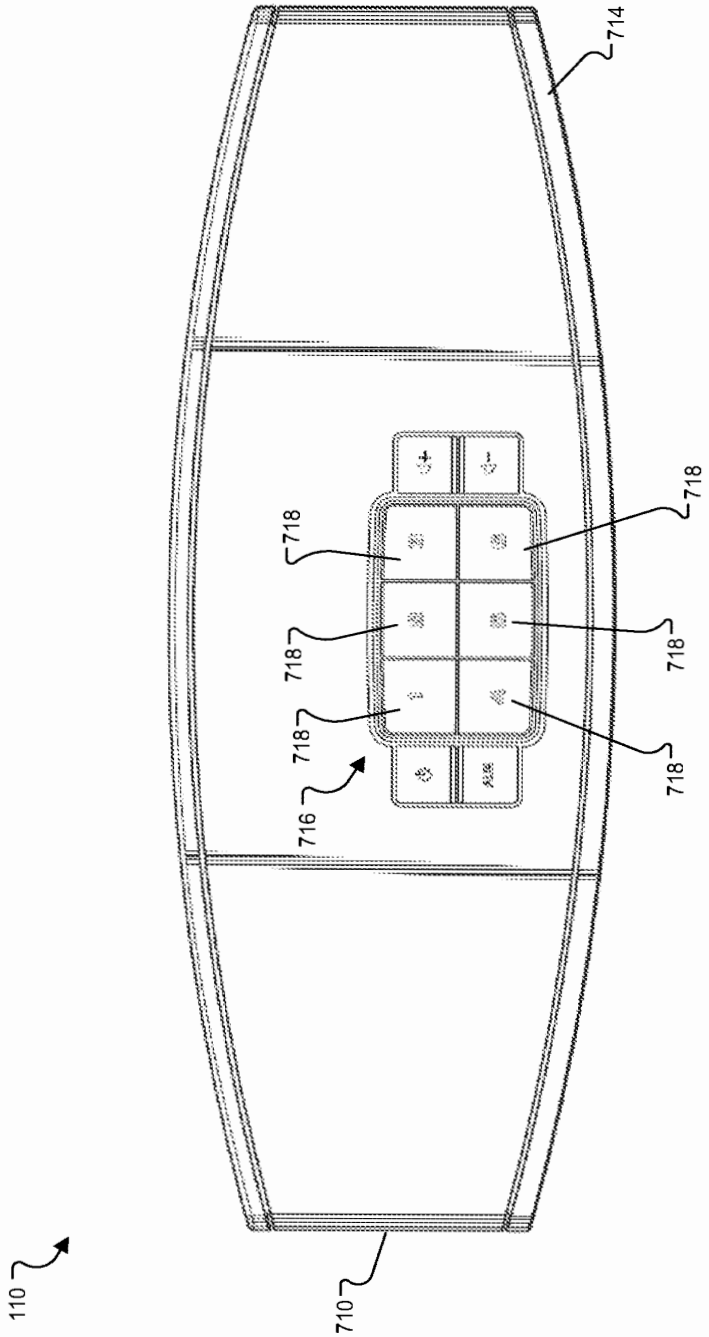


FIG. 7B

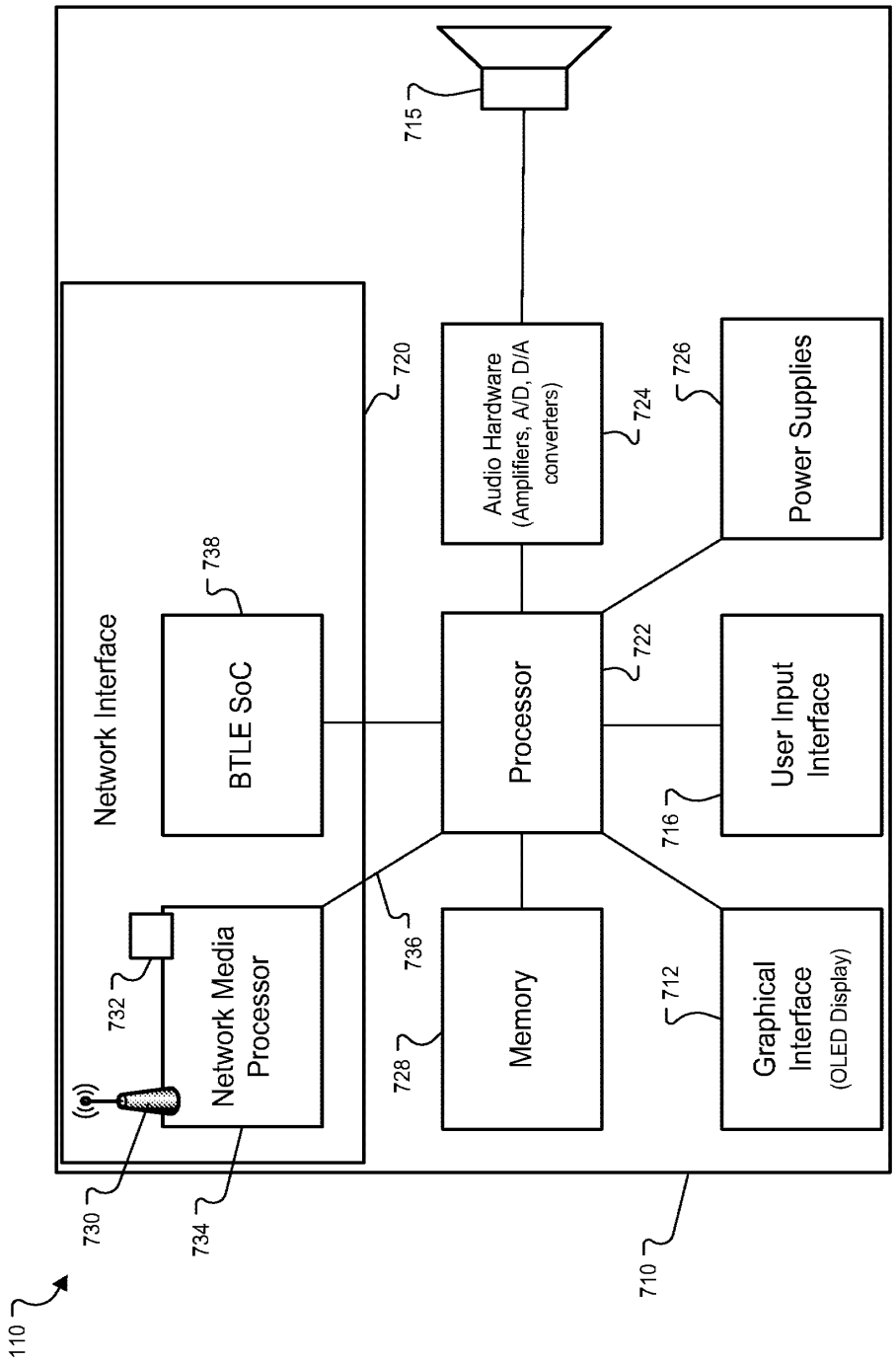

110
730
734
710
732
738
720
715
Network Interface
BTLE SoC
Network Media Processor
Audio Hardware (Amplifiers, A/D, D/A converters)
724
726
Power Supplies
Processor
722
User Input Interface
716
736
728
Memory
712
Graphical Interface (OLED Display)

FIG. 7C

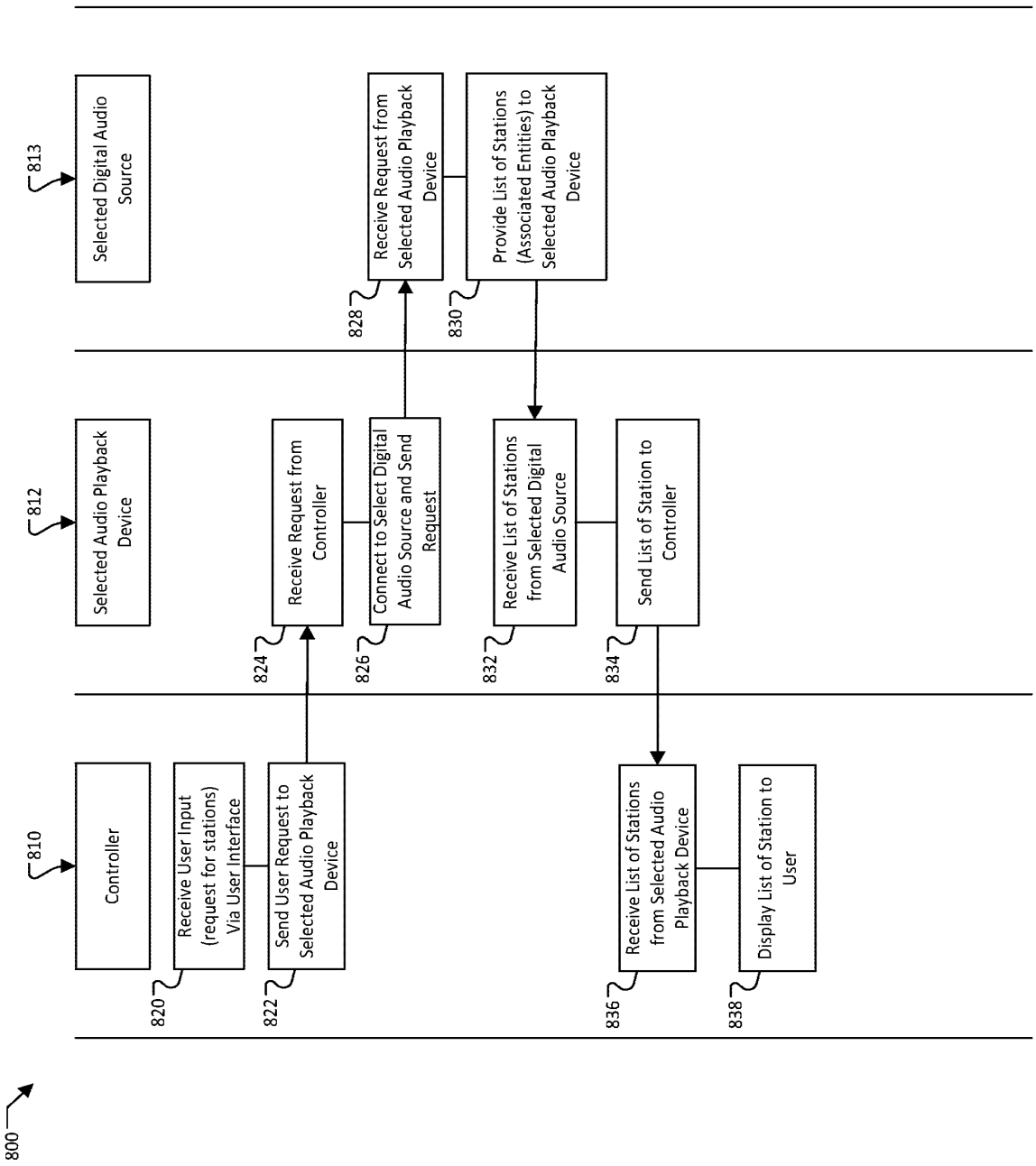

800
810
Controller
820
Receive User Input (request for stations) Via User Interface
822
Send User Request to Selected Audio Playback Device
812
Selected Audio Playback Device
824
Receive Request from Controller
826
Connect to Select Digital Audio Source and Send Request
813
Selected Digital Audio Source
828
Receive Request from Selected Audio Playback Device
830
Provide List of Stations (Associated Entities) to Selected Audio Playback Device
832
Receive List of Stations from Selected Digital Audio Source
834
Send List of Station to Controller
836
Receive List of Stations from Selected Audio Playback Device
838
Display List of Station to User

FIG. 8

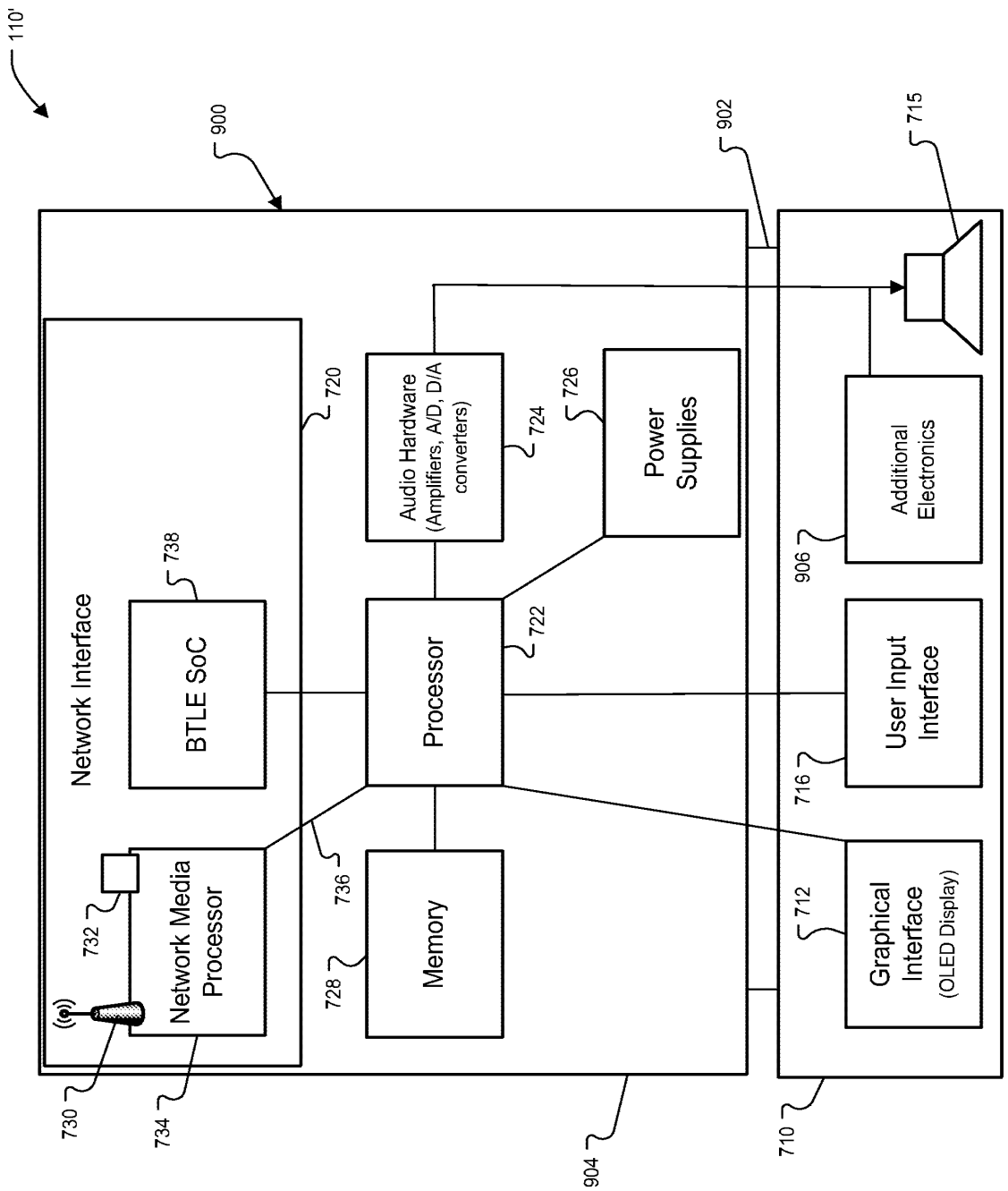

110'
900
902
715
720
Audio Hardware (Amplifiers, A/D, D/A converters)
724
726
Power Supplies
Additional Electronics
906
738
Network Interface
BTLE SoC
Processor
722
User Input Interface
716
732
736
Network Media Processor
Memory
728
712
Graphical Interface (OLED Display)
730
734
904
710

FIG. 9

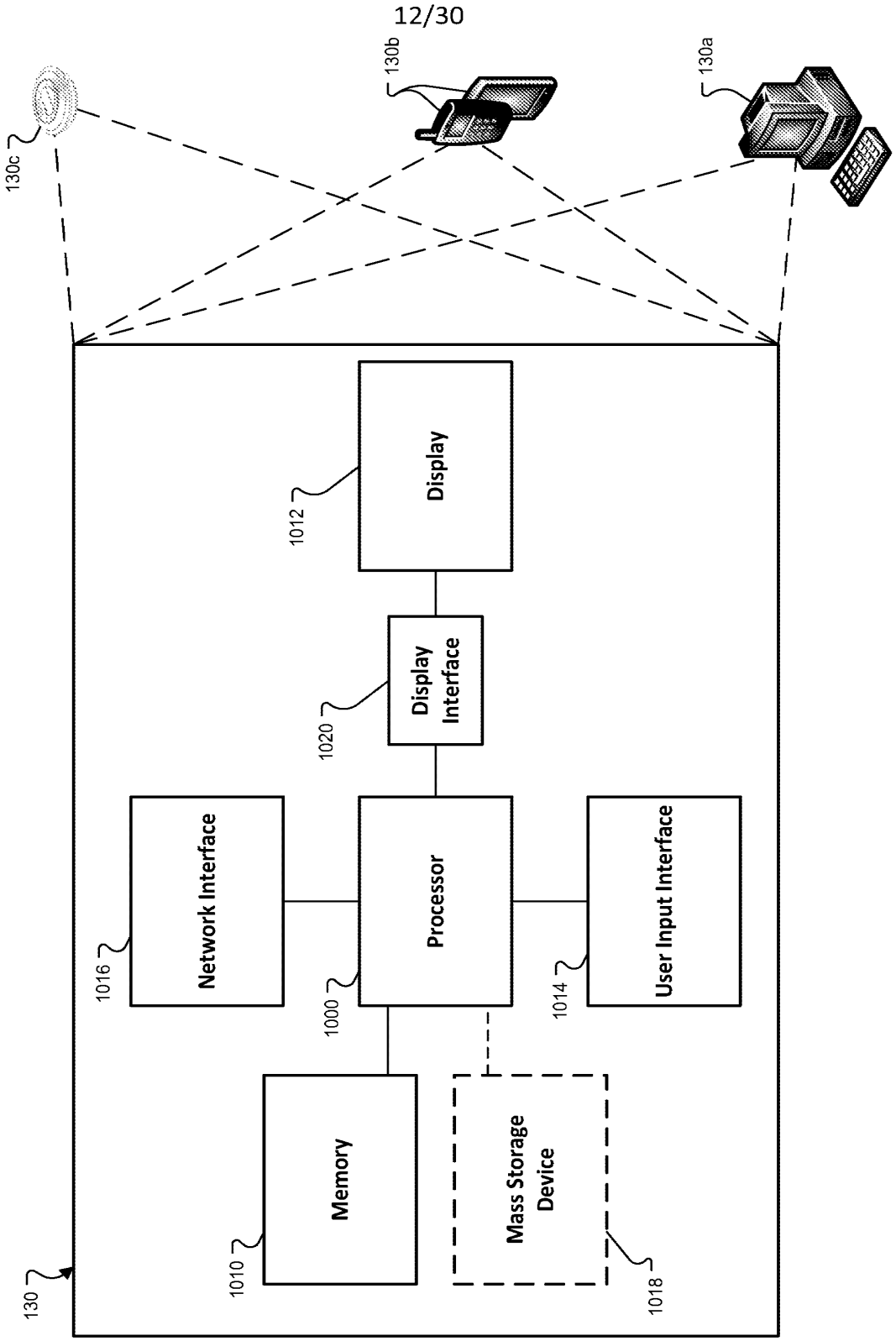

130c
130b
130a
Display
1012
Display Interface
1020
Network Interface
1016
Processor
1000
User Input Interface
1014
Memory
1010
Mass Storage Device
1018
130

FIG. 10

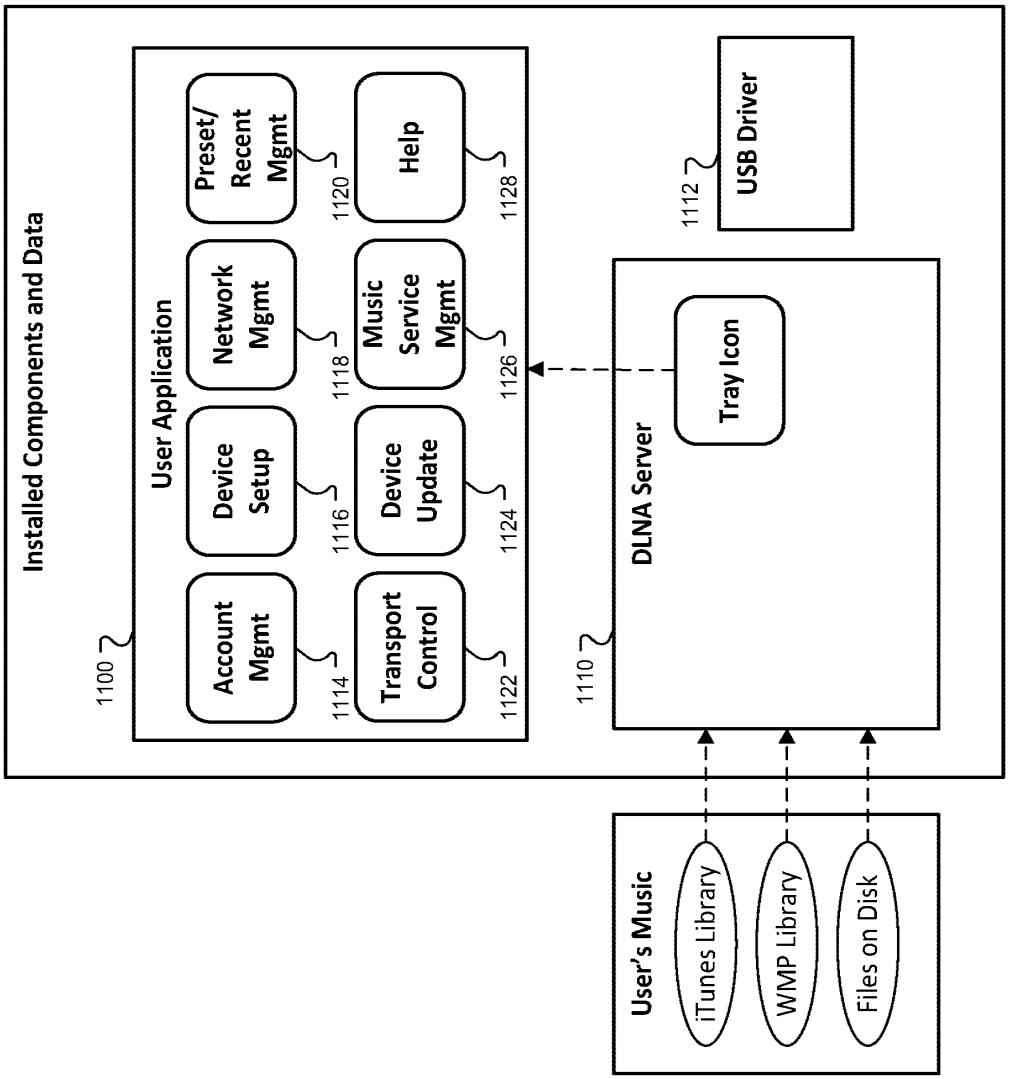

Installed Components and Data
1100
User Application
Account Mgmt
1114
Transport Control
1122
Device Setup
1116
Device Update
1124
Network Mgmt
1118
Music Service Mgmt
1126
Preset/ Recent Mgmt
1120
Help
1128
1110
DLNA Server
Tray Icon
1112
USB Driver
User's Music
iTunes Library
WMP Library
Files on Disk

FIG. 11

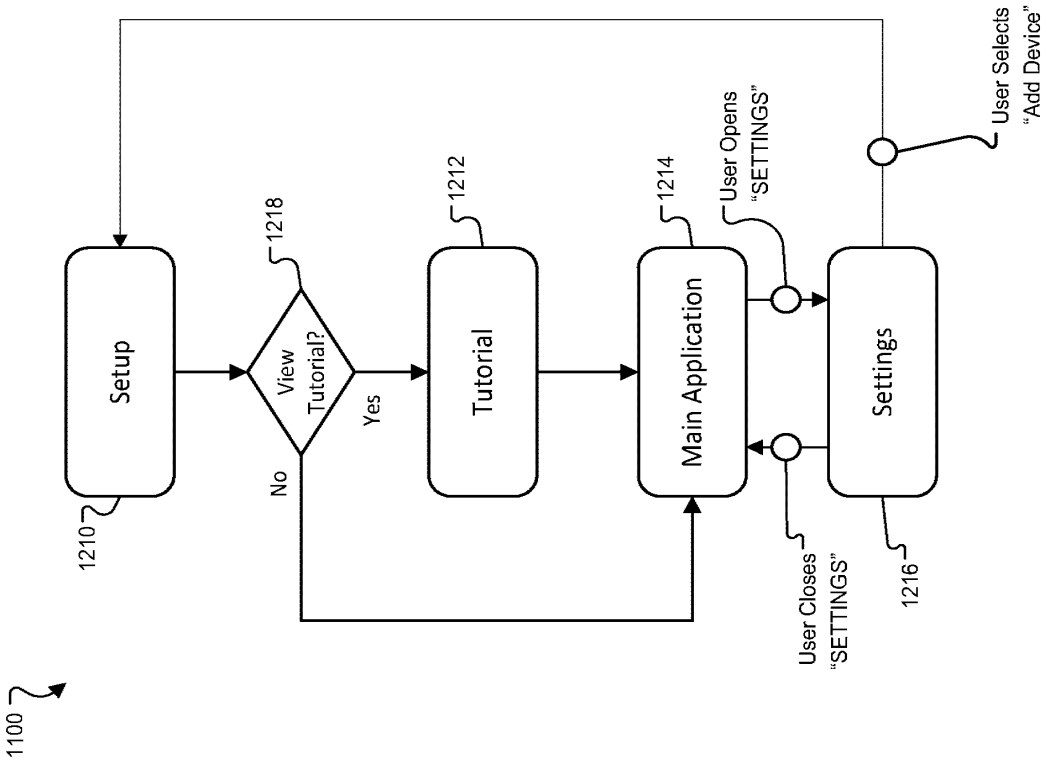

1100
Setup
1210
View Tutorial?
1218
Yes
No
Tutorial
1212
Main Application
1214
User Opens "SETTINGS"
User Closes "SETTINGS"
Settings
1216
User Selects "Add Device"

FIG. 12

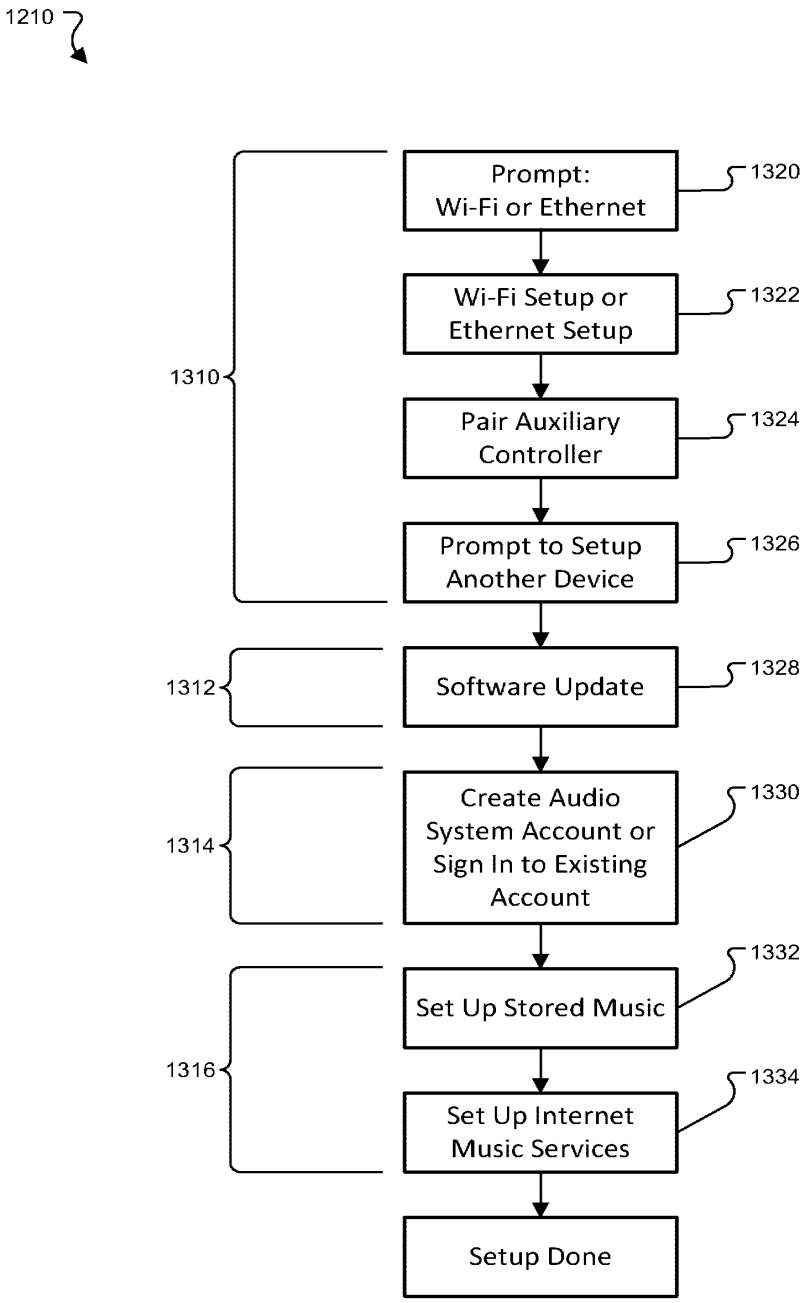

1210
Prompt: Wi-Fi or Ethernet
1320
Wi-Fi Setup or Ethernet Setup
1322
Pair Auxiliary Controller
1324
Prompt to Setup Another Device
1326
1310
Software Update
1328
1312
Create Audio System Account or Sign In to Existing Account
1330
1314
Set Up Stored Music
1332
Set Up Internet Music Services
1334
1316
Setup Done

FIG. 13

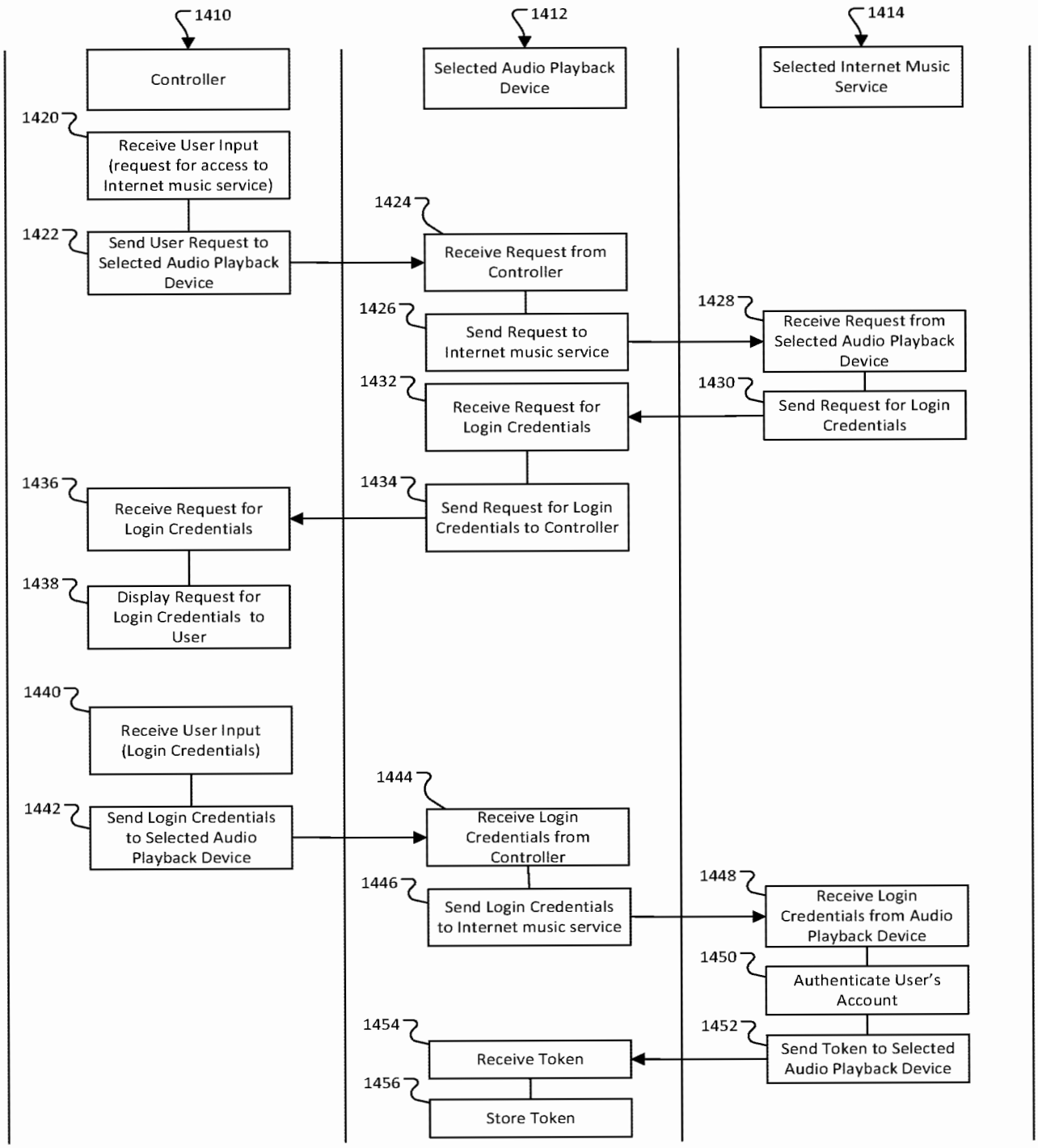

1410
Controller
1412
Selected Audio Playback Device
1414
Selected Internet Music Service
1420
Receive User Input (request for access to Internet music service)
1422
Send User Request to Selected Audio Playback Device
1424
Receive Request from Controller
1426
Send Request to Internet music service
1428
Receive Request from Selected Audio Playback Device
1430
Send Request for Login Credentials
1432
Receive Request for Login Credentials
1434
Send Request for Login Credentials to Controller
1436
Receive Request for Login Credentials
1438
Display Request for Login Credentials to User
1440
Receive User Input (Login Credentials)
1442
Send Login Credentials to Selected Audio Playback Device
1444
Receive Login Credentials from Controller
1446
Send Login Credentials to Internet music service
1448
Receive Login Credentials from Audio Playback Device
1450
Authenticate User's Account
1452
Send Token to Selected Audio Playback Device
1454
Receive Token
1456
Store Token

FIG. 14A

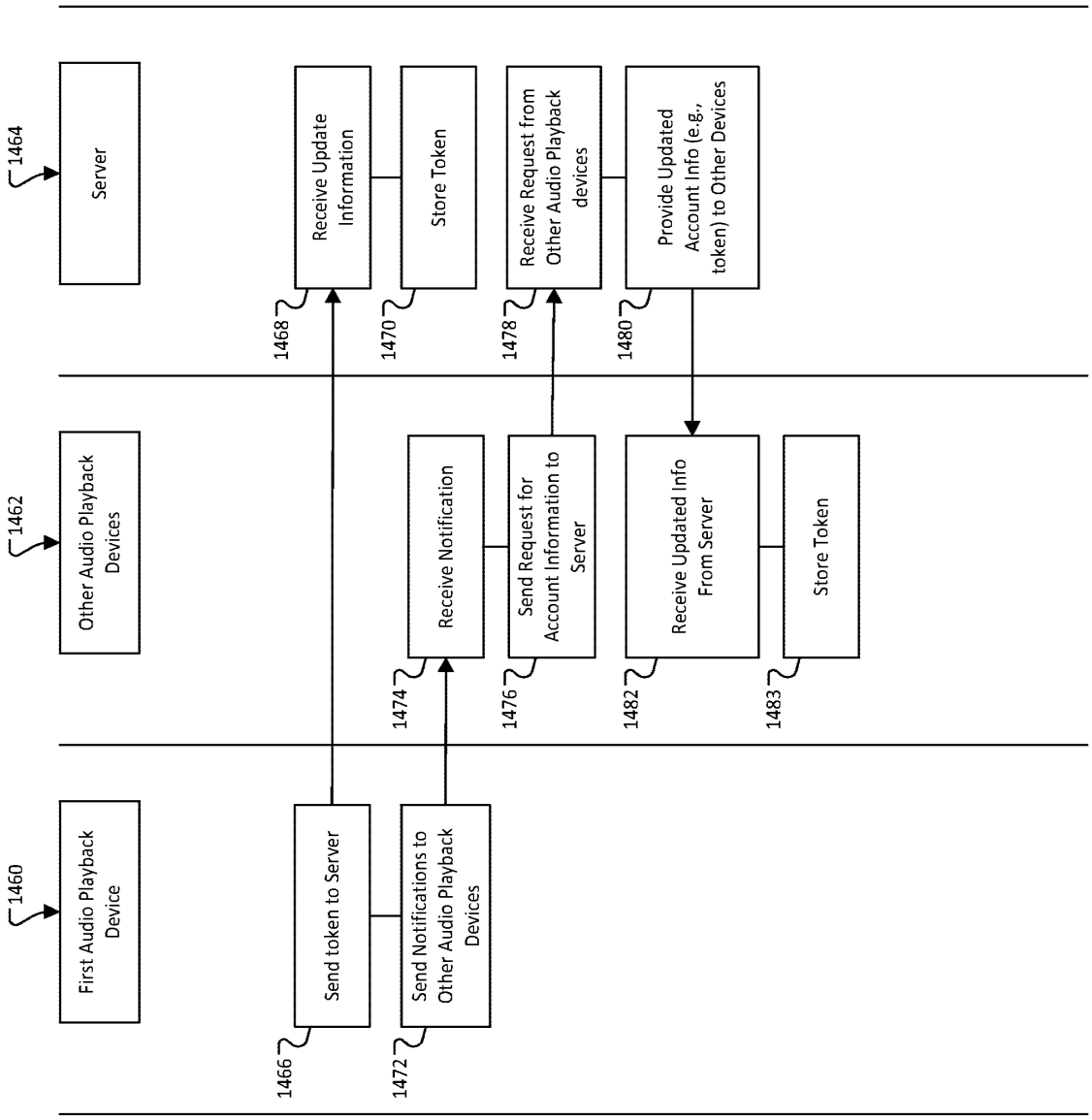

1464
Server
1462
Other Audio Playback Devices
1460
First Audio Playback Device
Receive Update Information
Store Token
Receive Request from Other Audio Playback devices
Provide Updated Account Info (e.g., token) to Other Devices
Receive Notification
Send Request for Account Information to Server
Receive Updated Info From Server
Store Token
Send token to Server
Send Notifications to Other Audio Playback Devices
1468
1470
1478
1480
1474
1476
1482
1483
1466
1472

FIG. 14B

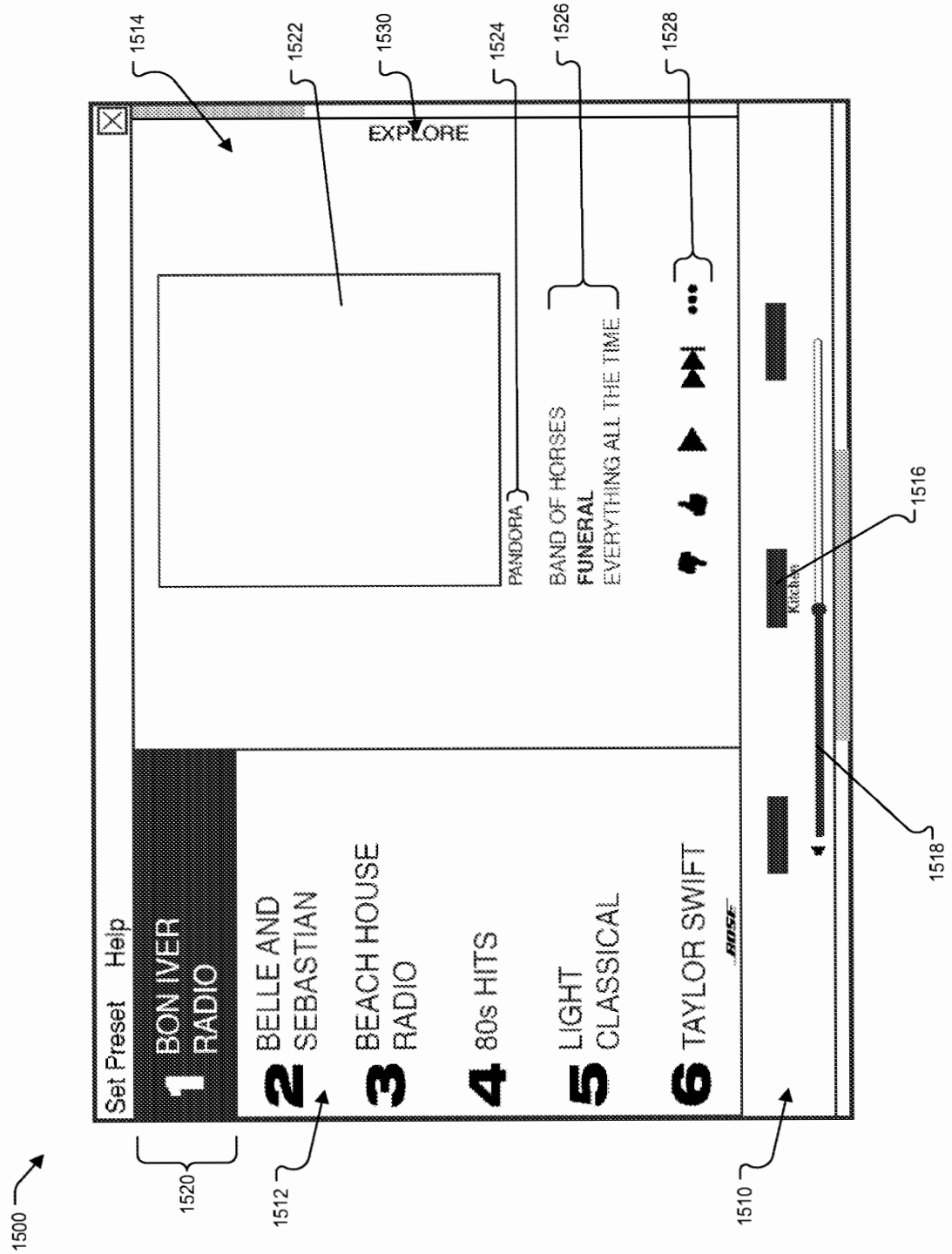

1500
1520
1512
1510
1514
1522
1530
1524
1526
1528
1516
1518
Set Preset Help
1 BON IVER RADIO
2 BELLE AND SEBASTIAN
3 BEACH HOUSE RADIO
4 80s HITS
5 LIGHT CLASSICAL
6 TAYLOR SWIFT
EXPLORE
PANDORA
BAND OF HORSES
FUNERAL
EVERYTHING ALL THE TIME
Kitchen

FIG. 15A

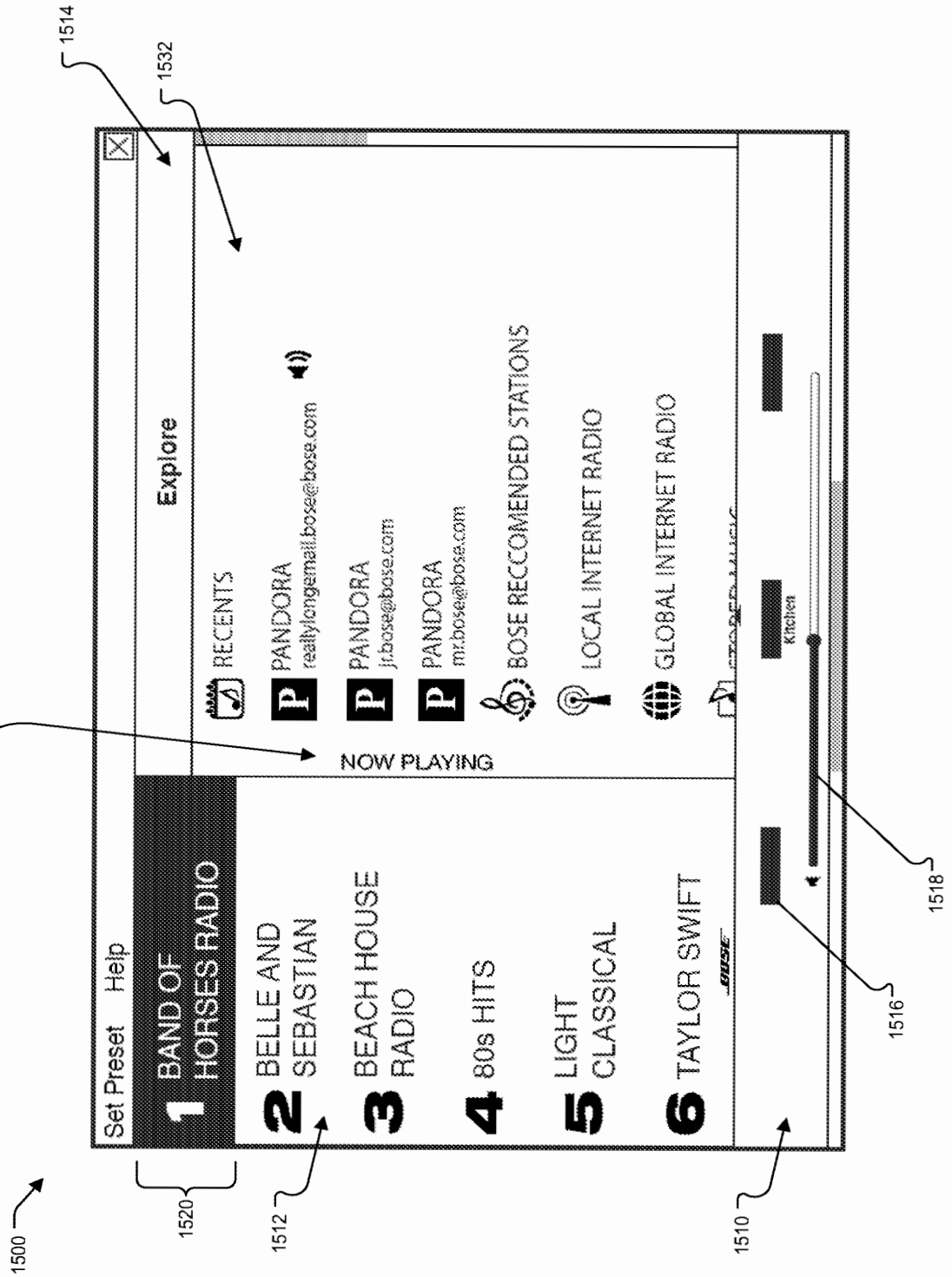

1514
1532
1534
1500
1520
1512
1510
1516
1518
Set Preset
Help
Explore
NOW PLAYING
1 BAND OF HORSES RADIO
2 BELLE AND SEBASTIAN
3 BEACH HOUSE RADIO
4 80s HITS
5 LIGHT CLASSICAL
6 TAYLOR SWIFT
RECENTS
PANDORA
realtylongemail.bose@bose.com
PANDORA
jr.bose@bose.com
PANDORA
mr.bose@bose.com
BOSE RECCOMENDED STATIONS
LOCAL INTERNET RADIO
GLOBAL INTERNET RADIO
Kitchen

FIG. 15B

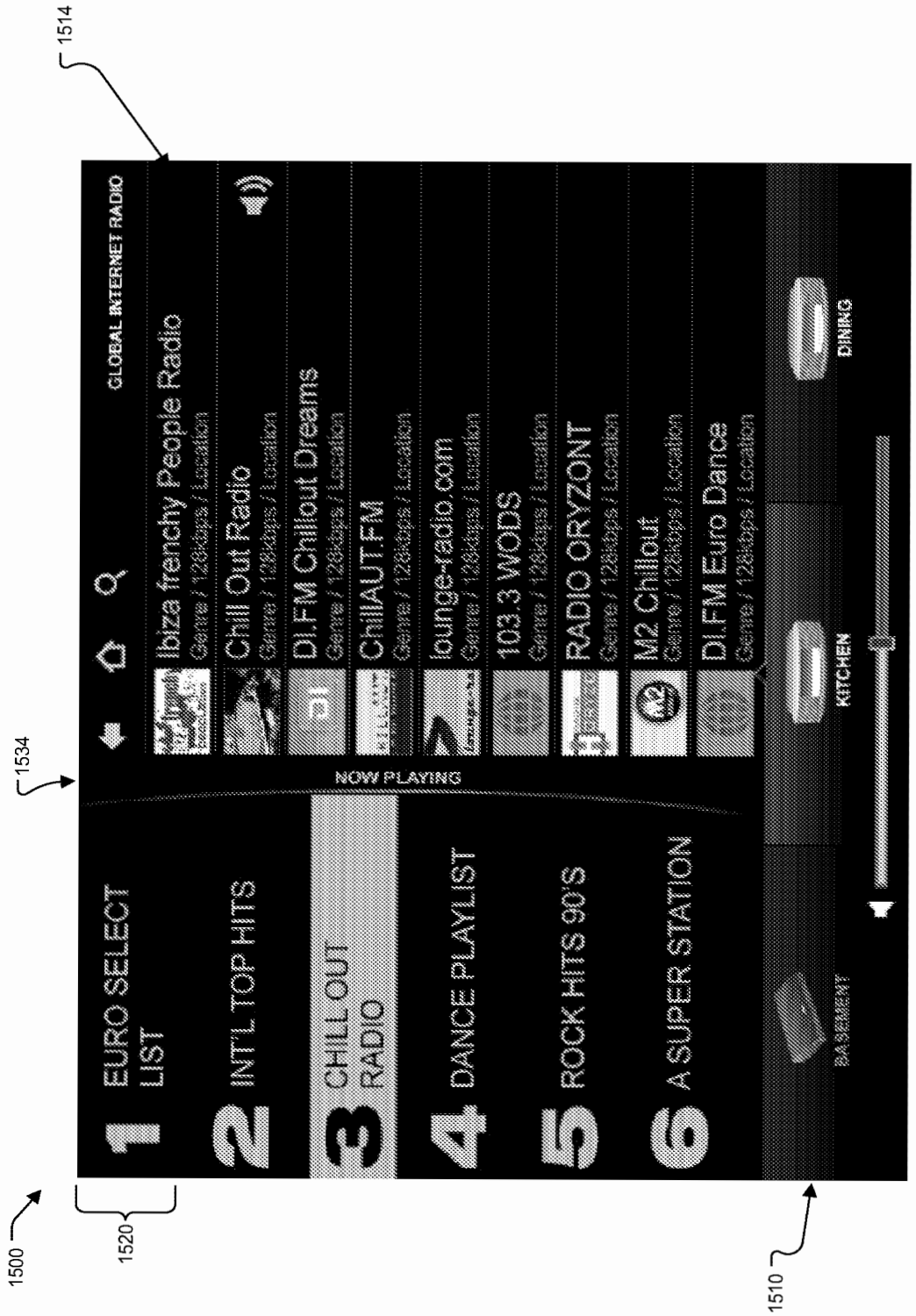

1514
1534
1500
1520
1510
GLOBAL INTERNET RADIO
Ibiza frenchy People Radio
Chill Out Radio
DI.FM Chillout Dreams
ChillAUT.FM
lounge-radio.com
103.3 WODS
RADIO ORYZONT
M2 Chillout
DI.FM Euro Dance
Genre / 128kbps / Location
NOW PLAYING
1 EURO SELECT LIST
2 INT'L TOP HITS
3 CHILL OUT RADIO
4 DANCE PLAYLIST
5 ROCK HITS 90'S
6 A SUPER STATION
BASEMENT
KITCHEN
DINING

FIG. 15C

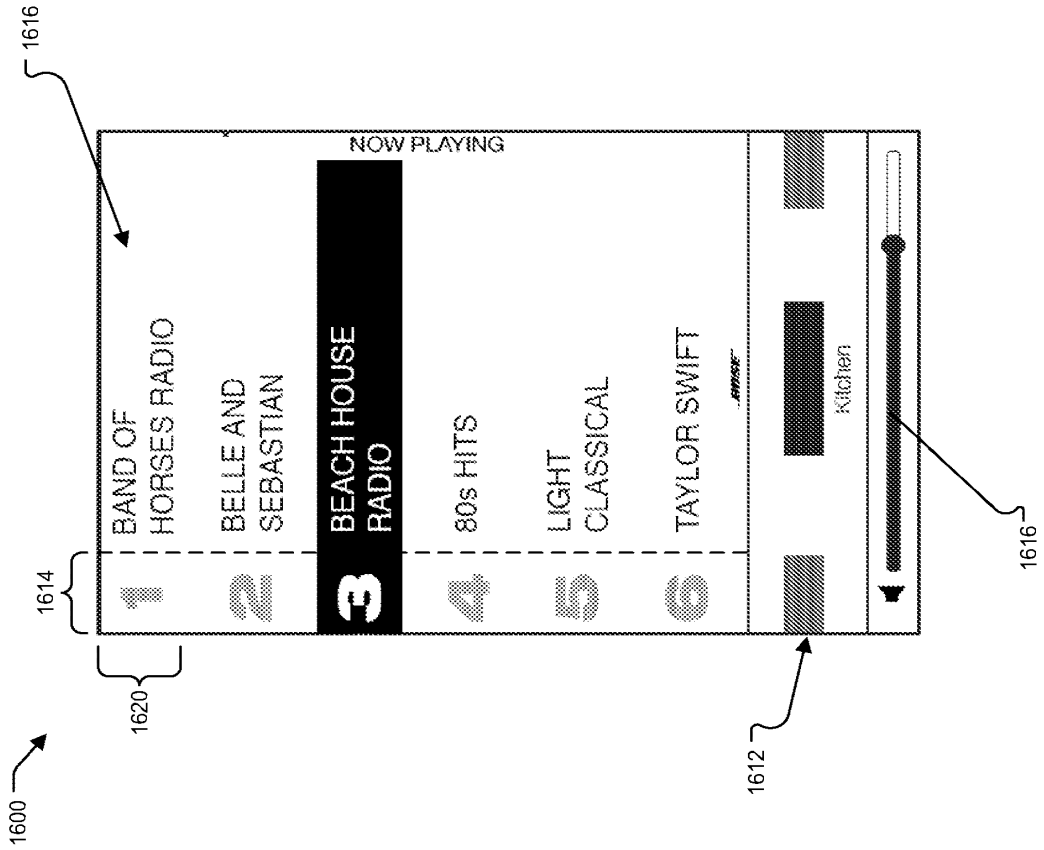

1616
NOW PLAYING
1 BAND OF HORSES RADIO
2 BELLE AND SEBASTIAN
3 BEACH HOUSE RADIO
4 80s HITS
5 LIGHT CLASSICAL
6 TAYLOR SWIFT
Kitchen
1614
1620
1600
1612
1616

FIG. 16A

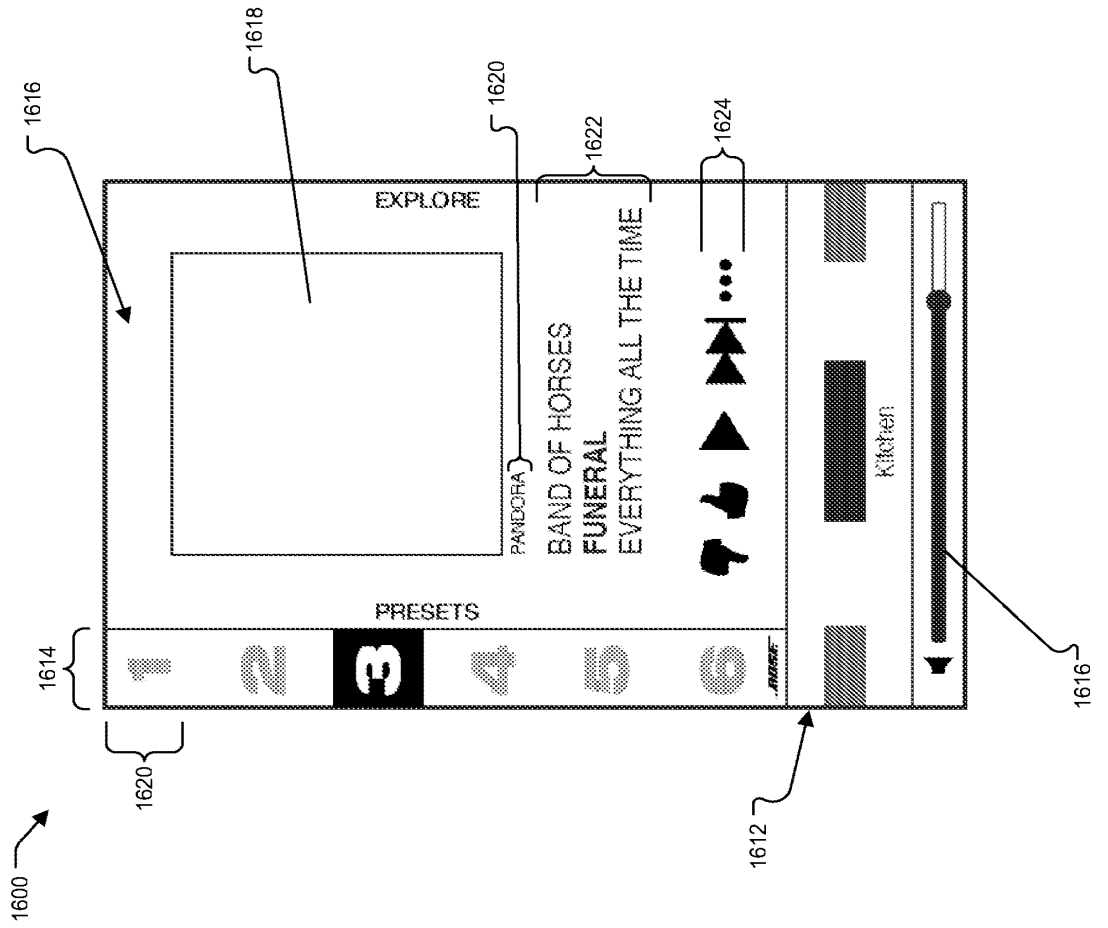

1600
1612
1614
1616
1618
1620
1622
1624
EXPLORE
PANDORA
BAND OF HORSES
FUNERAL
EVERYTHING ALL THE TIME
PRESETS
1
2
3
4
5
6
Kitchen

FIG. 16B

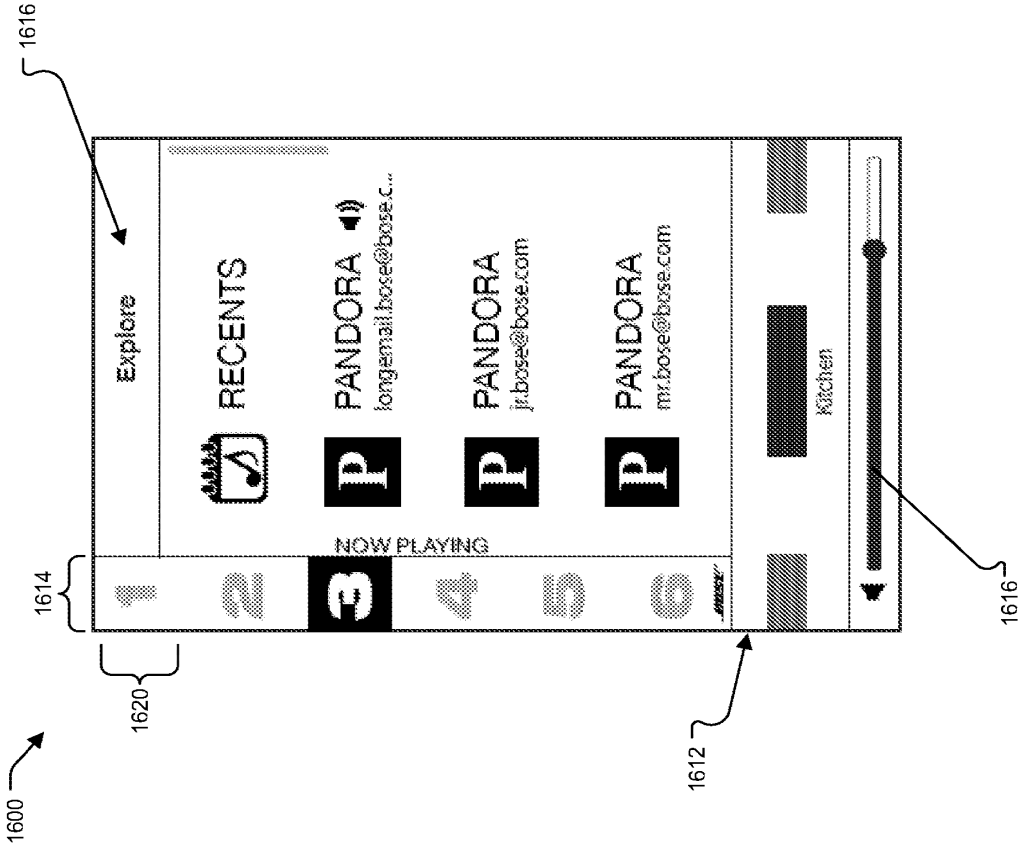

1616
Explore
RECENTS
PANDORA
longemail.bose@bose.c...
PANDORA
jl.bose@bose.com
PANDORA
mr.bose@bose.com
NOW PLAYING
1
2
3
4
5
6
Kitchen
1614
1620
1600
1612
1616

FIG. 16C

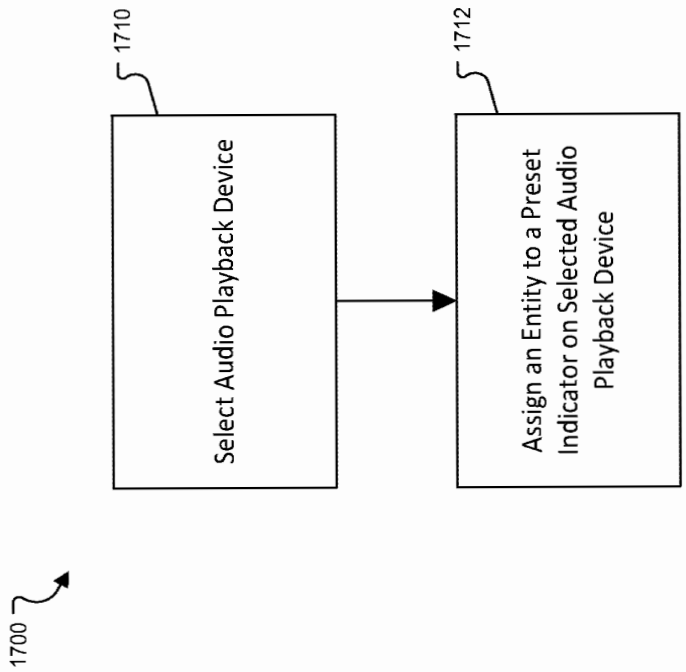

1700
1710
Select Audio Playback Device
1712
Assign an Entity to a Preset Indicator on Selected Audio Playback Device

FIG. 17

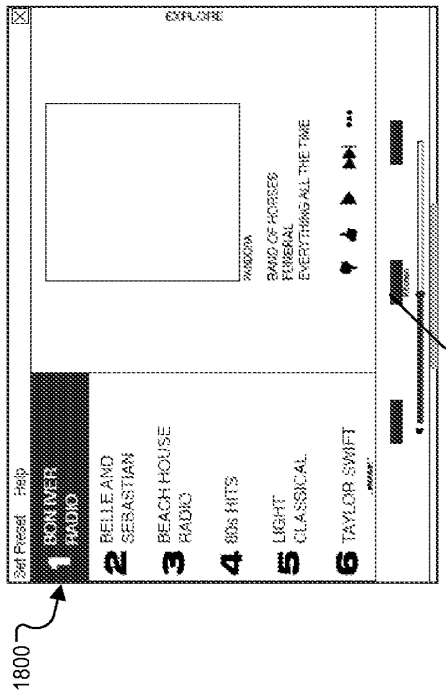


FIG. 18B

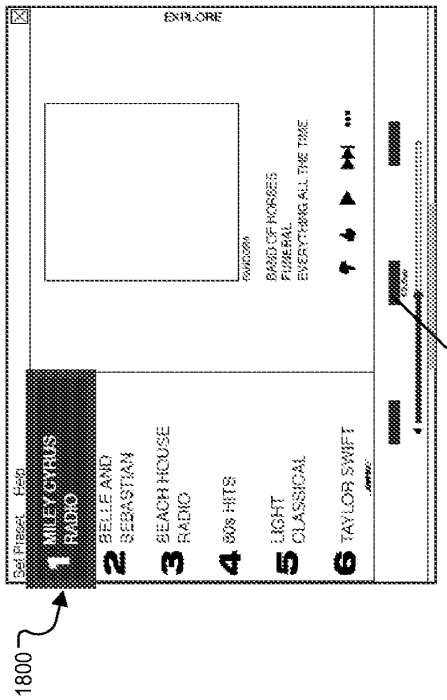


FIG. 18A

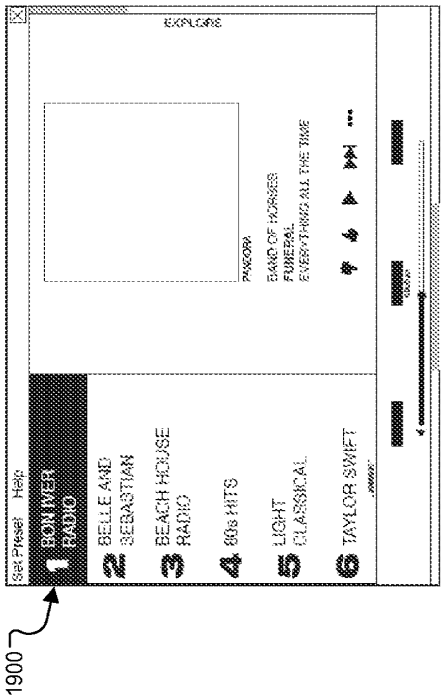


FIG. 19B

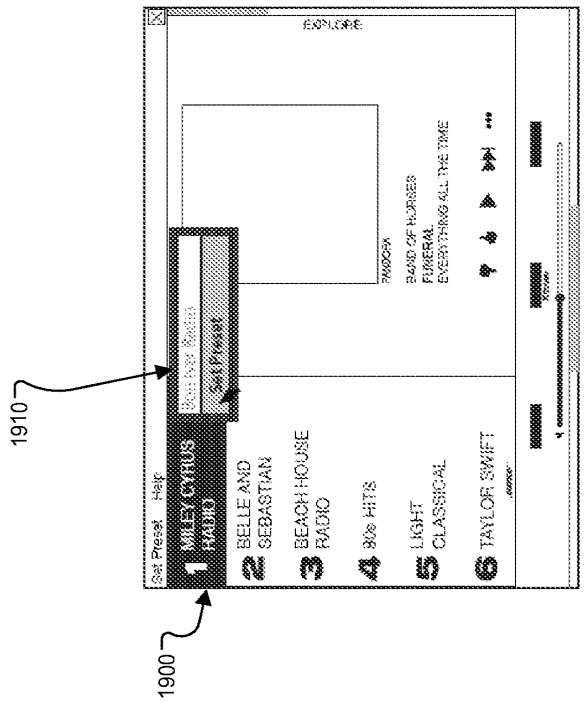


FIG. 19A

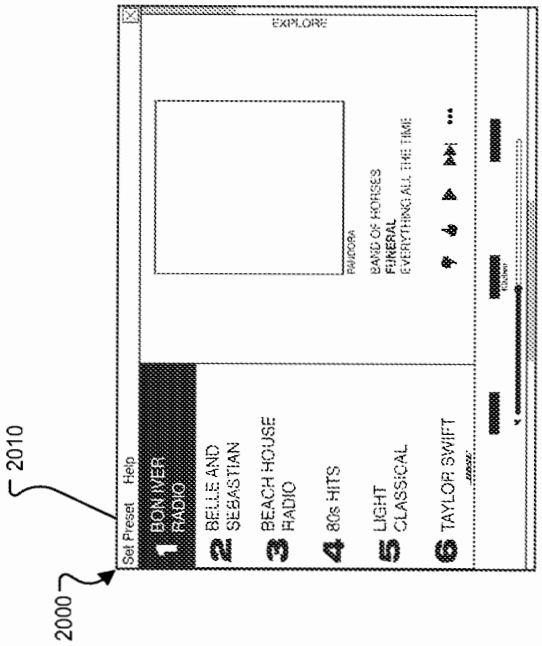


FIG. 20B

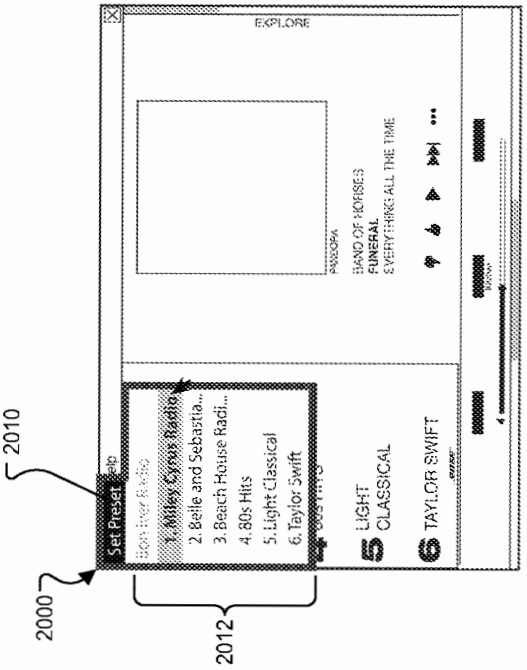


FIG. 20A

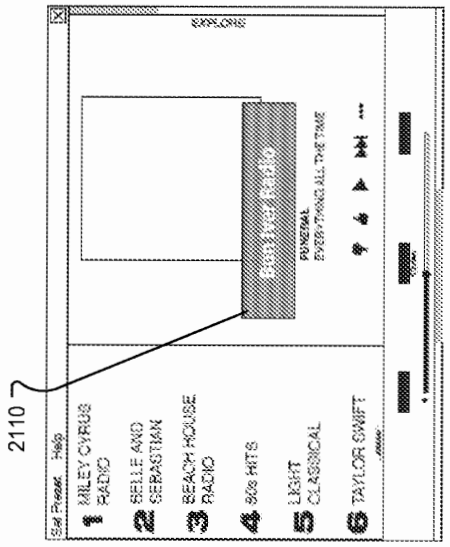


FIG. 21B

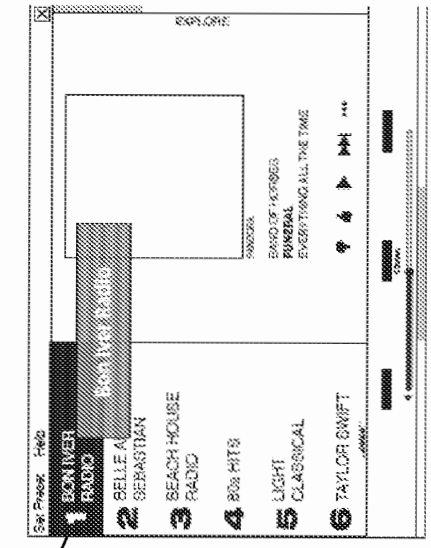


FIG. 21C

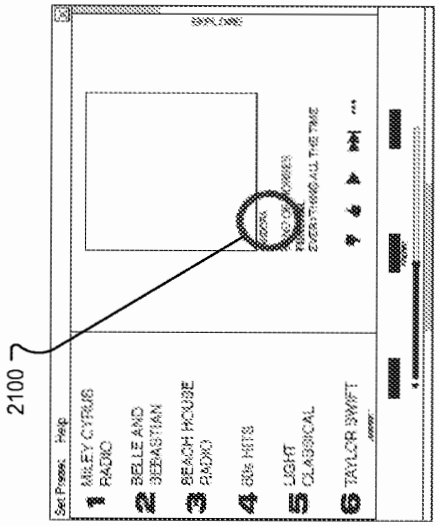


FIG. 21A

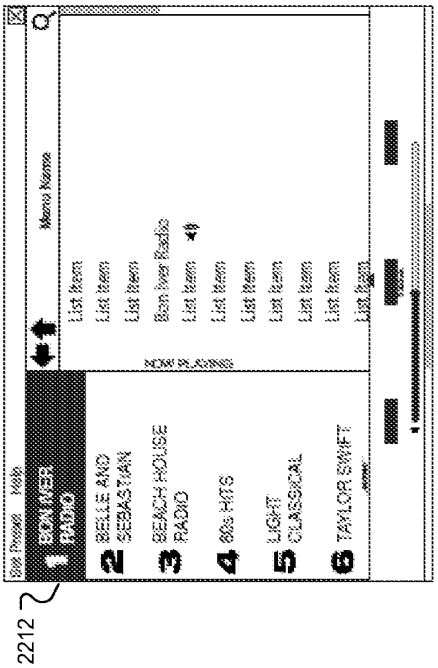


FIG. 22B

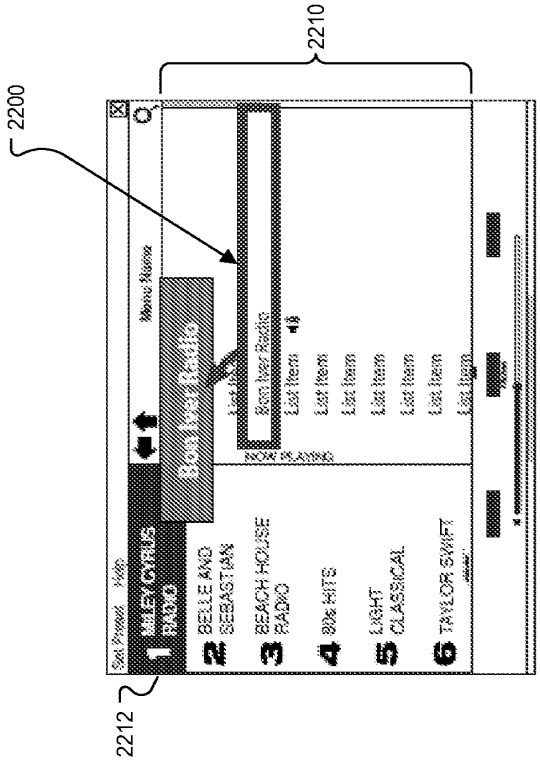


FIG. 22A

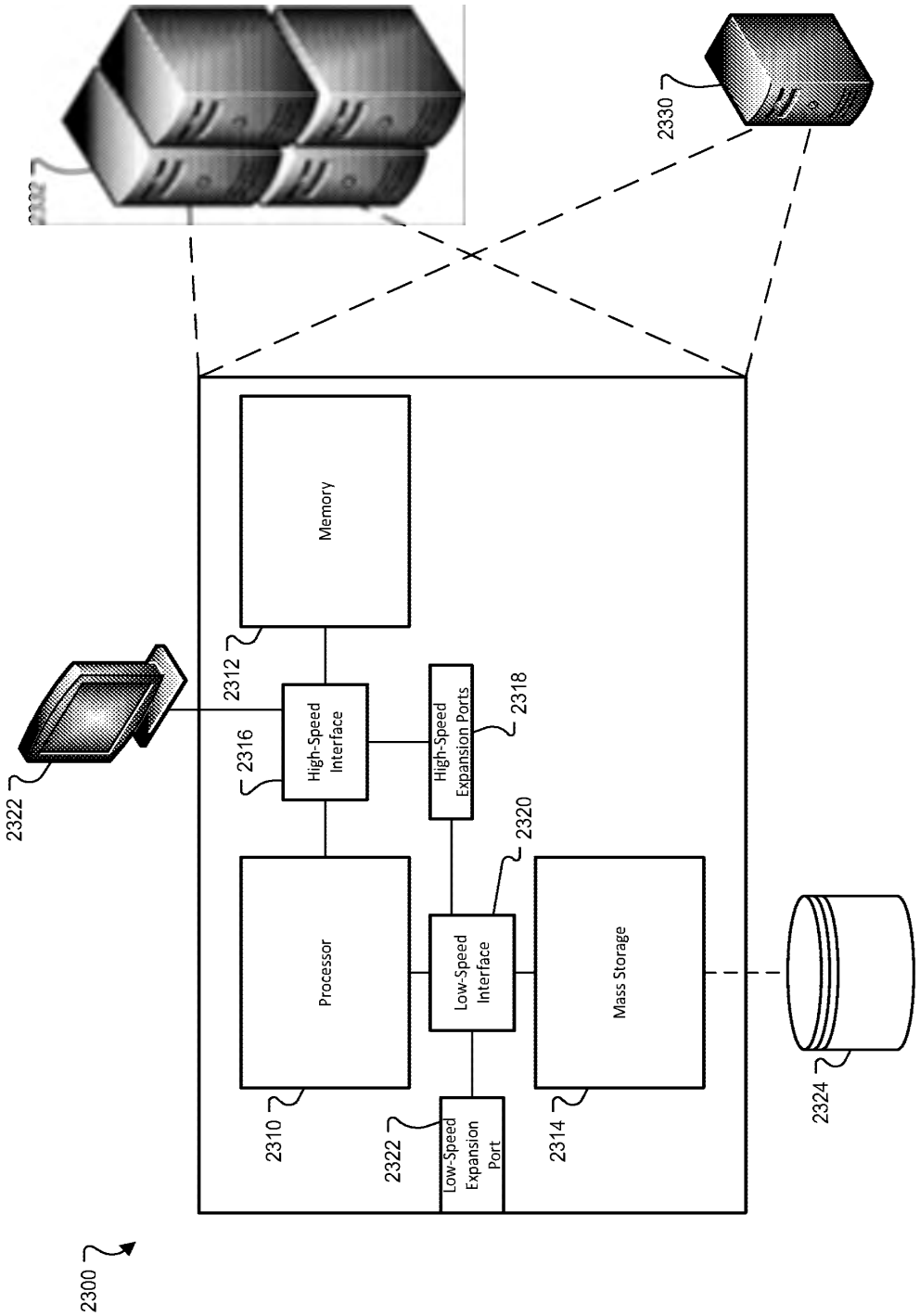

2330
Memory
2312
2316
High-Speed Interface
High-Speed Expansion Ports
2318
2322
2320
Processor
Low-Speed Interface
Mass Storage
2324
2310
2322
Low-Speed Expansion Port
2314
2300

FIG. 23

Electronic Acknowledgement Receipt

EFS ID:	24156949
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	23-NOV-2015
Filing Date:	17-APR-2013
Time Stamp:	19:07:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS.pdf	1058043 c1f289a46babd87348ea8087e67ccf55a8cf2823	no	15

Warnings:	
Information:	

2	Foreign Reference	EP0772374A2.pdf	350320 d0540f032eddeb881bde140e8cffe91866034bd3	no	6
Warnings:					
Information:					
3	Foreign Reference	EP2043381A2.pdf	500649 cfc9c3ebd465cd227af4d42f9c2ae879e4bd6622	no	11
Warnings:					
Information:					
4	Foreign Reference	EP2161950A2.pdf	438198 2055aa8a99d8f8a574f4bbd38868c6446f7d6b3d	no	10
Warnings:					
Information:					
5	Foreign Reference	EP2591617B1.pdf	1046822 af13974cacabcc4384fbf2614f669a4c46855494	no	17
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Information:					
6	Foreign Reference	GB2486183A.pdf	680286 e007f2f1707f277d675a1db46b358fa7a14aa0af	no	19
Warnings:					
Information:					
7	Foreign Reference	WO2014149533.pdf	3677125 bd4da631ed015fcc74fc3544541f18b0689ac174	no	93
Warnings:					
Information:					
8	Non Patent Literature	Canadian_No_2842342_Office_Action_9-14-15.pdf	112506 25fb30feb8e47e22bfff761255af2ad1a3f5e84f	no	2
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9	Non Patent Literature	14184526_NOA_10_07_2015.pdf	413026 2df309cd5defdfec9f57f8d2fe875e434c17d741	no	7
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10	Non Patent Literature	13435739_NOA_10-9-15.pdf	137478 468399a2da97d635c6c982ed1e83326394c42660	no	4

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Information:					
11	Non Patent Literature	13864251_NOA_10-13-15.pdf	412777 f446ea4ce7d2a6887897d9a2ddcb7564bb98c5c1	no	7
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Information:					
12	Non Patent Literature	10816217_Advisory_Action_09-28-2009.pdf	174667 3a5f804e29f38bea322ef41774b76c85b1e92c61	no	4
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Information:					
13	Non Patent Literature	14505027_OA_FirstAction_04-15-2015.pdf	287523 d8dc39ae1d02f5a859d0de8dc489678b544b5a12	no	6
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Information:					
14	Non Patent Literature	12035112_Advisory_Action_1-5-12.pdf	140953 8bc47a9d37f6102d0b6b51005c7ae0cd0bb0df0f	no	3
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Information:					
15	Non Patent Literature	12035112_Final_OA_10-13-11.pdf	329933 ab97007eb9463e539f8c67fa35797baf773f39ea	no	10
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Information:					
16	Non Patent Literature	10861653_Non-Final_OA_2-18-09.pdf	652571 624420cc4c7ad7e6337846b15f9b9b6dba417595	no	18
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17	Non Patent Literature	12035112_Non-Final_OA_3-10-11.pdf	388655 3982f869da68eb1e6785c6b4d882bdcf88c54b31	no	12
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18	Non Patent Literature	10861653_Non-Final_OA_6-27-08.pdf	658074 77e5adff5ac294909dd37994d168e6c290dc0ed0	no	19
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19	Non Patent Literature	12035112_NOA_6-14-12.pdf	448104 ebb923b463a14d8e8cfeef9f0950752da2be90e7	no	9

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Information:					
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			Total Files Size (in bytes):	12352225	

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13864249
Filing Date	2013-04-17
First Named Inventor	NICHOLAS; A. J. Millington
Art Unit	2442
Examiner Name	SURVILLO, OLEG
Attorney Docket Number	13-0402

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	1	2003169089	JP	A	2003-06-13	ANCL INC., et al.		☐
	2	2003506765	JP	A	2003-02-18			☐
	3	0110125	WO	A1	2001-02-08	CHUNG RANDALL M [US]		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402

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	1	"Corrected Notice of Allowance mailed on 19 August 2015, issued in connection with U.S. Patent Application No. 13/907666, filed on 31 May 2013, 2 pages.".	☐
	2	"Notice of Allowance mailed on 21 September 2015, issued in connection with U.S. Patent Application No. 13/297000, filed on 15 November 2011, 11 pages.".	☐
	3	"Notice of Allowance mailed on 22 September 2015, issued in connection with U.S. Patent Application No. 13/888203, filed on 6 May 2013, 7 pages".	☐
	4	"Notice of Allowance mailed on 24 September 2015, issued in connection with U.S. Patent Application No. 13/705174, filed on 5 December 2012, 7 pages.".	☐
	5	"Notice of Allowance mailed on 24 September 2015, issued in connection with U.S. Patent Application No. 14/184935, filed on 20 February 2014, 7 pages".	☐
	6	"Notice of Allowance mailed on 27 August 2015, issued in connection with U.S. Patent Application No. 13/705177, filed on 5 December 2012, 34 pages.".	☐
	7	"Notice of Allowance mailed on 27 August 2015, issued in connection with U.S. Patent Application No. 14/505027, filed on 2 October 2014, 18 pages.".	☐
	8	"Notice of Allowance mailed on 3 September 2015, issued in connection with U.S. Patent Application No. 13/705174, filed on 5 December 2012, 4 pages.".	☐
	9	"Notice of Rejection issued on 15 September 2015 in connection with Japanese Patent Application No. 2014-220704, 7 pages".	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-10-09
Name/Print	Benjamin M. Urban	Registration Number	71,591

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STREAM DATA DECENTRALIZED DISTRIBUTION METHOD AND ITS SYSTEM

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Classification: **- international:** ***G06F13/00; G06F21/10; H04L12/28; H04L12/751; H04L12/801; H04L12/911;*** (IPC1-7): H04L12/56

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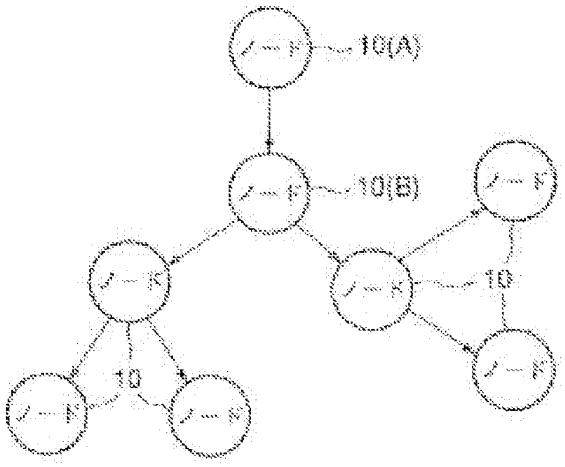
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Abstract of JP2003169089 (A)

PROBLEM TO BE SOLVED: To provide a stream data decentralized distribution technique which can actualize autonomous or personal stream data distribution in network environment such as the Internet, specially, between user terminals. ;SOLUTION: The stream data decentralized distribution system is actualized which allows nodes 10 to mutually send and receive stream data in the network environment such as the Internet. Each node 10 exchanges topology information showing connection relation between upstream and downstream nodes and relays stream data from the upstream node to the downstream node. Each node 10 is optionally disconnected from the network and connected to the upstream node under a predetermined condition. ;COPYRIGHT: (C)2003,JPO


10(A)
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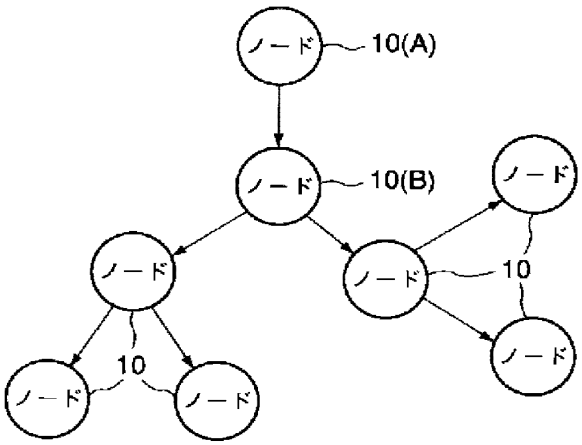
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最終頁に続く

(54)【発明の名称】　ストリームデータ分散配信方法及びそのシステム

(57)【要約】
【課題】インターネットなどのネットワーク環境において、特にユーザ端末間での自律的又は個人的なストリームデータ配信を実現できるストリームデータ分散配信技術を提供することにある。
【解決手段】インターネットなどのネットワーク環境において、各ノード１０間でストリームデータの送受信を行なうストリームデータ分散配信システムを実現する。各ノード１０は、上流ノードと下流ノードとの接続関係を示すトポロジ情報を交換し、上流ノードから下流ノードへストリームデータを中継する。各ノード１０は、任意にネットワークから離脱し、かつ所定の条件に従って上流ノードに対して接続する。



【特許請求の範囲】
【請求項１】　各ノードが相互接続して構築されるネットワークにおいて、各ノード間でストリームデータの送受信を実行するストリームデータ分散配信機能を実現する方法であって、
前記各ノードは、上流ノードと下流ノードとの接続関係を認識するためのトポロジ情報を管理するトポロジ管理手段、当該トポロジ情報をノード間で交換する手段、及び前記ストリームデータの送受信手段を有し、
上流ノード又は下流ノードとの接続を実行するステップと、
接続した上流ノード又は下流ノードとの間で前記トポロジ情報を交換するステップと、
上流ノードとして動作する場合に、前記トポロジ情報に基づいて認識される下流ノードに対して前記ストリームデータを送信するステップとから構成されるストリームデータ分散配信方法。
【請求項２】　前記トポロジ管理手段は、
自ノードとの接続関係を認識するための上流ノード又は下流ノードの識別情報を含む前記トポロジ情報を登録する機能と、
前記接続関係の変更に応じて前記トポロジ情報を更新する機能と、
前記トポロジ情報を下流ノードに提供する機能とを実現するように構成されていることを特徴とする請求項１に記載のストリームデータ分散配信方法。
【請求項３】　下流ノードとして動作する場合に、前記トポロジ情報に基づいて認識される上流ノードから送信されたストリームデータを受信するステップを更に有することを特徴とする請求項１または請求項２のいずれか１項に記載のストリームデータ分散配信方法。
【請求項４】　前記トポロジ情報に基づいて認識される上流ノードから送信されたストリームデータを受信し、かつ前記トポロジ情報に基づいて認識される下流ノードに対して当該ストリームデータを送信する中継機能を実現するステップを更に有することを特徴とする請求項１から請求項３のいずれか１項に記載のストリームデータ分散配信方法。
【請求項５】　新たな上流ノードまたは下流ノードとの接続確立あるいは既存の上流ノードまたは下流ノードとの接続切断に応じて、前記トポロジ管理手段は前記トポロジ情報を更新するステップを更に有することを特徴とする請求項１から請求項４のいずれか１項に記載のストリームデータ分散配信方法。
【請求項６】　既存の上流ノードとの接続を切断して、新たな上流ノードとの接続を確立するステップと、
前記接続確立ステップによる接続確立に応じて、前記更新ステップにより更新された前記トポロジ情報により認識される上流ノードから送信されたストリームデータを受信するステップと、
前記トポロジ情報により認識される下流ノードが存在する場合に、前記受信ステップにより受信したストリームデータを当該下流ノードに送信するステップとを更に有することを特徴とする請求項１から請求項５のいずれか１項に記載のストリームデータ分散配信方法。
【請求項７】　ストリームデータを配信するサーバを上流ノードとして、当該上流ノードから送信されたストリームデータを受信するステップと、
前記受信ステップにより受信したストリームデータを、前記トポロジ情報に基づいて認識される下流ノードに対して中継するステップとを更に有することを特徴とする請求項１から請求項６のいずれか１項に記載のストリームデータ分散配信方法。
【請求項８】　インターネット上で、前記ネットワークに接続された複数の上流ノードを登録して、前記各ノードに対して紹介するサーバが設けられて、
下流ノードとして、前記サーバから接続可能な上流ノードの紹介を受けるステップと、
前記サーバから紹介された上流ノードに対して接続要求を実行するステップと、
前記接続要求に応じて接続許可された上流ノードに接続するステップとを更に有することを特徴とする請求項１から請求項７のいずれか１項に記載のストリームデータ分散配信方法。
【請求項９】　前記上流ノードに接続するステップの後に、自ノードを前記サーバに登録するステップを更に有することを特徴とする請求項８に記載のストリームデータ分散配信方法。
【請求項１０】　下流ノードからの接続要求に応じて接続認証処理を実行するステップと、
前記接続認証処理ステップでの処理結果が接続許可の場合には、当該下流ノードとの間で通信するステップとを更に有することを特徴とする請求項１から請求項９のいずれか１項に記載のストリームデータ分散配信方法。
【請求項１１】　受信した前記ストリームデータを再生するステップを更に有することを特徴とする請求項１から請求項１０のいずれか１項に記載のストリームデータ分散配信方法。
【請求項１２】　各ノードが相互接続して構築されるネットワークにおいて、各ノード間でストリームデータの送受信を実行して、ストリームデータ分散配信機能を実現するためのプログラムであって、
前記各ノードは、前記プログラムを実行するコンピュータを有し、
上流ノードと下流ノードとの接続関係を認識するためのトポロジ情報の登録、更新、提供の各機能を含む管理機能と、
上流ノード又は下流ノードとの接続を実行する機能と、
接続した上流ノード又は下流ノードとの間で前記トポロジ情報を交換する機能と、

上流ノードとして動作する場合に、前記トポロジ情報に基づいて認識される下流ノードに対して前記ストリームデータを送信又は中継する機能とを前記コンピュータに実現させるためのプログラム。

【請求項１３】　下流ノードとして動作する場合に、前記トポロジ情報に基づいて認識される上流ノードから送信されたストリームデータを受信する機能と、

受信した前記ストリームデータを再生する機能とを前記コンピュータに実現させることを特徴とする請求項１２に記載のプログラム。

【請求項１４】　新たな上流ノードまたは下流ノードとの接続確立あるいは既存の上流ノードまたは下流ノードとの接続切断に応じて、前記トポロジ情報を更新する機能を前記コンピュータに実現させることを特徴とする請求項１２または請求項１３のいずれか１項に記載のプログラム。

【請求項１５】　下流ノードからの接続要求に応じて接続認証処理を実行する機能と、

前記接続認証処理の結果が接続許可の場合には、当該下流ノードとの間で通信する機能とを前記コンピュータに実現させることを特徴とする請求項１２から請求項１４のいずれか１項に記載のプログラム。

【請求項１６】　受信した前記ストリームデータを再生する機能とを前記コンピュータに実現させることを特徴とする請求項１２から請求項１５のいずれか１項に記載のプログラム。

【請求項１７】　各ノードが相互接続して構築されるネットワークにおいて、各ノード間でストリームデータの送受信を実行するストリームデータ分散配信機能を実現するシステムであって、

前記各ノードは、

上流ノード又は下流ノードとの接続の確立または切断を実行する手段と、

上流ノードと下流ノードとの接続関係を認識するためのトポロジ情報を管理するトポロジ管理手段と、

接続した上流ノード又は下流ノードとの間で前記トポロジ情報を交換する手段と、

上流ノードとして動作する場合に、前記トポロジ情報に基づいて認識される下流ノードに対して前記ストリームデータを送信する手段とを具備したことを特徴とするストリームデータ分散配信システム。

【請求項１８】　前記トポロジ管理手段は、

自ノードとの接続関係を認識するための上流ノード又は下流ノードの識別情報を含む前記トポロジ情報を登録する手段と、

新たな上流ノードまたは下流ノードとの接続確立あるいは既存の上流ノードまたは下流ノードとの接続切断による前記接続関係の変更に応じて前記トポロジ情報を更新する手段と、

前記トポロジ情報を下流ノードに提供する手段とを含むことを特徴とする請求項１７に記載のストリームデータ分散配信システム。

【請求項１９】　下流ノードとして動作する場合に、前記トポロジ情報に基づいて認識される上流ノードから送信されたストリームデータを受信する手段と、

前記トポロジ情報に基づいて認識される下流ノードが存在する場合に、前記受信手段により受信したストリームデータを当該下流ノードに送信する中継手段とを更に有することを特徴とする請求項１７または請求項１８のいずれか１項に記載のストリームデータ分散配信システム。

【請求項２０】　前記各ノードは、

下流ノードからの接続要求に応じて接続認証処理を実行する手段と、

接続許可の場合には当該下流ノードと接続する手段と、

接続拒否の場合には接続拒否を示すメッセージを当該下流ノードに送信する手段とを有することを特徴とする請求項１７から請求項１９のいずれか１項に記載のストリームデータ分散配信システム。

【請求項２１】　前記受信手段は、

既存の上流ノードとの接続を切断して、新たな上流ノードとの接続確立に応じて、前記トポロジ管理手段により更新された前記トポロジ情報により認識される上流ノードから送信されたストリームデータを受信し、

前記中継手段は、

前記トポロジ情報により認識される下流ノードが存在する場合に、前記受信手段により受信したストリームデータを当該下流ノードに送信することを特徴とする請求項１９に記載のストリームデータ分散配信システム。

【請求項２２】　前記各ノードは、受信した前記ストリームデータを再生する手段を更に有することを特徴とする請求項１７から請求項２１のいずれか１項に記載のストリームデータ分散配信システム。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、一般的にはネットワーク環境下でストリームデータを分散配信する方法に関し、特にインターネット上においてユーザ端末間でストリームデータの分散配信機能を実現する技術に関する。

【０００２】

【従来の技術】近年、インターネットを代表とする情報通信ネットワーク環境において、ブロードバンド化の推進により、主として動画（映像）や音声のコンテンツ情報（以下ストリームデータと呼ぶ場合がある）の伝送を容易に行なうことが可能になりつつある。ブロードバンド化のネットワーク環境としては、例えばＡＤＳＬ（asymmetric digital subscriber line）伝送方式やＣＡＴＶ（cable television）ネットワークを利用した有線通信方式以外に、携帯電話などの無線通信方式（移動体通

信方式）によるネットワーク環境も含まれる。

【０００３】ところで、インターネットに接続されるユーザ端末としては、パーソナルコンピュータ、各種のディジタル情報機器（例えばディジタル・テレビ受信機など）、携帯電話（ＰＨＳも含む）、あるいは無線通信機能を有する携帯型情報端末（ＰＤＡ：personal digital assistantとも呼ばれている）等が含まれる。

【０００４】ブロードバンド化のネットワーク環境下で、これらのユーザ端末を使用することにより、ストリームデータを受信して、ユーザの違和感を伴なうことなく、動画や音声のコンテンツ情報を再生することが可能となる。従来では、インターネットによる情報サービスや、個人間の情報交換では、文字情報や静止画像が主体であり、動画や音声などのストリームデータの通信は限定されたものであった。従って、今後、ブロードバンド化のネットワーク環境の普及に伴なって、ストリームデータ配信サービス事業などのビジネス分野だけでなく、ユーザ間で個人的情報を交換するプライベートの分野でも、ストリームデータ配信に対する需要が増大することが予想される。

【０００５】

【発明が解決しようとする課題】ネットワーク環境下でのブロードバンド化の推進により、インターネットの基幹系や、各家庭のユーザ端末と接続する支線系について、帯域の増強や通信コストの低減化が実現されつつある。

【０００６】しかし一方で、ストリームデータ配信に対する需要の増大化に伴なって、ストリームデータを送信するためのシステムに対して、負荷容量（配信能力）の増大化が要求されている。このことは、特にサーバを中心とする多大な設備投資が要求されて、システム構築に要するコストの増大化を招くことになる。

【０００７】一般的に、ストリームデータの配信システムは、サービス事業者（インターネットサービスプロバイダ：ＩＳＰなど）が管理するサーバにより実現されている。従って、サービス事業者側において、コスト面からサーバの負荷容量を増強できない場合、ストリームデータ配信に対する需要の増大化に対応できず、ブロードバンド化により増強されたインターネットの帯域を十分に活用できない状況になる。

【０００８】このような問題点を解消するために、ストリームデータを分散配信（配送）する各種の技術が開発されている。これらの先行技術により、ストリームデータの送信（配信）を行なうサーバの負荷を軽減することが可能となる。しかしながら、いずれの先行技術も基本的には、分散配信システムを事業者が管理するサーバにより中央制御する方式である。このため、ストリームデータの送信に関するサーバの負荷は軽減できても、一方で、分散配信システムを構成するためのトポロジ（ノード間の接続関係）の制御などに関するサーバの負荷が増大するという問題がある。

【０００９】さらに、分散配信システムを中央制御する方式は、サービス事業者が管理するサーバによりストリームデータ配信を行なう事業者向けのアプローチである。換言すれば、ユーザ間で個人的情報を交換するプライベートの分野において、サービス事業者が管理するサーバを要することなく、いわば自律的又は個人的なストリームデータ配信を実現する分散配信システムに関する技術は開発されていない。

【００１０】そこで、本発明の目的は、インターネットなどのネットワーク環境において、特にユーザ端末間での自律的又は個人的なストリームデータ配信を実現できるストリームデータ分散配信技術を提供することにある。

【００１１】

【課題を解決するための手段】本発明の観点は、インターネットなどのネットワーク環境において、各ユーザ端末（ノード）間でストリームデータの送受信を行なうストリームデータ分散配信システムを動的に構築するための方法に関する。本方法の特徴は、各ユーザ端末のネットワーク接続関係を認識するためのトポロジ情報を、各ノード（ユーザ端末）が分散管理する構成にある。換言すれば、各ノードが自律的に、トポロジ情報を記憶し、更新し、提供するなどの管理を行なう機能を備えている。

【００１２】本発明の観点によるストリームデータ分散配信方法は、各ノードが相互接続して構築されるネットワークにおいて、各ノード間でストリームデータの送受信を実行して、ストリームデータ分散配信機能を実現する方法であって、各ノードは、上流ノードと下流ノードとの接続関係を認識するためのトポロジ情報を管理する手段、当該トポロジ情報をノード間で交換する手段、及び前記ストリームデータの送受信手段を有し、上流ノード又は下流ノードとの接続を実行するステップと、接続した上流ノード又は下流ノードとの間でトポロジ情報を交換するステップと、上流ノードとして動作する場合に、トポロジ情報に基づいて認識される下流ノードに対して前記ストリームデータを送信するステップとから構成されている。

【００１３】本発明の観点によるストリームデータ分散配信方法であれば、サービス事業者が管理するストリームデータ配信用サーバや、分散配送系制御サーバなどを要することなく、例えばインターネットに接続されたユーザ端末間で、ストリームデータの送信、受信または中継を行なうことができる。

【００１４】各ノードは、トポロジ情報により認識した上流ノードに接続し、当該上流ノードから送信されるストリームデータを受信できる。また、トポロジ情報により認識した下流ノードに対してストリームデータを送信できる。この場合、上流ノードとして機能する自ノード

は、複数の下流ノードに接続し、ストリームデータを同時並行的に送信することができる。また、上流ノードからストリームデータを受信した下流ノードは、他の下流ノードからの接続要求に応じて、上流ノードとして機能し、当該下流ノードに対して受信したストリームデータを送信（要するに中継）することができる。従って、サービス事業者が運営する高性能のストリームデータ配信用サーバを要することなく、インターネットに接続された各ユーザ端末間で、ストリームデータの分散配信を実現することができる。但し、一般的には、各ユーザ端末は、ＩＳＰや通信事業者などを介して、インターネットへの接続を行なうことになる。

【００１５】本発明のストリームデータ分散配信方法を利用すれば、一般ユーザが個人的な撮影映像を、インターネットに接続したパーソナルコンピュータなどを利用して、関係者のみに配信するようなパーソナル放送とも言えるサービスが可能となる。また、ユーザまたは事業者は、多数の視聴者に向けてライブやコンサートなどの中継放送を行なういわゆるインターネット放送を実現できる。この場合、インターネット放送事業者は、商業用のインターネット・ストリームデータ配信サービスにおける配信サーバの負荷を軽減させることができる。即ち、インターネット放送事業者が管理するサーバから、少数の各ユーザ端末にストリームデータを配信し、当該各ユーザ端末から他の各ユーザ端末に対して当該ストリームデータを配信することができる。これにより、インターネット放送事業者が管理するサーバの負荷を、直接的にストリームデータを配信する先のユーザ端末数に応じて軽減することができる。

【００１６】

【発明の実施の形態】以下図面を参照して、本発明の実施の形態を説明する。

【００１７】（システムの基本的構成）図１は、本実施形態に関するストリームデータ分散配信システムの概念を示す図である。

【００１８】本システムは、特にブロードバンドのインターネット等のような常時接続の高速ネットワーク環境を想定し、当該ネットワークに接続された複数のノード１０によりストリームデータを分散配信する構成である。ここで、ストリームデータとは、動画（映像）や音声等の連続的ディジタルデータを意味する。また、ノード１０とは、一般的には、ネットワークに接続されたユーザ端末であるが、サーバやルータなどのネットワーク機器であってもよい。ユーザ端末としては、具体的には、パーソナルコンピュータ、無線通信機能を有する携帯型情報端末（ＰＤＡや、ノート型パーソナルコンピュータなどを意味する）、あるいは携帯電話（ＰＨＳも含む）等のディジタル情報機器（デバイス）を意味する。また、ユーザ端末としては、前記のデバイス単体だけでなく、ＬＡＮもしくは無線ＬＡＮにより、複数のデバイスを接続して構成されるシステムを意味する場合もある。

【００１９】本システムでは、あるノード１０（Ａ）から送信されたストリームデータを受信したノード１０（Ｂ）は、ストリームデータを復号して再生（視聴）すると共に、他のノード１０に中継する。この場合、ノード１０（Ｂ）は、データ処理能力及びネットワーク接続帯域の許容範囲内で、複数のノード１０に対してストリームデータを中継する。

【００２０】要するに、本システムは、上流ノードから下流ノードへストリームデータの中継を実行することにより、高性能の配信用サーバを要することなく、多数のユーザ端末に対してストリームデータ配信を行なうストリームデータ分散配信機能を実現する。ここで、上流ノードとは、自ノードに対して上流であり、ストリームデータの送信元ノードまたは中継ノードである。また、下流ノードとは、自ノードに対してストリームデータの送信先ノードである。下流ノードは、ストリームデータを受信する受信ノード、または更に下流ノードに対して送信する中継ノードでもある。

【００２１】図２は、本システムの具体的構成の一例を示すブロック図である。

【００２２】本システムの具体的想定としては、多数のユーザ端末であるノード１０がインターネット２０に接続されて構築されたネットワークにおいて、ストリームデータ分散配信系に参加した各ユーザ端末に対してストリームデータが配信される構成である。各ノード１０は、例えばＡＤＳＬ伝送方式やＣＡＴＶネットワークを使用して、常時接続型の高速回線によりインターネットに接続される環境を想定している。

【００２３】あるノード１０は、例えばパーソナルコンピュータ（ＰＣ）１１と、ブロードバンド・ネットワーク接続インターフェース（ＢＢＮＩＤ）１２とを有するユーザ端末である。ＢＢＮＩＤ（Broad-Band Network Interface Device）１２は、具体的にはＡＤＳＬモデムまたはケーブルモデム（ＣＡＴＶインターネット用モデム）等と、ルータ機能とを一体化したネットワーク機器である。これらのノード１０は、インターネット２０を介して受信したストリームデータを、例えばＰＣ１１のディスプレイ上に再生し、かつ他の下流ノード１０へ中継する。

【００２４】また、あるノード１０は、例えばＰＣ１１とディジタルビデオカメラ（ＤＶＣ）１３とを有する。これらのノード１０は上流ノードとして、ＤＶＣ１３により撮影した映像（音声を含む）からなるストリームデータを、ＰＣ１１にセットされたソフトウェア（同実施形態のメイン構成要素）により送信するユーザ端末である。

【００２５】（ノードの構成）次に、図３を参照して、同実施形態のユーザ端末であるノード１０の構成を説明

する。

【００２６】同実施形態のノード１０は、例えばパーソナルコンピュータと、当該コンピュータにセットされるソフトウェアと、各種デバイスとから構成される。図３は、同実施形態のメイン構成要素であり、ＰＣ１１内で稼動する当該ソフトウェア構成を示すブロック図である。

【００２７】ストリームデータ分散配信システムを構成する各ノード１０は、全て同一のソフトウェア構成を有し、ストリームデータの送信、受信、中継、再生の各機能を実現する。以下、ソフトウェア構成の各要素について具体的に説明する。なお、同実施形態のソフトウェア構成は、特定のＯＳ（operating system）には依存しない設計である。

【００２８】本ソフトウェア構成は、トポロジエンジン３０と、ストリームエンジン３１と、ストリームスイッチ部３２と、ノード全体の操作環境を司るＧＵＩ（graphical user interface）３３と、ストリーム再生部３４とからなる。

【００２９】トポロジエンジン３０は、概略的にはメッセージ（制御情報）を交換することにより、各ノード１０間のネットワーク接続関係（トポロジ：topology）を構成する機能を実現する。具体的には、トポロジエンジン３０は、各ノード１０間をＴＣＰ／ＩＰ（transmission control protocol/internet protocol）で接続して、各種のメッセージを送受信する。さらに、トポロジエンジン３０は、直接あるいは間接的に接続された近傍のノードの存在を、メッセージの交換を通じて認識する。トポロジエンジン３０は、当該近傍ノードの存在情報及びストリームデータの受信状態から代替トポロジを求めて、当該トポロジに従って一度構成した各ノード１０間の接続関係を変更する。

【００３０】ストリームエンジン３１は、ノード１０間でのストリームデータの送信、受信、中継の各機能を実現するソフトウェアである。ストリームエンジン３１は、トポロジエンジン３０から受け取ったトポロジ情報（後述するトポロジ情報テーブル）に基づいて、隣接ノードである下流ノード（単数又は複数）に向けてストリームデータを送信する。また、隣接ノードである上流ノード（単数又は複数）からストリームデータを受信する。

【００３１】ここで、隣接ノードとは、自ノードと直接的に接続している上流又は下流のノードを意味する。また、近傍ノードとは、自ノードと間接的に接続している上流又は下流のノードを意味する。トポロジ情報（トポロジ情報テーブル）は、各ノード間の論理的な接続関係を示す情報（上流／下流及び隣接／近傍を識別する情報）、及び当該接続関係が形成された隣接または近傍のノードを特定する情報（ネットワークアドレスなど）を含む（図１５を参照）。

【００３２】ストリームエンジン３１は、ストリームデータ送受信用のＴＣＰ／ＩＰ接続を確立し、各ノード間でストリームデータの送受信を実行する。ストリームエンジン３１は、ストリームデータのデータ形式（符号化方式）に依存しない汎用的配送機能を有し、例えばＭＰＥＧ規格等の各種のデータ形式に適用できる構成である。

【００３３】ストリームスイッチ部３２は、ストリームエンジン３１と他の機能、デバイス、ファイルとの連携機能を実現するためのソフトウェアである。ストリームスイッチ部３２は主機能として、ストリーム再生部３４を起動し、ストリームエンジン３１から取り出したストリームデータを渡す。ストリーム再生部３４は、ストリームデータから出力用の映像や音声を復号化して、再生するためのソフトウェアである。更に、ストリームスイッチ部３２は、ローカル装置である例えばデジタルビデオカメラ（ＤＶＣ）１３や、ローカルファイル装置３６からストリームデータを取り出し、ストリームエンジン３１に渡すことにより他のノードに送信する機能を実現する。

【００３４】ＧＵＩ３３は、トポロジエンジン３０、ストリームエンジン３１、ストリームデータスイッチ部３２のそれぞれと、ユーザとのインターフェースを提供する。具体的には、ＧＵＩ３３は、ディスプレイの画面上に、隣接または近傍ノード間のトポロジ（接続関係）を可視的に表示したり、ストリームエンジン３１の通信データ量を可視的に表示する。また、ＧＵＩ３３は、ユーザからのコマンド入力に応じて、他ノードへの明示的接続要求や、自ノードの接続鍵の設定を行なう。接続鍵とは、トポロジエンジン３０に含まれるノード間の接続に関する認証機能で使用される鍵データである。

【００３５】ここで、接続鍵（ＣＫ）と公開鍵（ＰＫ）とを使用する認証機能を、具体的に説明する。あるノードが配信元（配信サーバの役割）となる場合、後述するように、ＧＵＩ３３の公開鍵取得部３３６が接続鍵発行サーバ７１から公開鍵（ＰＫ）を取得し、これをトポロジエンジン３０の接続認証部３０７が受け取り記憶する（図４及び図７を参照）。接続認証部３０７は、接続要求受理部３０６からの認証要求（接続鍵ＣＫを含む）に応じて、当該公開鍵（ＰＫ）を使用して接続鍵（ＣＫ）を復号して認証する。

【００３６】これに対して、視聴参加するノードは、ＧＵＩ３３の接続鍵取得部３３４が接続鍵発行サーバ７１から接続鍵（ＣＫ）を取得し、これをトポロジエンジン３０の接続認証部３０７が受け取り記憶する。また、上流ノードへの接続要求の際には、トポロジエンジン３０の接続要求部３０５は、接続認証部３０７から接続鍵（ＣＫ）を受け取り、上流ノードへ接続要求を実行する。

【００３７】更に、図４から図７を参照して、ノード１

０の各ソフトウェア構成を具体的に説明する。

【００３８】（トポロジエンジン）トポロジエンジン３０は、図４に示すように、トポロジ管理部３００、トポロジテーブル３０１、負荷状態監視部３０２、制御データ通信部３０３，３０４、接続要求部３０５、接続要求受理部３０６、及び接続認証部３０７の各機能要素部を有する。

【００３９】トポロジ管理部３００は、直接接続している上流ノードから受信したトポロジ情報（ＴＩ）に基づいて、隣接ノード群又は近傍ノード群の存在と、それらノード間の接続関係（トポロジ）を認識する。また、トポロジ管理部３００は、当該トポロジ情報（ＴＩ）のテーブル形式にしたトポロジ情報テーブルをトポロジテーブル３０１に記憶する（以下ＴＩを情報テーブルと表記する場合がある）。トポロジ管理部３００は、ノード間のトポロジの変化に応じて、トポロジテーブル３０１に記憶した情報テーブル（ＴＩ）を更新する。

【００４０】トポロジ管理部３００は、直接接続している隣接ノード、即ち上流ノード（通常では単数）及び下流ノード（単数又は複数）のノード識別子（ネットワークアドレス）をストリームエンジン３１に渡す。ストリームエンジン３１は、当該隣接ノードとの間にストリームデータ送受信用のＴＣＰ／ＩＰ接続を確立する。また、トポロジ管理部３００は、トポロジテーブル３０１に記憶された情報テーブル（ＴＩ）をＧＵＩ３３に渡す。ＧＵＩ３３は、当該情報テーブル（ＴＩ）に基づいて、ノード間のトポロジを可視化して画面上に表示する（図７を参照）。

【００４１】ここで、トポロジ情報テーブル（ＴＩ）について、図１４及び図１５を参照して具体的に説明する。

【００４２】図１４は、各ノード１０がネットワーク上で接続されている接続関係（トポロジ）の一例を示す図である。各ノード１０は、例えばネットワークアドレスに相当する識別子（ｎｏｄｅ０～ｎｏｄｅ５）により特定される。各ノード１０は、基本的には、自ノードに対して上流ノードからトポロジ情報（ＴＩ）を受け取り、トポロジテーブル３０１として登録する。そして、各ノード１０は、下流ノードからの接続要求に応じて、当該下流ノードとの接続関係を追加したトポロジ情報（ＴＩ）を下流ノードに提供する。

【００４３】ここで、仮に、ｎｏｄｅ０の上流ノード１０は、下流ノード（ｎｏｄｅ１，４）との接続関係を記録したトポロジ情報（ＴＩ－０）を、当該下流ノード（ｎｏｄｅ１，４）に提供する。このトポロジ情報（ＴＩ－０）は、図１５（Ａ）に示すように、接続関係にあるノード識別子（ｎｏｄｅ０，１，４）と、隣接ノード（直接的に接続したノード）である上流ノードの識別子（ｎｏｄｅ０のみ）とが対応付けされた情報テーブルである。なお、下流ノードの各識別子（ｎｏｄｅ１，４）に対しては、下流ノードであることを示すフラグ情報を付加してもよい。即ち、自ノード（ｎｏｄｅ０）は、当該フラグ情報により、トポロジ情報（ＴＩ－０）に登録された識別子（ｎｏｄｅ１，４）を隣接ノードである下流ノードとして認識できる。

【００４４】下流ノード（ｎｏｄｅ１）は、図１４に示すように、自ノードが上流ノードとして下流ノード（ｎｏｄｅ２，３）との接続関係を確立していると想定する。この場合、下流ノード（ｎｏｄｅ１）は、上流ノード（ｎｏｄｅ０）から提供されたトポロジ情報（ＴＩ－０）に、当該接続関係を追加したトポロジ情報（ＴＩ－１）を生成して、下流ノード（ｎｏｄｅ２，３）に提供する（図１５（Ｂ）を参照）。このトポロジ情報（ＴＩ－１）においても、同様に、下流ノードの各識別子（ｎｏｄｅ２，３）に対しては、下流ノードであることを示すフラグ情報を付加してもよい。

【００４５】ここで、下流ノード（ｎｏｄｅ２）は、提供されたトポロジ情報（ＴＩ－１）から、接続関係（１）～（３）を認識することができる。即ち、接続関係（１）として、自ノード以外に、上流ノード（ｎｏｄｅ１）に対する隣接ノードとして、下流ノード（ｎｏｄｅ３）の存在を認識できる。接続関係（２）として、自ノードの上流ノード（ｎｏｄｅ１）に対して、更に上流となるノード（ｎｏｄｅ０）の存在を認識できる。接続関係（３）として、上流ノード（ｎｏｄｅ０）の下流ノード（ｎｏｄｅ４）の存在を認識できる。これら間接的に接続されたノードｎｏｄｅ０、ｎｏｄｅ３，ｎｏｄｅ４は、自ノード（ｎｏｄｅ２）にとっての近傍ノードである。

【００４６】同様に、下流ノード（ｎｏｄｅ３）は、提供されたトポロジ情報（ＴＩ－１）から、接続関係（１）～（３）を認識することができる。即ち、接続関係（１）として、自ノード以外に、上流ノード（ｎｏｄｅ１）に対する隣接ノードとして、下流ノード（ｎｏｄｅ２）の存在を認識できる。接続関係（２）として、自ノードの上流ノード（ｎｏｄｅ１）に対して、更に上流となるノード（ｎｏｄｅ０）の存在を認識できる。接続関係（３）として、上流ノード（ｎｏｄｅ０）の下流ノード（ｎｏｄｅ４）の存在を認識できる。

【００４７】一方、下流ノード（ｎｏｄｅ４）は、図１４に示すように、自ノードが上流ノードとして下流ノード（ｎｏｄｅ５）との接続関係を確立していると想定する。この場合、下流ノード（ｎｏｄｅ４）は、提供されたトポロジ情報（ＴＩ－０）に、当該接続関係を追加したトポロジ情報（ＴＩ－４）を生成して、下流ノード（ｎｏｄｅ５）に提供する（図１５（Ｃ）を参照）。このトポロジ情報（ＴＩ－４）においても、同様に、下流ノードの識別子（ｎｏｄｅ５）に対しては、下流ノードであることを示すフラグ情報を付加してもよい。

【００４８】以上要するに、各ノードは、基本的に上流

から下流へ提供されるトポロジ情報（ＴＩ）をトポロジテーブル３０１として管理（登録、更新、提供等）することにより、隣接ノード及び近傍ノードの存在を認識することができる。隣接ノードとは、前述したように、自ノードと直接的に接続する上流ノード又は下流ノードである。近傍ノードとは、自ノードと間接的に接続されたノードである（必ずしも自ノードより上流又は下流の関係とは限らない）。

【００４９】なお、トポロジ情報（ＴＩ）は、下流に行くほど情報量が増大することになる。このため、予め情報量の上限値を設定し、当該上限値を超えた場合には、トポロジ管理部３００は、自ノードから最も遠い関係にあるノードの情報（識別子等）を削除するような構成が望ましい。

【００５０】負荷状態監視部３０２は、図４に示すように、後述するストリームエンジン３１のストリームデータバッファ（ＦＩＦＯ式バッファ）の格納状態（ＳＢ）を監視し、これによりストリームエンジン３１の負荷状態を判断する。負荷状態監視部３０２は、ストリームエンジン３１の負荷状態が許容範囲を超える場合には、トポロジ管理部３００に対して下流ノードの切断を指示する。なお、後述するように、ストリームエンジン３１のストリームデータバッファの格納状態（ＳＢ）は、ＧＵＩ３３に対しても通知される。

【００５１】制御データ通信部３０３は、接続要求部３０５からの指示に応じて、上流ノード１０Ａとの制御データ通信チャネルを確立する。上流ノード１０Ａは、自ノード１０からはストリームデータの送信元ノードに相当する。制御データ通信部３０３は、トポロジ情報（ＴＩ）を上流ノード１０Ａから受信する。また、制御データ通信部３０３は、上流ノード１０Ａを別のノードに切替える場合に、制御データ通信チャネルの切断を行なう。

【００５２】制御データ通信部３０４は、接続要求受理部３０６からの指示に応じて、下流ノード１０Ｂとの制御データ通信チャネルを確立する。下流ノード１０Ｂは、自ノードから送信するストリームデータの送信先ノードに相当する。制御データ通信部３０４は、トポロジ情報（ＴＩ）を下流ノード１０Ｂへ送信する。また、制御データ通信部３０４は、下流ノード１０Ｂが上流ノードを自ノードから別ノードへ切替えるときに、制御データ通信チャネルの切断を行なう。

【００５３】接続要求部３０５は、ＧＵＩ３３からの上流ノードの指定（ＣＲ）に応じて、上流ノード１０Ａに対する接続要求を行なう。さらに、接続要求部３０５は、接続要求を送信した上流ノード１０Ａからの接続受理通知に応じて、制御データ通信部３０３に対して接続を指示する。このとき、トポロジ管理部３００に対して、制御データ通信チャネルが確立された上流ノード１０Ａのネットワークアドレスの登録を指示する。接続要求部３０５は、接続要求に伴なって、接続対象の上流ノード１０Ａとの間で接続認証処理に必要な接続鍵データ（ＣＫ）と公開鍵データ（ＰＫ）の交換を行なう。

【００５４】接続要求受理部３０６は、下流ノード１０Ｂからの接続要求に応じて、接続認証部３０７により認証された場合に接続受理を行なう。接続要求受理部３０６は、接続受理に応じて制御データ通信部３０４に対して接続を指示すると共に、トポロジ管理部３００に対して、制御データ通信チャネルが確立された下流ノード１０Ｂのネットワークアドレスの登録を指示する。接続要求受理部３０６は、接続受理に伴なって、接続対象の下流ノード１０Ｂとの間で接続認証処理に必要な接続鍵データ（ＣＫ）と公開鍵データ（ＰＫ）の交換を行なう。なお、接続認証処理手順については、後述する。

【００５５】接続認証部３０７は、接続要求部３０５及び接続受理部３０６による他のノード（上流ノードと下流ノード）との接続に必要な接続認証処理を実行する。接続認証部３０７は、公開鍵暗号方式を利用した認証処理を実行し、認証チケットに相当する接続鍵データ（ＣＫ）と公開鍵データ（ＰＫ）をＧＵＩ３３から受け取る。また、接続認証部３０７は、接続要求部３０５及び接続要求受理部３０６のそれぞれとの間で、接続鍵データ（ＣＫ）と公開鍵データ（ＰＫ）の交換を実行する。

【００５６】ここで、前述したように、あるノードが配信元（配信サーバの役割）となる場合、ＧＵＩ３３の公開鍵取得部３３６が接続鍵発行サーバ７１から公開鍵データ（ＰＫ）を取得し、これをトポロジエンジン３０の接続認証部３０７が受け取り記憶する。接続認証部３０７は、接続要求受理部３０６からの認証要求（接続鍵データＣＫを含む）に応じて、当該公開鍵データ（ＰＫ）を使用して接続鍵データ（ＣＫ）を復号して認証する。また、視聴参加するノードは、ＧＵＩ３３の接続鍵取得部３３４が接続鍵発行サーバ７１から接続鍵データ（ＣＫ）を取得し、これをトポロジエンジン３０の接続認証部３０７が受け取り記憶する。また、上流ノードへの接続要求の際には、トポロジエンジン３０の接続要求部３０５は、接続認証部３０７から接続鍵データ（ＣＫ）を受け取り、上流ノードへ接続要求を実行する。

【００５７】（ストリームエンジン）ストリームエンジン３１は、図５に示すように、ストリームデータ送信部３１１、ストリームデータ受信部３１２、ストリームデータバッファ３１３、ストリームデータバッファ状態監視部３１４、及びストリームデータ通信接続管理部３１５の各機能要素部を有する。

【００５８】ストリームデータ送信部３１１は、ストリームデータバッファ３１３に格納されたストリームデータを下流ノードに送信する（中継する）。このとき、ストリームデータ送信部３１１は、ストリームデータ通信接続管理部３１５から接続許可の指示がなされた下流ノードに対してストリームデータを送信する。

【００５９】ストリームデータバッファ３１３は、ストリームデータ受信部３１２で受信された上流ノードからのストリームデータ、または、ストリームスイッチ部３２から受け取ったストリームデータを一時的に保存するＦＩＦＯ式バッファである。ストリームデータバッファ状態監視部３１４は、ストリームデータバッファ３１３の格納状態（ＳＢ）を常に監視し、トポロジエンジン３０及びＧＵＩ３３に通知する。ここで、格納状態（ＳＢ）とは、バッファ３１３のサイズに対してストリームデータが格納されているデータ量を意味する。

【００６０】ストリームデータ受信部３１２は、ストリームデータ通信接続管理部３１５から指定された上流ノードとの間にストリームデータ通信チャネルを確立する。そして、当該上流ノードから送信されたストリームデータを受信して、ストリームデータバッファ３１３に書き込む。ストリームデータ通信接続管理部３１５は、ストリームデータ通信チャネルによる接続関係を確立すべき隣接ノードのリストをトポロジエンジン３０から受け付ける。

【００６１】（ストリームスイッチ部）ストリームデータスイッチ部３２は、図６に示すように、ＧＵＩ３３からの指定（ＳＷ）に応じて、ストリームデータの入出力を切替える。即ち、ストリームスイッチ部３２は、ストリームエンジン３１から受け取ったストリームデータを、ストリームデータ再生部３４またはノードのローカルファイル装置６０に転送する。また、ストリームスイッチ部３２は、ローカル装置であるデジタルビデオカメラ（ＤＶＣ）３５や、エンコーダデバイス３６からのストリームデータ又はローカルファイル装置６０に格納しているストリームデータを読出して、ストリームエンジン３１に転送する。

【００６２】（ＧＵＩ）ＧＵＩ３３は、図７に示すように、ストリームデータ中継制御部３３１、中継状態（品質）表示部３３２、トポロジ表示部３３３、接続鍵取得部３３４、上流ノード決定部３３５、及び公開鍵取得部３３６の各機能要素部を有する。ＧＵＩ３３は、表示装置７０の表示画面上のアイコンに対する操作に応じたコマンドを入力したり、当該表示画面上に各種の表示情報を表示する。

【００６３】ストリームデータ中継制御部３３１は、ユーザからのコマンド入力に応じて、ストリームデータ中継の停止又は再開の指示（ＳＣ）をストリームエンジン３１に対して行なう。中継状態（品質）表示部３３２は、ストリームエンジン３１からストリームデータバッファ３１３の格納状態（ＳＢ）を読取り、表示画面上に表示させる処理を実行する。

【００６４】トポロジ表示部３３３は、トポロジエンジン３０からのトポロジ情報（ＴＩ）を受け取り、隣接ノード又は近傍ノードの接続関係を表示画面上に表示させる処理を実行する。接続鍵取得部３３４は、ユーザから入力された接続鍵データ（ＣＫ）、または後述する接続鍵発行サーバ７１から発行された接続鍵データ（ＣＫ）をトポロジエンジン３０に渡す。上流ノードへの接続要求の際には、トポロジエンジン３０の接続要求部３０５は、接続認証部３０７から接続鍵データ（ＣＫ）を受け取り、上流ノードへ接続要求を実行する。

【００６５】ＧＵＩ３３の公開鍵取得部３３６は、あるノードが配信元（配信サーバの役割）となる場合、接続鍵発行サーバ７１から公開鍵データ（ＰＫ）を取得し、トポロジエンジン３０の接続認証部３０７に渡す。接続認証部３０７は、接続要求受理部３０６からの認証要求（接続鍵データＣＫを含む）に応じて、当該公開鍵データ（ＰＫ）を使用して接続鍵データ（ＣＫ）を復号して認証する。

【００６６】上流ノード決定部３３５は、ユーザから指定された上流ノード、または後述するノード仲介サーバ７２から仲介された上流ノードのネットワークアドレスをトポロジエンジン３０に渡す。

【００６７】（接続確立手順）以下図８を参照して、同実施形態のノード間の接続処理の手順を説明する。

【００６８】ノード間の接続処理は、図８（Ａ）に示す自ノードから見て下流ノードとの接続処理と、同図（Ｂ）に示す自ノードから見て上流ノードとの接続処理とに分けられる。要するに、自ノードは、相対的関係としての上流ノードまたは下流ノードとの接続処理を実行する。

【００６９】まず、上流ノードとの接続処理では、自ノードのトポロジエンジン３０は、上流ノードに対して接続要求メッセージを送信する（ステップＳ１）。具体的には、図４に示す接続要求部３０５が、接続鍵データとＩＤデータとを含む接続要求メッセージを送信する。ＩＤデータは、例えばストリームデータ配信を行なう特定のネットワークを構築する目的のグループＩＤ、またはストリームデータのコンテンツ毎に設定されたコンテンツＩＤ等を含む。また、ＩＤデータは、各ノードのハードウェアを識別するためのＩＤデータ（例えばネットワーク・インターフェースのＭＡＣアドレスや、マイクロプロセッサに埋め込まれたシリアル番号など）を含む。

【００７０】自ノードは、上流ノードから接続要求に対する回答（接続認証処理の結果）を受信するまで待機状態となる（ステップＳ２）。そして、上流ノードから接続許可のメッセージを受信すると、トポロジエンジン３０は、当該上流ノードとの制御通信チャネルを確立し、当該上流ノードをトポロジテーブル３０１に登録する（ステップＳ４）。また、トポロジエンジン３０は、上流ノードから受信した接続許可のメッセージに含まれる公開鍵データを記憶する。更に、トポロジエンジン３０は、接続した上流ノードをストリームエンジン３１に登録させる（ステップＳ５）。これにより、ストリームエンジン３１は、当該上流ノードとストリームデータ通信

チャネルを接続し、ストリームデータを受信可能な状態となる。

【００７１】一方、自ノードは、上流ノードから接続拒否のメッセージを受信すると、別の上流ノードとの接続を試みる処理に移行できる（ステップＳ３のＮＯ，Ｓ６）。ここで、別の上流ノードとは、自ノードが要望するストリームデータの配信を受けるために必要な上流ノードであり、ストリームデータ分散配信ネットワークを構成する同一グループに所属するノードである（後述する）。

【００７２】次に、下流ノードとの接続処理、即ち、自ノードが相対的に上流ノードの場合の接続処理を、図８（Ａ）に示すフローチャートを参照して説明する。

【００７３】自ノードは、下流ノードから接続鍵データを含む接続要求メッセージを受信すると、接続認証処理を実行する（ステップＳ１１，Ｓ１２）。トポロジエンジン３０の接続認証部３０７は、接続鍵を予め取得してある公開鍵データを用いて復号することにより接続認証処理を実行し、認証できない場合には接続拒否メッセージを下流ノードに返信する（ステップＳ１３のＮＯ，Ｓ１７）。

【００７４】一方、トポロジエンジン３０は、認証成功の場合には、既存の下流ノードへのストリームデータ中継の品質が規定値以上であるか否かを判定し、判定結果が規定値以下の場合には接続拒否メッセージを下流ノードに返信する（ステップＳ１１４のＮＯ，Ｓ１７）。即ち、新たな下流ノードを接続した結果、中継品質が規定値以下になる場合には、自ノードは、下流ノードを増やすことを防ぐため接続を拒否する。

【００７５】トポロジエンジン３０は、最終的に接続を許可する場合には、公開鍵データを含む接続許可メッセージを下流ノードに返信する（ステップＳ１４のＹＥＳ，Ｓ１５）。更に、トポロジエンジン３０は、接続を許可した下流ノードをトポロジテーブル３０１に登録すると共に、当該下流ノードをストリームエンジン３１に登録させる（ステップＳ１６）。これにより、ストリームエンジン３１は、当該下流ノードとストリームデータ通信チャネルを接続し、ストリームデータを送信可能な状態となる。

【００７６】以上のような接続処理により、上流ノード及び下流ノードの各ノード間の接続が確立されて、図１に示すように、ストリームデータ分散配信系のネットワークを構成することができる。

【００７７】（上流ノード取得手順）以下図９を参照して、自ノードがストリームデータ配信を受けるために、即ちストリームデータ分散配信系に参加するために、新規に上流ノードを取得するための手順を説明する。ここで、同図（Ａ），（Ｃ）に示すステップＳ２１からステップＳ２６は、各ノード側での処理手順を示す。また、同図（Ｂ）に示すステップＳ３１からステップＳ３７は、ノード仲介サーバ側での処理手順を示す。

【００７８】ここでは、ノード仲介サーバ（図７のサーバ７２）の存在を想定し、このノード仲介サーバから上流ノードの紹介を受ける構成を説明する。

【００７９】ノード仲介サーバは、グループＩＤに対応する、即ち一つのストリームデータ分散配信系に属する複数のノードをノードデータベース７２０に登録している。当然ながら、ノードデータベース７２０には、複数のグループＩＤ（ストリームデータ分散配信系）についてそれぞれに属すノードを登録することができる。

【００８０】まず、自ノードは、上流ノード紹介要求メッセージ（グループＩＤを含む）を、ノード仲介サーバに送信する（ステップＳ２１）。ノード仲介サーバは、当該メッセージを受信すると、ノードデータベース７２０から当該ストリームデータ分散配信系に属すノードを検索する（ステップＳ３１，Ｓ３２）。そして、ノード仲介サーバは、検索したノードのネットワークアドレスを含む応答メッセージを返信する（ステップＳ３３）。

【００８１】自ノードは、応答メッセージから紹介された上流ノードのネットワークアドレスを取得し、当該上流ノードとの接続処理に移行する（ステップＳ２２，Ｓ２３）。ステップＳ２３は、図８のステップＳ１から開始される処理ステップである。この接続処理では、前述したように、紹介された上流ノードは、接続認証処理を実行して、最終的に接続許可又は接続拒否の判定を実行する。自ノードは、上流ノードとの接続が完了しない場合には、再度、ノード仲介サーバに対して紹介要求メッセージを送信する（ステップＳ２４のＮＯ，Ｓ２１）。

【００８２】上流ノードとの接続が完了すると、ノード仲介サーバに接続完了メッセージを送信する（ステップＳ２４のＹＥＳ，Ｓ２５）。ノード仲介サーバは、当該メッセージを受信すると、ノードデータベース７２０に当該自ノードを登録する（ステップＳ３４，Ｓ３５）。一方で、ノード仲介サーバは、自ノードからストリームデータ分散配信系ネットワークからの離脱を示すノード離脱メッセージを受信すると、ノードデータベース７２０から当該自ノードの登録を削除する（ステップＳＳ２６，Ｓ３６，Ｓ３７）。

【００８３】以上のような処理により、ストリームデータ分散配信系のネットワークに参加を希望するユーザは、ストリームデータを中継してくれる上流ノードに接続することができる。なお、ノード仲介サーバを介在させることなく、別の方法で上流ノードのネットワークアドレスを取得できれば、当該上流ノードへの接続は可能である。

【００８４】（トポロジ変更手順）以下図１０を参照して、各ノード間を接続して構成されたストリームデータ分散配信系ネットワークの接続関係であるトポロジを変更する場合の手順を説明する。

【００８５】ここでは、図１０（Ａ）に示すように、相

対的に下流側のノード（１）、ノード（２）、及び上流側のノード（３）が接続された状態のトポロジを想定する。ノード（２）は、同図（Ｂ）に示すように、トポロジ変更処理として、ノード（１）に対する上流ノードの変更処理を実行する。即ち、ノード（２）は、代替上流ノード（３）の指定を含む上流ノード変更メッセージを、下流ノード（１）に送信する（ステップＳ４１）。

【００８６】下流ノード（１）は、同図（Ｃ）に示すように、上流ノード（２）から上流ノード変更メッセージを受信すると、指定された代替上流ノード（３）に対する接続処理を実行する（ステップＳ４５，Ｓ４６）。接続処理では、下流ノード（１）は、代替上流ノード（３）に対して接続要求メッセージを送信する。代替上流ノード（３）は、同図（Ｄ）に示すように、受信した接続要求メッセージに基づいて、下流ノード（１）との接続処理を実行する（ステップＳ５０）。そして、代替上流ノード（３）は、接続許可メッセージまたは接続拒否メッセージを下流ノード（１）に返信する。なお、ステップＳ４６，Ｓ５０は、図８のステップＳ１，Ｓ１１から開始される処理ステップに対応する。

【００８７】下流ノード（１）は、代替上流ノード（３）から接続許可メッセージを受信した場合に、上流変更完了の通知を上流ノード（２）に送信する（ステップＳ４７）。下流ノード（１）は、上流ノード（２）との通信チャネル（制御データ通信チャネルとストリームデータ通信チャネル）を切断し、トポロジテーブル３０１から上流ノード（２）の登録を削除する（ステップＳ４８，Ｓ４９）。

【００８８】一方、上流ノード（２）は、上流変更完了の通知を受信すると、下流ノード（１）との通信チャネル（制御データ通信チャネルとストリームデータ通信チャネル）を切断し、トポロジテーブル３０１から下流ノード（２）の登録を削除する（ステップＳ４２，Ｓ４３，Ｓ４４）。

【００８９】以上のような上流変更処理により、上流ノードと下流ノードとの接続関係が変更されて、結果として各ノード間の接続関係であるトポロジを変更できる。このトポロジ変更機能は、例えばノード（２）がネットワークから離脱したり、新たにノード（３）が参加するような場合に有効である。即ち、下流ノード（１）は、各ノードの状況に応じて動的かつ自律的に上流ノードを変更できるため、ストリームデータを停止することなく受信することができる。

【００９０】（接続切断手順）以下図１１を参照して、同実施形態のノード間の接続切断処理の手順を説明する。ここでは、下流ノードから上流ノードに対する接続を切断する場合の手順を説明する。逆の場合も、基本的には同様の手順となる。

【００９１】まず、下流ノードは、同図（Ａ）に示すように、接続されている上流ノードに対して切断メッセージを送信する（ステップＳ６１）。上流ノードは、同図（Ｂ）に示すように、切断メッセージを受信すると、下流ノードに対して切断受理の通知を送信する（ステップＳ６６，Ｓ６７）。

【００９２】下流ノードは、上流ノードから切断受理の通知を受信すると、当該上流ノードとの通信チャネル（制御データ通信チャネルとストリームデータ通信チャネル）を切断する（ステップＳ６２，Ｓ６３）。さらに、下流ノードは、トポロジテーブル３０１から当該上流ノードの登録を削除する（ステップＳ６４）。

【００９３】一方、上流ノードは、下流ノードとの通信チャネル（制御データ通信チャネルとストリームデータ通信チャネル）を切断する（ステップＳ６８）。さらに、上流ノードは、トポロジテーブル３０１から下流ノードの登録を削除する（ステップＳ６９）。

【００９４】以上のような接続切断処理により、各ノードは、任意のタイミングで接続関係にあるノードとの接続を切断できる。この接続切断処理により、各ノード間のトポロジが変更となる。

【００９５】（下流ノードの処理手順）図１２は、下流ノード側の処理手順を整理して説明するためのフローチャートである。

【００９６】まず、ユーザがストリームデータ分散配信系ネットワークに参加する場合には、ユーザ端末が下流ノードとして初期化処理を実行することになる（ステップＳ７０）。具体的には、前述したように、ノード仲介サーバから上流ノードの紹介を受ける（ステップＳ８０）。当該下流ノードは、紹介された上流ノードに対する接続要求を実行する（ステップＳ８１）。上流ノードから接続許可通知を受信した場合には、上流ノードとの接続が完了となる（ステップＳ８２のＹＥＳ）。これにより、下流ノードは、紹介された上流ノードからストリームデータを受信することができる。

【００９７】次に、接続されている上流ノードから上流変更メッセージを受信すると（ステップＳ７１）、下流ノードは、当該メッセージに含まれる代替上流ノードに対して、接続要求を行なう（ステップＳ８１）。この接続要求に対して、代替上流ノードから接続許可通知を受信した場合には、上流ノードとの接続が完了となる（ステップＳ８２のＹＥＳ）。ここで、下流ノードは、紹介された上流ノードまたは代替上流ノードから接続拒否通知を受信した場合あるいは何ら応答が得られない場合には、ノード仲介サーバから新たな上流ノードの紹介を受ける（ステップＳ８２のＮＯ（Ａ），Ｓ８０）。

【００９８】一方、下流ノードは、接続している上流ノードとの通信途絶（通信チャネルの切断も含む）を検出した場合には（ステップＳ７２）、トポロジテーブル３０１から別の上流ノードを選択する（ステップＳ８３）。下流ノードは、選択した上流ノードに対する接続要求を実行する（ステップＳ８１）。上流ノードから接

続許可通知を受信した場合には、上流ノードとの接続が完了となる（ステップＳ８２のＹＥＳ）。

【００９９】選択した上流ノードから接続拒否通知を受信した場合には、下流ノードは、トポロジテーブル３０１から全ての上流ノードの候補について、選択及び接続要求を実行する（ステップＳ８２のＮＯ（Ｂ），Ｓ８４のＮＯ）。全ての上流ノードの候補から接続拒否通知を受信した場合には、下流ノードは、改めて、ノード仲介サーバから新たな上流ノードの紹介を受ける（ステップＳ８４のＹＥＳ，Ｓ８０）。

【０１００】また、下流ノードは、接続している上流ノードからのストリームデータ中継の品質低下を検出した場合には（ステップＳ７３）、当該上流ノードとの接続を切断し、トポロジテーブル３０１から別の上流ノードを選択する処理に移行する（ステップＳ８５，Ｓ８３）。以後の処理については、前記の上流ノードとの通信途絶の場合と同様である。

【０１０１】（トポロジ情報の交換手順）図１３は、各ノード間でのトポロジ情報の交換手順を整理して説明するためのフローチャートである。

【０１０２】各ノードは、前述したように、トポロジエンジン３０において、トポロジ管理部３００、トポロジテーブル３０１、及び制御データ通信部３０３，３０４により、トポロジ情報テーブル（ＴＩ）を交換する。

【０１０３】ここでは、上流ノードから下流ノードに対して、トポロジ情報テーブル（ＴＩ）を送信する場合を想定する。上流ノードは、接続した下流ノードに対して、自ノードと隣接ノードまたは近傍ノードとの接続関係を示すトポロジ情報テーブルを送信する（ステップＳ９０）。下流ノードは、上流ノードからトポロジ情報テーブルを受信すると、トポロジテーブル３０１に併合（追加）処理して格納する（ステップＳ９１，Ｓ９２）。

【０１０４】以上のように同実施形態によれば、特にブロードバンドのインターネット等のネットワーク環境において、各ノードに設けられたトポロジエンジン３０の機能により、各ノード間を接続して、上流ノードと下流ノードとから構成されるストリームデータ分散配信系ネットワークを形成することができる。具体的には、図１に示すように、例えば最上流のノード１０（Ａ）から送信するストリームデータを、近傍の下流ノード１０（Ｂ）に配信する。当該下流ノード１０（Ｂ）は、受信したストリームデータを復号して再生すると同時に、上流ノードとして、更に下流ノードに対して当該ストリームデータを中継する。同様にして、各下流ノードは、受信したストリームデータを復号再生すると同時に、上流ノードとして、更に下流ノードに対して中継する。但し、一般的には、各ノードは、ＩＳＰ（インターネット接続サービスプロバイダ）や通信事業者などを介して、インターネットへの接続を行なうことになる。

【０１０５】従って、ストリームデータ配信用のサーバが存在しなくても、クライアント（ユーザ端末）のみから構成されるストリームデータ配信系のネットワークを実現できる。このような分散ネットワーク形成機能を利用することにより、ストリームデータ配信用のサーバからストリームデータ配信を行なうネットワークの場合でも、当該サーバの配信処理に要する負荷の軽減を図ることができる。即ち、例えば放送事業者が運営するサーバから、各ユーザ端末にストリームデータを配信すると共に、当該各ユーザ端末から他の各ユーザ端末に対して当該ストリームデータを配信することができる。これにより、放送事業者が運営するサーバの負荷を、ストリームデータ配信先のユーザ端末数に依存せずに低く抑えることができる。

【０１０６】また、いわゆる商業用ストリームデータ配信系のネットワークではなく、ユーザが個人的な撮影映像などを、インターネットに接続した関係者のみの各ノードに対して配信するためのプライベートネットワークを構築することができる。このようなプライベートネットワークを利用して、パーソナル放送とも言えるサービスが可能となる。

【０１０７】なお、同実施形態では、ノード仲介サーバの存在を想定した場合について言及している。このノード仲介サーバは、ストリームデータ配信用のサーバ、即ち分散配信系の中央制御サーバとは全く異なるものであり、単に上流サーバとしての候補を紹介するだけの限定された機能しか備えていないサーバである。従って、当該サーバは、ネットワークを構成する全ノードを正確に認識するようなデータベースを必要とせず、ネットワークに参加しているノードの中で未知のノードが存在していても差し支えない。また、ユーザが、ノード仲介サーバからの紹介とは別の方法で、上流ノードを知っている場合には、当然ながら、ノード仲介サーバは不要である。要するに、同実施形態では、ノード仲介サーバの存在は必須要件ではなく、実際上のサービス効率の観点からは望ましい存在である。

【０１０８】（同実施形態に適用可能なビジネスモデルまたは応用例）同実施形態のストリームデータ分散配信系ネットワークを適用することにより、以下のようなビジネスモデルまたは応用例を実現できる。

【０１０９】（１）例えば結婚式の披露宴などで、ユーザが個人的に撮影した映像を、ストリームデータとして各ユーザ（関係者のみ）に配信するパーソナル放送またはコミュニティ放送とも呼べるシステムを実現できる。この場合、ネットワークを構築する各ノードは、例えば公開鍵方式による接続認証機能により特定されるユーザ端末のみから構成される。

【０１１０】（２）前記（１）の拡張系として、ビデオカメラを用意した複数のユーザが集まり、各ユーザ間で同時に送受信することにより、ビデオ・チャット・サー

ビスを実現できる。

【０１１１】（３）ビデオカメラを備えたノードを、例えば街頭など屋外の特定の場所や、ビル、コンサートホール等に設置し、事件やイベントが発生した場合に、当該ビデオカメラにより撮影した映像（音声付）を、予め契約し、接続鍵の配布を受けた各ノードに対して中継するロケーション・サービスとも呼べるビジネスモデルを実現できる。この場合、各ノードは、サービス事業会社と契約することにより、当該会社が運営するネットワークに接続して、中継サービスを受けられる。具体的には、いわゆるインターネット・コンサートライブ放送を容易に実現できる。

【０１１２】（４）コンテンツの商用配信サービス系ネットワークにおいて、事業者が運営するサーバから各ユーザに対して、有料のコンテンツを配信する場合に、ユーザが中継ノードを提供することにより、サーバ側の配信負荷を軽減できる。この場合、中継ノードを提供したユーザに対して、当該コンテンツの視聴チケットに交換できるポイントを提供するようなインセンティブを与えることにより、同実施形態のシステムを有効に利用することができる。

【０１１３】（５）ノード間の制御データ通信チャネルを利用して、下流ノードから上流ノードへの情報通信を含め、各ノード間をピア・ツー・ピア（peer-to-peer）通信で結ぶことによって、ストリーム配信と同時に様々なコミュニケーション・サービスを実現することができる。例えば、下流から上流へと情報を集約することにより、配信コンテンツの人気投票サービス、クイズやアンケートに対するリアルタイム・サービスが可能となる。この場合も、同時アクセスを処理する大規模なサーバが不要になることがメリットである。また、下流ノード同士でチャットなどのコミュニケーションをストリーム配信と同時に実現できる。コンサート放送を見ながら、視聴者同士がチャットし合うようなサービスを提供できる。

【０１１４】

【発明の効果】以上詳述したように本発明によれば、インターネットなどのネットワーク環境において、特にユーザ端末間での自律的又は個人的なストリームデータ配信を実現できるストリームデータ分散配信技術を提供できる。具体的には、例えばブロードバンドのネットワーク環境を利用して、特別のストリームデータ配信用サーバを用意することなく、クライアント（端末ノード）間での動画・音声のストリームデータの分散配信を実現できる。

【図面の簡単な説明】

【図１】本発明の実施形態に関するストリームデータ分散配信システムの概念を示す図。

【図２】同実施形態に関するシステムの具体的構成の一例を示すブロック図。

【図３】同実施形態に関するノード（ユーザ端末）の構成を示すブロック図。

【図４】同ノードのトポロジエンジンの構成を示すブロック図。

【図５】同ノードのストリームエンジンの構成を示すブロック図。

【図６】同ノードのストリームデータスイッチ部の構成を示すブロック図。

【図７】同ノードのＧＵＩの構成を示すブロック図。

【図８】同実施形態に関するノード間の接続確立処理の手順を説明するためのフローチャート。

【図９】同実施形態に関する上流ノード取得手順を説明するためのフローチャート。

【図１０】同実施形態に関するトポロジ変更手順を説明するためのフローチャート。

【図１１】同実施形態に関するノード間の接続切断処理の手順を説明するためのフローチャート。

【図１２】同実施形態に関する下流ノード側の処理手順を説明するためのフローチャート。

【図１３】同実施形態に関する各ノード間でのトポロジ情報の交換手順を説明するためのフローチャート。

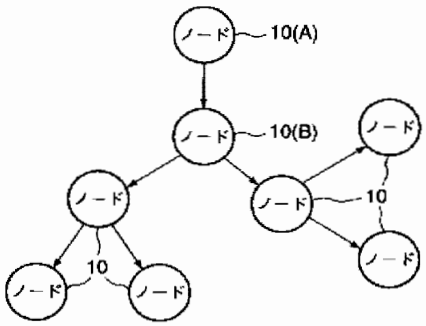
【図１４】同実施形態に関するトポロジ情報の内容を説明するための図。

【図１５】同トポロジ情報の一例を示す図。

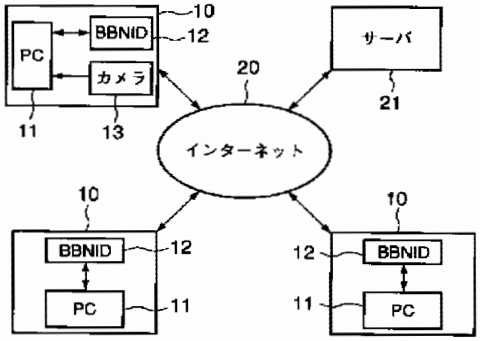
【符号の説明】

１０…ノード
１１…パーソナルコンピュータ（ＰＣ）
１２…ルータ
１３…ディジタルビデオカメラ（ＤＶＣ）
２０…インターネット
３０…トポロジエンジン
３１…ストリームエンジン
３２…ストリームスイッチ部
３３…ＧＵＩ
３４…ストリームデータ再生部
３００…トポロジ管理部
３０１…ノードテーブル
３０２…負荷状態監視部
３０３…制御データ通信部
３０４…制御データ通信部
３０５…接続要求部
３０６…接続要求受理部
３０７…接続認証部
３１１…ストリームデータ送信部
３１２…ストリームデータ受信部
３１３…ストリームデータバッファ
３１４…ストリームデータバッファ状態監視部
３１５…ストリームデータ通信接続管理部

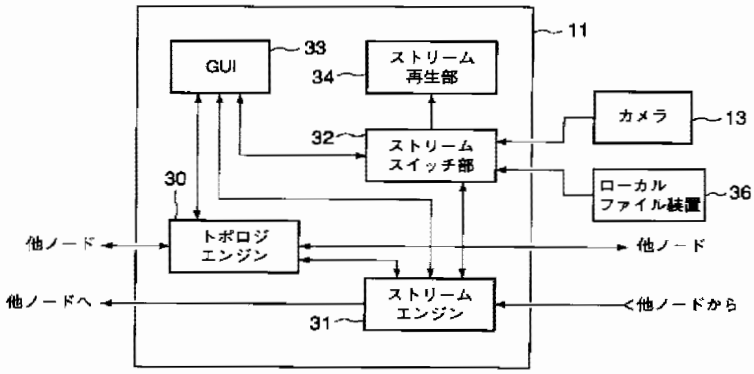
【図１】


ノード
10(A)
ノード
10(B)
ノード
ノード
10
ノード
ノード
10
ノード
ノード
10

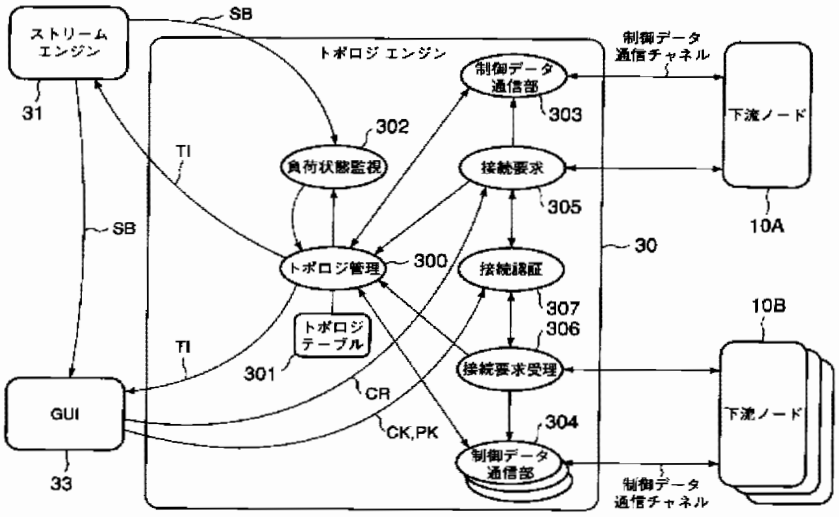
【図２】


10
BBNID
12
PC
カメラ
11
13
20
サーバ
21
インターネット
10
BBNID
12
PC
11
10
12
BBNID
11
PC

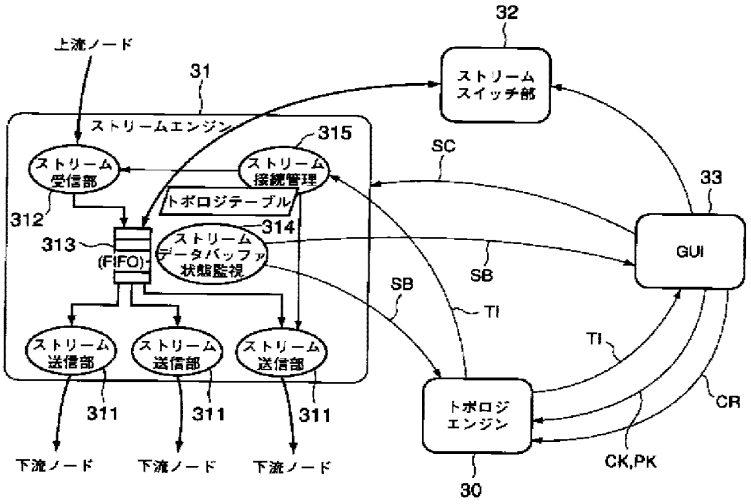
【図３】


11
GUI
33
ストリーム
再生部
34
カメラ
13
32
ストリーム
スイッチ部
ローカル
ファイル装置
36
30
トポロジ
エンジン
他ノード
他ノード
他ノードへ
ストリーム
エンジン
31
他ノードから

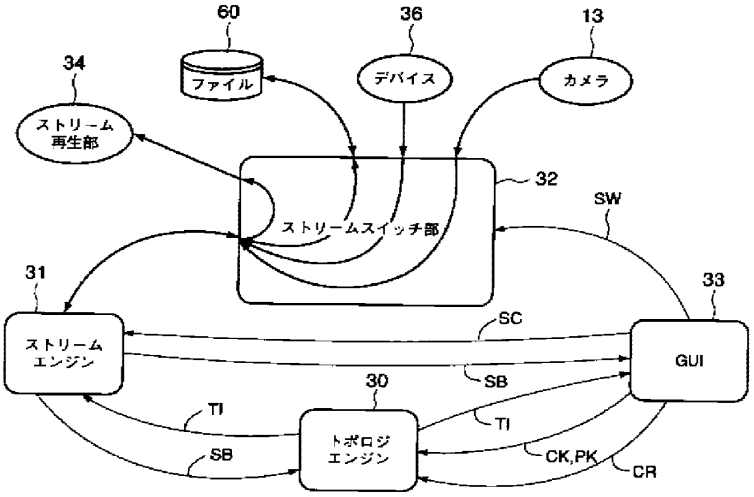
【図４】


ストリーム
エンジン
SB
31
トポロジ エンジン
制御データ
通信チャネル
制御データ
通信部
303
下流ノード
302
負荷状態監視
TI
接続要求
305
10A
SB
30
トポロジ管理
300
接続認証
307
10B
306
トポロジ
テーブル
TI
301
接続要求受理
CR
GUI
CK,PK
304
制御データ
通信部
下流ノード
33
制御データ
通信チャネル

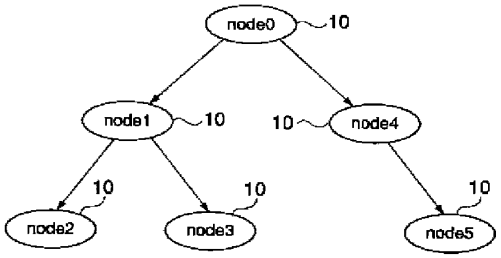
【図５】


上流ノード
31
32
ストリームスイッチ部
ストリームエンジン
315
ストリーム受信部
ストリーム接続管理
SC
33
トポロジテーブル
312
314
313
(FIFO)
ストリームデータバッファ状態監視
GUI
SB
SB
TI
TI
ストリーム送信部
ストリーム送信部
ストリーム送信部
CR
311
311
311
トポロジエンジン
CK,PK
下流ノード
下流ノード
下流ノード
30

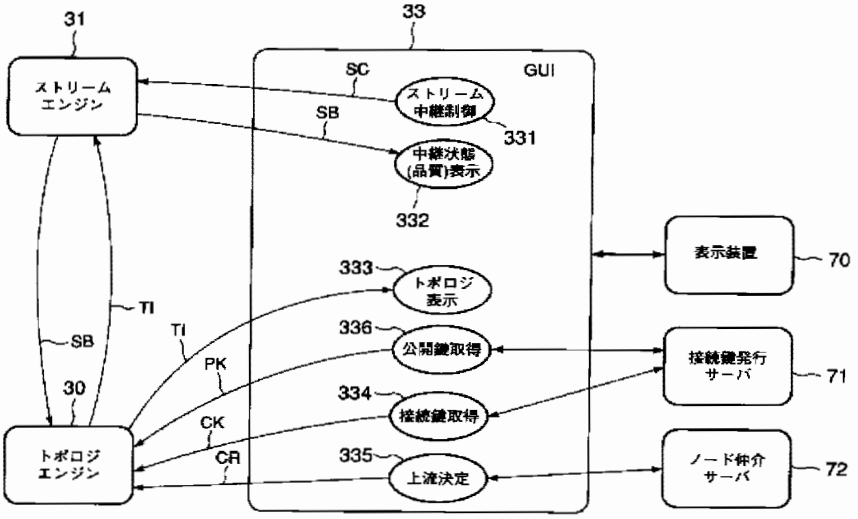
【図６】


60
36
13
34
ファイル
デバイス
カメラ
ストリーム再生部
32
SW
ストリームスイッチ部
31
33
SC
ストリームエンジン
GUI
SB
30
TI
TI
トポロジエンジン
CK,PK
SB
CR

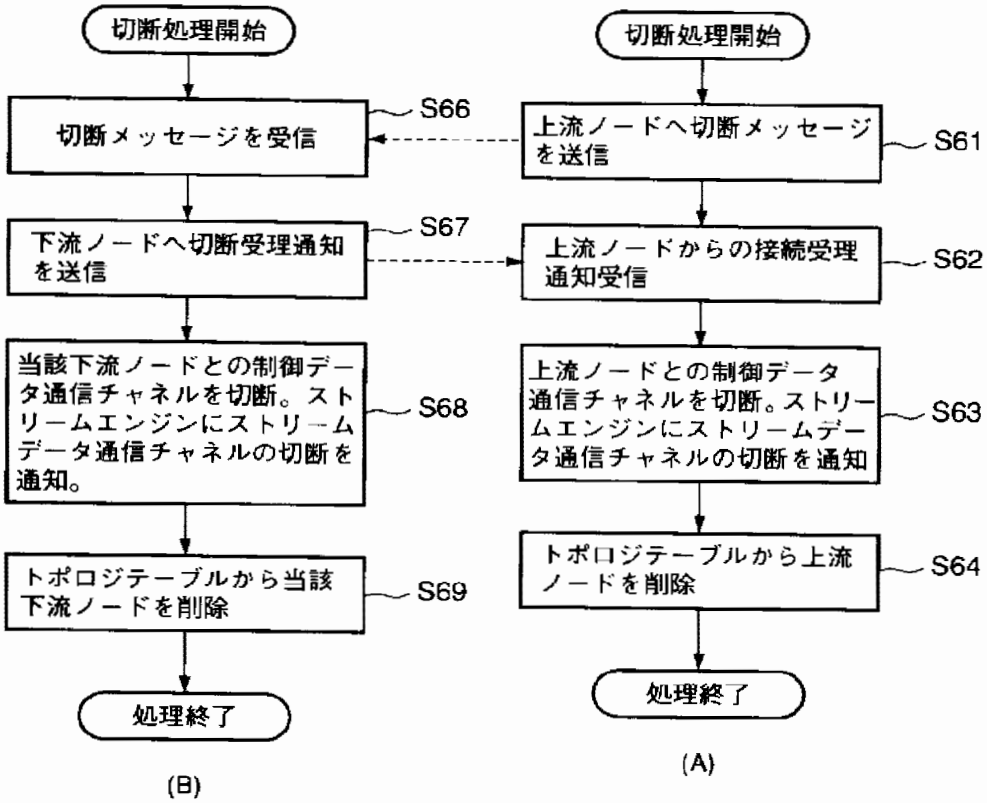
【図１４】


node0
10
node1
10
10
node4
10
10
10
node2
node3
node5

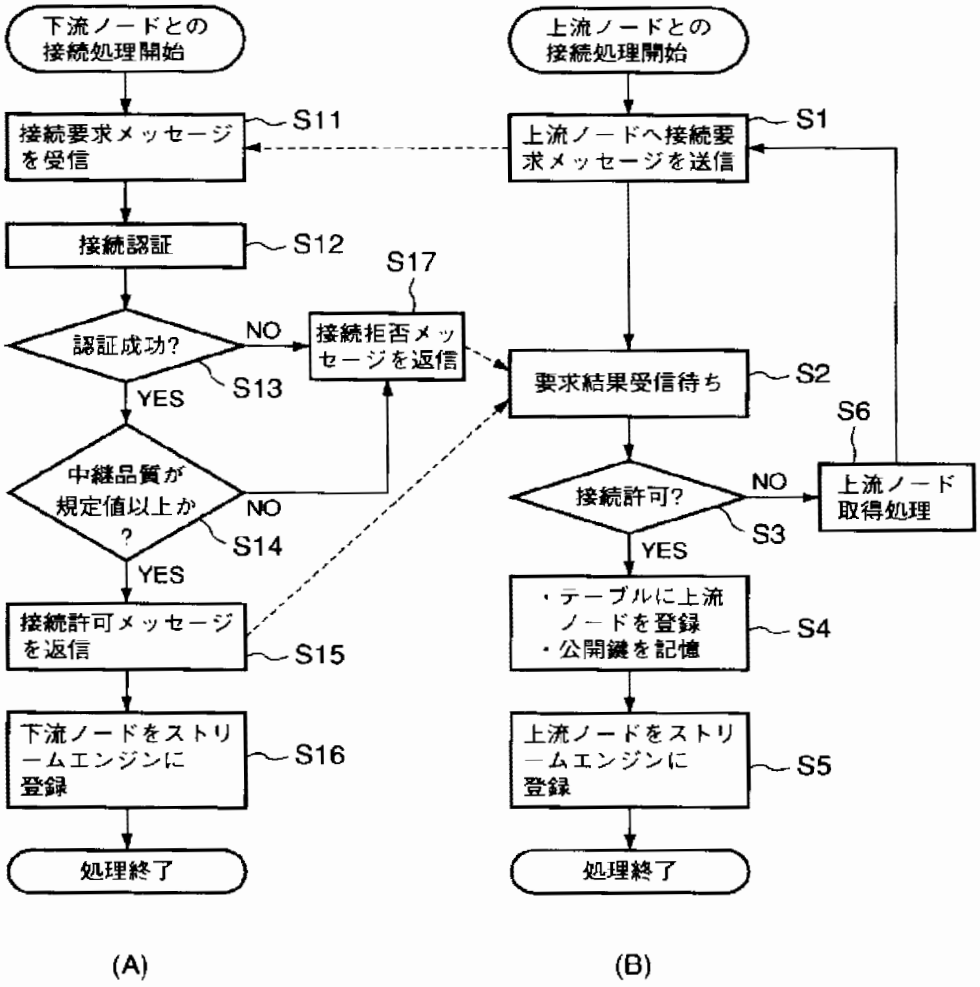
【図７】


31
33
ストリーム
エンジン
SC
GUI
ストリーム
中継制御
SB
331
中継状態
(品質)表示
332
表示装置
70
333
トポロジ
表示
TI
SB
TI
336
公開鍵取得
接続鍵発行
サーバ
71
PK
30
334
接続鍵取得
CK
トポロジ
エンジン
CR
335
上流決定
ノード仲介
サーバ
72

【図１１】


切断処理開始
切断メッセージを受信
S66
下流ノードへ切断受理通知
を送信
S67
当該下流ノードとの制御データ通信チャネルを切断。ストリームエンジンにストリームデータ通信チャネルの切断を通知。
S68
トポロジテーブルから当該下流ノードを削除
S69
処理終了
(B)
切断処理開始
上流ノードへ切断メッセージを送信
S61
上流ノードからの接続受理通知受信
S62
上流ノードとの制御データ通信チャネルを切断。ストリームエンジンにストリームデータ通信チャネルの切断を通知
S63
トポロジテーブルから上流ノードを削除
S64
処理終了
(A)

【図８】



【図１５】

TI-0

(A)

ノード識別子	直接接続している上流ノード識別子
node0	なし
node1	node0
node4	node0

TI-1

(B)

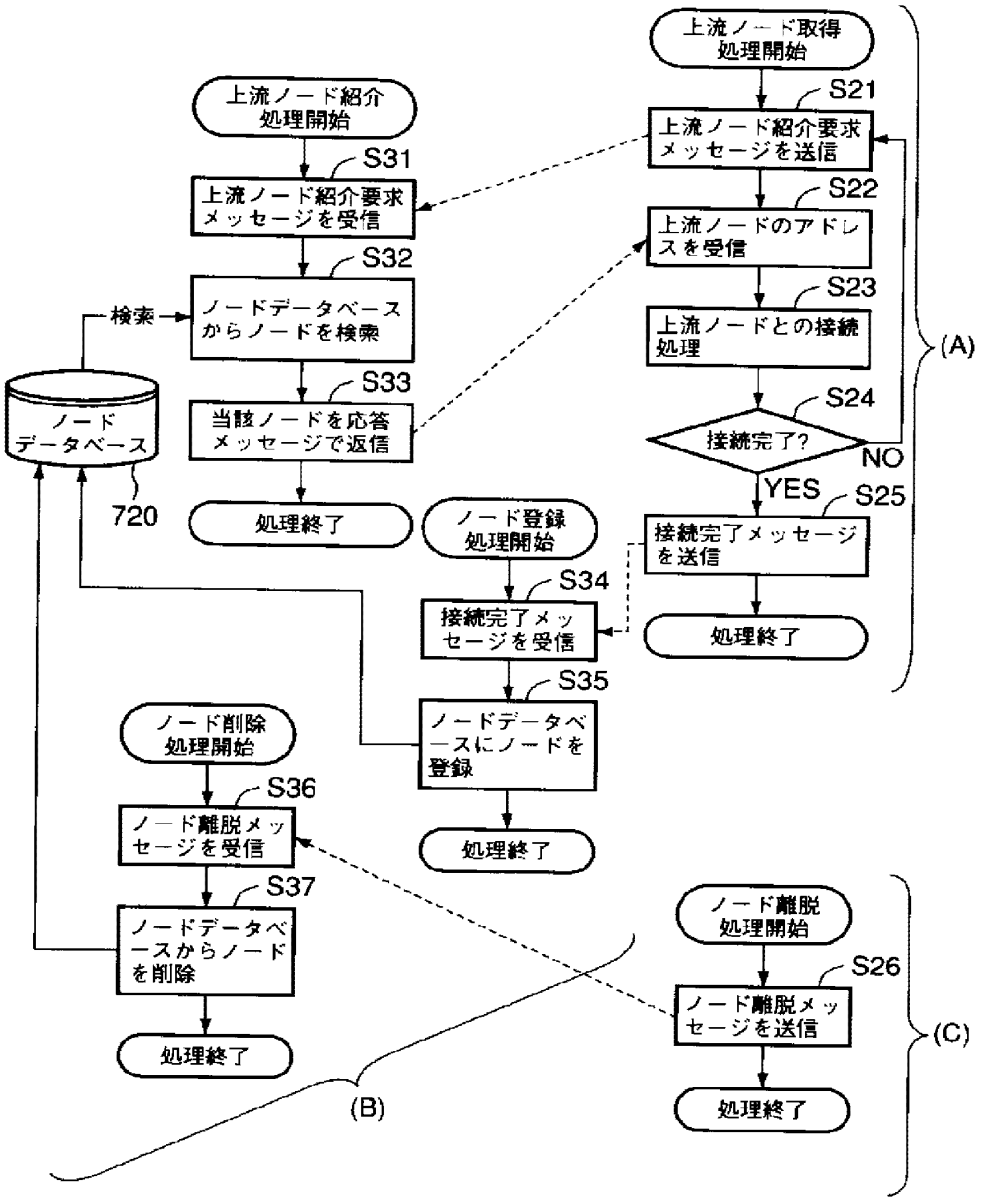
ノード識別子	直接接続している上流ノード識別子
node0	なし
node1	node0
node4	node0
node2	node1
node3	node1

TI-4

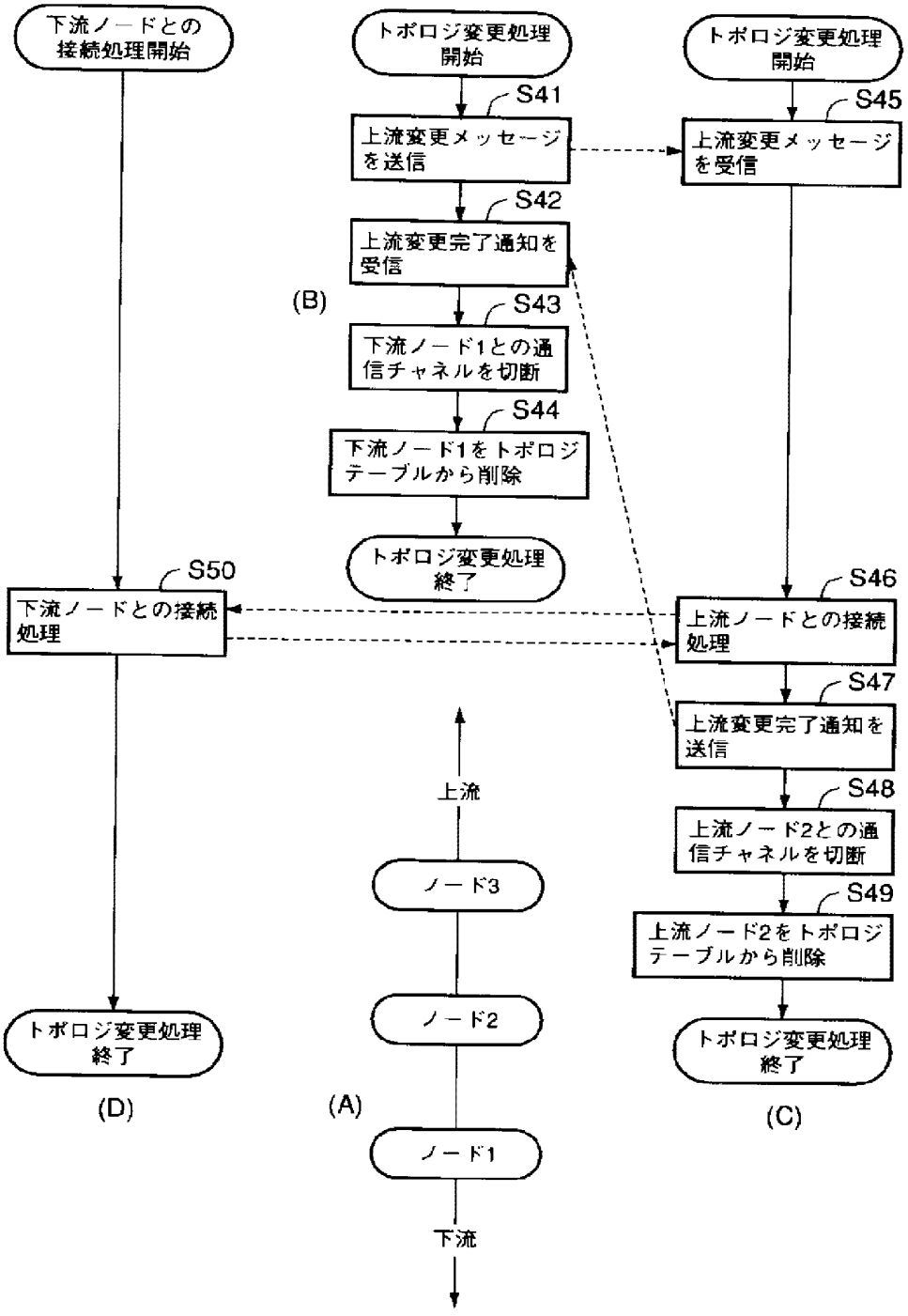
(C)

ノード識別子	直接接続している上流ノード識別子
node0	なし
node1	node0
node4	node0
node5	node4

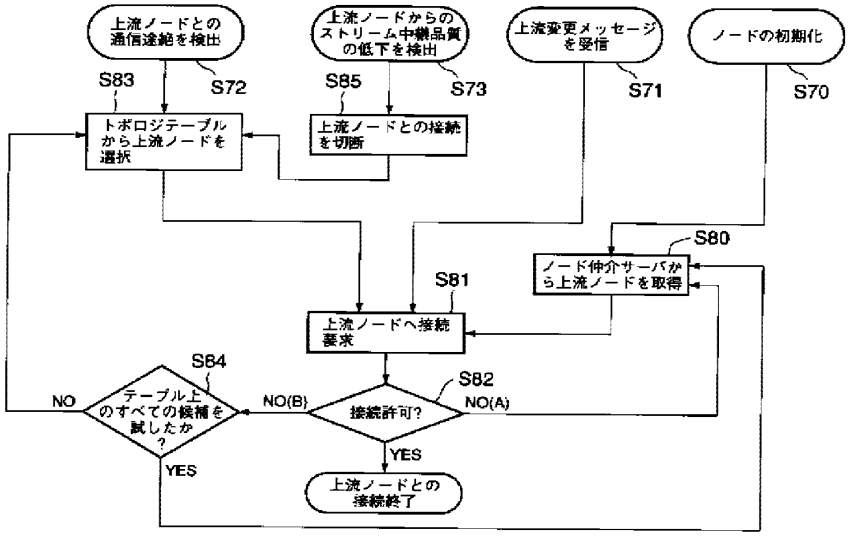
【図９】


上流ノード取得処理開始
S21
上流ノード紹介要求メッセージを送信
S22
上流ノードのアドレスを受信
S23
上流ノードとの接続処理
S24
接続完了?
NO
YES
S25
接続完了メッセージを送信
処理終了
(A)
上流ノード紹介処理開始
S31
上流ノード紹介要求メッセージを受信
S32
検索
ノードデータベースからノードを検索
S33
当該ノードを応答メッセージで返信
処理終了
ノード
データベース
720
ノード登録処理開始
S34
接続完了メッセージを受信
S35
ノードデータベースにノードを登録
処理終了
ノード削除処理開始
S36
ノード離脱メッセージを受信
S37
ノードデータベースからノードを削除
処理終了
(B)
ノード離脱処理開始
S26
ノード離脱メッセージを送信
処理終了
(C)

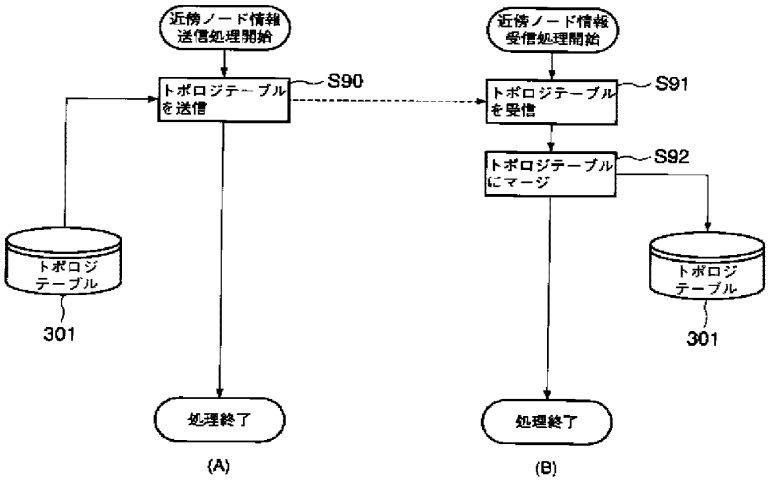
【図１０】


下流ノードとの接続処理開始
トポロジ変更処理開始
S41
上流変更メッセージを送信
S42
上流変更完了通知を受信
(B)
S43
下流ノード1との通信チャネルを切断
S44
下流ノード1をトポロジテーブルから削除
トポロジ変更処理終了
S50
下流ノードとの接続処理
トポロジ変更処理終了
(D)
上流
ノード3
ノード2
(A)
ノード1
下流
トポロジ変更処理開始
S45
上流変更メッセージを受信
S46
上流ノードとの接続処理
S47
上流変更完了通知を送信
S48
上流ノード2との通信チャネルを切断
S49
上流ノード2をトポロジテーブルから削除
トポロジ変更処理終了
(C)

【図１２】



【図１３】



フロントページの続き

Ｆターム(参考)　5K030 GA13 HA04 HD03 KA05 LC01
LC11

Espacenet

Bibliographic data: JP2003506765 (A) — 2003-02-18

VOD FROM A SERVER OR A USER TO ANOTHER USER

Inventor(s):

Applicant(s):

Classification: **- international:** ***G06F12/00; G06F13/00; H04N5/76; H04N5/765; H04N7/173;*** *H04N7/16;* (IPC1-7): G06F12/00; G06F13/00; H04N5/76; H04N5/765; H04N7/16; H04N7/173

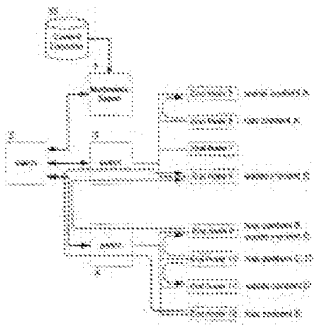
- cooperative: **H04N21/4331**; **H04N21/632**; **H04N21/816**; **H04N21/8456**; **H04N7/17336**

Application number: JP20010513892 20000802

Priority number(s): WO2000US21127 20000802 ; US19990475807 19991230 ; US19990146893P 19990802

Also published as: WO0110125 (A1) EP1205073 (A1) AU6619300 (A) CN1377556 (A)

Abstract not available for JP2003506765 (A)
Abstract of corresponding document: WO0110125 (A1)



A system and method for delivering data to multiple end users (5-12) using distributed storage system connected through a data communications network. The end user equipment for audio or video playback or recording contains a storage unit, such as a magnetic disk. Each storage unit can store data, such as digital video content, i.e. movies, or digital audio content, i.e. songs. The storage unit can also be configured to store portions, or fragments, of digital video or audio content, where the storage location, playback, and recording of digital video or audio content of each storage unit is administered, managed and controlled by a central facility (1). The content for playback of a video or audio content, or portions thereof, may reside on one or more physically separate storage unit, or may also reside on a central storage unit (13).

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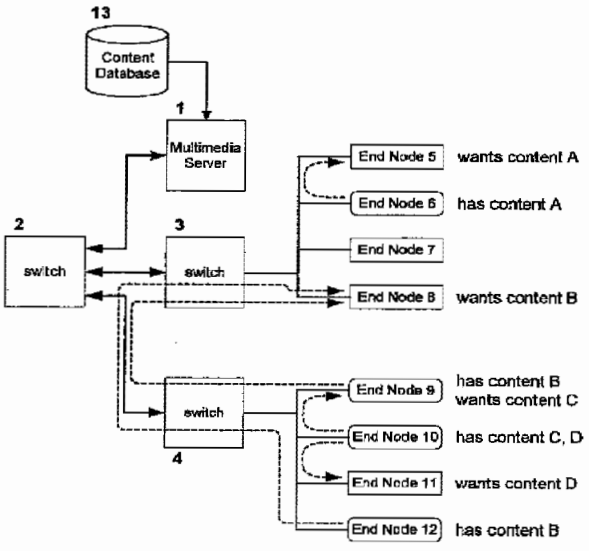
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(54)【発明の名称】　分散型記憶システムを使用してデータを配信するための方法および装置

(57)【要約】
データ通信ネットワークを介して接続された分散型記憶システムを使用して複数のエンド・ユーザにデータを配信するためのシステムおよび方法。オーディオ／ビデオの再生または記録用のエンド・ユーザ機器には、磁気ディスクなどの記憶ユニットが含まれる。各記憶ユニットは、デジタル・ビデオ・コンテンツすなわち映画や、デジタル・オーディオ・コンテンツすなわち音楽などの、データを格納することができる。記憶ユニットは、デジタルのビデオまたはオーディオ・コンテンツの一部、すなわちフラグメントを記憶するように構成することが可能であり、各記憶ユニットのデジタル・ビデオまたはオーディオ・コンテンツの記憶ロケーション、再生、および記録は、中央施設によって監督、管理、および制御される。ビデオまたはオーディオ・コンテンツまたはその一部の再生用コンテンツは、１つまたは複数の物理的に別々の記憶ユニット上に常駐することが可能であり、あるいは中央記憶ユニット上に常駐することも可能である。



【特許請求の範囲】

【請求項１】　データをオン・デマンドで通信ネットワーク内にある要求側のエンド・ユーザ・ユニット（「要求側ＥＵＵ」）に配信するための、データ・オン・デマンド・システムであって、

複数のエンド・ユーザ・ユニット（「ＥＵＵ」）を含み、前記ＥＵＵの少なくとも１つ（「第１のソースＥＵＵ」）が、前記通信ネットワークを介してデータ・ファイルを受け取り、前記データ・ファイルを記憶し、前記通信ネットワークを介して前記データ・ファイルを伝送するように適合されており、

さらに前記データ・オン・デマンド・システムが、前記複数のＥＵＵ間で、前記通信ネットワークを介したデータ・ファイルの伝送に対処するように適合されたサーバを含み、

前記サーバおよび前記第１のソースＥＵＵが、

前記サーバが前記通信ネットワークを介して前記データ・ファイルを前記第１のソースＥＵＵに伝送することを可能にし、

前記第１のソースＥＵＵ内に前記データ・ファイルを記憶し、さらに

前記要求側ＥＵＵから受け取った命令に応答して、前記サーバが、前記第１のソースＥＵＵに前記通信ネットワークを介して前記要求側ＥＵＵに前記データ・ファイルを伝送させることを可能にするように適合された、データ・オン・デマンド・システム。

【請求項２】　さらに前記サーバが、前記第１のソースＥＵＵの前記データ・ファイルのロケーションに関する情報を追跡するように適合された請求項１に記載のデータ・オン・デマンド・システム。

【請求項３】　前記データ・ファイル・システムが、

統合マルチメディア・プログラムと、

統合マルチメディア・プログラムの少なくとも１フラグメントと、

複数の統合マルチメディア・プログラムのフラグメントの組合せのうちの、少なくとも１つを含む請求項１に記載のデータ・オン・デマンド・システム。

【請求項４】　第２のソースＥＵＵをさらに含むシステムであって、

前記データ・ファイルが前記第１のソースＥＵＵによって記憶されたときに、

前記第２のソースＥＵＵが、前記データ・ファイルを受信して記憶するように適合され、

前記第１のソースＥＵＵからの伝送が１つまたは複数の所定の基準に合致した場合に、前記サーバおよび前記第２のソースＥＵＵが、前記第２のソースＥＵＵに、前記データ・ファイルの前記要求側ＥＵＵへの伝送を開始させるように適合された請求項１に記載のシステム。

【請求項５】　前記サーバが、少なくとも１つの所定の基準に基づいて、前記第１のソースＥＵＵに、記憶装置内にある前記データ・ファイルを少なくとも１つの他のデータ・ファイルと置き換えさせるように適合された請求項１に記載のシステム。

【請求項６】　データ通信ネットワークを介して接続された複数のエンド・ユーザ・ユニット（「ＥＵＵ」）に、オン・デマンドでデータ・ファイルの管理および配信を実行するサーバであって、前記サーバが、

中央処理ユニット（「ＣＰＵ」）と、

前記ＣＰＵに動作可能に接続されたメモリとを含み、前記メモリが前記ＣＰＵによって実行されるように適合されたプログラムを含み、

前記ＣＰＵおよび前記メモリが、前記複数のＥＵＵで前記データ・ファイルのロケーションを追跡しながら、少なくとも１つの所定の基準に基づいて記憶するために、複数のデータ・ファイルを前記複数のＥＵＵに分散するように動作可能に適合され、

前記ＣＰＵおよび前記メモリが、少なくとも１つのデータ・ファイルに関する第１のＥＵＵからの要求を受け取るように動作可能に適合され、

前記ＣＰＵおよび前記メモリが、第２のＥＵＵで前記少なくとも１つのデータ・ファイルを探し出し、前記要求に従って、前記少なくとも１つのデータ・ファイルを前記第１のＥＵＵに伝送するように前期第２のＥＵＵに指示するように動作可能に適合されたサーバ。

【請求項７】　前記ＣＰＵおよび前記メモリが、第１のデータ・ファイルと第２のデータ・ファイルの組合せに関する第３のＥＵＵからの要求を受け取るように動作可能に適合され、

前記ＣＰＵおよび前記メモリが、第４のＥＵＵに記憶された前記第１のデータ・ファイルおよび第５のＥＵＵに記憶された前記第２のデータ・ファイルを探し出すように動作可能に適合され、

前記ＣＰＵおよび前記メモリが、前記要求に従って前記第１および第２のデータ・ファイルを前記第３のＥＵＵに伝送するように前記第４および第５のＥＵＵに指示するように動作可能に適合された請求項６に記載のサーバ。

【請求項８】　前記第３のＥＵＵによって要求された前記第１と第２のデータ・ファイルの組合せが、統合データ・ファイルから２つのフラグメントを構成する請求項７に記載のサーバ。

【請求項９】　前記ＣＰＵおよび前記メモリが、複数のデータ・ファイルを探し出して管理し、要求に従って前期データ・ファイルの伝送を整列させるように動作可能に適合された請求項７に記載のサーバ。

【請求項１０】　前記ＣＰＵおよび前記メモリが、前記複数のＥＵＵ間での使用量情報を追跡するように動作可能に適合され、

前記ＣＰＵおよび前記メモリが、前記使用量情報に応答して記憶するために、前記複数のＥＵＵ間でデータ・ファイルを再分散するように動作可能に適合され、

前記ＣＰＵおよび前記メモリが、新しいデータ・ファイルが使用可能なときに、記憶するために前記新しいデータ・ファイルを前記複数のＥＵＵ間で分散するために追加するように動作可能に適合された請求項６に記載のサーバ。

【請求項１１】　データ・オン・デマンド・システム用のエンド・ユーザ・ユニットであって、

プロセッサと、

データ・ファイルを受け取るためにデータ通信ネットワークに接続されるように適合され、さらに前記データ通信ネットワークを介して前記データ・ファイルの少なくとも一部をサーバが指定した第２のエンド・ユーザ・ユニットに伝送するようにも適合されたモデムと、

データ通信ネットワークに接続されたサーバからの指示に応答して、前記データ・ファイルを記憶するように適合された記憶ユニットとを含む、エンド・ユー

ザ・ユニット。

【請求項１２】　少なくとも１つのデータ・ファイルを、通信ネットワークを介して中央記憶装置から複数のエンド・ユーザ・ユニット（「ＥＵＵ」）へオン・デマンドで配信する方法であって、

ａ）前記中央記憶装置で少なくとも１つのデータ・ファイルを記憶すること、

ｂ）前記データ・ファイルの少なくとも一部を前記第１のＥＵＵに伝送することによって、第１のＥＵＵを初期設定すること、

ｃ）前記第１のＥＵＵで前記データ・ファイルの一部を記憶すること、

ｄ）前記データ・ファイルの一部のロケーションに関する情報を追跡すること、

ｅ）第２のＥＵＵが前記データ・ファイルに関する要求を発行したときに、前記データ・ファイルの一部に関するロケーションを決定すること、

ｆ）前記第１のＥＵＵに記憶された前記データ・ファイルの一部に関して、前記第１のＥＵＵに指示を発行すること、および

ｇ）前記指示を受け取った時点で、前記第１のＥＵＵが前記データ・ファイルの一部を前記第２のＥＵＵに伝送することを含む方法。

【請求項１３】　前記方法が、

ａ）前記データ・ファイルの少なくとも一部を記憶するために第３のＥＵＵに伝送することによって、第３のＥＵＵを初期設定すること、

ｂ）前記第３のＥＵＵで前記データ・ファイルのロケーションに関する情報を追跡すること、

ｃ）前記第１のＥＵＵから前記第２のＥＵＵへの伝送を監視すること、

ｄ）前記第１のＥＵＵから前記第２のＥＵＵへの伝送が所定の基準を下回る場合、前記第２のＥＵＵへの前記データ・ファイルの一部の伝送に関して前記第３のＥＵＵに指示を発行し、前記第１のＥＵＵにその伝送を終了させる指示を発行すること、および

ｅ）前記指示を受け取った時点で、前記第３のＥＵＵが前記データ・ファイルの一部を前記第２のＥＵＵに伝送することをさらに含む請求項１２に記載の方法。

【請求項１４】　少なくとも１つのデータ・ファイルを、通信ネットワークを介して複数のエンド・ユーザ・ユニット（「ＥＵＵ」）のうち少なくとも１つへオン・デマンドで配信する方法であって、

ａ）前記通信ネットワークを介してアクセス可能な複数のデータ・ファイルを用意すること、

ｂ）前記複数のデータ・ファイルを記憶するために複数のＥＵＵに分散すること、

ｃ）前記複数のＥＵＵでの前記データ・ファイルのそれぞれの記憶ロケーションに関する情報を追跡すること、

ｄ）要求側ＥＵＵが前記複数のデータ・ファイルのうち少なくとも１つに関する要求を発行した場合、前記複数のデータ・ファイルのうちの前記少なくとも１つを記憶している少なくとも１つのＥＵＵを、少なくとも１つの所定の基準に基づいて、前記複数のＥＵＵから探し出すこと、および

ｅ）識別されたＥＵＵに、前記少なくとも１つのデータ・ファイルを前記要求側ＥＵＵに伝送させることを含む方法。

【請求項１５】　ステップｄ）の識別に関する前記所定の基準が、

前記複数のＥＵＵのそれぞれの間での、前記第２のＥＵＵへの伝送の品質と、

前記第２のＥＵＵを基準にした前記第１の複数のＥＵＵそれぞれの近さと、

第２の複数のＥＵＵを基準にした、前記複数のＥＵＵそれぞれのニーズとのうち、少なくとも１つの基準を含む請求項１４に記載の方法。

【請求項１６】　前記複数のデータ・ファイルが、マルチメディア・プログラムおよびデータを含む請求項１４に記載の方法。

【請求項１７】　マルチメディア・プログラムを、通信ネットワークを介してリモート記憶装置から複数のエンド・ユーザ・ユニット（「ＥＵＵ」）へオン・デマンドで配信する方法であって、

ａ）前記リモート記憶装置で少なくとも１つのマルチメディア・プログラムを記憶するステップと、

ｂ）前記マルチメディア・プログラムの少なくとも第１の部分を前記第１のＥＵＵに伝送することによって、第１のＥＵＵを初期設定するステップと、

ｃ）前記第１のＥＵＵで前記マルチメディア・プログラムの前記第１の部分を記憶するステップと、

ｄ）前記マルチメディア・プログラムの少なくとも第２の部分を前記第２のＥＵＵに伝送することによって、第２のＥＵＵを初期設定するステップと、

ｅ）前記第２のＥＵＵで前記マルチメディア・プログラムの前記第２の部分を記憶するステップと、

ｆ）前記の第１のＥＵＵおよび第２のＥＵＵで、前記マルチメディア・プログラムの前記第１および第２の部分の記憶ロケーションに関する情報を追跡するステップと、

ｇ）第３のＥＵＵが前記マルチメディア・プログラムに関する要求を発行したときに、前記マルチメディア・プログラムの前記第１および第２の部分を前記第３のＥＵＵに伝送するように対処するステップと、

ｈ）前記マルチメディア・プログラムの前記第１および第２の部分を受け取った時点で、ダウンロードするために前記第３のＥＵＵが前記マルチメディア・プログラムをアセンブルするステップとを含む方法。

【請求項１８】　前記マルチメディア・プログラムが、ビデオ・プログラム、オーディオ・プログラム、または映画プログラムのうち少なくとも１つを含む請求項１７に記載の方法。

【請求項１９】　前記マルチメディア・プログラムの各部分が、所定の暗号化キーによって暗号化される請求項１７に記載の方法。

【請求項２０】　複数のクライアントおよびサーバを備えたデータ通信ネットワークにおいて、複数のデータ・ファイルから少なくとも１つのデータ・ファイルをオン・デマンドで第１のクライアントに配信する方法であって、

ａ）前記複数のデータ・ファイルを所定の分散スキームに基づいて記憶するために、前記複数のクライアントおよびサーバのうち少なくとも１つに分散するステップと、

ｂ）前記データ・ファイルをそれぞれ、そのロケーションに関して追跡するステップと、

ｃ）前記複数のデータ・ファイルのうち１つに関する要求を前記第１のクライ

アントから受け取るステップと、

ｄ）前記クライアントおよび前記サーバのうち少なくとも１つから前記要求されたデータ・ファイルを探し出すステップと、

ｅ）前記クライアントおよび前記サーバのうち少なくとも１つに、前記要求されたデータ・ファイルを前記第１のクライアントに伝送するように指示するステップとを含む方法。

【請求項２１】　前記所定の分散スキームが、クライアントおよびサーバのロケーション、ならびに複数のデータ・ファイルのうち少なくとも１つに基づいている請求項２０に記載の方法。

【請求項２２】　通信ネットワークを使用してＶＯＤサービスを実行する方法であって、

ａ）前記通信ネットワーク内にある少なくとも１つのサーバを介してアクセス可能な複数の映画を用意するステップと、

ｂ）複数のセットトップ・ボックス（「ＳＴＢ」）を複数のクライアントに分散し、所定の要求に応じて前記映画をＳＴＢの少なくとも一部で記憶、表示、および伝送することができるステップと、

ｃ）前記ＳＴＢ全体および前記少なくとも１つのサーバで、複数の映画のフラグメントまたは全体を記憶し、前記映画のフラグメントのロケーションの追跡を続けるステップと、

ｄ）前記複数の映画からの映画に関してクライアントの１つから要求があった時点で、前記映画のフラグメントまたは全体を探し出すステップと、

ｅ）前記ＳＴＢおよび前記少なくとも１つのサーバの中から前記映画のフラグメントまたは全体を探し出した時点で、前記映画のフラグメントまたは全体を要求側クライアントに配信させるステップとを含む方法。

【発明の詳細な説明】

【０００１】

発明者：Ｒａｎｄａｌｌ　Ｍ．Ｃｈｕｎｇ

（関連出願の相互参照）

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【０００２】

（発明の分野）

本発明はデータ通信網に関し、より詳細には、分散型記憶ユニットを使用してインターネットなどのネットワークを介してデータを配信するための方法および装置に関する。

【０００３】

（背景技術）

ＶＣＲの出現以来、ムービー・オン・デマンド・システムによって、視聴者がビデオ店へ足を運ぶ必要性を軽減することが、社会全体の希望であった。「ビデオ・オン・デマンド」（「ＶＯＤ」）システムは、視聴者が任意の映画やビデオ・プログラムを選択し、次いでビデオのコンテンツを、即時、数時間後、または数日後のいずれかの要求時に視聴できるようにするものである。ビデオの配信は純粋には電子的であり、その結果、ビデオ・テープまたはビデオ・ディスクなどの物理的な媒体を購入するか、またはビデオ店で借りて視聴した後に返却する必要がない。

【０００４】

ケーブル会社は、自社のケーブル顧客に対して何らかの形でビデオ配信を実施してきた。ただし、記憶スペースおよび帯域幅の制限により、映画の選択はかなり制限され、視聴者はケーブル会社が指定した時間にしか映画を見ることはできなかった。古い「ゴッドファザー」の映画を水曜日の午後に見たいと思う人にとっては、不運である。したがってケーブル会社が提供するシステムは、真のＶＯ

Ｄシステムではなく、ましてや広範囲にわたる視聴者に好適な柔軟性を備えたシステムとは言えない。

【０００５】

数多くの視聴者に対して実際のビデオ・オン・デマンド・システムを実施することは、困難であり費用がかかる。典型的には、何百何千もの異なる最終消費者に対して、複数の同時連続ストリームのオーディオまたはビデオ・コンテンツを配信することができるマルチメディア・サーバが必要である。理想的には、顧客は何百もの映画や音楽のライブラリから自分のコンテンツを選択することができることである。ただし、典型的なハード・ディスク・ドライブは、省略なしの映画を２，３本しか保持できない可能性があり、すなわちマルチメディア・サーバは、５０またはそれ以上のディスク・ドライブを含まなければいけないことになる。図１Ａは、「ビデオ・オン・デマンド」を提供するためのこうした従来のケーブル・ブロードキャスト・システムを示す図である。

【０００６】

大規模な共用マルチメディア・サーバを用いることにおける他の難点は、デジタル・マルチメディア・コンテンツの多重ストリームを処理および伝送する必要があることである。標準解像度の圧縮テレビジョン信号は、平均毎秒約４メガビットのデータ速度で伝送される。１台のマルチメディア・サーバが、１００の異なるプログラムを同時に処理しなければならない場合、必要な総帯域幅の平均は毎秒４００メガビットとなる。さらにこの大量のデータは、不連続性が容易に感知されることなく１００人の視聴者に伝送されなければ、視聴者の体験を台無しにしてしまうことになる。したがって、サービス品質（ＱｏＳ）を保証しながらこうしたデータを中央サーバから多くのユーザへ高速で伝送することをサポートするためのネットワークは非常に高価であり、誰もが構築できるものではなかった。

【０００７】

ケーブル・モデムを使用するインターネットを介した通信の出現により、ケーブル・モデムがケーブル会社によるビデオ・オン・デマンドの提供を可能にするであろうと提案されてきた。インターネットに結合されたケーブル・モデムは、

ケーブル会社ができなかったこと、すなわちインターネットを使用したビデオ・オン・デマンド・システムを達成できると期待されてきた。

【０００８】

図１Ｂは、ケーブル・モデムを備えたケーブルＴＶブロードキャスト・システムを介して、ビデオ・オン・デマンドがどのようにして都市部で提供されるかを示す図である。このシステムでは、アナログＴＶ信号が衛星放送用パラボラ・アンテナ１によって受信される。アナログＴＶ信号は、信号結合器１０を介して、インターネットからのビデオ・オン・デマンド信号およびデジタル通信信号と結合される。

【０００９】

図１Ｂでは、ビデオ・オン・デマンド信号はデジタルであるが、アナログ信号も可能である。インターネット公衆ネットワーク２上にあるＷｏｒｌｄ　Ｗｉｄｅ　Ｗｅｂページなどのデジタル・コンテンツは、ルータ３を介してシステムに接続される。ルータ３は、インターネット・ネットワークとたとえばイーサネット（登録商標）・ネットワーク・スイッチ４との間などのように、ネットワーク間からのパケット・データを変換する際に使用される。イーサネット・ネットワーク・スイッチ４は、インターネット・ルータ３、ファイバ戻りチャネル復調器５、ファイル・サーバ６、マルチメディア・サーバ８、および変調器９との間でデータを送受信する。ファイバ戻りチャネル復調器５は、顧客構内設置機器（「ＣＰＥ」）から光ファイバ１１を介して戻ってきた信号をデジタル形式に変換するものであり、この信号はインターネットに送られるであろう。ファイル・サーバは、Ｗｏｒｌｄ　Ｗｉｄｅ　Ｗｅｂページを保持するため、またはインターネット情報のキャッシュに使用することができる。マルチメディア・サーバは、コンテンツ・データベース７を制御し、複数の映画や音楽を同時に読み取ることができる。コンテンツ・データベースは、デジタル化されたすべての映画や音楽を保持する。マルチメディア・サーバまたはイーサネット・スイッチからエンド・ユーザに送られるデジタル・データは、衛星放送用パラボラ・アンテナ１からのアナログＴＶ信号と結合される前に、デジタル／アナログ変調器９を通すことができる。

【００１０】

さらに図１Ｂを参照すると、光ファイバ１１と同軸ケーブル１３との間を通る信号は、同軸／光変換器１２によって変換することができる。アナログＴＶ信号は、ＴＶ受像機１７に伝送するためにセットトップ・ボックス１６を介して周波数変換され、デジタル信号は、ＰＣ１５で使用するためにケーブル・モデム１４によってデジタルに変換される。単一住居にある顧客構内設置機器１８（ＣＰＥ）は１セットの機器を、他の住居では他のＣＰＥ１９セットを収容し、それぞれの顧客が異なるビデオ、オーディオ、またはデータ・コンテンツを視聴することが可能である。

【００１１】

何百人、何千人の顧客が１セットのプロバイダ機器によって処理されるのは、珍しいことではない。これは、潜在的にマルチメディア・サーバが、それぞれの顧客への様々な映画や音楽のデータ・ストリームを同時に処理しなければならないことを意味する。何千人もの顧客がありマルチメディア・サーバが１台しかなければ、これは実質上不可能である。解決策の１つは、複数のマルチメディア・サーバを使用し、それぞれが顧客のサブセットを処理することができるようにすることであるが、これではすべての顧客を処理すると経費が倍増してしまう。その他の問題は、非常に大量のマルチメディア・データを、集中型マルチメディア・サーバやサーバ・グループから送信しなければならないということである。それぞれの顧客は、マルチメディア・サーバからの異なるビデオを時間的に異なる地点で（たとえば、ビデオの最初、中程、終わりを）視聴することがあるので、それぞれのビデオは別々のチャネルとして扱われる。通常のブロードキャスト・チャネルに加えて何百何千にも上る別々のチャネルの帯域幅は、現在の伝送経路が処理できる域を超えるものである。

【００１２】

したがって、複数の受信者がいつでも好きな時間に同じまたは異なるコンテンツを受信できるようなオン・デマンドのデータ配信システムが望ましい。

【００１３】

また、こうしたオン・デマンドのデータ配信システムが、サーバの帯域幅また

は伝送インフラストラクチャを使い尽くすことのないことが望ましい。

【００１４】

（発明の概要）

データ通信ネットワークを介して接続された分散型記憶システムを使用して複数のエンド・ユーザにデータを配信するためのシステムおよび方法が開示され、オーディオ／ビデオの再生または記録用のエンド・ユーザ機器には、磁気ディスクなどの記憶ユニットが含まれる。各記憶ユニットは、デジタル・ビデオ・コンテンツすなわち映画や、デジタル・オーディオ・コンテンツすなわち音楽などの、データを格納することができる。記憶ユニットは、デジタルのビデオまたはオーディオ・コンテンツの一部、すなわちフラグメントを記憶するように構成することが可能であり、各記憶ユニットのデジタル・ビデオまたはオーディオ・コンテンツの記憶ロケーション、再生、および記録は、中央施設によって監督、管理、および制御される。ビデオまたはオーディオ・コンテンツまたはその一部の再生用コンテンツは、１つまたは複数の物理的に別々の記憶ユニット上に常駐することが可能であり、あるいは中央記憶ユニット上に常駐することも可能である。

【００１５】

コンテンツは、再生のために、１つまたは複数の物理的に分散された記憶ユニットから読み出し、１つまたは複数の他の物理的に別々のサイトに送信することも可能であり、映画などのコンテンツの作品全体が、等しいかまたは異なるサイズの部片に分割され、１つまたは複数の部片を複数の物理的に別々の記憶ユニット上に記憶することができる。部片の記憶場所、伝送の順序、伝送の優先順位、および部片の宛先の割当ては、中央で監視および制御される。コンテンツは、同じコンテンツを近い将来他の顧客に配信する必要性を予測して、表示の必要のない記憶ユニットにも同時に伝送することが可能である。これによって、新しいリリースなど一定のプログラムの大量のダウンロードが予測される場合に、ピーク時またはオフピーク時など、いつでもリソースの動的な割振りが可能になる。

【００１６】

さらに、記憶ユニット間を接続するデータ通信ネットワークは、有線または無線のいずれも可能である。ケーブル・モデムでインターネットが使用され、さら

に他の形式のネットワーク接続がまったく同様に動作することができる。

【００１７】

当分野の技術者であれば理解されるように、以下の記述で開示される内容は、ローカルまたはリモートのいずれかでディスク・ドライブまたはファイル・サーバに結合された「セットトップ・ボックス」であり、この「セットトップ・ボックス」が他の「セットトップ・ボックス」のファイル・サーバとして動作する。したがって、集合体におけるセットトップ・ボックスは、それぞれのメンバ・セットトップ・ボックスに対して大規模であるがなお分散型の記憶設備として働くことができる。記憶されたプログラムまたはファイルは、複数のセットトップ・ボックスを介して分散して記憶または伝送するために、任意のサイズの部片にフラグメント化することもできる。さらに、他のコンピュータまたはセットトップ・ボックスのファイル・サーバとしても動作可能なディスク・ドライブを収容したパーソナル・コンピュータについても開示する。そのファイルは、複数のコンピュータまたはセットトップ・ボックスを介して分散型の記憶または伝送を行うために、任意のサイズの部片にフラグメント化することができる。

【００１８】

（好ましい実施形態の詳細な説明）

分散型記憶システムを使用してデータを配信するための方法および装置について開示する。以下の説明において、本発明は、サーバ、スイッチ、ルータ、データベース、エンド・ノード、ネットワーク、およびインターネットを用いて記載されており、これらは当分野の技術者が互いの情報交換で典型的に使用する用語である。また、当分野の技術者であれば、「データ」という用語が、オーディオまたはビデオのコンテンツ、マルチメディア・コンテンツ、あるいは単に通信ネットワークを通して伝送されるバイナリ・ビットを表すことができるものであることを理解されよう。

【００１９】

前述のように、マルチメディア・サーバの帯域幅要件を減らすことができる方法の１つは、コンテンツの第１の伝送をキャッシュするために、主ネットワーク伝送経路に沿った記憶ユニットを有することである。他のエンド・ユーザが将来

同じコンテンツを要求した場合に、キャッシュしている記憶ユニットから処理することができる。

【００２０】

図２Ａは、単一のマルチメディア・サーバが、１００人のユーザに対して同時にＡＶコンテンツを処理することを要求された場合の方法の一例を示す図である。一部のコンテンツの人気が高いために、多くの顧客が同じＡＶコンテンツを視聴する場合がある。たとえば、新作映画は数年前の映画よりも人気が高い可能性がある。ただし、ケーブル会社が番組を提供する場合などのように決められたスケジュールに従うのではなく、それぞれの顧客が自分の選択した時間に映画の視聴を開始できるようにすることが好ましい。すなわち、同じ映画が複数の顧客によって視聴されるが、映画は時間的に異なる地点で視聴される可能性があるため、データを重複して送信しなければならない。

【００２１】

図２Ｂは、配信請求を容易にするために、マルチメディア・サーバと顧客との間にキャッシュ・メモリを挿入する方法を示す図である。各キャッシュ・メモリは、全ての顧客のより小さなグループを処理する。ＡＶコンテンツが以前にグループのキャッシュ・メモリ内に記憶されていない場合、中央マルチメディア・サーバによって提供されることになる。ＡＶコンテンツは顧客に伝送され、グループ・キャッシュ・メモリにも一時的に記憶される。グループ内の他の顧客が同じＡＶコンテンツを要求した場合、ＡＶコンテンツは依然としてキャッシュ・メモリ内に常駐しているため、キャッシュ・メモリはこのコンテンツを容易に提供することができる。これによって、中央マルチメディア・サーバの負荷が減少し、サーバが使用する帯域幅が減少する。ただし、この方法には明らかな問題がある。キャッシュ・メモリが小さすぎると、ＡＶコンテンツのほんの一部だけしか記憶することができず、コンテンツへの要求の多くはキャッシュを迂回してしまう。これによって、帯域幅および中央マルチメディア・サーバへの負荷を減少させたことによる効果が低下する。しかし、キャッシュ・メモリを大きくすると経費が増加してしまう。

【００２２】

以下で開示するように、本発明は、エンド・ノード側の記憶ユニット・システムをマルチメディア・コンテンツの主記憶装置として動作させることによって、デジタル・マルチメディアなどのデータを分散する従来の方法に付随した問題を解決する方法を提供することを対象としている。マルチメディア・コンテンツの配信を増加させるために以前からの集中型マルチメディア・サーバを使用することもできるが、エンド・ノードからのマルチメディア・データに対する要求の大部分は、他方のエンド・ノード側にある個々の記憶ユニットで処理されることになる。

【００２３】

こうした分散型サーバ・システムを、時間が重要なマルチメディア・コンテンツを分散するのに使用すれば、現在の集中型サーバ・システム固有の問題を解決することができる。以下で説明するように、図３Ａおよび３Ｂは、集中型サーバを使用した従来のシステムを示す図であり、図４Ａ、４Ｂ、および４Ｃは、本発明に従った分散型サーバ・システムを示す図である。

【００２４】

図３Ａは、ユーザ・サイト側にインストールすることができる、従来のエンド・ノード機器を簡略的に示す構成図である。これは通常、ＴＶに結合されたセットトップ・ボックス（「ＳＴＢ」）である。ＳＴＢは、通常、ケーブル・モデムならびにデジタルのビデオおよびオーディオ圧縮解除回路を有する。図３Ｂに示されるように、マルチメディア・サーバ１は、すべてのマルチメディア・コンテンツを記憶するコンテンツ・データベース１３を制御する。ネットワーク・スイッチ２は、サーバ、ネットワーク・スイッチ３、およびネットワーク・スイッチ４の間でのデータ伝送を制御する。ネットワーク・スイッチ３は、ネットワーク・スイッチ２からのデータをユーザ・エンド・ノード５～８を介するように切り替え、ネットワーク・スイッチ４は、ネットワーク・スイッチ２からのデータをユーザ・エンド・ノード９～１２を介するように切り替える。この例では、エンド・ノード５、８、９、および１１が集中型サーバ１からのマルチメディア・データを受信している。サーバ１とスイッチ２は、高額な高帯域幅接続を必要とする可能性のある長距離電話によって隔てられている場合がある。エンド・ノード

５および８向けのコンテンツ・データ・ストリームＡおよびＢは、スイッチ２からスイッチ３に向けて送られ、エンド・ノード９および１１向けのコンテンツ・データ・ストリームＣおよびＤは、スイッチ２からスイッチ４に向けて送られる。次いでスイッチ３は、受け取ったデータをエンド・ノード５および８に向けて送り、スイッチ・ユニット４は、受け取ったデータをエンド・ノード９および１１に向けて送る。このシステムでは、Ａ～Ｄまでの４つのデータ・ストリームがすべて、コンテンツ・データベース１３から発せられ、サーバ１を介し、スイッチ２を介した後、スイッチ３および４を介したものでなければならない。マルチメディア・データの時間を重要とする性質により、コンテンツ・データベース１３とエンド・ユーザとの間の構成要素とネットワークとのすべての相互接続は、待ち時間が短く、かなりの高速でなければならない。図３Ａおよび３Ｂに示されたシステムは、特に多数のエンド・ノードが同時にデータを要求した場合には、明らかに限界があろう。

【００２５】

図４Ａは、ＴＶでデジタル・ビデオを視聴するための、消費者向けエンド・ノード機器を示す図である。そのＳＴＢには、ケーブル・モデム、ディスク記憶装置などの記憶ユニット、ならびにデジタルのビデオおよびオーディオ圧縮解除回路が含まれる。もちろん、ケーブルからのプログラムを表示するためのＴＶもある。図４Ｂは、たとえばディスク記憶装置などの記憶ユニットを備えたＰＣにデータを送るための、ケーブル・モデムまたはＤＳＬモデムのいずれかを使用して、デジタル・ビデオを視聴するためのＰＣ向け機器を示す図である。

【００２６】

図４Ｂに示されるようなＰＣベースのエンド・ノード機器では、そのオペレーションは、Ｒｅａｌ　Ｔｉｍｅ　Ｐｒｏｔｏｃｏｌ（ＲＴＰ）およびＲｅａｌ　Ｔｉｍｅ　Ｓｔｒｅａｍｉｎｇ　Ｐｒｏｔｏｃｏｌ（ＲＴＳＰ）と呼ばれるいくつかのインターネット・プロトコルをサポート可能な、ＳｕｎのＪａｖａ（登録商標）　Ｍｅｄｉａ　Ｆｒａｍｅｗｏｒｋ（ＪＭＦ）で作成されたソフトウェアによって制御することができる。当分野ではこれらのソフトウェア・プログラムは通常「既製品」であり、当分野の技術者はその機能についてもよく理解してい

る。Ｊａｖａプログラムは、データの伝送を容易にするためにＪＭＦライブラリを使用して書かれており、これはエンド・ノードを送信することをサポートし、他のプログラムはエンド・ノードを受け取るのをサポートするようにプログラムすることができる。当分野の技術者であれば、ソフトウェアをＰＣが調整タスクを制御するように作成できることも理解されよう。

【００２７】

現在では、デモンストレーションおよびプロトタイプ・ユニットの場合、受信側ＰＣを実行する人物がｈｔｔｐ：／／ｗｗｗ．ｊａｖａｓｏｆｔ．ｃｏｍでのダウンロードに使用可能なＳｕｎのＪａｖａ　Ｄｅｖｅｌｏｐｍｅｎｔ　Ｋｉｔ（ＪＤＫ）ソフトウェアをインストールし、その後その人物が、たとえばサービス提供業者からの電子メールを介して、受信ソフトウェアを取得することができる。

【００２８】

エンド・ノード機器のオペレーション用であるソフトウェアの製品バージョンでは、エンド・ユーザは提供業者のＷｅｂサイトを訪れ、受信／送信ソフトウェアをオンラインでインストールすることができる。自動開始ソフトウェア・ルーチンをＰＣの起動ディレクトリにインストールすることも可能であって、その結果、ＰＣの電源がオンになるかまたはリブートされたときに、受信／送信ソフトウェアを起動させることができる。何人かが単一のＰＣを共用している場合があるので、インストール・プログラムが特殊ファイルに個人化情報を記憶し、ＰＣおよび現在のＰＣユーザを識別することも可能である（この特殊ファイルは「ｃｏｏｋｉｅ．」ファイルとして一般に知られている）。

【００２９】

次に、エンド・ノード機器が起動時にどのように初期設定されるかを説明する。当分野の技術者であれば、本発明に従って自らの分散システムを開発しながら、自分自身の初期設定ルーチンおよびプロトコルを容易に考案できることに留意されたい。以下の考察は、例示のために示したものにすぎない。起動時に、エンド・ノード機器側、たとえばＰＣに常駐する受信／送信ソフトウェアは、サービス・プロバイダのＷｅｂサイトにある制御ソフトウェアにメッセージを送信し、

要求があれば受信または送信を行う準備ができていることを肯定すると共に、識別情報を送信することができる。サービス・プロバイダの制御ソフトウェアは、この肯定応答を受信した時点で、特定のＰＣが使用可能であることを知る。

【００３０】

エンド・ユニットが使用可能であることをサービス・プロバイダのサーバがいったん知ると、以下の処理を実行するためにコマンドとデータを送信することができる。

・エンド・ユニットがコマンドとデータを受け取って新しいコンテンツを追加する。
・エンド・ユニットがコマンドを受け取って古いコンテンツを削除する。
・エンド・ユニットがコマンドを受け取って既存のコンテンツを伝送する。
・既存のコンテンツの不正変更をチェックするか、または他の保守タスクを実行する。

【００３１】

一実施形態では、制御ソフトウェアは特定のＰＣが使用不能になったことを知る必要が生じることがある。このシナリオは、ユーザがＰＣをシャットダウンしたとき、ＰＣがクラッシュしたとき、ユーザの電源が故障したとき、またはケーブル・ネットワークが単に業務を停止したときに生じる可能性がある。ユーザがＰＣをスムースに、すなわち不意にではなくシャットダウンした場合、ＰＣ側の制御ソフトウェアにシャットダウンが通知され、これ以上使用できない旨のメッセージをサーバに返信することができる。

【００３２】

ＰＣがクラッシュしたか、またはプロバイダのサーバへの通知なしに使用可能性が除去された場合、分散システムは視聴しているユーが気付くことなく回復することが好ましい。たとえば他のエンド・ユーザ側の視聴者が映画を見たいために、一連の伝送がセットアップされると、サーバは考えられるすべてのエンド・ユーザが使用可能であるか否かを即時にチェック、たとえばポーリングすることができる。いずれかのエンド・ノード・ユニットが応答しない場合、次いでサーバは、そのエンド・ノード・ユニットを使用不能としてマークし、他のエンド・

ノード・ユニットと置き換えることができる。この初期伝送リストは、その後常に、使用可能であることを確認したエンド・ノード・ユニットを起動する。

【００３３】

いったん映画が開始されると、受信側ＰＣは、一定時間までにそれぞれの送信側ＰＣからのデータを予測するように構成することができる。１つのＰＣが予定時間までにデータを配信しない場合は、クラッシュの可能性があるため、受信側ＰＣはプロバイダのサーバに通知することができる。その後サーバは、代わりのエンド・ユニットに伝送リストの残りの部分を与え、その代わりのユニットのインターネット・アドレスを受信側ユニットに通知することによって、即時に他のエンド・ユニットに置き換えることができる。その移行を容易にするために、プロバイダは、バックアップ・サーバを維持することが可能であり、これは、代わりのエンド・ユニットが最高速度にいたるまで、遅延したコンテンツを数秒間受信側エンド・ユニットに提供するものである。

【００３４】

次に図４Ｃを参照する。図４Ｃに示されるように、コンテンツ・データベース１３は、分散システム全体にその仕事の一部をオフロードできるようにセットアップされる。代わりにすべてのマルチメディア・データは、各ユーザ・エンド・ノード内にあるローカルの記憶ユニット間で分散される（図示せず）。すべてのユーザ・エンド・ノードがローカルの記憶ユニットを有する必要はないが、記憶ユニットを有し分散に参加するユーザ・エンド・ノードが多ければ多いほど、システム性能は向上する。ここでマルチメディア・サーバ１は集中型管理者として動作し、ユーザ・エンド・ノード間でマルチメディア・コンテンツがどのように分散されるかを追跡する。マルチメディア・データではなくコマンドと状況情報のみが伝送されることになり、その記憶域はエンド・ノード間で分散されるため、サーバ１とスイッチ２との間のネットワーク接続が必要とする帯域幅が少なくなる。当分野の技術者であれば理解されるように、各エンド・ノード側の記憶ユニットはハード・ディスク・ドライブ、またはそのマルチメディア・コンテンツの記憶、伝送、および再生が可能な任意の種類の記憶デバイスであってよい。技術的な成熟段階に達したため記憶デバイスの価格は急速に下がっており、この形

態の分散型記憶はさらに魅力的かつ費用効果の高いものとなってきている。

【００３５】

図４Ｃで例示されたシステムでは、エンド・ノード５はマルチメディア・コンテンツＡを、エンド・ノード８はマルチメディアＢを、エンド・ノード９はマルチメディア・コンテンツＣを、さらにエンド・ノード１１はマルチメディアＤを要求しており、エンド・ノード６の記憶ユニットにはマルチメディア・コンテンツＡが、エンド・ノード９の記憶ユニットにはマルチメディア・コンテンツＢが、エンド・ノード１０の記憶ユニットにはマルチメディア・コンテンツＣおよびＤが、ならびにエンド・ノード１２の記憶ユニットにはマルチメディア・コンテンツＢが含まれている。

【００３６】

図４Ｃに示されるように、分散型記憶システムは、コンテンツ・データベース１３またはコンテンツが利用可能な箇所から伝送される様々なコンテンツ、たとえば映画を、マルチメディア・サーバ１がエンド・ノードに向けて送ることによって初期設定することができる。この分散は、一定のコンテンツの予測される評判、およびエンド・ノードが同じスイッチング・ネットワーク内にあるかどうかに基づいて実行することができる。たとえば、たとえば同じ地域にあり同じ直近のスイッチング・ネットワークを共用しているエンド・ノードが２００ある場合、新作の映画を確実に配信するためには、たとえば１０のエンド・ノードに常駐していればよい。配信は、過度の遅延がなければ、他のそれほど直近でないスイッチング・ネットワーク側にあるエンド・ノードからも行うことが可能である。その他の１９０のエンド・ノードには他のコンテンツを、フラグメント、全体、またはそれらの組み合わせとして配置することができる。需要が変化した場合、ロケーションおよび分散は、統計的分析のための一般的なツールを使用して追跡可能な使用量を反映するように変更することができるため、これは初期段階にすぎない。

【００３７】

さらに、初期またはそれ以降のロケーション管理は顧客の介入を必要としないため、オフピーク時に実行することができる。したがって、ほとんどの消費者が

眠っている午前３時に、消費者のエンド・ノード側にある記憶ユニットは、好ましくは中央サーバから静かに命令を受信し、コンテンツを伝送し、あるいは中央サーバを更新することができる。新しいコンテンツがリリースされると、その新しいコンテンツはそれほど新しくないコンテンツを徐々にまたはすべて一度に、削除または置換することになる。したがって分散型記憶システムは動的であり、目まぐるしく変化する消費者のニーズを適切にサポートし続けることができる。

【００３８】

コンテンツの記憶が分散されているため、エンド・ノード６はエンド・ノード５のサーバとして動作することができる。２つのノード間のネットワーク接続が共用媒体である場合、エンド・ノード６はコンテンツＡのデータをエンド・ノード５に直接伝送することが可能であり、そうでなければコンテンツＡをスイッチ３に送信し、次いでこれが従来のインターネットまたは任意のデータ通信のネットワーキングやアドレス指定技法を使用してノード５に送信することによって、コンテンツＡをエンド・ノード５に伝送することができる。マルチメディア・サーバ１は、エンド・ノード５から要求を受け取り、要求されたコンテンツの使用可能性をチェックし、最も適切な伝送方法、たとえばエンド・ノード６から伝送することなどを決定し、エンド・ノード６にコンテンツＡをエンド・ノード５に伝送するように命令するように、「トラフィック制御装置」として動作できる。

【００３９】

さらに図４Ｃを参照すると、エンド・ノード６がエンド・ノード５からのコンテンツＡの要求に応じているとき、エンド・ノード６側の視聴者が、同様に、こうしたコンテンツを再生することを要求する可能性がある。こうした状況では、データは記憶ユニット、たとえばハード・ドライブから、ＰＣまたはＳＴＢのいずれであってもプロセッサのメモリに読み出される。次いで、データはプロセッサのメモリからケーブルまたはＤＳＬネットワークへ伝送される。ローカルで視聴するために同時に非常に近隣で同じデータが必要な場合、そのデータは依然としてメモリ内にキャッシュされている可能性が高いので、ローカル・ディスプレイに送信することができる。メモリ内にキャッシュされていない場合、データは記憶ユニット、たとえばハード・ドライブから再度読み出すことができる。当分

野の技術者であれば理解されるように、高速プロセッサおよび通信機能を備えた現在のＰＣシステムならびにＳＴＢは、２セットの読取り要求を同時に処理することが容易である。

【００４０】

マルチメディア・サーバを集中型トラフィック制御装置として動作させる代わりに、それぞれのエンド・ノードにその要求を他のエンド・ノードにブロードキャストさせる方法がある。要求されたコンテンツを備えたエンド・ノードは、伝送状況を監視して、要求されたコンテンツにとって最もよいソースであるかどうかを判定する。最もよいソースであれば、要求に回答し、要求されたコンテンツを要求者に伝送する。要求に対する回答が複数ある場合、要求側エンド・ノードは受信の優先順位を決定し、伝送の優先順位をソース側エンド・ノードに通知する。伝送が混乱した場合、要求側ノードは優先順位に従って、次のソース側エンド・ノードに移ることができる。第２のソース側エンド・ノードは、第１のソース側エンド・ノードが終わった地点から伝送を開始することができる。

【００４１】

同様に、エンド・ノード９は、コンテンツＢを提供することでエンド・ノード８のサーバとして動作することが可能であると同時に、エンド・ノード１０からコンテンツＣを受け取ることができる。エンド・ノード１０はコンテンツＣおよびＤを記憶し、コンテンツＣをエンド・ノード９に送信すると同時にコンテンツＤをエンド・ノード１１に送信することによって、サーバとして動作することが可能である。

【００４２】

エンド・ノードは、それ自体だけでサーバとなる必要はない。他のエンド・ノードと順にまたは同時に動作して、配信を完了することができる。エンド・ノード８は、エンド・ノード９およびエンド・ノード１２の両方からコンテンツＢを受け取ることができる。これは、特にアップロード（エンド・ノードからスイッチへの方向）速度の方がダウンロード（スイッチからエンド・ノードへの方向）速度よりも遅い場合に、コンテンツＢの伝送時間を減らすために望ましい。これは、ケーブル・モデムおよびＡＤＳＬ（非対称デジタル加入者回線）ネットワー

ク技術に多く見られる。また、コンテンツ全体がエンド・ノードにダウンロードされる前に、コンテンツの再生が開始するような場合にも有用である。たとえば、エンド・ノード９からエンド・ノード８へのダウンロードの初期部分の速度に基づいて、コンテンツの終わりに達する前にエンド・ノード９からのダウンロードだけが完了するであろうと予測された場合、コンテンツＢの再生を開始しておくことができる。ただし、いったん再生が開始すると、スイッチ４からスイッチ３への予期せぬネットワークの輻輳によって、またはエンド・ノード９からスイッチ４へのアップロード速度の予期せぬ低下によって、ダウンロード速度が低下した場合、コンテンツＢの未視聴部分をエンド・ノード１２からエンド・ノード８に伝送することもできる。

【００４３】

例を挙げると、エンド・ノード８がエンド・ノード９からコンテンツＢの最初の２５％を受信したと想定する。このコンテンツの最初の２５％のダウンロード速度ならびにコンテンツの再生速度に基づいて、エンド・ノード８は再生を開始する。この例では、再生速度はダウンロード速度に等しい。３０％受信した時点で、ダウンロード速度が２分の１に低下する。ダウンロード速度が上がらない場合、コンテンツＢの再生は映画または音楽の９０％時点で中断されるであろう。その際、たとえば３５％時点で、エンド・ノード１２に、コンテンツＢの最後の２０％の伝送を即時に開始するように命令し、エンド・ノード９にコンテンツの伝送を３５％時点から続行して８０％時点で停止するように命令することができる。この方法は、アップロード伝送速度またはスイッチ間の伝送速度が、ダウンロード伝送速度よりも遅い場合に有用である。

【００４４】

この複数のエンド・ノードからの同時または並行した伝送方法は、再生データ速度およびダウンロード・データ速度がアップロード・データ速度よりも速い場合に、ネットワークの再生開始回数を減らすためにも使用することができる。たとえば、再生速度が毎秒２メガビットであり、ダウンロード速度が毎秒３メガビットをサポートすることが可能であって、単一のエンド・ノードのアップロード速度が毎秒１メガビットであると想定する。図５Ａに示されたネットワークでは

、エンド・ノード５がコンテンツＡの再生を希望しており、これはいくつかの異なるフラグメントとしてエンド・ノード６から５に記憶されている。異なるノードでのフラグメントのロケーションに関する情報は、マルチメディア・サーバ１に記憶しておくことが好ましい。異なるノードのアップロードおよびダウンロード機能もマルチメディア・サーバ１に記憶可能であるか、またはアップロード速度およびダウンロード速度を判定するための即時テストの伝送が可能である。

【００４５】

図５Ａを参照すると、エンド・ノード５はマルチメディア・サーバ１に接触する。サーバは他のエンド・ノードからエンド・ノード５へのフラグメント伝送を調整する。第１段階では、エンド・ノード６、７、および８がそれ自体に記憶されていたフラグメントをエンド・ノード５に伝送し、各伝送側のエンド・ノードからの個々のフラグメントが毎秒１メガビットでしかアップロードできないにもかかわらず、エンド・ノード５は３つのフラグメントを毎秒３メガビットで並行して受け取る。エンド・ノード６からのコンテンツの０～５％を含むフラグメントが再生速度の半分で伝送されるため、エンド・ノード５はフラグメントの最初の半分を受け取るまではコンテンツの再生を開始することができない。それよりも早く再生を開始した場合、フラグメントが完全に受信されるまでにデータが尽きて、再生にギャップが生じてしまう。

【００４６】

エンド・ノードのインターネット・アドレスが定まっておらず、時々変更される場合がある。インターネット・アドレスが変更されたときに制御側のマルチメディア・サーバ１に通知する際に、それぞれのエンド・ノードにあるプログラムを使用することができる。

【００４７】

図５Ｂに示されるように、エンド・ノード６、７、および８からのフラグメントがエンド・ノード５に伝送された場合、マルチメディア・サーバ１は、エンド・ノード９、１０、および１１などの必要なフラグメントを含む他のエンド・ノードから、次の１５～３０％のフラグメントの伝送を調整することができる。エンド・ノード９、１０、および１１がエンド・ノード５にデータを伝送している

間、エンド・ノード６、７、および８は、必要であれば異なるエンド・ノードにデータを伝送するのに使用できるようになる。

【００４８】

図５Ｂには、例示の目的で１つのコンテンツ・データベースおよび１つのマルチメディア・サーバのみしか示されていないが、本発明に従った分散システム全体は、郡、州、または国中に散在する、複数のマルチメディア・サーバを備えた複数のコンテンツ・データベースを実施することが可能であることに留意されたい。１つのエンド・ユニットに向かうコンテンツは、１つまたは複数のコンテンツ・サーバから、ならびに複数の他のエンド・ユニットから発信したものであってよい。この「集合体」効果によって、任意の特定サーバまたはデータベース１つにかかる負荷をオフロードすることが可能であり、エンド・ユニット付近にあるデータベースおよびサーバからのコンテンツ配信を達成するための効率的なスキームを提供することができる。

【００４９】

図５Ｂを参照すると、エンド・ノード５がコンテンツＡの視聴を完了すると、その記憶ユニットにはコンテンツＡのすべてのフラグメントのコピーが存在することになる。コンテンツＡが他のエンド・ノードにも評判であることが予測される、たとえば新作である場合、コンテンツ全体をエンド・ノード５に記憶したままにすることが可能であり、したがって他のエンド・ノードに配信することが可能であるか、または一部だけを保持しておくことも可能である。このエンド・ノードにどの部分を保持しておくかについては、他のエンド・ノードでのコンテンツＡの記憶、または分散状況に基づいて決定される。たとえば、他のエンド・ノードが他のフラグメントを十分に格納することができるため、コンテンツＡの最初の３０％フラグメントだけを必要とする記憶状況が可能である。コンテンツＡが近い将来視聴されることが予測されない場合は、即時に削除されるか、または他のコンテンツをエンド・ノード５の記憶ユニットに記憶する必要が生じたときに第一に削除するコンテンツに指定される。

【００５０】

次に図７を参照すると、サーバの指示に従ってコンテンツをエンド・ノード・

ユニットに分散するプロセスを示す流れ図が記載されている。図７に示されるように、エンド・ユーザユニット（ＥＵＵ１）は、たとえば、ＥＵＵ１が最初にエンド・ユーザの家にインストールされた後に、オンライン上にありアクティブで準備が整っていることを中央サーバに通知する。こうした通知があると、中央サーバはデータ・ブロックＮを記憶させるためにＥＵＵ１に伝送する。ＥＵＵ２が中央サーバからデータ・ブロックＮを要求したときに、中央サーバはＥＵＵ２に、データ・ブロックＮがＥＵＵ１から伝送される予定であることを通知する。したがって中央サーバはＥＵＵ１に対して、要求されたデータ・ブロックをＥＵＵ２に伝送するように命令することができる。この時点で、インターネット送信アドレスはＥＵＵ１であり、インターネット受信アドレスはＥＵＵ２である。要求されたデータ・ブロックを受け取ると、ＥＵＵ２は中央サーバに伝送が完了したことを通知する。

【００５１】

次に図８Ａおよび８Ｂを参照すると、本発明に従ったＶＯＤシステムの他の実施形態が示されている。図５Ａおよび５Ｂで以前に示されたシステムでは、いくつかのエンド・ノードが単一のマルチメディア・サーバ１によって処理されていたことに留意されたい。図８Ａおよび８Ｂは、このシステムの代替または精密にしたものであって、マルチメディア・サーバの機能が別々の部分に分割され、すなわち本質的にオフロードされており、コンテンツはエンド・ノードとマルチメディア・コンテンツ・サーバとの組み合わせから配信されている。ここでは、コンテンツ配信は分散型コンテンツ・サーバならびに他のエンド・ノードによって、あるいはサーバとエンド・ノードの組合せによって達成される。

【００５２】

図８Ａおよび８Ｂに示されたシステムでは、エンド・ノードＣおよびＤはパーソナル・コンピュータ（ＰＣ）または通常家庭内にある他の機器であってよい。制御サーバＡは、制御および調整の役割を果たすインターネット・サーバ・コンピュータであってよい。このインターネット・サーバ・コンピュータの例がＭｉｃｒｏｓｏｆｔ　ＮＴオペレーティング・システムを使用するＣｏｍｐａｑ　Ｐｒｏｌｉａｎｔサーバまたはこれと同等のものである。ＷｅｂサーバＢは、イン

ターネット・サーバ・コンピュータであってよく、その例が、Ｓｕｎ　Ｓｏｌａｒｉｓオペレーティング・システムを使用するＳｕｎ　ＭｉｃｒｏｓｙｓｔｅｍのＥｎｔｅｒｐｒｉｓｅサーバまたはこれと同等のものであり、Ｗｅｂページをエンド・ノードに配信するが、マルチメディア・コンテンツは保持している場合もしていない場合もある。マルチメディア・コンテンツ・サーバＥおよびＦは、マルチメディア・コンテンツを保持しているインターネット・サーバ・コンピュータであってよい。この例では機能が分割されているが、当分野の技術者であれば理解できるように、インターネット・サーバ・コンピュータの場合、制御、Ｗｅｂ処理、およびマルチメディア・コンテンツ処理機能を実行し、任意の組合せでこれを組み合わせることが可能である。

【００５３】

図８Ａおよび８Ｂは、マルチメディア・データを、マルチメディア・コンテンツ・サーバとエンド・ノードとの組合せからエンド・ノードへ配信する、本発明に従ったＶＯＤシステムの他の実施形態を示す図である。したがって、この実施形態により、マルチメディア・データを、マルチメディア・コンテンツ・サーバのみからエンド・ノードまたは複数のエンド・ノードに配信するシステムを構築させることが可能である。

【００５４】

本明細書で前述したように、映画ファイルなどのマルチメディア・コンテンツを第１に小さなファイルにフラグメント化し、この小さなファイルを記憶するためにエンド・ノードおよび／または他のサーバに分散することができる。この例では、コンテンツ・フラグメントはエンド・ノードＣ（ステップ３）、エンド・ノードＤ（ステップ４）、マルチメディア・コンテンツ・サーバＥ（ステップ３）、およびマルチメディア・コンテンツ・サーバＦ（ステップ３）に分散されている。さらに本発明では、ファイル・フラグメントのコピーを追加のエンド・ノードまたはサーバに分散させることが可能であり、その結果、各ファイル・フラグメントが複数のエンド・ノードまたはサーバ上に常駐することができる。この冗長性により、エンド・ノードまたはサーバを他のものと置き換えることが可能であり、エンド・ノードまたはサーバのデータ伝送が遅くなった場合に有用であ

る。データは、これらのエンド・ノードおよびサーバ上に常住することが可能であり、必要に応じて伝送することも可能である。

【００５５】

また、前述のように、視聴側エンド・ノードは、元のファイル順序でファイル・フラグメントを再統合することができる一部のソフトウェアを含むことが可能である。最終的に、映画のファイル・フラグメントを保持するエンド・ノードまたはインターネット・サーバが、制御サーバからコマンド受け入れ、ファイル・フラグメントをエンド・ノードまたはインターネット・サーバに配信するのを可能にする、何らかのソフトウェアを含むことができる。

【００５６】

図８Ａでは、エンド・ノードＤ側のユーザが、たとえば映画の視聴を希望したときにステップ１が発生する。ノードは映画のデータに関する要求をＷｅｂサーバＢに送信する。ステップ２では、ＷｅｂサーバＢが要求を制御サーバＡに渡す。次いで制御サーバＡが、どのエンド・ノードまたはインターネット・サーバに所望の映画のファイル・フラグメントが含まれているかを判定する。ステップ３では、制御サーバＡがエンド・ノードＣ、マルチメディア・コンテンツ・サーバＥ、およびマルチメディア・コンテンツ・サーバＦに対して、所望の映画のファイル・フラグメントをエンド・ノードＤに配信するように命令を送る。図８Ｂに示されたステップ４では、エンド・ノードＣ、マルチメディア・コンテンツ・サーバＥ、およびマルチメディア・コンテンツ・サーバＦが共に、映画のファイル・セグメントをエンド・ノードＤに配信する。様々なフラグメントの再統合または再アセンブリは、各フラグメントが同じタイトルから他のフラグメントに関する固有の識別を提供するように符号化されている場合、視聴側エンド・ノードによって実行可能であることに留意されたい。こうした再統合または再アセンブリによって、視聴側エンド・ノードに、視聴側エンド・ノードの初期の要求に応答して、サーバから配信されるフラグメントの「スクリプト」を取得させることもできる。この「スクリプト」は、自転車の組み立て方法に関する指示書とよく似ており、フラグメントの再統合および再アセンブリを容易にするものである。

【００５７】

映画のタイトルまたはデータ・ファイルがいったんフラグメント化されると、各フラグメントには、映画の全編におけるその位置を識別する固有のコードが備えられるということを指摘しておく。映画またはデータ・ファイルを位置符号化する標準的な方法は、インターネット・ファイルがパケット化され、インターネット全体にわたって別々に配信されて、受信の最終地点で再アセンブルされるという方法と同様に確立されることが好ましい。

【００５８】

図には示されていないが、当分野の技術者であれば、ＷｅｂサーバＢがマルチメディア・コンテンツ・サーバとしても動作可能であることが明らかであろう。

【００５９】

ＥＵＵが記憶するデータの各フラグメントは、セキュリティの目的で異なる暗号キーを用いて暗号化できることに留意されたい。たとえば、ＥＵＵが５つのプログラムから５つのフラグメントを、すなわち１プログラムから１フラグメントを記憶する場合、各フラグメントは専用の暗号キーを持つことができる。フラグメントまたはプログラムを暗号化することによって、ユーザがＥＵＵに無許可でアクセスできないようにする。当分野の技術者であれば理解されるように、各ＥＵＵでの記憶は、ＥＵＵが様々なコンテンツを省略なしで格納しているか、またはフラグメントの集まりを格納しているかどうかが、ユーザに対してトランスペアレントであることが好ましい。

【００６０】

上記の開示内容に従って、本発明は、待機時間を最小とし、単一のエンド・ノードからのコンテンツのアップロード伝送速度が、再生側エンド・ノードの再生およびダウンロード速度よりも遅い場合であっても、コンテンツをフラグメント化することおよび多数のネットワーク化された記憶ノード間でコンテンツを分散することによって、コンテンツの連続的な再生を提供する。さらに本発明は、複数のエンド・ノードが同じコンテンツを視聴し、各視聴間の遅延がわずかであることも可能にし、この遅延がフラグメントの持続時間によって設定される。本発明は、２つのデータ伝送方法で使用することができる。たとえば、ネットワークは図６に示されたＤＳＬ（デジタル加入者回線）技術を使用するか、あるいは図

１に示されたケーブルＴＶ技術と共に使用することができる。

【００６１】

以上、データ配信に関する本発明の大部分を、ビデオ・オン・デマンド・システムの実施に関して述べてきたが、当分野の技術者であれば、本発明が「データ・オン・デマンド」システムも実施可能であることを理解されよう。こうしたシステムでは、各エンド・ユーザ・サイトの記憶ユニットが、他のユーザまたはそれ自体がアクセスするためにデータを記憶することになる。記憶されるデータは、異なる種類のデータの部分、すなわちフラグメントであってもよく、たとえば中央サーバを介してデータの記憶、伝送、およびアセンブリを制御、追跡、および管理するためのメカニズムがあれば、これをいずれかの場所に記憶された他の部分とアセンブルして、完全な形にすることが可能である。こうしたネットワークを管理する者は、記憶したデータに招かれざるエンド・ユーザがアクセスするのを防ぐために、データのセキュリティおよび暗号手段を実施する義務を負う場合がある。

【００６２】

本発明は、当分野の技術者であれば明らかなように、従来の汎用デジタル・コンピュータを使用して実施することができ、かつ本発明の教示に従ってプログラムできる。ソフトウェア分野の技術者であれば明らかなように、熟練したプログラマであれば、本開示の教示に基づいて適切なソフトウェア符号化を容易に実行することができる。

【００６３】

本発明は、当分野の技術者であれば容易に理解できるように、適用分野特有の集積回路を作成することによって、または従来の構成要素回路の適切なネットワークを相互接続することによっても実施可能である。

【００６４】

本発明には、分散型プログラムの記憶または分散ネットワークのコンテンツ・フロー制御など、本発明のプロセスを実行するようにコンピュータをプログラムするのに使用可能な命令を含む記憶媒体である、コンピュータ・プログラム製品も含まれる。記憶媒体は、無制限に、フロッピィ・ディスク、光ディスク、ＣＤ

－ＲＯＭ、および光磁気ディスクを含む任意のタイプのディスク、ＲＯＭ、ＲＡＭ、ＥＰＲＯＭ、ＥＥＰＲＯＭ、磁気または光カード、あるいは、電子命令を記憶するのに好適な任意のタイプの媒体を含むことができる。本発明を具体化する装置が動作すると、物理現象でありデバイスを適切な方法で制御する信号をデバイスが処理するため、本発明の所望の結果が達成される。

【００６５】

上記の開示に照らせば、本発明の多数の修正および変形が可能であることは明白である。したがって、添付の特許請求の範囲の範囲内であれば、本発明が本明細書に具体的に記載されたものとは異なる他の方法で実施可能であることを理解されよう。

【図面の簡単な説明】

【図１Ａ】

ケーブル・ブロードキャスト・システムを介した従来のビデオ・オン・デマンド・システムを示す図である。

【図１Ｂ】

エンド・ユーザがケーブル・モデムを備えているケーブルＴＶブロードキャスト・システムを介した例示的なビデオ・オン・デマンド・システムを示す図である。

【図２】

Ａは単一のマルチメディア・サーバが１００人のユーザに対して同時にＡＶコンテンツを処理する方法の一例を示す図である。

Ｂはマルチメディア・サーバと顧客との間に３つのキャッシュ・メモリを挿入する方法の一例を示す図である。

【図３】

Ａはユーザ・サイト側のエンド・ノード機器を簡略的に示す構成図である。

Ｂは集中型サーバおよびユーザ・サイト側のエンド・ノード機器を備えた従来のＶＯＤシステムを簡略的に示す構成図である。

【図４】

Ａは本発明に従い、ＴＶで使用するためのケーブル・モデムを備えたエンド・

ノード機器を簡略的に示す構成図である。

Ｂは本発明に従い、ＰＣで使用するためのケーブルまたはＤＳＬモデムを備えたエンド・ノード機器を簡略的に示す構成図である。

ちゃ本発明の分散型サーバ・システムを簡略的に示す構成図である。

【図５Ａ】

再生開始回数を減らすために、複数のエンド・ノードからのコンテンツの同時伝送を示す図である。

【図５Ｂ】

再生開始回数を減らすために、複数のエンド・ノードからのコンテンツの同時伝送を示す図である。

【図６】

ＤＳＬネットワークに基づいたＶＯＤシステムを簡略的に示す構成図である。

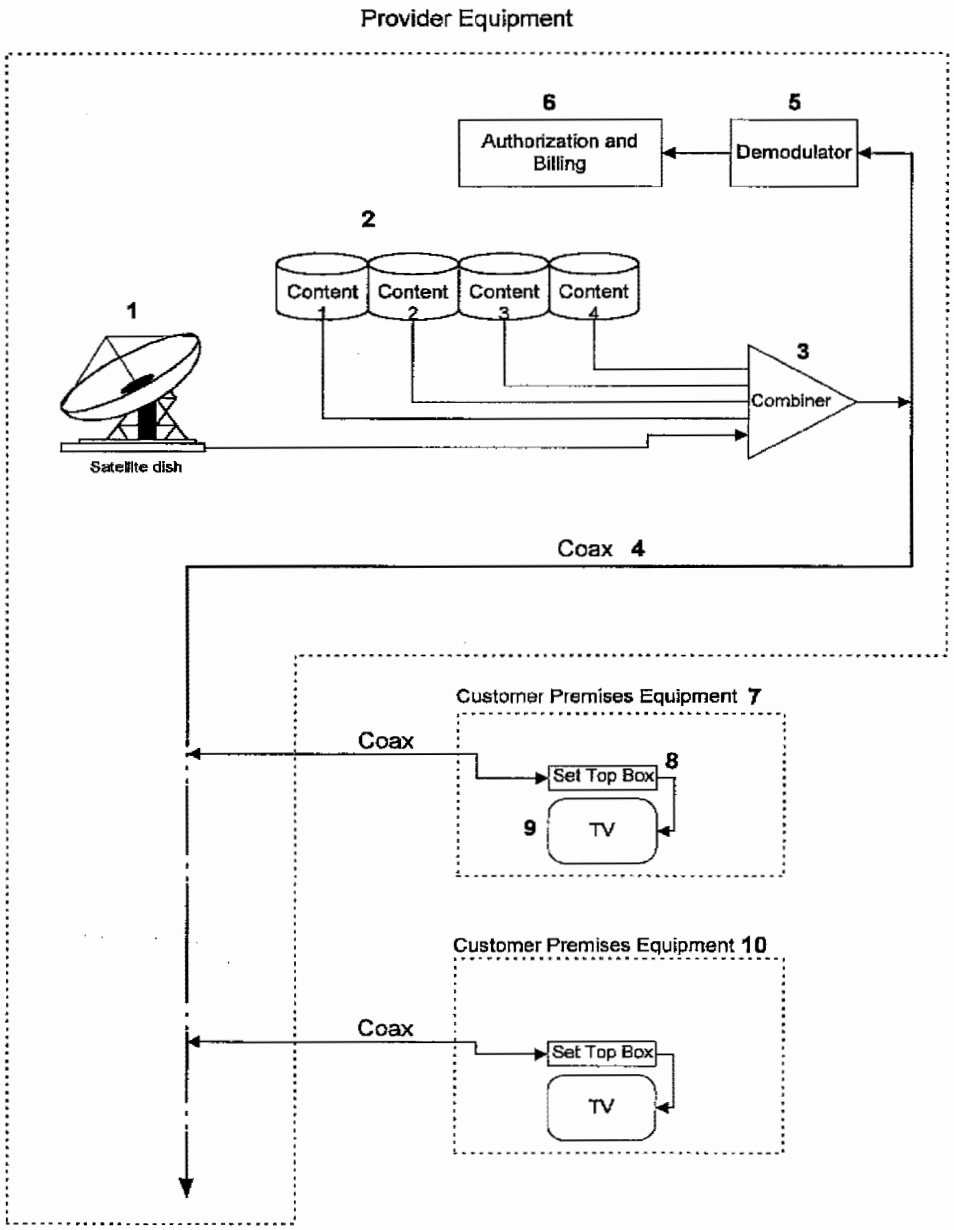
【図７】

エンド・ノード・ユニットへのコンテンツの分散プロセスを示す流れ図である。

【図８】

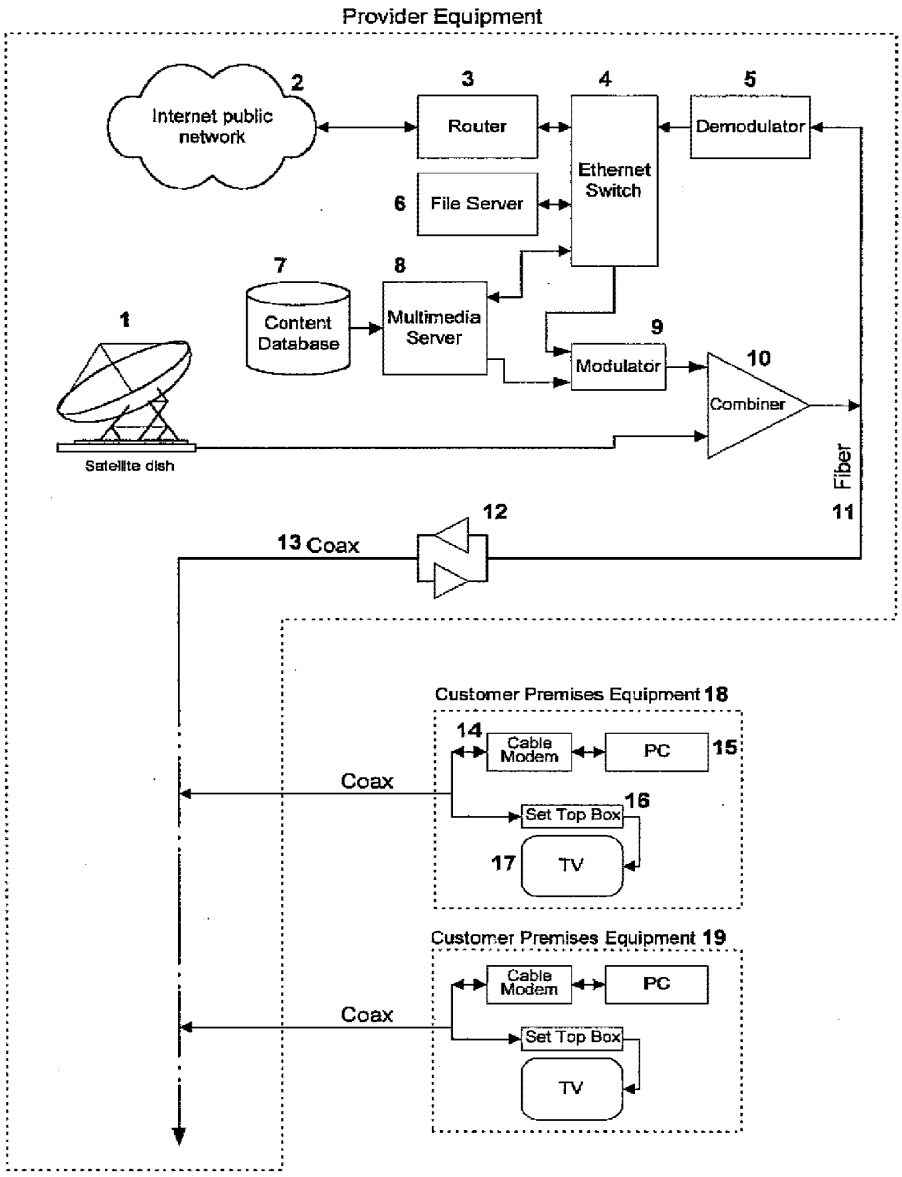
エンド・ノードとコンテンツ・サーバの組み合わせから配信されるコンテンツを備えたＶＯＤシステムの、他の実施形態を示す図である。

【図１Ａ】



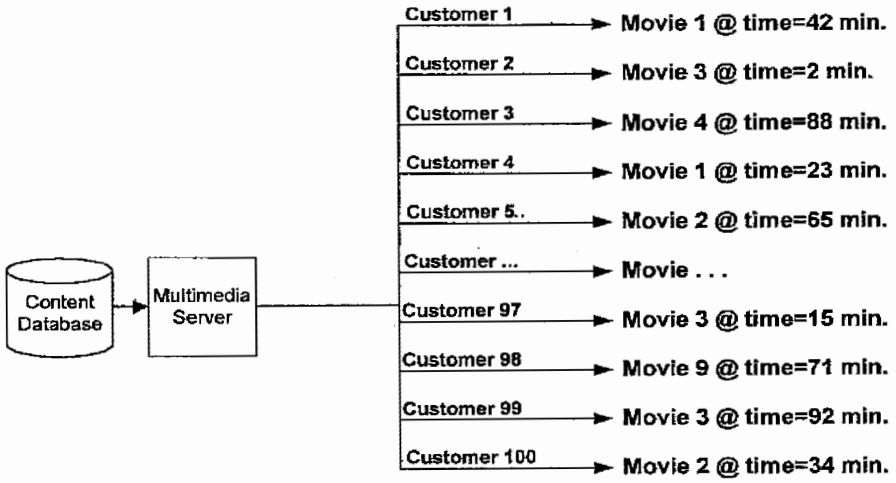
1	衛星放送用パラボラ・アンテナ	6	許可および課金
2	コンテンツ	7	顧客構内設置機器
3	結合器	8	セットトップ・ボックス
4	同軸ケーブル	１０	顧客構内設置機器
5	復調器	Provider Equipment	プロバイダ機器

【図１Ｂ】



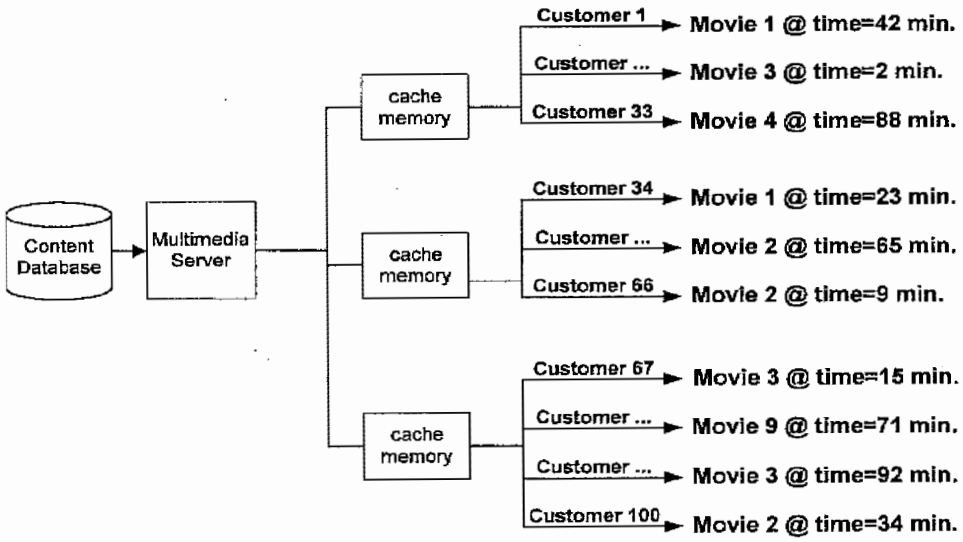
1	衛星放送用パラボラ・アンテナ	9	変調器
2	インターネット公衆ネットワーク	１０	結合器
3	ルータ	１１	光ファイバ
4	イーサネット・スイッチ	１３	同軸ケーブル
5	復調器	１４	ケーブル・モデム
6	ファイル・サーバ	１６	セットトップ・ボックス
7	コンテンツ・データベース	18,19	顧客構内設置機器
8	マルチメディア・サーバ	Provider Equipment	プロバイダ機器

【図２】



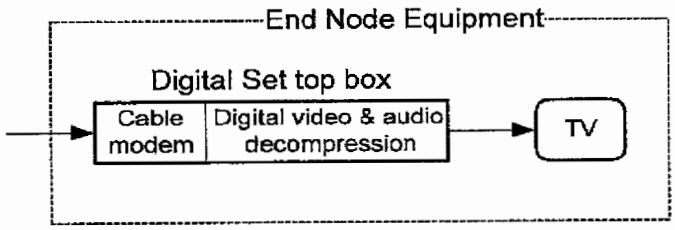
A

Content Database	コンテンツ・データベース
Multinedia Server	マルチメディア・サーバ
Customer	顧客
cache memory	キャッシュ・メモリ
Movie	顧客
time	時間
min.	分



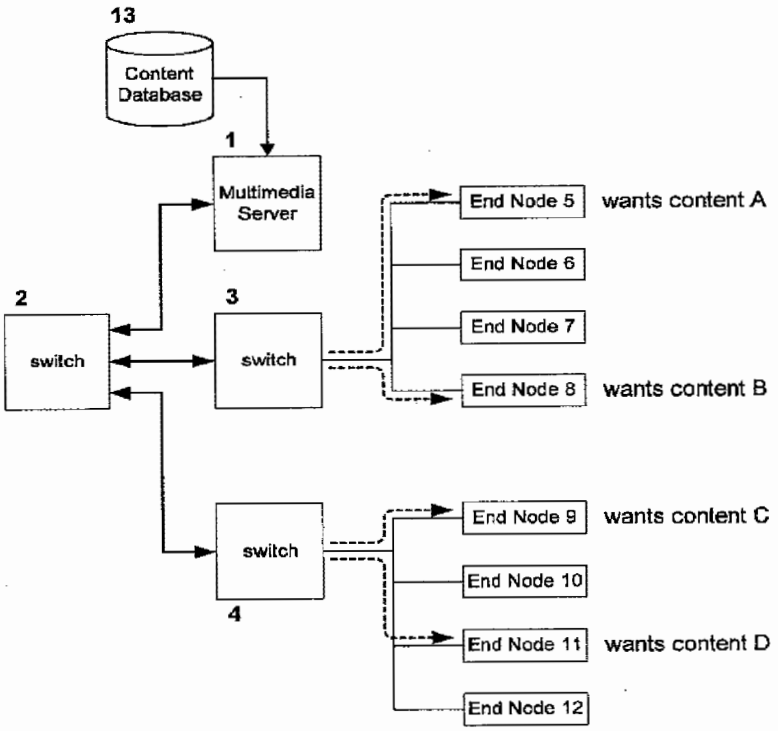
B

【図３】



A - Conventional End Node Equipment

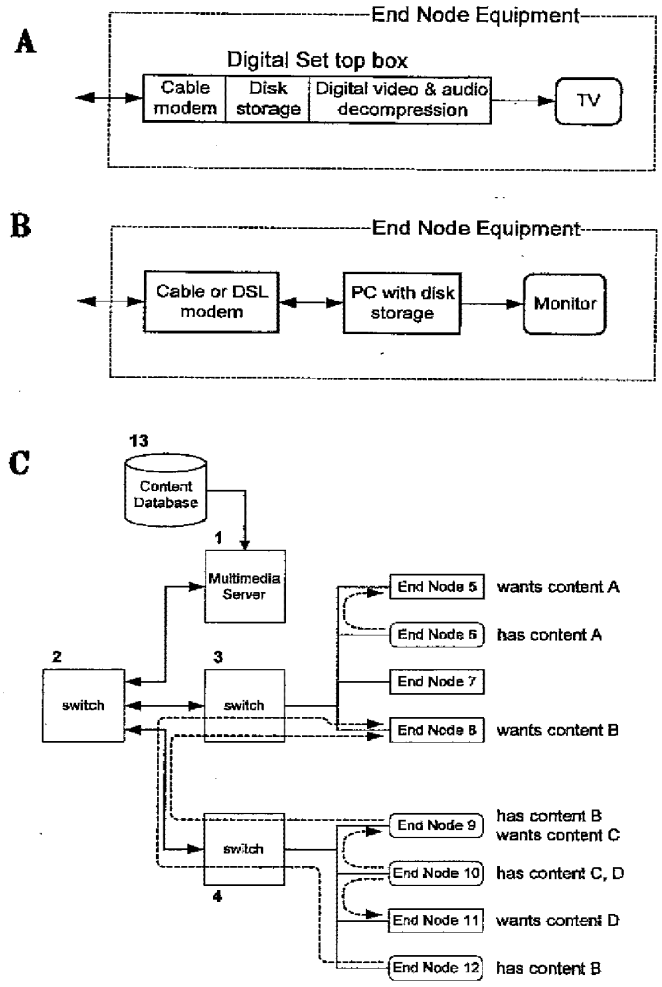
End Node Equipment　エンド・ノード機器
Digital Set top box　デジタル・セットトップ・ボックス
Cable modem　ケーブル・モデム
Digital video & audio decompression　デジタル・ビデオ＆オーディオ圧縮解除
Conventioal End Node Equipment　従来のエンド・ノード機器



B

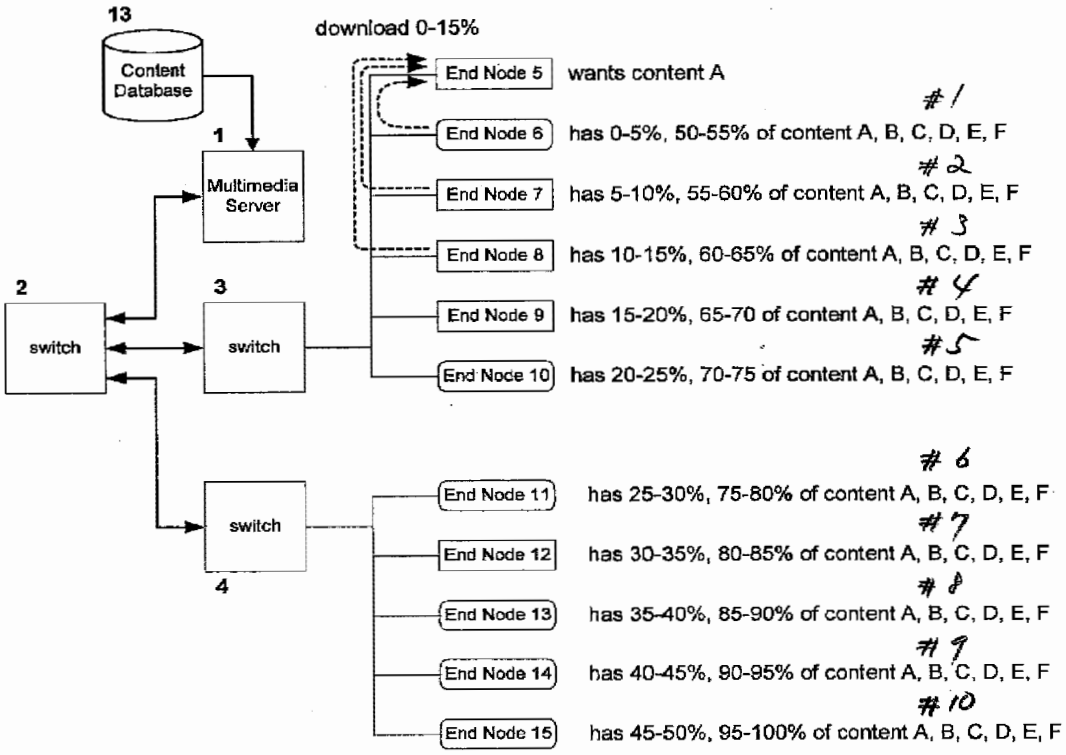
1　マルチメディア・サーバ
2～4　スイッチ
13　コンテンツ・データベース
End Node　エンド・ノード
Wants content　コンテンツを希望

【図４】



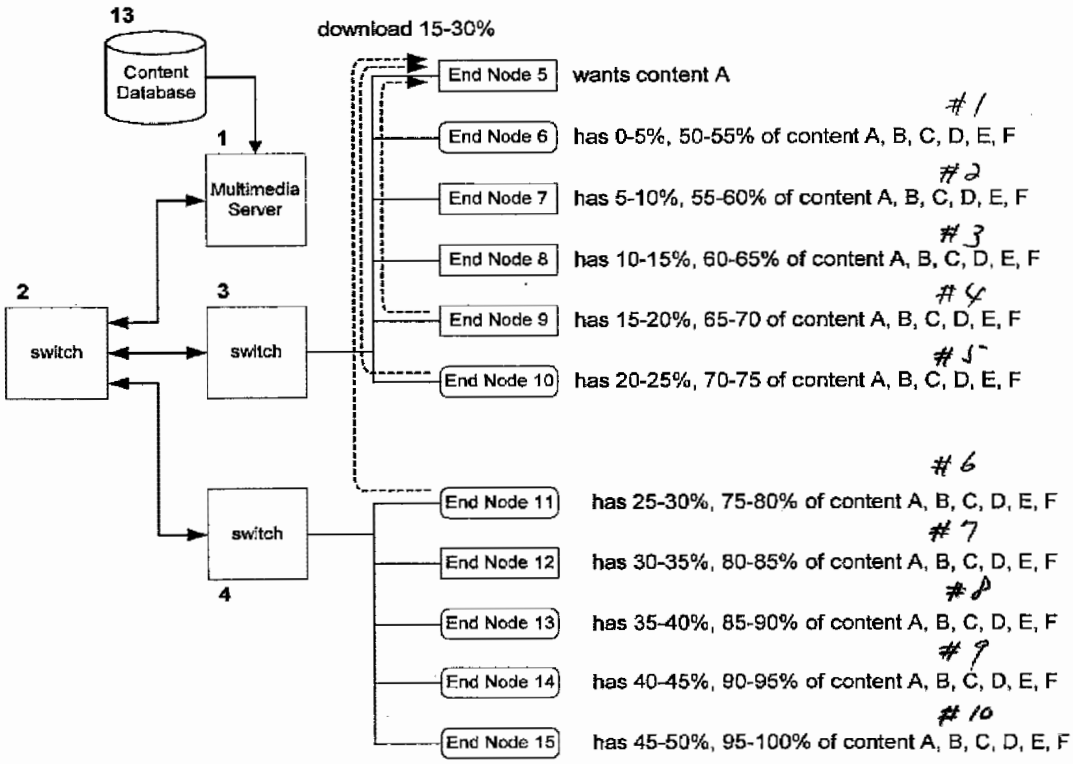
End Node Equipment　エンド・ノード機器
Digital Set top box　デジタル・セットトップ・ボックス
Cable modem　ケーブル・モデム
Digital video & audio decompression　デジタル・ビデオ＆オーディオ圧縮解除
Conventional End Node Equipment　従来のエンド・ノード機器
Cable or DSL modem　ケーブルまたはＤＳＬモデム
PC with disk storage　ディスク記憶装置を備えたＰＣ
Monitor　モニタ
１　マルチメディア・サーバ
２～４　スイッチ
１３　コンテンツ・データベース
End Node　エンド・ノード
Wants content　コンテンツを希望
has content　コンテンツを所有

【図５Ａ】



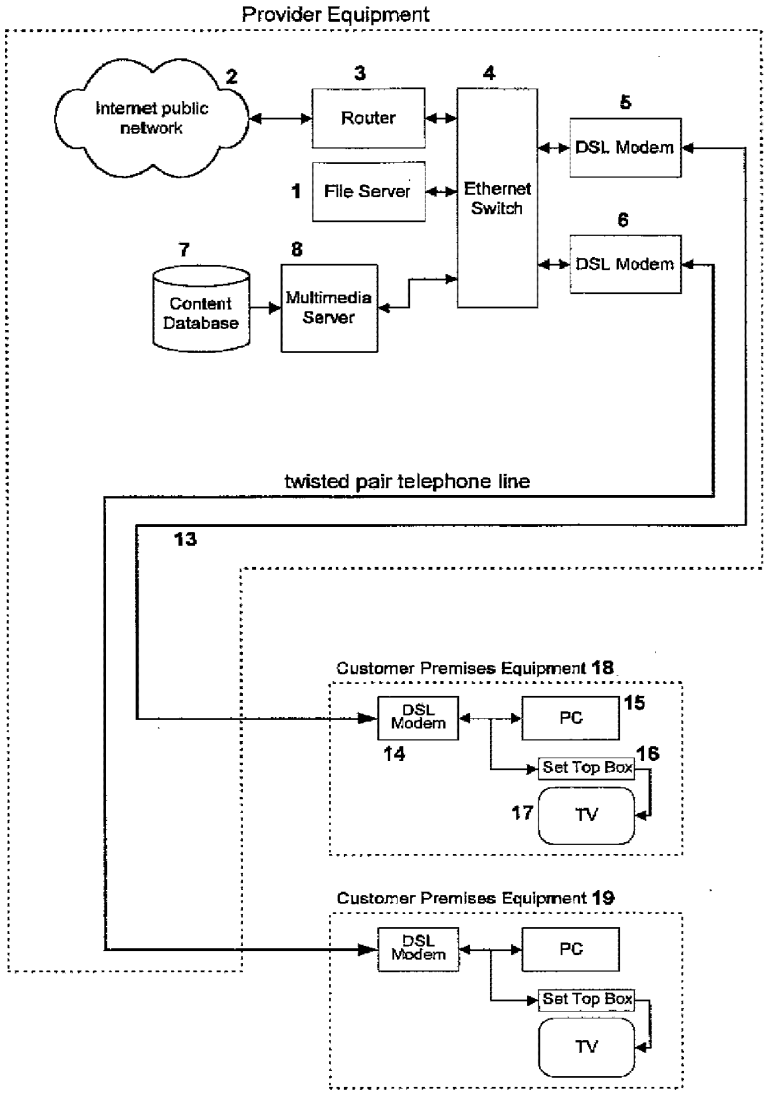
１　　マルチメディア・サーバ
２～４　　スイッチ
１３　　コンテンツ・データベース
End Node　エンド・ノード
Wants content　　コンテンツを希望
download 0-15%　０～１５％をダウンロード
＃1　　コンテンツA、B、C、D、E、Fの０～５％、５０～５５％を所有
＃2　　コンテンツA、B、C、D、E、Fの５～１０％、５５～６０％を所有
＃3　　コンテンツA、B、C、D、E、Fの１０～１５％、６０～６５％を所有
＃4　　コンテンツA、B、C、D、E、Fの１５～２０％、６５～７０％を所有
＃5　　コンテンツA、B、C、D、E、Fの２０～２５％、７０～７５％を所有
＃6　　コンテンツA、B、C、D、E、Fの２５～３０％、７５～８０％を所有
＃7　　コンテンツA、B、C、D、E、Fの３０～３５％、８０～８５％を所有
＃8　　コンテンツA、B、C、D、E、Fの３５～４０％、８５～９０％を所有
＃9　　コンテンツA、B、C、D、E、Fの４０～４５％、９０～９５％を所有
＃10　コンテンツA、B、C、D、E、Fの４５～５０％、９０～１００％を所有

【図５Ｂ】



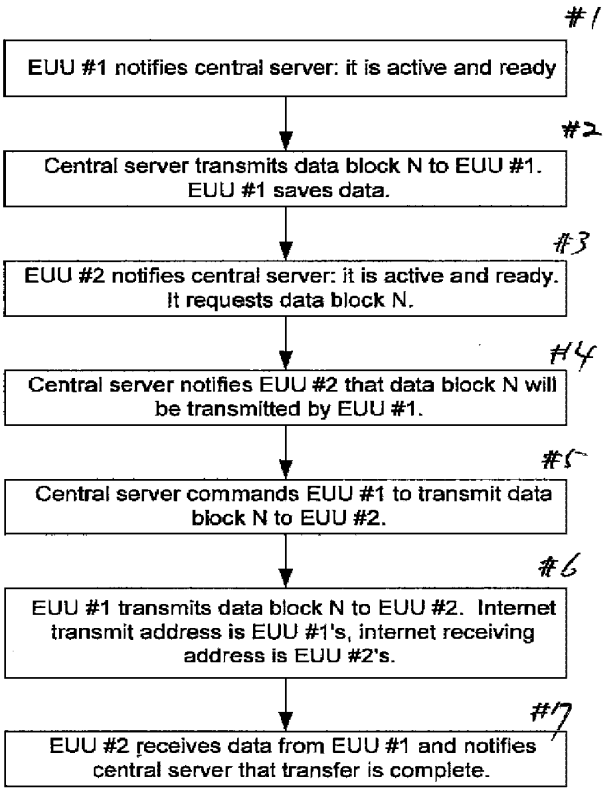
１　　マルチメディア・サーバ
２～４　　スイッチ
１３　　コンテンツ・データベース
End Node　エンド・ノード
Wants content　　コンテンツを希望
download 0-15%　　０～１５％をダウンロード
＃1　　コンテンツA、B、C、D、E、Fの０～５％、５０～５５％を所有
＃2　　コンテンツA、B、C、D、E、Fの５～１０％、５５～６０％を所有
＃3　　コンテンツA、B、C、D、E、Fの１０～１５％、６０～６５％を所有
＃4　　コンテンツA、B、C、D、E、Fの１５～２０％、６５～７０％を所有
＃5　　コンテンツA、B、C、D、E、Fの２０～２５％、７０～７５％を所有
＃6　　コンテンツA、B、C、D、E、Fの２５～３０％、７５～８０％を所有
＃7　　コンテンツA、B、C、D、E、Fの３０～３５％、８０～８５％を所有
＃8　　コンテンツA、B、C、D、E、Fの３５～４０％、８５～９０％を所有
＃9　　コンテンツA、B、C、D、E、Fの４０～４５％、９０～９５％を所有
＃10　コンテンツA、B、C、D、E、Fの４５～５０％、９０～１００％を所有

【図６】



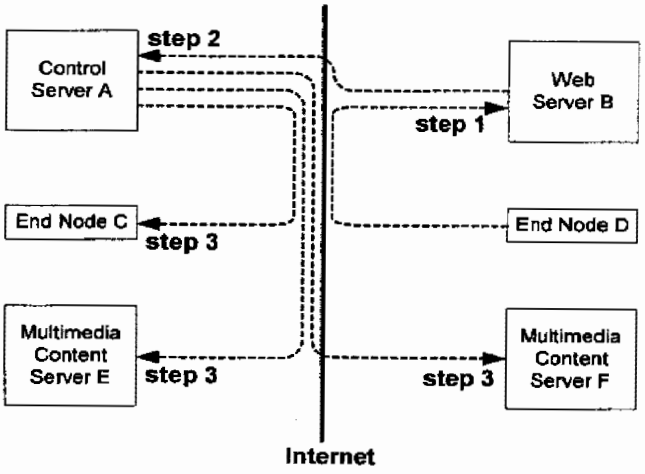
1	ファイル・サーバ	１６	セットトップ・ボックス
2	インターネット公衆ネットワーク	１８	顧客構内設置機器
3	ルータ	Provider Equipment	プロバイダ機器
4	イーサネット・スイッチ	twisted pair telephone lin	ツイスト・ペア電話回線
7	コンテンツ・データベース	modem	モデム
8	マルチメディア・サーバ	Set Top Box	セットトップ・ボックス

【図７】



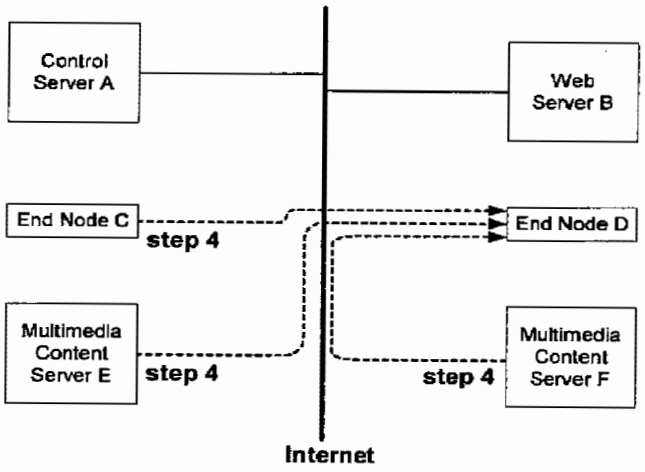
＃１　第１のＥＵＵが、アクティブで準備が整っていることを中央サーバに通知
＃２　中央サーバがデータ・ブロックＮを第１のＥＵＵに伝送し、第１のＥＵＵがデータを保存
＃３　第２のＥＵＵが、アクティブで準備が整っていることを中央サーバに通知。データ・ブロックＮを要求
＃４　中央サーバが、データ・ブロックＮが第１のＥＵＵによって伝送されることを第２のＥＵＵに通知
＃５　中央サーバが、第１のＥＵＵにデータ・ブロックＮを第２のＥＵＵに伝送するように命令
＃６　第１のＥＵＵがデータ・ブロックＮを第２のＥＵＵに伝送。インターネット送信アドレスが第１のＥＵＵ、インターネット受信アドレスが第２のＥＵＵ
＃７　第２のＥＵＵが第１のＥＵＵからデータを受信し、中央サーバに伝送が完了したことを通知

【図８】



A

Control Server　制御サーバ
End Node　エンド・ノード
step　ステップ
Server　サーバ
Internet　インターネット
Multimedia Content Server　マルチメディア・コンテンツ・サーバ



B

【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/21127

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :H04N 7/173
US CL :709/219
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 709/219; 345/327; 348/7,12,13; 455/4.2, 5.1; H04N 7/173, 7/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,815,194 A (UEDA) 29 September 1998 whole document	1-22
A	US 5,873,022 A (HUIZER et al.) 16 February 1999 whole document	1-22
A	US 5,884,141 A (INOUE et al.) 16 March 1999 whole document	1-22

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 10 NOVEMBER 2000	Date of mailing of the international search report 08 JAN 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer CHRISTOPHER GRANT Telephone No. (703) 305-4755

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7/173	610	5/91	L	

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(21) International Application Number: PCT/US00/21127

(22) International Filing Date: 2 August 2000 (02.08.2000)

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(74) Agent: YU, Philip, K.; Registered Patent Attorney, 100 E. Huntington Drive, Suite 100, Alhambra, CA 91801-1022 (US).

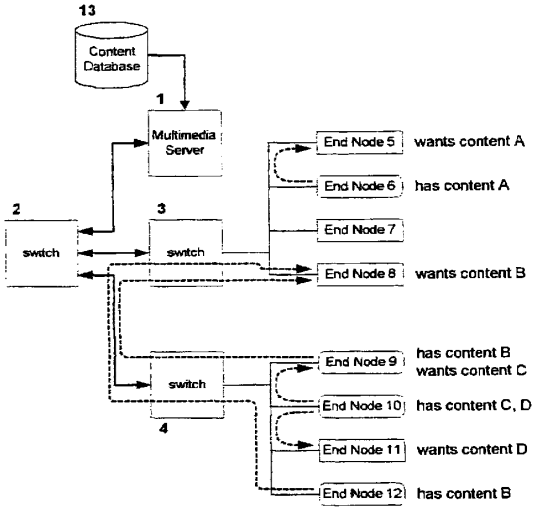
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(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: VOD FROM A SERVER OR A USER TO ANOTHER USER



(57) Abstract: A system and method for delivering data to multiple end users (5-12) using distributed storage system connected through a data communications network. The end user equipment for audio or video playback or recording contains a storage unit, such as a magnetic disk. Each storage unit can store data, such as digital video content, i.e. movies, or digital audio content, i.e. songs. The storage unit can also be configured to store portions, or fragments, of digital video or audio content, where the storage location, playback, and recording of digital video or audio content of each storage unit is administered, managed and controlled by a central facility (1). The content for playback of a video or audio content, or portions thereof, may reside on one or more physically separate storage unit, or may also reside on a central storage unit (13).

WO 01/10125 A1

VOD FROM A SERVER OR A USER TO ANTOHER USER

Cross Reference to Related Application

This application claims priority from provisional application Serial No. 60/146,893, "Method and Apparatus for Data Delivery Using Distributed Storage System," filed August 2, 1999.

Field of the Invention

The present invention relates to data communications networks and more specifically to a method and apparatus for delivering data using distributed storage units through a network, such as the Internet.

Art Background

Ever since the advent of VCR's, there has been a public desire to have a movie-on-demand system to alleviate the need for the viewers to go to the video store. A "video on demand" ("VOD") system provides viewers the ability to select an arbitrary movie or video program and then view the video content at a requested time, whether immediately, a few hours later or even a few days later. The delivery of the video is purely electronic, so that physical media like video tapes or video discs need not be purchased, nor rented at a video store and then returned after viewing.

Cable companies have implemented some form of video delivery system for their cable customers. However, due to limitations in the storage space and bandwidth, the selection of movies is quite limited and the viewers can only watch the movie at the time designated by the cable company. For those who feel like watching an old *Godfather* movie on Wednesday afternoon, they are out of luck. The system offered by the cable company is therefore not a true VOD system, much less a system with any degree of flexibility suitable for a broad range of viewers.

Implementing a practical video on-demand system for a large number of viewers is difficult and expensive. It typically requires a multimedia server which can deliver multiple simultaneous continuous streams of audio or video content to hundreds or thousands of different end customers. Ideally, the customers could choose their content from a library of hundreds of movies or songs. However, a typical hard disk drive may only be able to hold a few full length movies, which means that a multimedia server would have to contain 50 or more disk drives. Figure **1A** illustrates such a conventional cable broadcasting system for "video-on-demand" provisioning.

Another difficulty in implementing a large shared multimedia server is the need to handle and transmit multiple streams of digital multimedia content. A standard definition compressed television signal would be transmitted at an average data rate of about 4 megabits per second. If one multimedia server had to serve one hundred different programs simultaneously, the average total bandwidth required would be 400 megabits per second. This large amount of data would also have to be transmitted to the one hundred viewers without appreciable discontinuity, or the viewing experience would be ruined. A network to support such a high data rate with a guaranteed Quality of Service (QoS) to many users from a central server is thus very expensive, and has been impractical for anyone to build.

With the advent of communication through the Internet using cable modems, it has been suggested that cable modems may enable the provisioning of video on-demand by cable companies. It has been hoped that cable modems coupled with the Internet can achieve what cable companies have failed, that is, a video on-demand system using the Internet.

Figure **1B** illustrates how video on-demand might be provisioned over a cable TV broadcast system with cable modems for a metropolitan area. In this system, analog TV signals are received by a satellite dish 1. The analog TV signals are combined with video on-demand signals and digital communication signals from the Internet through a signal combiner 10.

In Figure **1B**, the video-on-demand signals are digital, although they can also be analog signals. Digital content, such as World Wide Web pages, on the Internet public network 2, are connected to the system through a router 3. The router 3 is used to

translate packet data from one network to another, such as between the Internet network and the example Ethernet network switch 4. The Ethernet network switch 4 directs data to and from the Internet router 3, the fiber return channel demodulator 5, a file server 6, the multimedia server 8, and the modulator 9. The fiber return channel demodulator 5 translates signals returning from the customer premises equipment ("CPE") through the optical fiber 11, back into digital format, where it might then be sent to the Internet. A file server can be used to hold World Wide Web pages or for caching Internet information. The multimedia server controls the content database 7, and can read out multiple movies or songs simultaneously. The content database holds all of the digitized movies or songs. Digital data from the multimedia server or the Ethernet switch going to the end users can go through a digital to analog modulator 9, before being combined with the analog TV signals from the satellite dish 1.

Referring still to Figure **1B**, signals going between the optical fiber 11 and the coax cables 13 can be translated by the coax-to-fiber converter 12. The analog TV signals would be frequency converted through the set top box 16, for transmission to the TV set 17, while the digital signals would be converted to digital by the cable modem 14 for use by the PC 15. The customer premises equipment 18 (CPE) at a single residence may contain one set of equipment, while another residence may contain another set of CPE 19, with each customer viewing different video, audio, or data content.

It is not unusual to have hundreds or thousands of customers served by one set of provider equipment. That means a multimedia server would have to potentially serve different movie or music data streams to each customer simultaneously. This is practically impossible if there are thousands of customers and only one multimedia server. One solution may be to have multiple multimedia servers, with each one serving a subset of the customers; however, this also multiplies the cost of servicing all of the customers. A remaining problem is that a very large amount of multimedia data must travel from a centralized multimedia server, or group of servers. Because each customer may be viewing different videos at different points in time (for instance, at the beginning, middle, or end of the video) from the multimedia server, each video is treated as a separate channel. The bandwidth of hundreds or thousands of separate channels, in addition to the normal broadcast channels is higher than what current transmission pathways can handle today.

Therefore, it is desirable to have an on-demand data delivery system where the multiple recipients can receive the same or different content at any time they choose.

It is also desirable to have such an on-demand data delivery system without exhausting the bandwidth of the server or the transmission infrastructure.

Summary of the Invention

A system and method for delivering data to multiple end users using distributed storage system connected through a data communications network is disclosed, where the end user equipment for audio/video playback or recording contains a storage unit, such as a magnetic disk. Each storage unit can store data, such as digital video content, i.e. movies, or digital audio content, i.e. songs. The storage unit can also be configured to store portions, or fragments, of digital video or audio content, where the storage location, playback, and recording of digital video or audio content of each storage unit is administered, managed and controlled by a central facility. The content for playback of a video or audio content, or portions thereof, may reside on one or more physically separate storage unit, or may also reside on a central storage unit.

The content may also be read out and transmitted concurrently from one or more physically distributed storage units to one or more other physically separate sites for playback, where an entire piece of content, such as a movie, may be separated into equal or unequal sized pieces, and one or more pieces may be stored on multiple physically separate storage units. The assignment of the storage locations of the pieces, the order of transmission, priority of transmission, and destination of the pieces is centrally administered and controlled. The content can also be transmitted simultaneously to storage units other than the one needing it for display, to anticipate the need to deliver the same content to other customers in the near future. This allows for dynamic allocation of resources at any time, peak or off-peak, in anticipation of heavy downloading of certain programs, such as new releases.

Further, the data communications network connecting between the storage units can be either wired or wireless. While the Internet is used with the cable modems, other forms of networking connections can work just as well.

As will be appreciated by those skilled in the art, what is disclosed in the following description is a "set-top box" which is coupled to a disk drive, or a file server, either

locally or remotely, where the "set-top box" acts as a file server for other "set-top boxes." As such, the set-top boxes in the aggregate can serve as a massive and yet distributed storage facility for each of the member set-top boxes. The stored programs or files may also be fragmented into pieces of arbitrary sizes for distributed storage or transmission over multiple set-top boxes. Also, what is disclosed is a personal computer which contains a disk drive which can act as a file server for other computers or set-top boxes, where the files may be fragmented into pieces of any arbitrary sizes for distributed storage or transmission over multiple computers or set-top boxes.

Brief Description of the Drawings

Figure **1A** shows a conventional video-on-demand system over a cable broadcast system.

Figure **1B** shows an exemplary video-on-demand system over a cable TV broadcast system, where uses end-users are equipped with cable modems.

Figure **2A** illustrates an example of how a single multimedia server might serve AV content to a hundred users simultaneously.

Figure **2B** illustrates an example of how three cache memories can be inserted in between the multimedia server and the customers.

Figure **3A** is a simplified block diagram of an End Node Equipment at a user's site.

Figure **3B** depicts a simplified block diagram of a conventional VOD system with a centralized server and end node equipment at user's site.

Figure **4A** is a simplified block diagram of an End Node Equipment with cable modem for use with a TV in accordance with the present invention.

Figure **4B** is a simplified block diagram of an End Node Equipment with cable or DSL modem for use with a PC in accordance with the present invention.

Figure **4C** depicts a simplified block diagram of a distributed server system of the present invention.

Figures **5A, 5B** illustrate simultaneous transfer of content from multiple end nodes to reduce playback starting time.

Figure 6 depicts a simplified block diagram of a VOD system based on DSL network.

Figure 7 is a flow diagram depicting the process of distributing content to end node units.

Figures **8A** and **8B** illustrate another embodiment of the VOD system with the content being delivered from a combination of end nodes and content servers.

Detailed Description of the Preferred Embodiment

A method and apparatus for data delivery using distributed storage system is disclosed. In the description that follows, the present invention is described in terms of servers, switches, routers, databases, end nodes, networks and the Internet, which are the terms typically used by those skilled in the art in communicating among themselves. Also, it should be understood by those skilled in the art that the term "data" can represent audio or video content, multimedia content, or simply binary bits transmitted across a communications network.

As previously mentioned, one possible way of reducing the multimedia server's bandwidth requirements is to have storage units along the main network transmission paths to cache the first transmission of the content. Future requests for the same content from other end users can be serviced from the caching storage unit.

Figure **2A** shows an example of how a single multimedia server might be requested to serve AV content to a hundred users simultaneously. Many customers may be viewing the same AV content, because some content is more popular than others. For instance, a newly released movie may be much more popular than one several years old. However, it is desirable to allow each customer to start viewing the movie at a time of their own choosing, rather than on a fixed schedule, which happens to be the way cable companies offer video programs. This means that although the same movie is being viewed by more than one customer, the data must be sent in duplicate, because the movies may be viewed at different points in time.

Figure **2B** shows how cache memories may be inserted in between the multimedia server and the customers to ease the delivery demand. Each cache memory serves a smaller group of the full set of customers. If AV content has not been previously stored in

a group's cache memory, it will be provided by the central multimedia server. The AV content will be transferred to the customer, and also temporarily stored in the group cache memory. If another customer in the group requests the same AV content, and the AV content still resides in the cache memory, then the cache memory can readily provide the content. This reduces the load on the central multimedia server and reduces the bandwidth used by the server. However, there is an obvious problem to this approach. If the cache memory is too small, then only a small portion of the AV content can be stored, causing many requests for content to bypass the cache. This reduces the effectiveness in reducing the bandwidth and load on the central multimedia server. However, making the cache memory large will increase the cost.

As will be disclosed, the present invention is directed to providing a solution to the problems with the conventional ways of distributing data such as digital multimedia by having a system of storage units at the end nodes, acting as the primary storage of the multimedia content. A centralized multimedia server could still be used to augment the delivery of multimedia content, but the bulk of the requests for multimedia data from the end nodes will be serviced from the individual storage units at the other end nodes.

Such a distributed server system can address the problems inherent in the current centralized server system when used for distributing time-critical multimedia content. As will be described below, Figures **3A** and **3B** illustrate the conventional system utilizing a centralized server, while Figures **4A, 4B** and **4C** illustrate a distributed server system in accordance with the present invention.

Figure **3A** is a simplified block diagram of a conventional End Node Equipment which can be installed at the user's site. It is generally a set-top box ("STB") coupled to the TV. The STB generally has a cable modem and a digital video and audio decompression circuitry. As shown in Figure **3B**, the multimedia server 1 controls the content database 13, which stores all of the multimedia content. The network switch 2 controls the data transfers among the server, network switch 3, and network switch 4. Network switch 3 switches the data from network switch 2 to the user end nodes 5 through 8, while network switch 4 switches the data from network switch 2 to the user end nodes 9 through 12. In this example, end nodes 5, 8, 9, and 11 are receiving multimedia data from the centralized server 1. The server 1 and switch 2 may be separated

by a long distance, possibly requiring expensive high bandwidth connections. The content data streams A and B for end nodes 5 and 8 are routed from switch 2 to switch 3, while the content data streams C and D for end nodes 9 and 11 are routed from switch 2 to switch 4. Switch 3 then routes the data it receives to end nodes 5 and 8, and switch unit 4 routes the data it receives to end nodes 9 and 11. In this system, all four of the data streams A through D must come from content database 13, through server 1, through switch 2, and then through switches 3 and 4. Because of the time critical nature of the multimedia data, all of the components and network interconnections between the content database 13 and the end users must be very high speed, with low latency. The system as in Figures **3A** and **3B** clearly will have its limitations, particularly when there are a large number of end nodes requesting data simultaneously.

Figure **4A** shows a consumer-oriented End Node equipment for viewing digital video on a TV. Its STB contains the cable modem, a storage unit such as disk storage and digital video and audio decompression circuitry. Of course, there is the TV for displaying the program from the cable. Figure **4B** shows PC-oriented equipment for viewing digital video, using either a cable modem or DSL modem for getting the data to the PC with a storage unit, e.g. disk storage.

For a PC-based end node equipment as shown in Figure **4B**, its operation can be controlled by software written in Sun's Java Media Framework (JMF), which can support several Internet protocols called Real Time Protocol (RTP) and Real Time Streaming Protocol (RTSP). These software programs are generally considered "off the shelf" by those skilled in the art and their capabilities are also well understood by those skilled in the art. Java programs can also be written to use the JMF library to facilitate the transfer of data, which can be programmed to support its transmitting end node and another program to support its receiving end node. Those skilled in the art will also appreciate that software may be written for a PC to control the coordinating tasks.

Currently, for a demonstration and prototype unit, the person running the receiving PC installs the Sun Java Development Kit (JDK) software, available for download at http://www.javasoft.com, and the person can then obtain the receiver software, e.g. via electronic mail from the service vendor.

In a production version of the software for operating the end node equipment, an end user can visit the vendor's web site, to install the receive/transmit software on-line. An auto-start software routine can also be installed in the PC's startup directory so that the receive/transmit software can start up when the PC is turned on or rebooted. The installation program can also store personalization information in a special file, to identify the PC and the current PC user, since several people may share a single PC (this special file is commonly known as a "cookie." file).

The following illustrates how an end node equipment may be initialized at start-up. It should be noted that those skilled in the art can readily devise their own initialization routine and protocol while developing their distribution systems in accordance with the present invention. The following discussion is for illustration purposes only. At start-up, the receive/transmit software resident at the end node equipment, e.g. PC, can send a message to the control software on the service provider's web site, acknowledging that it is ready to receive or transmit if requested, as well as sending the identification information. Upon receipt of the acknowledgement, the service provider's control software knows that that particular PC is available.

Once the service provider's server knows that an end unit is available, it can send commands and data to:

- add new content with the end unit receiving command and data;
- delete old content with the end unit receiving a command;
- transmit existing content with the end unit receiving a command;
- check existing content for tampering or perform other maintenance tasks.

In one embodiment, the control software may need to know when a particular PC is no longer available. This scenario may happen when the user shuts the PC down, when the PC crashes, when the user's power fails, or when the cable network simply stops working. If the user shuts the PC down smoothly, i.e. not abruptly, the control software at the PC can be notified of the shutdown, and can send a message back to the server that it will no longer be available.

If the PC crashes or its availability is removed without notification to the provider's server, the distribution system should preferably recover from that without ruining the viewing user's experience. If a series of transfers is being setup, say because a viewer at

another end node unit wants to watch a movie, then the server can immediately check, e.g. poll, with all of the end units that it thinks are available. If any end node unit fails to respond, then the server could mark that end node unit as unavailable, and substitute another end node unit. The initial transfer list would then always start out with end node units that have been confirmed to be available.

Once the movie starts, the receiving PC can be configured to expect data from each transmitting PC by a certain time. If one PC doesn't deliver data by the scheduled time, due to a possible crash, then the receiving PC can notify the provider's server. The server can then immediately substitute another end unit, by giving the substituted end unit the remaining part of the transfer list, and by notifying the receiving unit of the substituted unit's internet address. To ease the transition, the provider may keep a backup server which would provide the delayed content to the receiving end unit for a few seconds, until the substituted end unit is up to speed.

Reference is now to Figure **4C**. As shown in Figure **4C**, the content database13 is set up so that it can offload some of its duties to the whole distribution system. All of the multimedia data is instead distributed among the storage units local in each of the user end nodes (not shown). It may not be necessary for all of the user end nodes to have local storage units, but system performance is improved when more and more user end nodes have storage units and participate in the distribution. Multimedia server 1 now acts as a centralized administrator, keeping track of how the multimedia content is distributed among the user end nodes. The network connection between server 1 and switch 2 now needs much less bandwidth, because only commands and status information are transferred, and not the multimedia data, the storage of which is now distributed among the end nodes. As will be appreciated by those skilled in the art, the storage unit at each end node can be a hard disk drive, or any kind of storage device capable of storing, transferring and playing back its multimedia content. As the prices of the storage devices plummet due to technological maturity, this form of distributed storage becomes more attractive and cost effective.

In the system exemplified in Figure **4C**, end node 5 wants multimedia content A, end node 8 wants multimedia content B, end node 9 wants multimedia content C, and end node 11 wants multimedia content D, while the storage unit of end node 6 contains multimedia content A, the storage unit of end node 9 contains multimedia content B, the

storage unit of end node 10 contains multimedia content C and D, and the storage unit of end node 12 contains multimedia content B.

The distributed storage system, as illustrated in Figure **4C**, can be initialized by the multimedia server 1 directing various contents, e.g. movies, to be transferred from the content database 13, or wherever contents may be available, to the end nodes. The distribution can be based on the anticipated popularity of certain contents and whether the end nodes are within the same switching network. For example, if there are 200 end nodes sharing the same immediate switching network, e.g. in the same neighborhood, a newly released movie may need to be resident at, say, 10 end nodes to provide assured delivery. The delivery can also come from end nodes at other not-so-immediate switching networks, if the delay is not significant. The other 190 end nodes can be populated with other contents, in fragments, in whole or in combination thereof. This is only the initial phase, since as the demands change, the location and distribution can certainly be changed to reflect the usage, which can be tracked using common tools for statistical analysis.

Moreover, the initialization or subsequent location management can be done during off-peak hours, since no intervention from the consumer should be needed. Therefore, at 3 A.M., while most consumers are asleep, the storage units at their end nodes may be quietly receiving instructions, preferably from the central server, transferring contents, or updating the central server. As new contents are released, the new ones will cause the not-so-new contents to be deleted or replaced, either gradually or all at once. The distributed storage system is thus dynamic and able to continue to adequately support the consumers' ever-changing needs.

Because storage of the content is distributed, end node 6 can act as a server for end node 5. If the network connection between the two nodes is a shared medium, then it may be possible for end node 6 to transmit the content A data directly to end node 5, otherwise it can transmit the content A to end node 5 by sending it to switch 3, which will then send it to node 5, using conventional Internet, or any data communications networking, addressing techniques. The multimedia server 1 can preferably act as a "traffic controller" to receive requests from end node 5, check availability of the requested content, determine the most expedient way of transfer, e.g. from end node 6, and command end node 6 to transfer the content A to end node 5.

Still referring to Figure **4C**, it may happen that when end node 6 is responding to a request for content A from end node 5, the viewer at end node 6 also requests such content A for playback. In such situation, data can be read out of the storage unit, e.g. hard drive, into the processor's memory, whether it is the PC or the STB. Then the data is transferred out of the processor's memory and out to the cable or DSL network. If the same data is needed at very close to the same time for local viewing, that data is likely still cached in the memory and can be sent to the local display. If it isn't still cached in the memory, then the data can be re-read from the storage unit, e.g. hard drive. As can be appreciated by those skilled in the art, current PC systems with their high speed processors and communications functionality, as well as the STBs, can readily handle two sets of read requests simultaneously.

An alternative to the multimedia server acting as a centralized traffic controller is to let each end node broadcast its request to other end nodes. The end nodes with the requested content will monitor the transmission status to determine if it is the best source for the requested content. If so, it will reply and transmit the requested content to the requester. When there are multiple replies to its request, the requesting end node will determine the priority for receiving and notify the source end node(s) of the priority for transmission. If transmission is bogged down, the requesting node can go to the next source end node according to the priority. The second source end node can transmit to pick up where the first source end node leaves off.

Similarly, end node 9 can act as a server for end node 8, providing it with content B, and at the same time, receives content C from end node 10. End node 10 stores content C and D, and can act as a server by sending content C to end node 9 and simultaneously sending content D to end node 11.

The end nodes do not have to be servers by themselves only. They can work, sequentially or concurrently, with other end nodes to complete a delivery. End node 8 can receive content B from both end node 9 and end node 12. This may be desirable to reduce the transmission time of content B, particularly if the upload (direction from the end node to the switch) speed is lower than the download (switch to end node) speed. This is often the case for cable modems and ADSL (Asymmetric Digital Subscriber Line) network technology. It also can be useful in the situation where the playback of the content starts before the entire content has been downloaded to the end node. For instance, the playback

of content B may have started because it was expected that the download from end node 9 only would complete before the end of the content was reached, based on the speed of the early part of the download from end node 9 to end node 8. However, once playback starts, if the download speed is reduced due to unexpected network congestion from switch 4 to switch 3 or due to unexpected reduction in upload speed from end node 9 to switch 4, then the unviewed portion of content B can also be transferred from end node 12 to end node 8.

By way of an example, suppose that end node 8 has received the first 25% of content B from end node 9. Based on the download rate of this first 25% of the content as well as the playback rate for the content, end node 9 starts the playback. In this example, the playback rate is equal to the download rate. At the 30% reception point, the download rate slows down by a factor of 2. If the download rate is not increased, the playback of content B will be interrupted at the 90% point of the movie or song. At, say the 35% point, end node 12 can be commanded to immediately start transferring the last 20% of content B, and end node 9 can be commanded to continue transferring the content from the 35% point but to stop at the 80% point. This method can be useful where the upload transfer rate or the switch to switch transfer rate is lower than the download transfer rate.

The method of simultaneous, or concurrent, transfer from multiple end nodes can also be used to reduce the playback starting time for a network where the playback data rate and the download data rate are higher than the upload data rate. For instance, suppose the playback rate is 2 megabits per second, the download rate is capable of supporting 3 megabits per second, and the upload speed of a single end node is 1 megabit per second. For the network shown in Figure **5A**, end node 5 wants to play content A, which is stored as a number of different fragments in end nodes 6 through 15. The information on the location of the fragments at the different nodes can preferably be stored on the multimedia server 1. The upload and download capability of the different nodes can also be stored on the multimedia server 1, or there could be an immediate test transfer to determine the upload and download speeds.

Referring to Figure **5A**, end node 5 would contact the multimedia server 1, which would coordinate the transfer of the fragments to end node 5 from the other end nodes. In the first phase, end nodes 6, 7, and 8 would transfer their stored fragments to end node 5, which would receive the three fragments concurrently at 3 megabits per second, even

though the individual fragments from each transmitting end node can be uploaded only at 1 megabit per second. Since the fragment containing 0-5% of the content from end node 6 is being transmitted at half the playback speed, end node 5 could not start playing the content until the first half of the fragment has been received. If it started playing any sooner, the data would run out before the fragment could be fully received, causing a gap in the playback.

It may occasionally happen that the Internet address of the end nodes is not fixed, but can change from time to time. A program on each of the end nodes can be used to inform the controlling multimedia server 1 when its Internet address changes.

When the fragments from end nodes 6, 7, and 8 have been transferred to end node 5, the multimedia server 1 could arrange the transfer of the next 15-30% fragments from other end nodes containing the necessary fragments, such as end nodes 9, 10, and 11, as shown in Figure **5B**. While end nodes 9, 10, and 11 are transmitting data to end node 5, end nodes 6, 7, and 8 would become available to transfer data to a different end node, if needed.

It should be noted that while only one content database and one multimedia server is depicted in Figure **5B** for illustration purposes, the entire distribution system in accordance with the present invention may implement multiple content databases with multiple multimedia servers, scattered throughout the county, state or country. Content going to one end unit may come from one or more content servers as well as from multiple other end units. This "aggregation" effect can offload the burden on any one particular server or database, while providing an efficient scheme to achieve content delivery from databases and servers in proximity of the end units.

Referring to Figure **5B**, when end node 5 has completed viewing content A, its storage unit will have a complete copy of all of the fragments of content A. If content A is expected to be popular with other end nodes, e.g. new releases, the entire content could remain stored on end node 5, so it could be delivered to other end nodes, or just a few portions could be kept. What portions to be kept at this end node can be determined based on the storage, or distribution, situation of content A at other end nodes. For example, the storage situation may be such that only the first 30% fragment of content A is needed, since other end nodes may contain sufficient other fragments. If content A is not

expected to be viewed in the near future, it could be deleted immediately, or designated to be the first content to be deleted when other content needs to be stored in end node 5's storage unit.

Reference is now turned to Figure 7, where a flow diagram depicting the process of distributing content to end node units as directed by the server is described. As shown in Figure 7, end-user unit (EUU1) notifies the central server it is on-line, active and ready, for example, after the EUU1 is first installed at an end-user's house. Upon such notice, the central server transmits data block N to EUU1 for storage. When EUU2 requests data block N from the central server, the central server will notify EUU2 that data block N will be transmitted from EUU1. The central server can thus command EUU1 to transmit the requested data block to EUU2. At this point, the Internet transmit address is EUU1's, while the Internet receiver address is EUU2's. Upon receipt of the requested data block, EUU2 notifies the central server that transmission is now completed.

Reference is now to Figures **8A** and **8B**, where another embodiment of the VOD system in accordance with the present invention is shown. It should be pointed out that in the system previously shown in Figures **5A** and **5B**, a number of end nodes are served by a single multimedia server 1. Figures **8A** and **8B** show an alternative to, or elaboration of, this system, where the multimedia server's function has been split, or essentially off-loaded, into separate parts, and the content is delivered from a combination of end nodes and multimedia content servers. The content delivery is now accomplished by distributed content servers as well as by other end nodes, or the combination of servers and end nodes.

In this system as shown in Figures **8A** and **8B**, the end nodes C and D may be personal computers (PC's) or other equipment which normally reside in a home. Control Server A may be an Internet server computer which performs the control and coordination role. An example of this Internet server computer is a Compaq Proliant server or its equivalent, using the Microsoft NT operating system. Web Server B may be an Internet server computer, an example of which is Sun Microsystems' Enterprise server or its equivalent, using the Sun Solaris operating system, which delivers web pages to end nodes, but which may or may not hold the multimedia content. Multimedia Content Servers E and F may be Internet server computers which hold multimedia content. Although the functions are separated for this example, it is possible for an Internet server

computer to perform and combine the control, web serving, and multimedia content serving functions in any combination, as can be appreciated by those skilled in the art.

Figures **8A** and **8B** show another embodiment of the VOD system, in accordance with the present invention, delivering multimedia data to an end node from a combination of multimedia content servers and end nodes. This embodiment thus makes it possible to build a system which delivers multimedia data to an end node, or multiple end nodes, only from multimedia content servers.

As previously described in the present application, the multimedia content, such as a movie file, may first be fragmented into smaller files, and the smaller files may be distributed for storage by end nodes and/or other servers. For this example, the content fragments would be distributed onto End Node C (step 3), End Node D (step 4), Multimedia Content Server E (step 3), and Multimedia Content Server F (step 3). The present invention also makes it possible to distribute copies of the file fragments to additional end nodes or servers, so that each file fragment may reside on more than one end node or server. This redundancy can allow the substitution of one end node or server for another, which may be useful if an end node or server is slow in transmitting data. The data may reside on these end nodes and servers, and may be transmitted when needed.

Also, as previously described, the viewing end node may contain some software which may re-integrate the file fragments into the original file order. Finally, the end nodes or Internet servers which hold the movie file fragments may contain some software which allows it to accept commands from a control server and to deliver the file fragments to an end node or to an Internet server.

In Figure **8A**, step 1 occurs when a user at End Node D, say, wishes to view a movie. It sends a request to Web Server B for the movie data. In step 2, Web Server B passes the request to Control Server A. Control Server A then determines which end nodes or Internet servers contain the desired movie file fragments. In step 3, Control Server A sends instructions to End Node C, Multimedia Content Server E, and Multimedia Content Server F to deliver the desired movie file fragments to End Node D. In step 4, shown in Figure **8B**, End Node C, Multimedia Content Server E, and Multimedia Content Server F together deliver the movie file fragments to End Node D. It should be pointed that the re-integration, or re-assembly, of the various fragments can be done by the viewing end node, if each fragment is coded to provide unique identification with respect

to other fragments from the same title. Such re-integration or re-assembly may also let the viewing end node obtain a "script" of the fragments to be delivered from the server responding to the viewing end node's initial request. This "script" will facilitate the re-integration and re-assembly of the fragments, much like an instruction manual on how to assemble a bicycle.

It should be pointed out that once a movie title, or a data file, is fragmented, each fragment should have a unique code identifying its position in the full length movie. Preferably a standardized way of position-coding the movie or data file is established, in a similar manner Internet files are packetized and delivered separately throughout the Internet, only to be reassembled at the last point for the reception.

Although it is not shown, it should be apparent to those skilled in the art that it is possible for Web Server B to also act as a multimedia content server.

It should be noted that each fragment of data being stored by an EUU can be encrypted with a different encryption key for security reasons. For example, if an EUU stores 5 fragments from 5 programs, i.e. 1 fragment from 1 program, each fragment can have its own encryption key. Having the fragments or programs encrypted will prevent any unauthorized access of the EUU by its user. As can be appreciated by those skilled in the art, the storage in each EUU is preferably transparent to the user, whether the EUU contains a full-length feature or a collection of fragments of various contents.

In accordance with the above disclosure, the present invention provides continuous playback of content, with a minimal amount of waiting, even though the upload transmission rate of content from a single end node is lower than the playback and download rates of the playing end node by fragmenting the content and distributing the content among a large number of networked storage nodes. The present invention also allows multiple end nodes to view the same content, with a small delay between each viewing, where the delay is set by the time duration of a fragment. The present invention can be used with any means of two way transmission of data. For instance, the network could use DSL (digital subscriber line) technology shown in Figure **6**, instead of, or in conjunction with, the cable TV technology shown in Figure **1.**

While the present invention for data delivery has largely been described in terms of implementing a video-on-demand system with distributed storage, it should be appreciated

by those skilled in the art the present invention can also implement a "data-on-demand" system. In such a system, the storage unit at each end-user's site will store data for access by other users or by itself. The stored data can also be portions, or fragments, of distinct kinds of data, which can be assembled with other portions stored elsewhere to form a complete piece, provided there is mechanism, e.g. via a central server, to control, track and manage the storage, transmission and assembly of the data. Also, it may behoove those who manage such networks to implement data security and encryption measures to prevent the uninvited access of stored data by the end-user.

The invention may be conveniently implemented using a conventional general purpose digital computer and programmed according to the teachings of the present invention, as will be apparent to those skilled in the art. Appropriate software coding can readily be done by skilled programmers based on the teachings of the present disclosure, as will be apparent to those skilled in the software art.

The invention may also be implemented by the preparation of application specific integrated circuits or by interconnecting an appropriate network of conventional component circuits, as will be readily apparent to those skilled in the art.

The present invention also includes a computer program product which is a storage medium including instructions which can be used to program a computer to perform a process of the invention, such as the storage of the distributed programs, or the content flow control of the distribution network. The storage medium can include, without limitation, any type of disk including floppy disks, optical disks, CD-ROMs and magneto-optical disks, ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions. As an apparatus embodying the present invention is operated, the device processes signals which are physical phenomena and control the device in a appropriate manner so that the desired results of the invention are achieved.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A data on-demand system for delivering data on-demand to a requesting end-user unit ("Requesting EUU") in a communications network, comprising:

a plurality of end-user units ("EUUs"), at least one of said EUU ("First Source EUU") adapted to receive a data file through said communications network, to store said data file and to transmit said data file through said communications network;

a server adapted to direct transmission of data files through said communications network among said plurality of EUUs,

wherein said server and said First Source EUU are adapted:

to permit said server to transmit said data file through said communications network to said First Source EUU;

to store said data file in said First Source EUU; and

to permit said server, in response to an instruction received from said Requesting EUU, to cause said First Source EUU to transmit said data file through said communications network to said Requesting EUU.

2. A data on-demand system as in Claim 1, wherein said server is additionally adapted to track information regarding the location of said data file at said First Source EUU.

3. A data on-demand system as in Claim 1, wherein said data file comprises at least one of the following:

an integral multimedia program;

at least one fragment of an integral multimedia program;

a combination of fragments of a plurality of integral multimedia programs.

4. A system according to Claim 1, further comprising a Second Source EUU, wherein:

said Second Source EUU is adapted to receive and store said data file as said data file is stored by said First Source EUU; and

said server and said Second Source EUU are adapted to cause said Second Source EUU to begin transmitting said data file to said Requesting EUU when transmission from said First Source EUU meets one or more of predetermined criteria.

5. A system according to Claim 1, wherein said server is adapted to cause said First Source EUU to replace said data file in storage with at least one other data file based on at least one predetermined criterion.

6. A server for managing and delivering data files on-demand to a plurality of end-user units ("EUUs") connected through a data communications network, the server comprising:

a central processing unit ("CPU");

a memory operatively connected to said CPU, said memory containing a program adapted to be executed by said CPU, wherein:

said CPU and said memory operatively adapted to distribute a plurality of data files to said plurality of EUUs for storage based on at least one of predetermined criteria, while tracking the locations of said data files at said plurality of EUUs,

said CPU and said memory operatively adapted to receive a demand from a first EUU for at least one data file,

said CPU and said memory operatively adapted to locate said at least one data file at a second EUU and to instruct said second EUU to transmit said at least one data file to said first EUU according to said demand.

7. A server according to Claim 6, wherein:

said CPU and said memory operatively adapted to receive a demand from a third EUU for a combination of a first data file and a second data file,

said CPU and said memory operatively adapted to locate said first data file stored at a fourth EUU and said second data file stored at a fifth EUU,

said CPU and said memory operatively adapted to instruct said fourth and fifth EUUs to transmit said first and second data files to said third EUU according to said demand.

8. A server according to Claim 7, wherein said combination of first and second data files demanded by said third EUU constitute 2 fragments from an integral data file.

9. A server according to Claim 7, wherein:

said CPU and said memory operatively adapted to locate and manage a plurality of data files and sequence transmission of said data files according to demands.

10. A server according to Claim 6, wherein:

said CPU and said memory operatively adapted to track usage information among said plurality of EUUs;

said CPU and said memory operatively adapted to re-distribute data files among said plurality of EUUs for storage in response to said usage information;

said CPU and said memory operatively adapted to add new data files for distribution among said plurality of EUUs for storage when said new data files are available.

11. An end-user unit for a data on-demand system, comprising:

a processor;

a modem adapted to connect with a data communications network to receive a data file, said modem also adapted to transmit at least a portion of said data file through said data communication network to a second end-user unit specified by the server;

a storage unit adapted to store said data file in response to an instruction from a server connected to the data communication network.

12. A method of delivering at least one data file on-demand from a central storage to a plurality of end-user units ("EUUs") through a communications network, comprising:

a) storing at least one data file at said central storage;

b) initializing a first EUU by transmitting at least a portion of said data file to said first EUU;

c) storing said portion of data file at said first EUU;

d) tracking information regarding location of said portion of data file;

e) determining location for said portion of data file, when a second EUU issues a demand for said data file;

f) issuing instruction to said first EUU for said portion of data file stored at said first EUU;

g) upon receipt of said instruction, said first EUU transmitting said portion of data file to said second EUU.

13. The method according to Claim **12**, the method further comprising:

a) initializing a third EUU by transmitting at least said portion of data file to a third EUU for storage;

b) tracking information regarding location of said data file at said third EUU;

c) monitoring transmission from said first EUU to said second EUU;

d) if transmission from said first EUU to said second EUU falls below a predetermined criterion, issuing instruction to said third EUU for

transmission of said portion of data file to said second EUU and issuing instruction to said first EUU to terminate its transmission;

e) upon receipt of said instruction, said third EUU transmitting said portion of data file to said second EUU.

14. A method of delivering at least one data file on-demand to at least one of a plurality of end-user units ("EUUs") through a communications network, comprising:

a) providing a plurality of data files accessible through said communications network;

b) distributing said plurality of data files to a plurality of EUUs for storage;

c) tracking information regarding respective storage locations of said plurality of data files at said plurality of EUUs;

d) when a requesting EUU issues a demand for at least one of said plurality of data files, locating at least one EUU storing said at least one of said plurality of data files from said plurality of EUUs based on at least one of predetermined criteria;

e) causing the identified EUU to transmit said at least one data file to said requesting EUU.

15. The method according to Claim 14, wherein said predetermined criteria in the step d) of identifying comprises at least one of the following criteria:

quality of transmission between each of said plurality of EUUs to said second EUU;

proximity of each of said first plurality of EUUs relative to said second EUU;

needs of each of said plurality of EUUs relative to a second plurality of EUUs.

16. The method according to Claim 14, wherein said plurality of data files comprises multimedia programs and data.

17. A method of delivering multimedia programs on-demand from a remote storage to a plurality of end-user units ("EUUs") through a communications network, comprising the steps of:

a) storing at least one multimedia program at said remote storage;

b) initializing a first EUU by transmitting at least a first portion of said multimedia program to said first EUU;

c) storing said first portion of said multimedia program at said first EUU;

d) initializing a second EUU by transmitting at least a second portion of said multimedia program to said second EUU;

e) storing said second portion of said multimedia program at said second EUU;

f) tracking information regarding storage locations of said first and second portions of said multimedia program at said first EUU and second EUU;

g) when a third EUU issues a demand for said multimedia program, directing said first and second portions of said multimedia program to be transmitted to said third EUU;

h) upon receipt of said first and second portions of said multimedia program, said third EUU assembling said multimedia program for downloading.

18. The method according to Claim 17, wherein said multimedia program comprises at least one of video programs, audio programs or movie programs.

19. The method according to Claim 17, wherein each portion of said multimedia program is encrypted with a predetermined encrypted key.

20. In a data communication network with a plurality of clients and servers, a method of delivering at least one data file from a plurality of data files on demand to a first client, comprising the steps of:

a) distributing said plurality of data files to at least one of said plurality of clients and servers for storage based on a predetermined distribution scheme;

b) tracking each of said data files as to its location;

c) upon receiving a request for one of said plurality of data files from said first client;

d) locating from at least one of said clients and said servers storing said requested data file;

e) instructing at least one of said clients and said servers to transmit said requested data file to said first client.

21. The method according to claim **20**, wherein said predetermined distribution scheme is based on at least one of: location of the clients and servers, and popularity of the data files.

22. A method of conducting a VOD service using a communications network, comprising the steps of:

a) providing a plurality of movies which are accessible through at least one server in said communications network;

b) distributing a plurality of set-top boxes ("STBs") to a plurality of clients, at least a portion of the STBs being capable of storing, presenting and transmitting said movies upon a predetermined request;

c) storing the plurality of movies, in fragments or in whole, throughout said STBs and said at least one server, and keeping track of the locations of the fragments of said movies;

d) upon request from one of the clients for a movie from said plurality of movies, locating said movie, in fragments or in whole;

e) upon locating said movie, in fragments or in whole, among said STBs and said at least one server, causing said movie, in fragments or in whole, to be delivered to the requesting client.

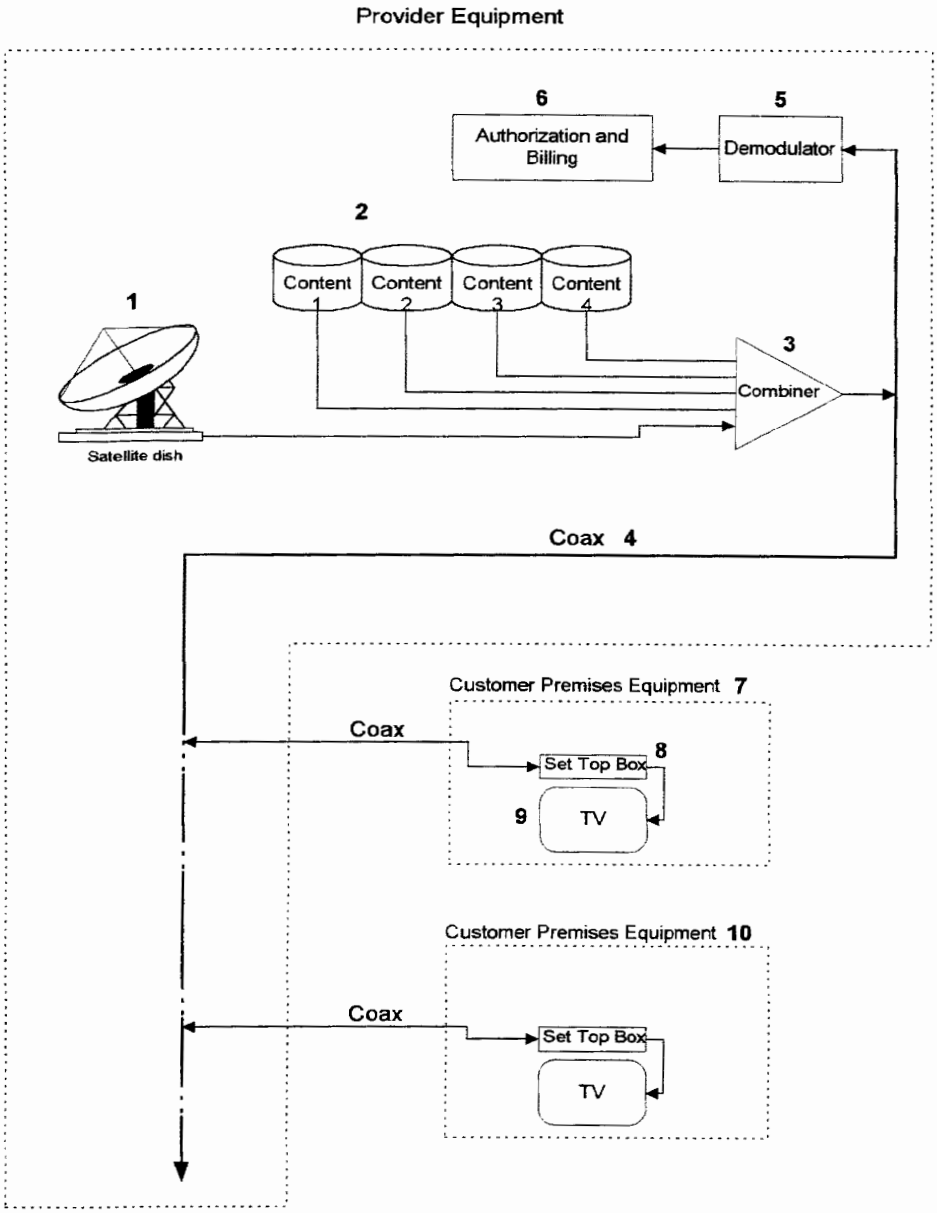

Provider Equipment
6
Authorization and Billing
5
Demodulator
2
Content 1
Content 2
Content 3
Content 4
1
3
Combiner
Satellite dish
Coax 4
Customer Premises Equipment 7
Coax
8
Set Top Box
9
TV
Customer Premises Equipment 10
Coax
Set Top Box
TV

Figure 1A

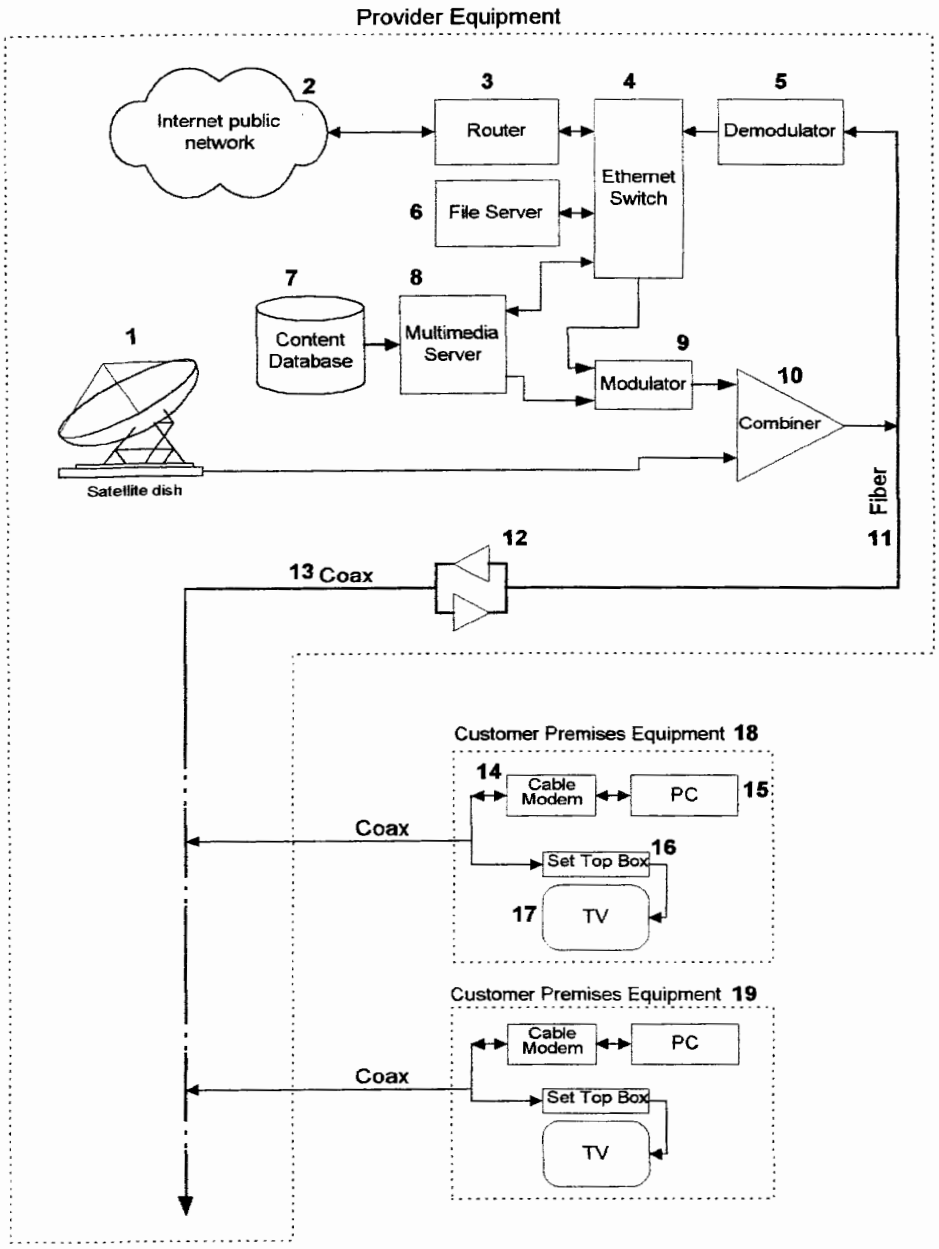

Provider Equipment
Internet public network
2
3
Router
4
Ethernet Switch
5
Demodulator
6
File Server
7
Content Database
8
Multimedia Server
9
Modulator
10
Combiner
1
Satellite dish
Fiber
11
12
13 Coax
Customer Premises Equipment 18
14
Cable Modem
PC
15
Coax
16
Set Top Box
17
TV
Customer Premises Equipment 19
Cable Modem
PC
Coax
Set Top Box
TV

Figure 1B

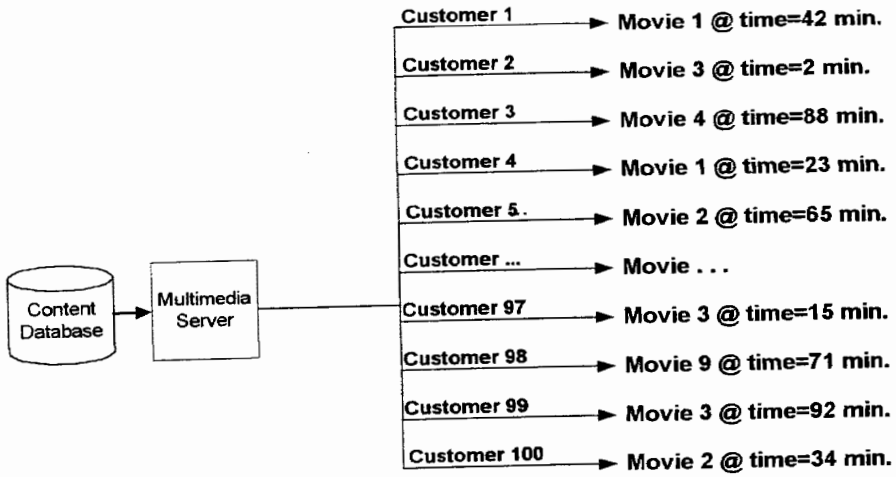


Figure 2A

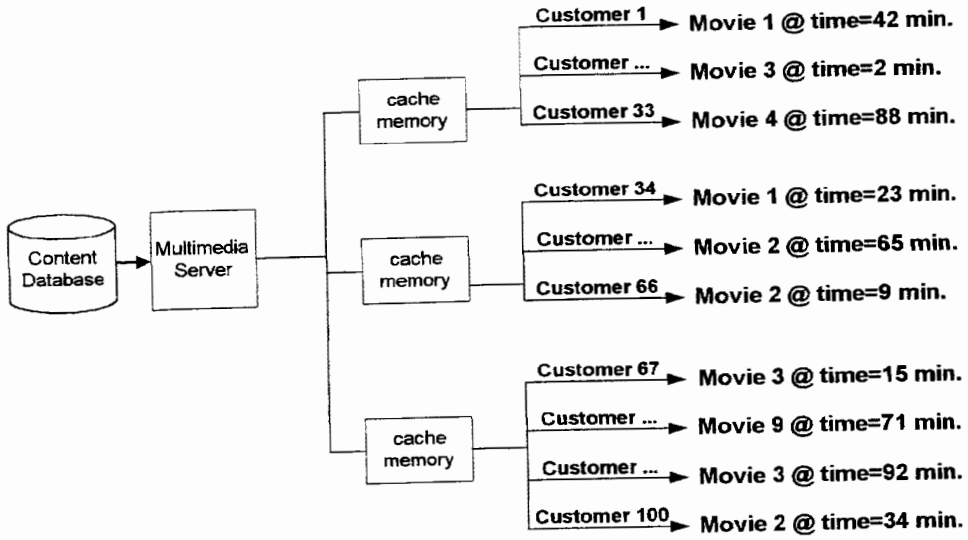


Figure 2B

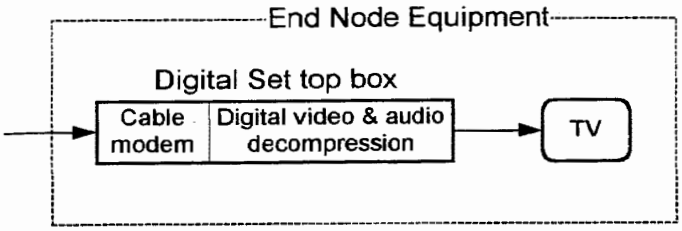


Figure 3A - Conventional End Node Equipment

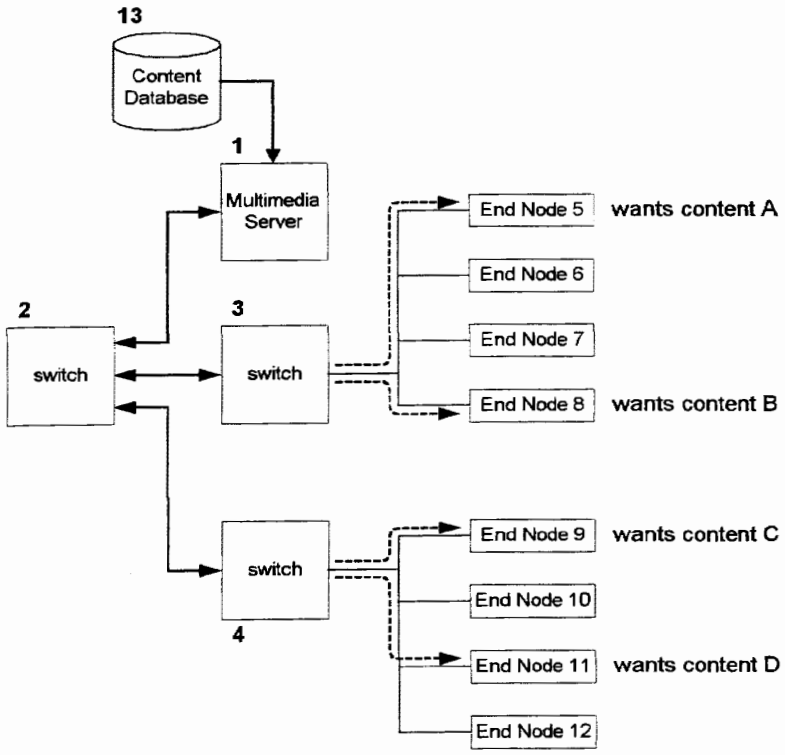


Figure 3B

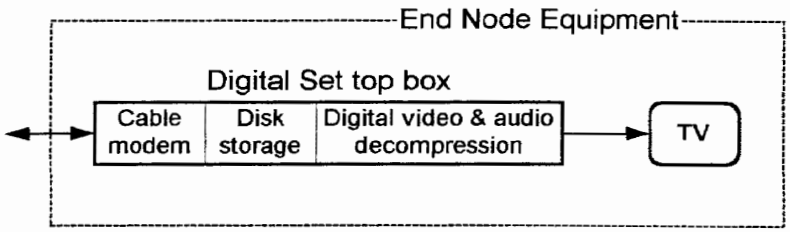


Figure 4A

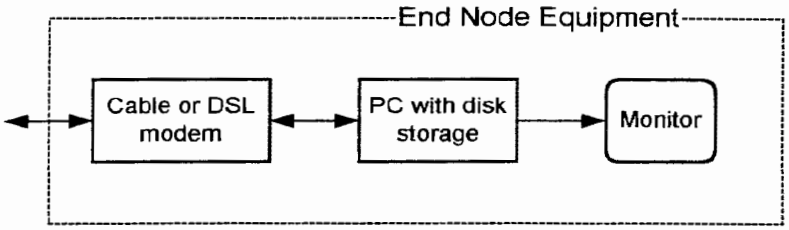


Figure 4B

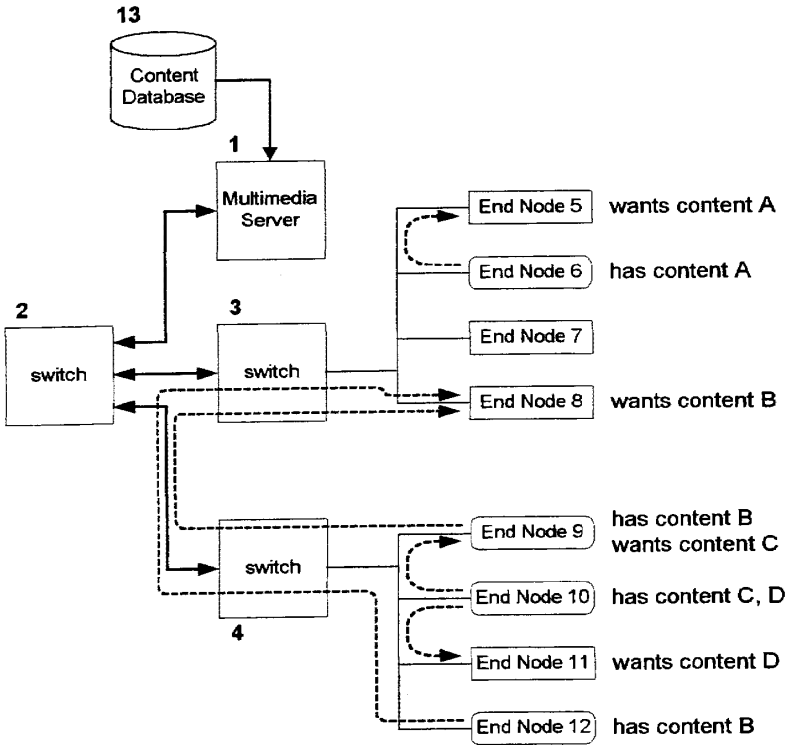

13
Content Database
1
Multimedia Server
2
switch
3
switch
4
switch
End Node 5
wants content A
End Node 6
has content A
End Node 7
End Node 8
wants content B
End Node 9
has content B
wants content C
End Node 10
has content C, D
End Node 11
wants content D
End Node 12
has content B

Figure 4C

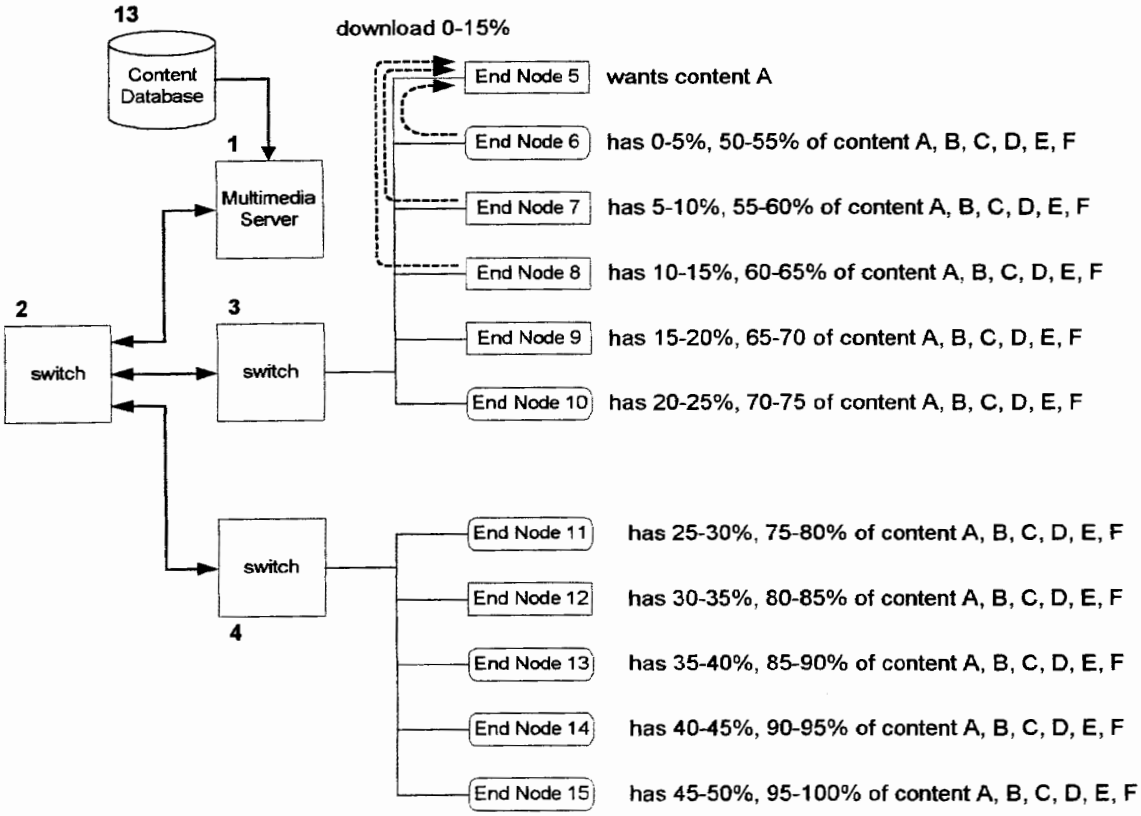

13
Content Database
download 0-15%
End Node 5
wants content A
1
Multimedia Server
End Node 6
has 0-5%, 50-55% of content A, B, C, D, E, F
End Node 7
has 5-10%, 55-60% of content A, B, C, D, E, F
End Node 8
has 10-15%, 60-65% of content A, B, C, D, E, F
2
3
switch
switch
End Node 9
has 15-20%, 65-70 of content A, B, C, D, E, F
End Node 10
has 20-25%, 70-75 of content A, B, C, D, E, F
switch
End Node 11
has 25-30%, 75-80% of content A, B, C, D, E, F
End Node 12
has 30-35%, 80-85% of content A, B, C, D, E, F
4
End Node 13
has 35-40%, 85-90% of content A, B, C, D, E, F
End Node 14
has 40-45%, 90-95% of content A, B, C, D, E, F
End Node 15
has 45-50%, 95-100% of content A, B, C, D, E, F

Figure 5A

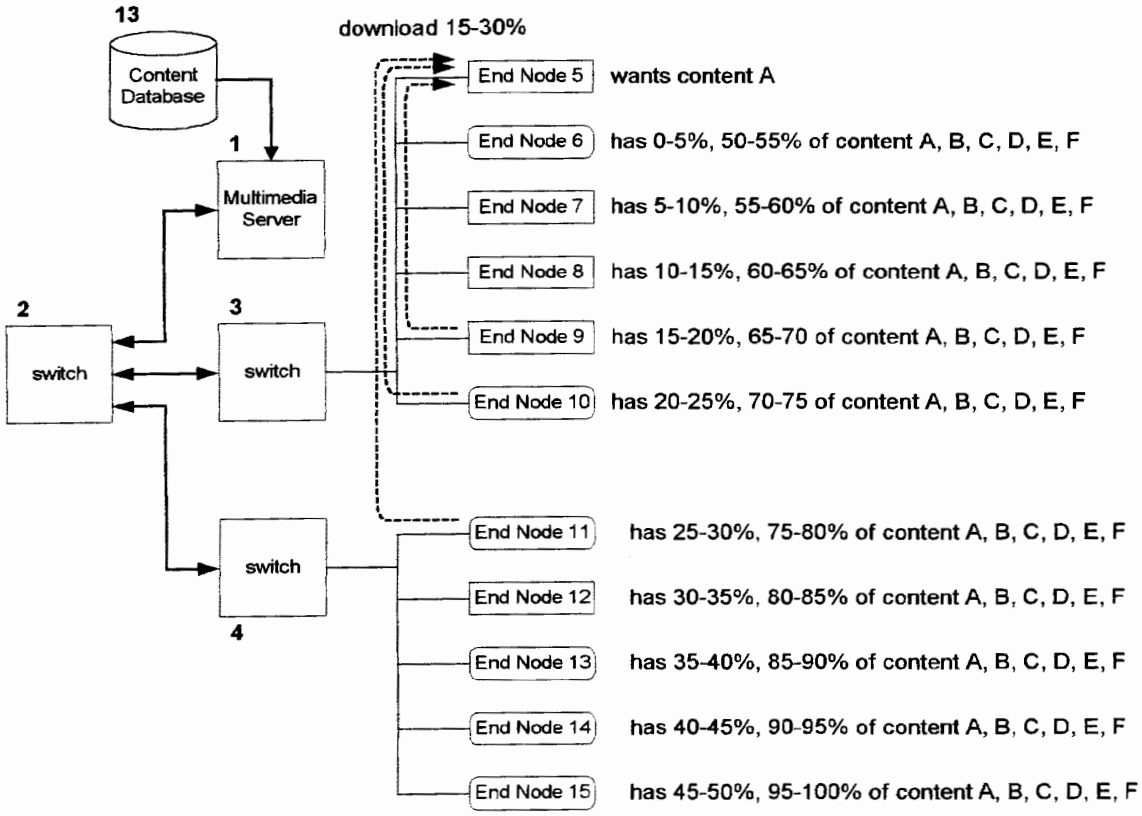

13
Content Database
1
Multimedia Server
2
switch
3
switch
4
switch
download 15-30%
End Node 5
wants content A
End Node 6
has 0-5%, 50-55% of content A, B, C, D, E, F
End Node 7
has 5-10%, 55-60% of content A, B, C, D, E, F
End Node 8
has 10-15%, 60-65% of content A, B, C, D, E, F
End Node 9
has 15-20%, 65-70 of content A, B, C, D, E, F
End Node 10
has 20-25%, 70-75 of content A, B, C, D, E, F
End Node 11
has 25-30%, 75-80% of content A, B, C, D, E, F
End Node 12
has 30-35%, 80-85% of content A, B, C, D, E, F
End Node 13
has 35-40%, 85-90% of content A, B, C, D, E, F
End Node 14
has 40-45%, 90-95% of content A, B, C, D, E, F
End Node 15
has 45-50%, 95-100% of content A, B, C, D, E, F

Figure 5B

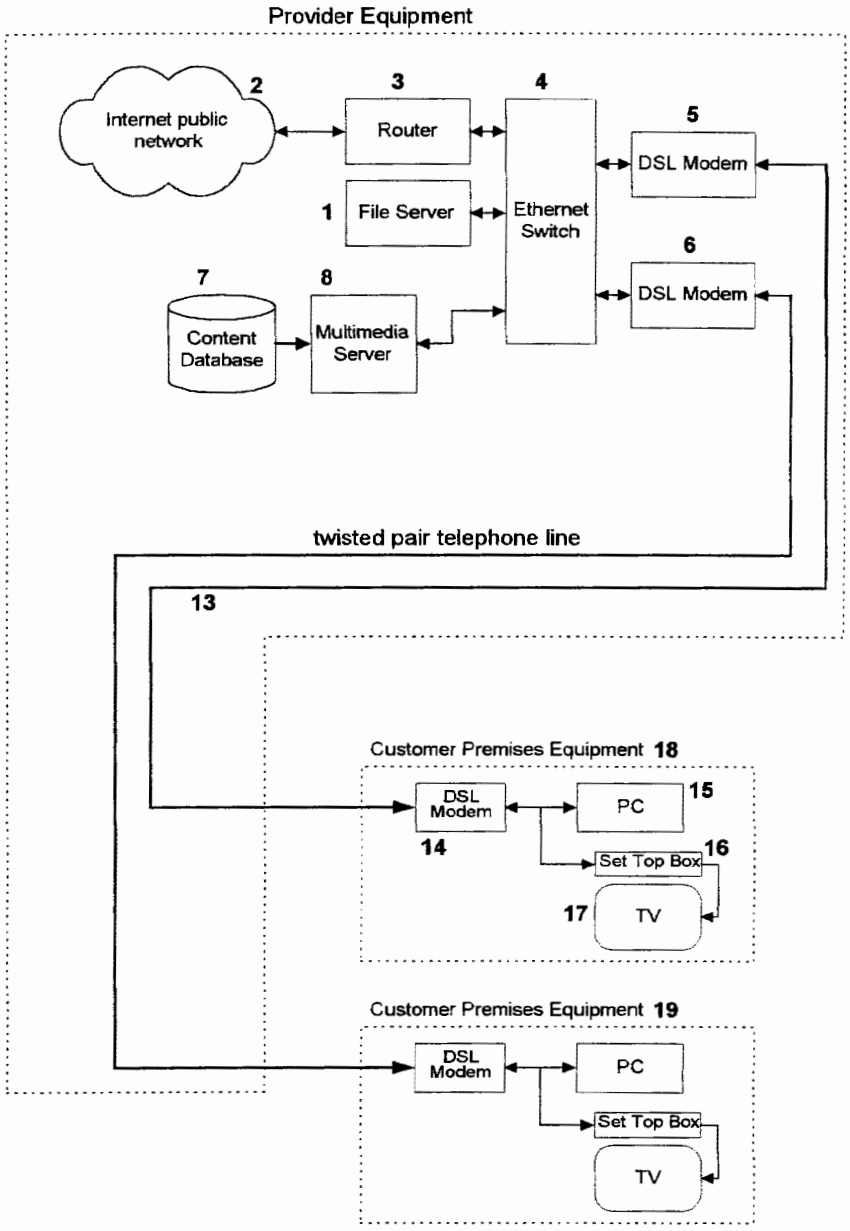

Provider Equipment
Internet public network
2
Router
3
Ethernet Switch
4
DSL Modem
5
File Server
1
DSL Modem
6
Content Database
7
Multimedia Server
8
twisted pair telephone line
13
Customer Premises Equipment 18
DSL Modem
14
PC
15
Set Top Box
16
TV
17
Customer Premises Equipment 19
DSL Modem
PC
Set Top Box
TV

Figure 6

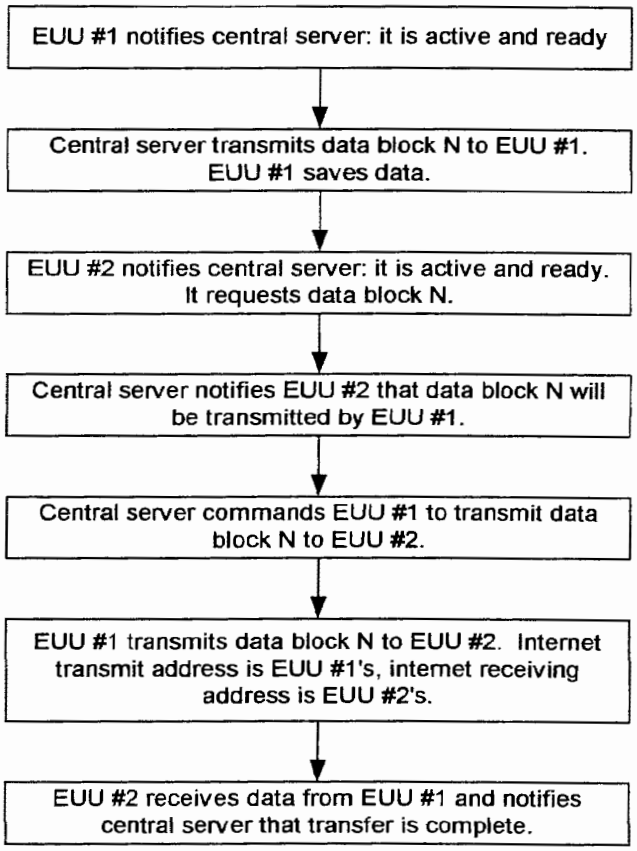

EUU #1 notifies central server: it is active and ready
Central server transmits data block N to EUU #1. EUU #1 saves data.
EUU #2 notifies central server: it is active and ready. It requests data block N.
Central server notifies EUU #2 that data block N will be transmitted by EUU #1.
Central server commands EUU #1 to transmit data block N to EUU #2.
EUU #1 transmits data block N to EUU #2. Internet transmit address is EUU #1's, internet receiving address is EUU #2's.
EUU #2 receives data from EUU #1 and notifies central server that transfer is complete.

Figure 7

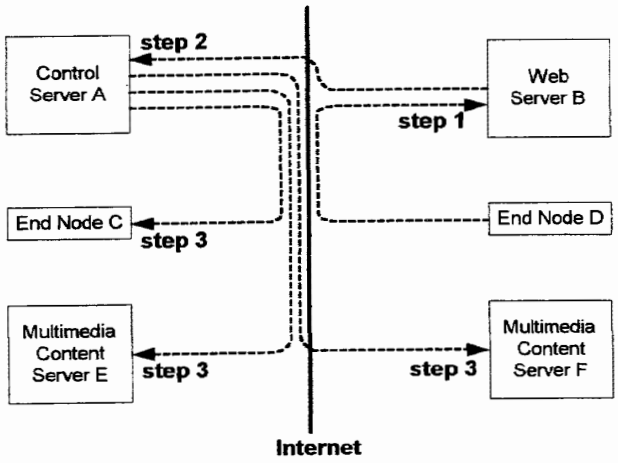


Figure 8A

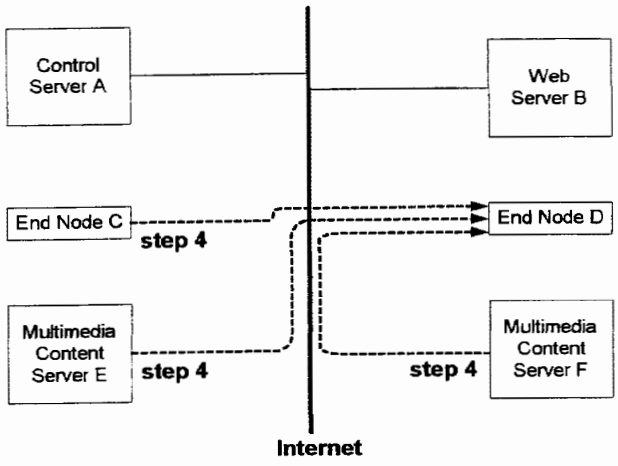


Figure 8B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/21127

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04N 7/173
US CL :709/219

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 709/219; 345/327; 348/7,12,13; 455/4.2, 5.1; H04N 7/173, 7/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,815,194 A (UEDA) 29 September 1998 whole document	1-22
A	US 5,873,022 A (HUIZER et al.) 16 February 1999 whole document	1-22
A	US 5,884,141 A (INOUE et al.) 16 March 1999 whole document	1-22

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Date of the actual completion of the international search 10 NOVEMBER 2000	Date of mailing of the international search report 08 JAN 2001
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Electronic Acknowledgement Receipt

EFS ID:	23741437
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	09-OCT-2015
Filing Date:	17-APR-2013
Time Stamp:	14:26:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS.pdf	707253 914490b410439fbdf6f00be988f0cc0b07360106	no	5

Warnings:	
Information:	

2	Foreign Reference	JP2003169089.pdf	1819191 9d9f707f6897394efd823384531ccbee8c02e9ff	no	22
Warnings:					
Information:					
3	Foreign Reference	JP2003506765.pdf	2102143 28262bc3a8cb4c09b8b12c5eb5a6a3609d9297b6	no	46
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4	Foreign Reference	WO0110125A1.pdf	1576645 b65f9570bbb587ec501b672b075480c4fd45448b5	no	38
Warnings:					
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6	Other Reference-Patent/App/Search documents	13297000_NOA_9-21-15.pdf	753177 e07fb2ecb5293148338e3682df7f2b9cfe1ab780	no	17
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13	Other Reference-Patent/App/Search documents	JP2014-220704_NoticeOfRejection_9-15-15.pdf	155605 4c4284e08a78c78c60e19290456dcb307dc22059	no	7
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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

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	2	6122668		2000-09-19	TENG; Peter Y. et al.	
	3	6449653		2002-09-10	KLEMETS; Anders Edgar et al.	
	4	6823225		2004-11-23	SASS; Jonathan	
	5	7068596		2006-06-27	MOU; Hensen	
	6	7313593		2007-12-25	PULITO; Brian et al.	
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	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

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	1	20010047377		2001-11-29	SINCAGLIA; Nicholas William et al.	
	2	20020159596		2002-10-31	DURAND; Julian et al.	
	3	20020165721		2002-11-07	CHANG; Kenneth H.P. et al.	
	4	20030219007		2003-11-27	BARRACK; Craig et al.	
	5	20040012620		2004-01-22	BUHLER; Rene et al.	
	6	20040048569		2004-03-11	KAWAMURA; Harumi	
	7	20040080671		2004-04-29	SIEMENS; Duane et al.	
	8	20040224638		2004-11-11	FADELL; Anthony M. et al.	
	9	20050015551		2005-01-20	EAMES; Russell Mark et al.	
	10	20050131558		2005-06-16	BRAITHWAITE; Michael et al.	

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	11	20050166135		2005-07-28	BURKE; David G. et al.	
	12	20060193454		2006-08-31	ABOU-CHAKRA RABIH . et al.	

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	1	"Advisory Action mailed on 28 July 2015, issued in connection with U.S. Patent Application No. 14/184522, filed on 19 February 2014, 7 pages".	☐
	2	"BAUDISCH et al., "Flat Volume Control: Improving Usability by Hiding the Volume Control Hierarchy in the User Interface", 2004, 8 pages.".	☐
	3	"CHAKRABARTI et al., "A Remotely Controlled Bluetooth Enabled Environment", IEEE, 2004, pp. 77-81.".	☐
	4	"SCHMANDT et al., "Impromptu: Managing Networked Audio Applications for Mobile Users", 2004, 11 pages.".	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	5	"Final Office Action mailed on 10 August 2015, issued in connection with U.S. Patent Application No. 14/290493, filed on 29 May 2014, 26 pages.".	☐
	6	"Final Office Action mailed on 11 August 2015, issued in connection with U.S. Patent Application No. 13/864247, filed on 17 April 2013, 15 pages".	☐
	7	"Final Office Action mailed on 15 July, 2015, issued in connection with U.S. Patent Application No. 14/504812, filed on 2 October 2014, 18 pages".	☐
	8	"Final Office Action mailed on 3 August 2015, issued in connection with U.S. Patent Application No. 13/848921, filed on 22 March 2013, 13 pages".	☐
	9	"FULTON et al., "The Network Audio System: Make Your Application Sing (As Well As Dance)!", The X Resource, 1994, 14 pages.".	☐
	10	"HANS et al., "Interacting with Audio Streams for Entertainment and Communication", 2003, 7 pages.".	☐
	11	"LEVERGOOD et al., "AudioFile: A Network-Transparent System for Distributed Audio Applications", Digital Equipment Corporation, 1993, 109 pages.".	☐
	12	"Notice of Allowance mailed on 10 August 2015, issued in connection with U.S. Patent Application No. 13/848904, filed on 22 March 2013, 9 pages".	☐
	13	"Notice of Allowance mailed on 12 August 2015, issued in connection with U.S. Patent Application No. 13/435739, filed on 30 March 2012, 27 pages".	☐
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	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	16	"Notice of Allowance mailed on 17 July 2015, issued in connection with U.S. Patent Application No. 13/864251, filed on 17 April 2013, 20 pages".	☐
	17	"Notice of Allowance mailed on 29 July 2015, issued in connection with U.S. Patent Application No. 13/359976, filed on 27 January 2012, 28 pages".	☐
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	21	"Notice of Allowance mailed on 5 August 2015, issued in connection with U.S. Patent Application No. 13/435776, filed on 30 March 2012, 26 pages".	☐
	22	"NUTZEL et al., "Sharing Systems for Future HiFi Systems", IEEE, 2004, 9 pages.".	☐
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☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-08-21
Name/Print	Benjamin M. Urban	Registration Number	71,591

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EFS ID:	23282236
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	22-AUG-2015
Filing Date:	17-APR-2013
Time Stamp:	00:09:07
Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS.pdf	708558 d1920d699f77a4a5d558b8ccaaf996a898ece433	no	7

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18	Non Patent Literature	13359976_NOA_7-29-15.pdf	1036691 cec3a24f34a1aa66bc1acacc918278cd7a63a9ce	no	28
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	Application Number	13864249
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	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5726989		1998-03-10	DOKIC; Miroslav V.	
	2	5923869		1999-07-13	KASHIWAGI; Yoshiichiro et al.	
	3	6108485		2000-08-22	KIM; Jeong-Kyu	
	4	6343028		2002-01-29	KUWAOKA; Toshiharu	
	5	6687664		2004-02-03	SUSSMAN; Robert et al.	
	6	6778493		2004-08-17	ISHII; Atsushi	
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	2	20030035072		2003-02-20	HAGG; Wilhelm	
	3	20030198254		2003-10-23	SULLIVAN; Gary E. et al.	
	4	20030198255		2003-10-23	SULLIVAN; Gary E. et al.	
	5	20030200001		2003-10-23	GODDARD; Mark D.	
	6	20040248601		2004-12-09	CHANG; Chin-Chi	
	7	20060098936		2006-05-11	IKEDA; Wataru et al.	
	8	20070043847		2007-02-22	CARTER; Harry N. et al.	
	9	20100284389		2010-11-11	RAMSAY; Max et al.	

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	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	10	20100299639		2010-11-25	RAMSAY; Max Gordon et al.		

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	1	"Advisory Action mailed on 1 June 2015, issued in connection with U.S. Patent Application No. 14/516867, filed on 17 October 2014, 11 pages".	☐
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	9	"Notice of Allowance mailed on 2 July 2015, issued in connection with U.S. Patent Application No. 13/848904, filed on 22 March 2013, 17 pages".	☐
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Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-07-10
Name/Print	Benjamin M. Urban	Registration Number	71,591

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	22880700
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	10-JUL-2015
Filing Date:	17-APR-2013
Time Stamp:	18:42:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS.pdf	708015 d69ceac320d47b934253d5c705d4d95c5bb4439c	no	6

Warnings:	
Information:	

2	Non Patent Literature	14516867_Advisory_Action_6-1-15.pdf	616982 3050ba39fb3247f76c85a3bd34cf48d66e7055ba	no	11
Warnings:					
Information:					
3	Non Patent Literature	Baldwin_2009_Reference.pdf	903362 8422d4841e69a7c92fd17aabe0be48a687b08db3	no	4
Warnings:					
Information:					
4	Non Patent Literature	14184522_Final_OA_6-15-15.pdf	1039401 500960021d5c52b1643c0d46ae9b5bbbdbc1c826	no	25
Warnings:					
Information:					
5	Non Patent Literature	13848932_Non-Final_OA_6-12-15.pdf	513062 96ccb5337b8cafed96c91c39264e5f0b3513cd9e	no	16
Warnings:					
Information:					
6	Non Patent Literature	13533105_Non-Final_OA_6-19-15.pdf	1289356 8300207d63e690baa8e42f54863f97e4466e1d30	no	38
Warnings:					
Information:					
7	Non Patent Literature	13705176_Non-Final_OA_6-23-15.pdf	1076722 bd20eb51ad8026f7b519b42758da06c87ba8ed3f	no	30
Warnings:					
Information:					
8	Non Patent Literature	14564544_Non-Final_OA_6-3-15.pdf	275013 02d3b0eb2d284579abf30b84dd36b9ef841cf439	no	7
Warnings:					
Information:					
9	Non Patent Literature	13871795_Non-Final_OA_6-4-15.pdf	513966 d0e52ff11adeef9811795be56fba251f3b0d49d9	no	16
Warnings:					
Information:					
10	Non Patent Literature	13848904_NOA_7-2-15.pdf	715510 671c946de78fe21f82cd17aca6daeffae723af7c	no	17
Warnings:					
Information:					

11	Non Patent Literature	13888203_NOA_7-2-15.pdf	788278 720041564c35623e97d0aa0250e19c5706d9580c	no	19
Warnings:					
Information:					
12	Non Patent Literature	14184935_NOA_7-2-15.pdf	903361 d3e7e726fc1250edd4c48065dc353fc04a6dc292	no	23
Warnings:					
Information:					
13	Non Patent Literature	13297000_NOA_7-6-15.pdf	913287 ae1344298983a152e8108d05ce6a8da86526ce30	no	24
Warnings:					
Information:					
		Total Files Size (in bytes):	10256315		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5761320		1998-06-02	FARINELLI; Robert et al.	
	2	6535121		2003-03-18	MATHNEY; Richard K. et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20140181569		2014-06-26	MILLINGTON; Nicholas A.J. et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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NON-PATENT LITERATURE DOCUMENTS Remove

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	"European Extended Search Report for Application No. 14181454.1 mailed on 31 March 2015, 9 pages.".	☐
	2	"Final Office Action mailed on 28 April 2015, issued in connection with U.S. Patent Application No. 14/186850, filed on 21 February 2014, 20 pages".	☐
	3	"Notice of Allowance mailed on 19 May 2015, issued in connection with U.S. Patent Application No. 13/907666, filed on 31 May 2013, 7 pages".	☐
	4	"Re-Exam Non-Final Office Action mailed on 22 April 2015, issued in connection with U.S. Patent Application No. 90/013423, filed on 5 January 2015, 16 pages.".	☐

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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-05-29
Name/Print	Benjamin M. Urban	Registration Number	71,591

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	22479361
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	31-MAY-2015
Filing Date:	17-APR-2013
Time Stamp:	15:49:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	13-0402_MBHB15-518-CON_IDS.pdf	707174 4c2a8c4f5807918e898686f128cc35447cdc12d6	no	4

Warnings:	
Information:	

2	Non Patent Literature	European_No_141814541_Extended_Search_Report.pdf	391494 1106f6014f64d2cca986d44d5e77d1edb5813b56	no	9
Warnings:					
Information:					
3	Non Patent Literature	14186850_Final_OA_4-28-15.PDF	709014 d9e9dbd6b72a32d09fbed664a38c47e275cf7138	no	20
Warnings:					
Information:					
4	Non Patent Literature	13907666_NOA_5-19-15.PDF	407923 f502be4aefeae6f0c3ee493757b88ae48d95988a	no	7
Warnings:					
Information:					
5	Non Patent Literature	90013423_Non-Final_OA_4-22-15.pdf	585475 687eca797422ef5378b7be99928d400300c018a1	no	16
Warnings:					
Information:					
		Total Files Size (in bytes):	2801080		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13864249
Filing Date	04-17-2013
First Named Inventor	NICHOLAS; A. J. Millington
Art Unit	2442
Examiner Name	SURVILLO, OLEG
Attorney Docket Number	13-0402 (MBHB 15-518-CON)

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6816818		2004-11-09	WOLF; Michael Jaochim. et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030018797		2003-01-23	DUNNING; Ted E. et al.	
	2	20030067437		2003-04-10	MCCLINTOCK; Dale Thomas et al.	
	3	20040213230		2004-10-28	DOUSKALIS; William et al.	
	4	20040228367		2004-11-18	MOSIG; Rudiger et al.	
	5	20130018960		2013-01-17	KNYSZ; Matthew S. et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	6	20040208158		2004-10-21	FELLMAN; Ronald D. et al.	
	7	20020114354		2002-08-22	SINHA; Pranesh. et al.	
	8	20020080783		2002-06-27	FUJIMORI; Junichi	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	"Advisory Action mailed on 25 March 2015, issued in connection with U.S. Patent Application No. 13/533105, filed 26 June 2012, 5 pages.".	☐
	2	"Final Office Action mailed on 26 March 2015, issued in connection with U.S. Patent Application No. 14/184528, filed on 19 February 2014, 18 pages".	☐
	3	"Final Office Action mailed on 4 March 2015, issued in connection with U.S. Patent Application No. 13/848904, filed on 22 March 2013, 16 pages.".	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

	4	"Final Office Action mailed on 5 March 2015, issued in connection with U.S. Patent Application No. 13/888203, filed on 6 May 2013, 13 pages.".	☐
	5	"Final Office Action mailed on 9 March 2015, issued in connection with U.S. Patent Application No. 14/516867, filed on 17 October 2014, 14 pages.".	☐
	6	"Non-Final Office Action mailed on 12 March 2015, issued in connection with U.S. Patent Application No. 13/705174, filed 5 December 2012, 13 pages.".	☐
	7	"Non-Final Office Action mailed on 13 March 2015, issued in connection with U.S. Patent Application No. 13/705177, filed 5 December 2012, 15 pages.".	☐
	8	"Non-Final Office Action mailed on 27 March 2015, issued in connection with U.S. Patent Application No. 13/705178, filed 5 December 2012, 14 pages.".	☐
	9	"Non-Final Office Action mailed on 4 March 2015, issued in connection with U.S. Patent Application No. 13/435776, filed on 30 March 2012, 16 pages.".	☐
	10	"Pre-Interview First Office Action mailed on 10 March 2015, issued in connection with U.S. Patent Application No. 14/505027, filed on 2 October 2014, 4 pages.".	☐
	11	"Advisory Action mailed on 15 April 2015, issued in connection with U.S. Patent Application No. 14/184526, filed on 19 February 2014, 9 pages.".	☐
	12	"Advisory Action mailed on 15 April 2015, issued in connection with U.S. Patent Application No. 14/184935, filed on 20 February 2014, 9 pages.".	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	04-17-2013
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	13-0402 (MBHB 15-518-CON)

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Benjamin M. Urban/	Date (YYYY-MM-DD)	2015-04-23
Name/Print	Benjamin M. Urban	Registration Number	71,591

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	22126947
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	107361
Filer:	Benjamin Michael Urban
Filer Authorized By:	
Attorney Docket Number:	13-0402 (MBHB 15-518-CON)
Receipt Date:	23-APR-2015
Filing Date:	17-APR-2013
Time Stamp:	16:14:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	13533105_Advisory_Action_3-25-15.pdf	218958 006d28fd77d799a1965f257e8ae29ae2612d36da	no	5

Warnings:	
Information:	

2	Non Patent Literature	14184528_Final_OA_3-26-15.pdf	605224 88b78fc5cf9f88526ce7d1eea287eb6284659d12	no	18
Warnings:					
Information:					
3	Non Patent Literature	13848904_Final_OA_3-4-15.pdf	536474 5ab7b3c4b09c851e1d8dde8337b3ac29af7cf428	no	16
Warnings:					
Information:					
4	Non Patent Literature	13888203_Final_Rejection_3-5-15.pdf	452379 ffb224c98f18d2cfebd30b2bfb3a74cedf3d80e4	no	13
Warnings:					
Information:					
5	Non Patent Literature	14516867_Final_OA_3-9-15.pdf	493096 52c677d8704b8b74a1dffae4658c3a3c95632b6b	no	14
Warnings:					
Information:					
6	Non Patent Literature	13705174_NonFinal_OA_3-12-15.pdf	390533 fccb351de023e03317bf33631b8674c6943346cb	no	13
Warnings:					
Information:					
7	Non Patent Literature	13705177_Non-Final_OA_3-13-15.pdf	467012 57778be2fe6748e486536da62d73f48d35825a09	no	15
Warnings:					
Information:					
8	Non Patent Literature	13705178_Non-Final_OA_3-27-15.pdf	431284 4a55c02cbf9c8eb4b7ec902d0d2473bda8535b46	no	14
Warnings:					
Information:					
9	Non Patent Literature	13435776_Non-Final_Rejection_3-4-15.pdf	553426 c85dbfe1c8fe2d35e56f9d69126c9aa39c2ad2fc	no	16
Warnings:					
Information:					
10	Non Patent Literature	14505027_PreInterview_First_Office_Action_3-10-15.pdf	142375 5fe5ce90bc3280cf6895c7304a55e5cd64c5b68d	no	4
Warnings:					
Information:					

11	Non Patent Literature	14184526_Advisory_Action_4-15-15.pdf	516346 45c64a0f8faf4858cf5eeff4a60bc3ed15387e29	no	9
Warnings:					
Information:					
12	Non Patent Literature	14184935_Advisory_Action_4-15-15.pdf	525787 111a50b28ddfe78c3b04ab88356f0a02a26618cb	no	9
Warnings:					
Information:					
13	Information Disclosure Statement (IDS) Form (SB08)	13-0402_IDS.pdf	707570 865406864848 29b7764dfe558957bf92701a3013	no	6
Warnings:					
Information:					
			Total Files Size (in bytes):	6040464	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/864,249	04/17/2013	Nicholas A. J. Millington	SNS-71301US11 (13-0402)

CONFIRMATION NO. 9806

107361
McDonnell Boehnen Hulbert & Berghoff LLP
Sonos, Inc.
300 South Wacker Drive
Chicago, IL 60606

POA ACCEPTANCE LETTER

OC000000074422292

Date Mailed: 04/06/2015

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/01/2015.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/qtran/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/864,249	04/17/2013	Nicholas A. J. Millington	SNS-71301US11 (13-0402)

CONFIRMATION NO. 9806

109473
Invention Mine LLC - SNS
200 S. Wacker Drive
Suite 3100
Chicago, IL 60606

POWER OF ATTORNEY NOTICE

OC000000074422261

Date Mailed: 04/06/2015

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/01/2015.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/qtran/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/AIA/80 (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

■ Practitioners associated with Customer Number: 107361

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

■ The address associated with Customer Number: 107361

OR

☐	Firm or Individual Name			
	Address			
	City		State	Zip
	Country			
	Telephone		Email	

Assignee Name and Address: Sonos, Inc, 223 E. De La Guerra St.
Santa Barbara, CA 93101

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	[signature]	Date	10/2/2012
Name	Mark Triplett	Telephone	(805) 965-3001
Title	Director, IP		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	21912179
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Jeffrey Armstrong
Filer Authorized By:	
Attorney Docket Number:	SNS-71301US11 (13-0402)
Receipt Date:	01-APR-2015
Filing Date:	17-APR-2013
Time Stamp:	09:58:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	SonosPOA.pdf	59137 ad1d213683cc4019bf26d10570655bcd3505ff0	no	1

Warnings:	
Information:	

Total Files Size (in bytes):	59137

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13864249
Filing Date	2013-04-17
First Named Inventor	MILLINGTON, NICHOLAS A. J.
Art Unit	2442
Examiner Name	SURVILLO, OLEG
Attorney Docket Number	SNS-71301US11 (13-0402)

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5153579		1992-10-06	FISCH; Kenneth D. et al.	
	2	7206967		2007-04-17	MARTI; Philippe et al.	
	3	7711774		2010-05-04	ROTHSCHILD; Leigh M.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20010046235		2001-11-29	TREVITT; Stephen et al.	
	2	20020173273		2002-11-21	SPURGAT; Jeffrey Jonathan et al.	
	3	20040098754		2004-05-20	VELLA; Zane et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

	4	20050062637		2005-03-24	EL; Zabadani Hicham Mahmoud et al.	
	5	20130022221		2013-01-24	KALLAI; Christopher et al.	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2338374	GB		1999-12-15	MOTOROLA LTD.		☐
	2	07-210129	JP		1995-08-11	INTERNAT'L BUSINESS MACH CORP (IBM)		☐
	3	2005108427	JP		2005-04-21	RICOH KK.		☐

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	"Advisory Action mailed on 2 March 2015, issued in connection with U.S. Patent Application No. 13/848932, filed on March 22, 2013, 3 pages.".	☐
	2	"Advisory Action mailed on 26 February 2015, issued in connection with U.S. Patent Application No. 14/184,528, filed on 19 February 2014, 3 pages.".	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

	3	"Final Office Action mailed on 11 February 2015, issued in connection with U.S. Patent Application No. 14/184526, filed on 19 February 2014, 13 pages".	☐
	4	"Final Office Action mailed on 11 February 2015, issued in connection with U.S. Patent Application No. 14/184,935, filed on 20 February 2014, 17 pages".	☐
	5	"Final Office Action mailed on 12 February 2015, issued in connection with U.S. Patent Application No. 14/184522, filed on 19 February 2014, 20 pages".	☐
	6	"INTERNATIONAL BUREAU,"International Preliminary Report on Patentability" issued in connection with International Patent application No. PCT/US2013/046372, mailed December 31, 2014, 5 pages.".	☐
	7	"International Preliminary Report on Patentability and Written Opinion, issued by the International Searching Authority in connection with International Patent Application No. PCT/US2013/046386, mailed on January 8, 2015, 8 pages".	☐
	8	"Non-Final Office Action mailed on 26 February 2015, issued in connection with U.S. Patent Application No. 14/186,850, filed on 21 February 2014, 25 pages.".	☐
	9	"Non-Final Office Action mailed on 30 January 2015, issued in connection with U.S. Patent Application No. 14/504,812, filed on 2 October 2014, 13 pages".	☐
	10	"Non-Final Office Action mailed on 30 January 2015, issued in connection with U.S. Patent Application No. 14/290,493, filed on 29 May 2014, 29 pages.".	☐
	11	Final Office Action mailed on 3 March 2015, issued in connection with U.S. Patent Application No. 13/864251, filed on 17 April 2013, 13 pages.	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

EFS Web 2.1.17

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

CERTIFICATION STATEMENT

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☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Robert J. Irvine III/	Date (YYYY-MM-DD)	2015-03-20
Name/Print	Robert J. Irvine III	Registration Number	41865

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Acknowledgement Receipt

EFS ID:	21838782
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	GB2338374.pdf	570090 3f631e460ac8630289b34fec71d695ffa1250fe1	no	16

Warnings:	
Information:	

2	Foreign Reference	JP07210129.pdf	1047465 c0f7b2f5445519535515cb21b06d7dca1b83a6b7	no	13
Warnings:					
Information:					
3	Foreign Reference	JP2005108427_Combined_flattened.pdf	1974366 99b3b0640d2fbae2bddc91bb971e0d4f84930974	no	23
Warnings:					
Information:					
4	Non Patent Literature	13848932_Advisory_Action_3-2-15.pdf	129403 4e86cb3cfe17cb7328f5d3ff64a102cf3d0c9c41	no	3
Warnings:					
Information:					
5	Non Patent Literature	14184528_Advisory_Action_2-26-15.pdf	124587 e77e42d136a5952f36322b77909680f5060eb3ff	no	3
Warnings:					
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6	Non Patent Literature	14184526_Final_OA_2-11-15.pdf	444504 4d2ca224f13835ab971c56f83091a5b9dc090bca	no	13
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7	Non Patent Literature	14184935_Final_OA_2-11-15.pdf	597904 06df6bf664b3ebc72f1e54a3a57394b1c15d22d3	no	17
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9	Non Patent Literature	PCTUS13046372_Intl_Preliminary_Report_12-31-14.pdf	215183 37addc80d791e2aa8c7948f7d9e827acb6c7aca0	no	5
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10	Non Patent Literature	PCTUS2013046386_Intl_Preliminary_Report_1-8-15.pdf	308278 d483d48dbb01747b5d9fb4710b31c32aadf7ba53	no	8
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11	Non Patent Literature	14186850_NonFinal_OA_2-26-15.pdf	880420 fa1e6f863f190c6087cde949a09e681683355aa0	no	25
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12	Non Patent Literature	14504812_Non-Final_OA_1-30-15.pdf	440781 2cbe5e2c810c0fb061fdfb7738a764184c196d0b	no	13
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13	Non Patent Literature	14290493_NonFinal_OA_1-30-15.pdf	979980 474204afb3d454e359995b393fdb69f335e07ba3	no	29
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14	Non Patent Literature	13864251_Final_OA_3-3-15.pdf	454610 2c7c737ae1fd3642d55b1c7d1545fc7b3c7626d3	no	13
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15	Information Disclosure Statement (IDS) Form (SB08)	SNS-71301US11-SuppIDS-13-0402-MAR2015.pdf	707644 25df845f3052ec03f74355b52d80f28c005fc3b1	no	6
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H4L LDSL L1H10
H4D DPAB D512 D536 D568 D576 D580 D584 D585

(56) Documents Cited

GB 2316823 A	**GB 2310098 A**	**GB 2250154 A**
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US 5317323 A	**US 4916455 A**	**US 4698781 A**

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INT CL^6 **G01S 5/00 5/06 , H04Q 7/38**
ONLINE: WPI

(54) Abstract Title
Locating a mobile telephone using time of arrival measurements

(57) Apparatus and method for determining the location of a subscriber unit 1 in a mobile telecommunications network and particularly in a GSM cellular network, includes the provision of several receiver or "slave" stations 4, 5, 6, controlled by a "master" base transceiver station 2 and positioned at separate known locations within each cell. Each of the receiver slave stations 4, 5, 6, which are synchronised by means of an on-board GPS receiver clock (10 fig. 2), measures the time of arrival of a signal (e.g. fill frame) transmitted from the subscriber unit 1. The time of arrival measurements recorded by each "slave" station 4, 5, 6 are then transmitted (e.g. via SMS, GPRS or USSD) to a computation device 3 for computation of the subscriber unit's 1 location relative to the "slave" stations 4, 5, 6. The computation device 3 may be provided at the "master" station. In operation, the "master" station may on reception of a location request from the subscriber unit 1 or network, perform a rough estimate of the location of the unit 1 using GSM data (e.g. power measurement, timing advance data etc), decide which "slave" stations 4, 5, 6 to use in the location determination and then instruct the "slave" stations to start receiving signals and the subscriber unit 1 to transmit a signal burst. Power and signal quality estimates may be provided along with time of arrival and spatial or polarisation diversity techniques may be used to improve sensitivity,(e.g. reception of two successive signal bursts on different antennas at the slave stations).

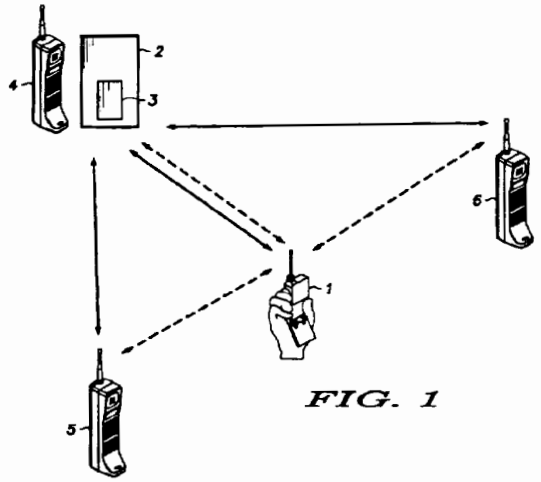


FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 338 374 A

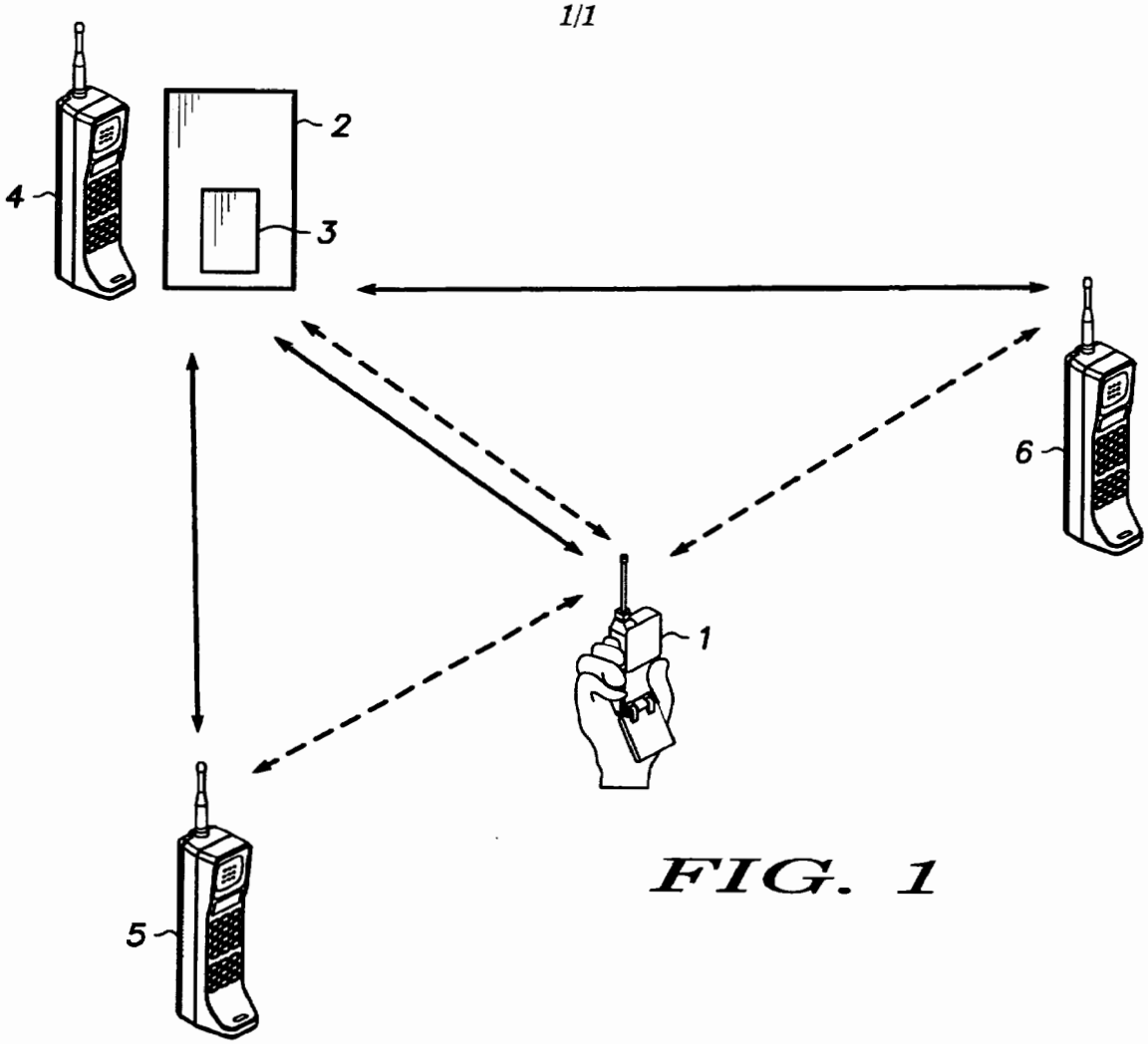

2
3
4
5
6
1

FIG. 1

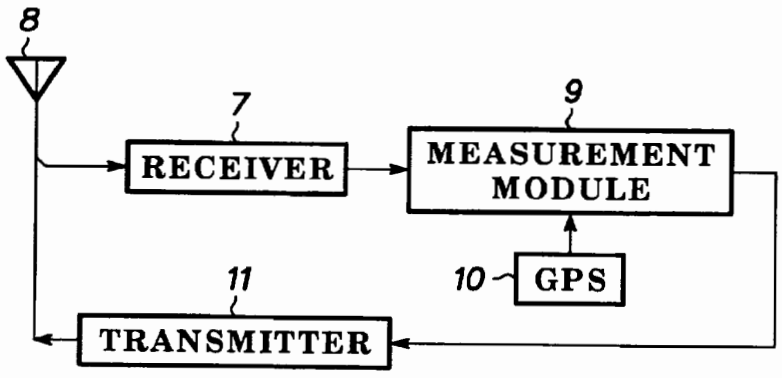

8
7
RECEIVER
9
MEASUREMENT MODULE
10
GPS
11
TRANSMITTER

FIG. 2

LOCATION APPARATUS AND METHOD IN A MOBILE TELECOMMUNICATIONS SYSTEM

This invention relates to determining location in mobile communication systems and particularly though not exclusively, to the cellular GSM system (Global System for Mobile Communications), a description of which can be found in the book "The GSM System for Mobile Communications" by M. Mouley and M. Pautet.

A cellular radio telephone radio system generally includes a switch controller coupled to the public switched telephone network (PSTN) and a plurality of base stations. Each of the plurality of base stations generally defines a geographic region or "cell" proximate to the base station to produce coverage areas. One or more mobile stations communicate with a base station that facilitates a call between the mobile station and the PSTN. The communication link over a carrier signal from the base station to a mobile station is referred to as the downlink. Conversely, the communication link from a mobile station to the base station is referred to as the uplink.

GSM networks are made up of mobile services switching centres, base station systems and mobile stations. These three entities can be broken down further into smaller entities such as within the base station system there are base station controllers, base transceiver stations and transcoders.

It may be advantageous to determine the location of a mobile station. For example, such information would be useful to emergency, tariffing services and traffic routing services. The accuracy required is dictated by the service for which location determination is needed. For example, for tariffing, an accuracy of 500 metres might be acceptable. However, for the purpose of locating the nearest restaurant, for example, an accuracy of less than 100 metres would be needed. The initial driving force for location

determination was the legislation brought out in the United States of America (known as E911) which requires that a mobile station can be located to within 125 metres for 67% of the time for the emergency services. This is to be introduced in stages and is expected to be operational by the year 2001. At present, in countries operating GSM networks there is no such legislation in place. However, the need for location determination in GSM systems is gaining momentum with a plethora of services being anticipated and also location-selective tariffing being proposed.

Most known methods of locating a mobile station in a mobile telecommunications network involve a calculation of the distances between three or more base stations and mobile stations. One known method of estimating the distance between a base station and a mobile station in a GSM network involves measuring the propagation delay incurred by the carrier signal during its return trip from the base station to a mobile station. (See for example, WO-A-9205672). Once the distance between three or more known fixed points and the mobile stations are known, the mobile station's relative position can be calculated. For example, the so-called "circle method" described in WO-A-9205672 is based on measurements of three independent distances. With three given known reference points in a plane, it is possible to establish the co-ordinates of any other point in the same plane using the distances between the reference points and the point in question.

Location of a mobile station by using the known technique based on measurements of propagation delay require that the mobile station is simultaneously visible to at least three base stations. Environmental constraints on the cellular network may not always make this possible.

The present invention seeks to remove this constraint.

In one aspect, the present invention consists of apparatus for determining the location of a mobile station in a mobile telecommunications system, the apparatus comprising:

a computation device,
a master station, and
a plurality of slave stations positioned at known locations,

in which the master station incorporates a transmitter and a receiver for communicating with the mobile station and with the plurality of slave stations,

and in which each slave station incorporates a clock, a receiver for receiving signals from the mobile station, measuring means for measuring the time of arrival of the signals, and a transmitter for facilitating transmission of the time of arrival measurements to the computation device for calculating the location of the mobile station.

The computation device may be located at the master station or at some other remote location. Time of arrival measurements may be transmitted directly to such a remote location or via the master station.

The master station may, in part, comprise a conventional base transceiver station fitted with additional components in accordance with the invention.

The slave stations may comprise a modified form of radio telecommunication handset and may, conveniently, be mounted at the top of lamp posts, for example.

The clock required by each slave station could comprise part of a commercially available GPS receiver (Global Positioning System).

Hence the invention advantageously requires only relatively inexpensive equipment additional to the mobile telecommunication infrastructure. Each base transceiver station in the network would preferably control a minimum of three slave stations (in order to give a reasonably accurate fix on the location of the mobile station) within the cell it serves. Conveniently, one could be co-located with the master station. The slave stations need only be small and can be mounted almost anywhere, preferably at a site with an electrical power supply. They could, of course, be powered by battery or solar cells. Another advantage is that they do not require a dedicated leased telecommunications line.

The invention provides the further advantage in that only one transceiver station needs to be used in the location process. Therefore, in large cells where there may be no or very weak signals from neighbouring base transceivers stations, location estimates can still be performed.

Further, by virtue of this invention, location determination by time of arrival measurements does not require time synchronisation of the entire telecommunications network. This would otherwise have to be done by the additional, complicated method of using a common clock, or establishing a reference station which calculates the time offsets between different components of the network. Using this invention, it is sufficient for just the slave stations peculiar to a cell to be synchronised.

The signals sent by the mobile station to the slave stations can be kept very simple in content, i.e. no large amount of data needs to be transmitted over the network. The signals may comprise conventional "fill-frames" for example.

Further, the data generated by the slave stations e.g. time of arrival measurements can be transmitted in SMS format (short message service), GPRS or USSD. This latter facet enables multiple measurements to be

made in order to improve the accuracy of the location computation without putting a prohibitive load on the network.

Hence the location apparatus of the present invention can be "overlaid" on an existing radio communications network and be invisible to it.

Initial control commands may originate from the master station (i.e. a serving base transceiver station in one particular embodiment) or the location procedure can be initiated either by the mobile station or by the controlling network components. (For example, a mobile switching centre).

The apparatus can be extended in the cellular network context so that any slave station can be used by any base transceiver station within range.

In a second aspect, the invention consists of a method for determining the location of a mobile station in a mobile telecommunication system, the method including the steps of:

receiving at a plurality of time-synchronised slave station, control signals from a master station,

receiving at each of the slave stations signals from the mobile station,

measuring at each of the slave stations the time of arrival of the signals, from the mobile station.

transmitting from each of the slave stations the time of arrival measurements to a computation device,

and computing in the computation device the location of the mobile station with respect to the slave stations according to the time of arrival measurements.

The method may further comprise the step, in the master station, of receiving a location request from either the mobile station or from a controlling element of the telecommunications network.

In a preferred embodiment, the master station designates particular slave stations for receiving signals from the mobile station and for performing the time of arrival measurements. It may also instruct the mobile station when, at a particular moment in time, to transmit a signal burst.

Some embodiments of the invention will now be described by way of example only, with reference to the drawings of which;

Figure 1 is a schematic diagram of location apparatus in accordance with the invention and incorporated in a GSM cellular network,

and Figure 2 is a schematic block diagram of the components of a slave station of Figure 1.

Referring then to Figure 1, a mobile station 1 is located in a cell served by a base transceiver station (BTS) 2. The BTS 2 incorporates a computation device 3. Co-located with the BTS 2 and powered therefrom is a first slave station 4. Two additional slave stations 5 and 6 are located within the cell and are remote from the BTS 2. Other slave stations may also be located in the cell but only two remote stations are shown here for clarity. Each slave station 4, 5, 6 comprises a modified handset.

The locations of the BTS 2 and all three slave station 4, 5, 6 are known. The location of the mobile station 1 is initially not known at all.

Communications links exist between mobile station 1 and the BTS 2 (on an uplink and a downlink), between the BTS 2 and the slave stations 4, 5, 6 (on

an uplink and a downlink) and between the mobile station 1 and the slave stations 4, 5, 6 (on an uplink only).

With reference to Figure 2, each slave station includes the following components. A receiver 7 connected to an antenna 8 receives signals from the mobile station 1. The output of the receiver 7 is fed to a first input of a measurement module 9. A second input of the measurement module is connected to the clock output of a conventional GPS receiver 10 for time synchronisation of each slave station.

The measurement module 9 performs time of arrival measurements on signals received from the mobile station 1 and feeds the measured values to a transmitter 11 for onward transmission via the antenna 8 to the computation device 3 in the BTS 2.

The BTS 2 and the mobile station 1 comprise, for the most part, conventional commercial equipment and function in the conventional manner in addition to facilitating the location operation.

The location apparatus of Figures 1 and 2 operates as follows.

The mobile station 1 (or alternatively the GSM network) initiates a location request to the BTS 2. The BTS 2 firstly on reception of the location request either directly or via the GSM network, performs a rough estimate of the position of the mobile station 1 by using data generic to the GSM system. Such data could include power measurement data, timing advance data, sector data, etc.

The BTS 2 then decides which slave stations are to be used in the location estimate. In this example, slave stations 4, 5 and 6 are to be used. The BTS 2 then checks the GPS clock 10 of the co-located slave station 4 and calculates a time for the designated slave stations to start receiving signals

from the mobile station 1. This time can be roughly synchronised with the GSM frame structure, timing advance, etc.

BTS 2 then contacts the relevant slave stations 4, 5, 6 via paging or SMS signal, to inform them of the start time of the receiving and measurement process, the frequency the mobile station 1 will transmit on and the GSM time slot. Optionally, each slave station 4, 5, 6 can confirm to the BTS that this message has arrived correctly.

The BTS 2 then instructs the mobile station 1 to transmit a signal burst. The slave stations now have knowledge of the frequency and timing parameters relating to this signal burst and are therefore able to measure time of arrival at the measurement module 9. As all slave stations are synchronised via the GPS receiver clock, the time of arrival measurements will be relatively accurate.

The slave stations 4, 5, 6 then each transmit their time of arrival measurements to the computation device 3 in the BTS 2 via an SMS message. Optionally, the slave stations 4, 5, 6 also transmit to the BTS 2 signal power estimate and signal quality estimate to assist in predicting the accuracy of the computed location of the mobile station 1.

The computation device 3 then calculates the mobile stations location (relative to the slave stations 4, 5, 6) by any one of several known methods, e.g. the aforementioned circle method.

As one of the slave stations 4 is co-located with the BTS 2, the BTS location can be used in the location calculation.

Finally, the BTS 2 transmits the computed location information to the network service provider via a mobile switching centre for example.

In an alternative embodiment, the computation device 3 is not located at the BTS 2 but at some other remote location. In this case the BTS 2 forwards the time of arrival measurement on to this remote location.

Location apparatus in accordance with this invention is less susceptible to interference than systems which rely on downlink measurements. This is because downlink measurements systems rely on receiving signals which originate well outside the serving cell.

The sensitivity of the invention may be improved by employing spatial or polarisation diversity techniques. E.g. by receiving and measuring two successive location signal bursts from the mobile station on different antennas incorporated in the slave stations.

CLAIMS

1. Apparatus for determining the location of a mobile station in a mobile telecommunications system, the apparatus comprising:

A computation device;
A master station, and
a plurality of slave stations positioned at known locations;

in which the master station incorporates a transmitter and a receiver for communicating with the mobile station and with the plurality of slave stations, and in which each slave station incorporates a clock, a receiver for receiving signals from the mobile station, measuring means for measuring the time of arrival of the signals and a transmitter for facilitating transmission of the time of arrival measurements to the computation device for calculating the location of the mobile station.

2. Apparatus as claimed in Claim 1 in which the master station includes a processor for performing an estimate of the location of the mobile station and for determining which slave stations to communicate with.

3. Apparatus as claimed in Claim 2 in which the processor is configured to generate transmission instructions to the mobile station.

4. A method for determining the location of a mobile station in a mobile telecommunications system, a method including the steps of:

receiving at a plurality of time-synchronised slave stations, control signals from a master station;

receiving at each of the slave stations, signals from the mobile station;

measuring at each of the slave stations, the time of arrival of the signals from the mobile station;

transmitting from each of the slave stations, the time of arrival measurements to a computation device;

and computing in the computation device, the location of the mobile station with respect to the slave stations according to the time of arrival measurements.

5. A method as claimed in Claim 4 and further comprising the step of:

in the master station receiving a location request from the mobile station.

6. A method as claimed in either of Claims 4 or 5 and further including the step of in the master station performing an estimate of the location of the mobile station and designating particular slave stations for receiving signals from the mobile station and for performing time of arrival measurements.

7. A method as claimed in any of Claims 4 to 6 and further including the step of in the master station instructing the mobile station when to transmit signals to the slave stations.

8. A method as claimed in claim 6 and including the further step of at each slave station transmitting a message to the master station confirming receipt of the destination message.

9. Apparatus for determining the location of a mobile station in a mobile telecommunications system substantially as hereinbefore described with reference to the drawings.

10. A method for determining the location of a mobile station in as mobile telecommunications system substantially hereinbefore described with reference to the drawings.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB 9812404.3 **Examiner:** Anita Keogh
Claims searched: 1-8 **Date of search:** 1 December 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4D (DPAB), H4L (LDSL)

Int Cl (Ed.6): G01S (5/00, 5/06), H04Q (7/38)

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	GB 2316823 A	(MOTOROLA) see whole document, especially page 2 line 24 to page 3 line 2 and figure 1.	X: 4 Y: 1
X,Y	GB 2310098 A	(WESBY) see whole document, especially page 4 line 1 to page 5 line 7 and page 6 lines 23-30	X: 4 Y: 1
X,Y	GB 2250154 A	(ROKE MANOR) see whole document especially page 19 line 23-page 22 line 15	X: 4 Y:1
X	EP 0733912 A2	(GEC) see whole document especially column 4 line 19 to column 5 line 37	1, 4, 7
X,Y	EP 0385600 A2	(ISC CARDION) see whole document	X: 4 Y: 1
X	US 5327144	(STILP et al.) See whole document, especially claim 1	4
X,Y	US 5317323	(KENNEDY et al.) See whole document especially col. 2 line 65 to col. 5 line 29	X: 4 Y: 1
X	US 4916455	(BENT et al.) See whole document, especially column 4 lines 9-41	4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB 9812404.3 **Examiner:** Anita Keogh
Claims searched: 1-8 **Date of search:** 1 December 1998

Category	Identity of document and relevant passage	Relevant to claims
Y	US 4698781 (COCKERELL) see whole document	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

PATENT ABSTRACTS OF JAPAN

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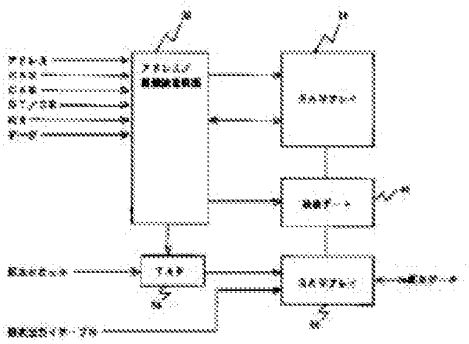
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(54) SELF-TIMING TYPE REAL-TIME DATA TRANSFER FOR VIDEO RAM

(57)Abstract:
PURPOSE: To easily and efficiently eliminate the need of a complicated high- speed circuit from a VRAM base memory subsystem for making real-time data transfer.
CONSTITUTION: A video RAM semiconductor memory device is constituted of a RAM array 10 having address inputs for inputting row addresses, column addresses, and target addresses and a sequential access array 20 having a sequential output port. The video RAM is provided with an address/control logic circuit 30 which detects stimulation, such as the RAS clock, indicating the rough timing for data transfer between the arrays 10 and 20 from an external controller. The circuit 30 supplies a control signal which is internally synchronized to a sequential clock and the control signal is generated during the period during which the value of a tap point is equal to a value which is smaller than a target programmable value or input target address by '1'. Therefore, the row in the array 10 corresponding to an input row address is transferred between the arrays 10 and 20.



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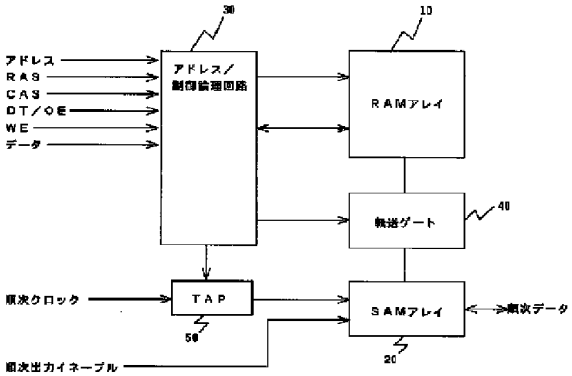
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(54)【発明の名称】　ビデオＲＡＭにおける自己タイミング式リアルタイム・データ転送

(57)【要約】

【目的】　ＶＲＡＭベース・メモリ・サブシステムに使用されるリアルタイム・データ転送に関連する複雑で高速な回路の必要を簡単かつ効率的に除去すること。

【構成】　ビデオＲＡＭ半導体メモリ・デバイスが、行アドレス、列アドレスおよび目標アドレスを入力するためのアドレス入力を有するＲＡＭアレイと、順次出力ポートを有する順次アクセス・アレイから構成される。このビデオＲＡＭは、ＲＡＭアレイと順次アクセス・アレイの間のデータ転送のための粗タイミング位置を示す外部コントローラからのＲＡＳクロックなどの刺激を検出するアドレス／制御論理回路を有する。制御論理回路は、内部的に順次クロックと同期化される制御信号を供給し、この制御信号は、タップ・ポインタがプログラム可能目標値または入力目標アドレスより１つ小さい値に等しい期間の間に発生する。これによって、入力行アドレスに対応するＲＡＭアレイ内の行が、ＲＡＭアレイと順次アクセス・アレイの間で転送される。



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【特許請求の範囲】

【請求項１】データ転送を指令する刺激を外部コントローラから受け取るステップと、

タップ・ポインタがプログラム可能な目標値と等しい期間の間にＲＡＭ内の１行から順次アクセス・メモリへの、内部的に順次クロックに同期化されたデータ転送を実行するステップとを含む、ＲＡＭ、順次アクセス・メモリおよびタップ・ポインタを有するビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２】刺激が、データ転送信号の状態遷移であることを特徴とする、請求項１に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項３】転送されるデータが、前の順次アクセス・メモリ内容より１つ大きい行アドレスを有するＲＡＭ行に含まれるデータであることを特徴とする、請求項１に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項４】さらに、アドレス入力に存在する行アドレスを読み取るステップを含む、請求項１に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項５】転送されるデータが、行アドレスに対応するＲＡＭ行に含まれるデータであることを特徴とする、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項６】刺激が、データ転送信号がイネーブル状態である時のＲＡＳの状態遷移であることを特徴とする、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項７】プログラム可能な目標値が、事前に選択された値にセットされることを特徴とする、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項８】データ転送を実行するステップが、列アドレスを事前に選択された値にセットするステップと、タップ・ポインタに列アドレスをロードするステップとを含むことを特徴とする、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項９】さらに、アドレス入力に存在する列アドレスを読み取るステップを含む、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１０】プログラム可能な目標値が、事前に選択された値にセットされることを特徴とする、請求項９に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１１】プログラム可能な目標値が、列アドレス

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より１つ小さい値にセットされることを特徴とする、請求項９に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１２】列アドレスが、０であることを特徴とする、請求項１１に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１３】列アドレスを読み取るステップが、第１入力信号の状態の変化に応答して発生することを特徴とする、請求項９に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１４】第１入力信号が、ＣＡＳであることを特徴とする、請求項１３に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１５】データ転送を実行するステップが、タップ・ポインタに列アドレスをロードするステップを含むことを特徴とする、請求項９に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１６】さらに、アドレス入力に存在する目標アドレスを読み取るステップを含む、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１７】プログラム可能な目標値が、目標アドレスより１つ小さい値にセットされることを特徴とする、請求項１６に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１８】データ転送を実行するステップが、列アドレスを事前に選択された値にセットするステップと、タップ・ポインタに列アドレスをロードするステップとを含むことを特徴とする、請求項１７に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項１９】目標が、０に等しいことを特徴とする、請求項１７に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２０】さらに、アドレス入力に存在する列アドレスを読み取るステップを含む、請求項１７に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２１】列アドレスを読み取るステップが、第１入力信号の状態の変化に応答して発生することを特徴とする、請求項２０に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２２】第１入力信号が、ＣＡＳであることを特徴とする、請求項２１に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２３】データ転送を実行するステップが、タップ・ポインタに列アドレスをロードするステップを含む

ことを特徴とする、請求項２０に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２１】目標アドレスを読み取るステップが、第２入力信号の状態が変化する時に発生することを特徴とする、請求項１６に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２５】第２入力信号が、データ転送信号であることを特徴とする、請求項２４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２６】行アドレスの読取りが、第３入力信号の状態が変化する時に発生することを特徴とする、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２７】第３入力信号が、ＲＡＳであることを特徴とする、請求項２６に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２８】さらに、順次アクセス・メモリの内容を直列ポートから出力するステップを含む、請求項４に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項２９】出力のステップが、データ転送を実行するステップの後に発生する最初の順次クロック・サイクルの立ち上がりエッジに応答して開始されることを特徴とする、請求項２８に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

【請求項３０】ＲＡＭアレイと、
直列出力ポートを有する順次アクセス・アレイと、
アドレスを入力するためのアドレス入力と、
ＲＡＭアレイと順次アクセス・アレイとの間でのデータ転送の粗いタイミング位置を示す、外部コントローラからの刺激を検出するための感知手段と、
感知手段が刺激を検出するのに応答して、ＲＡＭアレイと順次アクセス・アレイとの間でのデータ転送を指令する制御信号を出力することを特徴とし、順次クロックに同期化され、タップ・ポインタがプログラム可能な目標値より１つ小さい値に等しい期間の間発生する制御信号を供給するための、制御論理回路と、
制御論理回路によって供給される制御信号に応答して、ＲＡＭアレイと順次アクセス・アレイとの間でデータを転送するための転送ゲートとを含む、ビデオＲＡＭ半導体メモリ・デバイス。

【請求項３１】刺激が、データ転送信号の状態遷移であることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３２】転送されるデータが、前の順次アクセス・メモリ内容より１つ大きい行アドレスを有するＲＡＭ行に含まれるデータであることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３３】転送されるデータが、アドレス入力で読み取られる行アドレスに対応するＲＡＭ行に含まれることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３４】刺激が、データ転送信号がイネーブル状態である時のＲＡＳの状態遷移であることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３５】プログラム可能な目標値が、事前に選択された値にセットされることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３６】プログラム可能な目標値が、アドレス入力で読み取られた列アドレスより１つ小さい値にセットされることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３７】列アドレスが０であることを特徴とする、請求項３６に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３８】列アドレスが、第１入力信号の状態の変化に応答して読み取られることを特徴とする、請求項３６に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項３９】第１入力信号がＣＡＳであることを特徴とする、請求項３８に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４０】データ転送を指令する制御信号が出力されるのと同時に、制御論理回路が、列アドレスをタップ・ポインタにロードすることを特徴とする、請求項３６に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４１】プログラム可能な目標値が、アドレス入力で読み取られた目標アドレスより１つ小さい値にセットされることを特徴とする、請求項３３に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４２】目標アドレスが、０に等しいことを特徴とする、請求項４１に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４３】目標アドレスが、第２入力信号の状態の変化に応答して読み取られることを特徴とする、請求項４１に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４４】第２入力信号が、データ転送信号であることを特徴とする、請求項４３に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４５】列アドレスが、アドレス入力で読み取られることを特徴とする、請求項４１に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４６】データ転送を指令する制御信号が出力されるのと同時に、制御論理回路が、タップ・ポインタに列アドレスをロードすることを特徴とする、請求項４５に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４７】列アドレスが、第１入力信号の状態の変

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化に応答して読み取られることを特徴とする、請求項４５に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４８】第１入力信号が、ＣＡＳであることを特徴とする、請求項４７に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項４９】行アドレスが、第３入力信号の状態の変化に応答して読み取られることを特徴とする、請求項３３に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項５０】第３入力信号が、ＲＡＳであることを特徴とする、請求項４９に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項５１】直列ポートが、データ転送の後の最初に発生する順次クロック・サイクルの立ち上がりエッジに応答して、順次アクセス・アレイの内容を出力し始めることを特徴とする、請求項３０に記載のビデオＲＡＭ半導体メモリ・デバイス。

【請求項５２】アドレス入力に存在する行アドレスを読み取るステップと、

アドレス入力に存在する列アドレスを読み取るステップと、

データ転送信号がイネーブル状態である時にＲＡＳの状態遷移を検出するステップと、

タップ・ポインタが列アドレスより１つ小さい値に等しい期間の間に、行アドレスに対応するＲＡＭ内の行から順次アクセス・メモリへ、内部的に順次クロックに同期化された状態で、行アドレスに対応するＲＡＭ行に含まれるデータを転送するステップとを含む、ＲＡＭ、順次アクセス・メモリおよびタップ・ポインタを有するビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

【請求項５３】列アドレスが０であることを特徴とする、請求項５２に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

【請求項５４】列アドレスを読み取るステップが、ＣＡＳの状態の変化に応答して発生することを特徴とする、請求項５２に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

【請求項５５】行アドレスを読み取るステップが、ＲＡＳの状態の変化に応答して発生することを特徴とする、請求項５２に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、全般的には表示メモリ・サブシステム、グラフィックスおよび表示装置アダプタのシステムおよびサブシステムに関し、具体的は半導体メモリ・デバイスに関する。さらに具体的にいうと、

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本発明は、ビデオＲＡＭおよび同様のメモリ・デバイスに関する。

【０００２】

【従来の技術】ビデオＲＡＭ（ＶＲＡＭ）とは、２ポートＲＡＭ（ランダム・アクセス・メモリ）であり、本質的には従来のＤＲＡＭにメモリ・データを順次アクセスできる第２ポートを追加したものである。ＶＲＡＭは、ＲＡＭアレイ、順次アクセス・メモリ（ＳＡＭ）・アレイ、アドレス／制御論理回路および転送ゲートからなる。ＲＡＭアレイは、ＶＲＡＭの主（ＲＡＭ）ポートに接続され、ＤＲＡＭやＳＲＡＭのＲＡＭアレイと同一の形で振る舞う。ＳＡＭアレイは、シフト・レジスタと称する場合もあるが、ＶＲＡＭの副（ＳＡＭまたは直列）ポートに接続され、外部非同期クロックである順次クロックの制御下で順次アクセスできる。アドレス／制御論理回路は、ＲＡＭポートのアドレス多重化を管理し、ＶＲＡＭの制御と大域タイミング機能のすべてを提供する。転送ゲートは、アドレス／制御論理回路の制御下で、メモリ・データをＲＡＭアレイとＳＡＭアレイの間で受け渡しできるようにする機構である。

【０００３】ＶＲＡＭの利点は、ＲＡＭアレイとＳＡＭアレイの間でデータを転送しなければならない時を除いて、２つのポートを独立に非同期に操作できることである。ＳＡＭアレイは、通常はＲＡＭアレイ１行分の記憶容量を有し、完全に１行分のメモリ・データが、単一のデータ転送サイクルでＲＡＭとＳＡＭの間で転送される。２つのポートの独立非同期動作は、表示メモリ・サブシステムへの応用に優れており、この場合、ＲＡＭポートは表示メモリの内容更新に使用され、ＳＡＭポートは、ＣＲＴなどの表示装置上でラスタ化される表示データを供給する。ＲＡＭポートは、一般に、更新ハードウェア（たとえばグラフィックス・プロセッサ）の周波数で動作する。ＳＡＭポートは、一般に、表示装置の要件によって指定される周波数で動作する。表示装置上でラスタ化される表示データは、ＳＡＭポートから取得されるので、ＲＡＭポート帯域幅のほぼ全てを、表示メモリの内容の更新に使用できる。

【０００４】表示メモリ・サブシステムでは、ＶＲＡＭがＳＡＭポートに表示データを供給する。ＳＡＭアレイは、表示データの１行分の容量しかないので、表示フレームの時間の間、表示データの新しい行を連続的に再ロードされなければならない。一般に、表示データの新しい行のそれぞれは、前の行よりアドレスが１つ大きい行から取得される。ＲＡＭアレイから表示データの新しい行をＳＡＭアレイに再ロードする作業は、ＲＡＭポートでデータ転送サイクルを実行することによって達成される。ＲＡＭアレイとＳＡＭアレイの間でのデータの転送は、ＲＡＭポートでの通常のＤＲＡＭアクセス・サイクルに対する唯一の割込みである。このデータ転送は、２つの別個のタイプに分けることができる。すなわち、

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1　順次クロックが停止しており、ＳＡＭポートがインアクティブの時

2　順次クロックが動作しており、ＳＡＭポートがアクティブの時

【０００５】前者は通常、表示フレームの帰線消去期間中に次の水平走査線の表示データをＳＡＭにロードすることに関連しており、順次クロックが停止しているので、ＲＡＭポートでのデータ転送サイクルは、順次クロックと同期する必要がない。後者は通常、表示フレームの水平走査線に関するアクティブ・ビデオ期間に関連しており、順次クロックが動作しているので、ＳＡＭポートでの表示データに必要な継ぎ目のない流れを維持するために、ＲＡＭポートでのデータ転送サイクルを順次クロックと正確に同期させる必要がある。後者はしばしば、ＶＲＡＭの術語で「リアルタイム・データ転送」と称し、ＶＲＡＭベース表示サブシステムの術語で「ミッドライン再ロード」と称する。

【０００６】表示メモリ・サブシステムの設計では、「リアルタイム・データ転送」の制御とタイミングが大きな問題になる。「リアルタイム・データ転送」は、時間にクリティカルなリアルタイム・アクセスであり、ＲＡＭポートとＳＡＭポートの間の正確な同期を必要とする。このように時間にクリティカルなリアルタイム・アクセスは、アクセスの同期と制御のために複雑で高速な回路を必要とする可能性がある。このため、ＶＲＡＭベース表示メモリ・サブシステムの設計者は、しばしば、表示データの「ミッドライン再ロード」とそれに関連するＶＲＡＭの「リアルタイム・データ転送」を避けるために、柔軟性を犠牲にしたり表示メモリを活用しないことを選択する。

【０００７】多くのＶＲＡＭベース表示メモリ・サブシステムに使用されている、ミッドライン再ロードを避けるための通常の方法には、表示メモリの内容をビデオ表示画面にマッピングする方法に対する複数の制約が含まれる。この制約には、通常は下記が含まれる。

・表示フレームの最初の水平走査線の表示データの開始アドレスが固定される。

・後続水平走査線のそれぞれの開始アドレスを生成するためのアドレス増分が、表示メモリ・サブシステム内のＶＲＡＭのＳＡＭアレイの容量と等しい値か、その２進分数に固定される。

・水平走査線の長さは、表示データの量が表示メモリ・サブシステム内のＶＲＡＭのＳＡＭアレイの容量を超えないものにする必要がある。

【０００８】「ミッドライン再ロード」を避け、従って「リアルタイム・データ転送」を避けるためには、これらの制約のすべてを満たさなければならない。汎用のグラフィックス・アダプタや表示装置コントローラの場合、これらの制約を適用することはできない。

【０００９】「リアルタイム・データ転送」を避けるためのもう１つの手段が、いわゆる「スプリット・レジスタ」機構を組み込んだ最近の１ＭＢ　ＶＲＡＭの一部に見られる。これらのＶＲＡＭでは、ＳＡＭアレイが、いわゆる「スプリット・レジスタ・データ転送」によって独立にロードすることのできる２つの半分に分割され、これによって、ＳＡＭの半分がアクティブである間にＳＡＭの他方の半分にロードすることが可能になっている。この機構は、問題の軽減に大いに役立つが、ＳＡＭアレイの容量を完全かつ効率的に利用してはおらず、潜在的に、「スプリット・レジスタ」機構を使用しない時に必要になるはずのデータ転送アクセスの２倍のアクセスをもたらす可能性がある。

【００１０】時間にクリティカルなデータ転送に必要な高精度を維持しながら「リアルタイム・データ転送」を可能にする、代替手法の提案の１つが、転送に関するタイミングのすべてを、コントローラを介して外部から供給するのではなく、ＶＲＡＭの内部で維持するというものである。この場合、ＶＲＡＭに事前プログラミングされたパラメータに基づいて、すべての転送が自動的にＶＲＡＭによって内部的に開始され、順次クロックと同期化されるので、転送が簡単に順次出力ストリームと同期化される。この手法を用いる場合、外部制御はタイミングに導入されず、したがって、リアルタイム・データ転送に必要な高精度のタイミングが達成される。

【００１１】しかし、この手法にはいくつかの短所がある。第１に、内部タイミングによる転送に適応するために、ＶＲＡＭ設計が非常に複雑になり、通常のＶＲＡＭと非互換になる。第２に、パラメータが静的であり、通常動作中の順次データ出力の再配列が困難になっているので、この設計は柔軟性に欠ける。第３に、このＶＲＡＭは、内部データ転送を行っている時に、ＲＡＭポートでの同時アクセスを回避するために、ＶＲＡＭメモリ・コントローラにビジー信号を供給するか、待ち状態をもたらす必要があるはずである。第４に、このビジー・プロトコルの処理のために、特に複数のＶＲＡＭからのビジー信号を管理しなければならない場合に、ビデオ・コントローラ回路の複雑さが増す。さらに、このビジー・ハンドシェーク・プロトコルが存在するが故に、既存のビデオ・コントローラのいずれもが、このＶＲＡＭと共に利用するのに適したものでなくなる。

【００１２】

【発明が解決しようとする課題】本発明の目的は、従来のビデオ・ランダム・アクセス・メモリ（ＶＲＡＭ）・デバイスに対する新規の機能強化によって、通常はＶＲＡＭベース・メモリ・サブシステムに使用されるリアルタイム・データ転送に関連する潜在的に複雑で高速な回路の必要を、簡単かつ効率的に除去することである。本発明のもう１つの目的は、厳密なマッピング制限がシステムに課せられず、ＳＡＭの効率が犠牲にされないようにすることである。本発明のもう１つの目的は、過度に

複雑でなく、非常に柔軟かつ動的であり、待ち状態ハンドシェーク・プロトコルを導入せず、既存のビデオ・コントローラとの完全な互換性を有し、従来のＶＲＡＭデータ転送の自然な拡張であるＶＲＡＭ回路設計を提供することである。

【００１３】

【課題を解決するための手段】本発明によれば、ビデオＲＡＭ半導体メモリ・デバイスが、行アドレス、列アドレスおよび目標アドレスを入力するためのアドレス入力を有するＲＡＭアレイと、順次出力ポートを有する順次アクセス・アレイから構成される。このビデオＲＡＭは、ＲＡＭアレイと順次アクセス・アレイの間のデータ転送のための粗タイミング位置を示す外部コントローラからのＲＡＳクロックなどの刺激を検出するアドレス／制御論理回路を有する。制御論理回路は、内部的に順次クロックと同期化される制御信号を供給し、この制御信号は、タップ・ポインタがプログラム可能目標値または入力目標アドレスより１つ小さい値に等しい期間の間に発生する。これによって、入力行アドレスに対応するＲＡＭアレイ内の行が、ＲＡＭアレイと順次アクセス・アレイの間で転送される。

【００１４】本発明の上記ならびに他の目的、特徴および長所は、下記の詳細な説明から明らかになる。

【００１５】

【実施例】これより図面を参照するが、具体的には図１を参照すると、本発明の好ましい実施例によるＶＲＡＭのブロック図が示されている。このＶＲＡＭには、ＲＡＭアレイ１０、ＳＡＭアレイ２０、アドレス／制御論理回路３０、転送ゲート４０およびタップ・ポインタ（ＴＡＰ）５０が含まれる。ＲＡＭアレイ１０は、ＶＲＡＭの主（ＲＡＭ）ポートに接続され、アドレス／制御論理回路３０の制御下でＤＲＡＭまたはＳＲＡＭと同一の形で振る舞う。ＳＡＭアレイ２０は、シフト・レジスタと呼ばれる場合もあるが、ＶＲＡＭの副（ＳＡＭまたは直列）ポートに接続され、外部非同期クロックである順次クロックの制御下で順次アクセスすることができる。ＳＡＭアレイ２０に対する順次アクセスは、タップ・ポインタ（ＴＡＰ）５０によって制御され、タップ・ポインタ（ＴＡＰ）５０は、順次クロックのサイクルごとに増分されるカウンタからＳＡＭアレイ２０のアドレスを生成する。タップ・ポインタ（ＴＡＰ）５０は、アドレス／制御論理回路３０の制御下で初期値をロードされ、そのカウントの末尾に達するまで順次クロックのサイクルごとにカウンタを増分し、末尾に達した後には、ラップして最初の値に戻る。アドレス／制御論理回路３０は、アドレス多重化とＲＡＭポート上のデータ・フローを管理し、ＶＲＡＭの制御と大域タイミング機能のすべてを提供する。転送ゲート４０は、アドレス／制御論理回路３０の制御下で、ＲＡＭアレイ１０とＳＡＭアレイ２０の間でメモリ・データを受け渡しできるようにする機構である。

【００１６】ここで図２を参照すると、順次クロックがインアクティブの状態での通常のデータ読取り転送サイクルのタイミング図が示されている。通常のＶＲＡＭでは、データ読取り転送サイクルは、行アドレス・ストローブ（ＲＡＳ）の立ち下がりエッジでデータ転送／出力イネーブル（ＤＴ／ＯＥ）をロー・レベルにセットすることによって示される。ＲＡＳの立ち下がりエッジでは、アドレス入力から行アドレス（Ｒ）が取得され、行Ｒがアクティブにされる。列アドレス・ストローブ（ＣＡＳ）の立ち下がりエッジでは、アドレス入力から列アドレス（Ｃ）が取得される。その後、ＤＴ／ＯＥの立ち上がりエッジで、実際のＲＡＭ→ＳＡＭデータ転送が発生する。データ転送時には、ＳＡＭアレイ２０に、ＲＡＭアレイ１０の行Ｒの内容がロードされ、タップ・ポインタ（ＴＡＰ）５０に、列アドレスＣがロードされる。実際のデータ転送後の順次クロックの最初の立ち上がりエッジで、ＳＡＭアレイ２０の新しい内容が、最初の順次クロック立ち上がりエッジの時刻でのタップ・ポインタ値によって与えられるＳＡＭ位置から始まるＳＡＭポートで使用可能になる。順次データの最初の項目は、列アドレスＣの行Ｒからのデータである（このデータの簡略表記が｛Ｒ；Ｃ｝である。本明細書全体を通じて、データの記述のすべてを簡略化するためにこの表記を使用する）。順次クロックの後続の立ち上がりエッジのそれぞれで、タップ・ポインタ（ＴＡＰ）５０の増分が発生し、ＳＡＭポートにＳＡＭアレイ２０の内容が順次提示される。すなわち、｛Ｒ；Ｃ｝の後に、｛Ｒ；Ｃ＋１｝、｛Ｒ；Ｃ＋２｝などが続く。

【００１７】図３は、順次クロックがアクティブの状態での、いわゆる「リアルタイム・データ転送」の通常のデータ読取り転送サイクルのタイミング図である。図３からわかるように、順次クロックが動作している状態でデータ読取り転送が実行される場合、ＳＡＭポートでのデータの正しいシーケンスを維持するために、ＤＴ／ＯＥの立ち上がりエッジによって示されるデータ転送のタイミングは、正しい順次クロック・サイクル中に発生するように正確に維持されなければならない。現在のＶＲＡＭは、最小１５ｎｓの順次クロック・サイクルを有し、通常は、ＤＴ／ＯＥの立ち上がりエッジが、前の順次クロックの立ち上がりエッジから５ｎｓ以上後、次の順次クロックの立ち上がりエッジから５ｎｓ以上前に発生することを必要とする。これは、転送のタイミングを、５ｎｓの狭さになる可能性のある「窓」の中に納めなければならず、非常に高速の回路が必要になることを意味する。将来のＶＲＡＭは、さらに高速の順次クロックを有する可能性があり、「窓」もそれ相応に狭くなる可能性がある。

【００１８】本発明の自己タイミング式リアルタイム・データ転送ＶＲＡＭは、高速の外部制御回路を必要とせ

ずに、非常に狭いタイミング「窓」の中でリアルタイム・データ転送のタイミングを正確に定める能力を有する。このＶＲＡＭは、外部コントローラが転送タイミングを供給することを必要とするのではなく、タイミングにクリティカルなリアルタイム・アクセスを簡単かつ効率的に同期化する内部タイミング式データ転送を介してこのような高精度をもたらす。

【００１９】ここで図４を参照すると、本発明の好ましい実施例による３パラメータの一般事例での自己タイミング式データ転送（ＳＴＤＴ）リアルタイム・データ読取り転送サイクルのタイミング図が示されている。この図には、ＳＴＤＴ機能の制御の有利な手段が示されている。当業者であれば了解できるように、制御入力の相対タイミング、シーケンス、極性および動作機能を変更した、他の有利な制御手段を考案することができる。ＳＴＤＴアクセスの実際の動作は、ＳＴＤＴ機能が従来のリアルタイム・データ転送アクセスの代替として提供されるのか、それに追加して提供されるのかを含む、複数の要因に依存する。

【００２０】ＳＴＤＴ機能の最も一般的な場合では、３つのパラメータが必要である。必要なパラメータは、下記のとおりである。

・Ｒ　行アドレス
・Ｃ　列アドレス
・Ｔ　ＳＴＤＴの目標

【００２１】この３つの必要なパラメータは、「ＳＴＤＴ目標」（Ｔ）が必ず列アドレス（Ｃ）と等しくなるようにすることによって、２つに減らすことができる。ここでは、３パラメータを有するＳＴＤＴ機能の一般事例を説明し、下で、２パラメータの事例（Ｃ＝Ｔ）を、ＳＴＤＴの有用な変形の例として説明する。ＳＴＤＴ機能のこのような他の変形および単純化の詳細と応用分野は、当業者であれば容易に識別できるであろう。

【００２２】ＲＡＳの立ち下がりエッジで、アドレス入力から行アドレス（Ｒ）を取得し、行Ｒをアクティブにする。さらに、ＲＡＳの立ち下がりエッジで、ＤＴ／ＯＥがロー・レベルであれば、そのアクセスがデータ読取り転送であることが示される（ＶＲＡＭでは通常こうなっている）。ＣＡＳの立ち下がりエッジで、アドレス入力から列アドレス（Ｃ）を取得する。ＤＴ／ＯＥの立ち上がりエッジで、入力アドレスから目標アドレスを取得し、ＳＴＤＴ目標を、目標アドレスと等しい値にセットする。タップ・ポインタが、ＳＴＤＴ目標より１つ少ない値に達し（ＴＡＰ＝Ｔ　１）、ＳＴＤＴ目標（Ｔ）へ増分されようとしている時に、順次クロックの立ち上がりエッジに応答してデータ転送が行われる。データ転送時には、データが行ＲとＳＡＭの間で転送され、タップ・ポインタに、列アドレス（Ｃ）がロードされる。

【００２３】データ転送後の最初の順次クロックの立ち上がりエッジに応答して、ＳＡＭの新しい内容が、直列ポートで使用可能になる。タップ・ポインタは、順次クロックに応答して、データ転送中にシーケンスＴ－２、Ｔ－１、Ｃ、Ｃ＋１、Ｃ＋２に従う。ＳＡＭポートでの直列データの流れは、このデータ転送中に継ぎ目なしにステップし、シーケンス｛Ｑ；Ｔ　２｝、｛Ｑ；Ｔ　１｝、｛Ｒ；Ｃ｝、｛Ｒ；Ｃ＋１｝、｛Ｒ；Ｃ＋２｝に従う。おそらく、ほとんどの場合に、このシーケンスは、Ｑ＝Ｒ－１かつＣ＝Ｔ＝０であって、メモリ・アドレス空間内で連続したものになるはずである。しかし、このＳＴＤＴ機能の３パラメータの事例では、非常に有利な柔軟性と応用の有用性がもたらされる。

【００２４】ご存じのように、ＲＡＳ、ＣＡＳおよびＤＴ／ＯＥを含む、ビデオ表示システムの外部コントローラからのクロック刺激は、粗い粒度でのデータ転送のタイミングを示す。ＶＲＡＭがこの刺激を受け取ったならば、データ転送は、タップ・ポインタが目標アドレスより１つ小さい値に達する際に、内部的に順次クロックと同期化される。したがって、本発明のＶＲＡＭは、極度に狭いタイミング「窓」の間に転送を行うのに必要であり、直列ポートから順次データをリアルタイムで継ぎ目なしに転送するのに必要な微細タイミング粒度で、高精度自己タイミング式データ転送を行う能力を有する。

【００２５】図５は、本発明の好ましい実施例の２パラメータ事例（Ｃ＝Ｔ）でのＳＴＤＴリアルタイム・データ読取り転送サイクルのタイミング図である。この図は、ＳＴＤＴ機能の変形の制御の有利な手段を示す図である。前と同様に、制御入力の相対タイミング、シーケンス、極性および動作機能を変更した、他の有利な制御手段を考案することができる。２パラメータ事例（Ｃ＝Ｔ）は、行アドレスと列アドレスだけを供給する必要があり、ＤＴ／ＯＥの立ち上がりエッジのタイミングは、このＳＴＤＴの変形に本質的に無関係なので、同一のままにすることができるという点で、従来のデータ読取り転送とある種の共同作用を有する。

【００２６】ＲＡＳの立ち下がりエッジで、アドレス入力から行アドレス（Ｒ）を取得し、行Ｒをアクティブにする。さらに、ＲＡＳの立ち下がりエッジで、ＤＴ／ＯＥがロー・レベルであれば、そのアクセスがデータ読取り転送であることが示される（ＶＲＡＭでは通常こうなっている）。これは、ＳＴＤＴのＣ＝Ｔ変形でのＤＴ／ＯＥの唯一の機能であり、唯一のタイミング必要条件である。したがって、図５に示されているように、ＤＴ／ＯＥの立ち上がりエッジのタイミングは無関係である。ＣＡＳの立ち下がりエッジで、アドレス入力から列アドレス（Ｃ）を取得する。この２パラメータ変形では、列アドレス（Ｃ）がＳＴＤＴ目標でもある（Ｃ＝Ｔ）。タップ・ポインタが、ＳＴＤＴ目標より１つ少ない値に達し（ＴＡＰ＝Ｃ－１）、ＳＴＤＴ目標（Ｃ）へ増分されようとしている時に、順次クロックの立ち上がりエッジに応答してデータ転送が行われる。データ転送時には、

データが行ＲとＳＡＭの間で転送される。データ転送時にタップ・ポインタに列アドレス（Ｃ）をロードしてもよいが、タップ・ポインタは、順次クロックによってその値まで増分されるはずなので、この動作は不要である。

【００２７】データ転送後の最初の順次クロックの立ち上がりエッジに応答して、ＳＡＭの新しい内容が、直列ポートで使用可能になる。タップ・ポインタは、順次クロックに応答して、データ転送中にシーケンスＣ　２、Ｃ－１、Ｃ、Ｃ＋１、Ｃ＋２に従う。ＳＡＭポートでの直列データの流れは、このデータ転送中に継ぎ目なしにステップし、シーケンス｛Ｑ；Ｃ－２｝、｛Ｑ；Ｃ－１｝、｛Ｒ；Ｃ｝、｛Ｒ；Ｃ＋１｝、｛Ｒ；Ｃ＋２｝に従う。おそらく、ほとんどの場合に、このシーケンスは、Ｑ＝Ｒ－１かつＣ＝Ｔ＝０であって、メモリ・アドレス空間内で連続したものになるはずである。

【００２８】２パラメータ事例の代替事例が発生するのは、行アドレスと目標アドレスだけが入力される時である。列アドレスは、０になるか（Ｃ＝０）、ＶＲＡＭにプログラムされた事前に選択された別の値になり、ＳＴＤＴ目標（Ｔ）は、目標アドレスと同一にセットされる。タップ・ポインタが、ＳＴＤＴ目標より１つ少ない値に達し（ＴＡＰ＝Ｔ－１）、ＳＴＤＴ目標（Ｔ）へ増分されようとしている時に、順次クロックの立ち上がりエッジに応答してデータ転送が行われる。データ転送時には、データが行ＲとＳＡＭの間で転送され、タップ・ポインタに、事前に選択された列アドレス（Ｃ）がロードされる。

【００２９】ＳＴＤＴの１パラメータ変形または無パラメータ変形を実施することも可能である。１パラメータ事例では、行アドレスＲだけが供給され、列アドレスとＳＴＤＴ目標には、なんらかの事前に選択された値がセットされる。たとえば、ビット長５１２のＳＡＭの場合、ＳＴＤＴ目標を０にセットし、列アドレスを１２にセットすることができる。タップ・ポインタがＳＴＤＴ目標より１つ小さい値に達し、ＳＴＤＴ目標へ増分されようとしている時に、順次クロックの立ち上がりエッジに応答してデータ転送が行われる。この例では、タップ・ポインタが最大カウント値（すなわち、９ビットＴＡＰの場合は５１１または２進数の「１１１１１１１１１」）に達し、次の増分の際にラップアラウンドして０に戻ろうとしている時に、順次クロックに応答してデータ転送が行われる。データ転送時には、データがＲＡＭの行ＲとＳＡＭの間で転送され、タップ・ポインタに、列アドレス（Ｃ）、たとえば値１２がロードされる。

【００３０】無パラメータ事例では、列アドレスとＳＴＤＴ目標が、０または事前に選択された何らかの値になり、ＳＡＭの新しい内容になるデータの行アドレスが、ＳＡＭの前の内容をロードするのに使用された前の行アドレスより１つ大きい値になる。この０パラメータ事例

では、行アドレス・シーケンスを起動し、再起動するための何らかの手段を使用できるようにする必要がある。それでも、外部コントローラからのタイミング刺激が、データ転送の粗タイミング位置を供給するために必要である。さらに、望むならば、３つを超えるパラメータを有するＳＴＤＴの変形を設けることが可能である。

【００３１】上で述べたどの事例でも、データ転送は、ＶＲＡＭデバイスによって内部的にタイミングを取られ、順次クロック・ストリームにデータ転送が同期化された。従来のリアルタイム・データ転送と異なり、ＳＴＤＴデータ転送は、ＲＡＭポートに制御信号を印加する外部回路によってタイミングを決定されるのではなく、ＶＲＡＭデバイス自体によってタイミングを決定されている。外部制御信号に対する唯一のタイミング必要条件は、データ転送の前に、ＳＴＤＴアクセスが開始され、必要なＳＴＤＴパラメータが供給されていることと、ＳＴＤＴアクセスがデータ転送の後に打ち切られることである。これらの必要条件を満足するには、複雑な回路や高速回路は必要ない。というのは、タイミング粒度を、高速順次クロック・ストリームへの同期に必要なものよりはるかに粗くすることができるからである。

【００３２】本発明を実施するのに必要な、従来のＶＲＡＭに対する追加修正のサイズは、ＶＲＡＭの全サイズを大きく増加させるものではない。ＶＲＡＭ設計にＳＴＤＴを実施するには、ＳＴＤＴ機能の検出と制御のためにＶＲＡＭのアドレス／制御論理回路にわずかな追加修正を行うことだけが必要である。また、ＴＡＰカウンタ回路に取り付けられる比較器を追加する必要がある。この比較器のビット数は、ＴＡＰカウンタのビット数（長さ５１２のＳＡＭの場合９ビット）と同一である。ＳＴＤＴ機能のうちの可能な変形の１つまたはすべてを、現在のＶＲＡＭ内で使用可能な通常のデータ転送アクセスの代わりに、またはそれに追加して提供することができる。さらに、本発明を、表示メモリ・サブシステムで使用されるものとして、主にデータ読取り転送（ＲＡＭ→ＳＡＭ）に関して説明してきたが、本発明は、現在のＶＲＡＭの一部に見られるデータ書込み転送（ＳＡＭ→ＲＡＭ）に関連して応用することもできる。

【００３３】好ましい実施例に関して本発明を具体的に図示し、説明してきたが、当業者であれば、本発明の趣旨と範囲から逸脱せずに形態と詳細にさまざまな変更を加えられることを理解するであろう。

【００３４】まとめとして、本発明の構成に関して以下の事項を開示する。

【００３５】（１）データ転送を指令する刺激を外部コントローラから受け取るステップと、タップ・ポインタがプログラム可能な目標値と等しい期間の間にＲＡＭ内の１行から順次アクセス・メモリへの、内部的に順次クロックに同期化されたデータ転送を実行するステップとを含む、ＲＡＭ、順次アクセス・メモリおよびタップ・

ポインタを有するビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２）刺激が、データ転送信号の状態遷移であることを特徴とする、上記（１）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（３）転送されるデータが、前の順次アクセス・メモリ内容より１つ大きい行アドレスを有するＲＡＭ行に含まれるデータであることを特徴とする、上記（１）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（４）さらに、アドレス入力に存在する行アドレスを読み取るステップを含む、上記（１）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（５）転送されるデータが、行アドレスに対応するＲＡＭ行に含まれるデータであることを特徴とする、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（６）刺激が、データ転送信号がイネーブル状態である時のＲＡＳの状態遷移であることを特徴とする、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（７）プログラム可能な目標値が、事前に選択された値にセットされることを特徴とする、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（８）データ転送を実行するステップが、列アドレスを事前に選択された値にセットするステップと、タップ・ポインタに列アドレスをロードするステップとを含むことを特徴とする、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（９）さらに、アドレス入力に存在する列アドレスを読み取るステップを含む、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１０）プログラム可能な目標値が、事前に選択された値にセットされることを特徴とする、上記（９）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１１）プログラム可能な目標値が、列アドレスより１つ小さい値にセットされることを特徴とする、上記（９）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１２）列アドレスが、０であることを特徴とする、上記（１１）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１３）列アドレスを読み取るステップが、第１入力信号の状態の変化に応答して発生することを特徴とする、

上記（９）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１４）第１入力信号が、ＣＡＳであることを特徴とする、上記（１３）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１５）データ転送を実行するステップが、タップ・ポインタに列アドレスをロードするステップを含むことを特徴とする、上記（９）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１６）さらに、アドレス入力に存在する目標アドレスを読み取るステップを含む、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１７）プログラム可能な目標値が、目標アドレスより１つ小さい値にセットされることを特徴とする、上記（１６）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１８）データ転送を実行するステップが、列アドレスを事前に選択された値にセットするステップと、タップ・ポインタに列アドレスをロードするステップとを含むことを特徴とする、上記（１７）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（１９）目標が、０に等しいことを特徴とする、上記（１７）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２０）さらに、アドレス入力に存在する列アドレスを読み取るステップを含む、上記（１７）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２１）列アドレスを読み取るステップが、第１入力信号の状態の変化に応答して発生することを特徴とする、上記（２０）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２２）第１入力信号が、ＣＡＳであることを特徴とする、上記（２１）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２３）データ転送を実行するステップが、タップ・ポインタに列アドレスをロードするステップを含むことを特徴とする、上記（２０）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２４）目標アドレスを読み取るステップが、第２入力信号の状態が変化する時に発生することを特徴とする、上記（１６）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。

（２５）第２入力信号が、データ転送信号であることを特徴とする、上記（２４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の

方法。
（２６）行アドレスの読取りが、第３入力信号の状態が変化する時に発生することを特徴とする、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。
（２７）第３入力信号が、ＲＡＳであることを特徴とする、上記（２６）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。
（２８）さらに、順次アクセス・メモリの内容を直列ポートから出力するステップを含む、上記（４）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。
（２９）出力のステップが、データ転送を実行するステップの後に発生する最初の順次クロック・サイクルの立ち上がりエッジに応答して開始されることを特徴とする、上記（２８）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式データ転送の方法。
（３０）ＲＡＭアレイと、直列出力ポートを有する順次アクセス・アレイと、アドレスを入力するためのアドレス入力と、ＲＡＭアレイと順次アクセス・アレイとの間でのデータ転送の粗いタイミング位置を示す、外部コントローラからの刺激を検出するための感知手段と、感知手段が刺激を検出するのに応答して、ＲＡＭアレイと順次アクセス・アレイとの間でのデータ転送を指令する制御信号を出力することを特徴とし、順次クロックに同期化され、タップ・ポインタがプログラム可能な目標値より１つ小さい値に等しい期間の間発生する制御信号を供給するための、制御論理回路と、制御論理回路によって供給される制御信号に応答して、ＲＡＭアレイと順次アクセス・アレイとの間でデータを転送するための転送ゲートとを含む、ビデオＲＡＭ半導体メモリ・デバイス。
（３１）刺激が、データ転送信号の状態遷移であることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３２）転送されるデータが、前の順次アクセス・メモリ内容より１つ大きい行アドレスを有するＲＡＭ行に含まれるデータであることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３３）転送されるデータが、アドレス入力で読み取られる行アドレスに対応するＲＡＭ行に含まれることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３４）刺激が、データ転送信号がイネーブル状態である時のＲＡＳの状態遷移であることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３５）プログラム可能な目標値が、事前に選択された値にセットされることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３６）プログラム可能な目標値が、アドレス入力で読み取られた列アドレスより１つ小さい値にセットされることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３７）列アドレスが０であることを特徴とする、上記（３６）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３８）列アドレスが、第１入力信号の状態の変化に応答して読み取られることを特徴とする、上記（３６）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（３９）第１入力信号がＣＡＳであることを特徴とする、上記（３８）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４０）データ転送を指令する制御信号が出力されるのと同時に、制御論理回路が、列アドレスをタップ・ポインタにロードすることを特徴とする、上記（３６）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４１）プログラム可能な目標値が、アドレス入力で読み取られた目標アドレスより１つ小さい値にセットされることを特徴とする、上記（３３）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４２）目標アドレスが、０に等しいことを特徴とする、上記（４１）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４３）目標アドレスが、第２入力信号の状態の変化に応答して読み取られることを特徴とする、上記（４１）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４４）第２入力信号が、データ転送信号であることを特徴とする、上記（４３）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４５）列アドレスが、アドレス入力で読み取られることを特徴とする、上記（４１）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４６）データ転送を指令する制御信号が出力されるのと同時に、制御論理回路が、タップ・ポインタに列アドレスをロードすることを特徴とする、上記（４５）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４７）列アドレスが、第１入力信号の状態の変化に応答して読み取られることを特徴とする、上記（４５）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４８）第１入力信号が、ＣＡＳであることを特徴とする、上記（４７）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（４９）行アドレスが、第３入力信号の状態の変化に応答して読み取られることを特徴とする、上記（３３）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（５０）第３入力信号が、ＲＡＳであることを特徴とする、上記（４９）に記載のビデオＲＡＭ半導体メモリ・デバイス。
（５１）直列ポートが、データ転送の後の最初に発生する順次クロック・サイクルの立ち上がりエッジに応答し

て、順次アクセス・アレイの内容を出力し始めることを特徴とする、上記（３０）に記載のビデオＲＡＭ半導体メモリ・デバイス。

（５２）アドレス入力に存在する行アドレスを読み取るステップと、アドレス入力に存在する列アドレスを読み取るステップと、データ転送信号がイネーブル状態である時にＲＡＳの状態遷移を検出するステップと、タップ・ポインタが列アドレスより１つ小さい値に等しい期間の間に、行アドレスに対応するＲＡＭ内の行から順次アクセス・メモリへ、内部的に順次クロックに同期化された状態で、行アドレスに対応するＲＡＭ行に含まれるデータを転送するステップとを含む、ＲＡＭ、順次アクセス・メモリおよびタップ・ポインタを有するビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

（５３）列アドレスが０であることを特徴とする、上記（５２）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

（５４）列アドレスを読み取るステップが、ＣＡＳの状態の変化に応答して発生することを特徴とする、上記（５２）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

（５５）行アドレスを読み取るステップが、ＲＡＳの状態の変化に応答して発生することを特徴とする、上記（５２）に記載のビデオＲＡＭ半導体メモリ・デバイス内での自己タイミング式リアルタイム・データ転送の方法。

【図面の簡単な説明】

【図１】本発明の好ましい実施例によるＶＲＡＭのブロック図である。

【図２】順次クロックがインアクティブの状態での通常のデータ読取り転送サイクルのタイミング図である。

【図３】順次クロックがアクティブの状態での、いわゆる「リアルタイム・データ転送」の通常のデータ読取り転送サイクルのタイミング図である。

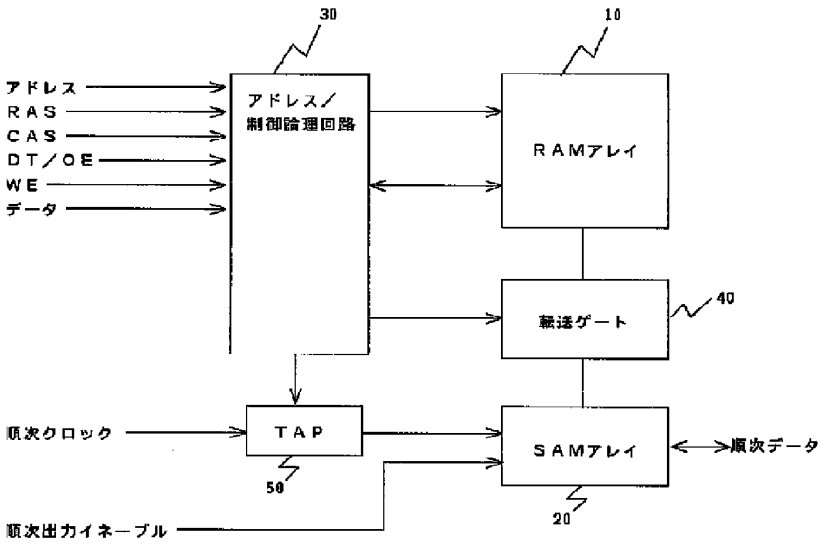
【図４】本発明の好ましい実施例による３パラメータの一般事例での自己タイミング式データ転送（ＳＴＤＴ）リアルタイム・データ読取り転送サイクルのタイミング図である。

【図５】本発明の好ましい実施例による２パラメータの事例でのＳＴＤＴリアルタイム・データ読取り転送サイクルのタイミング図である。

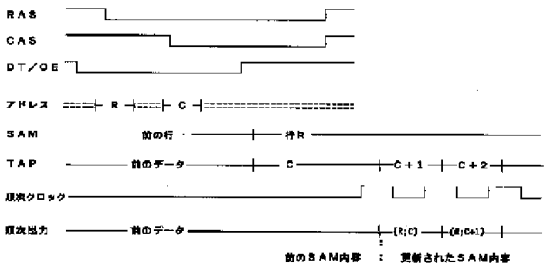
【符号の説明】

１０　ＲＡＭアレイ
２０　ＳＡＭアレイ
３０　アドレス／制御論理回路
４０　転送ゲート
５０　タップ・ポインタ（ＴＡＰ）

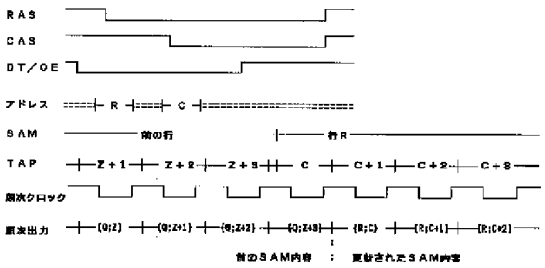
【図１】



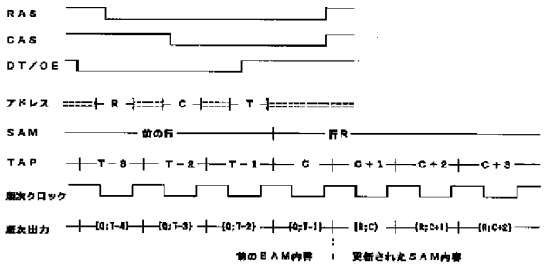
【図２】



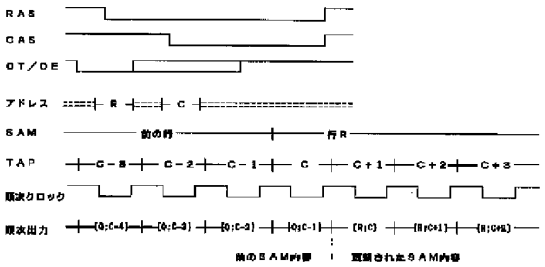
【図３】



【図４】



【図５】



フロントページの続き

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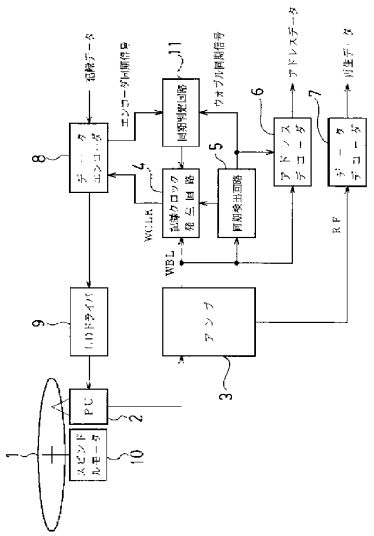
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(54)【発明の名称】データ記録用クロック信号発生装置

(57)【要約】
【目的】　ウォブル信号にアドレス情報などを位相変調によって重畳した光ディスクの場合でも、ウォブル信号に安定して位相同期した記録用クロックを発生させるようにする。
【構成】　この記録クロック発生回路４は、ウォブル信号を抽出し、記録用クロック信号を分周した分周クロック信号を発生し、上記ウォブル信号と上記分周クロック信号との位相を比較して位相差信号を発生し、上記位相差信号に基づく周波数制御信号を発生し、上記周波数制御信号に基づいて制御した周波数を有する上記記録用クロック信号を発生することにより、光ディスクのアドレス情報又は同期信号が位相変調された所定タイミングの近傍では位相差信号の発生を行なわせないようにする。
【選択図】　図１



【特許請求の範囲】
【請求項１】
所定の周波数成分を有し、所定タイミングでアドレス情報と同期信号とが位相変調によって重畳したウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスクにデータを記録するときの前記ウォブル信号に位相同期させた記録用クロック信号を発生するデータ記録用クロック信号発生装置であって、
前記ウォブル信号を抽出するウォブル信号抽出手段と、
前記記録用クロック信号を分周した分周クロック信号を発生する記録用クロック信号分周手段と、
前記ウォブル信号と前記分周クロック信号との位相を比較して位相差信号を発生する位相差信号発生手段と、
該手段によって発生された前記位相差信号に基づく周波数制御信号を発生する周波数制御信号発生手段と、
該手段によって発生された前記周波数制御信号に基づいて制御した周波数を有する前記記録用クロック信号を発生する記録用クロック信号発生手段とを備え、
前記光ディスクの前記アドレス情報又は前記同期信号が位相変調された所定タイミングの近傍では前記位相差信号発生手段による位相差信号の発生を行なわせないようにする手段を設けたことを特徴とするデータ記録用クロック信号発生装置。
【発明の詳細な説明】
【技術分野】
【０００１】
この発明は、データ記録可能な光ディスク，ハードディスク等の記録媒体のデータ記録装置に備えるデータを記録するための記録用クロック信号を生成するデータ記録用クロック信号発生装置に関する。
【背景技術】
【０００２】
所定の周波数成分を有するウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスクとして、ＣＤ－Ｒ，ＣＤ－ＲＷ，ＤＶＤ－Ｒ，及びＤＶＤ－ＲＡＭなどの記録媒体（メディア）が知られており、これらの光ディスクのウォブル信号に位相同期した記録用クロック信号を発生させるデータ記録用クロック信号発生装置（例えば、特許文献１，特許文献２参照）がある。
【０００３】
また、データ書き換え型光ディスクの性質として、同じ場所に何度も繰り返して記録すると、記録マークおよびその周辺が熱的ストレスなどによって劣化し、次に異なる信号を記録した時には、マークが正確に記録できないという性質があるが、このような問題を軽減するために、記録開始点をランダムに可変にし、同じ場所を繰り返して使用することを防ぐことによって、ディスク材料の疲労を平均化して軽減し、結果的に繰り返し使用回数を向上させる光ディスクの記録方法及び光ディスク装置（例えば、特許文献３，特許文献４参照）があった。
【０００４】
さらに、ウォブル信号にアドレス情報などを位相変調によって重畳した光ディスク（例えば、特許文献５参照）があり、光ディスクのウォブル信号に位相同期した記録用クロック信号を発生させるデータ記録用クロック信号発生装置もある。
【０００５】
図１４は、従来の光ディスク駆動装置の構成例を示すブロック図である。
まず、光ディスク１には、所定の周波数成分を有するウォブル信号でウォブリングされたデータ記録用トラックが存在する。
【０００６】
図１５は、光ディスク１上のウォブリングされたデータ記録用トラックの構造例を示す説明図である。

トラックの位置を示すグルーブ部がアドレス情報に対応してウォブリングされており、ウォブル信号にはアドレス情報と同期信号とが変調されて重畳されている。

【０００７】

図１４に示した従来の光ディスク駆動装置では、光ピックアップ（ＰＵ）２からは、光ディスク１上のデータ記録用トラックに向けて、レーザビームを照射する。

そして、光ディスク１上のトラックで反射されたレーザビームは、光ピックアップ２に戻され、光ピックアップ２内のディテクタで電気信号に変換される。

【０００８】

アンプ３は、光ピックアップ２で検出された電気信号を増幅し、光ディスク１上に記録されたデータに対応する再生信号（ＲＦ）と、トラックのウォブリングに対応したウォブル信号（ＷＢＬ）を出力する。

その再生信号（ＲＦ）は、データの再生を行なう場合に検出され、ウォブル信号（ＷＢＬ）は、データの記録及び再生双方の動作で検出される。

【０００９】

記録クロック発生回路４は、ウォブル信号（ＷＢＬ）に位相同期した記録用クロック信号（ＷＣＬＫ）を発生する。

【００１０】

図１６は、図１４に示した従来の記録クロック発生回路の構成例を示すブロック図である。

この記録クロック発生回路４は、いわゆるＰＬＬ（Ｐｈａｓｅ Ｌｏｃｋｅｄ Ｌｏｏｐ）回路で構成される。

位相比較器４１は、ウォブル信号（ＷＢＬ）と、記録用クロック信号（ＷＣＬＫ）を分周器４５で所定比に分周した信号（分周クロック）との位相差を比較する。

【００１１】

位相比較器４１からの出力は、チャージポンプ４２によって電圧信号に変換された後、フィルタ４３で平滑化され、ＶＣＯ（Ｖｏｌｔａｇｅ Ｃｏｎｔｒｏｌｌｅｄ Ｏｓｃｉｌｌａｔｏｒ）に入力される。

ＶＣＯの出力クロック、すなわち記録用クロック信号（ＷＣＬＫ）は、入力電圧によってその周波数が制御される。その結果、記録用クロック信号（ＷＣＬＫ）の位相は、ウォブル信号（ＷＢＬ）に同期したものになる。

【００１２】

図１４に戻り、従来の光ディスク駆動装置の同期検出回路５とアドレスデコーダ６は、それぞれウォブル信号に重畳された同期信号とアドレス情報を検出する。

そして、データの記録を行なう場合、データエンコーダ８は、記録用クロック信号（ＷＣＬＫ）に同期して記録データに所定の変調処理を施す。

【００１３】

ＬＤドライバ９は、変調された記録データに応じて光ピックアップ２が出射するレーザビーム強度を変調する。

この結果、データ記録用トラックのウォブル信号に同期してデータの記録が行なわれる。

【特許文献１】特開平１０－２９３９２６号公報
【特許文献２】特開平１１－６６５６３号公報
【特許文献３】特公平８　１０４８９号公報
【特許文献４】特開平１０－３６６７号公報
【特許文献５】特開平１０－６９６４６号公報

【発明の開示】

【発明が解決しようとする課題】

【００１４】

しかしながら、上述した特許文献３に記載された技術は、記録開始点をランダムに可変にし、同じ場所を繰り返して使用することを防ぐことによって、ディスク材料の疲労を平

均化して軽減し、結果的に繰り返し使用回数を向上させるものであり、そのランダムな記録開始点を得るために複数のアナログディレイ回路を使用しなければならないので装置コストが高価になるという問題があった。

【００１５】

次に、上述したような従来の記録クロック発生回路では、ウォブル信号が正常に検出されていれば、記録用クロック信号（ＷＣＬＫ）の位相は、常にウォブル信号（ＷＢＬ）に同期したものとなる。

【００１６】

しかし、光ディスク上には小さな欠陥が存在する場合もあり、また、光ディスク表面にごみなどが付着する場合もあり、このような欠陥やゴミなどが付着した部分ではウォブル信号に欠落が生じ、正常な検出がされなくなる場合がある。

【００１７】

そこで、上述したような従来のＰＬＬ回路で構成された記録クロック発生回路では、いわゆるＰＬＬのフライホイール効果があるため、ウォブル信号の小さな欠落に対しては、ウォブル信号と記録用クロック信号との位相同期は保たれる。

【００１８】

しかし、ウォブル信号の欠落が大きい場合には、欠落中にウォブル信号と記録用クロック信号との位相がずれてしまい、欠落後、記録用クロック信号がウォブル信号周期の整数倍の位相ずれを生じた状態で位相同期する、いわゆるビットスリップが生じる場合がある。

【００１９】

そして、ビットスリップが生じた場合、ウォブル信号と記録用クロックの位相ずれは回復させることができず、記録データが所定位置からずれた状態で記録されることになる。

【００２０】

また、ビットスリップが生じたまま、あるセクタまでのデータの記録を完了させた後、続くセクタから新たにデータを記録させた場合に、記録データの接続部でデータの重なりや不要な空白が生じる。

このような場合、記録データ接続部付近のデータが正しく再生できなくなるという最悪の事態を招き易くなるという問題があった。

【００２１】

次に、ウォブル信号にアドレス情報などを位相変調によって重畳した光ディスク（例えば、特許文献５参照）の場合、位相変調のためにウォブル信号位相に急な変化が生じる部分があり、従来の記録クロック発生回路では、ウォブル信号と記録用クロック信号との位相ずれが生じてしまうという問題があった。

【００２２】

この発明は上記の課題を解決するためになされたものであり、ウォブル信号にアドレス情報などを位相変調によって重畳した光ディスクの場合でも、ウォブル信号に安定して位相同期した記録用クロックを発生させる記録クロック発生回路を提供することを目的とする。

【課題を解決するための手段】

【００２３】

この発明は上記の目的を達成するため、所定の周波数成分を有し、所定タイミングでアドレス情報と同期信号とが位相変調によって重畳したウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスクにデータを記録するときの上記ウォブル信号に位相同期させた記録用クロック信号を発生するデータ記録用クロック信号発生装置であって、上記ウォブル信号を抽出するウォブル信号抽出手段と、上記記録用クロック信号を分周した分周クロック信号を発生する記録用クロック信号分周手段と、上記ウォブル信号と上記分周クロック信号との位相を比較して位相差信号を発生する位相差信号発生手段と、その手段によって発生された上記位相差信号に基づく周波数制御信号を発生する周波数制御信号発生手段と、その手段によって発生された上記周波数制御信号に基づいて制御した

周波数を有する上記記録用クロック信号を発生する記録用クロック信号発生手段とを備え、上記光ディスクの上記アドレス情報又は上記同期信号が位相変調された所定タイミングの近傍では上記位相差信号発生手段による位相差信号の発生を行なわせないようにする手段を設けたデータ記録用クロック信号発生装置を提供する。

【発明の効果】

【００２４】

この発明による記録クロック発生装置は、位相変調によってウォブル信号位相に急な変化が生じる部分で位相比較器の動作をマスクするので、ウォブル信号と記録用クロック信号との位相ずれが生じることが無くなり、ウォブル信号に安定して位相同期した記録用クロックを発生させることができる。

【発明を実施するための最良の形態】

【００２５】

以下、この発明を実施するための最良の形態を図面に基づいて具体的に説明する。

図１は、この発明の参考例及びこの発明の一実施形態である光ディスク駆動装置の構成例を示すブロック図であり、図１４に示した光ディスク駆動装置と共通する部分には同一符号を付してその説明を省略する。

【００２６】

この光ディスク駆動装置の記録クロック発生回路４は、所定の周波数成分を有するウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスク１にデータを記録するときの上記ウォブル信号に位相同期させた記録用クロック信号を発生するデータ記録用クロック信号発生装置であり、その記録クロック発生回路４等がこの発明及びこの発明の参考例に係る以下の各手段の機能を果たす。

【００２７】

上記ウォブル信号を抽出するウォブル信号抽出手段と、上記記録用クロック信号を分周した分周クロック信号を発生する記録用クロック信号分周手段と、上記ウォブル信号と上記分周クロック信号との位相を比較して位相差信号を発生する位相差信号発生手段と、その手段によって発生された上記位相差信号に基づく周波数制御信号を発生する周波数制御信号発生手段と、その手段によって発生された上記周波数制御信号に基づいて制御した周波数を有する上記記録用クロック信号を発生する記録用クロック信号発生手段とを備え、上記記録用クロック信号分周手段が上記記録用クロック信号を分周するときの基準分周比とその基準分周比とは異なる分周比とを所定の順序に従って設定する分周比設定手段。

【００２８】

また、上記光ディスクにデータを記録する毎に、上記記録用クロック分周手段に対して設定する基準分周比とその基準分周比とは異なる分周比の組み合わせの順序を異ならせる手段。

【００２９】

さらに、上記ウォブル信号に重畳されている同期信号を検出する同期検出手段と、その手段によって検出された上記同期信号と上記光ディスクの記録データとの同期関係を判定する同期関係判定手段と、その手段によって上記同期信号に対して上記記録データのタイミングが遅れているものと判定された場合、上記記録用クロック分周手段に設定する分周比の平均値が上記基準分周比よりも長い値になるようにし、上記同期信号に対して上記記録データのタイミングが進んでいるものと判定された場合、上記記録用クロック分周手段に設定する分周比の平均値が上記基準分周比よりも短い値になるようにする制御手段。

【００３０】

また、所定の周波数成分を有し、所定タイミングでアドレス情報と同期信号とが位相変調によって重畳したウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスクにデータを記録するときの上記ウォブル信号に位相同期させた記録用クロック信号を発生するデータ記録用クロック信号発生装置であって、上記ウォブル信号を抽出するウォブル信号抽出手段と、上記記録用クロック信号を分周した分周クロック信号を発生する記録用クロック信号分周手段と、上記ウォブル信号と上記分周クロック信号との位相を

比較して位相差信号を発生する位相差信号発生手段と、その手段によって発生された上記位相差信号に基づく周波数制御信号を発生する周波数制御信号発生手段と、その手段によって発生された上記周波数制御信号に基づいて制御した周波数を有する上記記録用クロック信号を発生する記録用クロック信号発生手段とを備え、上記光ディスクの上記アドレス情報又は上記同期信号が位相変調された所定タイミングの近傍では上記位相差信号発生手段による位相差信号の発生を行なわせないようにする手段。

【００３１】

さらに、所定の周波数成分を有するウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスクにデータを記録するときの上記ウォブル信号に位相同期した記録用クロック信号を発生するデータ記録用クロック信号発生装置であって、上記ウォブル信号を抽出するウォブル信号抽出手段と、上記記録用クロック信号を分周した分周クロックを発生する記録用クロック信号分周手段と、上記ウォブル信号と上記分周クロック信号との位相を比較して位相差信号を発生する位相差信号発生手段と、その手段によって発生された上記位相差信号に基づく第１の周波数制御信号を発生する第１周波数制御信号発生手段と、上記ウォブル信号を所定の分周比で分周するウォブル信号分周手段と、その手段によって分周されたウォブル信号の周期を上記記録用クロック信号の周期でカウントするウォブル信号周期カウント手段と、その手段によってカウントされた周期に基づく第２の周波数制御信号を発生する第２周波数制御信号発生手段と、上記ウォブル信号周期カウント手段によってカウントされた周期が所定の範囲内にある場合には上記第１周波数制御信号発生手段によって発生された第１の周波数制御信号によって制御した周波数を有する上記記録用クロック信号を発生し、上記周期が所定の範囲外にある場合には上記第２周波数制御信号発生手段によって発生された第２の周波数制御信号によって制御した周波数を有する上記記録用クロック信号を発生する記録用クロック信号発生手段。

【００３２】

さらにまた、所定の周波数成分を有するウォブル信号でウォブリングされたデータ記録用トラックを有する光ディスクにデータを記録するときの上記ウォブル信号に位相同期した記録用クロック信号を発生するデータ記録用クロック信号発生装置であって、上記ウォブル信号を抽出するウォブル信号抽出手段と、上記記録用クロック信号を分周した分周クロックを発生する記録用クロック信号分周手段と、上記ウォブル信号と前記分周クロック信号との位相を比較して位相差信号を発生する位相差信号発生手段と、その手段によって発生された上記位相差信号に基づく第１の周波数制御信号を発生する第１周波数制御信号発生手段と、上記ウォブル信号を所定の分周比で分周するウォブル信号分周手段と、その手段によって分周されたウォブル信号の周期を上記記録用クロック信号の周期でカウントするウォブル信号周期カウント手段と、その手段によってカウントされた周期に基づく第２の周波数制御信号を発生する第２周波数制御信号発生手段と、上記ウォブル信号周期カウント手段によってカウントされた周期が所定の範囲内にある場合には上記第１周波数制御信号発生手段によって発生された第１の周波数制御信号によって制御した周波数を有する上記記録用クロック信号を発生し、上記周期が所定の範囲外にあることが所定回数連続して検出された場合には上記第２周波数制御信号発生手段によって発生された第２の周波数制御信号によって制御した周波数を有する上記記録用クロック信号を発生する記録用クロック信号発生手段。

上記各機能については以下順に説明する。

【００３３】

まず、この発明の参考例の記録クロック発生回路について説明する。

図２は、図１に示したこの発明の参考例の記録クロック発生回路４の内部構成例を示すブロック図であり、図１６と共通する部分には同一符号を付している。

この記録クロック発生回路４は、いわゆるＰＬＬ（Ｐｈａｓｅ Ｌｏｃｋｅｄ Ｌｏｏｐ）回路で構成されており、ウォブル信号（ＷＢＬ）に位相同期した記録用クロック信号（ＷＣＬＫ）を発生する。

【００３４】

分周器４５は、分周比設定テーブル４７から出力される分周比制御信号に応じて記録用クロック信号（ＷＣＬＫ）を分周した分周クロック信号を出力する。
その分周クロック信号は、位相比較器４１にフィードバックされると共に、分周クロックカウンタ４６にも入力される。

【００３５】

分周クロックカウンタ４６は、分周クロック信号のエッジ毎にカウント値を変化させる。
分周比設定テーブル４７は、分周クロックカウンタ４６のカウント値と分周条件設定値に応じて分周器４５へ分周比制御信号を出力する。

【００３６】

図３は、上記分周器４５，分周クロックカウンタ４６，及び分周比設定テーブル４７のさらに詳細な構成例を示す図である。
この分周クロックカウンタ（２ｂｉｔ　Ｃｎｔ）４６は、２ビットカウンタで構成される。

【００３７】

また、分周器４５は、４ビットカウンタであるＡカウンタ（Ａ　Ｃｎｔ：４ｂｉｔ　Ｃｎｔ）４５１，３ビットカウンタであるＢカウンタ（Ｂ　Ｃｎｔ：３ｂｉｔ　Ｃｎｔ）４５２，同期式ＳＲＦＦ４５５，インバータ（Ｉｎｖ）４５３，及び３ｔｏ１構成のマルチプレクサ（Ｍｕｘ）４５４で構成される。

【００３８】

このＡカウンタ４５１，Ｂカウンタ４５２，及び同期式ＳＲＦＦ４５５には、図示を省略した記録用クロック信号（ＷＣＬＫ）をそれぞれ入力しており、以下の説明では、記録用クロック信号の１周期を１Ｔと表現する。

【００３９】

Ａカウンタ４５１，Ｂカウンタ４５２のカウントイネーブル入力（ＥＮ）には、それぞれ同期式ＳＲＦＦ４５５のＱｂ出力，Ｑ出力を接続している。

【００４０】

同期式ＳＲＦＦ４５５のＳ入力には、Ａカウンタ４５１のフルカウント出力（＝１５），すなわち、Ａカウンタ４５１のカウント値が最大値“１５”であることを示す信号を接続している。

【００４１】

同期式ＳＲＦＦ４５５のＲ入力には、Ｂカウンタ４５２のフルカウント出力（＝７），すなわち、Ｂカウンタ４５２のカウント値が最大値“７”であることを示す信号を接続している。

【００４２】

Ａカウンタ４５１のフルカウント出力（＝１５）は、Ｂカウンタ４５２のロード入力（ＬＤ）にも接続している。
Ｂカウンタ４５２のフルカウント出力（－７）は、Ａカウンタ４５１のロード入力（ＬＤ）にも接続している。

【００４３】

Ａカウンタ４５１のデータ入力（Ｄｉ）には、“７”，“８”，“９”の各値の中からマルチプレクサ４５４で選択された一つの値が入力され、ロード（ＬＤ）入力がアクティブになった場合には、Ａカウンタ４５１のカウント値は“７”，“８”，“９”のいずれかの値に設定される。

【００４４】

Ｂカウンタ４５２のデータ入力（Ｄｉ）には、値“０”が入力され、ロード（ＬＤ）入力がアクティブになった場合には、Ｂカウンタ４５２のカウント値は“０”に設定される。

【００４５】

次に、分周器４５の動作について説明する。

Ａカウンタ４５１とＢカウンタ４５２は、交互にカウント動作を行なう。
Ａカウンタ４５１は、マルチプレクサ４５４で選択される値によって、“７”，“８”，“９”のいずれかの初期値から、最終値“１５”までのカウント動作を行なう。
つまり、Ａカウンタ４５１は１回のカウント動作で７Ｔ分，８Ｔ分，又は９Ｔ分のカウントを行なう。
【００４６】
Ｂカウンタ４５２は、初期値“０”から最終値“７”までのカウント動作を行なう。
つまり、Ｂカウンタ４５２は１回のカウント動作で８Ｔ分のカウントを行なう。
【００４７】
また、分周クロックは、同期式ＳＲＦＦ４５５のＱ出力をインバータ４５３で反転させた信号である。
したがって、分周クロック１サイクル分の動作は、Ａカウンタ４５１の１回のカウント動作と、Ｂカウンタ４５２の１回のカウント動作とを組み合わせたものであり、その周期は１５Ｔ分，１６Ｔ分，又は１７Ｔ分になる。
【００４８】
すなわち、分周器４５の基準分周比は“１６”になり、その基準分周比に対して±１の分周比変化を可能にしている。
【００４９】
分周クロックカウンタ４６のカウントイネーブル入力（ＥＮ）には、Ｂカウンタのフルカウント出力（＝７）を接続している。
そのため、分周クロックカウンタ４６は、Ａカウンタ４５１の１回のカウント動作とＢカウンタ４５２の１回のカウント動作とを組み合わせた分周クロックの１サイクル分の動作の終了毎に、そのカウント値をアップさせる。
分周クロックカウンタ４６は、ここでは２ビットカウンタなので、カウント値は０から３までの値になる。
【００５０】
分周比設定テーブル４７には、分周クロックカウンタ４６から２ビットのカウントデータと、分周条件設定値として２ビットのデータとが入力される。
分周比設定テーブル４７は、分周クロックカウンタ４６のカウント値と分周条件設定値とに応じて、表１に示す真理値表にしたがって分周比制御信号を出力する。
【００５１】

【表１】

分周条件設定値	分周クロックカウンタ値	Sel7	Sel8	Sel9
0	0	0	1	0
	1	0	1	0
	2	0	1	0
	3	0	1	0
1	0	0	0	1
	1	0	1	0
	2	0	1	0
	3	1	0	0
2	0	0	0	1
	1	1	0	0
	2	0	0	1
	3	1	0	0
3	0	0	1	0
	1	0	1	0
	2	0	0	1
	3	1	0	0

【００５２】
分周比設定テーブル４７の分周比制御信号はマルチプレクサ４５４に接続しており、その分周比制御信号に応じてＡカウンタ４５１の初期値が選択される。
マルチプレクサ４５４は、分周比制御信号（Ｓｅｌ７）がアクティブの場合には値“７”を選択し、分周比制御信号（Ｓｅｌ８）がアクティブの場合には値“８”を選択し、分周比制御信号（Ｓｅｌ９）がアクティブの場合には値“９”を選択する。
【００５３】
図４は、分周器４５の動作の説明に供するタイミング図であり、同図に基づいて図３に示した分周器４５の動作を詳細に説明する。
図４では４段のタイミング図を同時に示しているが、１段目が分周条件設定値＝０の場合，２段目が分周条件設定値＝１の場合，３段目が分周条件設定値＝２の場合，４段目が分周条件設定値＝３の場合のそれぞれの動作タイミングである。
【００５４】
また、同図の水平方向に分周クロックカウンタの値が“０”から“３”までのタイミング図を示しているが、分周クロックカウンタの値が“３”になった後は再び“０”の動作に戻る。
【００５５】
まず、分周条件設定値＝０の場合の動作を説明する。
表１の真理値表に基づいて、分周条件設定値＝０の場合は、分周比設定テーブル４７は、分周クロックカウンタ４６からのカウント値に関わらずに分周比制御信号（Ｓｅｌ８）のみをアクティブにする。
【００５６】
したがって、Ａカウンタ４５１の初期値は、すべての分周クロックサイクルの先頭で“７”にセットされ、Ａカウンタ４５１のカウント動作は、すべての分周クロックサイクルで８Ｔ分になり、分周クロック１サイクル分の周期は１６Ｔになる。
【００５７】
次に、分周条件設定値＝１の場合の動作を説明する。
分周クロックカウンタ値が“０”になる分周クロックサイクルにおけるＡカウンタ４５

１の初期値は、その直前、すなわち、分周クロックカウンタ４６のカウント値が“４”になる分周クロックサイクル最後のマルチプレクサ４５４からの出力によって決まる。

【００５８】

表１の真理値表に基づいて、分周条件設定値＝１，分周クロックカウンタ値＝４では、分周比制御信号（Ｓｅｌ７）がアクティブになっているから、分周クロックカウンタ４６のカウント値が“０”になる分周クロックサイクルにおけるＡカウンタ４５１の初期値は“７”になる。

【００５９】

そのため、分周クロックカウンタ４６のカウント値が“０”になる分周クロックサイクルにおけるＡカウンタ４５１のカウント動作は９Ｔ分になり、分周クロック１サイクル分の周期は１７Ｔになる。

【００６０】

そして、上述と同様にして、分周クロックカウンタ４６のカウント値が“１”になる分周クロックサイクル周期は１５Ｔになる。

また、分周クロックカウンタ４６のカウント値が“２”になる分周クロックサイクル周期は１６Ｔになる。

さらに、分周クロックカウンタ４６のカウント値が“３”になる分周クロックサイクル周期は１６Ｔになる。

【００６１】

すなわち、分周条件設定値＝１の場合、分周クロック１サイクル分の周期は一定ではなく、「１７Ｔ→１５Ｔ→１６Ｔ→１６Ｔ→，１７Ｔ→１５Ｔ→１６Ｔ→１６Ｔ→，…」というパターンを繰り返す。

【００６２】

そして、上述と同様にして、分周条件設定値＝２の場合、分周クロック１サイクル分の周期は、「１７Ｔ→１５Ｔ→１７Ｔ→１５Ｔ→，１７Ｔ→１５Ｔ→１７Ｔ→１５Ｔ→，…」というパターンを繰り返す。

また、分周条件設定値＝３の場合、分周クロック１サイクル分の周期は、「１７Ｔ→１６Ｔ→１６Ｔ→１５Ｔ→，１７Ｔ→１６Ｔ→１６Ｔ→１５Ｔ→…」というパターンを繰り返す。

【００６３】

このように、分周クロック１サイクル分の周期を所定のパターンで変化させた場合、分周クロックの位相がどのように変化するかを考慮する。

分周条件設定値＝０の場合、分周クロック１サイクル分の周期は常に１６Ｔであり、１６Ｔは上述のように基準分周比である。

【００６４】

以下の説明では、分周条件設定値＝０の場合の分周クロック信号の位相を基準にして分周クロック信号の位相変化を説明する。

位相比較器４１が注目する位相は、分周クロック信号に関してはその立ち上りエッジ位相とする。

【００６５】

分周クロックは同期式ＳＲＦＦ４５５のＱ出力を反転したものなので、図４では、同期式ＳＲＦＦ４５５のＱ出力の立ち下がりエッジ位相に注目する。

分周条件設定値－１の場合、分周クロックカウンタ４６のカウント値が“０”になる分周クロックサイクル周期は１７Ｔであるから、同期式ＳＲＦＦ４５５のＱ出力の立ち下がりエッジ位相は、分周クロック基準位相に対して１Ｔ分の遅れが生じる。

【００６６】

また、分周クロックカウンタ４６のカウント値が“１”になる分周クロックサイクル周期は１５Ｔであるから、直前のサイクルの立ち下がりエッジ位相遅れと差し引きして、同期式ＳＲＦＦ４５５のＱ出力の立ち下がりエッジ位相は分周クロック基準位相と一致する。

【００６７】
さらに、分周クロックカウンタ４６のカウント値が“２”，“３”になる分周クロックサイクル周期は１６Ｔであるから、同期式ＳＲＦＦ４５５のＱ出力の立ち下がりエッジ位相は分周クロック基準位相と一致する。
【００６８】
すなわち、分周条件設定値－１の場合、分周クロック位相は分周クロック基準位相に対して、「１Ｔ遅れ　→　一致　→　一致　→　一致　→…」というパターンを繰り返す。
【００６９】
そして、上述と同様にして、分周条件設定値＝２の場合、分周クロック位相は分周クロック基準位相に対して、「１Ｔ遅れ　→　一致　→　１Ｔ遅れ　→　一致　→…」というパターンを繰り返す。
【００７０】
また、分周条件設定値＝３の場合、分周クロック位相は分周クロック基準位相に対して、「１Ｔ遅れ　→　１Ｔ遅れ　→　１Ｔ遅れ　→　一致　→…」というパターンを繰り返す。
【００７１】
次に、上記のように分周クロック位相が変化した場合のウォブル信号（ＷＢＬ）位相と記録用クロック信号（ＷＣＬＫ）位相の関係について説明する。
ＰＬＬの動作時定数は、一般に位相比較周期に比べて長い周期が設定される。
そのため、上記のように分周クロック位相が変化しても、記録用クロック信号周波数は略一定の値に保たれ、定常状態においては分周クロック信号の平均的位相がウォブル信号位相に一致するようなロック状態が得られる。
【００７２】
図５は、分周条件設定値＝１の場合の定常状態でロックした状態のウォブル信号（ＷＢＬ），記録用クロック信号（ＷＣＬＫ），及び分周クロック信号のタイミングを示す図である。
【００７３】
同図の上段の（ａ）～（ｄ）には、それぞれウォブル信号（ＷＢＬ），分周クロック信号，及び分周クロックカウンタ４６のカウント値の関係を示し、下段の（ｅ）～（ｇ）には、位相比較が行なわれる立ち上りエッジ部分を拡大して、それぞれウォブル信号（ＷＢＬ），記録用クロック信号（ＷＣＬＫ），及び分周クロック信号の関係を示している。
【００７４】
上述のように、定常状態でロックした状態では分周クロック信号の平均的位相がウォブル信号位相に一致する。
その結果、ウォブル信号に対する分周クロックの位相は、図５の（ｇ）に示すように「０．７５Ｔ遅れ　→　０．２５Ｔ進み　→　０．２５Ｔ進み　→　０．２５Ｔ進み→…」という関係になる。
【００７５】
分周条件設定値＝１の場合、分周クロックカウンタ４６のカウント値が“０”の場合の分周クロック位相のみが分周クロック基準位相に対して１Ｔ遅れていることを考えると、ウォブル信号位相に対する分周クロック基準位相は、常に“０．２５Ｔ”の進みになる。
このことは、ウォブル信号位相に対する記録用クロック信号位相が、“０．２５Ｔ”の進みになることと等価である。
【００７６】
また、図示を省略するが、上述と同様にして、分周条件設定値＝２，３の場合、ウォブル信号位相に対する記録用クロック信号位相は、それぞれ“０．５Ｔ”，“０．７５Ｔ”の進みになる。
【００７７】
このようにして、この記録クロック発生回路４では、分周条件設定値が“０”から“３”の範囲で、その値に応じてウォブル信号と記録用クロック信号との位相関係を０．２５

Ｔ単位で“０Ｔ”から“０．７５Ｔ”まで変化させることができる。

【００７８】

次に、図６のタイミング図に基づいて、この記録クロック発生回路が、ウォブル信号と記録用クロック信号との位相関係をさらに大きく変化させるときの制御について説明する。

【００７９】

図６の上段には、分周条件設定値を“３”から“０”に変化させた場合の分周器４５の動作タイミングを示している。

ここでは、分周条件設定値を“３”から“０”に変化させるタイミングを、分周クロックカウンタ４６のカウント値が“３”から“０”に変化するタイミングに一致させる。

【００８０】

分周条件設定値が“３”であり、分周クロックカウンタ４６のカウント値が“３”になる分周クロックサイクル周期は、上述の説明のように１５Ｔになる。

【００８１】

また、分周条件設定値が“０”であり、分周クロックカウンタ４６のカウント値が“０”になる分周クロックサイクル周期は、Ａカウンタ４５１の初期値が分周条件設定値が“３”であり、分周クロックカウンタ４６のカウント値が“３”の段階で設定されたものになるので１７Ｔになる。

【００８２】

同様にして、分周条件設定値が“０”であり、分周クロックカウンタ４６のカウント値が“１”，“２”，“３”になる分周クロックサイクル周期は、上述の説明のように１６Ｔになる。

【００８３】

すなわち、分周条件設定値を“３”から“０”に変化させた直後の分周クロックサイクル周期は、分周条件設定値が“０”のままの分周クロックサイクル周期と異なり、丸々１Ｔ分の周期が加えられたものになり、それ以降は、その１Ｔ分の周期加算による位相ずれが累積されたままになる。

【００８４】

そのため、分周条件設定値を“３”にし、ウォブル信号に対して記録用クロック信号の位相を０．７５Ｔ進ませた状態から、分周条件設定値を“０”に変化させた場合、ウォブル信号に対する記録用クロック信号の位相は１Ｔ進んだ状態になる。

【００８５】

この状態からさらに、分周条件設定値を“１→２→３”と変化させた場合、定常状態におけるウォブル信号に対する記録用クロック信号の位相は、「１．２５Ｔ→１．５Ｔ→１．７５Ｔ進んだ」状態になる。

【００８６】

図６の下段には、分周条件設定値を“０”から“３”に変化させた場合の分周器４５の動作タイミングを示している。

ここでは、分周条件設定値を“０”から“３”に変化させるタイミングを、分周クロックカウンタ４６のカウント値が“３”から“０”に変化するタイミングに一致させるものとする。

【００８７】

分周条件設定値が“０”であり、分周クロックカウンタ４６のカウント値が“３”になる分周クロックサイクル周期は、上述した説明のように１６Ｔになる。

【００８８】

また、分周条件設定値が“３”になり、分周クロックカウンタ４６のカウント値が“０”になる分周クロックサイクル周期は、Ａカウンタ４５１の初期値が分周条件設定値が“０”であり、分周クロックカウンタ４６のカウント値が“３”の段階で設定されたものになるので１６Ｔになる。

【００８９】

同様にして、分周条件設定値が“３”であり、分周クロックカウンタ４６のカウント値が“１”，“２”，“３”になる分周クロックサイクル周期は、上述の説明のようにそれぞれ“１６Ｔ”，“１６Ｔ”，“１５Ｔ”になる。

【００９０】

すなわち、分周条件設定値を“０”から“３”に変化させた直後の分周クロックサイクル周期は、分周条件設定値が“３”のままの分周クロックサイクル周期と異なり、丸々１Ｔ分の周期が差し引かれたものとなり、それ以降は、その１Ｔ分の周期加算による位相ずれが累積されたままになる。

【００９１】

そのため、分周条件設定値を“０”にし、ウォブル信号に対して記録用クロック信号の位相を一致させた状態から分周条件設定値を“３”に変化させた場合、ウォブル信号に対する記録用クロック信号の位相は０．２５Ｔ遅れた状態になる。

【００９２】

この状態からさらに、分周条件設定値を“２→１→０”と変化させた場合、定常状態におけるウォブル信号に対する記録用クロック信号の位相は「０．２５Ｔ→０．５Ｔ→０．７５Ｔ遅れた」状態になる。

【００９３】

このようにして、この参考例の記録クロック発生回路は、分周条件設定値が“０”から“３”の範囲で、その値に応じてウォブル信号と記録用クロック信号との位相関係を０．２５Ｔ単位で“０Ｔ”から“０．７５Ｔ”まで変化させることができるだけではなく、分周条件設定値を「３→０→１→２→３．．．」というようにバイナリカウンタ式に増加させていくか、「０→３→２→１→０．．．」というように減少させていくことにより、ウォブル信号と記録用クロック信号との位相関係を０．２５Ｔ単位で無限に変化させることができる。

【００９４】

なお、上記のこの発明の参考例の記録クロック発生回路では、分周クロックカウンタ４６のカウント長を“４”にし、分周器４５の分周比変化の繰り返しサイクルを“４”にしているので、ウォブル信号と記録用クロック信号との位相関係の設定単位が“０．２５Ｔ”になっているが、カウント長をより長くし、分周比変化の繰り返しサイクルも同じく長くすることにより、より細かい単位で位相関係の設定が可能になる。

【００９５】

次に、この発明の他の参考例の記録クロック発生回路について説明する。

この記録クロック発生回路は、図２及び図３に示したような構成と同じであり、上述と同じように図１に示した光ディスク駆動装置の記録クロック発生回路４として用いられるが、その機能が上述のものとは若干異なる。

【００９６】

この場合の記録クロック発生回路４は、図示を省略したコントローラによって光ディスク１にデータを記録する毎に記録クロック発生回路４内で設定される分周条件設定値をランダムに選択する。

【００９７】

このようにして、この記録クロック発生回路４によれば、光ディスクにデータを記録する毎に、ウォブル信号と記録用クロック信号との位相関係がランダムに変化し、光ディスクの記録領域の同じ場所を繰り返して使用することを防ぐことができ、ディスク材料の疲労を平均化して軽減し、結果的に繰り返し使用回数を向上させることができる。

【００９８】

しかも、アナログディレイ回路を使用しないで記録開始点をランダムに可変することが可能なので、装置コストを低減することができ、低価格で提供することができる。

【００９９】

次に、この発明のまた他の参考例の記録クロック発生回路について説明する。

この記録クロック発生回路は、図２及び図３に示したような構成と同じであり、上述と

同じように図１に示した光ディスク駆動装置の記録クロック発生回路４として用いられるが、その機能が上述の２つのものとは若干異なる。

【０１００】

この記録クロック発生回路は上記他の参考例と同様に図２、図６に示すような構成のもので、図１に示す光ディスク駆動装置の記録クロック発生回路４として用いられる。

【０１０１】

この場合の記録クロック発生回路４の発生した記録クロックでデータを記録する光ディスク１には、ウォブル信号にアドレス情報と同期信号とが変調されて重畳されている。

【０１０２】

この記録クロック発生回路４の同期検出回路５は、ウォブル信号に重畳された同期信号を検出し、ウォブル同期信号を出力する。

アドレスデコーダ６は、ウォブル信号に重畳されたアドレス情報を検出する。

【０１０３】

データエンコーダ８は、記録用クロック信号（ＷＣＫ）に同期させて記録データに変調を施す他に、変調データ中に同期信号を挿入する。

また、同期信号挿入のタイミングでエンコーダ同期信号を出力する。

同期判定回路１１は、ウォブル同期信号とエンコーダ同期信号とのタイミングを監視する。

【０１０４】

通常、ウォブル信号と記録用クロック信号との位相が同期した状態では、ウォブル同期信号とエンコーダ同期信号とのタイミングは一致する。

しかし、記録クロック発生回路４にビットスリップが生じた場合、ウォブル信号と記録用クロックの位相ずれが生じるので、その生じたビットスリップ分だけウォブル同期信号とエンコーダ同期信号との間にタイミング差が生じる。

【０１０５】

そこで、同期検出回路５は、ウォブル同期信号とエンコーダ同期信号との間にタイミング差が生じた場合、この差に応じて記録クロック発生回路４に設定する分周条件設定値を変化させる。

【０１０６】

図７は、図１に示した光ディスク駆動装置においてビットスリップが生じた場合の同期検出回路５の動作の説明に供する各種信号のタイミング図である。

同図に示す例では、左から２番目と３番目の同期信号の間でビットスリップが生じており、３番目のウォブル同期信号とエンコーダ同期信号との間にタイミング差を生じている。

【０１０７】

また、ビットスリップの発生により、ウォブル信号に対して記録用クロックの位相は遅れ方向に生じているので、エンコーダ同期信号の発生位置よりも早いタイミングでウォブル同期信号が生じている。

【０１０８】

このような場合、同期検出回路５は、ビットスリップによって生じた記録用クロックの位相遅れを修正するために、記録用クロック信号の位相を進める方向に分周条件設定値を変化させる。

【０１０９】

上述のように制御すると、図２と図３に示した記録クロック発生回路４では、分周条件設定値を「０→１→２→３→０→１．．．」というようにバイナリカウンタ式に増加させることにより、ウォブル信号に対する記録用クロックの位相を０．２５Ｔ単位で進めて行くことができる。

【０１１０】

また、同期検出回路５は、ウォブル同期信号とエンコーダ同期信号との間にタイミング差がなくなるまで分周条件設定値を変化させていく。

その結果、ビットスリップによって生じた記録用クロックの位相遅れを修正することができる。

【０１１１】

このようにして、この記録クロック発生回路によれば、ウォブル信号の欠落などによって記録用クロック信号がウォブル信号に対してビットスリップを生じた場合でも、ウォブル信号と記録用クロックの位相ずれを回復させることができ、記録データを所定位置に復旧させることが可能になる。

【０１１２】

次に、この発明の一実施形態の記録クロック発生回路について説明する。

図８は、この発明の一実施形態の記録クロック発生回路の構成を示すブロック図であり、図１６に示した記録クロック発生回路の構成と略同じであるが、位相比較器４１に位相比較マスク信号を入力するようにしたところが異なる。

【０１１３】

そして、この記録クロック発生回路も、図１に示した光ディスク駆動装置の記録クロック発生回路として用いられる。

また、この場合の記録クロック発生回路の発生した記録クロックでデータを記録する光ディスク１には、ウォブル信号にアドレス情報と同期信号とが位相変調されて重畳されている。

【０１１４】

図９は、位相変調されたウォブル信号の波形例を示す説明図である。

この記録クロック発生回路を用いた図１の光ディスク駆動装置では、同期検出回路５はウォブル信号に重畳された同期信号を検出すると共に、アドレス情報と同期信号が位相変調された所定タイミングの近傍では、図８に示した位相比較器４１に対して位相差検出をマスクさせるための位相比較マスク信号を出力する。

【０１１５】

図１０は、同期検出回路５が位相比較マスク信号を出力するときのタイミング例を示す説明図である。

同図に示すように、ウォブル信号に重畳された同期信号（ウォブル同期信号）を検出し、光ディスク１上の同期信号とアドレス信号（アドレス情報の検出信号）の検出区間では位相比較マスク信号を出力する。

【０１１６】

このようにして、この記録クロック発生回路によれば、位相変調によってウォブル信号の位相に急な変化が生じる部分では位相比較器４１の動作をマスクするので、ウォブル信号と記録用クロック信号との位相ずれが生じることが無くなり、ウォブル信号に安定して位相同期させた記録用クロック信号を発生させることができる。

【０１１７】

次に、この発明のさらに他の参考例の記録クロック発生回路について説明する。

図１１は、この発明のさらに他の参考例の記録クロック発生回路の構成を示すブロック図であり、図２，図８，及び図１６に示した記録クロック発生回路と共通する部分には同一符号を付している。

【０１１８】

そして、この記録クロック発生回路も、図１に示した光ディスク駆動装置の記録クロック発生回路として用いられる。

【０１１９】

この記録クロック発生回路は、周波数比較器４０１がウォブル信号を所定比で分周し、その分周されたウォブル信号の周期を記録用クロック信号の周期でカウントし、そのカウント値に応じて周波数差信号をチャージポンプ４０２へ出力し、また、切り換え信号をマルチプレクサ４０３へ出力する。

【０１２０】

チャージポンプ４０２は、周波数差信号を電圧信号に変換する。

マルチプレクサ４０３は、周波数比較器４０１からの切り換え信号に応じて、チャージポンプ４２，チャージポンプ４０２の出力の一方を選択して出力する。

【０１２１】

図１２は、図１１に示した周波数比較器４０１の内部構成を示すブロック図である。

この周波数比較器４０１のカウンタ４０１１は、ウォブル信号（ＷＢＬ）を所定比で分周し、分周ウォブルパルスをカウンタ４０１２とレジスタ４０１３へそれぞれ出力する。

【０１２２】

カウンタ４０１２は、分周クロックの数をカウントし、分周ウォブルパルス毎にリセットされる。

レジスタ４０１３には、分周ウォブルパルス毎にリセットされる直前のカウンタ４０１２のカウント値がロードされる。

【０１２３】

その結果、レジスタ４０１３には、分周されたウォブル信号の周期を記録用クロック信号の周期でカウントした値がロードされることになり、その値はウォブル信号周波数に対して分周クロック周波数が小さい時には小さい値になり、大きい時には大きい値になり、ウォブル信号周波数に対する分周クロック周波数を示す値になる。

【０１２４】

データコンパレータ４０１４は、レジスタ４０１３の値が所定値よりも大きい場合にはＤｏｗｎ信号を、小さい場合にはＵｐ信号をそれぞれ出力する。

また、データコンパレータ４０１４は、レジスタ４０１３の値が所定の範囲内にある場合には、チャージポンプ４２の出力を選択するように切り換え信号（Ｍｕｘ）をアクティブにし、所定の範囲外の場合には、チャージポンプ４０２の出力を選択するように切り換え信号（Ｍｕｘ）をインアクティブにする。

上記所定範囲の値は、ＰＬＬ回路のキャプチャレンジに相当するように選ぶ。

【０１２５】

その結果、図１１のＶＣＯ４４は、ウォブル信号周波数と記録クロック周波数との関係がキャプチャレンジ外の場合には、周波数比較器４０１から出力されるＵｐ信号又はＤｏｗｎ信号に応じてキャプチャレンジ内に近づくように駆動し、キャプチャレンジ内に入ると位相比較器４１出力に応じて駆動する。

【０１２６】

このようにして、この記録クロック発生回路によれば、ウォブル信号周波数と記録クロック周波数との関係がキャプチャレンジ外にあっても速やかにＰＬＬのロックが可能になる。

【０１２７】

次に、この発明のさらにまた他の参考例の記録クロック発生回路について説明する。

この記録クロック発生回路は、図１１に示した記録クロック発生回路の構成と同じであるが、その周波数比較器４０１の内部構成が上述のものとは異なる。そして、図１に示した光ディスク駆動装置の記録クロック発生回路として用いられる。

【０１２８】

図１３は、この発明のさらにまた他の参考例の記録クロック発生回路の周波数比較器４０１の内部構成を示すブロック図である。

この周波数比較器４０１の構成は、図１２に示したものと同様にカウンタ４０１１，カウンタ４０１２，レジスタ４０１３，及びデータコンパレータ４０１４を備えている。さらに、新たなカウンタ４０１５とフリップフロップ４０１６を設けている。

【０１２９】

この周波数比較器４０１のデータコンパレータ４０１４は、レジスタ４０１３値が所定の範囲内にある場合には切り換え信号（Ｍｕｘ）をアクティブにする。

フリップフロップ４０１６は、その切り換え信号（Ｍｕｘ）がアクティブになるとセットされ、その出力である切り換え信号（Ｍｕｘ′）をアクティブにする。

【０１３０】

データコンパレータ４０１４は、レジスタ４０１３の値が所定の範囲外の場合には、切り換え信号（Ｍｕｘ）をインアクティブにするが、切り換え信号（Ｍｕｘ′）はすぐにはインアクティブとはならない。

【０１３１】

カウンタ４０１５は、切り換え信号（Ｍｕｘ）がインアクティブの場合、分周ウォブルパルス毎にカウント値をアップさせる。

また、カウンタ４０１５は、切り換え信号（Ｍｕｘ）がアクティブの場合、分周ウォブルパルスによってカウント値をリセットする。

そして、上記カウント値が所定値に達すると、フリップフロップ４０１６に対してリセット信号を出力し、切り換え信号（Ｍｕｘ′）をインアクティブにする。

【０１３２】

こうして、レジスタ４０１３にロードされるカウント値が所定の範囲外であることが所定回数連続して検出された場合には、切り換え信号（Ｍｕｘ′）をインアクティブにする。

【０１３３】

したがって、ウォブル信号周波数と記録クロック周波数との関係がキャプチャレンジ内にあるにもかかわらず、ウォブル信号の欠落などによって周波数比較器４０１が誤ってキャプチャレンジ外であると判定することを防ぐことができる。

【０１３４】

このようにして、この記録クロック発生回路によれば、ウォブル信号周波数と記録クロック周波数との関係がキャプチャレンジ外にあっても速やかにＰＬＬのロックを可能にすると共に、ＰＬＬのロック中にウォブル信号の欠落などによって不必要な引き込み動作が生じることを防ぐことができる。

【図面の簡単な説明】

【０１３５】

【図１】この発明の参考例及びこの発明の一実施形態である光ディスク駆動装置の構成例を示すブロック図である。

【図２】図１に示したこの発明の参考例の記録クロック発生回路の内部構成例を示すブロック図である。

【図３】図２に示した分周器，分周クロックカウンタ，及び分周比設定テーブルのさらに詳細な構成例を示す図である。

【図４】図２に示した分周器の動作の説明に供する各種信号のタイミング図である。

【０１３６】

【図５】図２に示した記録クロック発生回路における分周条件設定値＝１の場合の定常状態でロックした状態のウォブル信号，記録用クロック信号，及び分周クロック信号のタイミングを示す図である。

【図６】図２に示した記録クロック発生回路におけるウォブル信号と記録用クロック信号との位相関係をさらに大きく変化させるときの制御の説明に供する各種信号のタイミング図である。

【図７】図１に示した光ディスク駆動装置においてビットスリップが生じた場合の同期検出回路の動作の説明に供する各種信号のタイミング図である。

【０１３７】

【図８】この発明の一実施形態の記録クロック発生回路の構成を示すブロック図である。

【図９】図１に示した光ディスクの位相変調されたウォブル信号の波形例を示す説明図である。

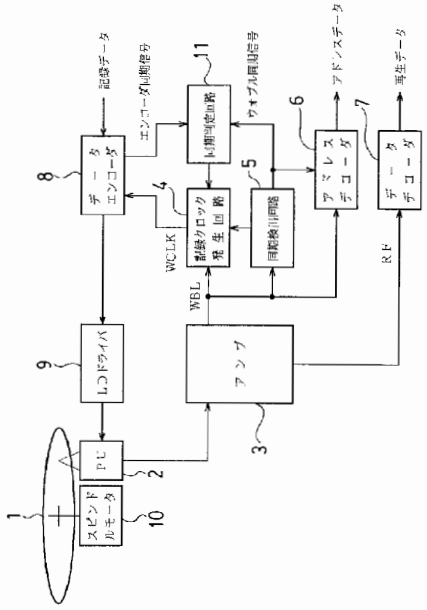
【図１０】図１に示した同期検出回路が位相比較マスク信号を出力するときのタイミング例を示す説明図である。

【図１１】この発明のさらに他の参考例の記録クロック発生回路の構成を示すブロック図である。

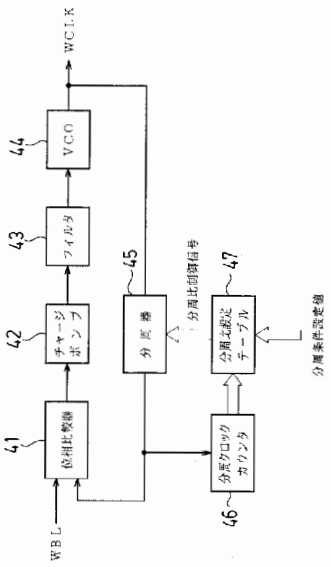
【図１２】図１１に示した周波数比較器の内部構成を示すブロック図である。

【０１３８】
【図１３】この発明のさらにまた他の参考例の周波数比較器の内部構成を示すブロック図である。
【図１４】従来の光ディスク駆動装置の構成例を示すブロック図である。
【図１５】光ディスク１上のウォブリングされたデータ記録用トラックの構造例を示す説明図である。
【図１６】図１４に示した従来の記録クロック発生回路の構成例を示すブロック図である。
【符号の説明】
【０１３９】
１：光ディスク　２：光ピックアップ（ＰＵ）　３：アンプ　４：記録クロック発生回路　５：同期検出回路　６：アドレスデコーダ　７：データデコーダ　８：データエンコーダ　９：ＬＤドライバ　１０：スピンドルモータ　１１：同期判定回路　４１：位相比較器　４２，４０２：チャージポンプ　４３：フィルタ　４４：ＶＣＯ　４５：分周器　４６：分周クロックカウンタ　４７：分周比設定テーブル　４５１：Ａカウンタ　４５２：Ｂカウンタ　４５３：インバータ　４０３，４５４：マルチプレクサ　４５５：同期式ＳＲＦＦ　４０１：周波数比較器　４０１１，４０１２，４０１５：カウンタ　４０１３：レジスタ　４０１４：データコンパレータ　４０１６：フリップフロップ

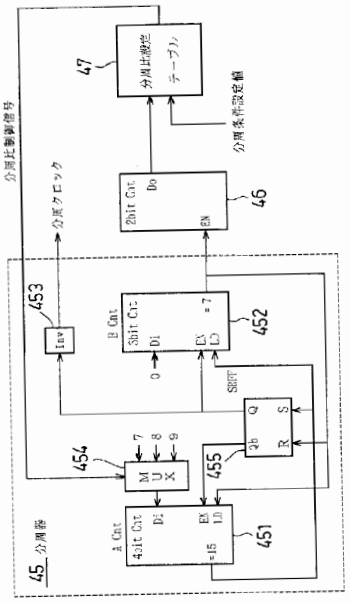
【図１】



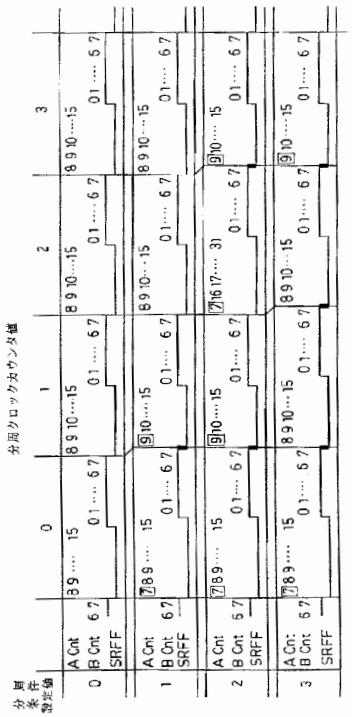
【図２】



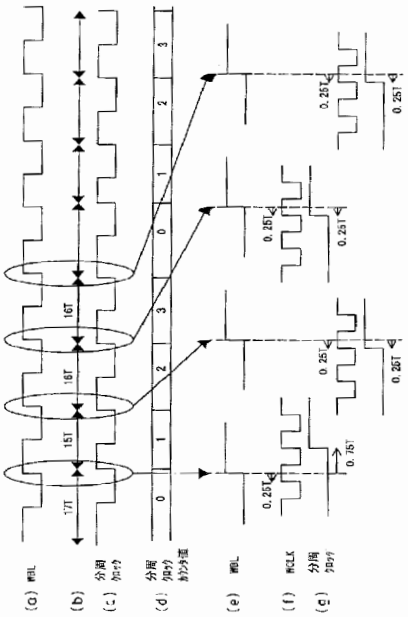
【図３】


分周比制御信号
分周クロック
分周条件設定値
47
分周比設定テーブル
46
2bit Cnt
Do
EN
B Cnt
Shift Cnt
Di
CK
CE
=7
452
453
Inv
454
M U X
455
SHIFT
Q
R
S
A Cnt
4bit Cnt
=15
451
45 分周器

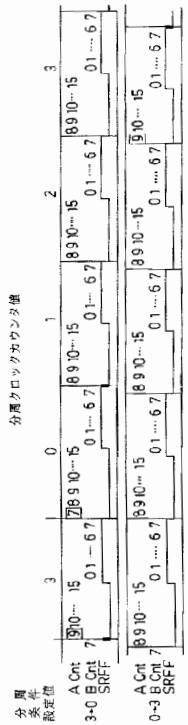
【図４】


分周クロックカウント値
分周条件設定値
A Cnt
B Cnt
SRFF

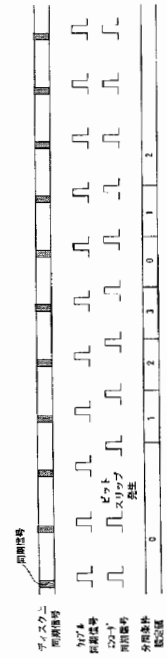
【図５】


(a) 基準
(b)
(c) 分周クロック
(d) 分周クロックカウント値
(e) 遅延
(f) 遅延CLK
(g) 分周クロック
17T
15T
16T
0.25T
0.75T

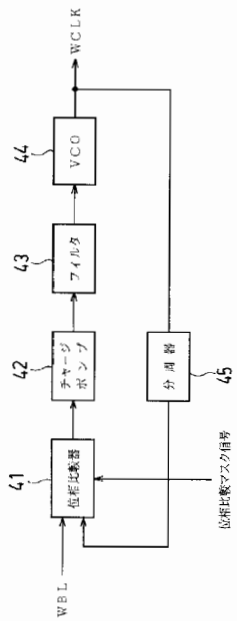
【図６】


分周クロックカウント値
分周条件設定値
A Cnt
B Cnt
SRFF
3→0
0→3

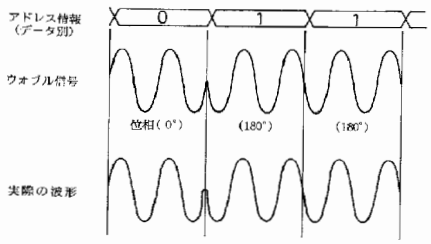
【図７】



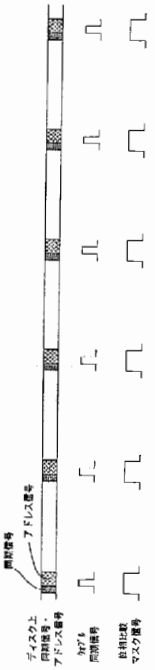
【図８】


WCLK
44
VCO
43
フィルタ
42
チャージポンプ
分周器
45
41
位相比較器
WBL
位相比較マスク信号

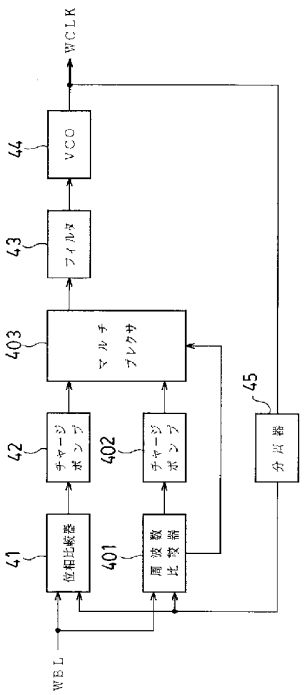
【図９】


アドレス情報
（データ別）
0
1
1
ウオブル信号
位相（0°）
（180°）
（180°）
実際の波形

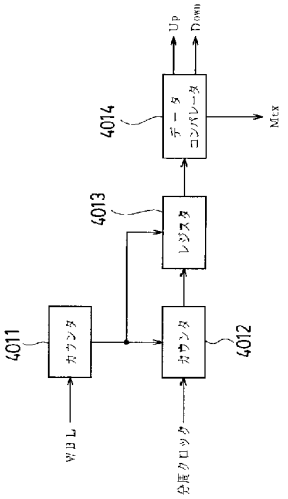
【図１０】



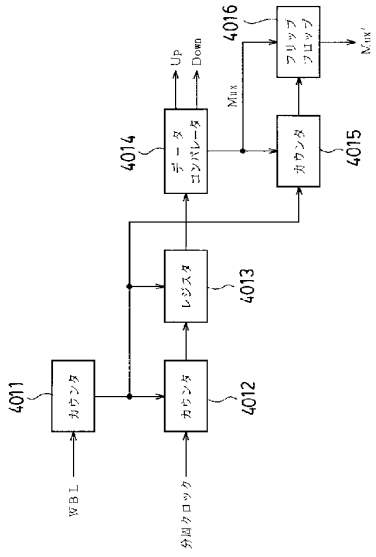
【図１１】



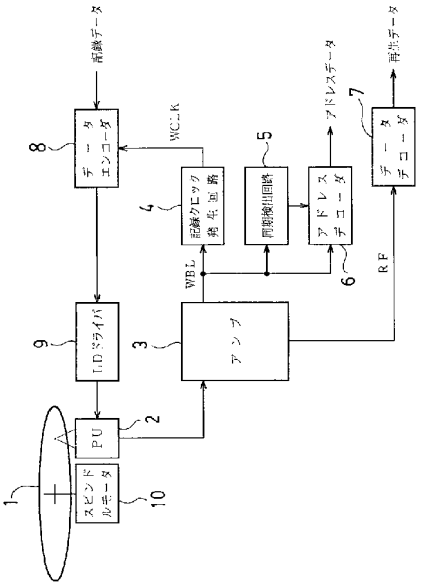
【図１２】



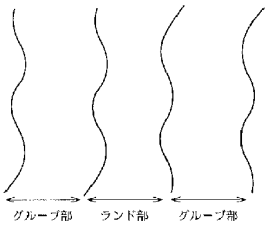
【図１３】



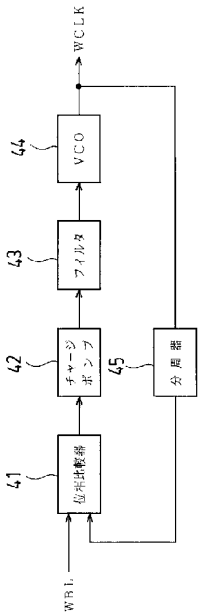
【図１４】



【図１５】


グルーブ部
ランド部
グルーブ部

【図１６】


WCLK
44
VCO
43
フィルタ
42
チャージポンプ
45
分周器
41
位相比較器
WBL

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2005-108427**
(43)Date of publication of application : **21.04.2005**

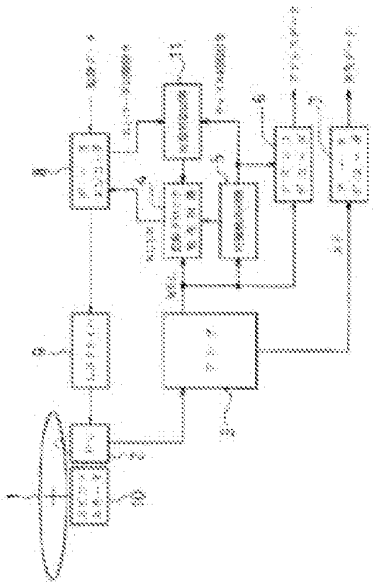
(51)Int.Cl. **G11B 20/14**
G11B 7/0045
G11B 7/005

(21)Application number : **2004-355032**
(22)Date of filing : **08.12.2004**

(71)Applicant : **RICOH CO LTD**
(72)Inventor : **SHIGEMORI TOSHIHIRO**

(54) DATA RECORDING CLOCK SIGNAL GENERATOR

(57)Abstract:
PROBLEM TO BE SOLVED: To generate a recording clock stably synchronized in phase with a wobbling signal even in an optical disk in which address information is superimposed on a wobbling signal by phase modulation.
SOLUTION: A recording clock generator circuit 4 extracts a wobbling signal, generates a frequency-divided signal obtained by frequency-dividing a recording clock signal, generates a phase difference signal by comparing phases between the wobbling signal and the frequency-divided signal, generates a frequency control signal based on the phase difference signal, and also generates the recording clock signal having a frequency controlled based on the frequency control signal. Thus, no phase difference signal is generated near the predetermined timing in which the address information or the synchronous signal of an optical disk is phase-modulated.



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 13-0410-PCT	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2013/046372	International filing date *(day/month/year)* 18 June 2013 (18.06.2013)	Priority date *(day/month/year)* 26 June 2012 (26.06.2012)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant SONOS, INC.		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 31 December 2014 (31.12.2014)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Simin Baharlou e-mail: pt09.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
GEORGE CHRISTOPHER N.

HANLEY, FLIGHT & ZIMMERMAN, LLC 150 S.
WACKER DRIVE SUITE 2100 CHICAGO IL 60606 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**26 August 2013 (26.08.2013)**
Applicant's or agent's file reference 13-0410-PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/046372	**18 June 2013 (18.06.2013)**	26 June 2012 (26.06.2012)

International Patent Classification (IPC) or both national classification and IPC

G06F 15/16(2006.01)i

Applicant
SONOS, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	23 August 2013 (23.08.2013)	PARK, Sang Hyun Telephone No. +82-42-481-8263

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046372

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046372

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	2-3,12-13	YES
	Claims	1,4-11,14-20	NO
Inventive step (IS)	Claims	2-3,12-13	YES
	Claims	1,4-11,14-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations :

(1) Reference is made to the following documents:

D1: US 2007-0048713 A1 (DANIEL PLASTINA et al.) 01 March 2007
D2: US 2012-0030366 A1 (COLLART TODD et al.) 02 February 2012
D3: US 2006-0143236 A1 (MICHAEL WU) 29 June 2006
D4: US 2008-0091771 A1 (JEFFREY L. ALLEN et al.) 17 April 2008

(2) Novelty & Inventive Steps

Concerning claims 1-10:
Claims 1,4-10
D1 discloses a community media playlist sharing system, wherein system users can upload media playlists which are automatically converted to a standardized format, media playlists can be shared with other users of the community media playlist sharing system, users can link to other playlists and obtain media from playlists automatically from third party points of purchase, users can provide recommendations, ratings and rankings relative to other playlists by system users and receive recommendations from other users and an editorial staff, participate in social networking functions including forums, discussions, weblogs, playlist topic groups and inter-user communications based on affinity for similar playlists, create playlists manually, automatically, or in real time, and wherein system users can obtain points for participation and popularity in the system and obtain profit by meta-affiliate sharing of profit for purchases of music made through playlists submitted by that user as well as through playlist toolbars distributed to third party websites.[paragraph 73 - paragraph 156, and figures 1-23] As all of the features of claims 1,4-10 are disclosed in D1, these claims are anticipated in D1. Therefore, claims 1,4-10 lack novelty under PCT Article 33(2) and are not considered as involving an inventive step under PCT Article 33(3).
Claims 2-3:
The subject matter of claims 2-3 is different from that of D1 in a guest mode. And it is

Continued on Supplemental Box

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Box No. V

not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claims 2-3 are novel and involve an inventive step under PCT Article 33(2) and (3).

Concerning claims 11-20:
Claims 11,14-20:
D1 discloses a community media playlist sharing system, wherein system users can upload media playlists which are automatically converted to a standardized format, media playlists can be shared with other users of the community media playlist sharing system, users can link to other playlists and obtain media from playlists automatically from third party points of purchase, users can provide recommendations, ratings and rankings relative to other playlists by system users and receive recommendations from other users and an editorial staff, participate in social networking functions including forums, discussions, weblogs, playlist topic groups and inter-user communications based on affinity for similar playlists, create playlists manually, automatically, or in real time, and wherein system users can obtain points for participation and popularity in the system and obtain profit by meta-affiliate sharing of profit for purchases of music made through playlists submitted by that user as well as through playlist toolbars distributed to third party websites.[paragraph 73 - paragraph 156, and figures 1-23] As all of the features of claims 11,14-20 are disclosed in D1, these claims are anticipated in D1. Therefore, claims 11,14-20 lack novelty under PCT Article 33(2) and are not considered as involving an inventive step under PCT Article 33(3).
Claims 12-13:
The subject matter of claims 12-13 is different from that of D1 in a guest mode. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claims 12-13 are novel and involve an inventive step under PCT Article 33(2) and (3).

(3) Industrial Applicability

The subject matter of claims 1-20 is believed to be industrially applicable under PCT Article 33(4) because the claimed invention can be used in the computer industry.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING TRANSMITTAL OF COPY OF INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (CHAPTER I OF THE PATENT COOPERATION TREATY)
(PCT Rule 44bis.1(c))

To:

JASPER, Joseph, T.
Hanley, Flight & Zimmerman, LLC
150 S. Wacker Drive, Suite 2100
Chicago, Illinois 60606
ETATS-UNIS D'AMERIQUE

Date of mailing *(day/month/year)* 08 January 2015 (08.01.2015)	
Applicant's or agent's file reference 12-0402-PCT	**IMPORTANT NOTICE**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/046386	18 June 2013 (18.06.2013)	26 June 2012 (26.06.2012)

Applicant
SONOS, INC.

The International Bureau transmits herewith a copy of the international preliminary report on patentability (Chapter I of the Patent Cooperation Treaty)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Philippe Bécamel
Facsimile No. +41 22 338 82 70	e-mail: pt03.pct@wipo.int

Form PCT/IB/326 (January 2004)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 12-0402-PCT	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2013/046386	International filing date *(day/month/year)* 18 June 2013 (18.06.2013)	Priority date *(day/month/year)* 26 June 2012 (26.06.2012)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant SONOS, INC.		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 31 December 2014 (31.12.2014)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Philippe Bécamel e-mail: pt03.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
JASPER JOSEPH T.

HANLEY, FLIGHT & ZIMMERMAN, LLC 150 S.
WACKER DRIVE, SUITE 2100 CHICAGO IL 60606 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**30 September 2013 (30.09.2013)**
Applicant's or agent's file reference 12-0402-PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/046386	**18 June 2013 (18.06.2013)**	26 June 2012 (26.06.2012)

International Patent Classification (IPC) or both national classification and IPC

G06Q 50/10(2012.01)i

Applicant
SONOS, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	27 September 2013 (27.09.2013)	KIM Sung Gon Telephone No. +82-42-481-8746

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046386

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046386

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-21	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-21	NO
Industrial applicability (IA)	Claims	1-21	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 7483958 B1 (TAREK Z. ELABBADY et al.) 27 January 2009
D2: US 2010-0228740 A1 (ALAN CANNISTRARO et al.) 09 September 2010

1. Novelty and Inventive Step

1.1 Claims 1-10

1.1.1 Independent claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a method comprising: presenting media content information (e.g., music file, a play list) to the user, determining whether an original media playing license associated with the particular media contents file is available, generating a temporary media playing license from the original media playing license, the temporary media playing license specifying restrictions relating to playback of the particular media content file via the home network device; and sending the temporary media playing license to the home network device (See abstract, column 11, lines 1-20, claim 1, figure 4 in D1). Claim 1 differs from D1 in facilitating addition of content to the playlist by at least one participating user; and playback of content from the playlist in the restricted playback mode. However, D2 discloses a method comprising: receiving from at least one of the plurality of user devices a vote on a media item; and organizing the playlist based on the received votes (See abstract, paragraphs [0047]-[0057], claim 1, figure 4 in D2). Accordingly, claim 1 would have been obvious over D1 and D2. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Box No. V

1.1.2 Dependent claims 2-10

The additional feature of claim 2 is identical to the feature of D1 in that media items in the playlist are automatically chosen and added to the playlist by a program on the playlist host device (See claim 6 in D1). Accordingly, claim 2 would have been obvious over D1 and D2. Therefore, claim 2 lacks an inventive step under PCT Article 33(3).

Claim 3 further specifies authenticating the at least one participating user to enable the at least one participating user to add content to the playlist in the restricted playback mode. However, the additional feature of claim 3 is virtually suggested by the feature of D2 considering that the host receives an opt-in command from an authorized user and the opt-in command instructs the host to allow remote access to the playlist (See abstract, paragraphs [0047]-[0057], figure 4 in D2). Accordingly, claim 3 would have been obvious over D1 and D2. Therefore, claim 3 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 4 is identical to the feature of D2 in receiving from at least one of the plurality of user devices a vote on a media item; and organizing the playlist based on the received votes (See abstract, paragraphs [0047]-[0057], claim 1, figure 4 in D2). Accordingly, claim 4 would have been obvious over D1 and D2. Therefore, claim 4 lacks an inventive step under PCT Article 33(3).

Claims 5, 6 further specify that facilitating addition of content comprises accepting user selection of the content from a list of available content via a graphical user interface, and the list of available content includes a library of shared music available via a network. However, the additional features of claims 5, 6 are virtually suggested by the feature of D1 considering presenting media content information (e.g., metadata from the media library) to the user through a display screen, and selecting one or more music files, a play list, or other grouping of music files by the user (See abstract, column 11, lines 1-20, claim 1, figure 4 in D1). And D2 discloses a step of sending a playlist on a host device to a plurality of portable devices for display on a graphical user interface (See paragraph [0009] in D2). Accordingly, claims 5, 6 would have been obvious over D1 and D2. Therefore, claims 5, 6 lack an inventive step under PCT Article 33(3).

Claim 7 further comprises that the restricted playback mode is initiated and ended by a host user according to user authorization. However, the additional feature of claim 7 is merely a

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

matter of design option when the general knowledge in relevant field of the art is used. Accordingly, claim 7 would have been obvious over D1 and D2. Therefore, claim 7 lacks an inventive step under PCT Article 33(3).

Claim 8 further specifies configuring the restricted playback mode for a fixed time interval. However, the additional feature of claim 8 is virtually suggested by the feature of D2 considering ordering changes can be postponed until the interval since the last touch event has exceeded 2 seconds (See paragraph [0089] in D2). Accordingly, claim 8 would have been obvious over D1 and D2. Therefore, claim 8 lacks an inventive step under PCT Article 33(3).

Claim 9 further specifies that a restricted playback mode includes a specified configuration of zones. However, the additional feature of claim 9 is virtually suggested by the feature of D1 considering that the media content license may be associated with a specific entity or with multiple entities (e.g., groups) (See column 7, lines 61-66 in D1). Accordingly, claim 9 would have been obvious over D1 and D2. Therefore, claim 9 lacks an inventive step under PCT Article 33(3).

Claim 10 further comprises that the subset of playback functions includes limited user interaction with at least one of zone configuration and content playback parameters. However, the additional feature of claim 10 is merely a matter of design option when the general knowledge in relevant field of the art is used. Accordingly, claim 10 would have been obvious over D1 and D2. Therefore, claim 10 lacks an inventive step under PCT Article 33(3).

1.2 Claims 11-20

1.2.1 Independent claim 11
Claim 11 relates to a tangible computer readable storage medium including instructions which, when executed by a processor, are to implement at least a method. But it shares similar technical features with claim 1. Accordingly, the same reasoning applies to claim 11. Therefore, claim 11 lacks an inventive step under PCT Article 33(3).

1.2.2 Dependent claims 12-20
Claims 12-20 share the same technical features with claims 2-10, respectively. Accordingly, the

Continued on The Next Page

Supplemental Box

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Continuation of : Previous Page

same reasoning applies to claims 12-20. Therefore, claims 12-20 lack an inventive step under PCT Article 33(3).

1.3 Independent claim 21

Claim 21 relates to a media playback system, but it shares similar technical features with claim 1. Accordingly, the same reasoning applies to claim 21. Therefore, claim 21 lacks an inventive step under PCT Article 33(3).

2. Industrial Applicability

Claims 1-21 are industrially applicable under PCT Article 33(4).

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	Filing Date	2013-04-17
	First Named Inventor	NICHOLAS; A. J. Millington
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11(13-0402)

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	3	7606174		2009-10-20	OCHI; Mitsunori et al.	
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	1	20020177411		2002-11-28	YAJIMA; Kiyoshi et al.	
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Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
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	Attorney Docket Number	SNS-71301US11 (13-0402)

	18	"Welcome. You're watching Apple TV." Apple TV 2nd Generation Setup Guide, 10 March 2011 <http://manuals.info.apple.com/MANUALS/1000/MA1555/en_US/Apple_TV_2nd_gen_Setup_Guide.pdf> Retrieved 10/16/14, 35 pages".	☐
	19	"Welcome. You're watching Apple TV." Apple TV 3rd Generation Setup Guide, 16 March 2012 <http://http://manuals.info.apple.com/MANUALS/1000/MA1607/en_US/apple_tv_3rd_gen_setup.pdf> Retrieved 10/16/14, 35 pages".	☐
	20	Presentations at WinHEC 2000, May 2000, 139 pages	☐

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, Nicholas A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Robert J. Irvine III/	Date (YYYY-MM-DD)	2014-12-10
Name/Print	Robert J. Irvine III	Registration Number	41865

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EFS ID:	20918756
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
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Filer:	Robert Johnson Irvine
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	EP2713281A1.pdf	6287811 ecdb9e9ca317329b831f8107adbe320a5a0740ac	no	84

Warnings:	
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2	Foreign Reference	WO0153994.pdf	5932836 09404d5d6d41941a67a7f2c362059700a1f7bc65	no	124
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3	Non Patent Literature	13907666_Advisory_Action_9-5-14.pdf	152370 1707a483855b99e4e8bc2d75050d9bd7bb59be20	no	3
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4	Non Patent Literature	Bluetooth_Spec_Dec1999_Part1-ref.pdf	24091759 3ce7354aa00e02f452e5df701720d148b45e4abb	no	270
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5	Non Patent Literature	Bluetooth_Spec_Dec1999_Part2-ref.pdf	23079506 a6f9c7298af8fc1645de93b581bf5b1971f92c82	no	270
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6	Non Patent Literature	Bluetooth_Spec_Dec1999-Part3A-REF.pdf	5265507 76e33932d5020954a2adb3a08bf1fabfa239d136	no	150
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7	Non Patent Literature	Bluetooth_Spec_Dec1999_Part3B-ref.pdf	16111633 e35a75d30df1e03bae5d9f12938489f6816c8cec	no	120
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8	Non Patent Literature	Bluetooth_Spec_Dec1999_Part4-ref.pdf	24728443 c63c461b3f3c3f4bc526ebba2f90b46ab0e9105b	no	266
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9	Non Patent Literature	Bluetooth_Spec_Jul1999-pp1-250.pdf	8830213 457993d17c05be5840592d28de3dd33d01ba8ccd	no	250
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13	Non Patent Literature	DellStartHereJune2000-ref.pdf	933107 e7c865528f6c143df9033d564b1fa36e8ba533c9	no	2
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14	Non Patent Literature	Dell_Reference_Guide_June2000.pdf	3683918 7043da83937ff4a8ce909d3bb6fa0e7d37823556	no	70
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23	Non Patent Literature	13435776_Non-Final_OA_10-24-14.pdf	433397 18be3c859a2a71ea7a1957b32908301597a153ef	no	14
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24	Non Patent Literature	14176808_NOA_9-25-14.pdf	361630 0e7283ea67d6ca0c772529bf9ff717a3b8e8c31d	no	5
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25	Non Patent Literature	Palm_Handbook_for_Palm_VII_May2000-ref.pdf	11373793 ce9a1f3fada5a9c19f7af07eab6a82a3922c7d65	no	311
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26	Non Patent Literature	AppleTV_SetupGuide_1stGeneration_4-8-08.pdf	1284517 8cabdddce7ff04507362da1525b7fc1d56e82be8	no	40
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27	Non Patent Literature	AppleTV_SetupGuide_2ndGeneration_3-11-10.pdf	638763 c2611e10f42b68640cbb17d04b7b9f3eeb152e8e	no	36
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28	Non Patent Literature	AppleTV_SetupGuide_3rdGeneration_3-16-12.pdf	648465 17c4524dbb10949016409881 21d3fdccb3be13fa	no	36
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29	Non Patent Literature	WinHEC_2000_slide_deck-ref.pdf	4118273 72a54d42fb7d522b1d145dc0fab734ac5494e458	no	139
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30	Information Disclosure Statement (IDS) Form (SB08)	SNS-71301US11-13-0402-SuppIDS-DEC2014.pdf	708530 a786c7d553d036c040fe124923ed84397cfa5d3a	no	7
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Remarks:
- This application was filed on 17-09-2013 as a divisional application to the application mentioned under INID code 62.
- Claims filed after the date of filing of the application (Rule 68(4) EPC).

(54) System and method for synchronizing operations among a plurality of independently clocked digital data processing devices

(57) A system is described for maintaining synchrony of operations among a plurality of devices that have independent clocking arrangements. The system includes a task distribution device that distributes tasks to a synchrony group comprising a plurality of devices that are to perform the tasks distributed by the task distribution device in synchrony. The task distribution device distributes each task to the members of the synchrony group over a network. Each task is associated with a time stamp that indicates a time, relative to a clock maintained by the task distribution device, at which the members of the synchrony group are to execute o the task. Each member of the synchrony group periodically obtains from the task distribution device an indication of the current time indicated by its clock, determines a time differential between the task distribution device's clock and its respective clock and determines therefrom a time at which, according to its respective clock, the time stamp indicates that it is to execute the task.

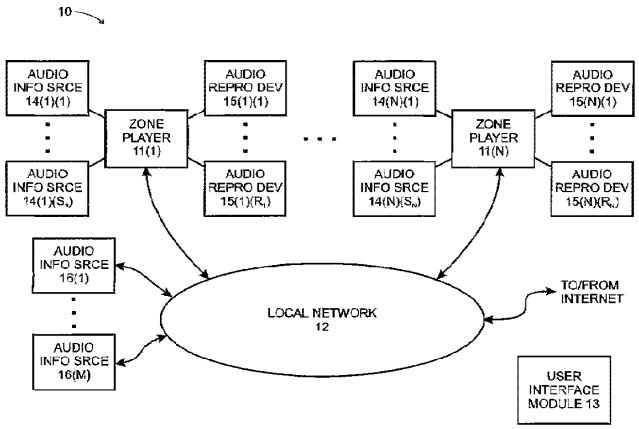


FIG. 1

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EP 2 713 281 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to the field of digital data processing devices, and more particularly to systems and methods for synchronizing operations among a plurality of independently-clocked digital data processing devices. The invention is embodied in a system for synchronizing operations among a plurality of devices, in relation to information that is provided by a common source. One embodiment of the invention enables synchronizing of audio playback as among two or more audio playback devices that receive audio information from a common information source, or channel.

[0002] More generally, the invention relates to the field of arrangements that synchronize output generated by a number of output generators, including audio output, video output, combinations of audio and video, as well as other types of output as will be appreciated by those skilled in the art, provided by a common channel. Generally, the invention will find utility in connection with any type of information for which synchrony among independently-clocked devices is desired.

BACKGROUND OF THE INVENTION

[0003] There are a number of circumstances under which it is desirable to maintain synchrony of operations among a plurality of independently-clocked digital data processing devices in relation to, for example, information that is provided thereto by a common source. For example, systems are being developed in which one audio information source can distribute audio information in digital form to a number of audio playback devices for playback. The audio playback devices receive the digital information and convert it to analog form for playback. The audio playback devices may be located in the same room or they may be distributed in different rooms in a residence such as a house or an apartment, in different offices in an office building, or the like. For example, in a system installed in a residence, one audio playback device may be located in a living room, while another audio playback device is be located in a kitchen, and yet other audio playback devices may be located in various bedrooms of a house. In such an arrangement, the audio information that is distributed to various audio playback devices may relate to the same audio program, or the information may relate to different audio programs. If the audio information source provides audio information relating to the same audio program to two or more audio playback devices at the same time, the audio playback devices will generally contemporaneously play the same program. For example, if the audio information source provides audio information to audio playback devices located in the living room and kitchen in a house at the same time, they will generally contemporaneously play the same program.

[0004] One problem that can arise is to ensure that, if two or more audio playback devices are contemporaneously attempting to play back the same audio program, they do so simultaneously. Small differences in the audio playback devices' start times and/or playback speeds can be perceived by a listener as an echo effect, and larger differences can be very annoying. Differences can arise because for a number of reasons, including delays in the transfer of audio information over the network. Such delays can differ as among the various audio playback devices for a variety of reasons, including where they are connected into the network, message traffic and other reasons as will be apparent to those skilled in the art.

[0005] Another problem arises from the following. When an audio playback device converts the digital audio information from digital to analog form, it does so using a clock that provides timing information. Generally, the audio playback devices that are being developed have independent clocks, and, if they are not clocking at precisely the same rate, the audio playback provided by the various devices can get out of synchronization.

SUMMARY OF THE INVENTION

[0006] The invention provides a new and improved system and method for synchronizing operations among a number of digital data processing devices that are regulated by independent clocking devices. Generally, the invention will find utility in connection with any type of information for which synchrony among devices connected to a network is desired. The invention is described in connection with a plurality of audio playback devices that receive digital audio information that is to be played back in synchrony, but it will be appreciated that the invention can find usefulness in connection with any kind of information for which coordination among devices that have independent clocking devices would find utility.

[0007] In brief summary, the invention provides, in one aspect, a system for maintaining synchrony of operations among plurality of devices that have independent clocking arrangements. The system includes a task distribution device that distributes tasks to a synchrony group comprising a plurality of devices that are to perform the tasks distributed by the task distribution device in synchrony. The task distribution device distributes each task to the members of the synchrony group over a network. Each task is associated with a time stamp that indicates a time, relative to a clock maintained by the task distribution device, at which the members of the synchrony group are to execute the task. Each

member of the synchrony group periodically obtains from the task distribution device an indication of the current time indicated by its clock, determines a time differential between the task distribution device's clock and its respective clock and determines therefrom a time at which, according to its respective clock, the time stamp indicates that it is to execute the task.

[0008] In one embodiment, the tasks that are distributed include audio information for an audio track that is to be played by all of the devices comprising the synchrony group synchronously. The audio track is divided into a series of frames, each of which is associated with a time stamp indicating the time, relative to the clock maintained by an audio information channel device, which, in that embodiment, serves as the task distribution device, at which the members of the synchrony group are to play the respective frame. Each member of the synchrony group, using a very accurate protocol, periodically obtains the time indicated by the audio information channel device, and determines a differential between the time as indicated by its local clock and the audio information channel device's clock. The member uses the differential and the time as indicated by the time stamp to determine the time, relative to its local clock, at which it is to play the respective frame. The members of the synchrony group do this for all of the frames, and accordingly are able to play the frames in synchrony.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] This invention is pointed out with particularity in the appended claims. The above and further advantages of this invention may be better understood by referring to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 schematically depicts an illustrative networked audio system, constructed in accordance with the invention;
FIG. 2 schematically depicts a functional block diagram of a synchrony group utilizing a plurality of zone players formed within the networked audio system depicted in FIG. 1 ;
FIG. 2A schematically depicts two synchrony groups, illustrating how a member of one synchrony group can provide audio information to the members of another synchrony group;
FIG. 3 depicts an functional block diagram of a zone player for use in the networked audio system depicted in FIG. 1 ; and
FIG. 4 is useful in understanding an digital audio information framing methodology useful in the network audio system depicted in FIG. 1.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

[0010] FIG. 1 depicts an illustrative network audio system 10 constructed in accordance with the invention. With reference to FIG. 1, the network audio system 10 includes a plurality of zone players 11(1) through 11(N) (generally identified by reference numeral 11(n)) interconnected by a local network 12, all of which operate under control of one or more user interface modules generally identified by reference numeral 13. One or more of the zone players 11(n) may also be connected to one or more audio information sources, which will generally be identified herein by reference numeral 14(n)(s), and/or one or more audio reproduction devices, which will generally be identified by reference numeral 15(n)(r). In the reference numeral 14(n)(s), index "n" refers to the index "n" of the zone player 11(n) to which the audio information source is connected, and the index "s" (s=1,...,S_n) refers to the "s-th" audio information source connected to that "n-th" zone player 11(n). Thus, if, for example, a zone player 11(n) is connected to four audio information sources 14(n)(1) through 14(n)(4), the audio information sources may be generally identified by reference numeral 14(n)(s), with S_n=4. It will be appreciated that the number of audio information sources S_n may vary as among the various zone players 11(n), and some zone players may not have any audio information sources connected thereto. Similarly, in the reference numeral 15(n)(r), index "n" refers to the index "n" of the zone player 11(n) to which the audio reproduction device is connected, and the index "r" (r=1,...,R_n) refers to the "r-th" audio information source connected to that "n-th" zone player 11(n). In addition to the audio information sources 14(n)(s), the network audio system 10 may include one or more audio information sources 16(1) through 16(M) connected through appropriate network interface devices (not separately shown) to the local network 12. Furthermore, the local network may include one or more network interface devices (also not separately shown) that are configured to connect the local network 12 to other networks, including a wide area network such as the Internet, the public switched telephony network (PSTN) or other networks as will be apparent to those skilled in the art, over which connections to audio information sources may be established.

[0011] The zone players 11(n) associated with system 10 may be distributed throughout an establishment such as residence, an office complex, a hotel, a conference hall, an amphitheater or auditorium, or other types of establishments as will be apparent to those skilled in the art or the like. For example, if the zone players 11(n) and their associated audio information source(s) and/or audio reproduction device(s) are distributed throughout a residence, one, such as zone player 11(1) and its associated audio information source(s) and audio reproduction device(s) may be located in a living

room, another may be located in a kitchen, another may be located in a dining room, and yet others may be located in respective bedrooms, to selectively provide entertainment in those rooms. On the other hand, if the zone players 11(n) and their associated audio information source(s) and/or audio reproduction device(s) are distributed throughout an office complex, one may, for example, be provided in each office to selectively provide entertainment to the employees in the respective offices. Similarly, if the zone players 11(n) and associated audio information source(s) and/or audio reproduction device(s) are used in a hotel, they may be distributed throughout the rooms to provide entertainment to the guests. Similar arrangements may be used with zone players 11(n) and associated audio information source(s) and/or audio reproduction device(s) used in an amphitheater or auditorium. Other arrangements in other types of environments will be apparent to those skilled in the art. In each case, the zone players 11(n) can be used to selectively provide entertainment in the respective locations, as will be described below.

[0012] The audio information sources 14(n)(s) and 16(m) may be any of a number of types of conventional sources of audio information, including, for example, compact disc ("CD") players, AM and/or FM radio receivers, analog or digital tape cassette players, analog record turntables and the like. In addition, the audio information sources 14(n)(s) and 16(m) may comprise digital audio files stored locally on, for example, personal computers (PCs), personal digital assistants (PDAs), or similar devices capable of storing digital information in volatile or non-volatile form. As noted above, the local network 12 may also have an interface (not shown) to a wide area network, over which the network audio system 10 can obtain audio information. Moreover, one or more of the audio information sources 14(n)(s) may also comprise an interface to a wide area network such as the Internet, the public switched telephony network (PSTN) or any other source of audio information. In addition, one or more of the audio information sources 14(n)(s) and 16(m) may comprise interfaces to radio services delivered over, for example, satellite. Audio information obtained over the wide area network may comprise, for example, streaming digital audio information such as Internet radio, digital audio files stored on servers, and other types of audio information and sources as will be appreciated by those skilled in the art. Other arrangements and other types of audio information sources will be apparent to those skilled in the art.

[0013] Generally, the audio information sources 14(n)(s) and 16(m) provide audio information associated with audio programs to the zone players for playback. A zone player that receives audio information from an audio information source 14(n)(s) that is connected thereto can provide playback and/or forward the audio information, along with playback timing information, over the local network 12 to other zone players for playback. Similarly, each audio information source 16(m) that is not directly connected to a zone player can transmit audio information over the network 12 to any zone player 11(n) for playback. In addition, as will be explained in detail below, the respective zone player 11(n) can transmit the audio information that it receives either from an audio information source 14(n)(s) connected thereto, or from an audio information source 16(m), to selected ones of the other zone players 11(n'), 11(n"),... (n not equal to n', n",...) for playback by those other zone players. The other zone players 11(n'), 11(n"),... to which the zone player 11(n) transmits the audio information for playback may be selected by a user using the user interface module 13. In that operation, the zone player 11(n) will transmit the audio information to the selected zone players 11(n'), 11(n"),... over the network 12. As will be described below in greater detail, the zone players 11(n), 11(n'), 11(n"),... operate such that the zone players 11(n'), 11(n"),... synchronize their playback of the audio program with the playback by the zone player 11(n), so that the zone players 11(n), 11(n'), 11(n") provide the same audio program at the same time.

[0014] Users, using user interface module 13, may also enable different groupings or sets of zone players to provide audio playback of different audio programs synchronously. For example, a user, using a user interface module 13, may enable zone players 11(1) and 11(2) to play one audio program, audio information for which may be provided by, for example, one audio information source 14(1)(1). The same or a different user may, using the same or a different user interface module 13, enable zone players 11 (4) and 11(5) to contemporaneously play another audio program, audio information for which may be provided by a second audio information source, such as audio information source 14(5)(2). Further, a user may enable zone player 11(3) to contemporaneously play yet another audio program, audio information for which may be provided by yet another audio information source, such as audio information source 16(1). As yet another possibility, a user may contemporaneously enable zone player 11(1) to provide audio information from an audio information source connected thereto, such as audio information source 14 (1) (2), to another zone player, such as zone player 11(6) for playback.

[0015] In the following, the term "synchrony group" will be used to refer to a set of one or more zone players that are to play the same audio program synchronously. Thus, in the above example, zone players 11(1) and 11(2) comprise one synchrony group, zone player 11(3) comprises a second synchrony group, zone players 11 (4) and 11(5) comprise a third synchrony group, and zone player 11(6) comprises yet a fourth synchrony group. Thus, while zone players 11(1) and 11(2) are playing the same audio program, they will play the audio program synchronously. Similarly, while zone players 11(4) and 11(5) are playing the same audio program, they will play the audio program synchronously. On the other hand, zone players that are playing different audio programs may do so with unrelated timings. That is, for example, the timing with which zone players 11(1) and 11(2) play their audio program may have no relationship to the timing with which zone player 11 (3), zone players 11(4) and 11(5), and zone player 11(6) play their audio programs. It will be appreciated that, since "synchrony group" is used to refer to sets of zone players that are playing the same audio program

synchronously, zone player 11(1) will not be part of zone player 11(6)'s synchrony group, even though zone player 11(1) is providing the audio information for the audio program to zone player 11(6).

[0016] In the network audio system 10, the synchrony groups are not fixed. Users can enable them to be established and modified dynamically. Continuing with the above example, a user may enable the zone player 11(1) to begin providing playback of the audio program provided thereto by audio information source 14(1)(1), and subsequently enable zone player 11(2) to join the synchrony group. Similarly, a user may enable the zone player 11 (5) to begin providing playback of the audio program provided thereto by audio information source 14(5)(2), and subsequently enable zone player 11(4) to join that synchrony group. In addition, a user may enable a zone player to leave a synchrony group and possibly join another synchrony group. For example, a user may enable the zone player 11 (2) to leave the synchrony group with zone player 11(1), and join the synchrony group with zone player 11(6). As another possibility, the user may enable the zone player 11(1) to leave the synchrony group with zone player 11(2) and join the synchrony group with zone player 11(6).In connection with the last possibility, the zone player 11(1) can continue providing audio information from the audio information source 14(1)(1) to the zone player 11(2) for playback thereby.

[0017] A user, using the user interface module 13, can enable a zone player 11(n) that is currently not a member of a synchrony group to join a synchrony group, after which it will be enabled to play the audio program that is currently being played by that synchrony group. Similarly, a user, also using the user interface module 13, can enable a zone player 11(n) that is currently a member of one synchrony group, to disengage from that synchrony group and join another synchrony group, after which that zone player will be playing the audio program associated with the other synchrony group. For example, if a zone player 11(6) is currently not a member of any synchrony group, it, under control of the user interface module 13, can become a member of a synchrony group, after which it will play the audio program being played by the other members of the synchrony group, in synchrony with the other members of the synchrony group. In becoming a member of the synchrony group, zone player 11(6) can notify the zone player that is the master device for the synchrony group that it wishes to become a member of its synchrony group, after which that zone player will also transmit audio information associated with the audio program, as well as timing information, to the zone player 11(6).As the zone player 11(6) receives the audio information and the timing information from the master device, it will play the audio information with the timing indicated by the timing information, which will enable the zone player 11(6) to play the audio program in synchrony with the other zone player(s) in the synchrony group.

[0018] Similarly, if a user, using the user interface module 13, enables a zone player 11(n) associated with a synchrony group to disengage from that synchrony group, and if the zone player 11(n) is not the master device of the synchrony group, the zone player 11(n) can notify the master device, after which the master device can terminate transmission of the audio information and timing information to the zone player 11(n). If the user also enables the zone player 11(n) to begin playing another audio program using audio information from an audio information source 14(n)(s) connected thereto, it will acquire the audio information from the audio information source 14(n)(s) and initiate playback thereof. If the user enables another zone player 11(n') to join the synchrony group associated with zone player l 11(n), operations in connection therewith can proceed as described immediately above.

[0019] As yet another possibility, if a user, using the user interface module 13, enables a zone player 11(n) associated with a synchrony group to disengage from that synchrony group and join another synchrony group, and if the zone player is not the master device of the synchrony group from which it is disengaging, the zone player 11(n) can notify the master device of the synchrony group from which it is disengaging, after which that zone player will terminate transmission of audio information and timing information to the zone player 11(n) that is disengaging. Contemporaneously, the zone player 11(n) can notify the master device of the synchrony group that it (that is, zone player 11(n)) is joining, after which the master device can begin transmission of audio information and timing information to that zone player 11(n). The zone player 11(n) can thereafter begin playback of the audio program defined by the audio information, in accordance with the timing information so that the zone player 11(n) will play the audio program in synchrony with the master device.

[0020] As yet another possibility, a user, using the user interface module 13, may enable a zone player 11(n) that is not associated with a synchrony group, to begin playing an audio program using audio information provided to it by an audio information source 14(n)(s) connected thereto. In that case, the user, also using the user interface module 13 or a user interface device that is specific to the audio information source 14(n)(s), can enable the audio information source 14(n)(s) to provide audio information to the zone player 11(n). After the zone player 11(n) has begun playback, or contemporaneously therewith, the user, using the user interface module 13, can enable other zone players 11(n'), 11(n"),... to join zone player 11(n) 's synchrony group and enable that zone player 11(n) to transmit audio information and timing information thereto as described above, to facilitate synchronous playback of the audio program by the other zone players 11(n'), 11(n")....

[0021] A user can use the user interface module 13 to control other aspects of the network audio system 10, including but not limited to the selection of the audio information source 14(n)(s) that a particular zone player 11(n) is to utilize, the volume of the audio playback, and so forth. In addition, a user may use the user interface module 13 to turn audio information source(s) 14(n)(s) on and off and to enable them to provide audio information to the respective zone players 11(n).

[0022] Operations performed by the various devices associated with a synchrony group will be described in connection with FIG. 2, which schematically depicts a functional block diagram of a synchrony group in the network audio system 10 described above in connection with FIG. 1. With reference to FIG. 2, a synchrony group 20 includes a master device 21 and zero or more slave devices 22(1) through 22 (G) (generally identified by reference numeral 22(g)), all of which synchronously play an audio program provided by an audio information channel device 23. Each of the master device 21, slave devices 22(g) and audio information channel device 23 utilizes a zone player 11(n) depicted in FIG. 1, although it will be clear from the description below that a zone player may be utilized both for the audio information channel device for the synchrony group 20, and the master device 21 or a slave device 22(g) of the synchrony group 20. As will be described below in more detail, the audio information channel device 23 obtains the audio information for the audio program from an audio information source, adds playback timing information, and transmits the combined audio and playback timing information to the master device 21 and slave devices 22(g) over the network 12 for playback. The playback timing information that is provided with the audio information, together with clock timing information provided by the audio information channel device 23 to the various devices 21 and 22(g) as will be described below, enables the master device 21 and slave devices 22(g) of the synchrony group 20 to play the audio information simultaneously.

[0023] The master device 21 and the slave devices 22(g) receive the audio and playback timing information, as well as the clock timing information, that are provided by the audio information channel device 23, and play back the audio program defined by the audio information. The master device 21 is also the member of the synchrony group 20 that communicates with the user interface module 13 and that controls the operations of the slave devices 22(g) in the synchrony group 20. In addition, the master device 21 controls the operations of the audio information channel device 23 that provides the audio and playback timing information for the synchrony group 20. Generally, the initial master device 21 for the synchrony group will be the first zone player 11(n) that a user wishes to play an audio program. However, as will be described below, the zone player 11(n) that operates as the master device 21 can be migrated from one zone player 11(n) to another zone player 11(n'), which preferably will be a zone player that is currently operating as a slave device 22(g) in the synchrony group.

[0024] In addition, under certain circumstances, as will be described below, the zone player 11(n) that operates as the audio information channel device 23 can be migrated from one zone player to another zone player, which also will preferably will be a zone player that is currently operating as a member of the synchrony group 20. It will be appreciated that the zone player that operates as the master device 21 can be migrated to another zone player independently of the migration of the audio information channel device 23. For example, if one zone player 11(n) is operating as both the master device 21 and the audio information channel device 23 for a synchrony group 20, the master device 21 can be migrated to another zone player 11(n') while the zone player 11(n) is still operating as the audio information channel device 23. Similarly, if one zone player 11(n) is operating as both the master device 21 and the audio information channel device 23 for a synchrony group 20, the audio information channel device 23 can be migrated to another zone player 11(n') while the zone player 11(n) is still operating as the master device 21. In addition, if one zone player 11(n) is operating as both the master device 21 and the audio information channel device 23 for a synchrony group 20, the master device 21 can be migrated to another zone player 11(n') and the audio information channel device can be migrated to a third zone player 11(n").

[0025] The master device 21 receives control information from the user interface module 13 for controlling the synchrony group 20 and provides status information indicating the operational status of the synchrony group to the user interface module 13. Generally, the control information from the user interface module 13 enables the master device 21 to, in turn, enable the audio information channel device 23 to provide audio and playback timing information to the synchrony group to enable the devices 21 and 22(g) that are members of the synchrony group 20 to play the audio program synchronously. In addition, the control information from the user interface module 13 enables the master device 21 to, in turn, enable other zone players to join the synchrony group as slave devices 22(g) and to enable slave devices 22(g) to disengage from the synchrony group. Control information from the user interface module 13 can also enable the zone player 11(n) that is currently operating as the master device 21 to disengage from the synchrony group, but prior to doing so that zone player will enable the master device 21 to transfer from that zone player 11(n) to another zone player 11(n'), preferably to a zone player 11(n') that is currently a slave device 22(g) in the synchrony group 20. The control information from the user interface module 13 can also enable the master device 21 to adjust its playback volume and to enable individual ones of the various slave devices 22(g) to adjust their playback volumes. In addition, the control information from the user interface module 13 can enable the synchrony group 20 to terminate playing of a current track of the audio program and skip to the next track, and to re-order tracks in a play list of tracks defining the audio program that is to be played by the synchrony group 20.

[0026] The status information that the master device 21 may provide to the user interface module 13 can include such information as a name or other identifier for the track of the audio work that is currently being played, the names or other identifiers for upcoming tracks, the identifier of the zone player 11(n) that is currently operating as the master device 21, and identifiers of the zone players that are currently operating as slave devices 22(g). In one embodiment, the user interface module 13 includes a display (not separately shown) that can display the status information to the user.

[0027] It will be appreciated that the zone player 11(n) that is operating as the audio information channel device 23 for one synchrony group may also comprise the master device 21 or any of the slave devices 22(g) in another synchrony group. This may occur if, for example, the audio information source that is to provide the audio information that is to be played by the one synchrony group is connected to a zone player also being utilized as the master device or a slave device for the other synchrony group. This will be schematically illustrated below in connection with FIG. 2A. Since, as noted above, the zone player 11(n) that is operating as the audio information channel device 23 for the synchrony group 20 may also be operating as a master device 21 or slave device 22(g) for another synchrony group, it can also be connected to one or more audio reproduction devices 15(n)(r), although that is not depicted in FIG. 2. Since the master device 21 and slave devices 22(g) are all to provide playback of the audio program, they will be connected to respective audio reproduction devices 15(n)(r). Furthermore, it will be appreciated that one or more of the zone players 11(n) that operate as the master device 21 and slave devices 22(g) in synchrony group 20 may also operate as an audio information channel device for that synchrony group or for another synchrony group and so they may be connected to one or more audio information sources 14(n)(s), although that is also not depicted in FIG. 2. In addition, it will be appreciated that a zone player 11(n) can also operate as a audio information channel device 23 for multiple synchrony groups.

[0028] If the audio information channel device 23 does not utilize the same zone player as the master device 21, the master device 21 controls the audio information channel device by exchanging control information over the network 12 with the audio information channel device 23. The control information is represented in FIG. 2 by the arrow labeled CHAN_DEV_CTRL_INFO. The control information that the master device 21 provides to the audio information channel device 23 will generally depend on the nature of the audio information source that is to provide the audio information for the audio program that is to be played and the operation to be enabled by the control information. If, for example, the audio information source is a conventional compact disc, tape, or record player, broadcast radio receiver, or the like, which is connected to a zone player 11(n), the master device 21 may merely enable the zone player serving as the audio information channel device 23 to receive the audio information for the program from the audio information source. It will be appreciated that, if the audio information is not in digital form, the audio information channel device 23 will convert it to digital form and provide the digitized audio information, along with the playback timing information, to the master device 21 and slave devices 22(g).

[0029] On the other hand, if the audio information source is, for example, a digital data storage device, such as may be on a personal computer or similar device, the master device 21 can provide a play list to the audio information channel device 23 that identifies one or more files containing the audio information for the audio program. In that case, the audio information channel device 23 can retrieve the files from the digital data storage device and provide them, along with the playback timing information, to the master device 21 and the slave devices 22(g). It will be appreciated that, in this case, the audio information source may be directly connected to the audio information channel device 23, as, for example, an audio information source 14(n)(s), or it may comprise an audio information source 16(m) connected to the network 12. As a further alternative, if the audio information source is a source available over the wide area network, the master device 21 can provide a play list comprising a list of web addresses identifying the files containing the audio information for the audio program that is to be played, and in that connection the audio information channel device 23 can initiate a retrieval of the files over the wide area network. As yet another alternative, if the audio information source is a source of streaming audio received over the wide area network, the master device 21 can provide a network address from which the streaming audio can be received. Other arrangements by which the master device 21 can control the audio information channel device 23 will be apparent to those skilled in the art.

The master device 21 can also provide control information to the synchrony group's audio information channel device 23 to enable a migration from one zone player 11(n) to another zone player 11(n'). This may occur if, for example, the audio information source is one of audio information sources 16 or a source accessible over the wide area network via the network 12. The master device 21 can enable migration of the audio information channel device 23 for several reasons, including, for example, to reduce the loading of the zone player 11(n), to improve latency of message transmission in the network 12, and other reasons as will be appreciated by those skilled in the art.

[0030] As noted above, the audio information channel device 23 provides audio and playback timing information for the synchrony group to enable the master device 21 and slave devices 22(g) to play the audio program synchronously. Details of the audio and playback timing information will be described in detail below in connection with FIGS. 3 and 4, but, in brief, the audio information channel device 23 transmits the audio and playback timing information in messages over the network 12 using a multi-cast message transmission methodology. In that methodology, the audio information channel device 23 will transmit the audio and playback timing information in a series of messages, with each message being received by all of the zone players 11(n) comprising the synchrony group 20, that is, by the master device 21 and the slave devices 22(g). Each of the messages includes a multi-cast address, which the master device 21 and slave devices 22(g) will monitor and, when they detect a message with that address, they will receive and use the contents of the message. The audio and playback timing information is represented in FIG. 2 by the arrow labeled "AUD+PBTIME INFO," which has a single tail, representing a source for the information at the audio information channel device 23, and multiple arrowheads representing the destinations of the information, with one arrowhead extending to the master device

21 and other arrowheads extending to each of the slave devices 22(g) in the synchrony group 20. The audio information channel device 23 may make use of any convenient multi-cast message transmission methodology in transmitting the audio and playback timing information to the synchrony group 20. As will be described in detail in connection with FIG. 4, the audio and playback timing information is in the form of a series of frames, with each frame having a time stamp. The time stamp indicates a time, relative to the time indicated by a clock maintained by the audio information channel device 23, at which the frame is to be played. Depending on the size or sizes of the messages used in the selected multi-cast message transmission methodology and the size or sizes of the frames, a message may contain one frame, or multiple frames, or, alternatively, a frame may extend across several messages.

[0031] The audio information channel device 23 also provides clock time information to the master device 21 and each of the slave devices 22(g) individually over network 12 using a highly accurate clock time information transmission methodology. The distribution of the clock time information is represented in FIG. 2 by the arrows labeled "AICD_CLK_INF (M)" (in the case of the clock time information provided to the master device 21) and "AICD_CLK_INF (S_1)" through "AICD_CLK_INF (S_G)" (in the case of audio information channel device clock information provided to the slave devices 22(g)). In one embodiment, the master device 21 and slave devices 22(g) make use of the well-known SNTP (Simple Network Time Protocol) to obtain current clock time information from the audio information channel device 23. The SNTP makes use of a unicast message transfer methodology, in which one device, such as the audio information channel device 23, provides clock time information to a specific other device, such as the master device 21 or a slave device 22(g), using the other device's network, or unicast, address. Each of the master device 21 and slave devices 22(g) will periodically initiate SNTP transactions with the audio information channel device 23 to obtain the clock time information from the audio information channel device 23. As will be described below in more detail, the master device 21 and each slave device 22(g) make use of the clock time information to determine the time differential between the time indicated by the audio information channel device's clock and the time indicated by its respective clock, and use that time differential value, along with the playback time information associated with the audio information and the respective device's local time as indicated by its clock to determine when the various frames are to be played. This enables the master device 21 and the slave devices 22(g) in the synchrony group 20 to play the respective frames simultaneously.

[0032] As noted above, the control information provided by the user to the master device 21 through the user interface module 13 can also enable the master device 21 to, in turn, enable another zone player 11(n') to join the synchrony group as a new slave device 22(g). In that operation, the user interface module 13 will provide control information, including the identification of the zone player 11(n') that is to join the synchrony group to the master device 21. After it receives the identification of the zone player 11(n') that is to join the synchrony group, the master device 21 will exchange control information, which is represented in FIG. 2 by the arrows labeled SLV_DEV_CTRL_INF (S_1) through SLV_DEV_CTRL_INF (S_G) group slave control information, over the network 12 with the zone player I 11(n') that is identified in the control information from the user interface module 13. The control information that the master device 21 provides to the new zone player 11(n') includes the network address of the zone player 11(n) that is operating as the audio information channel device 23 for the synchrony group, as well as the multi-cast address that the audio information channel device 23 is using to broadcast the audio and playback timing information over the network. The zone player that is to operate as the new slave device 22(g') uses the multi-cast address to begin receiving the multi-cast messages that contain the audio information for the audio program being played by the synchrony group.

[0033] It will be appreciated that, if the zone player 11(n) that is operating as the master device 21 for the synchrony group 20 is also operating the audio information channel device 23, and if there are no slave devices 22(g) in the synchrony group 20, the audio information channel device 23 may not be transmitting audio and playback timing information over the network. In that case, if the new slave device 22(g') is the first slave device in the synchrony group, the zone player 11(n) that is operating as both the master device 21 and audio information channel device 23, can begin transmitting the audio and playback timing information over the network 12 when the slave device 22(g') is added to the synchrony group 20. The zone player 11(n) can maintain a count of the number of slave devices 22(g) in the synchrony group 20 as they join and disengage, and, if the number drops to zero, it can stop transmitting the audio and playback timing information over the network 12 to reduce the message traffic over the network 12.

[0034] The new slave device 22(g') added to the synchrony group 20 uses the network address of the audio information channel device 23 for several purposes. In particular, the new slave device 22(g') will, like the master device 21 (assuming the zone player 11(n) operating as the master device 21 is not also the audio information channel device 23), engage in SNTP transactions with the audio information channel device 23 to obtain the clock timing information from the audio information channel device 23. In addition, the new slave device 22(g') can notify the audio information channel device 23 that it is a new slave device 22(g') for the synchrony group 20 and provide the audio information channel device 23 with its network address. As will be described below, in one embodiment, particularly in connection with audio information obtained from a source, such as a digital data storage device, which can provide audio information at a rate that is faster than the rate at which it will be played, the audio information channel device 23 will buffer audio and timing information and broadcast it over the network 12 to the synchrony group 20 generally at a rate at which it is provided by the source. Accordingly, when a new slave device 22(g') joins the synchrony group 20, the playback timing information may indicate

that the audio information that is currently being broadcast by the audio information channel device 23 using the multicast methodology is to be played back some time in the future. To reduce the delay with which the new slave device 22(g') will begin playback, the audio information channel device 23 can also retransmit previously transmitted audio and timing information that it had buffered to the new slave device 22(g') using the unicast network address of the slave device 22(g').

[0035] The master device 21 can also use the slave device control information exchanged with the slave devices 22(g) for other purposes. For example, the master device 21 can use the slave device control information to initiate a migration of the master from its zone player 11(n) to another zone player 11(n'). This may occur for any of a number of reasons, including, for example, that the master device 21 is terminating playback by it of the audio program and is leaving the synchrony group 20, but one or more of the other devices in the synchrony group is to continue playing the audio program. The master device 21 may also want to initiate a migration if it is overloaded, which can occur if, for example, the zone player 11(n) that is the master device 21 for its synchrony group is also operating as an audio information channel device 23 for another synchrony group.

[0036] The user can also use the user interface module 13 to adjust playback volume by the individual zone players 11(n) comprising the synchrony group. In that operation, the user interface module 13 provides information identifying the particular device whose volume is to be adjusted, and the level at which the volume is to be set to the master device 21. If the device whose volume is to be adjusted is the master device 21, the master device 21 can adjust its volume according to the information that it receives from the user interface module 13. On the other hand, if the device whose volume is to be adjusted is a slave device 22(g), the master device 21 can provide group slave control information to the respective slave device 22(g), to enable it to adjust its volume.

[0037] The user can also use the user interface module 13 to enable a synchrony group 20 to cancel playing of the track in an audio program that is currently being played, and to proceed immediately to the next track. This may occur, for example, if the tracks for the program is in the form of a series of digital audio information files, and the user wishes to cancel playback of the track that is defined by one of the files. In that case, when the master device 21 receives the command to cancel playback of the current track, it will provide channel device control information to the audio information channel device 23 so indicating. In response, the audio information channel device 23 inserts control information into the audio and playback timing information, which will be referred to as a "resynchronize" command. In addition, the audio information channel device 23 will begin transmitting audio information for the next track, with timing information to enable it to be played immediately. The resynchronize command can also enable playback of a track to be cancelled before it has been played. Details of these operations will be described below.

[0038] As noted above, there may be multiple synchrony groups in the network audio system 10, and further that, for example, a zone player 11(n) may operate both as a master device 21 or a slave device 22(g) in one synchrony group, and as the audio information channel device 23 providing audio and playback timing information and clock timing information for another synchrony group. An illustrative arrangement of this will be described in connection with FIG. 2A. With reference to FIG. 2A, that FIG. depicts elements of two synchrony groups, identified by reference numerals 20(1) and 20(2), respectively. For clarity, FIG. 2A does not show a number of elements, the presence of which would be evident from FIGS. 1 and 2 as described above. For example, FIG. 2A does not depict the audio information sources from which audio information is obtained for the synchrony groups or the audio reproduction devices that are used to produce sound for the master and slave devices, which are depicted in both FIGS. 1 and 2. In addition, FIG. 2A does not depict arrows that represent control information provided by the respective master devices to the slave devices in the respective synchrony groups, or to the audio information channel devices that provide audio and timing information for the respective synchrony groups, which are depicted in FIG. 2. In addition, FIG.2A does not depict the arrows that represent the clock timing information provided by the audio information channel devices to the respective members of the respective synchrony groups, which are also depicted in FIG. 2. As will be noted below, however, FIG. 2A does depict arrows representing the audio and playback timing information provided by the respective audio information channel devices for the respective synchrony groups 20(1), 20(2), to the master and slave devices comprising the respective synchrony groups 20(1), 20(2).

[0039] Each synchrony group 20(1), 20(2) comprises elements of a number of zone players. A functional block diagram of a zone player will be described below in connection with FIG. 3. Synchrony group 20(1) includes a master device 21(1) and "K" slave devices 22(1)(1) through 22(K)(1) (the index "1" in reference numeral 21(1) and the last index in reference numeral 22(1)(1) through 21(K)(1) corresponds to the index of the synchrony group 20(1) to which they belong) utilize zone players 11(1) and 11(K+1) respectively. Similarly, synchrony group 20(2) includes a master device 21(2) and "L" slave devices 22(1)(2) through 22(L)(2) that utilize zone players 11(K+2) through 11(K+L+2). In the illustrative arrangement depicted in FIG. 2A, both synchrony groups 20(1) and 20(2) are controlled by the user interface module 13, which can provide control information to, and receive status information from, the master devices 21(1) and 21(2) independently. It will be appreciated that separate user interface modules may be provided to provide control information to, and receive status information from, the respective master devices 21(1),21(2).

[0040] As noted above, the slave device 22(1)(2) in synchrony group 20(2) utilizes zone player 11(K+3). In the illustrative

arrangement depicted in FIG. 2A, the audio information channel device 23(1) that provides audio and playback timing information to the master and slave devices 21(1), 22(1)(1),..., 22(K)(1) of synchrony group 20(1) also utilizes zone player 11(K+3). As noted above, this may occur if, for example, the audio information source that is to provide audio information to be played by the synchrony group 20(1) is connected to the zone player 11(K+3). Thus, when the master device 21(1) of synchrony group 20(1) exchanges channel device control information with the audio information channel device 23(1), it is effectively exchanging channel device control information with the zone player 11(K+3). Similarly, when the master and slave devices 21(1), 22(1)(1),..., 22(K)(1) of synchrony group 20(1) receive audio and playback timing information, as well as clock timing information, from the audio information channel device 23(1), they are effectively receiving the information from the zone player 11(K+3). FIG.2A depicts a multi-headed arrow representing audio and playback timing information transmitted by the zone player 11(K+3), as audio information channel device 23(1), to the master and slave devices 21(1), 22(1)(1),...,11(K)(1) comprising synchrony group 20(1).

[0041] On the other hand, in the illustrative arrangement depicted in FIG. 2A, the synchrony group 20(2) utilizes a zone player 11(K+L+3) as its audio information channel device 23(2). As with synchrony group 20(1), when the master device 21(2) of synchrony group 20(2) exchanges channel device control information with the audio information channel device 23(2), it is effectively exchanging channel device control information with the zone player 11(K+L+3). Similarly, when the master and slave devices 21(2), 22(1)(2),..., 22(L)(2) of synchrony group 20(2) receive audio and playback timing information, as well as clock timing information, from the audio information channel device 23(2), they are effectively receiving the information from the zone player 11(K+L+3). FIG. 2A depicts a multi-headed arrow representing audio and playback timing information transmitted by the zone player 11(K+3) as audio information channel device 23(2) to the master and slave devices 21(2), 22(1) (2),..., 22(L) (2) comprising synchrony group 20(2).

[0042] In the illustrative arrangement depicted in FIG. 2A, zone player 11(K+L+3), which is the audio information channel device 23(2) for synchrony group 20(2), is not shown as being either a master or a slave device in another synchrony group. However, it will be appreciated that zone player 11(K+L+3) could also be utilized as the master device or a slave device for another synchrony group. Indeed, it will be appreciated that the zone player that is utilized as the audio information channel device for synchrony group 20(2) may also be a zone player that is utilized as the master device 21(1) or a slave device 22(1) (1),..., 22(K)(1) in the synchrony group 20(1).

[0043] A zone player 11(n) that is utilized as a member of one synchrony group may also be utilized as the audio information channel device for another synchrony group if the audio information source that is to supply the audio information that is to be played by the other synchrony group is connected to that zone player 11(n). A zone player 11(n) may also be utilized as the audio information channel device for the other synchrony group if, for example, the audio information source is an audio information source 16(m) (FIG.1) that is connected to the network 12 or an audio information source that is available over a wide area network such as the Internet. The latter may occur if, for example, the zone player 11(n) has sufficient processing power to operate as the audio information channel device and it is in an optimal location in the network 12, relative to the zone players comprising the other synchrony group (that is the synchrony group for which it is operating as audio information channel device) for providing the audio and playback timing information to the members of the other synchrony group. Other circumstances under which the zone player 11(n) that is utilized as a member of one synchrony group may also be utilized as the audio information channel device for another synchrony group will be apparent to those skilled in the art.

[0044] As was noted above, the master device 21 for a synchrony group 20 may be migrated from one zone player 11(n) to another zone player 11 (n'). As was further noted above, the audio information channel device 23 for a synchrony group 20 may be migrated from one zone player 11(n) to another zone player 11(n'). It will be appreciated that the latter may occur if, for example, the audio information source that provides the audio program for the synchrony group is not connected to the zone player 11(n) that is operating as the audio information channel device 23, but instead is one of the audio information sources 16(m) connected to the network 12 or a source available over a wide area network such as the Internet. Operations performed during a migration of an audio information channel device 23 from one zone player 11(n) to another zone player 11(n') will generally depend on the nature of the audio information that is being channeled by the audio information channel device 23. For example, if the audio information source provides streaming audio, the zone player 11(n) that is currently operating as the audio information channel device 23 for the synchrony group 20, can provide the following information to the other zone player 11(n') that is to become the audio information channel device 23 for the synchrony group 20:

(a) the identification of the source of the streaming audio information,
(b) the time stamp associated with the frame that the zone player 11(n) is currently forming, and
(c) the identifications of the zone players that are operating as the master device 21 and slave devices 22(g) comprising the synchrony group 20.

After the zone player 11(n') receives the information from the zone player 11(n), it will begin receiving the streaming

audio from the streaming audio information source identified by the zone player I 11(n), assemble the streaming audio information into frames, associate each frame with a time stamp, and transmit the resulting audio and playback timing information over the network 12. The zone player 11(n') will perform these operations in the same manner as described above, except that, instead of using the time indicated by its digital to analog converter clock 34 directly in generating the time stamps for the frames, the initial time stamp will be related to the value of the time stamp that is provided by the zone player 11(n) (reference item (b) above), with the rate at which the time stamps are incremented corresponding to the rate at which its (that is, the zone player 11(n')'s) clock increments. In addition, the zone player 11(n') will notify the zone players that are operating as the master device 21 and slave devices 22(g) of the synchrony group 20 that it is the new audio information channel device 23 for the synchrony group 20, and provide the multi-cast address that it will be using to multi-cast the audio and playback timing information, as well as its unicast network address. After the members of the synchrony group 20 receive the notification from the zone player 11(n') indicating that it is the new audio information channel device 23 for the synchrony group 20, they will receive the audio and playback timing information from the zone player 11(n') instead of the zone player 11(n), using the multi-cast address provided by the zone player 11(n'). In addition, they can utilize the zone player 11(n')'s unicast network address to obtain current time information therefrom. It will be appreciated that the zone player 11(n') will determine its current time in relation to the time stamp that is provided by the zone player 11(n) (reference item (b) above) or the current time information that it received from the zone player 11(n) using the SNTP protocol as described above.

[0045] Generally similar operations can be performed in connection with migrating the audio information channel device from one zone player 11(n) to another zone player 11(n') if the audio information is from one or more audio information files, such as may be the case if the audio information comprises MP3 or WAV files that are available from sources such as sources 16(m) connected to the network 12 or over from sources available over a wide area network such as the Internet, except for differences to accommodate the fact that the audio information is in files. In that case, the zone player 11(n) that is currently operating as the audio information channel device 23 for the synchrony group 20 can provide the following information to the zone player 11(n') that is to become the audio information channel device 23 for the synchrony group 20:

(d) a list of the audio information files containing the audio information that is to be played;
(e) the identification of the file for which the zone player 11(n) is currently providing audio and playback timing information, along with the offset into the file for which the current item of audio and playback timing information is being generated and the time stamp that the zone player 11(n) is associating with that frame, and
(f) the identifications of the zone players that comprise the master device 21 and slave devices 22(g) comprising the synchrony group 20.

After the zone player 11(n') receives the information from the zone player 11(n), it will begin retrieving audio information from the file identified in item (e), starting at the identified offset. In addition, the zone player 11(n') can assemble the retrieved audio information into frames, associate each frame with a time stamp and transmit the resulting audio and playback timing information over the network 12. The zone player 11(n') will perform these operations in the same manner as described above, except that, instead of using the time indicated by its digital to analog converter clock 34 directly in generating the time stamps for the frames, the value of the initial time stamp will be related to the time stamp that is provided by the zone player 11(n) (reference item (e) above), with the rate at which the time stamps are incremented corresponding to the rate at which its (that is, the zone player 11(n') 's) clock increments. In addition, the zone player 11(n') will notify the zone players that are operating as the master device 21 and slave devices 22(g) of the synchrony group 20 that it is the new audio information channel device 23 for the synchrony group 20, and provide the multi-cast address that it will be using to multi-cast the audio and playback timing information, as well as its unicast network address. After the members of the synchrony group 20 receive the notification from the zone player 11(n') indicating that it is the new audio information channel device 23 for the synchrony group 20, they will receive the audio and playback timing information from the zone player I 11(n') instead of the zone player I 11(n), using the multi-cast address provided by the zone player 11(n'). In addition, they can utilize the zone player 11(n')'s unicast network address to obtain current time information therefrom. It will be appreciated that the zone player I 11(n') will determine its current time in relation to the time stamp that is provided by the zone player 11(n) (reference item (b) above) or the current time information that it received from the zone player 11(n) using the SNTP protocol as described above. The zone player 11(n') will process successive audio information files in the list that it receives from the zone player 11(n) (reference item (d)).

[0046] Operations performed by the zone players 11(n) and 11(n') in connection with migration of the audio information channel device 23 for other types of audio information will be apparent to those skilled in the art. In any case, preferably, the zone player 11(n) will continue operating as an audio information channel device 23 for the synchrony group 20 for at least a brief time after it notifies the zone player 11(n') that it is to become audio information channel device for the synchrony group, so that the zone player 11(n') will have time to notify the zone players in the synchrony group 20 that it is the new audio information channel device 23 for the synchrony group.

[0047] Before proceeding further in describing operations performed by the network audio system 10, it would be helpful to provide a detailed description of a zone player 11(n) constructed in accordance with the invention. FIG. 3 depicts a functional block diagram of a zone player 11(n) constructed in accordance with the invention. All of the zone players in the network audio system 10 may have similar construction. With reference to FIG. 3, the zone player 11(n) includes an audio information source interface 30, an audio information buffer 31, a playback scheduler 32, a digital to analog converter 33, an audio amplifier 35, an audio reproduction device interface 36, a network communications manager 40, and a network interface 41, all of which operate under the control of a control module 42. The zone player 11(n) also has a device clock 43 that provides timing signals that control the general operations of the zone player 11(n). In addition, the zone player 11(n) includes a user interface module interface 44 that can receive control signals from the user interface module 13 (FIGS. 1 and 2) for controlling operations of the zone player 11(n), and provide status information to the user interface module 13.

[0048] Generally, the audio information buffer 31 buffers audio information, in digital form, along with playback timing information. If the zone player 11(n) is operating as the audio information channel device 23 (FIG. 2) for a synchrony group 20, the information that is buffered in the audio information buffer 31 will include the audio and playback timing information that will be provided to the devices 21 and 22(g) in the synchrony group 20. If the zone player 11(n) is operating as the master device 21 or a slave device 22(g) for a synchrony group, the information that is buffered in the audio information buffer 31 will include the audio and playback timing information that the zone player 11(n) is to play.

[0049] The audio information buffer 31 can receive audio and playback timing information from two sources, namely, the audio information source interface 30 and the network communications manager 40. In particular, if the zone player 11(n) is operating as the audio information channel device 23 for a synchrony group 20, and if the audio information source is a source 14(n)(s) connected to the zone player I 11(n), the audio information buffer 31 will receive and buffer audio and playback timing information from the audio information source interface 30. On the other hand, if the zone player 11(n) is operating as the audio information channel device 23 for a synchrony group 20, and if the audio information source is a source 16(m) connected to the network 12, or a source available over the wide area network, the audio information buffer 31 will receive and buffer audio and playback timing information from the network communications manager 40. It will be appreciated that, if the zone player 11(n) is not a member of the synchrony group, the zone player 11(n) will not play this buffered audio and playback timing information.

[0050] On yet another hand, if the zone player 11(n) is operating as the master device 21 or a slave device 22(g) in a synchrony group, and if the zone player 11(n) is not also the audio information channel device 23 providing audio and playback timing information for the synchrony group 20, the audio information buffer 31 will receive and buffer audio and playback timing information from the network communications manager 40.

[0051] The audio information source interface 30 connects to the audio information source(s) 14(n)(s) associated with the zone player 11(n). While the zone player 11(n) is operating as audio information channel device 23 for a synchrony group 20, and if the audio information is to be provided by a source 14(n)(s) connected to the zone player 11(n), the audio information source interface 30 will selectively receive audio information from one of the audio information source(s) 14(n)(s) to which the zone player is connected and store the audio information in the audio information buffer 21. If the audio information from the selected audio information source 14(n)(s) is in analog form, the audio information source interface 30 will convert it to digital form. The selection of the audio information source 14(n)(s) from which the audio information source interface 30 receives audio information is under control of the control module 42, which, in turn, receives control information from the user interface module through the user interface module interface 44. The audio information source interface 30 adds playback timing information to the digital audio information and buffers the combined audio and playback timing information in the audio information buffer 21.

[0052] More specifically, as noted above, the audio information source interface 30 receives audio information from an audio information source 14(n)(s), converts it to digital form if necessary, and buffers it along with playback timing information in the audio information buffer 21. In addition, the audio information source interface 30 will also provide formatting and scheduling information for the digital audio information, whether as received from the selected audio information source 14(n)(s) or as converted from an analog audio information source. As will be made clear below, the formatting and scheduling information will control not only playback by the zone player 11(n) itself, but will also enable other zone players 11(n'), 11(n"),... that may be in a synchrony group for which the zone player 11(n) is the master device, to play the audio program associated with the audio information in synchrony with the zone player 11(n).

[0053] In one particular embodiment, the audio information source interface 30 divides the audio information associated with an audio work into a series of frames, with each frame comprising digital audio information for a predetermined period of time. As used herein, an audio track may comprise any unit of audio information that is to be played without interruption. On the other hand, an audio program may comprise a series of one or more audio tracks that are to be played in succession. It will be appreciated that the tracks comprising the audio program may also be played without interruption, or alternatively playback between tracks maybe interrupted by a selected time interval. FIG. 4 schematically depicts an illustrative framing strategy used in connection with one embodiment of the invention for a digital audio stream comprising an audio work. More specifically, FIG.4 depicts a framed digital audio stream 50 comprising a sequence of

frames 51(1) through 51(F) (generally identified by reference numeral 51(f)). Each frame 51(f), in turn, comprises a series of audio samples 52(f)(1) through 52(f)(S) (generally identified by reference numeral 52(f)(s)) of the audio track. Preferably all of the frames will have the same number "S" of audio samples, although it will be appreciated from the following that that is primarily for convenience. On the other hand, it will be appreciated that, the number of audio samples may differ from "S"; this may particularly be the case if the frame 51(f) contains the last audio samples for the digital audio stream for a particular audio work. In that case, the last frame 51(F) will preferably contain samples 52(F)(1) through 52(F)(x), where "x" is less than "S." Generally, it is desirable that the number of samples be consistent among all frames 51(f), and in that case padding, which will not be played, can be added to the last frame 51(F).

[0054] Associated with each frame 51(f) is a header 55(f) that includes a number of fields for storing other information that is useful in controlling playback of the audio samples in the respective frame 51(f). In particular, the header 55(f) associated with a frame 51(f) includes a frame sequence number field 56, an encoding type field 57, a sampling rate information field 58, a time stamp field 60, an end of track flag 61, and a length flag field 62. The header 55(f) may also include fields (not shown) for storing other information that is useful in controlling playback. Generally, the frame sequence number field 56 receives a sequence number "f" that identifies the relative position of the frame 51(f) in the sequence of frames 51(1)..51(f)...51(F) containing the digital audio stream 50. The encoding type field 57 receives a value that identifies the type of encoding and/or compression that has been used in generating the digital audio stream. Conventional encoding or compression schemes include, for example, the well-known MP3 and WAV encoding and/or compression schemes, although it will be appreciated that other schemes may be provided for as well. The sampling rate information field 58 receives sampling rate information that indicates the sampling rate for the audio samples 52(f)(s). As will be apparent to those skilled in the art, the sampling rate determines the rate at which the zone player 11(n) is to play the audio samples 52(f)(s) in the frame, and, as will be described below, determines the period of the digital to analog converter clock 34.

[0055] The condition of the end of work flag 61 indicates whether the frame 51(f) contains the last digital audio samples for the audio track associated with the framed digital audio work 50. If the frame 51(f) does not contain the audio samples that are associated with the end of the digital audio stream 50 for a respective audio work, the end of work flag will be clear. On the other hand, if the frame 51(f) does contain the audio samples that are associated with the end of the digital audio stream 50 for a respective audio work, the end of work flag 61 will be set. In addition, since the number of valid audio samples 52(F)(s) in the frame 51(F), that is, the samples that are not padding, may be less than "S," the default number of audio samples in a frame 51(f), the length flag field 62 will contain a value that identifies the number of audio samples in 52(F)(s) in the last frame 51(F) of the audio work 50. If, as noted above, the frames have a consistent number "S" of samples, the samples 52(F)(x+1) through 52(F)(S) will contain padding, which will not be played.

[0056] The time stamp field 60 stores a time stamp that identifies the time at which the zone player 11(n) is to play the respective frame. More specifically, for each frame of a framed digital audio stream 50 that is buffered in the audio information buffer 21, the audio information source interface 30, using timing information from the digital to analog converter clock 34, will determine a time at which the zone player 11(n) is to play the respective frame, and stores a time stamp identifying the playback time in the time stamp field 60. The time stamp associated with each frame will later be used by the playback scheduler 32 to determine when the portion of the digital audio stream stored in the frame is to be coupled to the digital to analog converter 33 to initiate play back. It will be appreciated that the time stamps that are associated with frames in sequential frames 51(1), 51(2),..., 51(F), will be such that they will be played back in order, and without an interruption between the sequential frames comprising the digital audio stream 50. It will further be appreciated that, after a time stamp has been determined for the first frame, stored in frame 51(1), of a digital audio stream 50, the audio information source interface 30 can determine time stamps for the subsequent frame 51(2), 51(3),...., 51 (F) in relation to the number of samples "S" in the respective frames and the sample rate. The time stamps will also preferably be such that frames will be played back after some slight time delay after they have been buffered in the audio information buffer 21; the purpose for the time delay will be made clear below.

[0057] Returning to FIG. 3, in addition to dividing the digital audio information into frames, the audio information source interface 30 also aggregates and/or divides the frames 51(f) as necessary into packets, each of which will be of a length that would fit into a message for transmission over the network, and associates each packet with a packet sequence number. For example, if a packet will accommodate multiple frames 51(f), 51(f+1),... 51(f+y-1), it will aggregate them into a packet and associate them with a packet number, for example p(x). If the entire frames 51(f) and 51(f+y-1) was accommodated in packet p(x), where "x" is the sequence number, which will occur if the size of a packet is an exact multiple of the frame size, the next packet, p(x+1) will begin with frame 51(f+y) and will include frames 51(f+y),..., 51(f+2y-1). Subsequent packets p(x+2),.... will be formed in a similar manner. On the other hand, if the packet length will not accommodate an exact multiple of the frame size, the last frame in the packet will be continued at the beginning of the next packet.

[0058] If the audio information source interface 30 is aware of track boundaries, which may be the case if the tracks are divided into files, the packets will reflect the track boundaries, that is, the packets will not contain frames from two tracks. Thus, if the last frames associated with a track are insufficient to fill a packet, the packet will contain padding

from the last frame associated with the track to the end of the packet, and the next packet will begin with the first frames associated with the next track.

[0059] In one embodiment, the audio information source interface 30 stores the packets in the audio information buffer 31 in a ring buffer. As is conventional, a ring buffer includes a series of storage locations in the buffer. Each entry will be sufficient to store one packet. Four pointers are used in connection with the ring buffer, a first pointer pointing to the beginning of the ring buffer, a second pointer pointing to the end of the ring buffer, an third "write" pointer pointing to the entry into which a packet will be written and a fourth "read" pointer pointing to the entry from which packet will be read for use in playback. When a packet is read from the ring buffer for playback, it will be read from the entry pointed to by the read pointer. After the packet has been read, the read pointer will be advanced. If the read pointer points beyond the end of the ring buffer, as indicated by the end pointer, it will be reset to point to the entry pointed to by the beginning pointer, and the operations can be repeated.

[0060] On the other hand, when the audio information source interface 30 stores a packet in the ring buffer, first determine whether the entry pointed to by the write pointer points to the same entry as the entry pointed to by the read pointer. If the write pointer points to the same entry as the entry pointed to by the read pointer, the entry contains at least a portion of a packet that has not yet been read for playback, and the audio information source interface 30 will delay storage of the packet until the entire packet has been read and the read pointer advanced. After the read pointer has been advanced, the audio information source interface 30 can store the packet in the entry pointed to by the write pointer. After the packet has been stored, the audio information source interface 30 will advance the write pointer. If the write pointer points beyond the end of the ring buffer, as indicated by the end pointer, it will be reset to point to the entry pointed to by the beginning pointer, and the operations can be repeated.

[0061] As noted above, the zone player 11(n) can operate both as an audio information channel device 23 and a member of the synchrony group 20 of which it is a member. In that case, the audio information buffer 31 can contain one ring buffer. On the other hand, the zone player 11(n) can operate as an audio information channel device 23 for one synchrony group 20(1) (FIG. 2A) and a member of another synchrony group 20(2). In that case, the audio information buffer 31 would maintain two ring buffers, one for the audio and timing information associated with synchrony group 20(1), and the other for the audio and timing information associated with synchrony group 20(2). It will be appreciated that, in the latter case, the zone player 11(n) will only use the audio and timing information that is associated with synchrony group 20(2) for playback.

[0062] The playback scheduler 32 schedules playback of the audio information that is buffered in the audio information buffer 31 that is to be played by the zone player 11(n). Accordingly, under control of the playback scheduler 32, the digital audio information that is buffered in the audio information buffer 21 that is to be played by the zone player 11(n) is transferred to the digital to analog converter 33 for playback. As noted above, if the zone player 11(n) is operating as an audio information channel device 23 for a synchrony group 20 for which it is not a member, the playback scheduler 32 will not schedule the digital audio information that is to be played by that synchrony group 20 for playback. The playback scheduler 32 only schedules the digital audio information, if any, that is buffered in the audio information buffer 31 that is associated with a synchrony group for which the zone player 11(n) is a member, whether as master device 21 or a slave device 22(g).

[0063] Essentially, the playback scheduler 32 makes use of the read pointer associated with the circular buffer that contains the audio and playback timing information that is to be played by the zone player 11(n). The playback scheduler 32 retrieves the packet information from the entry of the ring buffer pointed to by the read pointer, and then advances the ring pointer as described above. The playback scheduler 32 determines the boundaries of the frames in the packet and uses the time stamps in the time stamp fields 60 associated with the respective frame 51(f), along with timing information provided by the zone player 11(n)'s digital to analog converter clock 34, to determine when the respective frame is to be transferred to the digital to analog converter 33. Generally, when the time stamp associated with a buffered digital audio information frame corresponds to the current time as indicated by the digital to analog converter clock 34, the playback scheduler 32 will enable the respective frame to be transferred to the digital to analog converter 33.

[0064] The digital to analog converter 33, also under control of the digital to analog converter clock 34, converts the buffered digital audio information to analog form, and provides the analog audio information to the audio amplifier 35 for amplification. The amplified analog information, in turn, is provided to the audio reproduction devices 15(n)(r) through the audio reproduction device interface 36. The audio reproduction devices 15(n)(r) transform the analog audio information signal to sound thereby to provide the audio program to a listener. The amount by which the audio amplifier 35 amplifies the analog signal is controlled by the control module 42, in response to volume control information provided by the user through the user interface module 13.

[0065] The network communications manager 40 controls network communications over the network 12, and the network interface 41 transmits and receives message packets over the network 12. The network communications manager 40 generates and receives messages to facilitate the transfer of the various types of information described above in connection with FIG. 2, including the channel device control information, slave device control information, audio and playback timing information and the audio information channel device's clock timing information. In connection with the

channel device control information and the slave device control information, the network communications manager 40 will generate messages for transfer over the network 12 in response to control information from the control module 42. Similarly, when the network communications manager 40 receives messages containing channel device control information and slave device control information, the network communications manager will provide the information to the control module 42 for processing.

[0066] With regards to the audio information channel device's clock timing information, as noted above, the master device 21 and slave devices 22(g) of the synchrony group 20 obtain the clock timing information from the audio information channel device 23 using the well-known SNTP. If the zone player 11(n) is operating as the audio information channel device 23 for a synchrony group, during the SNTP operation, it will provide its current time, particularly a current time as indicated by its digital to analog converter clock 34. On the other hand, if the zone player 11(n) is operating as the master device 21 or slave device 22(g) of a synchrony group 20, it will receive the clock timing information from the audio information channel device 23. After the respective device 21, 22(g) has obtained the audio information channel device's clock timing information, it will generate a differential time value AT representing the difference between the time T indicated by its digital to analog converter clock 34 and the current time information from the audio information channel device 23. The differential time value will be used to update the time stamps for the frames of the digital audio stream 50 (FIG. 4) that are received from the audio information channel device.

[0067] With regards to the audio and playback timing information, operations performed by the network communications manager 40 will depend on whether

(i) the audio and playback timing information has been buffered in the audio information buffer 31 for transmission, as audio information channel device 23, over the network 12 to the master device 21 and/or slave devices 22(g) of a synchrony group, or

(ii) the audio and playback timing information has been received from the network 12 to be played by the zone player 11(n) as either the master device 21 for a synchrony group or a slave device in a synchrony group.

[0068] It will be appreciated that the network communications manager 40 may be engaged in both (i) and (ii) contemporaneously, since the zone player 11(n) may operate both as the audio information channel device 23(1) for a synchrony group 20(1) (reference FIG. 2A) of which it is not a member, and a member of another synchrony group 20(2) for which another zone player 11(n') is the audio information channel device 23(2). With reference to item (i) above, after a packet that is to be transmitted has been buffered in the respective ring buffer, the network communications manager 40 retrieves the packet, packages it into a message and enables the network interface 41 to transmit the message over the network 12. If the control module 42 receives control information from the user interface module 13 (if the master device 21 is also the audio information channel device 23 for the synchrony group 20) or from the master device (if the master device 21 is not the audio information channel device 23 for the synchrony group 20) that would require the transmission of a "resynchronize" command as described above, the control module 42 of the audio information channel device 23 enables the network communications manager 40 to insert the command into a message containing the audio and playback timing information. Details of the operations performed in connection with the "resynchronize" command will be described below. As noted above, the "resynchronize" command is used if the user enables a synchrony group to terminate the playback of a track that is currently being played, or cancel playback of a track whose playback has not begun.

[0069] On the other hand, with reference to item (ii) above, if network interface 41 receives a message containing a packet containing frames of audio and playback timing information that the zone player 11(n) is to play either as a master device 21 or a slave device for a synchrony group 20, the network interface 41 provides the audio and playback timing information to the network communications manager 40. The network communications manager 40 will determine whether the packet contains a resynchronize command and, if so, notify the control module 42, which will enable operations to be performed as described below. In any case, the network communications manager 40 will normally buffer the various frames comprising the audio and playback timing information in the audio information buffer 31, and in that operation will generally operate as described above in connection with the audio information source interface 30. Before buffering them, however, the network communications manager 40 will update their time stamps using the time differential value described above. It will be appreciated that the network communications manager 40 will perform similar operations whether the messages that contain the packets were multi-cast messages or unicast messages as described above

[0070] The updating of the time stamps by the master device 21 and the slave devices 22(g) in the synchrony group 20 will ensure that they all play the audio information synchronously. In particular, after the network communications manager 40 has received a frame 51(f) from the network interface 41, it will also obtain, from the digital to analog converter clock 34, the zone player 11(n)'s current time as indicated by its digital to analog converter clock 34. The network communications manager 40 will determine a time differential value that is the difference between the slave device's current clock time, as indicated by its digital to analog converter 34, and the audio information channel device's time as indicated by the audio information channel device's clock timing information. Accordingly, if the master or slave

device's current time has a value T_S and the audio information channel device's current time, as indicated by the clock timing information, has a value T_C, the time differential value $\Delta T=T_S-T_C$. If the current time of the master or slave device in the synchrony group 20, as indicated by its digital to analog converter clock 34, is ahead of the audio information channel device's clock time as indicated by the clock timing information received during the SNTP operation, the time differential value will have a positive value. On the other hand, if the master or slave device's current time is behind the audio information channel device's clock time, the time differential value ΔT will have a negative value. If the zone player 11(n) obtains clock timing information from the audio information channel device 23 periodically while it is a member of the synchrony group 20, the network communications manager 40 can generate an updated value for the time differential value AT when it receives the clock timing information from the audio information channel device 23, and will subsequently use the updated time differential value.

[0071] The network communications manager 40 uses the time differential value AT that it generates from the audio information channel device timing information and zone player 11(n)'s current time to update the time stamps that will be associated with the digital audio information frames that the zone player 11(n) receives from the audio information channel device. For each digital audio information frame that is received from the audio information channel device, instead of storing the time stamp that is associated with the frame as received in the message in the audio information buffer 21, the network communications manager 40 will store the updated time stamp with the digital audio information frame. The updated time stamp is generated in a manner so that, when the zone player 11(n), as a member of the synchrony group plays back the digital audio information frame, it will do so in synchrony with other devices in the synchrony group.

[0072] More specifically, after the zone player 11(n)'s network interface 41 receives a message containing a packet that, in turn, contains one or more frames 51(f), it will provide the packet to the network communications manager 40. For each frame 51(f) in the packet that the network communications manager 40 receives from the network interface 41, the network communications manager 40 will add the time differential value AT to the frame's time stamp, to generate the updated time stamp for the frame 51(f), and store the frame 51(f), along with the header 55(f) with the updated time stamp in the audio information buffer 31. Thus, for example, if a frame's time stamp has a time value T_F, the network communications manager 40 will generate an updated time stamp T^U_F having a time value $T^U_F=T_F+\Delta T$. Since time value T^U_F according to the slave device's digital to analog converter clock 34 is simultaneous to the time value T_F according to the audio information channel device's digital to analog converter clock 34, the zone player 11(n) device will play the digital audio information frame at the time determined by the audio information channel device 23. Since all of the members of the synchrony group 20 will perform the same operations, generating the updated time stamps T^U_F for the various frames 51(f) in relation to their respective differential time values, all of the zone players 11(n) in the synchrony group 20 will play them synchronously. The network communications manager 40 will generate updated time stamps T^U_F for all of the time stamps 60 in the packet, and then store the packet in the audio information buffer 31.

[0073] It will be appreciated that, before storing a packet in the audio information buffer 21, the network communications manager 40 can compare the updated time stamps T^U_F associated with the frames in the packet to the slave device's current time as indicated by its digital to analog converter clock 34. If the network communications manager 40 determines the time indicated by the updated time stamps of frames 51(f) in the packet are earlier than the zone player's current time, it can discard the packet instead of storing it in the audio information buffer 21, since the zone player 11(n) will not play them. That is, if the updated time stamp has a time value T^U_F that identifies a time that is earlier than the zone player's current time T_S as indicated by the zone player's digital to analog converter clock 34, the network communications manager 40 can discard the packet.

[0074] If the zone player 11(n) is operating as the master device 21 of a synchrony group 20, when the user, through the user interface module 13, notifies the zone player 11(n) that another zone player 11(n') is to join the synchrony group 20 as a slave device 22(g), the control module 42 of the zone player 11(n) enables the network communications manager 40 to engage in an exchange of messages, described above in connection with FIG. 2, to enable the other zone player 11(n') to join the synchrony group 20 as a slave device. As noted above, during the message exchange, the messages generated by the network communications manager 40 of the zone player 11(n) will provide the network communications manager of the zone player 11(n') that is to join the synchrony group 20 with information such as the multi-cast address being used by the audio information channel device 23 that is providing the audio program to the synchrony group 20, as well as a unicast network address for the audio information channel device 23. After receiving that information, the network communications manager and network interface of the zone player 11(n') that is to join the synchrony group 20 can begin receiving the multi-cast messages containing the audio program for the synchrony group, engage in SNTP transactions with the audio information channel device 23 to obtain the latter's current time, and also enable the audio information channel device 23 to send the zone player 11(n') frames 51(f) that it had previously broadcast using the unicast message transmission methodology as described above.

[0075] On the other hand, if the network communications manager 40 and network interface 41 of the zone player 11(n) receive a message over the network 12 indicating that it is to become a slave device 22(g) of a synchrony group for which another zone player 11(n') is the master device, the network communications manager 40 for zone player

11(n) will provide a notification to the control module 42 of zone player 11(n). Thereafter, the control module 42 of zone player 11(n) can enable the network communications manager 40 of zone player 11(n) to perform the operations described above to enable it to join the synchrony group 20.

[0076] As noted above, the user, using user interface module 13, can enable the synchrony group to terminate playback of a track of an audio program that is currently being played. After playback of a track that is currently being played has been terminated, playback will continue in a conventional manner with the next track that has been buffered in the audio information buffer 31. It will be appreciated that that could be the next track that is on the original play list, or a previous track. In addition, the user can enable the synchrony group 20 to cancel playback of a track that it has not yet begun to play, but for which buffering of packets has begun in the synchrony group 20. Both of these operations make use of the "resynchronize" command that the master device 21 of the synchrony group 20 can enable the audio information channel device 23 to include in the multi-cast message stream that it transmits to the synchrony group 20. Generally, in response to receipt of the resynchronize command, the members of the synchrony group 20 flush the ring buffer containing the packets that they are to play in the future. In addition, if the members of the synchrony group provide separate buffers for their respective digital to analog converters 33, the members will also flush those buffers as well. After the audio information channel device transmits a packet containing the resynchronize command:

(i) in the case of the use of the resynchronize command to terminate playing of a track that is currently being played, the audio information channel device 23 will begin multi-casting packets for the next track, to begin play immediately, and will continue through the play list in the manner described above; and

(ii) in the case of the use of the resynchronize command to cancel play of a track for which buffering has begun, but which is to be played in the future, the audio information channel device 23 will begin multi-casting packets for the track after the track that has been cancelled, to be played beginning at the time the cancelled track was to begin play, and will also continue through the play list in the manner described above.

It will be appreciated that,

(a) in the first case (item (i) directly above), the resynchronize command can enable the read pointer to be set to point to the entry in the circular buffer into which the first packet for the next track will be written, which will correspond to the entry to which the write pointer points, but

(b) in the second case (item (ii) directly above), the resynchronize command can enable the write pointer for the circular buffer to be set to point to the entry that contains the first packet for the track whose play is being cancelled.

It will further be appreciated that, if a track is cancelled for which buffering has not begun, the resynchronize command will generally not be necessary, since the audio information channel device 23 for the synchrony group 20 need only delete that track from the play list.

[0077] Operations performed in connection with use of the resynchronize command to cancel playback of a track that is currently being played will be described in connection with Packet Sequence A below, and operations performed in connection with the use of the resynchronize command to cancel playback of a track that is has not yet begun to play, but for which buffering of packets has begun, will be described in connection with Packet Sequence B below.

Packet Sequence A

[0078]

(A1.0) [packet 57]
(A1.1) [continuation of frame 99]
(A1.2) [frame 100, time = 0:00:01, type = mp3 audio]
(A1.3) [frame 101, time = 0:00:02, type = mp3 audio]
(A1.4) [frame 102, time = 0:00:03, type = mp3 audio]

(A2.0) [packet 58]
(A2.1) [continuation of frame 102]
(A2.2) [frame 103, time = 0:00:04, type = mp3 audio]
(A2.3) [frame 104, time = 0:00:05, type = mp3 audio]
(A2.4) [frame 105, time = 0:00:06, type = mp3 audio]

(continued)

(A3.0) [packet 59]
(A3.1) [continuation of frame 105]
(A3.2) [frame 106, time = 0:00:07, type = mp3 audio]
(A3.3) [frame 107, time = 0:00:08, type = mp3 audio]
(A3.4) [frame 108, time = 0:00:09, type = mp3 audio]
(A4.0) [packet 60]
(A4.1) [continuation of frame 108]
(A4.2) [frame 109, time = 0:00:10, type = mp3 audio]
(A4.3) [Resynchronize command]
(A4.4) [Padding, if necessary]

(A5.0) [packet 61]
(A5.1) [frame 1, time = 0:00:07, type = mp3 audio]
(A5.2) [frame 2, time = 0:00:08, type = mp3 audio]
(A5.3) [frame 3, time = 0:00:09, type = mp3 audio]
(A5.4) [frame 4, time = 0.00.10, type = mp3 audio]

(A6.0) [packet 62]
(A6.1) [continuation of frame 4]
(A6.2) [frame 5, time = 0:00:11, type = mp3 audio]
(A6.3) [frame 6, time = 0:00:12, type = mp3 audio]
(A6.4) [frame 7, time = 0:00:13, type = mp3 audio]

[0079] Packet Sequence A comprises a sequence of six packets, identified by packet 57 through packet 62, that the audio information channel device 23 multi-casts in respective messages to the members of a synchrony group 20. It will be appreciated that the series of messages that the audio information channel device 23 may multi-cast to the synchrony group 20 may include a messages prior to the packet 57, and may also include messages after packet 62. Each packet comprises a packet header, which is symbolized by lines (A1.0), (A2.0),...(A6.0) in Packet Sequence A, and will generally also include information associated with at least a portion of a frame. In the packets represented in Packet Sequence A, each packet includes information associated with a plurality of frames. Depending on the lengths of the packets, each packet may contain information associated with a portion of a frame, an entire frame, or multiple frames. In the illustration represented by Packet Sequence A, it is assumed that each packet may contain information associated with multiple frames. In addition, it is assumed that a packet does not necessarily contain information associated with an integral number of frames; in that case, a packet may contain information associated with a portion of a frame, and the next packet will contain the information associated with the rest of a frame.

[0080] The frames and associated header playback timing information contained in the various packets are symbolized by lines (A1.1), (A1.2),..., (A1.4), (A2.1),.... (A6.4) of Packet Sequence A. Thus, for example, line (A1.2) of packet 57 represents the one-hundredth frame, that is, frame 51(100) (reference FIG.4), of the track whose audio information is being transmitted in the sequence of packets that includes packet 57. The frame 51 (100) is to be played at an illustrative time, according to the audio information channel device's digital to analog converter clock, of "time=0:00:01," and the frame is encoded and/or compressed using the well-know MP3 encoding and compression methodology. In that case, the legend "time = 0:00:01" represents the time stamp that would be included in field 60 (FIG. 4) of the header associated with the frame 50(100) as multi-cast by the audio information channel device for the synchrony group. It will be appreciated that the playback time and encoding/compression methodology will be referred in the header 55(100) that is associated with the frame 51(100). It will also be appreciated that the header may also contain additional information as described above.

[0081] Similarly, line (A1.3) of packet 57 represents the one-hundred and first frame, that is, frame 51(101), of the track whose audio information is being transmitted in the sequence of packets that includes packet 57. The frame 51(101) is to be played at an illustrative time, according to the audio information channel device's digital to analog converter clock, of "0:00:02," and the frame is also encoded and/or compressed using the MP3 encoding and compression methodology. Line (A1.4) of packet 57 represents similar information, although it will be appreciated that, depending on the length of packet 57, the line may not represent the information for an entire frame 51(102) and/or its associated header. If the length of packet 57 is not sufficient to accommodate the information for the entire frame 51(102) and/or associated header, the information will continue in packet 58, as represented by line (A2.1) in Packet Sequence A. Similarly, if the

length of packet 56 was not sufficient to contain the information for an entire frame 51(99) preceding frame 51(100), packet 57 (lines (A1.0) through 1.4) may contain any information from frame 51 (99) that packet 56 was unable to accommodate.

[0082] As noted above, when the master device 21 or a slave device 22(g) in the synchrony group 20 receives the packet 57, its respective network communications manager 40 will update the time stamps associated with the various frames 51(f) as described above before buffering the respective frames in the respective audio information buffer 31.

[0083] Packets 58 and 59 contain information that is organized along the lines described above in connection with packet 57.

[0084] Packet 60 also contains, as represented by lines (A4.1) and (A4.2), information that is organized along the lines of the information represented by lines (Ax.1) and (Ax.2) ("x" equals an integer) described above in connection with packets 57 through 59. On the other hand, packet 60 contains a resynchronize command, as represented by line (A4.3). Packet 60 also may contain padding, as represented by line 4.4, following the resynchronize command. As noted above, the master device 21 of a synchrony group 20 will enable the audio information channel device 23 that is providing audio information to the synchrony group 20 to multi-cast a message containing the resynchronize command when it receives notification from the user interface module 13 that the user wishes to cancel playback of a track that is currently being played. In the example depicted in Packet Sequence A, as will be described below, the audio information channel device 23 receives notification from the master device 21 that the user wishes to cancel playback of a track at a time corresponding to "time = 0:00:07" according to its digital to analog converter clock 34, and, in line (A4.3) of packet 60 it will provide the resynchronize command, followed by padding, if necessary.

[0085] As will be apparent from examining lines (A3.1) through (A3.4) of packet 59 and lines (A4.1) and (A4.2) of packet 60, although the audio information channel device 23 has received the notification from the synchrony group's master device 21 to multi-cast the resynchronize command at a time corresponding to "time = 0:00:07" according to the clock time indicated by its digital to analog converter clock 34, it (that is, the audio information channel device 23) has already multi-cast messages containing frames that are to be played at that time and subsequently. That is, the audio information channel device 23 has, multi-cast in packet 59, frames 51(106) through 51(108) that contain time stamps "time = 0:00:07," "time = 0:00:08" and "time = 0:00:09," respectively, and, in packet 60, in addition to the continuation of frame 51(108), frame 51(109) that contains time stamp "time = 0:00:10." (It will be appreciated that the times indicated by the illustrative time stamps are for illustration purposes only, and that in an actual embodiment the time stamps may have different values and differentials.)

[0086] As noted above, the audio information channel device 23 multi-casts a message containing a packet that, in turn, contains the resynchronize command when it receives the notification from the master device 21 to do so. In the example depicted in Packet Sequence A, the packet will be multi-cast when the audio information channel device's digital to analog converter clock time corresponds to"0:00:07." Subsequently, two things happen. In one, aspect, when the master device 21 and slave devices 22(g) receive the packet that contains the resynchronize command, they will stop playing the audio program that they are playing.

[0087] In addition, the audio information channel device 23 will begin transmitting frames containing audio information for the next track, including therewith time stamps immediately following the digital to analog converter clock time at which the packet including the resynchronize command was transmitted. Accordingly, and with further reference to Packet Sequence A, the audio information channel device 23 will multi-cast a message containing packet 61. As indicated above, packet 61 contains, as represented in lines (A5.1) through (A5.3), frames 51(1) through 51(3), which are the first three frames of the next track of the audio program that is to be played. It is also compressed and encoded using the MP3 encoding and compression scheme, and it is accompanied by time stamps "time = 0:00:07," "time = 0:00:08" and "time = 0:00:10." As noted above, the time stamp "time=0:00:07" corresponds to the clock time at which the audio information channel device 23 multi-casts the resynchronize command, and, when the master device 21 and slave devices 22(g) receive these frames, they would be expected to begin playing them very shortly, if not immediately after the audio information channel device 23 multi-casts the message containing the packet that, in turn, contains the resynchronize command. Packet 61 also includes at least a portion of the next frame, that is, frame 51(4), for that track. In addition, Packet Sequence A depicted above further includes a subsequent packet, namely, packet 62, that contains any necessary continuation of frame 51 (4), as well as three subsequent frames. If any additional packets are required for the track, as well as for subsequent tracks, they can be multi-cast in a similar manner.

[0088] As further noted above, the resynchronize command can also be used to cancel playing of one or more tracks for which playback has begun. This will be illustrated in connection with Packet Sequence B :

Packet Sequence B

[0089]

(B1.0) [packet 157]
(B1.1) [continuation of frame 99]
(B1.2) [frame 100, time = 0:00:01, type = mp3 audio]
(B1.3) [frame 101, time = 0:00:02, type = mp3 audio]
(B1.4) [frame 102, time = 0:00:03, type = mp3 audio]

(B2.0) [packet 158]
(B2.1) [continuation of frame 102]
(B2.2) [frame 103, time = 0:00:04, type = mp3 audio]
(B2.3) [frame 104, time = 0:00:05, type = mp3 audio]
(B2.4) [frame 105, time = 0:00:06, type = mp3 audio]

(B3.0) [packet 159]
(B3.1) [continuation of frame 105]
(B3.2) [frame 106, time = 0:00:07, type = mp3 audio]
(B3.3) [track boundary notification]
(B3.4) [Padding, if necessary]

(B4.0) [packet 160]
(B4.1) [frame 1, time = 0:00:08, type = mp3 audio]
(B4.2) [frame 2, time = 0:00:09, type = mp3 audio]
(B4.3) [frame 3, time = 0:00:10, type = mp3 audio]

(B5.0) [packet 161]
(B5.1) [continuation of frame 3]
(B5.2) [frame 4, time = 0:00:11, type = mp3 audio]
(B5.3) [Resynchronize, after packet 159]
(B5.4) [Padding, if necessary]

(B6.0) [packet 162]
(B6.1) [frame 1, time = 0:00:08, type = mp3 audio]
(B6.2) [frame 2, time = 0:00:09, type = mp3 audio]
(B6.3) [frame 3, time = 0:00:10, type = mp3 audio]
(B6.4) [frame 4, time = 0:00:11, type = mp3 audio]

(B7.0) [packet 163]
(B7.1) [continuation of frame 4]
(B7.2) [frame 5, time = 0:00:12, type = mp3 audio]
(B7.3) [frame 6, time = 0:00:13, type = mp3 audio]
(B7.4) [frame 7, time = 0:00:14, type = mp3 audio]

[0090] Packet Sequence B comprises a series of seven packets, identified by packet 157 through 163 , that the audio information channel device 23 multi-casts to the members of a synchrony group 20. As with Packet Sequence A, it will be appreciated that the series of packets that the audio information channel device 23 may multi-cast to the synchrony group 20 may include packets prior to the packet 157, and may also include packets after packet 162. Each packet comprises a packet header, which is symbolized by lines (B1.0), (B2.0),... (B7.0) in Packet Sequence B. As in Packet Sequence A, each packet will also generally include information associated with at least a portion of a frame 51(f) along with its associated frame 55(f). As in the packets represented in Packet Sequence A, each packet includes information associated with a plurality of frames. Depending on the lengths of the packets, each packet may contain information associated with a portion of a frame, an entire frame, or multiple frames. Further, as with Packet Sequence A, it is assumed that each packet may contain information associated with multiple frames. In addition, it is assumed that a packet does not necessarily contain information associated with an integral number of frames; in that case, a packet

may contain information associated with a portion of a frame, and the next packet will contain the information associated with the rest of a frame.

[0091] The structures of the packets represented by Packet Sequence B are similar to those described above in connection with Packet Sequence A, and will not be repeated here. Generally, Packet Sequence B illustratively contains a sequence of packets that represent at least portions of three tracks that may have been selected from, for example, a play list. In particular, packets 157 through 159 represent frames from a portion of one track, packets 160 and 161 represent frames from a second track and packets 162 and 163 represent frames from a third track. The play list indicated that the first, second and third tracks were to be played in that order. With particular reference to Packet Sequence B, it should be noted that line (B3.3) indicates that packet 159 includes an indication that that packet contains the last frame for the track, and line (B3.4) provides for padding to the end of the packet. The first frame of the next track begins in packet 160.

[0092] In connection with the use of the resynchronize command to cancel playback of a track, at least a portion of which the audio information channel device 23 has multi-cast to the members of the synchrony group, packet 161, in line (B5.3) represents a resynchronize command that indicates that resynchronization is to occur after packet 159, that is, immediately after the packet that contains the last frame of the first of the three tracks represented by the packets in Packet Sequence B. It should be noted that the resynchronize command is in the packet 161, while the resynchronization is to occur at packet 160, that is, the synchrony group is to not play the track starting with packet 160, but instead is to begin playing the track frames for which begin with the next packet, that is, packet 162. As with Packet Sequence A, in Packet Sequence B the audio information channel device 23, in packet 162 and 163, multi-casts frames whose time stamps indicate that they are to be played when the frames that were multi-cast in packets 160 and 161 were to be played. By use of the resynchronize command and specifying a packet in this manner, the audio information channel device can cancel playback of a track for which playback has not yet begun.

[0093] It will be appreciated that the resynchronize command is generally not necessary for cancelling play back of a track that the audio information channel device 23 has not started multi-casting to the synchrony group 20, since the audio information channel device 23 itself can re-order the play list to accommodate the cancellation.

[0094] The invention provides a number of advantages. In particular, the invention provides a network audio system in which a number of devices share information can reproduce audio information synchronously, notwithstanding the fact that packets, which may contain digital audio information, transmitted over the network to the various zone players connected thereto may have differing delays and the zone players operate with independent clocks. Moreover, although the invention has been described in connection with audio information, it will be appreciated that the invention will find utility in connection with any type of isochronous information for which synchrony among devices is desired. The system is such that synchrony groups are created and destroyed dynamically, and in such a manner as to avoid requiring a dedicated device as the master device.

[0095] It will be appreciated that a number of changes and modifications may be made to the network audio system 10 as described above. For example, although the invention has been described as providing that the audio information channel device 23 provides digital audio information to the members synchrony group 20 that has been encoded using particular types of encoding and compression methodologies, it will be appreciated that the audio information channel device 23 can provide digital audio information to various members of the synchrony group 20 that have been encoded and compressed using different types of encoding and compression methodologies, and, moreover, for which different sampling rates have been used. For example, the audio information channel device 23 may provide digital audio information to the master device 21 and slave devices 22(1) through 22(g_1) using the MP3 methodology at a specified sampling rate, the digital audio information for the same program to slave devices 22(g_1+1) through 22(g_2) using the WAV methodology at one specified sampling rate, and to slave devices 22(g_2+1) through 22(G) using the WAV methodology at another specified sampling rate. In that case, the audio information channel device 23 can specify the particular encoding and compression methodology that has been used in the encoding type field 57 associated with each frame and the sampling rate in the sampling rate field 58. Moreover, since the encoding and compression type and sampling rate are specified for each frame, the encoding and compression type and sampling rate can be changed from frame to frame. The audio information channel device 23 may use different multi-cast addresses for the different encoding and compression types and sampling rates, but it will be appreciated that that would not be required.

[0096] It will be appreciated that two advantages of providing that the encoding and compression methodology and the sampling rate is provided on a frame-by-frame basis, instead of on, for example, a track-by-track basis, is that that would facilitate a slave device joining the synchrony group 20 at a frame mid-track, without requiring, for example, the master device 21 or the audio information channel device 23 to notify it of the encoding and compression methodology or the sampling rate.

[0097] Another modification is that, instead of the network communications manager 40 of a member of a synchrony group 20 generating the updated time stamp T^u_F for a digital audio information frame by adding the time differential value AT to the time stamp T_F associated with a frame, the network communications manager 40 may instead generate the updated time stamp T^U_F by subtracting the differential time value AT from the member's current time T_S as indicated

by the member's digital to analog converter clock 34 at the time at which the digital audio information is received. It will be appreciated, however, that there may be variable time delays in processing of messages by the slave device's network communications manager 40, and so it may be preferable to generate the time differential value AT using the time stamp T_F provided by the audio information channel device 23.

[0098] In addition, instead of the network communications manager 40 of a member of a synchrony group generating an updated time stamp to reflect the difference between the times indicated by the member's digital to analog converter clock and the audio information channel device's digital to analog converter clock, the network communications manager 40 can generate the time differential value AT and provide it to the member's playback scheduler 32. In that case, the member's network communications manager 40 can store each digital audio information frame along with the time stamp T_F as received from the master device in the audio information buffer 21. The playback scheduler 32 can utilize the time differential value ΔT, and the time stamps T_F associated with the digital audio information frames, to determine when the respective digital audio information frames are to be played. In determining when a digital audio information frame is to be played, the playback scheduler can add the time differential value to the time stamp T_F associated with the digital audio frame, and enable the digital audio frame to be coupled to the digital to analog converter 33 when the time indicated by the sum corresponds to the current time as indicated by the slave device's digital to analog converter clock 34. Alternatively, when the member's digital to analog converter clock 34 updates its current time T_S, the playback scheduler can generate an updated current time T'_S by subtracting the differential time value AT from the current time T_S, and using the updated current time T'_S to determine when to play a digital audio information frame.

[0099] As described above, the members of a synchrony group 20 periodically obtain the audio information channel device's current time value and uses the current time value that it receives from the audio information channel device to periodically update the time differential value AT that it uses in updating the time stamps associated with the various frames. It will be appreciated that, if the digital to analog converter clock(s) associated with the member(s) of a synchrony group 20 are ensured to have the same rate as the digital to analog converter clock, a member need only obtain the current time value from the audio information channel device once, at the beginning of playback.

[0100] As another alternative, if the zone players are provided with digital to analog converter clock 34 whose time and rate can be set by an element such as the network communications manager 40, when a zone player 11(n) is operating as a member of a synchrony group 20, its network communications manager 40 can use the various types of timing information that it receives from the audio information channel device 23, including the current time information and the playback timing information indicated by the time stamps that are associated with the various frames 51(f) comprising the audio and playback timing information that it receives, to adjust the synchrony group member's digital to analog converter clock's time value and/or the clock rate that it uses for playback.

[0101] If the clock's time value is to be adjusted, when the synchrony group member's network communications manager 40 initially receives the current time information from the audio information channel device 23 for the synchrony group 20, the network communications manager 40 can set the synchrony group member's digital to analog converter clock 34 to the current time value as indicated by the audio information channel device's current time information. The network communications manager 40 can set the clock 34 to the current time value indicated by the audio information channel device's current time information once, or periodically as it receives the current time information.

[0102] Alternatively or in addition, the synchrony group member's network communications manager 40 can use one or both of the current time information and/or the playback timing information in the time stamps associated with the respective frames 51(f) to adjust the clock rate of the clock 34 that it uses for playback. For example, when the synchrony group member's network communications manager 40 receives a frame 51(f_X) having a time stamp having a time value T_{fx}, it can generate the updated time value $T^U_{fx} = T_{fx} + \Delta T$ as described above, and store the frame
with the time stamp with the updated time value in the audio information buffer 30. In addition, since both the number of samples in a frame and the sampling rate, which determines the rate at which the frame is to be played, are known to the network communications manager 40, it can use that information, along with the updated time value T^U_{Fx} that is to be used for frame 51(f_X) to generate an expected updated time value T^E_{fx+1}, that is expected for the updated time stamp of the next frame 51(f_{x+1}). After the synchrony group member's network communications manager 40 receives the next frame 51(f_{x+1}), it can generate the updated time value T^U_{fx+1} and compare that value to the expected updated time value T^E_{fx+1}. If the two time values do not correspond, or if
the difference between them is above a selected threshold level, the clock that is used by the audio information channel device 23 to generate the time stamps is advancing at a different rate than the synchrony group member's digital to analog converter clock 34, and so the network communications manager 40 can adjust the rate of the digital to analog converter clock 34 to approach that of the clock used by the audio information channel device 23 so that the differential time value AT is constant. On the other hand, if the two time values do correspond, then the time differential value AT is constant, or the difference is below a threshold level, and the network communications manager 40 need not change the clock rate of the digital to analog converter clock 34. It will be appreciated that, if the clock rate is to be adjusted, the rate adjustment can be fixed, or it can vary based on, for example, the difference between the updated time value T^U_{fx+1}, and the expected

updated time value T^E_{fx+1}.

[0103] It will also be appreciated that, if no rate adjustment is performed for one frame 51 (f_{X+1}), the synchrony group member's network communications manager 40 can generate an expected updated time value T^E_{fx+2} that is expected for the updated time stamp of the next frame 51(f_{X+2}) using the updated time value T^U_{Fx} determined for frame 51(f_X), along with the number of samples in a frame and the sampling rate, and compare the expected updated time value T^E_{fx+2} to the updated time value T^U_{fx+2} that it generates when it receives frame 51(f_{X+2}). At that point, if the network communications manager 41 determines that two time values do not correspond, or if the difference between them is above a selected threshold level, it can adjust the rate of the digital to analog converter clock 34. Similar operations can be performed if no rate adjustment is performed for several successive frames 51(f_{X+1}), 51(f_{X+2}),.... This will accommodate the possibility that the rate differential between the clock 34 and the clock used by the audio information channel device 23 in generating the time stamps have rates that differ by an amount sufficiently small that it cannot be detected using time stamps of two or more successive frames.

[0104] Instead or in addition to adjusting the clock rate as described above, the synchrony group member's network communications manager 40 can perform similar operations in connection with adjusting the clock rate in connection with the current time information that it receives from the audio information channel device 23.

[0105] Furthermore, although the network audio system 10 has been described such that the master device 21 of a synchrony group 20 can, in response to control information provided thereto by a user through the user interface module 13, provide a notification to a zone player 11(n) that it is to become a member of its synchrony group 20 as a slave device 22(g), it will be appreciated that the user interface module 13 can provide the notification directly to the zone player 11(n) that is to become a member of the synchrony group 20. In that case, the zone player 11(n) can notify the master device 21 that it is to become a slave device 22(g) in the synchrony group 20, after which the master device 21 can provide information regarding the synchrony group 20, including the multi-cast and unicast addresses of the audio information channel device and other information as described above.

[0106] Similarly, although the network audio system 10 has been described such that the master device 21 of a synchrony group 20 can, in response to control information provided thereto by a user through the user interface module 13, provide a command to a slave device 22(g) to enable the slave device 22(g) to adjust its volume, it will be appreciated that the user interface module 13 can provide control information directly to the slave device 22(g) to enable the slave device 22(g) to adjust its volume.

[0107] In addition, although the network audio system 10 has been described such that each frames 51(f) is associated with a frame sequence number (reference field 56, FIG. 4), it will be appreciated that, if the packets described above in connection with Packet Sequence A and Packet Sequence B are provided with packet sequence numbers, the frame sequence numbers need not be provided, since the packet sequence numbers can suffice for defining the frame sequencing.

[0108] Furthermore, although the network audio system 10 has been described such that the zone players 11(n) are provided with an audio amplifier 35 for amplifying the analog signal provided by the respective digital to analog converters 33, it will be appreciated that a zone player may be provided that does not itself include an audio amplifier. In that case, the analog signal may be coupled to an external amplifier for amplification as necessary before being provided to the audio reproduction device(s) 15(n)(r). It will be appreciated that a single zone player 11(n) may be provided with multiple audio amplifiers and audio reproduction device interfaces, and, if necessary, multiple digital to analog converters 33, to provide audio programs for corresponding numbers of synchrony groups.

[0109] Similarly, although the zone players 11(n) have been described such that they may be connected to one or more audio information sources, it will be appreciated that an audio information source may form part of and be integrated into a zone player 11(n). For example, a zone player may include a compact disk player, cassette tape player, broadcast radio receiver, or the like, that has been integrated into it. In addition, as noted above, an individual zone player 11(n) may be connected to multiple audio information sources and may contemporaneously operate as the audio information channel device 23 for multiple synchrony groups.

[0110] In addition, although FIG. 1 shows the network audio system 10 as including one user interface module 13, it will be appreciated that the system 10 may include a plurality of user interface modules. Each user interface module be useful for controlling all of the zone players as described above, or alternatively one or more of the user interface modules may be useful for controlling selected subsets of the zone players.

[0111] Moreover, it will be appreciated that, although the invention has been described in connection with audio information, it will be appreciated that the invention will find utility in connection with any type of information for which synchrony among devices connected to a network is desired.

[0112] As noted above, while a zone player 11(n) is operating as audio information channel device 23 for a synchrony group 20, when the zone player 11(n)'s audio information source interface 30 or network communications manager 40 stores digital audio information frames based on audio information from an audio information source 14(n)(s) in the audio information buffer 31, it will provide time stamps for the respective frames to schedule them for playback after some time delay after they have been buffered in the audio information buffer 31. The delay is provided so that, for other zone

players 11(n'), 11(n''),... that are operating as members of a synchrony group, there will be sufficient time for the audio and playback timing information to be transferred over the network 12 to those other zone players 11(n'), 11(n''),... so that it can be processed and played by them at the appropriate time as described above. The time period that is selected for the time delay may be fixed or variable, and in either case may be based on a number of factors. If the time period selected for the time delay is fixed, it may be based on, for example, factors such as an estimate of the maximum latency in the network 12, the estimated maximum loading of the various components comprising the zone players 11(n), and other estimates as will be appreciated by those skilled in the art.

[0113] The time delay may be the same for audio information from all types of audio information sources, and may be constant over the entire period that the synchrony group 20 is playing an audio work. Alternatively, different time delays may be utilized based on various criteria. For example, if the audio information is to be played independently of information associated with other types of media, the time delay may be selected to be relatively long, on the order of a significant fraction of a second, or longer. On the other hand, if the audio information is to be played contemporaneously with, for example, video information, which may be supplied by, for example, a video disk, video tape cassette, over cable, satellite, or broadcast television, which may not be buffered or which may be displayed independently of the network audio system 10, it may be undesirable to provide for such a lengthy delay, since the time delay of the audio playback, in relation to the video display, may be noticeable. In that case, the zone player 11(n) may provide for a much shorter time delay. In one embodiment, the time delay provided for audio information to be played concurrently with video information is selected to be generally on the order of fifty milliseconds, which would barely, if at all, be perceptible to someone viewing the video. Other desirable time delays for information from other types of sources will be apparent to those skilled in the art.

[0114] As yet a further possibility, the zone player 11(n), when operating as an audio information channel device 23 for a synchrony group 20, can dynamically determine the time delay based on a number of conditions in the network audio system 10, including, for example, the message transfer latency in network 12, the loading of microprocessors or other components that are used in the various zone players 11(n'), 11(n''),... that may comprise a synchrony group 20, as well as other factors. For example, if the audio information channel device 23 determines that the latency in the network 12 has increased beyond a selected threshold, the audio information channel device 23 can adjust the delay to increase the likelihood that the members of the synchrony group 20 will be able to receive the packets and process the frames so that they will be able to play them at the appropriate times. Similarly, if the audio information channel device 23 is notified that a member of the synchrony group 20 to which it provides audio information requires additional time to receive and process the frames that it transmits, the audio information channel device 23 can adjust the delay accordingly. It will be appreciated that, to reduce or minimize possible discontinuities in the audio playback by the members of the synchrony group, the audio information channel device 23 can, instead of adjusting the time delay during a particular audio track, adjust the time delay between tracks, during silent periods of a track or otherwise as will be appreciated by those skilled in the art. In addition, the audio information channel device 23 can use conventional audio compression methodologies to facilitate a speeding up and/or slowing down of playback of an audio track while it is in the process of providing additional time delay. Generally, the members of the synchrony group 20 can provide notifications to the audio information channel device 23 if they determine that they will need an additional time delay, and the audio information channel device 23 can adjust the time delay in accordance with the notifications from the members of the synchrony group 20.

[0115] It will be appreciated that a system in accordance with the invention can be constructed in whole or in part from special purpose hardware or a general purpose computer system, or any combination thereof, any portion of which may be controlled by a suitable program. Any program may in whole or in part comprise part of or be stored on the system in a conventional manner, or it may in whole or in part be provided in to the system over a network or other mechanism for transferring information in a conventional manner. In addition, it will be appreciated that the system may be operated and/or otherwise controlled by means of information provided by an operator using operator input elements (not shown) which may be connected directly to the system or which may transfer the information to the system over a network or other mechanism for transferring information in a conventional manner.

[0116] The foregoing description has been limited to a specific embodiment of this invention. It will be apparent, however, that various variations and modifications may be made to the invention, with the attainment of some or all of the advantages of the invention. It is the object of the appended claims to cover these and such other variations and modifications as come within the true spirit and scope of the invention.

[0117] The following numbered clauses set out further exemplary embodiments of the present invention.

1. A system comprising plurality of devices, one of the devices operating as a task source device and at least one other device operating as a member of a synchrony group, A. the task source device being configured to distribute a series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to a clock maintained by the task source device, at which the devices comprising the synchrony group are to execute the respective task; B each member device being configured to: (i) periodically obtain from the task source device

an indication of a current time value indicated by the task source device's clock, and (ii) determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value indicated by the task source device's clock, and a current time value indicated by its respective clock, a time, relative to its respective clock, at which it is to execute the task.

2. A system as defined in clause 1 in which the synchrony group comprises a plurality of member devices.

3. A system as defined in clause 2 in which each device comprising a, member of the synchrony group is further configured to execute each task that it receives from the task source device at the determined time, thereby to facilitate execution by them of respective tasks in the series in respective timing relationships relative to the time indicated by the task source device's clock.

4. A system as defined in clause 3 in which the member devices are configured to execute respective tasks in synchrony.

5. A system as defined in clause 2 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the master device being configured to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

6. A system as defined in clause 5 further including a user interface module configured to control the master device's performance of said at least one type of synchrony group management operation, the master device being further configured to provide status information relating to the status of the synchrony group to the user interface module.

7. A system as defined in clause 6 in which the status information includes identifications of the devices comprising the synchrony group.

8. A system as defined in clause 6 in which the status information includes an identification of the task currently being executed.

9. A system as defined in clause 5, the system comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is configured to enable the at least one additional device to join the synchrony group as a slave device.

10. A system as defined in clause 9 in which the task source device is configured to distribute tasks to the member devices using a selected multi-cast transmission methodology, the member devices being configured to buffer the tasks until they are to be executed, and further in which, when the at least one additional device joins the synchrony group as a slave device, the task source device is enabled to transmit at least one previously distributed task to the slave device using a selected unicast transmission methodology.

11. A system as defined in clause 5 in which, in at least one type of synchrony group management operation, the master device is configured to enable the task source device to join the synchrony group as a slave device, the task source device continuing to operate as the task source device for the synchrony group.

12. A system as defined in clause 5 in which, in at least one type of synchrony group management operation, the master device is configured to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group.

13. A system as defined in clause 5 in which, in at least one type of synchrony group management operation, the master device is configured to control the series of tasks to be distributed by the task source device.

14. A system as defined in clause 5 in which, in at least one type of synchrony group management operation, the master device is further configured to control execution by the member devices of the tasks that have been distributed by the task source device.

15. A system as defined in clause 14 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which in at least one type of synchrony group management operation, the master device is configured to enable the member devices to terminate execution of a task sequence that is currently being executed.

16. A system as defined in clause 15 in which, in the synchrony group management operation enabling the member devices to terminate execution of a task sequence that is currently being executed, the master device enables the task source device to distribute a command to enable the member devices to terminate execution of the task sequence, the member devices being configured to, after receiving the command, terminate execution of the task sequence.

17. A system as defined in clause 14 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which at least one type of synchrony group management operation, the master device is configured to enable the member devices to cancel execution of a task sequence that has been previously distributed, but for which execution has not begun.

18. A system as defined in clause 17 in which, in the synchrony group management operation enabling the member devices to cancel execution of a task sequence that has been previously distributed but for which execution has not begun, the master device enables the task source device to distribute a command to enable the member devices to cancel execution of the task sequence, the member devices being configured to, after receiving the command,

cancel execution of the task sequence.

19. A system as defined in clause 5 in which, in at least one type of synchrony group management operation, the member device operating as the master device is configured to enable the master device to migrate from one member device to another member device in the synchrony group.

20. A system as defined in clause 5 in which, in at least one type of synchrony group management operation, the master device is configured to enable the task source device to migrate from one device to another device in the system.

21. A system as defined in clause 20 in which

A. the device operating as the task source device is configured to, after being enabled to migrate the task source device to said other device, provide migration information to the other device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices,

B. the other device being configured to, after receiving the migration information,

i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

22. A system as defined in clause 21 in which the information respecting the tasks that are to be distributed is a source of streaming information, the other device being configured to, after receiving the migration information, assemble the streaming information into tasks and associate each task with a said time stamp.

23. A system as defined in clause 21 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the other device being configured to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

24. A system as defined in clause 23 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being configured to assemble the information from a position in the file associated with the identified offset.

25. A system as defined in clause 23 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the other device being configured to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

26. A system as defined in clause 1 in which the task source device is further configured to distribute the tasks using a selected multi-cast message transmission methodology.

27. A system as defined in clause 1 in which the task source device is configured to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

28. A system as defined in clause 27 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

29. A system as defined in clause 28 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp.

30. A system as defined in clause 27 in which task source device is configured to obtain information associated with the tasks from at least two types of information sources, the task source device being further configured to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

31. A system as defined in clause 1 in which at least one member device is further configured to adjust its clock rate in relation to a clock rate value maintained by the task source device's clock.

32. A system as defined in clause 31 in which the at least one member device is configured to adjust its clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

33. A system as defined in clause 1 in which at least one other device operates as a task source device configured to distribute tasks to a second synchrony group, the device operating as the task source device for the first synchrony group also operating as a member device of a second synchrony group.

34. A system as defined in clause 1 in which at least one member device comprises:

A. a task receiving module configured to receive the series of tasks,
B. a current time retrieval module configured to obtain, from the task source device, the current time value as indicated by the task source's clock;
C. an execution time determination module configured to determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the member device's respective clock at which the task is to be executed; and
D. a task execution module configured to execute each respective task at the time determined by the execution time determination module.

35. A system as defined in clause 34 further including a control module for controlling execution of commands received by said interface module.
36. A system as defined in clause 35 in which the at least one member device further comprises a buffer configured to buffer tasks that the task receiving module receives from the task source device until they are to be executed, the task execution module being configured to execute the buffered tasks at the times determined by the execution time determination module.
37. A system as defined in clause 36 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being configured to not execute subsequent tasks in the task sequence that have been buffered.
38. A system as defined in clause 37 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a subsequent task sequence at a time determined by the execution time determination module.
39. A system as defined in clause 36 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, enable the task execution module to not execute tasks from that task sequence that have been buffered.
40. A system as defined in clause 39 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.
41. A system as defined in clause 34 in which the member device includes:

A. a migration information receiving module configured to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and
B. a migration control module configure to, after the migration information has been received.,

i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and
ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

42. A system as defined in clause 41 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into tasks and associate each task with a said time stamp.
43. A system as defined in clause 41 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.
44. A system as defined in clause 43 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.
45. A system as defined in clause 43 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain infor-

mation from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

46. A system as defined in clause 34 in which the member device further includes a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

47. A system as defined in clause 46 in which the clock rate adjustment module is configured to adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

48. A system as defined in clause 1 in which the task source device comprises:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. an execution control command generation module configured to, in response to a predetermined event, enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

49. A system as defined in clause 48 in which the task transmission module is configured to utilize a selected multi-cast transmission methodology.

50. A system as defined in clause 48 in which the predetermined event comprises input indicia provided by an operator.

51. A system as defined in clause 50 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

52. A system as defined in clause 51 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

53. A system as defined in clause 51 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

54. A system as defined in clause 53 in which the task transmission module is configured to insert a command to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

55. A system as defined in clause 48 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

56. A system as defined in clause 55 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

57. A system as defined in clause 55 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

58. A system as defined in clause 57 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

59. A system as defined in clause 55 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and
(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and
(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

60 A system as defined in clause 1 in which the task source device comprises:

A. a task acquisition module configured to obtain respective ones of the tasks;
B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission module configured to transmit the series of tasks to said at least one other device; and
D. a task source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

61. A system as defined in clause 60 in which the task source device is configured to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

62. A system as defined in clause 61 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

63. A system as defined in clause 62 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

64. A system as defined in clause 62 in which task source device is configured to obtain information associated with the tasks from at least two types of information sources, the task source device being further configured to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

65. A device for executing a series of tasks provided by a task source at times specified by the task source in relation to a clock maintained by the task source, the device comprising

A. an interface module configured to receive the series of tasks, each task being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the task source, at which the device is to execute the respective task;
B. a current time retrieval module configured to obtain, from the task source, a current time value as indicated by the task source's clock;
C. an execution time determination module configured to determine, from the time stamp associated with each

respective task and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the task is to be executed; and

D. a task execution module configured to execute each respective task at the time determined by the execution time determination module.

66. A device as defined in clause 65 further including a control module for controlling execution of commands received by said interface module.

67. A device as defined in clause 65 further comprising a buffer configured to buffer tasks that the interface module has received until they are to be executed, the task execution module being configured to execute the buffered tasks at the times determined by the execution time determination module.

68. A device as defined in clause 67 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being configured to not execute subsequent tasks in the task sequence that have been buffered.

69. A device as defined in clause 68 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a subsequent task sequence at a time determined by the execution time determination module.

70. A device as defined in clause 69 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, enable the task execution module to not execute tasks from that task sequence that have been buffered.

71. A device as defined in clause 70 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

72. A device as defined in clause 66, the control module being configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks for execution by the task execution module.

73. A device as defined in clause 72 in which the control module is configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed task using a selected unicast transmission methodology.

74. A device as defined in clause 65 in which the control module is configured to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving tasks and the task execution module from executing previously received tasks that have not yet been executed.

75. A device as defined in clause 65 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable selected operations to be performed in response to the control information.

76. A device as defined in clause 75 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

77. A device as defined in clause 75 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

78. A device as defined in clause 75 in which, in response to control information to enable the task source to begin operating, the control module performs selected operations to enable the task source to begin operating.

79. A device as defined in clause 78, the device also operating as the task source, the device including a task generator module configured to, under control of the control module, obtain information from which the tasks are to be generated and generate the tasks.

80. A device as defined in clause 79 in which the interface module is further configured to transmit the tasks to at least one other device.

81. A device as defined in clause 79 in which the device is not the task source, the control module being configured to enable the interface module to transmit a command to enable the task source to operate.

82. A device as defined in clause 81 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks currently being executed to be terminated, the control module is configured to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of tasks associated with the task sequence to enable termination of execution of the task sequence.

83. A device as defined in clause 81 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks at least a portion of which have been received, but which are not being executed, the control module is configured to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of commands to disable execution of the task sequence.

84. A device as defined in clause 75 in which the control module is configured to enable the user interface module interface module to transmit status information to the user interface module.

85. A device as defined in clause 84 in which the status information includes the execution status of at least one task.

86. A device as defined in clause 65 further including:

A. a migration information receiving module configured to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control module configured to, after the migration information has been received.,

i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

87. A device as defined in clause 86 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into tasks and associate each task with a said time stamp.

88. A device as defined in clause 86 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

89. A device as defined in clause 88 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

90. A device as defined in clause 89 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

91. A device as defined in clause 65 further including a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

92. A task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the task source device comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. an execution control command generation module configured to, in response to a predetermined event, enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

93. A task source device as defined in clause 92 in which the task transmission module is configured to utilize a selected multi-cast transmission methodology.

94. A task source device as defined in clause 92 in which the predetermined event comprises input indicia provided by an operator.

95. A task source device as defined in clause 94 in which, in response to said predetermined event, the execution

control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

96. A task source device as defined in clause 95 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

97. A task source device as defined in clause 95 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and
(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and
(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

98. A task source device as defined in clause 97 in which the task transmission module is configured to insert a command to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

99. A task source device as defined in clause 92 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

100. A task source device as defined in clause 99 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

101. A task source device as defined in clause 99 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

102. A task source device as defined in clause 101 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

103. A task source device as defined in clause 99 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and
(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and
(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

104. A task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the task source device comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;
B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time, the task execution time determination module being configured to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by a clock maintained by the task source device; and
C. a task transmission module configured to transmit the series of tasks to said at least one other device.

105. A system as defined in clause 104 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.
106. A system as defined in clause 105 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp
107. A system as defined in clause 104 in which task source device is configured to obtain information associated with the tasks from at least two types of information sources, the task source device being further configured to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.
108. A task source device for distributing a series of tasks for execution by at least one other device, the task source device comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;
B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission module configured to transmit the series of tasks to said at least one other device; and
D. a task source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

109. A method of operating a system comprising plurality of devices, one of the devices operating as a task source device and at least one other device operating as a member of a synchrony group,

A. the task source device being enabled to distribute a series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to a clock maintained by the task source device, at which the devices comprising the synchrony group are to execute the respective task;
B each member device being enabled to:

(i) periodically obtain from the task source device an indication of a current time value indicated by the task source device's clock, and
(ii) determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value indicated by the task source device's clock, and a current time value indicated by its respective clock, a time, relative to its respective clock, at which it is to execute the task.

110. A method as defined in clause 109 in which the synchrony group comprises a plurality of member devices.
111. A method as defined in clause 110 in which each device comprising a member of the synchrony group is further enabled to execute each task that it receives from the task source device at the determined time, thereby to facilitate execution by them of respective tasks in the series in respective timing relationships relative to the time indicated by the task source device's clock.
112. A method as defined in clause 111 in which the member devices are enabled to execute respective tasks in synchrony.
113. A method as defined in clause 110 in which one of the member devices operates as a master device for the

synchrony group, any other member devices comprising respective slave devices, the master device being enabled to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

114. A method as defined in clause 113 further including a user interface module enabled to control the master device's performance of said at least one type of synchrony group management operation, the master device being further enabled to provide status information relating to the status of the synchrony group to the user interface module.

115. A method as defined in clause 114 in which the status information includes identifications of the devices comprising the synchrony group.

116. A method as defined in clause 114 in which the status information includes an identification of the task currently being executed.

117. A method as defined in clause 113, the method comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is enabled to enable the at least one additional device to join the synchrony group as a slave device.

118. A method as defined in clause 117 in which the task source device is enabled to distribute tasks to the member devices using a selected multi-cast transmission methodology, the member devices being enabled to buffer the tasks until they are to be executed, and further in which, when the at least one additional device joins the synchrony group as a slave device, the task source device is enabled to transmit at least one previously distributed task to the slave device using a selected unicast transmission methodology.

119. A method as defined in clause 113 in which, in at least one type of synchrony group management operation, the master device is enabled to enable the task source device to join the synchrony group as a slave device, the task source device continuing to operate as the task source device for the synchrony group.

120. A method as defined in clause 113 in which, in at least one type of synchrony group management operation, the master device is enabled to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group.

121. A method as defined in clause 113 in which, in at least one type of synchrony group management operation, the master device is enabled to control the series of tasks to be distributed by the task source device.

122. A method as defined in clause 113 in which, in at least one type of synchrony group management operation, the master device is further enabled to control execution by the member devices of the tasks that have been distributed by the task source device.

123. A method as defined in clause 122 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which in at least one type of synchrony group management operation, the master device is enabled to enable the member devices to terminate execution of a task sequence that is currently being executed.

124. A method as defined in clause 123 in which, in the synchrony group management operation enabling the member devices to terminate execution of a task sequence that is currently being executed, the master device enables the task source device to distribute a command to enable the member devices to terminate execution of the task sequence, the member devices being enabled to, after receiving the command, terminating execution of the task sequence.

125. A method as defined in clause 122 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which at least one type of synchrony group management operation, the master device is enabled to enable the member devices to cancel execution of a task sequence that has been previously distributed, but for which execution has not begun.

126. A method as defined in clause 125 in which, in the synchrony group management operation enabling the member devices to cancel execution of a task sequence that has been previously distributed but for which execution has not begun, the master device enables the task source device to distribute a command to enable the member devices to cancel execution of the task sequence, the member devices being enabled to, after receiving the command, cancel execution of the task sequence.

127. A method as defined in clause 113 in which, in at least one type of synchrony group management operation, the member device operating as the master device is enabled to enable the master device to migrate from one member device to another member device in the synchrony group.

128. A method as defined in clause 113 in which, in at least one type of synchrony group management operation, the master device is enabled to perform the step of enabling the task source device to migrate from one device to another device in the system.

129. A method as defined in clause 128 in which

A. the device operating as the task source device is enable to perform the step of, after being enabled to migrate the task source device to said other device, providing migration information to the other device, the migration

information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices,
B. the other device is enabled to, after receiving the migration information, perform the steps of

i. distributing the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and
ii. notifying the members of the synchrony group that it is to thereafter operate as the task source device.

130. A method as defined in clause 129 in which the information respecting the tasks that are to be distributed is a source of streaming information, the other device being enabled to, after receiving the migration information, perform the steps of assembling the streaming information into tasks and associating each task with a said time stamp.

131. A method as defined in clause 129 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the other device being enabled to perform the steps of obtaining information from the identified file, assembling the information into tasks and associating each task with a said time stamp.

132. A method as defined in clause 131 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being enabled to perform the step of assembling the information from a position in the file associated with the identified offset.

133. A method as defined in clause 131 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the other device being enabled to perform the step of obtaining information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

134. A method as defined in clause 109 in which the task source device is further enabled to distribute the tasks using a selected multi-cast message transmission methodology.

135. A method as defined in clause 109 in which the task source device is enabled to perform the step of providing, provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

136. A method as defined in clause 135 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

137. A method as defined in clause 136 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

138. A method as defined in clause 135 in which task source device is enabled to perform the steps of obtaining information associated with the tasks from at least two types of information sources, and selecting, for each task, the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

139. A method as defined in clause 109 in which at least one member device is further enabled to perform the step of adjusting its clock rate in relation to a clock rate value maintained by the task source device's clock.

140. A method as defined in clause 139 in which the at least one member device is enabled to perform the step of adjusting its clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

141. A method as defined in clause 109 in which at least one other device operates as a task source device enabled to distribute tasks to a second synchrony group, the device operating as the task source device for the first synchrony group also operating as a member device of a second synchrony group.

142. A method as defined in clause 109 including, within a member device,

A. a task receiving step of receiving the series of tasks,
B. a current time retrieval step of obtaining, from the task source device, the current time value as indicated by the task source's clock;
C. an execution time determination step of determining, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the member device's respective clock at which the task is to be executed; and
D. a task execution step of executing each respective task at the time determined during the execution time determination step.

143. A method as defined in clause 142 further including a control step for controlling execution of commands received during the task receiving step

144. A method as defined in clause 143 in which the at least one member device further comprises a buffer configured to buffer tasks received from the task source device during the task receiving step until they are to be executed, the task execution step including the step of executing the buffered tasks at the times determined during the execution time determination step.

145. A method as defined in clause 144 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the task receiving step being further enabled to receive task execution control commands for controlling task execution, the control step including the step of, in response to receipt of at least one task execution control command for controlling task execution, controlling the task execution step to terminate execution of a task sequence currently being executed, and further to not execute subsequent tasks in the task sequence that have been buffered.

146. A method as defined in clause 145 in which the control step includes the step of enabling the task execution step to resume execution of at least one task associated with a subsequent task sequence at a time determined during the execution time determination step.

147. A method as defined in clause 144 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the task receiving step including the step of receiving task execution control commands for controlling task execution, the control step including the step of, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, providing that tasks from that task sequence that have been buffered not be executed.

148. A method as defined in clause 147 in which the control step includes the step of enabling execution to resume of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

149. A method as defined in clause 142 in which the member device performs:

A. migration information receiving step of receiving migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and
B. a migration control step of, after the migration information has been received.,

i. distributing the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and
ii. notifying the members of the synchrony group that it is to thereafter operate as the task source device.

150. A method as defined in clause 149 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into tasks and associating each task with a said time stamp.

151. A method as defined in clause 149 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into tasks and associating each task with a said time stamp.

152. A method as defined in clause 151 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

153. A method as defined in clause 151 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into tasks and associating each task with as said time stamp.

154. A method as defined in clause 142 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

155. A method as defined in clause 154 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

156. A method as defined in clause 109 including, within a task source device,

A. a task acquisition step of obtaining respective ones of the tasks;
B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission step of transmitting the series of tasks to said at least one other device; and
D. an execution control command generation step of, in response to a predetermined event and during the task transmission step, the insertion into the series of tasks transmitted by the task transmission module of a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

157. A method as defined in clause 156 in which the task transmission step includes the step of utilizing a selected multi-cast transmission methodology.

158. A method as defined in clause 156 in which the predetermined event includes the step of receiving input indicia provided by an operator.

159. A method as defined in clause 158 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

160. A method as defined in clause 159 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

161. A method as defined in clause 159 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the task transmission step the insertion, into the series of tasks, of a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and
(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task se-

quences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and
(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

162. A method as defined in clause 161 in which the task transmission step includes the step of inserting a command into the task sequence to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

163. A method as defined in clause 159 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

164. A method as defined in clause 163 in which the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

165. A method as defined in clause 163 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the inserting into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

166. A method as defined in clause 165 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

167. A method as defined in clause 163 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the task transmission step, the insertion, into the series of tasks, of a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and
(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and
(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

168. A method as defined in clause 109 in which the task source device is enabled to perform

A. a task acquisition step of obtaining respective ones of the tasks;
B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission step of transmitting the series of tasks to said at least one other device; and
D. a task source device migration control step of, in response to a predetermined event, providing migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

169. A method as defined in clause 109 in which the task source device is enabled to perform the step of providing, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

170. A method as defined in clause 169 in which the task source device is enabled to perform the step of selecting

the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

171. A method as defined in clause 170 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

172. A method as defined in clause 169 in which task source device is enabled to perform the step of obtaining information associated with the tasks from at least two types of information sources, and selecting for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

173. A method of operating a device for executing a series of tasks provided by a task source at times specified by the task source in relation to a clock maintained by the task source, the method including

A. a task receiving step of receiving the series of tasks, each task being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the task source, at which the device is to execute the respective task;
B. a current time retrieval module of obtaining, from the task source, a current time value as indicated by the task source's clock;
C. an execution time determination step of determining, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the task is to be executed; and
D. a task execution module step of executing each respective task at the time determined during the execution time determination step.

174. A method as defined in clause 173 further including a control step for controlling execution of commands received by said interface module.

175. A method as defined in clause 174 further comprising a buffer configured to buffer tasks that have been received until they are to be executed, the task execution step including the step of executing the buffered tasks at the times determined during the execution time determination step.

176. A method as defined in clause 175 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further enabled to receive task execution control commands for controlling task execution, the control module being enabled to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being enabled to not execute subsequent tasks in the task sequence that have been buffered.

177. A method as defined in clause 176 in which the control step includes the step of enabling task execution to resume execution with at least one task associated with a subsequent task sequence at a time determined during the execution time determination step.

178. A method as defined in clause 175 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the task receiving step including the step of receiving task execution control commands for controlling task execution, the control step, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, including the step of providing that task execution not including execution of tasks from that task sequence that have been buffered.

179. A method as defined in clause 178 in which the control step includes the step of enabling task execution to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

180. A method as defined in clause 173, the control step including the step of, in response to receipt of a command to become a member of a synchrony group, receiving tasks during the task receiving step for execution during the task execution step.

181. A method as defined in clause 180 in which the control step includes the step of, in response to receipt of a command to become a member of a synchrony group, enable the task receiving step to include the step of receiving tasks currently being transmitted using a selected multi-cast transmission methodology, and further to include the step of retrieving at least one previously distributed task using a selected unicast transmission methodology.

182. A method as defined in clause 173 in which the control step includes the steps of, in receipt of a command to disengage from a synchrony group, disabling the receipt of tasks and the execution of previously-received tasks that have not yet been executed.

183. A method as defined in clause 173 further comprising a user interface module control information receiving step of receiving control information from a user interface module, the control step including the step of enabling selected operations to be performed in response to the control information.

184 A method as defined in clause 183 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control step includes the step of transmitting a command to the other device to enable the other device to become a member of the synchrony group.

185. A method as defined in clause 183 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

186. A method as defined in clause 185 in which, in response to control information to enable the task source to begin operating, the control step includes the step of performing selected operations to enable the task source to begin operating.

187. A method as defined in clause 186, the device also operating as the task source, the method including a task generation steps of, under control of the control step, obtaining information from which the tasks are to be generated and generating the tasks.

188. A method as defined in clause 187 further including the step of transmitting the tasks to at least one other device.

189. A method as defined in clause 187 in which the device is not the task source, the control step including the step of enabling the transmission of a command to enable the task source to operate.

190. A method as defined in clause 189 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks currently being executed to be terminated, the control step includes the step of transmitting a command to enable the task source to insert a resynchronize command in the series of tasks associated with the task sequence to enable termination of execution of the task sequence.

191. A method as defined in clause 189 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks at least a portion of which have been received, but which are not being executed, the control step includes the step of transmitting a command to enable the task source to insert a resynchronize command in the series of commands to disable execution of the task sequence.

192. A method as defined in clause 174 in which the control step includes the step of transmitting status information to the user interface module.

193. A method as defined in clause 192 in which the status information includes the execution status of at least one task.

194. A method as defined in clause 173 in which the member device performs:

A. migration information receiving step of receiving migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and
B. a migration control step of, after the migration information has been received.,

i. distributing the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and
ii. notifying the members of the synchrony group that it is to thereafter operate as the task source device.

195. A method as defined in clause 194 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into tasks and associating each task with a said time stamp.

196. A method as defined in clause 194 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into tasks and associating each task with a said time stamp.

197. A method as defined in clause 196 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

198. A method as defined in clause 196 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into tasks and associating each task with as said time stamp.

199. A method as defined in clause 173 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

200. A method as defined in clause 199 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

201. A method of operating a device for distributing a series of tasks for execution by at least one other device at respective execution times, the method comprising:

A. a task acquisition step of obtaining respective ones of the tasks;
B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission step of transmitting the series of tasks to said at least one other device; and
D. an execution control command generation step of, in response to a predetermined event and during the task transmission step, the insertion into the series of tasks transmitted by the task transmission module of a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

202. A method as defined in clause 201 in which the task transmission step includes the step of utilizing a selected multi-cast transmission methodology.

203. A method as defined in clause 201 in which the predetermined event includes the step of receiving input indicia provided by an operator.

204. A method as defined in clause 203 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

205. A method as defined in clause 204 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

206. A method as defined in clause 203 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the task transmission step the insertion, into the series of tasks, of a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and
(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and
(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

207. A method as defined in clause 206 in which the task transmission step includes the step of inserting a command into the task sequence to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

208. A method as defined in clause 201 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

209. A method as defined in clause 208 in which the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

210. A method as defined in clause 208 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the inserting into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

211. A method as defined in clause 210 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

212. A method as defined in clause 208 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the task transmission step, the insertion, into the series of tasks, of a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and
(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and
(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

213. A method of operating a device for distributing a series of tasks for execution by at least one other device at respective execution times, the method comprising:

A. a task acquisition step of obtaining respective ones of the tasks;
B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associating the respective task with a time stamp indicating its execution time, the task execution time determination step including the step of providing, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by a clock maintained by the task source device; and
C. a task transmission step of transmitting the series of tasks to said at least one other device.

214. A method as defined in clause 213 in which the task execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the device can be executed by at least one other device at the time indicated by the time stamp.

215. A method as defined in clause 214 in which the task execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the device can be distributed to other devices over a network for execution by the other devices at the time indicated by the time stamp.

216. A method as defined in clause 213 in which task acquisition step includes the step of obtaining information associated with the tasks from at least two types of information sources, the task execution time determination step including the step of selecting, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

217. A method of operating a device for distributing a series of tasks for execution by at least one other device, the method comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;
B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission module configured to transmit the series of tasks to said at least one other device; and
D. a task source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

218. A computer program product for use in connection with a computer to provide a device for executing a series of tasks provided by a task source at times specified by the task source in relation to a clock maintained by the task source, the computer program product comprising a computer-readable medium having encoded thereon:

A. an interface module configured to enable the computer to receive the series of tasks, each task being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the task source, at which the device is to execute the respective task;
B. a current time retrieval module configured to enable the computer to obtain, from the task source, a current time value as indicated by the task source's clock;
C. an execution time determination module configured to enable the computer to determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the task is to be executed; and
D. a task execution module configured to enable the computer to execute each respective task at the time determined by the execution time determination module.

219. A computer program product as defined in clause 218 further including a control module for enabling said computer to control execution of commands received by the interface module.

220. A computer program product as defined in clause 219 further comprising a buffer module configured to enable the computer to buffer tasks received by the interface module until they are to be executed, the task execution

module being configured to enable the computer to execute the buffered tasks at the times determined by the execution time determination module.

221. A computer program product as defined in clause 220 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to enable the computer to receive task execution control commands for controlling task execution, the control module being configured to enable the computer to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being configured to enable the computer to not execute subsequent tasks in the task sequence that have been buffered.

222. A computer program product as defined in clause 220 in which the control module is configured to enable the computer to enable the task execution module to resume execution of at least one task associated with a subsequent task sequence at a time determined by the execution time determination module.

223. A computer program product as defined in clause 219 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to enable the computer to receive task execution control commands for controlling task execution, the control module being configured to enable the computer to, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, enable the task execution module to not execute tasks from that task sequence that have been buffered.

224. A computer program product as defined in clause 223 in which the control module is configured to enable the computer to enable the task execution module to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

225. A computer program product as defined in clause 219, the control module being configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks for execution by the task execution module.

226. A computer program product as defined in clause 225 in which the control module is configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed task using a selected unicast transmission methodology.

227. A computer program product as defined in clause 219 in which the control module is configured to enable the computer to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving tasks and the task execution module from executing previously received tasks that have not yet been executed.

228. A computer program product as defined in clause 219 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable the computer to enable selected operations to be performed in response to the control information.

229. A computer program product as defined in clause 228 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

230. A computer program product as defined in clause 228 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

231. A computer program product as defined in clause 228 in which, in response to control information to enable the task source to begin operating, the control module performs selected operations to enable the task source to

begin operating.

232. A computer program product as defined in clause 231, the device also operating as the task source, the device including a task generator module configured to enable the computer to, under control of the control module, obtain information from which the tasks are to be generated and generate the tasks.

233. A computer program product as defined in clause 232 in which the interface module is further configured to enable the computer to transmit the tasks to at least one other device.

234. A computer program product as defined in clause 232 in which the device is not the task source, the control module being configured to enable the computer to enable the interface module to transmit a command to enable the task source to operate.

235. A computer program product as defined in clause 234 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks currently being executed to be terminated, the control module is configured to enable the computer to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of tasks associated with the task sequence to enable termination of execution of the task sequence.

236. A computer program product as defined in clause 234 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks at least a portion of which have been received, but which are not being executed, the control module is configured to enable the computer to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of commands to disable execution of the task sequence.

237. A computer program product as defined in clause 228 in which the control module is configured to enable the computer to enable the user interface module interface module to transmit status information to the user interface module.

238. A computer program product as defined in clause 237 in which the status information includes the execution status of at least one task.

239. A computer program product as defined in clause 218 further including:

A. a migration information receiving module configured to enable the computer to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and
B. a migration control module configured to enable the computer to, after the migration information has been received.,

i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and
ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

240. A computer program product as defined in clause 239 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control module being configured to enable the computer to, after the migration information has been received, assemble the streaming information into tasks and associate each task with a said time stamp.

241. A computer program product as defined in clause 239 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control module being configured to enable the computer to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

242. A computer program product as defined in clause 241 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control

module being configured to enable the computer to assemble the information from a position in the file associated with the identified offset.

243. A computer program product as defined in clause 241 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to enable the computer to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

244. A computer program product as defined in clause 218 further including a clock rate adjustment module configured to enable the computer to adjust the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

245. A computer program product as defined in clause 244 in which the clock rate adjustment module is configured to enable the computer to adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

246. A computer program product for use in connection with a computer to provide a task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a task acquisition module configured to enable the computer to obtain respective ones of the tasks;
B. a task execution time determination module configured to enable the computer to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission module configured to enable the computer to transmit the series of tasks to said at least one other device; and
D. an execution control command generation module configured to enable the computer to, in response to a predetermined event, enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

247. A computer program product as defined in clause 246 which the task transmission module is configured to enable the computer to utilize a selected multi-cast transmission methodology.

248. A computer program product as defined in clause 246 in which the predetermined event comprises input indicia provided by an operator.

249. A computer program product as defined in clause 246 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

250. A computer program product as defined in clause 249 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

251. A computer program product as defined in clause 249 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to enable the computer to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and
(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and
(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

252. A computer program product as defined in clause 251 in which the task transmission module is configured to enable the computer to insert a command to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

253. A computer program product as defined in clause 246 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

254. A computer program product as defined in clause 253 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

255. A computer program product as defined in clause 254 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

256. A computer program product as defined in clause 255 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

257. A computer program product as defined in clause 253 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to enable the computer to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and
(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and
(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

258. A computer program product for use in connection with a computer to provide a task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a task acquisition module configured to enable the computer to obtain respective ones of the tasks;
B. a task execution time determination module configured to enable the computer to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time, the task execution time determination module being configured to enable the computer to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by a clock maintained by the task source device; and
C. a task transmission module configured to enable the computer to transmit the series of tasks to said at least one other device.

259. A computer program product as defined in clause 258 in which the task execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

260. A computer program product as defined in clause 259 in which the task execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp.

261. A computer program product as defined in clause 258 in which task acquisition module is configured to enable the computer to obtain information associated with the tasks from at least two types of information sources, the task execution time determination module being configured to enable the computer to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

262. A computer program product for use in connection with a computer to provide a task source device for distributing a series of tasks for execution by at least one other device, the computer program product comprising a computer readable medium having encoded thereon:

A. a task acquisition module configured to enable the computer to obtain respective ones of the tasks;
B. a task execution time determination module configured to enable the computer to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;
C. a task transmission module configured to enable the computer to transmit the series of tasks to said at least one other device; and
D. a task source device migration control module configured to enable the computer to, in response to a pre-determined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

263. A system comprising a plurality of devices,

A one device being enabled to operate as a task source device, the task source device being enabled to transmit a series of tasks to the other devices, each task being associated with execution time information;
B. at least one device being enabled to operate as a task execution device, the task execution device being enabled to receive the series of tasks from the network and executing each respective task at a time in relation to the timing information associated with the respective task; and
C. one device being enabled to operate as a control device, the control device being enabled to control operations of the task source device and the task execution device.

264. A system as defined in clause 263 in which the device that is enabled to operate as the control device is also enabled to operate as a task execution device.

265. A system as defined in clause 263 in which the device that is enabled to operate as the control device is also enabled to operate as the task source device.

266. A system as defined in clause 263 in which the device that is enabled to operate as the task source device is also enabled to operate as a task execution device.

267. A system for facilitating processing of data by device operating as a member of a synchrony group, synchronously with a clock maintained by a data source device that provides the data to the synchrony group,

A. the data source device being configured to divide the data into a series of frames for distribution to the synchrony group, each frame being associated with a time stamp indicating a time, relative to a clock maintained by the data source device, at which the devices comprising the synchrony group are to process the frame;
B each member device in the synchrony group being configured to:

(i) periodically obtain from the data source device an indication of a current time value indicated by the data source device's clock;
(ii) receive the series of frames from the data source device;
(iii) determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value indicated by the data source device's clock, a current time value indicated by the member device's respective clock, a time, relative to the member device's respective clock, at which the member device is to process the frame; and
(iv) process the respective frame at the determined time.

268. A system as defined in clause 267 in which at least one frame comprises audio data, each member device, while processing each frame, producing sound represented by the respective frame.

269. A system as defined in clause 267 comprising a plurality of member devices, the member devices processing each frame synchronously in relation to the clock maintained by the data source device so that they all produce sound represented by the respective frame synchronously.

270. A system as defined in clause 269 in which the data source device is configured to provide time stamps for at least two successive frames so that the member devices will play them with a selected time interval therebetween.

271. A system as defined in clause 270 in which the time interval is zero.

272. A system as defined in clause 269 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the master device being configured to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

273. A system as defined in clause 272 in which the master device is further configured to provide status information relating to the status of the synchrony group to the user interface module.

274. A system as defined in clause 273 in which the status information includes identifications of the devices comprising the synchrony group.

275. A system as defined in clause 273 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, each audio track being associated with an identifier, the status information including the identification of the audio track currently being played.

276. A system as defined in clause 272, the system comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is configured to enable the at least one additional device to join the synchrony group as a slave device.

277. A system as defined in clause 276 in which the data source device is configured to distribute frames to the member devices using a selected multi-cast transmission methodology, the member devices being configured to buffer the frames until they are to be played, and further in which, when the at least one additional device joins the synchrony group as a slave device, the data source device is enabled to transmit at least one previously distributed frame to the slave device using a selected unicast transmission methodology.

278. A system as defined in clause 272 in which, in at least one type of synchrony group management operation, the master device is configured to enable the data source device to join the synchrony group as a slave device, the data source device continuing to operate as the data source device for the synchrony group.

279. A system as defined in clause 272 in which, in at least one type of synchrony group management operation, the master device is configured to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group and not playing frames distributed by the data source device.

280. A system as defined in clause 272 in which, in at least one type of synchrony group management operation, the master device is configured to control the series of frames to be distributed by the data source device.

281. A system as defined in clause 280 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, the master device being configured to control the frames to be distributed by the data source device on a track-by-track basis.

282. A system as defined in clause 281 in which, in at least one type of synchrony group management operation, the master device is further configured to control playback by the member devices of the frames associated with the respective audio tracks that have been distributed by the data source device in response to control information from the user interface module.

283. A system as defined in clause 282 in which, in response to control information from the user interface module to facilitate control of playback by the member devices, the master device is configured to enable the data source device to distribute a playback control command to the member devices.

284. A system as defined in clause 283 in which a playback control command enables the member devices to terminate playback of a track that is currently being played back.

285. A system as defined in clause 284 in which the playback control command enables the member devices to terminate playback of a track with a frame subsequent to a frame currently being played.

286. A system as defined in clause 283 in which the playback control command enables the member devices to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

287. A system as defined in clause 272 in which, in at least one type of synchrony group management operation, the member device operating as the master device is configured to enable the master device to migrate from itself to another member device in the synchrony group.

288. A system as defined in clause 272 in which, in at least one type of synchrony group management operation, the master device is configured to enable the data source device to migrate from one device to another device in the system.

289. A system as defined in clause 288 in which

A. the device operating as the data source device is configured to, after being enabled to migrate the data source device to said other device, provide migration information to the other device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices,
B. the other device being configured to, after receiving the migration information,

i. distribute the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and
ii. notify the members of the synchrony group that it is to thereafter operate as the data source device.

290. A system as defined in clause 289 in which the information respecting the frames that are to be distributed is a source of streaming information, the other device being configured to, after receiving the migration information, assemble the streaming information into frames and associate each frame with a said time stamp.

291. A system as defined in clause 289 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the other device being configured to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

292. A system as defined in clause 291 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being configured to assemble the information from a position in the file associated with the identified offset.

293. A system as defined in clause 291 in which the information respecting the frames that are to be distributed is

in a series of files identified in the migration information, the other device being configured to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

294. A system as defined in clause 267 in which the data source device is further configured to distribute the frames using a selected multi-cast message transmission methodology.

295. A system as defined in clause 267 in which the data source device is configured to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

296. A system as defined in clause 295 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

297. A system as defined in clause 296 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

298. A system as defined in clause 295 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

299. A system as defined in clause 267 in which at least one member device is further configured to adjust its clock rate in relation to a clock rate value maintained by the data source device's clock.

300. A system as defined in clause 299 in which the at least one member device is configured to adjust its clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

301. A system as defined in clause 267 in which at least one other device operates as a data source device configured to distribute frames to a second synchrony group, the device operating as the data source device for the first synchrony group also operating as a member device of a second synchrony group.

302. A system as defined in clause 267 in which at least one member device comprises:

A. an interface module configured to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;
B. a current time retrieval module configured to obtain, from the data source, a current time value as indicated by the data source's clock;
C. an processing time determination module configured to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and
D. a frame processing module configured to process each respective frame at the time determined by the processing time determination module.

303. A system as defined in clause 302 in which the at least one frame comprises audio data, each member device, while processing each frame, producing a signal representing sound represented by the respective frame.

304. A system as defined in clause 302 further including a control module for controlling execution of commands received by said interface module.

305. A device as defined in clause 304 further comprising a buffer configured to buffer frames that the interface module has received until they are to be processed, the frame processing module being configured to process the

buffered frames at the times determined by the processing time determination module.

306. A system as defined in clause 305 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to receive playback control commands for controlling processing of tracks, the control module being configured to execute at least one playback control command controlling track processing.

307. A system as defined in clause 306 in which at least one type of playback control command enables the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

308. A system as defined in clause 307 in which the playback control command enables the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

309. A system as defined in clause 306 in which the playback control command enables the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

310. A system as defined in clause 306 in which the control module is configured to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

311. A system as defined in clause 302 in which the member device includes:

A. a migration information receiving module configured to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and
B. a migration control module configure to, after the migration information has been received.,

i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and
ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

312. A system as defined in clause 311 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into frames and associate each frame with a said time stamp.

313. A system as defined in clause 311 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

314. A system as defined in clause 313 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

315. A system as defined in clause 313 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

316. A system as defined in clause 302 in which the member device further includes a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

317. A system as defined in clause 316 in which the clock rate adjustment module is configured to adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

318. A system as defined in clause 267 in which the data source device comprises:

A. a frame acquisition module configured to obtain respective ones of the frames;
B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to transmit the series of frames to said at least one other device; and
D. an execution control command generation module configured to, in response to a predetermined event, enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

319. A system as defined in clause 318 in which at least one frame comprises audio data, each member device, while processing each frame, producing generating a signal representing sound represented by the respective frame.

320. A system as defined in clause 318 in which the frame transmission module is configured to utilize a selected multi-cast transmission methodology.

321. A system as defined in clause 318 in which the predetermined event comprises input indicia provided by an operator.

322. A system as defined in clause 321 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

323. A system as defined in clause 322 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

324. A data source device as defined in clause 323 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and
(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and
(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

325. A system as defined in clause 324 in which the frame transmission module is configured to insert a command to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

326. A system as defined in clause 267 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

327. A system as defined in clause 326 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of

frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

328. A system as defined in clause 326 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

329. A system as defined in clause 328 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

330. A system as defined in clause 327 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and
(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and
(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

331. A system as defined in clause 267 in which the data source device comprises:

A. a frame acquisition module configured to obtain respective ones of the frames;
B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to transmit the series of frames to said at least one other device; and
D. a data source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

332. A system as defined in clause 331 in which the data source device is configured to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

333. A system as defined in clause 332 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

334. A system as defined in clause 333 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

335. A system as defined in clause 333 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

336. A device for processing a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the device comprising

A. an interface module configured to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;
B. a current time retrieval module configured to obtain, from the data source, a current time value as indicated by the data source's clock;
C. an processing time determination module configured to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and
D. a frame processing module configured to process each respective frame at the time determined by the processing time determination module.

337. A device as defined in clause 336 in which the frame comprises audio data, each member device, while processing each frame, producing a signal representing sound represented by the respective frame.

338. A device as defined in clause 336 further including a control module for controlling execution of commands received by said interface module.

339. A device as defined in clause 336 further comprising a buffer configured to buffer frames that the interface module has received until they are to be processed, the frame processing module being configured to process the buffered frames at the times determined by the processing time determination module.

340. A device as defined in clause 339 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to receive playback control commands for controlling processing of tracks, the control module being configured to execute at least one playback control command controlling track processing.

341. A device as defined in clause 340 in which at least one type of playback control command enables the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

342. A device as defined in clause 341 in which the playback control command enables the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

343. A device as defined in clause 340 in which the playback control command enables the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

344. A device as defined in clause 340 in which the control module is configured to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

345. A device as defined in clause 338, the control module being configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames for processing by the frame processing module.

346. A device as defined in clause 345 in which the control module is configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed frame using a selected unicast transmission methodology.

347. A device as defined in clause 346 in which the control module is configured to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving frames and the frame processing module from processing previously received frames that have not yet been processed.

348. A device as defined in clause 336 further comprising a user interface module interface module configured to

receive control information from a user interface module, the control module being configured to enable selected operations to be performed in response to the control information.

349. A device as defined in clause 348 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

350. A device as defined in clause 349 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

351. A device as defined in clause 348 in which, in response to control information to enable the data source to begin operating, the control module performs selected operations to enable the data source to begin operating.

352. A device as defined in clause 351, the device also operating as the data source, the device including a frame generator module configured to, under control of the control module, obtain information from which the frames are to be generated and generate the frames.

353. A device as defined in clause 342 in which the interface module is further configured to transmit the frames to at least one other device.

354. A device as defined in clause 343 in which the device is not the data source, the control module being configured to enable the interface module to transmit a command to enable the data source to operate.

355. A device as defined in clause 354 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track currently being processed to be terminated, the control module is configured to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of frames associated with the track to enable termination of processing of the track.

356. A device as defined in clause 354 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track at least a portion of which has been received, but for which processing has not begun, the control module is configured to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of commands to disable processing of the track.

357. A device as defined in clause 344 in which the control module is configured to enable the user interface module interface module to transmit status information to the user interface module.

358. A device as defined in clause 357 in which the status information includes the processing status of at least one frame.

359. A device as defined in clause 336 further including:

A. a migration information receiving module configured to receive migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and
B. a migration control module configured to, after the migration information has been received.,

i. distribute the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and
ii. notify the members of the synchrony group that it is to thereafter operate as the data source device.

360. A device as defined in clause 359 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information

has been received, assembling the streaming information into frames and associate each frame with a said time stamp.

361. A device as defined in clause 359 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

362. A device as defined in clause 361 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

363. A device as defined in clause 361 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

364. A device as defined in clause 336 further including a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

365. A data source device for distributing a series of frames for execution by at least one other device at respective execution times, the data source device comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;
B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to transmit the series of frames to said at least one other device; and
D. an execution control command generation module configured to, in response to a predetermined event, enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

366. A data source device as defined in clause 365 in which the frame transmission module is configured to utilize a selected multi-cast transmission methodology.

367. A data source device as defined in clause 365 in which the predetermined event comprises input indicia provided by an operator.

368. A data source device as defined in clause 367 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

369. A data source device as defined in clause 368 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

370. A data source device as defined in clause 368 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and
(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and
(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

371. A data source device as defined in clause 370 in which the frame transmission module is configured to, insert a command to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

372. A data source device as defined in clause 362 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

373. A data source device as defined in clause 372 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

374. A data source device as defined in clause 371 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

375. A data source device as defined in clause 374 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

376. A data source device as defined in clause 371 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and
(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and
(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

377. A data source device for distributing a series of frames for execution by at least one other device at respective execution times, the data source device comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;
B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time, the frame execution time determination module being configured to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by a clock maintained by the data source device; and
C. a frame transmission module configured to transmit the series of frames to said at least one other device.

377. A system as defined in clause 377 in which the data source device is configured to select the delay interval

between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

379. A system as defined in clause 378 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

380. A system as defined in clause 377 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

381. A data source device for distributing a series of frames for execution by at least one other device, the data source device comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;
B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to transmit the series of frames to said at least one other device; and
D. a data source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

382. A method for operating a system to facilitate processing of data by device operating as a member of a synchrony group, synchronously with a clock maintained by a data source device that provides the data to the synchrony group, the method including the steps of

A. enabling the data source device being to divide the data into a series of frames for distribution to the synchrony group, each frame being associated with a time stamp indicating a time, relative to a clock maintained by the data source device, at which the devices comprising the synchrony group are to process the frame;
B enabling each member device in the synchrony group to:

(i) periodically obtain from the data source device an indication of a current time value indicated by the data source device's clock;
(ii) receive the series of frames from the data source device;
(iii) determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value indicated by the data source device's clock, a current time value indicated by the member device's respective clock, a time, relative to the member device's respective clock, at which the member device is to process the frame; and
(iv) process the respective frame at the determined time.

383. A method as defined in clause 382 in which at least one frame comprises audio data, each member device, while processing each frame, being enabled to generate a signal representing sound represented by the respective frame.

384. A method as defined in clause 382, the system comprising a plurality of member devices, the method including the steps of enabling the member devices to process each frame synchronously in relation to the clock maintained by the data source device so that they all produce sound represented by the respective frame synchronously.

385. A method as defined in clause 384 including the step of enabling the data source device to provide time stamps for at least two successive frames so that the member devices will play them with a selected time interval therebetween.

386. A method as defined in clause 385 in which the time interval is zero.

387. A method as defined in clause 382 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the method including the step of enabling the master device to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

388. A method as defined in clause 387, the method including the step of enabling the master device to perform at least one type of synchrony group management operation in response to control information provided thereto by a user interface module.

389. A method as defined in clause 388 further including the step of enabling the master device to provide status information relating to the status of the synchrony group to the user interface module.

390. A method as defined in clause 389 in which the status information includes identifications of the devices comprising the synchrony group.

391. A method as defined in clause 389 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, each audio track being associated with an identifier, the status information including the identification of the audio track currently being played.

392. A method as defined in clause 388 the method comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is configured to enable the at least one additional device to join the synchrony group as a slave device.

393. A method as defined in clause 392 in which the data source device is configured to distribute frames to the member devices using a selected multi-cast transmission methodology, the member devices being configured to buffer the frames until they are to be played, the method including the step of, when the at least one additional device joins the synchrony group as a slave device, the enabling the data source device to transmit at least one previously distributed frame to the slave device using a selected unicast transmission methodology.

394. A method as defined in clause 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to enable the data source device to join the synchrony group as a slave device, the data source device continuing to operate as the data source device for the synchrony group.

395. A method as defined in clause 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group and not playing frames distributed by the data source device.

396. A method as defined in clause 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to control the series of frames to be distributed by the data source device.

397. A method as defined in clause 387 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, the method including the step of enabling the master device being configured to control the frames to be distributed by the data source device on a track-by-track basis.

398. A method as defined in clause 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to control playback by the member devices of the frames associated with the respective audio tracks that have been distributed by the data source device in response to control information from the user interface module.

399. A method as defined in clause 387 in which, in response to control information from the user interface module to facilitate control of playback by the member devices, the method includes the step of enabling the master device to enable the data source device to distribute a playback control command to the member devices.

400. A method as defined in clause 399 in which a playback control command enables the member devices to terminate playback of a track that is currently being played back.

401. A method as defined in clause 399 in which the playback control command enables the member devices to terminate playback of a track with a frame subsequent to a frame currently being played.

402. A method as defined in clause 399 in which the playback control command enables the member devices to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

403. A method as defined in clause 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the member device operating as the master device to enable the master device to migrate from itself to another member device in the synchrony group.

404. A method as defined in clause 403 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to enable the data source device to migrate from one device to another device in the system.

405. A method as defined in clause 404 in which

A. the device operating as the data source device is enable to perform the step of, after being enabled to migrate the data source device to said other device, providing migration information to the other device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices,
B. the other device is enabled to, after receiving the migration information, perform the steps of

i. distributing the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and
ii. notifying the members of the synchrony group that it is to thereafter operate as the data source device.

406. A method as defined in clause 405 in which the information respecting the frames that are to be distributed is a source of streaming information, the other device being enabled to, after receiving the migration information, perform the steps of assembling the streaming information into frames and associating each frame with a said time stamp.

407. A method as defined in clause 405 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the other device being enabled to perform the steps of obtaining information from the identified file, assembling the information into frames and associating each frame with a said time stamp.

408. A method as defined in clause 407 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being enabled to perform the step of assembling the information from a position in the file associated with the identified offset.

409. A method as defined in clause 407 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the other device being enabled to perform the step of obtaining information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

410. A method as defined in clause 382 including the step in which the data source is further configured to distribute the frames using a selected multi-cast message transmission methodology, the device being enabled to receive the frames using the selected multi-cast message transmission methodology.

411. A method as defined in clause 382 in which the data source device is enabled to perform the step of providing, provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

412. A method as defined in clause 411 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

413. A method as defined in clause 411 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

414. A method as defined in clause 411 in which data source device is enabled to perform the steps of obtaining information associated with the frames from at least two types of information sources, and selecting, for each frame, the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

415. A method as defined in clause 382 in which at least one member device is further enabled to perform the step of adjusting its clock rate in relation to a clock rate value maintained by the data source device's clock.

416. A method as defined in clause 415 in which the at least one member device is enabled to perform the step of adjusting its clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

417. A method as defined in clause 382 in which at least one other device operates as a data source device configured to distribute frames to a second synchrony group, the method including the steps of enabling the device to operate both as the data source device for the first synchrony group and also operating as a member device of a second synchrony group.

418. A method as defined in clause 382 including, within a member device,

A. a frame receiving step of receiving the series of frames,
B. a current time retrieval step of obtaining, from the data source device, the current time value as indicated by the frame source's clock;
C. an execution time determination step of determining, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the member device's respective clock at which the frame is to be executed; and
D. a frame execution step of executing each respective frame at the time determined during the execution time determination step.

419. A method as defined in clause 418 further including a control step for controlling execution of commands received during the frame receiving step

420. A method as defined in clause 419 in which the at least one member device further comprises a buffer configured to buffer frames received from the data source device during the frame receiving step until they are to be executed, the frame execution step including the step of executing the buffered frames at the times determined during the execution time determination step.

420. A method as defined in clause 420 in which the series of frames includes a series of frame sequences with each frame sequence including a subset of the series of frames, the frame receiving step being further enabled to receive frame execution control commands for controlling frame execution, the control step including the step of, in response to receipt of at least one frame execution control command for controlling frame execution, controlling the frame execution step to terminate execution of a frame sequence currently being executed, and further to not execute subsequent frames in the frame sequence that have been buffered.

422. A method as defined in clause 421 in which the control step includes the step of enabling the frame execution step to resume execution of at least one frame associated with a subsequent frame sequence at a time determined during the execution time determination step.

423. A method as defined in clause 420 in which the series of frames includes a series of frame sequences with each frame sequence including a subset of the series of frames, the frame receiving step including the step of receiving frame execution control commands for controlling frame execution, the control step including the step of, in response to receipt of at least one frame execution control command to cancel execution of a frame sequence for which at least one frame has been buffered but for which execution has not begun, providing that frames from that frame sequence that have been buffered not be executed.

424. A method as defined in clause 423 in which the control step includes the step of enabling execution to resume of at least one frame associated with a frame sequence subsequent to the frame sequence for which at least one frame has been buffered but for which execution has not begun.

425. A method as defined in clause 418 in which the member device performs:

A. migration information receiving step of receiving migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and
B. a migration control step of, after the migration information has been received.,

i. distributing the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and
ii. notifying the members of the synchrony group that it is to thereafter operate as the data source device.

426. A method as defined in clause 425 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into frames and associating each frame with a said time stamp.

427. A method as defined in clause 425 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into frames and associating each frame with a said time stamp.

428. A method as defined in clause 427 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

429. A method as defined in clause 427 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into frames and associating each frame with as said time stamp.

430. A method as defined in clause 418 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

431. A method as defined in clause 430 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

432. A method as defined in clause 382 of operating a device for distributing a series of frames for execution by at least one other device at respective execution times, the method comprising:

A. a frame acquisition step of obtaining respective ones of the frames;
B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission step of transmitting the series of frames to said at least one other device; and
D. an execution control command generation step of, in response to a predetermined event and during the

frame transmission step, the insertion into the series of frames transmitted by the frame transmission module of a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

433. A method as defined in clause 432 in which the frame transmission step includes the step of utilizing a selected multi-cast transmission methodology.

434. A method as defined in clause 432 in which the predetermined event includes the step of receiving input indicia provided by an operator.

435. A method as defined in clause 434 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

436. A method as defined in clause 435 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

437. A method as defined in clause 434 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the frame transmission step the insertion, into the series of frames, of a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and
(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and
(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

438. A method as defined in clause 437 in which the frame transmission step includes the step of inserting a command into the frame sequence to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

439. A method as defined in clause 435 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

440. A method as defined in clause 439 in which the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

441. A method as defined in clause 439 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the inserting into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

442. A method as defined in clause 441 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame,

in relation to the frame's position in the series of frames, for which execution has not begun.

443. A method as defined in clause 439 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the frame transmission step, the insertion, into the series of frames, of a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and
(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and
(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

444. A method as defined in clause 382 in which the data source device is enabled to perform

A. a frame acquisition step of obtaining respective ones of the frames;
B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission step of transmitting the series of frames to said at least one other device; and
D. a data source device migration control step of, in response to a predetermined event, providing migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

445. A method as defined in clause 382 in which the data source device is enabled to perform the step of providing, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

446. A method as defined in clause 445 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

447. A method as defined in clause 446 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp.

448. A method as defined in clause 445 in which data source device is enabled to perform the step of obtaining information associated with the frames from at least two types of information sources, and selecting for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

449. A method of enabling a device to process a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the device comprising

A. an interface step of receiving the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;
B. a current time retrieval step of obtaining, from the data source, a current time value as indicated by the data source's clock;
C. an processing time determination step of determining, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and

D. a frame processing step of processing each respective frame at the time determined during the processing time determination step.

450. A method as defined in clause 449 in which at least one frame comprises audio data, each member device, while processing said at least one frame, generating a signal representing sound represented by the respective frame.

451. A method as defined in clause 449 further including a control step for controlling execution of commands received by said device.

452. A method as defined in clause 451 further comprising a buffer configured to buffer frames that the interface module has received until they are to be processed, the frame processing step including the step of processing the buffered frames at the times determined during the processing time determination step.

453. A method as defined in clause 451 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to receive playback control commands for controlling processing of tracks, the method including the step of enabling the control module to execute at least one playback control command controlling track processing.

454. A method as defined in clause 453 including the step of, in response to at least one type of playback control command, enabling the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

455. A method as defined in clause 454 including the step of, in response to the playback control command, enabling the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

456. A method as defined in clause 452 including the step of, in response to the playback control command, enabling the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

457. A method as defined in clause 453 including the step of enabling the control module to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

458. A method as defined in clause 449 including the step of enabling the control module to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames for processing by the frame processing module.

459. A method as defined in clause 458 including the step of enabling the control module to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed frame using a selected unicast transmission methodology.

460. A method as defined in clause 449 including the step of enabling the control module to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving frames and the frame processing module from processing previously received frames that have not yet been processed.

461. A method as defined in clause 449, further including the steps of receiving control information from a user interface module, and enabling the control module to enable selected operations to be performed in response to the control information.

462. A method as defined in clause 461 including the step of, in response to control information to enable another device to become a member of the device's synchrony group, enabling the control module to enable the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

463. A method as defined in clause 461 including the step of, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, enabling the control module to enable transmission of a command to the other device to enable the other device to disengage

from the synchrony group.

464. A method as defined in clause 461 including the step of, in response to control information to enable the data source to begin operating, enabling the control module to perform selected operations to enable the data source to begin operating.

465. A method as defined in clause 464, the device also operating as the data source, the method including a frame generator step of, under control of the control module, obtaining information from which the frames are to be generated and generating the frames.

466. A method as defined in clause 465 further comprising the step of transmitting the frames to at least one other device.

467. A method as defined in clause 465 in which the device is not the data source, the method including the step of enabling the control module to enable transmission of a command to enable the data source to operate.

468. A method as defined in clause 467 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track currently being processed to be terminated, the method including the step of enabling the control module to enable transmission of a command to enable the data source to insert a resynchronize command in the series of frames associated with the track to enable termination of processing of the track.

469. A method as defined in clause 467 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track at least a portion of which has been received, but for which processing has not begun, the method including the step of enabling the control module to enable transmission of a command to enable the data source to insert a resynchronize command in the series of commands to disable processing of the track.

470. A method as defined in clause 451 further including the step of enabling the control module to enable the user interface module interface module to transmit status information to the user interface module.

471. A method as defined in clause 470 in which the status information includes the processing status of at least one frame.

472. A method as defined in clause 469 in which the member device performs:

A. migration information receiving step of receiving migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and
B. a migration control step of, after the migration information has been received.,

i. distributing the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and
ii. notifying the members of the synchrony group that it is to thereafter operate as the data source device.

473. A method as defined in clause 472 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into frames and associating each frame with a said time stamp.

474. A method as defined in clause 472 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into frames and associating each frame with a said time stamp.

475. A method as defined in clause 474 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including

the step of assembling the information from a position in the file associated with the identified offset.

476. A method as defined in clause 474 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into frames and associating each frame with as said time stamp.

477. A method as defined in clause 449 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

478. A method as defined in clause 477 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

479. A method of operating a device for distributing a series of frames for execution by at least one other device at respective execution times, the method comprising:

A. a frame acquisition step of obtaining respective ones of the frames;
B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission step of transmitting the series of frames to said at least one other device; and
D. an execution control command generation step of, in response to a predetermined event and during the frame transmission step, the insertion into the series of frames transmitted by the frame transmission module of a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

480. A method as defined in clause 479 in which at least one frame comprises audio data.

481. A method as defined in clause 479 in which the frame transmission step includes the step of utilizing a selected multi-cast transmission methodology.

482. A method as defined in clause 479 in which the predetermined event includes the step of receiving input indicia provided by an operator.

483. A method as defined in clause 482 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

484. A method as defined in clause 483 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

485. A method as defined in clause 482 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the frame transmission step the insertion, into the series of frames, of a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and
(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and

(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

486. A method as defined in clause 485 in which the frame transmission step includes the step of inserting a command into the frame sequence to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

487. A method as defined in clause 479 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

488. A method as defined in clause 487 in which the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

489. A method as defined in clause 487 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the inserting into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

490. A method as defined in clause 489 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

491. A method as defined in clause 488 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the frame transmission step, the insertion, into the series of frames, of a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and
(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and
(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

492. A method of operating a device for distributing a series of frames for execution by at least one other device at respective execution times, the method comprising:

A. a frame acquisition step of obtaining respective ones of the frames;
B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associating the respective frame with a time stamp indicating its execution time, the frame execution time determination step including the step of providing, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by a clock maintained by the data source device; and
C. a frame transmission step of transmitting the series of frames to said at least one other device.

493. A method as defined in clause 492 in which at least one frame comprises audio data.

494. A method as defined in clause 492 in which the frame execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the device can be executed by at least one other device at the time indicated by the time stamp.

495. A method as defined in clause 494 in which the frame execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the device can be distributed to other devices over a network for execution by the other devices at the time indicated by the time stamp.

496. A method as defined in clause 492 in which frame acquisition step includes the step of obtaining information associated with the frames from at least two types of information sources, the frame execution time determination step including the step of selecting, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

497. A method of operating a device for distributing a series of frames for execution by at least one other device, the method comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;
B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to transmit the series of frames to said at least one other device; and
D. a data source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

498. A method as defined in clause 497 in which at least one frame comprises audio data.

499. A computer program product for use in connection with a computer to provide a device for processing a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the computer program product comprising a computer-readable medium having encoded thereon

A. an interface module configured to enable the computer to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;
B. a current time retrieval module configured to enable the computer to obtain, from the data source, a current time value as indicated by the data source's clock;
C. an processing time determination module configured to enable the computer to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and
D. a frame processing module configured to enable the computer to process each respective frame at the time determined by the processing time determination module.

500. A computer program product as defined in clause 499 in which at least one frame comprises audio data, the computer, while processing said frame, generating a signal representing sound represented by the respective frame.

501. A computer program product as defined in clause 499 further including a control module a control module for enabling said computer to control execution of commands received by the interface module.

502. A computer program product as defined in clause 501 further comprising a buffer configured to enable the computer to buffer frames that the interface module has received until they are to be processed, the frame processing module being configured to enable the computer to process the buffered frames at the times determined by the processing time determination module.

503. A computer program product as defined in clause 502 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to enable the computer to receive playback control commands for controlling processing of tracks, the control module being configured to enable the computer to execute at least one playback control command controlling track processing.

504. A computer program product as defined in clause 503 in which at least one type of playback control command

enables the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

505. A computer program product as defined in clause 504 in which the playback control command enables the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

506. A computer program product as defined in clause 503 in which the playback control command enables the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

507. A computer program product as defined in clause 503 in which the control module is configured to enable the computer to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

508. A computer program product as defined in clause 501, the control module being configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames for processing by the frame processing module.

509. A computer program product as defined in clause 508 in which the control module is configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed frame using a selected unicast transmission methodology.

510. A computer program product as defined in clause 501 in which the control module is configured to enable the computer to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving frames and the frame processing module from processing previously received frames that have not yet been processed.

511. A computer program product as defined in clause 501 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable the computer to enable selected operations to be performed in response to the control information.

512. A computer program product as defined in clause 511 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

513. A computer program product as defined in clause 511 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

514. A computer program product as defined in clause 511 in which, in response to control information to enable the data source to begin operating, the control module performs selected operations to enable the data source to begin operating.

515. A computer program product as defined in clause 514, the device also operating as the data source, the device including a frame generator module configured to enable the computer to, under control of the control module, obtain information from which the frames are to be generated and generate the frames.

516. A computer program product as defined in clause 515 in which the interface module is further configured to enable the computer to transmit the frames to at least one other device.

517. A computer program product as defined in clause 515 in which the device is not the data source, the control module being configured to enable the computer to enable the interface module to transmit a command to enable the data source to operate.

518. A computer program product as defined in clause 517 in which each frame is associated with a track, each

track including at least one frame, and, in response to receipt of control information enabling processing of a track currently being processed to be terminated, the control module is configured to enable the computer to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of frames associated with the track to enable termination of processing of the track.

519. A computer program product as defined in clause 517 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track at least a portion of which has been received, but for which processing has not begun, the control module is configured to enable the computer to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of commands to disable processing of the track.

520. A computer program product as defined in clause 517 in which the control module is configured to enable the computer to enable the user interface module interface module to transmit status information to the user interface module.

521. A computer program product as defined in clause 520 in which the status information includes the processing status of at least one frame.

522. A computer program product as defined in clause 499 further including:

A. a migration information receiving module configured to enable the computer to receive migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and
B. a migration control module configured to enable the computer to, after the migration information has been received.,

i. distribute the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and
ii. notify the members of the synchrony group that it is to thereafter operate as the data source device.

523. A computer program product as defined in clause 522 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control module being configured to enable the computer to, after the migration information has been received, assemble the streaming information into frames and associate each frame with a said time stamp.

524. A computer program product as defined in clause 522 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control module being configured to enable the computer to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

525. A computer program product as defined in clause 524 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to enable the computer to assemble the information from a position in the file associated with the identified offset.

526. A computer program product as defined in clause 524 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to enable the computer to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

527. A computer program product as defined in clause 499 further including a clock rate adjustment module configured to enable the computer to adjust the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

528. A computer program product as defined in clause 527 in which the clock rate adjustment module is configured to enable the computer to adjust the clock rate in relation to time stamps associated with respective ones of the

frames received from the data source device.

529. A computer program product for use in connection with a computer to provide a data source device for distributing a series of frames for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a frame acquisition module configured to enable the computer to obtain respective ones of the frames;
B. a frame execution time determination module configured to enable the computer to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to enable the computer to transmit the series of frames to said at least one other device; and
D. an execution control command generation module configured to enable the computer to, in response to a predetermined event, enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

530. A computer program product as defined in clause 529 in which at least one frame comprises audio data.

531. A computer program product as defined in clause 529 in which the frame transmission module is configured to enable the computer to utilize a selected multi-cast transmission methodology.

532. A computer program product as defined in clause 529 in which the predetermined event comprises input indicia provided by an operator.

533. A computer program product as defined in clause 529 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

534. A computer program product as defined in clause 533 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

535. A computer program product as defined in clause 533 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to enable the computer to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and
(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and
(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

536. A computer program product as defined in clause 535 in which the frame transmission module is configured to enable the computer to insert a command to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

537. A computer program product as defined in clause 529 in which, in response to said predetermined event, the

execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

538. A computer program product as defined in clause 537 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

539. A computer program product as defined in clause 537 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

540. A computer program product as defined in clause 539 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

541. A computer program product as defined in clause 537 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to enable the computer to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and
(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and
(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

542. A computer program product for use in connection with a computer to provide a data source device for distributing a series of frames for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a frame acquisition module configured to enable the computer to obtain respective ones of the frames;
B. a frame execution time determination module configured to enable the computer to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time, the frame execution time determination module being configured to enable the computer to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by a clock maintained by the data source device; and
C. a frame transmission module configured to enable the computer to transmit the series of frames to said at least one other device.

543. A computer program product as defined in clause 542 in which the data is audio data.

544. A computer program product as defined in clause 542 in which the frame execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

545. A computer program product as defined in clause 544 in which the frame execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and

the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp.

546. A computer program product as defined in clause 542 in which frame acquisition module is configured to enable the computer to obtain information associated with the frames from at least two types of information sources, the frame execution time determination module being configured to enable the computer to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

547. A computer program product for use in connection with a computer to provide a data source device for distributing a series of frames for execution by at least one other device, the computer program product comprising a computer readable medium having encoded thereon:

A. a frame acquisition module configured to enable the computer to obtain respective ones of the frames;
B. a frame execution time determination module configured to enable the computer to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;
C. a frame transmission module configured to enable the computer to transmit the series of frames to said at least one other device; and
D. a data source device migration control module configured to enable the computer to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

548. A computer program product as defined in clause 547 in which the data is audio data.

Claims

1. A playback device (21) comprising:

a network interface (41) configured to receive an audio stream from a source device (14(n)(s); 16(m)) over a network (12);
an audio reproduction device interface (36) configured to output the audio stream from one or more audio reproduction devices (15(n)(r));
a user interface module interface (44) configured to transmit, via the network interface (41), to a user interface module (13), status information pertaining to a status of a synchrony group (20), wherein the playback device (21) is a member of the synchrony group (20) along with at least one additional zone playback device (11(n)).

2. A playback device (21) according to claim 1, wherein the status information comprises an identification of members of the synchrony group (20).

3. A playback device (21) according to claim 2, wherein the status information further comprises an identification of said playback device (21) as being a master member of the synchrony group (20).

4. A playback device (21) according to claim 2 or claim 3, wherein the status information further comprises an identification of said at least one additional zone playback device (11(n)) as being a slave member of the synchrony group (20).

5. A playback device (21) according to any of claims 1 to 4, wherein the status information further comprises an identification of the audio that is currently being played by members of the synchrony group (20).

6. A playback device (21) according to any of claims 1 to 5, wherein the status information further comprises an identification of audio that is scheduled to be played by the members of the synchrony group (20).

7. A playback device (21) according to any of claims 1 to 6, wherein the user interface module interface (44) is further configured to transmit status information, via the network interface (41), to one or more additional user interface modules.

8. A playback device (21) according to any of claims 1 to 7, wherein the playback device (21) further comprises an audio information channel device (23), the audio information channel device (23) being configured to transmit the audio stream, via the network interface (41), to said at least one additional zone playback device (11(n)) in the synchrony group (20).

9. A method of controlling audio playback, comprising:

receiving, by a network interface (41), an audio stream from a source device (14(n)(s); 16(m)) over a network (12);
outputting, via an audio reproduction device interface (36), the audio stream from one or more audio reproduction devices (15(n)(r));
transmitting, by a user interface module interface (44) and via the network interface (41) to a user interface module (13), status information pertaining to a status of a synchrony group (20), wherein the playback device (21) is a member of the synchrony group (20) along with at least one additional zone playback device (11(n)).

10. A method according to claim 9, wherein the status information comprises an identification of members of the synchrony group (20).

11. A method according to claim 10, wherein the status information further comprises an identification of said playback device (21) as being a master member of the synchrony group (20).

12. A method according to claim 10 or claim 11, wherein the status information further comprises an identification of said at least one additional zone playback device (11(n)) as being a slave member of the synchrony group (20).

13. A method according to any of claims 9 to 12, wherein the status information further comprises an identification of the audio that is currently being played by members of the synchrony group (20).

14. A method according to any of claims 9 to 13, wherein the status information further comprises an identification of audio that is scheduled to be played by the members of the synchrony group (20).

15. A method according to any of claims 9 to 14, wherein the method further comprises transmitting status information, by the user interface module interface (44) and via the network interface (41), to one or more additional user interface modules.

16. A method according to any of claims 9 to 15, wherein the method further comprises transmitting, by an audio information channel device (23) of the playback device (21), and via the network interface, the audio stream to said at least one additional zone playback device (11(n)) in the synchrony group (20).

17. A computer program comprising a set of instructions which, when executed by a processor, or a set of processors, of a playback device (21), causes the playback device (21) to perform the method according to any of claims 9 to 16.

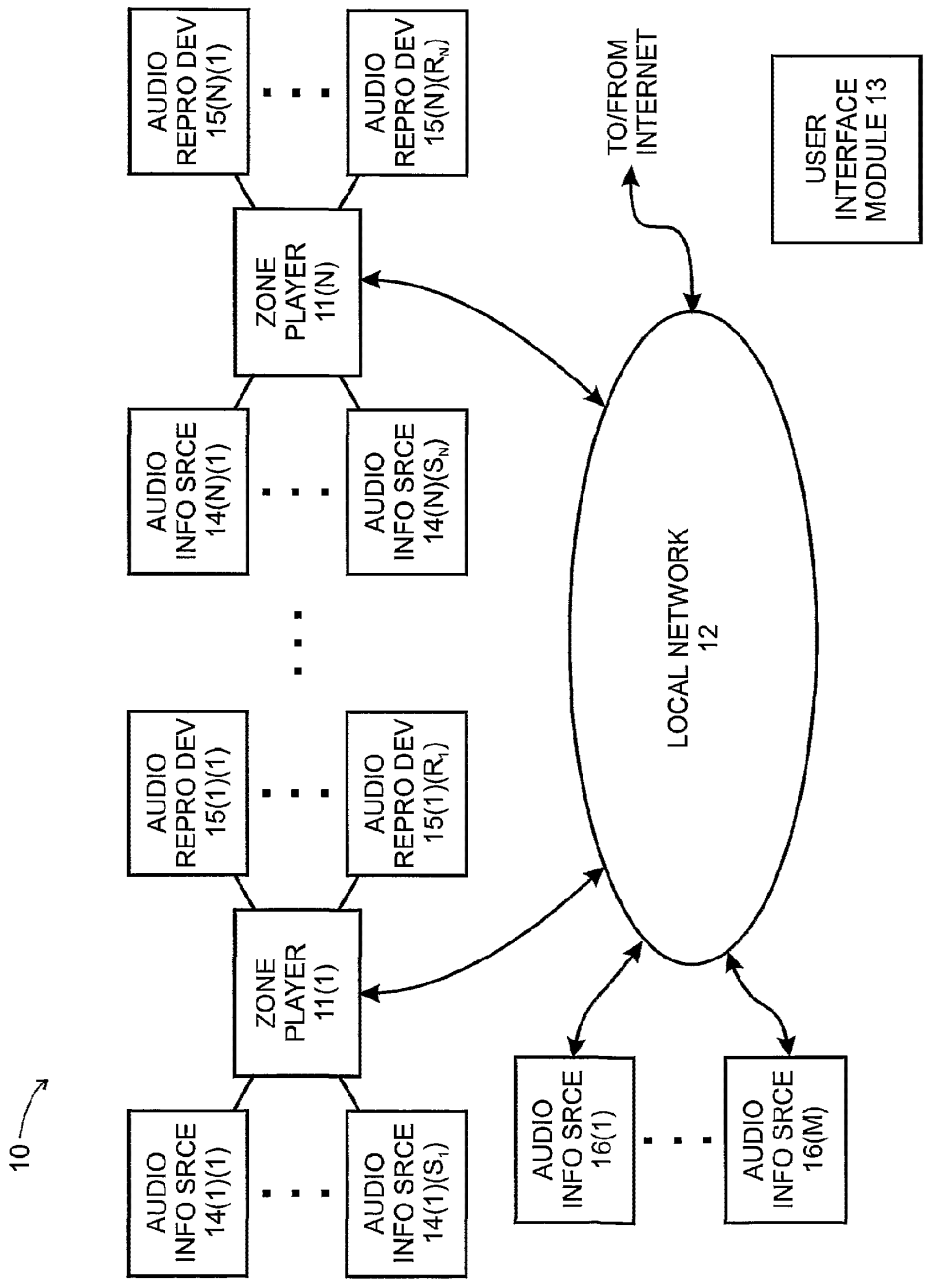

10
AUDIO INFO SRCE 14(1)(1)
AUDIO INFO SRCE 14(1)(S1)
AUDIO REPRO DEV 15(1)(1)
AUDIO REPRO DEV 15(1)(R1)
ZONE PLAYER 11(1)
AUDIO INFO SRCE 14(N)(1)
AUDIO INFO SRCE 14(N)(SN)
AUDIO REPRO DEV 15(N)(1)
AUDIO REPRO DEV 15(N)(RN)
ZONE PLAYER 11(N)
LOCAL NETWORK 12
TO/FROM INTERNET
USER INTERFACE MODULE 13
AUDIO INFO SRCE 16(1)
AUDIO INFO SRCE 16(M)

FIG. 1

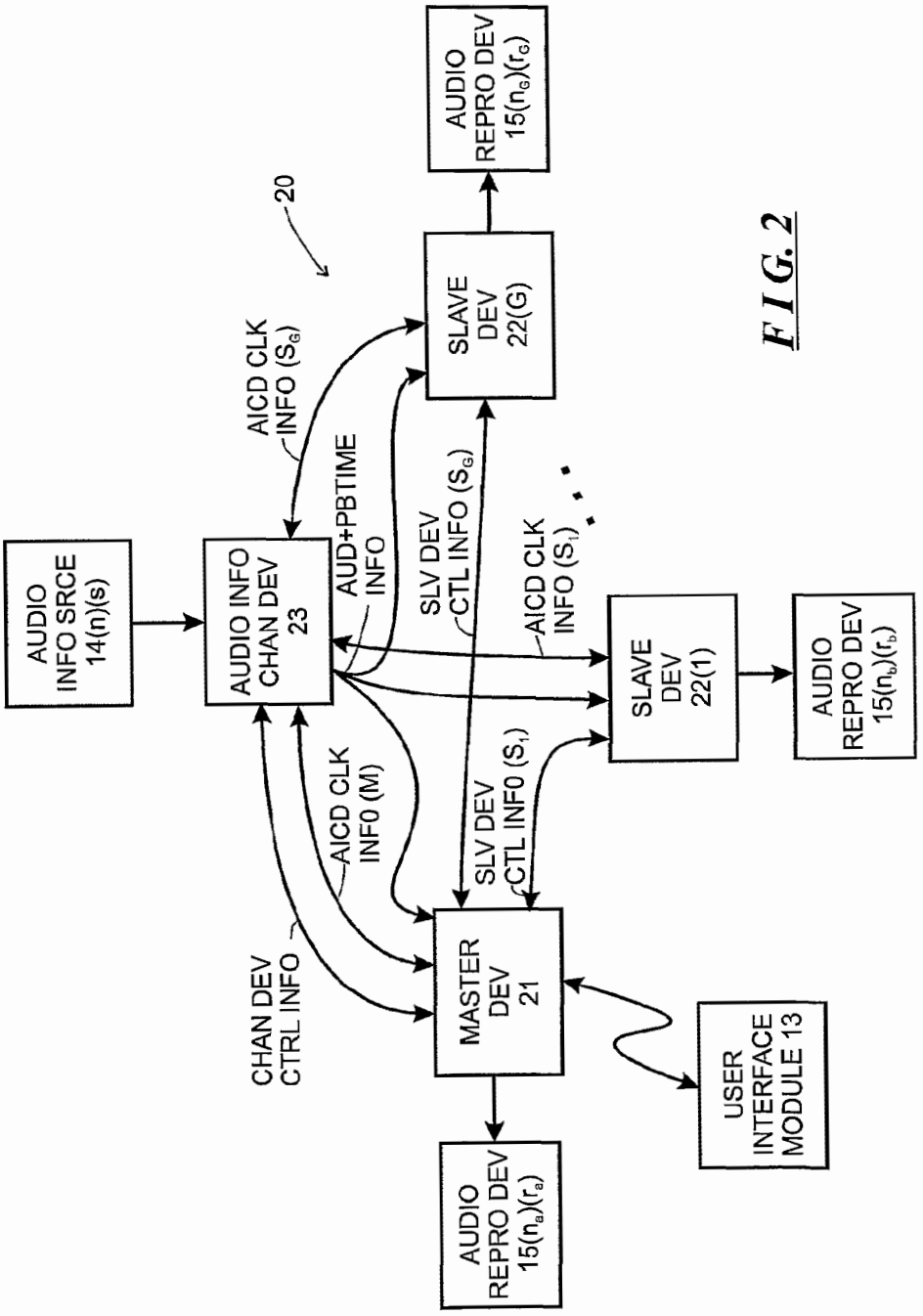

20
AUDIO INFO SRCE 14(n)(s)
AUDIO INFO CHAN DEV 23
AICD CLK INFO (S_G)
AUD+PBTIME INFO
SLV DEV CTL INFO (S_G)
AICD CLK INFO (S_1)
SLAVE DEV 22(G)
AUDIO REPRO DEV 15(n_G)(r_G)
SLAVE DEV 22(1)
AUDIO REPRO DEV 15(n_b)(r_b)
AICD CLK INFO (M)
SLV DEV CTL INFO (S_1)
CHAN DEV CTRL INFO
MASTER DEV 21
USER INTERFACE MODULE 13
AUDIO REPRO DEV 15(n_a)(r_a)

FIG. 2

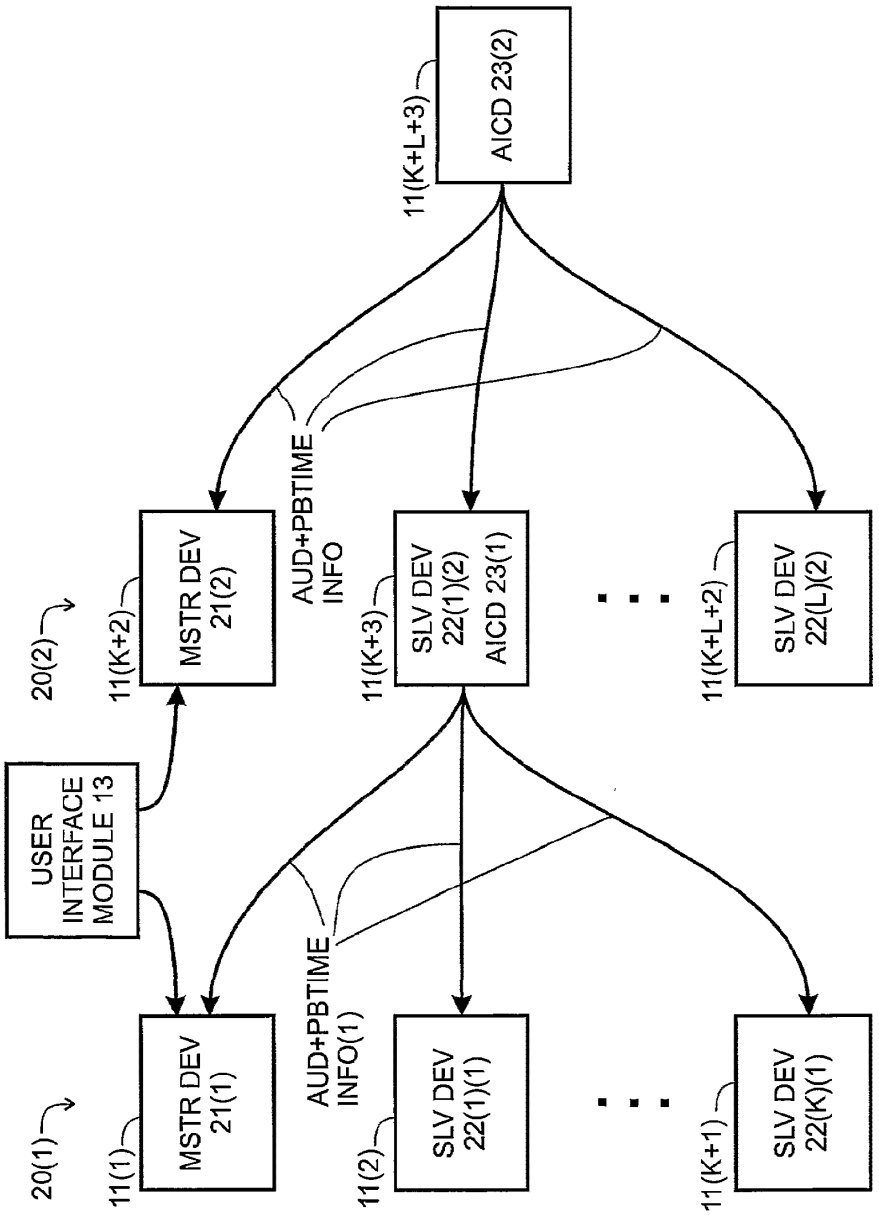

AICD 23(2)
11(K+L+3)
AUD+PBTIME INFO
20(2)
11(K+2)
MSTR DEV 21(2)
11(K+3)
SLV DEV 22(1)(2) AICD 23(1)
11(K+L+2)
SLV DEV 22(L)(2)
USER INTERFACE MODULE 13
AUD+PBTIME INFO(1)
20(1)
11(1)
MSTR DEV 21(1)
11(2)
SLV DEV 22(1)(1)
11(K+1)
SLV DEV 22(K)(1)

FIG. 2A

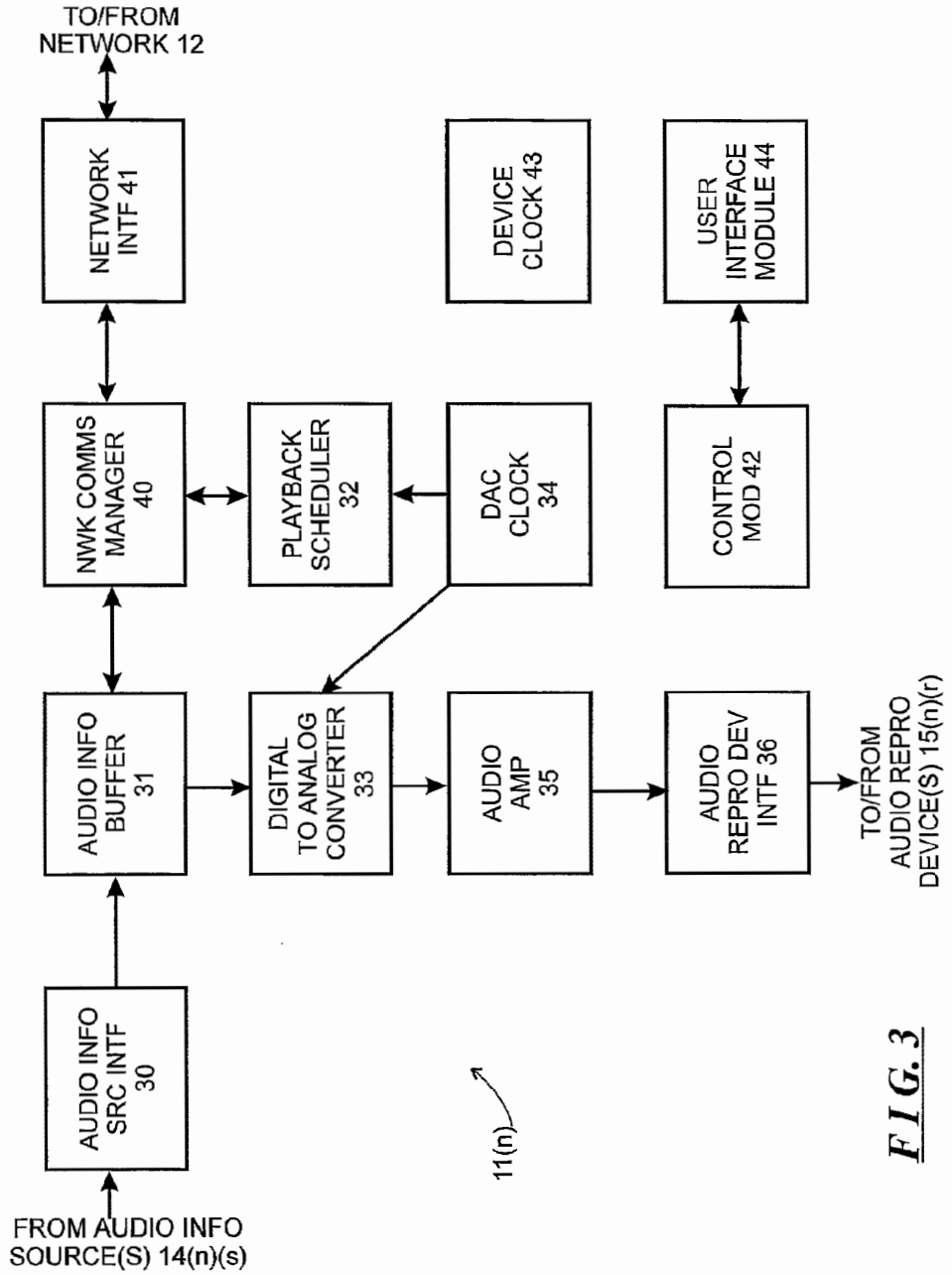

TO/FROM NETWORK 12
NETWORK INTF 41
DEVICE CLOCK 43
USER INTERFACE MODULE 44
NWK COMMS MANAGER 40
PLAYBACK SCHEDULER 32
DAC CLOCK 34
CONTROL MOD 42
AUDIO INFO BUFFER 31
DIGITAL TO ANALOG CONVERTER 33
AUDIO AMP 35
AUDIO REPRO DEV INTF 36
TO/FROM AUDIO REPRO DEVICE(S) 15(n)(r)
AUDIO INFO SRC INTF 30
11(n)
FROM AUDIO INFO SOURCE(S) 14(n)(s)

FIG. 3

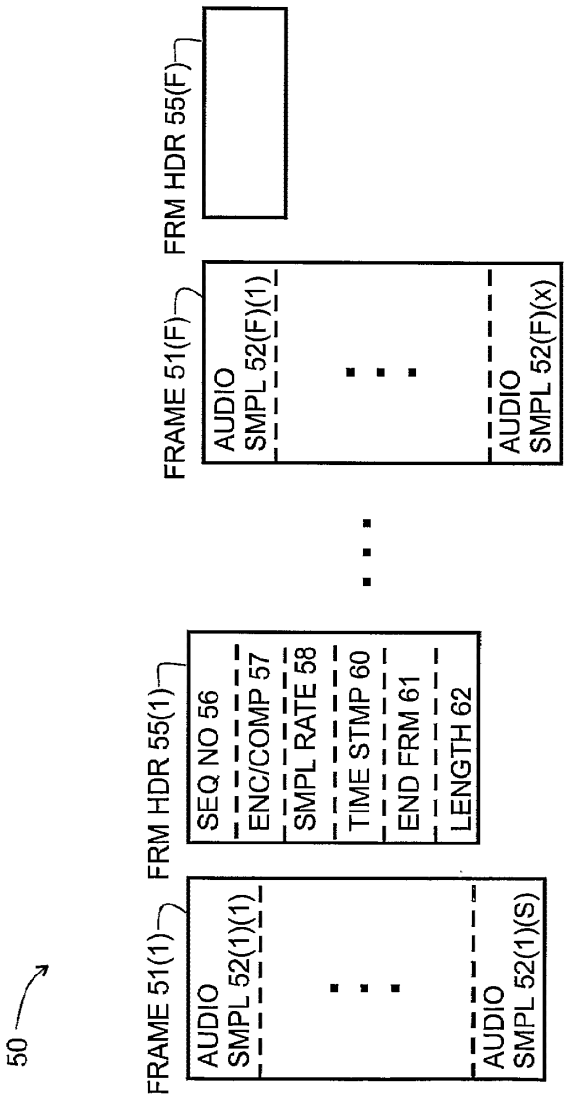

50
FRAME 51(1)
AUDIO SMPL 52(1)(1)
AUDIO SMPL 52(1)(S)
FRM HDR 55(1)
SEQ NO 56
ENC/COMP 57
SMPL RATE 58
TIME STMP 60
END FRM 61
LENGTH 62
FRAME 51(F)
AUDIO SMPL 52(F)(1)
AUDIO SMPL 52(F)(x)
FRM HDR 55(F)

FIG. 4

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 13 18 4747

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2003/023741 A1 (TOMASSETTI STEPHEN ROBERT [US] ET AL) 30 January 2003 (2003-01-30) * paragraph [0031] - paragraph [0043] * * paragraph [0064] - paragraph [0068] *	1-17	INV. G06F15/16 G06F9/48
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A	US 2002/194309 A1 (CARTER HARRY NICK [US] ET AL) 19 December 2002 (2002-12-19) * the whole document *	1-17	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 February 2014	Meyer-Vitali, André

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

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EUROPEAN SEARCH REPORT

Application Number
EP 13 18 4747

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 February 2014	Meyer-Vitali, André

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 18 4747

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-02-2014

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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09/563,173	2 May 2000 (02.05.2000)	US
09/562,939	2 May 2000 (02.05.2000)	US
09/563,104	2 May 2000 (02.05.2000)	US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier applications:

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US	09/563,250 (CIP)
Filed on	2 May 2000 (02.05.2000)
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Filed on	2 May 2000 (02.05.2000)
US	09/562,939 (CIP)
Filed on	2 May 2000 (02.05.2000)
US	09/563,104 (CIP)
Filed on	2 May 2000 (02.05.2000)

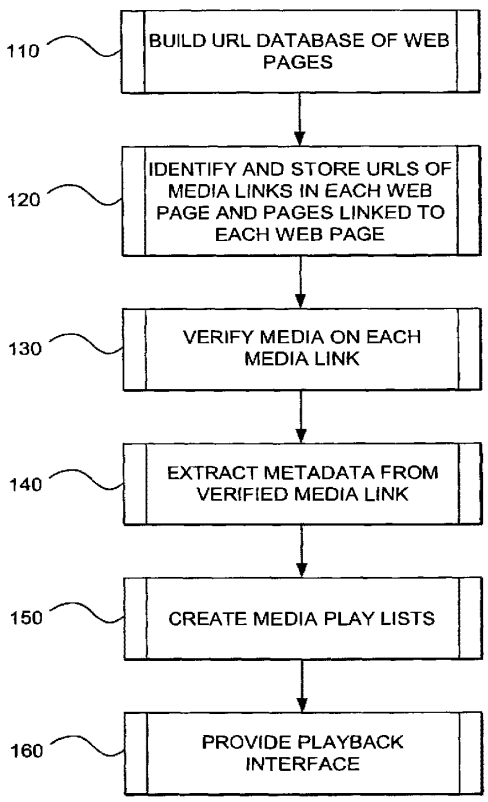
(71) Applicant *(for all designated States except US)*: **FRISKIT, INC.** [US/US]; Suite 124, 699 Mississippi Street, San Francisco, CA 94107 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **EYAL, Aviv**

[Continued on next page]

(54) Title: STREAMING MEDIA SEARCH AND PLAYBACK SYSTEM



(57) Abstract: A method is provided for playing back media from a network. The method includes receiving a search criteria from a network enabled device. The method further includes accessing a database comprising a plurality of network addresses, where the database associates each address with one or more classes of information. The addresses in the database each access a media network resource. The method further includes selecting at least one address in the database using the search criteria, and signaling the selected address to the network enabled device. The method also includes controlling the network enabled device so as to automatically access and play back the media resource of the selected address.

WO 01/53994 A2

[IL/US]; 690 Pennsylvania Avenue #210, San Francisco, CA 94107 (US). **APOSPOROS, George** [US/US]; 1340 Clay Street #25P, San Francisco, CA 94109 (US).

(74) Agent: MAHAMEDI, Van; Wilson Sonsini Goodrich & Rosati, 650 Page Mill Road, Palo Alto, CA 94304-1050 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

STREAMING MEDIA SEARCH AND PLAYBACK SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to the field of streaming media content search and playback over a network. In particular, the invention relates to a computer system that enables a continuous streaming media playback from a distribution of sites available over a network such as the Internet.

Description of the Related Art

Computers currently can access streaming media on the Internet. Streaming media available on the Internet include, for example, music, video clips such as movie trailers, home movies, and animation.

Users locate streaming media on the Internet by manually selecting links. Typically, users browse the media sites that contain numerous sub-links. Users sometimes select through a chain of links to locate a desired media on a media link. Once located, the desired media link may or may not contain the desired media.

Some services provide media search engine capabilities. Users may enter a search request for selected media creations by an artist. The media search engine then displays links to categories and/or sub-links of media that are determined to match one or more criteria in the search request set forth by the user. The determination of which links should be displayed in response to the search request is dependent on the algorithm used in by the search engine. Typically, links displayed to users of current search engines are not subject to a determination of the quality or availability of the media associated with the media links. Further, the search results are outputted to the user as a display of links for the user's selection.

Many Internet streaming media outlets provide a limited number of source nodes. The sites can be unreliable when the number of users accessing the site become congested.

SUMMARY OF THE INVENTION

An embodiment of the invention includes a method for playing back media from network. The method comprises receiving a search criteria from a network enabled device. The method further includes accessing a database comprising a plurality of network addresses, where the database associating each address with one or more classes of information. Each address accesses a media network resource. The method further includes selecting at least one address in the database using the search criteria, signaling the selected address to the network enabled device, and controlling the network enabled device so as to automatically access and play back the media resource of the selected address.

Another embodiment includes a method for playing back media from a network. The method includes receiving a request for media playback from a network enabled device. Further, accessing a database comprising a plurality of network addresses, where each address accessing a media network resource. The method also includes identifying at least two addresses from the database, signaling each identified address to the network enabled device, and controlling the network enabled device to access and automatically play back the media network resources of each of the signaled addresses.

In another embodiment, a computer system is provided for playing back media from a network. The computer system comprises a network enabled device comprising a media playback component. A database is included that comprises a plurality of addresses, where each address locates a media network resource on the network. The database includes one or more classes of information associated with each address in the plurality of addresses. The system also includes a network server module that is coupleable to the network enabled device and to the database. The network server module is able to receive a search request from the terminal that specifies one or more criterias. The network server module selects an address from the database that is associated with a class of information that matches the search criteria. The network server module signals the address to the network enabled device to cause the device to access the media network resource, and to signal media

playback component to load the media network resource after the device accesses the media network resource.

In another embodiment, a computer system is provided for playing back media from a network. The computer system includes a network enabled platform comprising a media playback component. A database includes a plurality of addresses, where each address locates a media network resource on the network. Each address accesses a media network resource. The embodiment further includes a network server module coupleable to the network enabled device and to the database. The network server receives a request for media playback from the network enabled device, selects multiple addresses from the database, and signal the multiple addresses to the network enabled device. The network server module control a media playback component on the network enabled device to use the addresses to automatically access and play back the media network resource associated with the addresses.

In another embodiment, a network enabled device is configured to playback media from a network. The network enabled device is coupleable over the network to a database that includes a plurality of addresses. Each address locates a media network resource on the network. The network enabled device includes a user-interface to prompt for a search request. The network interface signals the request to a network server module that is communicatable with the database, and receives one or more addresses in the database that match the search request. The network enabled device includes a media playback component that is configured to be programmatically controlled by the network server module to automatically load the media network resources located by the addresses that match the search request.

In another embodiment, a network enabled device is configured to playback media from a network. The network enabled device is coupleable over the network to a database comprising a plurality of addresses. Each address locates a media network resource on the network. The network enabled device comprises a user-interface including a plurality of user-interactive features, including a first user-interactive feature that prompts to receive a search request for media playback. A network interface signals the request to a network server module upon the first user-interactive feature receiving the

search request for media playback. The network interface is communicatable with the database to receive one or more addresses in the database that match the search request. A network playback component is configured to be programmatically controllable by the network server module to automatically load the media network resource associated with each address signaled to the network enabled device upon accessing the media network resource. A playback of the media playback component being controllable by one or more control user-interactive features.

An embodiment includes a system that provides media from a network to a terminal having a media playback component. The system includes a first network site and a second network site, where each network site locates one or more media network resources. Each media network resource is locatable on the network by a corresponding address that accesses the media network resource. A network server module is coupleable to the terminal through the network. The network server module identifies a first media network resource from the first network site and a second media network resource from the second network site. The network server module signals the corresponding address of the first media network resource to the terminal with control signals to cause the playback component to automatically load the first media network resource. The network server module automatically signals the corresponding address of the second media network resource to the terminal with control signals to cause the playback component to automatically load the second media network resource.

Another embodiment provides a media playback system for the Internet. The system includes an end terminal having a media playback component. A web server module is coupleable to the end terminal through the Internet. The web server module has access to one or more media web resources on a first web site, and to one or more media web resources on a second web site. The web server module signals a first link to a first media web resource on the first web site, and a second link to a second media web resource on the second web site. The web server module provides control signals to the end terminal to cause the end terminal to access and load the first media web resource and the second media web resource into the media playback component.

One or more of the embodiments may include a database that stores links to each of the plurality of media web resources, the web server module identifying the first link and the second link from the database.

Another embodiment includes a media playback system for the Internet. The system includes a terminal having a media playback component and a user-interface.

A web server module is coupleable to the user terminal through the Internet. The web server module has access to a plurality of links, where each link locates a media web resource. The plurality of links are accessible on a plurality of web sites. The web server module signals the plurality of links to the user terminal in a designated order to cause the terminal to load the media web resource located by each of the plurality of links into the media playback component. The embodiment also includes a database that stores the plurality of links. The database is accessible to signal the plurality of links to the web server module in the designated order. The user-interface signals one or more inputs from a user to the web server module. The one or more inputs direct the web server to alter the designated order in which the database signals the plurality of links to the web server module.

Another embodiment includes a system that provides media play-back on a network. The system includes a terminal that is coupleable to the network. A play-list module is coupleable to the terminal. The play-list module stores a first play-list signaled from the terminal. The first play-list includes a plurality of network addresses. A first network address locates a first media network resource on a first network site, and a second network address locates a second media network resource on a second network site. A network server module is coupleable to the terminal and to the play-list module. The network server module signals the first play-list to the terminal. The network server module controls the terminal to cause the terminal to access the media network resource associated with each network address in the first play-list, and to automatically load each respective media network resources into the media playback component.

Another embodiment includes a method for providing media to a terminal coupled to a network, where the terminal includes a media playback

component. A terminal is programmatically directed to access a first network site in the plurality of network sites. The media playback component on the terminal is caused to automatically load a first media web resource located at the first network site to playback a first media. The terminal is programmatically directed to access a second network site in the plurality of network sites. The media playback component on the terminal is caused to automatically load a second media web resource located at the second network site to playback a second media.

Another embodiment includes a method to provide media to a terminal coupled to the Internet. A database is accessed that stores a plurality of links, where each link opening a corresponding media web resource. A first link is selected from the database, the first link being located on a first network site. Next, a second link is selected from the database, the second link being located in a second network site. The second network site is external to the first network site. Then, the selected links are signaled to a media playback component on the terminal to sequentially access the media web resources associated with the selected links. The media playback component on the terminal is automatically signaled to load each of the media web resource accessed from the selected links so as to playback a media corresponding to each media web resource.

Another embodiment includes a system to share media playback from a network between a plurality of terminals. The plurality of terminals include a first terminal and a second terminal. The system includes a play-list component locatable on the network by a selectable link. The play-list component identifies a plurality of links to form a play-list, where each link in the play-list locating a media file on the network. The system includes a network server module that signals the plurality of links that form the play-list to the first terminal. The network server module receives a signal to transmit the selectable link to a second terminal to enable the second terminal to locate the play-list module.

In another embodiment, a method is provided to locate web resources on the Internet. A web site is accessed to identify a plurality of links using a web browser component. The web site can be automatically or programmatically accessed. Each of the plurality of links are selectable to open a corresponding

web resource of a specified data type on the web site. The plurality of links are made available to a plurality of Internet enabled devices that select one or more of the links.

Another embodiment includes a system to locating web resources on the Internet. The system includes a web browser component, and a database. A search module controls the web browser component to access at least one web site. The search module controls the web browser component to identify a plurality of links to media web resources at the web site. Each of the plurality of links are selectable to open a media web resource. The search module stores the plurality of links in the database.

Another embodiment includes a method to locate web resources on the Internet. A database that stores a plurality of links is accessed, the plurality of links being selectable to open a corresponding web media resources. Metadata information is programmatically identified about the web media resource corresponding to each of the plurality of links. The plurality of links are made accessible to a plurality of Internet enabled devices. The plurality of Internet enabled devices elect one or more of the links to open the corresponding media web resource.

Another embodiment includes a method to locate web resources on the Internet. A database is accessed that includes a plurality of links to media web resources. Each of the plurality of links are programmatically verified to open a corresponding web media resource. Each verified link is accessible to a plurality of Internet enabled devices that select one or more of the links to open the corresponding media web resource.

Another embodiment includes a system to locate web resources on the Internet. The system includes a first indexed data structure comprising a plurality of links. A media playback component is coupleable to the database. The media playback component loads each of the plurality of links to verify whether the link is selectable to open a media web resource. A second indexed data structure stores each verified link in the plurality of links. The second indexed data structure is available to the plurality of Internet enabled devices.

Another embodiment includes a method to providing links for use in a media search engine. A plurality of internal links on a network site are

identified. The network site makes a network resource of a specific data type accessible for a network enabled device. The internal links that are selectable to open the network resource of the specific data type are extracted. The external link is stored in a database. One or more of the links are automatically signaled to a media playback component in response to receiving a search requests from the network enabled device.

Another embodiment includes a method to provide links for use in a media search engine. The method includes a) receiving from a first indexed data structure a first external link to a first network site; b) initializing a second data structure to be empty;
c) determining if the first network site contains at least one internal link; d) storing the at least one internal link contained on the first network site that is not in the first indexed data structure and not in the second indexed data structure as another external link in the first indexed data structure; e) identifying the internal links contained on the first network site that are selectable to open a network resource of a specific data type or types; f) moving the first external link from the first indexed data structure to the second indexed data structure; and g) repeating steps a) through f) until the first indexed data structure is empty.

Another embodiment includes a computer system to search for links to streaming media playback on a network, the network being accessible to a network enabled device. The system includes a metacrawler to locate one or more media sites in directories containing streaming media. A media search module coupled to be signaled the one or more directories from the metacrawler. The media search module identifies a plurality of media links for the media sites. Each of the plurality of media links are selectable to open streaming media network resource. A metadata extraction module accesses each media link identified by the media search engine to extract metadata about the identified media link. A database comprising the plurality of media links identified by the media search engine, and the metadata is extracted about each identified media link. The database enables the network enabled device to access the plurality of media links.

An embodiment includes a rating system for rating media network resources on a network that is coupleable to a plurality of terminals. The rating system includes a database having a plurality of addresses. Each address locates a corresponding media network resource on the network. A network server module is coupleable to the plurality of terminals. The network server module accesses the database to signal one or more addresses from the database to the plurality of terminals. A rating module is coupleable to the plurality of terminals. The rating module receives a rating input from each of the plurality of terminals. The rating module associates the rating input with a selected address in the database.

In another embodiment, a rating system is provided to rate media network resources on a network. The rating system includes a database comprising a plurality of addresses that each locate a corresponding media network resource on the network. The database includes one or more classes of information associated with each of the plurality of addresses. A network server module is coupleable to the plurality of terminals. The network server module communicates with each of the plurality of terminals to receive a search request. The network server module signals the database to retrieve one or more addresses from the database in response to the search request. The retrieved addresses are associated with a class of information matching the search request. A rating module is coupleable to the plurality of terminals. The rating module receives a rating input from each of the plurality of terminals. The rating module associates the rating input with a selected address in the database.

Another embodiment includes a rating system for rating media network resources available over a network. The media network resources are located on the network by a plurality of terminals. The rating system includes a database that stores a plurality of addresses. Each address locates a corresponding media network resource on the network. The database includes a rating associated with each of the plurality of addresses. A network server module is coupleable to each of the plurality of terminals. The network server module accesses the database to signal one or more addresses from the database to the plurality of terminals. A rating module is coupleable to each of the plurality of terminals. The rating module receives a rating input from one of the terminals for each of

the plurality of addresses in the database. In response to receiving the rating input from one of the plurality of terminals for a selected address in the database, the rating module accesses the database and reconfigures the rating associated with the selected address. A play-list module accesses the addresses to select one or more combinations of addresses. The play-list module signals the play-list to the network server module as addresses to be signaled to one or more of the plurality of terminals.

In a variation, the address may be selected by the play-list module based on a criteria stored with the address in the database. Examples of criterias include rankings, reflecting preferences of users on terminals after playing back media located by the respective addresses. Other criterias that can be used to select addresses include metadata information, such as artist name and media title. For example, the search request may specify a ranking as one of the criterias. The play-list module then sorts the database for the ranking in selecting the addresses.

Another embodiment includes a method for ranking media sources on a network. The method includes accessing a database that stores a plurality of addresses. Each address locates a media resource on the network and each address is associated with a rating. A selected address from the database is signaled to a terminal coupled to the network. A rating input is received from the terminal after signaling the selected address to the terminal. The rating is associated for the selected address is adjusted in response to receiving the rating input.

Another embodiment includes a method for ranking media sources on a network. A database is accessed that stores a plurality of addresses. Each address locates a media resource on the network and each address is associated with a rating. A combination of addresses are selected to form a play-list. The play-list is signaled to a terminal coupled to the network. A ranking is received from the terminal after signaling the addresses in the play-list to the terminal. The rating is adjusted for each address signaled to the terminal from the play-list in response to receiving the ranking.

Another embodiment includes a method that ranks media sources on a network. A database that stores a plurality of addresses is accessed. Each

address locates a media resource on the network, and each address is associated with a rating. A selected address is signaled from the database to a terminal coupled to the network. A ranking is received from the terminal after the selected address is signaled to the terminal. The rating associated for the selected address is adjusted in response to receiving the ranking.

Another embodiment includes a network enabled device that comprises a media playback component. The media playback component is configured to communicate with a network-side module to receive a first plurality of links. Each of the first plurality of links locate a media file on a network. A web browser component is configured to receive a second plurality of links. Each of the second plurality of links hosts a media file located by one of the first plurality of links. The web browser component displays the web site for each of the second plurality of links when the media playback component plays back media from the media file being hosted by web site being displayed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow process describing an embodiment of the invention.

FIG. 2 is a block diagram illustrating an architecture for use with an embodiment of the invention.

FIG. 3 is a block diagram illustrating a back end architecture, under an embodiment of the invention.

FIG. 4 is a block diagram illustrating a media search and playback system, under an embodiment of the invention.

FIG. 5 is a block diagram illustrating components on an end terminal receiving control information from a server-side module, under an embodiment of the invention.

FIG. 6 is a flow chart illustrating a system for forming a search database of media resources accessible on a network, under an embodiment of the invention.

FIG. 7 is a flow chart illustrating a system for forming a search database of media resources accessible on a network, under an embodiment of the invention.

FIG. 8 is a flow chart for verifying records in a search database of media resources, under an embodiment of the invention.

FIG. 9 is a flow chart for extracting metadata about a media resource associated with a site on a network, under an embodiment of the invention.

FIG. 10 is a flow chart for forming play-lists for end users of a system under an embodiment of the invention.

FIG. 11 is a flow chart for receiving user input in response to playing back media resources from a search database, under an embodiment of the invention.

FIG. 12 is a block diagram of a media playback system including a rating feature, under an embodiment of the invention.

FIG. 13 is a flow chart describing user input to a user interface for a media playback system, under an embodiment of the invention.

FIG. 14 is a flow chart describing a rating system, under an embodiment of the invention.

FIG. 15 illustrates an exemplary structure for a database to maintain updated records on ratings for addresses containing media resources, under an embodiment of the invention.

FIG. 16 is a flow chart for creating play-lists using rating information, under an embodiment of the invention.

FIG. 17 is a flow chart for programmatically categorizing media files, under an embodiment of the invention.

FIG. 18 is a flow chart for creating personalized play-lists of streaming media files available in a network, under an embodiment of the invention.

FIG. 19 illustrates a distributed playback architecture, under an embodiment of the invention.

FIG. 20 illustrates a block diagram of a messaging application, under an embodiment of the invention.

FIG. 21 illustrates a user-interface for use with a media search and playback system, under an embodiment of the invention.

FIG. 22 includes another user-interface displaying an instance of the web browser while media is being played back, under an embodiment of the invention.

DETAILED DESCRIPTION

A. System Overview

According to an embodiment, a system is provided comprising a media search engine. The media search engine may be used to create a database of links to media files. The links may be structured according to predefined categories and/or user-defined search criteria. A client terminal includes a media player to automatically access one or more media files using the corresponding links. The media player then plays back media contained on the media files.

Among other advantages of the invention, the user terminal accesses media files at various sites on a network, without requiring users to manually select media links. For example, user-terminals may output music to a user by automatically accessing one or more Internet sites containing media files. The music is outputted without requiring users' to view and select links to sites containing the media.

In contrast to embodiments of the invention, using other systems to search for Internet files containing media can be a distracting and time-consuming experience for an end user. In many instances, such a search will yield a series of links on a directory or web search page. A user may have to click on each individual link, one at a time, to play each individual media file. The selected media file may be broken and unavailable to deliver media content. Even if the number of broken links is not high, the user must still click on the links one at a time to activate each media file, providing at best a stop-and-go experience.

In one embodiment of the invention, a user terminal is able to receive continuous media streaming from multiple sites on the Internet. Multiple sites may be accessible to enable the user terminal to receive streaming media without any interaction required from an end user other than signaling a request to receive streaming media. The user terminal automatically accesses media links containing media using a media playback component.

The media playback component may be controlled by one or more server-side modules. In one embodiment, the media playback component on the user terminal interacts with one or more play-lists generated by server side modules. The play-lists contain media links for the media playback application. The media links may be structured or ordered in the play-lists. The play-lists may be generated automatically by back-end modules and/or manually by editors. The play-lists may also be generated by end users.

The media playback component may also interact with one or more server side search modules to access media links on the network. The media links may be automatically selected based on, for example, a search criteria from the end user.

Embodiments of the invention provide a system to search and playback media accessible over a network. In one embodiment, a media search engine is provided to enable users to request media output based on a criteria set forth in a search request. The media search engine is able to efficiently locate streaming media on the network that matches criteria set forth in a search request. The system provides continuous playback of media found on multiple sites of the network. For example, a user may specify a search based on a specified artist. The system locates one or more sites on the Internet containing media files from the specified artist. The system enables the user terminal to automatically and continuously play back media creations available on the Internet sites.

Further, a backend system under an embodiment of the invention minimizes possibilities of broken links and mismatched search results. The backend system may also be used to perform manual and/or programmatic quality check of the media associated with each link.

Further, a search engine under an embodiment of the invention employs an Internet web browser software component on the back-end to perform searches and indexing of web resources. The Internet web browser component may be a configured or modified commercially available web browser component. Server-side modules may combine to control the browser in locating media links and media sites containing media content. As a result, the media search engine under this embodiment is efficiently implemented, using existing resources on the back-end system.

Among other advantages, embodiments of the invention enable streaming media from multiple media links to be automatically played to users. Embodiments of the invention also employ a scalable and distributed architecture. Scalability in this sense means that the service is available to a large (thousands or more) audience of simultaneous listeners or viewers while minimizing bottlenecks caused by congestion. Another advantage of a distributed architecture is that the unavailability of one media site, or of one or more media on the media site, does not preclude the user terminal from receiving media from another site. As a result, users are ensured a continuous listening or viewing experience.

Further, streaming media may be continuously outputted to users from multiple sites on the Internet based on personalized criteria set forth by users. The criteria may be set forth in one or more requests by an end user. The end user may experience media continuously outputted from multiple sites, based on only one request from the end user. This allows a user to request media through actions such as clicking requests through a user-interface.

An embodiment of the invention enables users to share streaming media experiences with other end users. For example, users may share play-lists containing links to multiple Internet sites. This enables individuals to create media programs of streaming media using multiple sites on the Internet. For example, play-lists may be shared among end users using a host web site, or e-mails.

B. Search and Playback System

A user terminal may transmit a search request from an end user to one or more modules on a server. A client side playback module, one or more server-side modules, or a combination of client and server side modules combine to access the user terminal to a site on the Internet that contains media content immediately available for loading and playback. The response to the search request is media output through the user terminal. The media content is outputted from the user terminal without any additional action on the part of the end user after the initial search request. Once media from one site is completed, the playback module automatically enables the user terminal to access and

playback media located on another Internet site. As a result, an embodiment enables the user terminal to output continuous streaming media to an end user, where the media outputted is accessed from multiple Internet sites.

Embodiments of the invention may be implemented on the Internet. Other embodiments may be implemented on any network that carries digital information, such as local-area networks (LANs), Wide Area Networks (WAN), Extranets, Intranets, Internet, and wireless networks, or networks utilizing wireless transmissions. An example of a network for use with an embodiment of the invention includes a network operating under a transmission control protocol/Internet protocol (TCP/IP). Embodiments of the invention may also be employed on proprietary WANs, such as America Online™. Thus, discussion of embodiments employed on the Internet are exemplary, and equally applicable to other types of networks described above.

A system for use with an embodiment includes a network enabled device, a network server module and a database. The network enabled device includes a device having components to couple to a network such as the Internet. The network enabled device includes a communication port and processor, and may also include memory and a display. The communication port may be a physical port, such as a connector extending a modem connection. The communication port may also be a wireless port, such as those configured to transmit and receive radio frequency data communications. Examples of network enabled devices include personal computers, handheld devices such as those operating Windows CE™ or Palm™ operating systems, and cellular phones with Internet capabilities such as Sprint PCS™ systems. Other examples of network enabled devices include smart appliances, such as systems including speakers and a processor to receive communications from the network.

The network enabled device may include a media playback component. The media playback component includes an application that plays back streaming media files. Examples of commercially available media playback components include Real Network Player™, Apple Quicktime Player™, and Microsoft Windows Media Player™.

In an embodiment, network server module includes server-side modules that communicate to the network enabled device through the communication port. The network modules may be coupleable to the network enabled device through a network such as the Internet. Alternatively, the network server module may exist on the terminal. The network server module may, for example, access a database on the network from the terminal. Still further, the network server module may exist on both the terminal and on a server on the network. Specifically, the network server module may comprise network-side code, executed on the terminal through a client application. For example, the network server module may includes applets or Java script delivered to the user terminal for execution of processes and functions, as disclosed herein.

The database stores a plurality of addresses. Each address locates a media network resource. The media network resource includes files that can be loaded into the media playback component to output media. As used herein, media refers to a combination of audio and/or video. Video media may include a collection of images assembled together in an animated fashion to resemble motion or action. Examples of video media include movie clips, recordings from video recorders, and animation such as cartoons. Still further, media may include a collection of still images and graphic presentations that are combined with audio media. Other examples of media include dynamic or animated pictures or text on a web page.

In one implementation, the media files may be loaded and played back to output music or music videos. As another example, media files may include video or animation with story-lines, plots, characters and resemble conventional television or radio programming. Other examples include movie clips, home movies, movie trailers, or highlights from sporting events.

As used herein, a module includes a program, a subroutine, a portion of a program, a software component or a hardware component capable of performing a stated task or function. A module can exist on a hardware component such as a server independently of other modules, or a module can exist with other modules on the same server or client terminal, or within the same program.

The network server module is coupleable to the network enabled device to exchange communications, and to access the database. The network enabled device provides a search request, including a search criteria. The search criteria includes any condition specified by the user to identify some of media files from other media files in the database. Examples of search criterias include titles, artist names, data types, user preferential ratings, quality, and duration.

The network server module selects at least one address from the database based on the search criteria. The identified addresses are signaled to the network enabled device. The network server module may communicate with the media playback component to cause the media playback component to playback the media resource located by the address.

FIG. 1 illustrates a process for use with a system to search for and playback Internet streaming media, under an embodiment of the invention. In one application, the process is performed on architectures described and illustrated with FIGS. 2 and 3. While the process is described with reference to an integral system, one or more steps described with FIG. 1 may be performed independently of other steps. Similarly, components and modules used to perform steps in FIG. 1 may also be implemented in different systems and architectures. Further, steps mentioned with FIG. 1 may be performed concurrently with one other, or in an order different than shown in FIG. 1.

In step 110, a system builds a database of addresses. An address may include a Universal Resource Locations (URL) for network and Internet sites. A media site include, for example, a web site that allows web users to access streaming media. In other embodiments, the media site may locate network media resources on other types of networks. The media sites may be located through a media search engine, as described elsewhere in this application. An exemplary process for identifying media sites under an embodiment of the invention is provided with FIG. 4.

Each media site may provide access to media through one or more media links available at the site or through other means. The media links identify web resources having media content. These web resources may include a file of arbitrary type. Examples of file types include Multipurpose Internet Mail Extension (MIME) types such as MOV, JPEG, or RAM. The file is

available for loading, browsing or playback on the World Wide web. Each media link may be either an internal or external link relatively to that particular media sites. An internal media link on a web-site may correspond to a URL that identifies a web resource located on the web domain, host, property or server of that site. An external media link on a media site identifies a web resource that is not located on web domain, host, property or server of that media site.

In step 120, the system identifies and stores in a database media links (URLs) for each media site. An exemplary process for identifying and storing media links on individual media site stored in a database of media site is provided with FIG. 5.

In step 130, each media link is verified. The media link is verified to contain media that is available for playback for users. Thus, broken links, inoperational or unavailable media are precluded from being verified.

In step 140, metadata information is extracted from each media link. Preferably, metadata information is extracted from each verified media link. In an embodiment, metadata may also be added to a list or database of extracted metadata. Additional metadata may be added using, for example, manual interactive editing and an editor interface (see for example, editor interface module 275 in FIG. 2). Examples of metadata information include (with an exemplary data structure type associated with each media link in parenthetical): identification (Integer), author (String), duration (String), media URL (URL), source web site (URL), media type (Integer), rating (Real number), number of votes (Integer), verification status (Boolean), edited status (Boolean), genre type (Index into a genre database table), play-list genre status (Boolean), mix (index into mixes database table), play-list mix status (Boolean), mood (index into moods database table), description (String), clip broadcast quality (integer), image size for videos (integer, integer), and play-list mood status (Boolean). One or more of these types of metadata may be extracted from the media links or from the actual media file. For example, a media link to a web resource may be extracted for identification, duration, author, and source web site. Similarly, one or more of these types of metadata may be added to the extracted metadata information. For example, genre type and description information may be added to the extracted metadata information.

In step 150, the system creates media play-lists using media database for predefined categories. In an embodiment, verified media links are structured into play-lists, such as described with FIG. 10.

In some embodiments, links to streaming media commercials may be inserted into the play-lists in various locations between media clips. These commercials are targeted to the audience likely to listen to the media available on the play-list. The commercial may be produced and broadcast from distributed sources, or from web server module. Other examples of streaming media that can be included with play-lists includes news items and weather reports.

In step 160, a playback interface is provided. The playback interface causes the media player component on the user terminal to play media associated with media links in each play-list. The playback interface may include features to manipulate play-lists, or to switch between play-lists. For example, the playback interface may allow for a user to skip media or web resources until a preferred media or web resource is located. The playback interface is a software or hardware application that is executed on the user terminal. The playback interface may be packaged as a web application, dynamically accessible through a web server module, or be packaged as a desktop software application.

In an embodiment, a playback interface module includes a streaming media clips rating system that allows users to rate each clip as it is played back. The back-end module rating system uses these votes to generate rated play-lists that are available through the playback Interface for playback.

Further, the playback interface module may include a system to allow users to send Internet e-mail notifications to one or more e-mail addressees regarding a media clip, or to send continuous streaming media programs containing multiple media clips from multiple network sources. Recipients may initiate the playback module by selecting one or more links contained in the e-mail. Selecting a link from the e-mail initiates the play back module on that recipient's terminal, causing the play back module to play back the media clip or the programming referred to by the sender.

The playback interface includes user interface elements that allow users to define and execute search criteria for media playback.

FIG. 2 is a block diagram illustrating an architecture of a system 200, under an embodiment of the invention. The system is shown to link a user terminal 210 with media that is accessible on the Internet 220, including the World Wide web 215. Other embodiments of the invention may operate with different types of networks.

The user terminal 210 includes any network enabled multimedia computing platform. In particular, user terminal 210 includes any Internet enabled multimedia computing platform. Examples of computing systems for user terminal 210 include personal computers (PC), personal digital assistants (PDA), smart phones, and Internet enabled televisions and radios, and other devices. The multimedia capability is manifested in the availability of a steaming multimedia playback software and or hardware component. Internet enabling means that the platform can access information over the Internet. In an embodiment, user terminal 210 runs the media location and playback interface module 270 that is accessible over the Internet. A communication channel 212, such as a phone line, wireless medium, or DSL line, is used to couple the user terminal 210 to the Internet. Alternatively, the playback module may be preinstalled on the client terminal. Under both configurations the playback module access media play-lists that are stored on an Internet web server.

A back-end database management system 245 is provided to maintain information used in providing media searching and playback to user terminal 210. The database management system 245 receives information from modules, including server-side modules that communicate with user terminal 210. In an embodiment, modules used to provide media search and playback capabilities to user terminal 210 include a media search module 230, an automatic verification and extraction module 255, an editor module 250, a play-list generator module 260, and a web server module 270. The modules may communicate with an interface of user terminal 210.

Under an embodiment, this communication is implemented using media play-lists on the web server module 270.

The modules may also communicate with software applications or components on the user terminal, such as a web browser application or a Streaming Media player component in a manner that will be described below.

In an embodiment, media search module 230 includes a media directories meta-crawler module 234 and a media search engine 238. The meta-crawler module 234 and the media search engine 238 may be operated independently and concurrently of one another. The meta-crawler module 234 conducts a general search of the Internet 220 to locate media sites. Media sites may include web pages that are likely to contain web resources, media links to web resources, or links to other web pages that have such media links and/or web resources. The meta-crawler module 234 adds the address or location of each found media site to a media site table 243 maintained by database management system 245. The media site table 243 may list media sites that identify a URL for each web page located by meta-crawler 234.

In one embodiment, the entire media site table 243 is programmatically generated by meta-crawler module 234, without any manual or interactive human input. In other embodiments, an editor module 232 may interface with database management system 245 to manually input a URL for one or more of the media sites into the media site table 243. Another embodiment may substitute editor module 232 for meta-crawler 234, so that the media subdirectory manually receives a URL for each media site.

The media search engine 238 accesses the media site table 243 maintained by database management system 245. The media search engine 238 identifies media links to web resources on each media site provided in the media site table 243. In an embodiment, media search engine 238 contacts each site in the media site table 243 to locate media links. The media search engine 238 then stores the addresses of each media link in the database management system 245. In an embodiment, a URL of each media link is stored in a portion of a media and metadata table 247.

An automatic media verification and metadata extraction (AMVME) module 240 accesses the portion of media and metadata table 247 that contains URLs to the media or media links. The AMVME module 240 verifies each media link in media and metadata table 247. The media links are verified to

contain web resources matching a criteria defining media. For example, each media link may be verified to contain a combination of audio or video, rather than be only a text document. In addition, the media links are verified as available for playback by users, to avoid broken or old links being maintained by database management system 245.

The AMVME module 240 also extracts metadata from the web resource associated with each media link in the media and metadata table 247. Preferably, AMVME module 240 extracts metadata from verified media links. The AMVME module 240 may automatically visit each media link on the Internet to extract metadata information, as well as verification information. The metadata extracted pertains to information available from the web resource or about the web resource on the media link. Examples of metadata that may be extracted by media extraction module 255 include information such as the author, duration, name, description text, broadcasting and playback quality of the media content and frame size and display resolution for images, video and home movie clips. For example, a media link may be associated with a web resource that is an audio media. Metadata that may be extracted from the media creation may include the artist name, the name of the media creation, length and audio/video quality. In an embodiment, media extraction module 255 also verifies that the media is available for playback from the media site. The AMVME module 240 may accesses database management system 245 to store verification and metadata information in media and metadata table 247.

In an embodiment, a metadata editor interface 275 is included in the system 200. The metadata interface 275 accepts manual entry from an editor pertaining to metadata of the web resource associated with each media link. The metadata interface module 275 may access one or more media links in the media and metadata table 247 to allow manual inspection of each web resource for metadata information. An editor operating metadata interface module 275 transmits a media streaming request to have the media of the web resource replayed for inspection on a terminal. The metadata editor interface 275 then allows for additional metadata to be stored in media and metadata table 247. Preferably, the additional metadata information includes metadata that is not programmatically available from the media link containing the web resource.

For example, metadata editor interface 275 may be used to add information to media and metadata table 247 information such as genre of the web resource, description of the web resource, and system predefined information, such as mood and mix, that are found applicable by the editor to the web resource.

A play-list generator module 260 generates a plurality of play-lists based on information in the database management system 245. In an embodiment, play-list generator 260 accesses media and metadata list 247 for URLs to media contained on stored media links. The play-list generator module 260 may create play-lists 284 from predefined categories characterized by information stored in the database system for media links and metadata stored in table 247. Play-lists 284 are stored on web server module 270.

Under one embodiment, the web server module 270 includes a media location and playback application. The user terminal 210 interfaces with the media location and playback application through the Internet. For example, web server module 270 makes the media location and playback application available on a web site. The user can launch the media location and playback application by clicking a link on the web site. Under another embodiment, the playback application is pre-installed on the user terminal.

The playback application accesses the web server module 270 to load media play-lists that are stored on it. In an embodiment, the playback application reads Media URLs and Metadata stored in one or more play-lists. This information is used to playback continuous media from the play-lists to the user. A web page or network site hosting the media file being played back may also be displayed as an instance of a web browser on the network enabled device. For example, audio media may be played back while the user is presented with a web page hosting the audio playback (see FIG. 22 and accompanying disclosure).

The media location and playback application may output or playback media processed by the back-end system and stored in the media and metadata table 247 upon receiving a request from user terminal 210. For example, under an embodiment, music may be outputted from user terminal 210 continuously in a manner that resembles a jukebox, Disk Jockey Mix or a radio station.

An interface of the user terminal 210 enables users to skip playback of media clips, or to switch categories. For example, a user on user terminal 210 may select to hear Jazz programming, and then switch to a genre of classical music. One or more features of a user-interface may be used to enable users to make selections (see FIG. 21 and accompanying text). The user may also control playback settings such as volume, pause, seek and retrieve additional media clip information, skip songs, or replay certain songs being automatically played. The user may also control and/or customize the creation of play-lists using the interface. For example, one musical play-list may include a combination of genres, such jazz and classical songs.

In an embodiment, the media location and playback application programmatically controls a streaming media multimedia software or hardware component to perform the actual streaming of the media digital bits to the user terminal's multimedia output device (such as video display and speakers hardware) . The media location and playback application contains functionality that responds to software events generated by the streaming media component. For example, a playback error generated by the streaming component may result in the application instructing the component to play another media file. In another example, the application determines and initiates playback of a media clip in response to the component reporting that the currently playing media has finished. The application may contain user interface elements that allow users to issue media playback commands. These commands are dispatched by the application to the component that implements the playback command for the currently played media.

In an embodiment, the media location and playback application works in combination with functional commands provided to the user via a web based software application. A user-interface may be provided to enable the user to select the function commands at the software application. An example of a user-interface is provided below, with FIG. 21 and accompanying text.

In an embodiment, a categorization module 290 accesses media and metadata table 247 to add metadata and to categorize media associated with media links in media and metadata table 247. The automatic process generates metadata such as music genre by consulting with information stored in other

records in media and metadata table 247. For example, the module can automatically set the genre metadata information for all media creations available in the table, for a given artists, according to genre metadata entered for one or more media creations by the same artists. This process greatly contributes the efficiency and scalability of the back-end system.

FIG. 3 is high-level system software components diagram for the system 300, under an embodiment of the invention. The diagram shows how software components may be written, deployed and interact to provide the functionality described by system 200. The components of system 200 may be described as a three-tier architecture. Components are written to spec and deployed to a backend tier, a middle tier, and a front tier. The backend tier includes the database management system 245. The database management system 245 includes a database 345 and a backend interface module 355. The backend interface module 355 may be provided with, for example, a Microsoft SQL Server system (MS SQL).

The middle tier includes modules that communicate with backend interface module 355. The middle tier may include a media sites manager 360 and a media manager 365 software components. The media sites manager 360 and the media manager 365 each independently communicate with backend interface module 355. The media sites manager 360 components exposes a programmatic interface 362 to communicate with modules and components in the front tier. The media manager 365 includes a first media manager interface 366 and a second media manager interface 368.

The front tier includes a media site module 330 and a media module 340. The media site module 330 communicates with site interface 362. The media site module 340 communicates with the first and second media manager interfaces 366 and 368. The first and second media manager interfaces 366 and 368 communicate with the media module 340. The media site module 330 includes a front-end interface 332 to a directory meta-crawler 310 and a media search engine 312 modules. The media site module 340 includes a front-end interface 342 to the media search engine 312, an editor interface module 314, and an automatic verification module 316. The directory meta-crawler 310 crawls Internet media directories web sites. The links to media web sites are

handed over to the MediaSite module 330 for storage in the database. The media search engine 312 searches for media links on web sites provided by the MediaSite module 330, these links are transferred through Interface 342 on the Media module 340 for storage in the database module 345.

The editor interface module 314 obtains media link for editing from the Media module 340, using Interface 342 and loads the media for editorial playback from the Internet. The editors provide metadata for media that are added to the database by the Media module 340.

The verification module 316 examines media files or web resources accessed through each media link and updates metadata regarding media availability in the database using Media module 340. This module also extracts metadata from Internet media and updates this in the database using Media module 340. The module queries the database for a batch of media records using the Media module 340 and automatically verifies and extracts metadata for the Internet media represented by these records.

With respect to communications from the backend tier to the front-end tier, database management system 345 of the backend tier provides records to the system 300. Each record or record set is disconnected from tables or databases of record(s). Disconnected records are transmitted from the backend tier to the front-end tier as active database objects (ADO) Disconnected record sets.

With respect to communications from the front-end tier to the backend tier, each disconnected record can be updated in the database by any components on any tier. Updated records are transmitted to the database management system 345 in the form of record set update operations. In an embodiment, directory meta-crawler 310 sends URLs to be added to records in database 345 to media site module 330 using an asynchronous method calls. The media search engine 312 transmits to media site module 330 using a get search method call for batch sites of URLs. The media search engine 312 uses an asynchronous method call to add media links and metadata associated with media links.

The components and all tiers expose programmatic interfaces that contain callable methods using the MS DCOM (distributed component object

model) software component technology. Communication between the tiers is also implemented using method calls on these components. The components are deployed in front, middle and back tier hardware systems. Alternatively, The components may be developed and deployed using the MS COM+ components technology. Using this technology, a COM+ In Memory Database system (IMDB) proxies and caches tables of the back-end database module 245. This process speeds up the search and editorial process. COM+ services such Queued Components may used to implement asynchronous method calls exposed on Interfaces 362 and 366.

C. Media Search Engine

Embodiments of the invention locate web resources on a network such as the Internet. In one embodiment, a network browser identifies a plurality of links to one or more network sites. The links are each selectable to open a network resource of a specified data type. The identified links are then made available to network enabled devices that can select one or more of the links.

As used herein, a network browser is software that performs core functions that include (i) loading network resources; (ii) parsing, translating and laying out network resources, and (iii) displaying the network resources. The network browser includes an application programmable interface (API). An embodiment of the invention employs the network browser on a back end to locate the network resources of the specified data type. One advantage of this embodiment is that the web browser is employed on the back end programmatically, rather than through manual interaction with an editor or other user.

A network browser may include a shell, an API, and a processing module. A component of the network browser includes the API and the processing module. For Internet applications, the processing module may include, for example, a MSHTM or DLL module. The network browser component performs functions that include loading a network resource, as well as parsing, translating, and laying out the network resource.

In an Internet application, a web browser component may be used to locate resources of a specified data type. The web browser component may be a

portion of a commercially available browser. For example, the web browser component for use with an embodiment of the invention may be a reconfigured Netscape Navigator™ or Internet Explorer™ browser.

In an embodiment, the web browser component is programmatically controlled through the API of the web browser to access the web resource for the plurality of links. The web browser may be programmatically controlled to bypass the shell of the web browser. For example, the API may be used to instruct the web browser to ignore the shell, or to detach the functionality of the shell. The remaining web browser component then identifies the links to the specified data types. The result is that the web browser component accesses the web resources of the plurality of links to identify the data types of the resources on the links while ignoring data such as images and sound.

In another embodiment, a search module controls the web browser component to access a web site. The search module controls the web browser component to identify a plurality of links to media web resources at the web site. Each of the plurality of links identified by the web browser component are selectable to open a media web resource. The search module stores the plurality of links in the database.

In another embodiment, a database includes a plurality of links to media web resources. The plurality of links are programmatically verified to determine whether each link opens a corresponding media web resource. The verified link are made available to a plurality of Internet enabled devices that select one or more of the links to open the corresponding media web resource.

The links may be verified on the back end using a media player, including a commercially available media player. For example, each link that needs to be verified may be programmatically loaded through an API of the media player. The response provided by the media player to the link determines whether the links are verified.

In another embodiment, the media player may be programmed to identify metadata from the media web resource of each link. The metadata may then be stored in a database associated with the link.

Among other advantages, embodiments enable network links to files of a particular data type to be rapidly accumulated and stored in a database. Each

of the links are selectable to open a file on the network. The files may enable a terminal to play back media. In an embodiment, the addresses access media files that can be loaded into the media playback component of the user terminal. The files can be stored in the database with information that characterizes the files associated with the links. Thus, the links may be characterized by, for example, metadata information, and one or more classes of information.

In addition, embodiments enable each link in the database to be programmatically verified, so that there are no broken or unavailable links in the database. Still further, some metadata information may be programmatically identified from each media file. In contrast, existing systems verify links manually, employing interactive users to perform the manual functions. Existing systems also extract metadata information manually.

FIG. 4 illustrates a block diagram in which system 200 receives a search request 203 and provides a response 209. In an embodiment, system 200 processes the search request 203 using the web server module 270 and the media and metadata database 247. The end terminal 210 signals the search request 203 to web server module 270. The web server module 270 accesses the media and metadata database 247 to retrieve one or more URLs matching the search request. The web server module 270 signals the response containing the retrieved URLs to the media playback component 211 of end terminal 210.

In an embodiment, the search request 203 includes one or more criterias that specify a selection of URLs from media and metadata database 247. The criterias may correspond to parameters in media and metadata database 247. The table 249 illustrates a data structure of media and metadata database 247. The table 249 includes a URL list comprising a plurality of URLs. Each URL provides direct access to a web resource containing media. Each URL is characterized by one or more parameters that correspond to metadata information about the web resource associated with the URL. As an example, table 249 provides parameters as being genre (G), data type (DT), category (C), web resource identity, and one or more play-lists (PLAY1, PLAY2, PLAY3).

The genre data is a broad class identifier of the media creation comprising the web resource of the respective URL. For music, the genre may include rock, classical, and jazz. For movies, the genre may correspond to

romance, comedy, horror etc. The genre may be identified either programmatically, or through an editor interface. One genre may be associated with one or more URLs in table 249. In the example provided, URL1-URL7 are in either one of three genres, G1, G2, and G3. Alternatively, several genres may be associated with one URL.

The data type parameter corresponds to the MIME characteristic of the web resource associated with the URL. The category parameter may correspond to a sub-class of a genre. For example, in music, a category may correspond to soft rock. In movies, a category may correspond to the time-period of the movie. The table 249 illustrates an example in which the category is unique to the genre. Thus, a web resource of one genre is not in the same category as a web resource of another genre. As an example, URL1 and URL3 are in the same category, as are URL2 and URL5. However, no other URLs are in the same category.

Other metadata information that may be included in media and metadata database 247 include identifier information. The identifier information identifies the web-resource. The identifier may provide name of a specific media creation, as well as an artist or author of the media creation.

In an embodiment, media and metadata database 247 includes play-list information as parameters of metadata information. The play-lists may be identified in any one of several ways. For example, the play-lists may be identified by a unique name or other identifier. The play-lists may be identified by another parameters, such as genre or category type. A Boolean data type may be associated between each URL and each play-lists.

The criterias of the search request 203 specify one or more parameters to media and metadata database 247. For example, search request 203 may include criterias corresponding to one or more of a genre, category, play-list, or identifier. In an embodiment, web server module 270 accesses media and metadata database 247 for URLs that have all of the parameters set forth in the search criteria.

The web server module 270 retrieves the URLs matching the criterias of the search request. The response 209 is signaled to the media play-back component 211. The response includes one or more URLs. It is noted that

when play-lists are requested, additional URLs multiple play-lists are provided. The response 209 may also include metadata information. For example, the response 209 may signal to end terminal 210 the duration of the web resource for each URL, the artist, the history, etc.

The web server module 270 further signals control information 207 to access the URL provided in the response 209. The control information 207 causes end terminal 210 to load the web resource for the media playback component 211. Thus, the media playback component automatically loads the web resources associated with each URL included in response 209. The experience provided to end user 210 is that media is outputted in response to inputting a search request. This is in contrast to other systems in which the user is provided links to media sites containing web resources matching the search criteria.

As an example, a user may specify a media creation from a specific category. For example, the user may input a search request for "nature sounds". The web server module 210 accesses media and metadata database 247 for parameters that match "nature sounds". In one application, a play-list is located that is pre-programmed to provide URLs to web resources containing nature sounds. The response 209 then comprises one or more play-lists, each containing multiple URLs to web resources containing nature sounds. In another application, a category parameter or sub-parameter is searched for "nature sounds". The response 209 may include one or more URLs that are not pre-programmed into play-lists. The response 209 may provide URLs to media playback component 211 one at a time, in groups (such as in play-lists), or all at once.

In an embodiment, categorization module 280 may be used to programmatically create one or more parameters such as illustrated by table 249. The parameters may be determined, by for example, identifying metadata information on the media site hosting the URL.

FIG. 5 is a block diagram illustrating the media playback component 211 being controlled by one or more modules of system 200, under an embodiment of the invention. The web server module 270 signals control information to an application program interface 276 of the media playback

component 211. The control information may be provided by the media locator and playback application of the web server module 270. The web server module 270 signals commands, with one or more URLs corresponding to media resources selected to be signaled to the user terminal 210. As an example, commands from web server module 270 may be instructions that use each URL as an arguments. Examples of commands that control the media playback component include play(URL) and pause (URL).

As an optional feature, web server module 270 may also signal control information to a web browser component 213 of user terminal 210. The control information may be in the form of commands to access and display a web site associated with the media resource. The commands may be provided to an application program interface 279 of the web browser component 213. This allows the system 200 to display the web site associated with the media resource selected to be played back on user terminal 210. Thus, user terminal 210 may play back media from the media resource while displaying the web site where the media resource is located. One advantage of this embodiment is that it allows users to receive media playback from the media resource in one medium, such as audio, while providing images, audio text, or media not associated with the media resource. Thus, users can listen to songs from media resources signaled to user terminal 210, while viewing banner ads on the web site where the media resource is located.

Each URL signaled from web server module 270 has a network protocol. For media resources, and specifically audio files, types of protocols include "HTTP" protocol, "PNM" protocol (RealNetworks, having .RM extensions), or "RTSP" protocol (having .RAM extensions). The URLs signaled by web server module 270 include the protocol at an initial portion of the string forming the URL. Preferably, for HTTP protocol files, the string portion corresponding to "HTTP" is replaced with "PNM". This adjustment prevents playback component 211 from failing as a result of a bug in the media playback component, particularly if the playback component 211 is a RealNetworks Player™.

The web server module 270 may be either a network-side module, client side module, or a combination of both. In either embodiment, web server module 270 may access the database directly or indirectly.

FIG. 6 illustrates a process for a component of an Internet media search module, under an embodiment of the invention. A process such as described with FIG. 6 may be used to build a database of media sites, where each media site includes media links and/or links to other media sites. In an embodiment, the process of FIG. 6 is applicable to meta-crawler module 234 in system 200 (FIG. 2).

The process of FIG. 6 is a backend operation that is unobservable to a user of the user terminal. Preferably, the flow process of FIG. 6 is an automatic or programmatically controlled process, conducted periodically. For example, media links may be identified and stored under a flow process such as shown by FIG. 6 every few days or weeks. The duration between executions of the flow process of FIG. 6 maybe referred to as an idle period.

The process of FIG. 6 provides for extracting URLs of media sites from a web pages directory. Examples of a web directory for use with an embodiment of the invention includes directories on web sites such as Yahoo.com® and Lycos.com®. The flow process of FIG. 6 is a backend operation that is unobservable to a user of user terminal 210. Preferably, the flow process of FIG. 6 is an automatic or programmatically controlled process that does not require human interaction.

In step 410, a directory home page is added to a searched-pages data structure. The searched-pages data structure maintains. A similarly structured parsed-pages data structure is also maintained to hold URL of pages already processed by the module. The parsed-pages data structure indicates whether a home page web directory was previously parsed by the process. The searched-pages and parsed- pages data structures are keyed or indexed by URL and they support querying for existence of a given URL in them. Examples of keyed or indexed data structures include database tables and hashtables.

In step 410, the parsed-pages data structure is empty, indicating that the directory home pages in the searched-page data structure have not been parsed.

In step 420, a determination is made as to whether the searched-pages data structure is empty. If the determination is affirmative, the flow process is done. This occurs when the process has parsed all the Internal web pages in the directory. If the determination is negative, a current page link is called from the searched-pages data structure in step 430. The current page is then loaded into memory and parsed. Parsing means loading and reading the HTML source (or equivalent) code of the web page so its content is accessible and in a machine-readable format.

In an embodiment, the page is parsed using an HTML parser component. An example of an HTML parser is a web browser. Thus, the current page may be parsed using a web Browser component. Specifically, step 440 of the process may be implemented using an application program interface (API) that is exposed by the web Browser component. In this context, the web Browser component is configured and used in a back-end server process with no visible presentation area or end user. It is configured not to load or render media at the web page so that the loading is more efficient. The configuration may occur through the API.

In an embodiment, the web browser is configured to parse web pages efficiently by, for example, automatically excluding a presentation layer from being displayed. Further, the web browser may be programmatically configured to not load or parse information that is not critical to the search function. For example, the web browser component can be configured to not load media data found on web pages.

In step 440, all links to media sites on the currently parsed-page are determined using the parser. The HTML parser API allows access to the page document object model. In step 450, all new external page links are added to the media sites database. An example of a web-page data structure is provided with media site database table 243 (FIG. 2). The database stores the URL of the media sites and not the sites themselves. New external page links implies media sites that are not already indexed or present in the media site database.

In step 460, all URLs also link to internal links found on the currently parsed page are added to the web pages data structure, provided that the URL in question is (i) not already existing in the searched pages data structure and (ii)

not already existing in the parsed pages data structure. In step 470, the currently parsed page is moved to the parsed pages data structure, and the flow process returns to step 420. This process adds the URL of all the media sites indexed by the directory to the media sites database.

FIG. 7 illustrates another component of an Internet media search module, under an embodiment of the invention. A process such as described with FIG. 7 may be used to identify and store media links to web resources that are accessible from one or more web site. The process of FIG. 7 may be used in conjunction with a process such as described with FIG. 4. In an embodiment, the process of FIG. 7 is applicable to media search engine 238 in system 200 (FIG. 2).

In an embodiment, the flow process of FIG. 7 is a backend operation that is unobservable to a user of the user terminal. Preferably, the flow process of FIG. 7 is an automatic or programmatically controlled process, conducted periodically. For example, media links may be identified and stored under a flow process such as shown by FIG. 7 every few days or weeks. The duration between executions of the flow process of FIG. 7 maybe referred to as an idle period.

The flow process of FIG. 7 assumes access to a media sites database store. The database includes URLs to each media site. An exemplary database of media sites includes media sites and metadata table 243, described with FIG. 2. Each record contains a URL field for media site and a field indicating the last date, if any that the process described in FIG. 5 lastly processed the web site at the URL in the URL field. Reference to a media site that is parsed implies that the media site was programmatically examined for media links to web resources, and for links to other media sites using a process such as the one described in FIG 5.

In step 510, MIME types are determined for web resources. Examples of MIME types that can be selected for step 510 include JPEG, MOV, RAM and WAVE.

In step 515, a record for a media site is fetched or received from the database. A condition of the media site received is that the media site was not parsed by the process described here during the idle period. This condition may

be specified by checking, for example, the date field associated with the record. For example, a date field may indicate when the media site was previously parsed.

A determination is made in step 520 as to whether a record and a URL was received in step 515. If no URL was received, the system interprets that all media sites in the database have already been parsed during the idle period. If a URL is received, the system in step 525 adds the URL of the media site to a URLs data structure of media sites to be processed. The URL data structure of unparsed media sites may be indexed or keyed. For example, the URL data structure may be a list, or a hashtable software data-structure.

In step 526, the last search field of the record fetched in step 515 is updated with the current date to indicate that the media site is parsed. In an embodiment, the field corresponds to a date in which the last parsing occurred.

In step 530, a URL in the date structure of unparsed media sites is fetched or received. If in step 535, a determination is made that the URL data structure is empty, the system returns to step 515. As will be further described, the flow process returns to step 515 only when step 570 is completed. If a determination is made that the URL data structure is not empty. Thus, steps 510-545 allow the flow process to distinguish between when a media site is being parsed for the first time, or has been previously parsed by the process during the idle period.

In step 545, media links on the media site fetched in step 530 are extracted from the HTML code of the page fetched in step 530. The media links are associated with web resources on that media site. In step 545, the media resources may be in any MIME format recognizable as media. In an embodiment, the currently parsed page is parsed using an HTML parser. An example of an HTML parser is a web browser. Thus, the media links may be extracted using a web browser. Specifically, the media links may be extracted using an application program interface (API) provided by a web browser software or hardware component. The web browser may be configured to perform this task efficiently by, for example, excluding a presentation layer. Further, the web browser may be programmatically configured to not load or parse information that is not critical to the search function. For example, the

browser component may be configured to not load media data found on web pages.

In step 550, new media links on each media site that match the MIME format specified in step 510 are added to a database. New media links refers to media links that do not already existing in the database from, for example, a previous execution of the flow process. In step 555, metadata is extracted from each new media link found in step 550. The metadata may also be stored in the database, with a reference to the URL the media that the metadata refers to. An exemplary database is provided with media and metadata table 247 (FIG. 2). An example of metadata is the URL of the web Page that provided a link for each media URL.

In step 560, the URLs of all new internal media site links on the media site currently being parsed are added to the URL data structure. New internal media site links refers to URLs of media sites that do not already exit in the URL data structure and that are not in the parsed URL data structure.

In step 570, the currently parsed page is removed from the URL data structure and added to the parsed URL data structure. The flow process returns to step 530.

D. Verification and Extraction Flow Processes

FIG. 8 illustrates a flow process that verifies and extracts metadata from Internet streaming media files. While media links are specified, other embodiments of the invention may employ the flow process of FIG. 8 within a system that incorporates verification and extraction of any content or resource associated with links stored in a database. A specific application employs a process such as described with FIG. 4 in the system 200. In the system 200, flow process of FIG. 8 may be performed by the AMVME module 240.

In step 610, a module operating the flow process of FIG. 8 fetches or receives an unverified URL from a database. An example of such a database is provided by media and metadata table 247 (FIG. 2). The unverified URL corresponds to a media link on a media site stored in a database such as the media site database 243 (FIG. 2).

In step 620, a determination is made as to whether a URL for a media link is present. If the URL to the media link is not present, the module assumes all media links have been determined as being verified, and the process is done.

If a URL exists, the module in step 630 loads the URL into an Internet multimedia playback software component and programmatically control the component to provide metadata embedded in the media file. In response to this request, the component loads some or the entire file over the Internet and provides the process with this information. In step 640, a determination is made as to whether the media or web resource associated with the URL was successfully loaded over the Internet by the module. If the determination is that media was not loaded, then in step 650 the URL associated with the media link is marked as unavailable and verified. The media is marked as verified to prevent the process from revisiting it once it already extracted metadata for it and verified it. The availability mark assists the flow processes described in FIG. 9 and FIG. 10. The determination may be in the negative if, for example, the media link is old and no longer contains a media file that is available for playback through its URL, or if the media link contains content other than what is designated as media.

In an embodiment, the process may use an availability rating for each media. Under such schema, each media is assumed to have the maximum availability score. For media that are currently not available for playback, step 650 may lower the score by one. The system may consider the media as unavailable if its score is below a predefined threshold. This process is useful since Internet streaming media availability may vary according to factors such as web server load and the time of day or year.

If the media is loaded, then in step 660 the media metadata is extracted from the playback component. Examples of metadata that can be extracted in this step include-artist name, playback duration, playback quality, frame size etc.

In step 670, extracted metadata is stored in a database with the associated URL of the media link that was presently verified. In step 680, the URL of the media link presently verified is marked as verified in the database. The flow process then returns to step 610.

FIG. 9 illustrates a process for interactively adding metadata to URLs of media stored in a database. In an embodiment, the database may correspond to verified URLs of media links determined in FIG. 8. For example, a process such as shown by FIG. 9 may be performed on information stored by AMVME module 240 in media and metadata table 243. The process of FIG. 9 may be performed by a module interface, such as editor interface 275 (FIG. 2).

In step 710, an unedited media record is fetched or received by an interface module from a database. The unedited record may be one or more categories of metadata and other information about a media link, media site, or web resource. In an embodiment, the unedited media information includes a URL to a media link, as well as metadata extracted programmatically, such as described with FIG. 8. In step 720, a determination is made as to whether a record was received. If no record is received in step 720, the flow process assumes there are no unedited records remaining in the database, and the process is done. If a record is received, the in step 730 the interface module is updated with the record received. This may correspond to displaying the record fields to the editor operating the editor interface.

In step 740, the web resource associated with the record received is loaded into an Internet multimedia playback software component. Preferably, the software component is programmatically constructed and controlled by the module interface. The software component plays back the media to the editor. The editor is able to experience the media played back from the web resource associated with the media link. The editor is able to determine metadata information regarding the web resource. For example, the editor may determine mood, genre, quality, appropriate mix name, and description of a web resource such as an audio media creation or a home movie clip. In an embodiment, the editor controls playback of media located by the search engine on the network side, such as by pausing and playing media back through an editor interface.

In step 745, a determination is made as to whether the record received also includes previously determined metadata. The previously determined metadata may be extracted programmatically in another process, such as described with FIG. 8. If the determination is made that the record received does not contain extracted metadata information, then in step 750 the editor

interface automatically extract metadata from the web resource associated with the URL of the record. To accomplish this step, the editor interface may access another module that automatically extracts certain types of metadata information. For example, the editor interface may forward the record to AMVME module 240 (FIG. 3) that performs a flow process such as shown by FIG. 8.

Once metadata is included with the record, then a determination is made in step 760 that the editor operating the interface module may choose to save the auto-extracted metadata already included with the record in the database. If the determination to step 760 is negative, then in step 765 the editor updates media information with editor provided metadata using input elements on the editorial software user interface. Once the determination in step 760 is positive, the record is marked as edited and updated in step 770. Then, all the newly added metadata for the media record is updated to the database. The process then continues from step 710 for the next unedited media. The media is marked as edited so it won't be included for editing in the process.

FIG. 10 illustrates a process for generating a play-list. The flow process of FIG. 10 assumes that play-lists names are predetermined and stored in a database. Each play-list is identifiable by its name. For example, classic music, jazz and rock. The play-lists include records of media links. In an embodiment, a record includes at least a URL to a streaming media that is categorized in a database as belonging to the play-list name. In step 810, a play-list name is received from the-play-lists database. In step 820, a determination is made as to whether a play-list name was received. If the determination is negative, the system assumes it produced play-lists for all play-lists names, and the flow process is done. This process is routinely executed to add all newly added media to the appropriate play-lists.

In step 830, media records that match search criteria are fetched from the media database. The criteria is that each record play-list record field must match the current play list name obtained in step 810 and that the 'in-play-list' record field for the play list name has False value. In step 840, a play-list is generated to include all media stored at the records fetched is step 830. The new play-list contains one record entry for each fetched media record. Preferably,

each play list record includes media URL and metadata information that is obtained from the media database record.

In step 850, the media records called in step 840 are labeled as being in the "in- play-list" for the current play-list name. This is achieved by setting the "in-play-list" value for the media database record to true for the appropriate play-list name.

In step 860, the generated play-list is made available to a server-side module, such as web server module 270 (FIG. 2). As an example, the play-lists may be stored, copied or appended to be made available on the web server module. Once the play-lists are available on a server-side module, media URLs and metadata stored in the play-lists is made available to the user terminal so that the user terminal may customize media output available from the play-list. Specifically, one or more playback applications that run on the user terminal may read the play-lists, access media links on the play-lists, continually play-back streaming media from media URLs in the play-list and present media metadata to users for further interaction. The play-list may also be configured to provide access to a client-side media player component that uses a URL of a media link to load and play the media associated through it. Additionally, users may further modify and edit play-lists to create personalized media programming. Further, play-lists may be dynamically generated by a web application in response to a request for media playback made on the user terminal.

FIG. 11 is a flow process for software or hardware application that enables a user terminal to playback streaming media programming determined by play-lists. An embodiment described below assumes that play-lists are available for the process, and that play-lists are identifiable by play-list names. For example, the play-lists may be dynamically generated by the play-list module, in response to a search criteria signaled from a user terminal. The play-lists may also be manually generated by editors on the network side. The play-lists may be predetermined by, for example, a process described with FIG. 10. The playback component can access the play-list without any direct interaction with server side modules.

In an embodiment, the flow process employs a streaming media player component installed on the user terminal. The media player may be preexisting on the user terminal. Examples of media players for use with an embodiment include RealNetwork Player™, Microsoft Windows Media Player™, and Apple QuickTime™. The application described in the process may be web based or installed on the user terminal.

In step 910, an application interface for a media player on the user terminal is provided.

In step 920, a default play-list name is selected from a list of play-lists. In an embodiment, a database of play-lists is stored on or accessible through the web server module 270. The play-list generator module creates and stores play-list on the web server module to provide the interface with the user terminal 210 and media player stored thereon. Each play-list may store two or more media links, and preferably a plurality of media links.

In step 930, one or more play-lists for the current play-list name are loaded. In step 940, media is presented and played-back on the user terminal. To playback media, server-side modules may provide the media player with URLs to media links that are stored in each play-list. Each play-list may include one or more media link URLs and media metadata. The user terminal then accesses the URL and loads the web resource associated with that media link into a streaming media playback component on the user terminal. Media playback on the user terminal includes outputting, for example, audio and/or video stored in digital format on web resources associated with a media link. In embodiments where the web resources include video media, the step described may dynamically adjust the interface size and the playback component that will handle the actual playback according to the media clip metadata.

Under an embodiment of the invention, the media playback component continuously plays back media by (i) accessing a first site on the network and playing back media from the first site, (ii) then automatically accessing a second site and playing back media from the second site. The media sites may be provided by play-lists which that are made accessible to the media playback component. The sequence for automatically and continuously playing back media may be repeated for each media link included in the play-list. The play-

lists may include hundreds of media links, thus allowing the media play back component to automatically and continuously play back media using numerous sites on a network. As a result, a user is able to experience continuous media play back for hours at a time.

The user terminal also includes an interactive interface to affect the media being played back. An end user on the user terminal may choose to manipulate media playback through one or more commands that may be inputted through the application interactive interface or presentation layer.

In step 945, a determination is made as to whether an event occurred. If an event occurred, the flow process determines the event. The flow process may determine the event that occurred sequentially or concurrently. Preferably, the flow process is configured to receive media playback event from the streaming media playback component. If the event is to skip the currently played media, then a determination in step 960 causes a corresponding action of the media being skipped, and the process step returning to step 940. If the process received a playback error event, or an playback error event, then a determination in step 965 causes the flow process to return to step 940 to playback media from the next web resource of the play-list or play-list name.

If a user quits the application, or signals to quit, then a determination in step 970 causes the flow process to be done. In step 975, a user may choose to view a new media web site while media is being played back on the user terminal. Then in step 980, the media web site is opened in a new Internet window, preferably using the client side web browser.

In step 982, a determination is made as to whether the action selected by the user on the user terminal is to send an e-mail message to one or more e-mail addresses that allow the receiver(s) to playback the current media and the current play-list played by the sender at the time of the event. A user may send either an e-mail containing the URL, the play-list, the play-list name or a URL link. When the message receiver clicks on the link, his terminal will execute the media playback application and will start playing back the media and the play-lists played at the time of the message-sending event. If the determination is positive, then in step 984 the user terminal prompts the user for an one or more e-mail addresses, and then prompts the user to transmit the e-mail. The user

need not have an e-mail client software application for the operation to succeed. The e-mail may be directed to terminals having a streaming media playback component and Internet access.

Preferably, the e-mail message is directed to a user having a user terminal that communicates with server-side modules so that the recipient user terminal is automatically plays back media from the transmitted media link received upon the e-mail being opened. Thus, server side modules may receive addresses from the terminal and act as the source of the email addressed to one or more recipients.

In step 986, a determination is made as to whether a user wishes to rate a media played back from the media links. If the determination is positive, then the user is prompted to rate the media in step 988. A rating value is transmitted to a backend web rating system application using the Internet. This operation is part of the service rating system that includes server side modules that produce, in combination with this operation, top and bottom rating media in each media category.

Step 990 illustrates other exemplary actions that may be received from a user on the user terminal interfacing with the playback application. For example, user actions may correspond to pausing media playback, adjusting volume, picture controls, size, seeking within the media, etc. In step 992, playback settings are changed according to user input. In an embodiment, the flow process returns to step 945 to check for another event if any of the determinations in step 982-992 are negative.

E. Rating System for Media Play Back

An embodiment of the invention includes a rating system with a media search and playback system. The rating system allows users to listen or view media segments available over the Internet according to a rating. In addition, users participate in determining rating media segments by providing a rating input after listening or viewing a media clip. The ratings may be used as a category, similar to other categories such as genres or categories.

FIG. 12 illustrates an architecture for use with the rating system, under an embodiment of the invention. The rating system 1000 may be employed

with, for example, the system 200 (FIG. 2). The rating system 1000 may include or cooperate with components of a system such as described with FIG. 2 to enable the user view and/or select media clips from play-lists. The generated play-lists may contain a list of links to media on the Internet. Selection of media clips by the user causes media to be played back to the user over the user terminal.

The rating system 1000 includes a backend database management component 1045. The database management component 1045 maintains organizational data structures such as tables that describe rating information for media clips. The media clips include Internet streaming audio or video. The rating information may be in the form of values such as, for example, total votes counted. In an embodiment, database management component 1045 maintains records that comprise meta information on each media clip including the URL to the media clip, the current rating of the media clip, and the total votes for that media clip.

A user 1010 on a user terminal interacts with a web-based playback interface 1020. As an example, play-back interface 1020 outputs play-lists 1018, 1022 to the user. The media clips in each play-lists may be outputted automatically, or displayed for the selection of the user. The play-back interface 1020 may also display to the user genre field 1016 or category field 1014 of the selected media clip, or play-list 1018, 1022. The playback interface 1020 includes features to enable a user on the user terminal to make entries or selections regarding preferences and opinions, as well as other types of information. The user may also view ratings stored on backend database 1045. The user may enter selections by, for example, using icons or other display features. The user may make entries by, for example, inputting text or voice. FIG. 12 illustrates a rating selection component 1012 as a feature of play-back interface 1020. As an example, the rating selection component 1012 allows users to rate a media output between a scale of 1 to 5.

A user 1010 may input a rating to play-back interface 1020. The rating is signaled from play-back module 1020 to a rating module 1030. In an embodiment, rating module 1030 maintains a tally for each media clip. The tally compiles ratings received from play-back module 1020. The ratings may

be received from more than one user and/or user terminal. The tally may be implemented through a protocol that enables the rating module 1030 to organize media clips according to an order. The organization of the media clips may correspond to a user preferential list, where preferred media clips are, for example, listed together or listed before less preferred clips. The rating module 1030 may also determine a genre, category, or other organization information through selections or entries received from the play-back module 1020. The selections may be tallied through any protocol, such as summation, averages, weighted averages and moving averages. In another embodiment, the rating module 1030 may maintain a text field to store user comments regarding each media clip.

In an embodiment, the rating component 1030 updates the rating information maintained in the database management component 1045. For example, the rating component 1030 may update values of the current rating and total votes for each media link.

A play-list generator 1040 generates play-lists based on rating information maintained in the database management component 1045. The play-list generator 1040 may signal to retrieve or receive records for each media clip. The play-list generator 1040 then automatically generates one or more play-list 1042. As previously discussed, each play-list is a list of media links. In an embodiment, the play-lists 1042 are generated according to the current rating and/or rating for each media clip. The generated play-lists are provided by the play-list generator 1040 for the play-back interface 1030.

The user 1010 may choose to listen to play-lists containing media clips rated according to one or more criteria. The play-lists may also be organized according to other factors, such as genre and category.

FIG. 13 is a flow chart that allows a user to listen to media clips that are rated according to one or more criteria. In step 1110, the user is provided a user-interface that allows users to receive media sorted according to one or more categories. The categories correspond to genres, such as type of music etc.

In step 1120, the user selects a category from the options presented by the user-interface. In response to the selection, the user terminal is provided

one or more play-list in step 1130. The play-list received by the user-terminal matches the category or genre selected by the user. Further, play-lists contain predetermined media links to media clips. The media clips in each of the play-lists are determined according to a rating system, using a system such as described by FIG. 12. The predetermined play-list may correspond to a play-list generated by play-list generator 1040 (FIG. 12). Once the play-list is received by the user terminal, the flow process returns to step 1120.

In step 1140, media clips are played back on the user terminal. The media clips are played back consecutively and automatically, so that the user experiences continuous media playback. For example, the play-lists may contain numerous media creations from a selected genre. The media creations may be determined for the play-list according to a rating formula. The user is provided the media creations of the selected genre continuously, so that the user's media experience resembles listening to an album.

FIG. 14 illustrates a flow process for updating a rating of a media clip, under an embodiment of the invention. In step 1210, a module is provided a rating event. The rating event is a rating for a particular media clip, having an associated URL. The rating from the user is predefined from a closed set. For example, the user may provide a rating from 1 to 5.

In step 1220, a record is located for the media clip that was currently rated. The record may be stored in a database, and include the media link for the media clip, the current rating of the media clip, and the votes received for that media clip. In an embodiment, the record may include more than one URL associated with the media clip that was rated. In an embodiment, the record is maintained in database management component 1045 (FIG. 12).

In step 1230, a rating field for the media record is updated. The rating field may correspond to the current rating of a media clip. A module such as the rating module 1030 may update the rating field in database management component 1045 (FIG. 12). The media record is updated to determine a new rating. In one embodiment, the new rating is an averaged based formula. The formula may also be weighted. An example of a formula to determine a rating, under an embodiment of the invention is:

Newrating= 1/(n+1) (N*(old rating)+user provided rating)

N is the total number of votes received, and newrating ranges between 0 and a maximum value.

In step 1240, record for the media clip rated is further updated to add an additional vote to the field for votes received. The flow process then returns to step 1210.

FIG. 15 illustrates an exemplary structure for a database to maintain updated records on ratings and votes tallied. The table may associate values corresponding number of votes, rating, and other information to a media link containing a media clip.

FIG. 16 illustrates a flow process for generating media clips into play-lists according to a rating criteria. Play-lists including a rating criteria are referred to as rated play-lists. The flow process assumes known categories for media clips. The flow process also assumes a rating for rated media clips, and the number of media clips in a rated play-list. The flow process may be used with any of the aforementioned embodiments.

In step 1410, a next category may be fetched from a database containing the different categories of media clips. In step 1420, the system makes a determination as to whether a category was received. If no category is received, the system assumes that there are no more media categories to be rated.

In step 1430, a new play-list is created for a current category. In step 1440, up to N rated media clips from a database of rated media clips are added to the play-list. Preferably, N is a constant in the flow process. Then in step 1450, an old play-list is deleted, and the new play-list is saved. The new play-list may be saved in a format that follows predefined protocol so that the play-list and its contents are accessible to a streaming media play back interface. The flow process then returns to step 1410.

FIG. 17 illustrates a flow process for programmatically categorizing media files. The process assumes a database containing metadata associated with media clips. The metadata includes metadata provided by a human editor. For example, the metadata may pertain to categories such as genre, mood and atmosphere.

In step 1510, a record is retrieved from the database. The record is retrieved with metadata information containing a first type of metadata information and a second type of metadata information. As an example, the first type of metadata information may correspond to a genre of music, and the second type of metadata information may correspond to an artist. In step 1520, a determination is made as to whether a record was received. If the determination is negative, then the process assumes that all media clips have been categorized.

If the determination in step 1520 is positive, then all records in the database having the first type of metadata information are retrieved in step 1530. In step 1540, all records retrieved in step 1530 are updated to include the second type of metadata information. As an example, all records belonging to a particular artist (first type of metadata information) or given additional metadata information of a particular genre (second type of metadata information). The process then returns to step 1510 to retrieve another record.

In one embodiment, the second type of metadata information is a genus category, and the first type of metadata information is a species of the first type of metadata information. Once the first record is known to have the a particular species and genus, the genus may be determined and stored for all records having the same species.

F. Personalized Media Playback

FIG. 18 is a flow process to create personalized play-lists of streaming media files available on the Internet (or other networks). The play-lists may be personalized by users on user-terminals.

In step 1610, a user chooses to add a URL of a selected media clip to a personal favorite play-list. In step 1620, the flow process adds the URL (and metadata) of the selected media clip to a user terminal store for user persistent information, such as an Internet cookie. The persistent data store is then accessible for the web-based play back application on the user terminal.

In step 1630, the user selects to play back media clips from that user's favorite play-list. In step 1640, the system reads back the media clips from the persisted data store. In step 1650, the system plays media clips using a URL

associated with each media clip. The cookie may also provide additional URLs. Thus, multiple media clips may be played continuously from different sites on the Internet.

The user may edit the play-list, change an order of the play-list, or delete selections from the play-list. The user may designate certain play-lists as personal, so as to identify the play-list with that user's terminal. Alternatively, the play-list may be stored on a network server and accessed using the media location and playback module. Users may access their personal play-lists from any one of a plurality of terminals that have access to the system.

G. Distributed Architecture

An implementation under an embodiment provides a distributed architecture in which a user terminal accesses media resources from a plurality of network sites. In a network such as the Internet, the user terminal accesses multiple web sites to playback media locates as files on those web sites.

A network site includes any network location having internal links. Embodiments of the invention access network sites providing links to media files and/or other network sites. A web site refers to a network site on the Internet. Examples of web sites include web pages, including web pages with HTML links to other web sites, to media files, and to other types of files.

The distributed architecture inverts conventional media distribution paradigms. Numerous streaming media files can be streamed to an individual user terminal continuously from throughout the Internet using the embodiment of the distributed playback architecture. The distribution architecture is scalable to provide thousands or millions of streaming media files to user terminals. The users can then play media files located throughout the Internet in a continuous manner from the numerous Internet sites.

FIG. 19 illustrates a distributed playback architecture, under an embodiment of the invention. A user terminal 1710 has access to N network sites that provide access to media, also referred to here as media sites. The N media sites 1722 via web server module 1770. The media sites 1722 each have one or more links to media web resources. The links are represented by URLs 1-N. The web server module 1770 can load the media resources onto a media

playback component of user terminal 1710. Once loaded, the media resources are played back by a media playback component on user terminal 1710.

In an embodiment, the media sites 1722 correspond to different locations on a network such as the Internet. For example, media sites may have different Internet addresses, including different domains. Each media site provides direct access to a media network resource. This implies that a URL (or link) to one of the media sites accesses the media network resource for playback without accessing another internal URL (or link).

In an embodiment, web server module 1770 signals multiple URL links to user terminal 1710. The media playback component of user terminal 1710 accesses each link to playback the media resource. The URLs are selected for media playback so as to output media from user terminal 1710 according to a predetermined program.

In an embodiment, the program is selected or defined from a search request of user. For example, a search request may designate a category for media output, such as a genre and artist. All URLs containing media from that artist and genre may be gathered and signaled from web server module 1770 to user terminal 1710. The URLs may be provided in any order, such as random, etc. or a chronological order of the artist.

In another embodiment, a program may be provided by one or more play-lists. Each play-list in the program may be generated by, for example, a play-list generator 1040 (FIG. 12). The play-lists may be personalized for the user of the end terminal 1710. For example, play-lists may be generated for preferences and profiles specified by the user of user terminal 1710. As another example, a user may couple to the Internet, prompting web server module 1770 to automatically signal one or more play-lists containing the URLs to user terminal 1710. Still, other embodiments provide for URLs to web resources, or play-lists containing the URLs to be randomly provided to user terminal 1710.

Among other advantages, the distributed architecture permits simultaneous playback of, for example, thousands or millions of multiple streams which do not congregate on a single point. This avoids congestion arising under examples of the current media paradigms. This ensures that the embodiment of our distributed architecture may "scale," or permit the

simultaneous playback of, for example, thousands or millions of simultaneous streams. Further, the quality of the user experience is not affected by scaling a system under the distributed architecture embodiment.

In contrast, conventional broadcasting employs one radio or television signal to broadcast to listeners or viewers. Media files disseminated over the Internet today may be distributed in a manner which is somewhat similar in that the media file is located on a single server (or small group of servers) which is accessed by potentially large number of Internet users. As a result, the experience of the users may diminish due to the limited ability of current systems to scale.

This distributed playback architecture, the delivery of streaming media through this playback architecture, in combination with the search functionality performed by the back-end module, and the rating and personalization features of the playback client terminal module permits the creation of a broadcasting system that is personalized by an end user. A personal broadcasting system permits each individual user to create media programs which can be sent to, for example, thousands or millions or other users who can simultaneously play different programming combinations using a distribution of Internet (or other network) sites.

An example of a distributed architecture playback system includes wireless devices that are communicatable to a network containing media resources. For example, media playback component 1710 may be loaded onto a wireless access protocol (WAP) enabled device. Examples of WAP enabled devices include handheld computes and cell phones. The WAP enabled device may use a wireless communication network to access network server module 1770. The WAP enabled device may also include output features, such as speakers or a display screen. The WAP enabled device accesses media sites 1722 by control of network server module 1770. The WAP enabled device then plays back media from the media sites 1722. The WAP enabled device may then be used to simulate a portable radio.

As another example, an automobile may be equipped with a wireless device. The wireless device accesses multiple media sites on a network such as the Internet to and provide playback of media clips. For example, the user may

select to hear music from a favorite play-list using the WAP enabled device in the automobile.

H. Messaging Applications

FIG. 20 is a diagram illustrating a messaging application, under an embodiment of the invention. The messaging application enables the user to share a media playback experience with other users having access to the network.

FIG. 20 assumes the messaging application is operated on a network such as the Internet. In the embodiment, a network interface or network-side module is used to enable messaging, rather than a client messaging applications. Examples of messaging applications for use with embodiments include e-mails, which are delivered to a folder on a recipient's terminal. Other types of electronic messages include instant messages, which can be displayed or heard on the recipients terminal automatically upon arrival.

A messaging module 2080 receives a messaging request from a first user terminal (sender) 2010. The messaging module 2080 may be an application or portion of network server module 2070. The messaging request is entered by the user through the user-interface 1900, using for example, an e-mail selection field 1990.

The messaging module 2080 receives addresses to deliver messages to recipient terminals (recipient) 2020. The sender 2010 may manually signal the recipients address using entry methods such as keyboards, graphic user selection features, or audio commands. Alternatively, messaging module 2080 has access to network stored addresses for the specific user. The network stored messages are then selectable from a terminal by the user on the sender terminal 2010.

In response to a request from sender 2010, messaging module 2080 generates a message 2085 for the recipient. The request may also include the address of the intended recipient(s). The message 2085 is sent to all recipients 2020 specified by sender 2010. The contents of the message 2085 include a URL to the network server module 2070. In an embodiment, the URL in the message is packaged with arguments or other coding to identify a play-list

maintained on the network server module 2070. The URL may also be packaged with arguments to identify the specific song being played when the sender causes the message to be transmitted to the recipient. Alternatively, the URL may identify to the recipient the search request or criteria used by the sender.

The recipient may choose to return a message 2082 to signal messaging module 2080. In one embodiment, the content of the message is constructed so that once the message is opened, the user can select a link to a module that stores or maintains the play-list 2075. For Internet applications, the link is HTML formatted to include the URL of network server module 2070, and arguments to identify the play-list selected by sender 2010. Once network server module 2070 is accessed by the recipient 2020, arguments 2088 contained with the link identify the specific play-list 2075 experienced by sender 2010 when the request to send the message was made.

If the message is instant, the recipient 2020 can respond immediately to simultaneously share the experience of sender 2010. Alternatively, the recipient 2020 can be made to respond automatically upon the recipient 2020 receiving the message 2085, so as to enable sender 2010 and 2020 to simultaneously or concurrently share the same media playback.

The argument 2088 that is packaged with the link may also identify individual media clips, and/or an entire play-lists. The recipient 2020 is able to experience media playback from individual media clips selected by sender 2010.

In another embodiment, message 2085 is constructed so that once the message is opened, the user is automatically connected to network server module 2070. The message may be an e-mail, stored in a designated folder of recipient 2020. The e-mail may include an HTML formatted URL to cause the recipient's terminal to access and communicate with network server module 2070. The HTML formatted URL may also include code that causes the user terminal to automatically access network server module 2070 upon the e-mail being opened. The HTML formatted link may also include arguments to specify the play-list 2088 and/or media clip identified by the sender, as well as other parameters of the URL. Once the play-list or media clip is identified by

network server module 2070, the recipient 2020 is able to share the media playback experience of the sender 2010. The sender 2010 can experience the media playback at the time sender 2010 requests the message to be sent.

In the embodiments shown, sender 2010 can select a media program that is signaled transmitted to recipient 2020 by messaging module 2080. The program may correspond to one or more play-lists, playing back multiple media resources. While sender 2010 is being played back the program, the sender 2010 can specify the address of recipient 2020 to messaging module 2080. The messaging module 2080 generate a message that includes a selectable link to enable the recipient to access the network server module 2070. Arguments or scripting contained with the URL identify the particular play-list being signaled to the sender 2010. Since the play-list is updated after every media resource is played back to sender 2010, recipient 2020 accesses the play-list at the selection being played back to the sender 2010. The play-list is then signaled to the sender 2010 and recipient 2020 simultaneously, or approximately thereabout. Alternatively, recipient 2020 accesses the play-list beginning with the media clip played back to sender 2010 when the sender 2010 selected to transmit the message to recipient 2020.

As an example, sender 2010 transmits a search request causing media, based on search criterias of a specific artist and a ranking. The network server module 2070 identifies URLs matching the search request and forms play-list 2075 for sender 2010. After reviewing the play-list 2075, the sender 2010 decides to share the media playback with a friend, recipient 2020, whom the sender believes would appreciate play-list 2075. The sender 2010 requests messaging module 2080 to transmit message 2085 to recipient 2020 by submitting the recipient's e-mail address to the messaging module 2080. The message 2085 sits on the recipient's terminal until accessed. The recipient 2020 selects message 2085 to access play-list 2075. Unless the messaging is nearly instantáneous, the recipient experiences media playback from the play-list 2075 when sender 2010 request message 2085 to be sent. Alternatively, sender 2010 may request the entire play-list 2075 to be transmitted to recipient 2020. In this way, sender 2010 and recipient 2020 may share a common interest in certain genres, category, artists etc. of media playback.

I. User-Interface

FIG. 21 illustrates a user-interface 1900, under an embodiment of the invention. The user-interface 1900 may correspond to the play-back interface 1020, described with FIG. 10. Alternatively, the user-interface may be a terminal side component in communication with one or more server-side modules, such as for example web server module 1070 (FIG. 12).

In an embodiment such as shown by FIG. 12, user-interface 1900 includes a plurality of user-interactive features. The user-interactive features enable users to interact with the system 200 from the user terminal 210. Some of the plurality of user-interactive features allow users to submit search requests and other media requests for playback. Other control user-interactive features allow users to affect the play back of the media resources.

The user-interface 1900 may output to the user information, images, and/or audio that is different than the media resource being played back. For example, user-interface 1900 displays metadata information to the users about the media resource being played back. In addition, the user-interface 1900 enables users to, for example, view advertisement, receive electronic messages, and create and manage play-lists.

In an embodiment such as shown by FIG. 21, the user-interface 1900 includes a first menu field 1910, a second menu field 1920, and a third menu field 1930. The first menu field 1910 allows the user to select a first criteria for media resources that are to be played back. The second menu field 1920 allows the user to select a second criteria from a set of media resources matching the first criteria. The third menu field 1930 allows the user to select a third criteria from the a set of media resources matching both the first and second criteria. Each of the menu fields 1910-1930 may be in the form of click and drag-down menus.

The user-interface 1900 may also include a text field 1940. The text field 1940 allows users to enter a search criteria. The search criteria entered in text field 1940 may be combined with the search criterias of one or more menu fields 1910-1930 using a Boolean operation. Preferably, all search criterias are AND together into a single search criteria. For example, the search criteria

entered in text field 1940 may correspond to an artist name, or a title of a media creation.

In an embodiment, the user-interface 1900 provides features that prompt a user for input, such as for one more search criterias. The web server module 270 receives the search criteria(s) signaled from user terminal 210, and access media and metadata table 247. Each of the menu field 1910-1930 may also allow users to enter text field as the search criterias. The search criteria(s) are matched to URLs containing metadata having the same (or equivalent) criterias. For example, the search request may specify a genre, and a first name of an artist. Then, web access server 270 locates URLs to media resources having associated metadata information that identifies the media resource as being of the same genre, and as containing the same first name in the artist name metadata indexed data structure.

The web server module includes a feedback display portion 1950. The feedback display portion 1950 may signal information, messages, advertisement etc. to the end user. In an embodiment, feedback display portion 1950 displays metadata information about the media resource being played back. For example, a song of a particular genre and category may be played back. The display screen portion 1950 may display the title of the song, the artist name, a play-list associated with the song, a rating component of the song, and the song's duration. Information is read when the media playback component loads the media resource.

Other user-interactive features may also be included in user-interface 1900. In an embodiment, user-interface 1900 includes a play-list feature 1960. The play-list feature 1960 enables users to add a media creation to a play-list. The play-list feature 1960 may, as an example, be a selectable icon. Upon selecting the play-list feature 1960, a pop-up window (not shown) may be displayed allowing a user to name or select the play-list that will include the media resource being played. In this way, a user of user terminal 210 can provide input to create and manage play-lists, using systems such as described with FIG. 12 and 19.

The user-interface 1900 may include one or more control user-interactive features. The control user-interactive features may be in the form of

selectable icons. A skip feature 1972 causes, for example, web server module 270 to signal a URL of another media creation to the media playback component. This causes the media playback component to start playing back a new media creation. A pause feature 1974 enables users to pause the media playback component from playing back the media resource. The pause feature 1974 may signal the media playback component directly, or cause the web server module to signal the command to the media playback component. Reselecting the pause feature 1974 then causes the media creation to be played back from the portion where playback was paused. Similarly, a seek feature 1976 may signal to seek or move to a specific instance of playback on the media resource. A volume feature 1978 signals the application program interface 276 (FIG. 5) to raise the volume of the media resource being played back.

The user-interface 1900 may also include a rating feature 1980. The rating feature 1980 may be in the form of multiple selectable icons, where the icons are arranged to correspond to a rating. For example, five icons may be provided to represent best to worst ratings. In an embodiment, the rating feature 1980 enables a user to rate a media resource during or after it is played back on the user terminal 210. With reference to an embodiment such as described with FIG. 12, the rating feature 1980 is used to prompt a user to signal a rating to rating component 1030 (FIG. 12). The rating feature 1980 may be a user response to a media clip played back on user terminal 210. The rating component 1030 receives the rating and modifies rating information associated with the URL that is stored in 1045. The rating information may then be provided to other users or user terminals. For example, the rating information may then be signaled to display portions 1950 of other user terminals 210 who select that media clip for playback.

The user-interface 1900 also includes a personal play-list feature 1985. The personal play-list feature includes iconic selection features, including an add icon 1987 to add a URL to a play-list, and a play icon 1989 to play a personal play-list. The add icon 1987 enables a user to signal play-list generator 1040 (FIG. 12) to add a URL to the personal play-list. The URL being added to the play-list may correspond to a media resource being played back on user terminal 210. The play icon 1989 may be selected to cause web server module

1070 (FIG. 12) to signal URLs from the personal play-list to the media playback component of user terminal 210. In this way, user terminal 210 may select to have continuous media output from resources previously selected to be on a play-list.

The user-interface 1900 may also include an e-mail selection feature 1990. The e-mail selection feature 1990 may be iconic, to allow selection by the user upon the media playback. Once selected, an e-mail program on user terminal 210 may be launched. The e-mail program may be directed to open a new message, and attach the URL of the selected media resource.

FIG. 22 illustrates an embodiment in which user-interface 1900 is displayed on the desktop along a second window 2210 showing a web site 2212. The web site 2212 hosts the media file being played back. In this embodiment, web server module 1070 signals a media file URL to the media player component of the terminal. The web server module 1070 concurrently signals the web browser component 213 on the terminal another URL to the hosting web site. The web browser 213 opens the second window 2210 to display the web site while the media from the media file is being played back on the terminal. In this way, users are displayed the web site hosting the media file while media from the media file is played back. This allows the user to view, for example, banner ads, artist name and titles, and copyright information while media from the web site is being played back.

After the playback is complete for one media file, a URL to a next media file is signaled to the media player component on the terminal. The next URL may be determined by a sequence of a play-list, or by a result to a search term inputted from the user. If the URL of the next media file is hosted on a web site that is different than the preceding web site, then web server module 270 signals the URL of the next hosting web site to the web browser. The second window 2210 then displays a second web site 2212' that hosts the media file being played back. In this way, the second window 2210 displays only web sites hosting the media files being played back.

J. Conclusion

The foregoing description of various embodiments of the invention has been presented for purposes of illustration and description. It is not intended to limit the invention to the precise forms disclosed. Many modifications and equivalent arrangements will be apparent.

CLAIMS

What is claimed is:

1. A method for playing back media from a network, the method comprising:

receiving a search criteria from a network enabled device;

accessing a database comprising a plurality of network addresses, the database associating each address with one or more classes of information, each address accessing a media resource;

selecting at least one address in the database using the search criteria;

signaling the selected address to the network enabled device; and

controlling the network enabled device so as to automatically access and play back the media resource of the selected address.

2. The method of claim 1, wherein selecting at least one address in the database includes matching the search criteria with a parameter in the one or more classes of information associated with that address.

3. The method of claim 1, wherein accessing a database comprising a plurality of network addresses includes accessing a plurality of links to Internet sites, each link containing no other internal link.

4. The method of claim 3, wherein selecting at least one address in the database using the search criteria includes selecting a plurality of links in the database using the search criteria, signaling the selected plurality of links to the network enabled device, and programmatically controlling the network enabled device so as to automatically access and sequentially play back the media resource of each of the plurality of selected links in a designated order.

5. The method of claim 4, wherein controlling the network enabled device so as to automatically access and sequentially play back the media resource includes sequentially playing back the media resource of each of the plurality of selected links after accessing the respective selected link.

6. The method of claim 3, wherein receiving a search criteria from a network enabled device includes receiving the search criteria corresponding to an artist name, and wherein selecting at least one address in the database using the search criteria includes selecting a plurality of links that are each associated with a class of information containing a parameter corresponding to the artist name.

7. The method of claim 3, wherein receiving a search criteria from a network enabled device includes receiving the search criteria corresponding to a title of a network media resource, and wherein selecting at least one address in the database using the search criteria includes selecting a plurality of links that are each associated with a class of information containing a parameter corresponding to the title of the network media resource.

8. The method of claim 2, wherein receiving a search criteria from a network enabled device includes receiving the search criteria corresponding to a musical category, and wherein selecting at least one address in the database using the search criteria includes selecting a plurality of links that are each associated with a class of information containing a parameter corresponding to the musical category.

9. A method for playing back media from a network, the method comprising:

receiving a request for media playback entered on a network enabled device;

accessing a database comprising a plurality of network addresses, each address accessing a media resource;

identifying at least two addresses from the database;

signaling each identified address to the network enabled device; and

controlling the network enabled device to access and automatically play back the media resources of each of the signaled addresses.

10. The method of claim 9, wherein controlling the network enabled device to access the media resources of the signaled links includes signaling a uniform resource locator for one or more of the media resources to a media playback

component to cause the network media resources of the signaled links to be accessed and played back on the network enabled device.

11. The method of claim 10, wherein receiving a request for media playback includes receiving the request for media playback from an Internet enabled device, and wherein the method further comprises signaling the uniform resource locator of the one or more media resources to a web browser component on the Internet enabled device to cause a web page to be displayed on the Internet enabled device while the media playback component plays back the media resource on the network enabled device.

12. The method of claim 11, wherein receiving a request for media playback from a network enabled device includes receiving a request for a play-list comprising a plurality of addresses, the play-list arranging the plurality of addresses so that the addresses are loaded by the media playback component in a designated order, wherein identifying at least two addresses in the database includes identifying the addresses in the play-list, and wherein controlling the network enabled device to access and automatically play back the media resources of the signaled addresses includes accessing and playing back each media resource in the play-list sequentially in the designated order.

13. The method of claim 12, wherein receiving a request for media playback from a network enabled device includes receiving a request for a program comprising multiple play-lists, each play-list being corresponding to a predetermined selection of media resources, wherein identifying at least two addresses includes identifying the addresses in each of the play-lists in the program, and wherein controlling the network enabled device to access and automatically playback the media resources of the signaled addresses includes accessing and playing back each media resource in a sequential order designated by the play-lists of the program.

14. A computer system for playing back media from a network, the computer system comprising:

a network enabled device comprising a media playback component;

a database comprises a plurality of addresses, each address locating a media resource on the network;

a network server module that communicates with the network enabled device and with the database, the network server module being able to receive a search request entered on the network enabled device that specifies one or more criterias, to select at least one address from the database that is associated with a class of information that matches the search criteria, and to cause the media playback component to load the media resource located by the selected address.

15. The computer system of claim 14, wherein the database stores one or more classes of information associated with each address in the plurality of addresses.

16. The computer system of claim 15, wherein the database is locatable by the network enabled device on the network.

17. The computer system of claim 15, wherein at least a portion of the database resides on the network enabled device.

18. The computer system of claim 14, wherein the network server module signals the selected address to the network enabled device to cause the media playback component to load the media resource located by the selected address.

19. The computer system of claim 18, wherein the network server module communicates with the network enabled device through the network.

20. The computer system of claim 14, wherein the network server module is located at least partially on the network enabled device and communicates with the database through the network.

21. The computer system of claim 14, wherein the network server module comprises a sequence of code that is signaled to the network enabled device from another device on the network, the sequence of code being executable on the network enabled device.

22. The computer system of claim 14, wherein the network enabled device comprises the media playback component, and wherein the network server module programmatically controls the media playback component of the network enabled device to playback the media resource.

23. The computer system of claim 14, wherein the network enabled device is a network enabled device selected from a group of devices consisting of a personal computer, a handheld computer, a smart network appliance, and a wireless Internet enabled device.

24. The computer system of claim 14, wherein the database comprises a plurality of links to Internet sites, wherein each link accesses a media resource without requiring another internal link.

25. The computer system of claim 14, wherein all or a portion of the database resides on the network enabled device.

26. The computer system of claim 14, wherein all or a portion of the database is accessible to the network enabled device over the network.

27. The computer system of claim 14, wherein the one or more classes of information for each address in the database include types of metadata selected from the group consisting of genre, title, and data format of the network resource.

28. The computer system of claim 14, wherein the media resource is a streaming media file that outputs a combination of at least video or audio once the media resource is loaded by the media playback component.

29. The computer system of claim 14, wherein the network includes the Internet, the network enabled device includes an Internet enabled device, each of the plurality of addresses includes links to a media web resource, and wherein the network server module signals control information to the Internet enabled device to cause the Internet enabled device to programmatically access each of a plurality of media web resources signaled to the network enabled device.

30. The computer system of claim 29, wherein the web server module signals control information to the media playback component and a web browser component of the Internet enabled device, to cause the media playback component of the network enabled device to programmatically load and playback the media web resource while the web browser displays a web page of a web site corresponding to the media web resource being played back.

31. A computer system for playing back media from a network, the computer system comprising:

a network enabled platform comprising a media playback component;

a database comprising a plurality of addresses, each address locating a media resource on the network, each address accessing a media resource; and

a network server module that coupleable to the media playback component and the database, the network server being able to receive a request for media playback from the network enabled device, to select multiple addresses from the database, to signal the multiple addresses to the network enabled device, and to control a media playback component on the network enabled device to use the addresses to automatically access and play back the media resource associated with the addresses.

32. The computer system of claim 31, wherein the network server module resides on the network.

33. The computer system of claim 31, wherein at least a portion of the network server module resides on the network enabled device.

34. The computer system of claim 31, wherein the network server module comprises a sequence of code that is signaled to the network enabled device from another device on the network, the sequence of code being executable on the network enabled device.

35. The computer system of claim 31, wherein the network enabled device is an Internet enabled device comprising the media playback component and a

network browser component, the database comprises a plurality of links to media web resources, wherein the network server module programmatically controls the media playback component of the Internet enabled device to access and playback the media web resource of each link signaled to the Internet enabled device.

36. The computer system of claim 31, wherein the network enabled device further comprises a web browser component, and wherein the network server module programmatically controls the web browser component to display a web page associated with the media web resource being played back.

37. The computer system of claim 31, further comprising a play-list module coupleable to the network server module, the play-list module generating a play-list based on one or more criterias designated by a user of the network enabled device, the play-list comprising a plurality of addresses that are signaled to the network enabled device in response to the request for media playback.

38. The computer system of claim 31, wherein the network enabled device is a terminal device selected from a group of devices consisting of a personal computer, a handheld computer, a wireless Internet enabled device, and a handheld computer.

39. The computer system of claim 31, wherein the database comprises a plurality of links to Internet sites, wherein each link accesses a media web resource and contains no other internal link.

40. The computer system of claim 31, wherein all or a portion of the database resides on the network enabled device.

41. The computer system of claim 31, wherein all or a portion of the database is accessible to the network enabled device over the network.

42. A network enabled device configured to playback media from a network, the network enabled device being coupleable over to a database

comprising a plurality of addresses, each address locating a media resource on a network, the network enabled device comprising:

a user-interface to prompt for a search request;

a network interface to signal the request to a network server module that is communicatable with the database, and to receive one or more addresses in the database that match the search request; and

a media playback component being configured to be programmatically controllable by the network server module to automatically load the media resource associated with each address signaled to the network enabled device upon accessing the media resource.

43. The network enabled device of claim 42, wherein the user interface is controllable by the network server module after the network server module signals the response, the user-interface providing one or more prompts to enable an end user to control the media played back from the one or more media resources associated with the addresses signaled from the network server module.

44. The network enabled device of claim 42, wherein the user-interface prompts for a user to signal the network server module to immediately access a next address signaled to the network enabled device from the network server module.

45. The network enabled device of claim 44, wherein the user-interface prompts for the end user to signal the media playback component to repeat playing back a previously played media resource.

46. The network enabled device of claim 42, wherein the user interface prompts for a specific media resource from the media resources signaled from the network server module for playback, and to pause playback from the media resources signaled from the web server module.

47. The network enabled device of claim 42, wherein the network access component is a web browser residing on an Internet enabled device.

48. The network enabled device of claim 42, wherein all or a portion of the database is accessible to the network enabled device over the network.

49. The network enabled device of claim 42, wherein all or a portion of the database resides on the network enabled device.

50. The network enabled device of claim 42, wherein the network device is Internet enabled, wherein the network interface signals the request to a web server module that is communicatable with the database to receive one or more links to web sites containing media web resources, the one or more links containing no internal links, and wherein the Internet enabled device further comprises a web browser component, the web browser component being controllable by the web server module to automatically access and display a web page associated with the media web resource being played back by the media playback component.

51. The network enabled device of claim 50, wherein the network interface includes a communication port between the network enabled device and the network.

52. A network enabled device configured to play back media from a network, the network enabled device being coupleable over the network to a database comprising a plurality of addresses, each address locating a media resource on the network, the network enabled device comprising:

a user-interface including a plurality of user-interactive features, a first user-interactive feature in the plurality of user-interactive features prompting to receive a search request for media playback;

a network interface that signals the request to a network server module upon the first user-interactive feature receiving the search request for media playback, the network interface being communicatable with the database to receive one or more addresses in the database that match the search request; and

a media playback component being configured to be programmatically controllable by the network server module to automatically load the media resource associated with each address signaled to the network

enabled device upon accessing the media resource, a playback of the media playback component being controllable by one or more control user-interactive features in the plurality of user-interactive features.

53. The network enabled device of claim 52, wherein the first user-interactive feature in the plurality of user-interactive features is selected from a group consisting of selectable icons, text-entry field, and menu items.

54. The network enabled device of claim 53, wherein the control user-interactive features are selected from a group of selectable icons having functions corresponding to skipping to a next address selected to be signaled to the network enabled device, pausing the media resource being played back; repeating the media resource previously played back, and stopping playback from the media playback component.

55. The network enabled device of claim 53, wherein the user-interface includes a plurality of user-interactive features to select a characteristic of a media playback from the media playback component.

56. The network enabled device of claim 55, wherein the user-interface features include the plurality of user-interactive features to select a genre, an artist, or a title of a network media resource for playback .

57. The network enabled device of claim 56, wherein the search request is composed by selecting one or more of the user-interactive features of the user-interface.

58. A method for sharing media playback on a first terminal coupled to a network with other terminals coupled to the network, the method comprising:

signaling a link in a play-list to the first terminal, the play-list including one or more links to media files on the network;

receiving a signal from the first terminal to message a second terminal while the first terminal is playing back media from one of the media files;

signaling the second terminal a selectable link to enable the second terminal to receive one or more links in the play-list; and

signaling the one or more links in the play-list to the second terminal upon the selectable link being selected by the second terminal.

59. The method of claim 58, wherein signaling the second terminal a selectable link includes messaging the second terminal the link to the play-list.

60. The method of claim 58, wherein signaling the second terminal a selectable link includes signaling a message to the second terminal that causes the second terminal to access the play-list once the message is opened.

61. The method of claim 58, wherein signaling the one or more links in the play-list to the second terminal includes signaling each link in the play-list to the first terminal and to the second terminal concurrently.

62. The method of claim 58, further comprising receiving the signal from the first terminal to message the second terminal while the first terminal is playing back media located by a link in the play-list, and causing the media playback component of the second terminal to load the media file being played by the first terminal.

63. The method of claim 58, wherein signaling a link to the second terminal that locates the play-list module includes signaling the link to include arguments that locate the address in the play-list corresponding to the media file being played back on the first terminal.

64. A system for sharing media playback from a network between a plurality of terminals, the plurality of terminals including a first terminal and a second terminal, the system comprising:

a play-list component locatable on the network by a selectable link, the play-list component identifying a plurality of links to form a play-list, each link in the play-list locating a media file on the network;

a network server module signaling the plurality of links that form the play-list to the first terminal, the network server module being able

to receive a signal to transmit the selectable link to the second terminal to enable the second terminal to locate the play-list module.

65. The system of claim 64, wherein the network server module signals the plurality of links that form the play-list to the second terminal upon the selectable link being transmitted to the second terminal is selected.

66. The system of claim 64, wherein the messaging module transmits the selectable link as a content of a message.

67. The system of claim 64, wherein the play-list module transmits the selectable link with a corresponding message to the second terminal so that the selectable link is selected when the message opened.

68. The system of claim 65, wherein the play-list module identifies the plurality of links to form a plurality of play-lists, and wherein the messaging module transmits the selectable link with identifiers that identify the play-list being signaled to the first terminal.

69. The system of claim 68, wherein the messaging module transmits the selectable link with identifiers that identify the media file being played back on the first terminal.

70. The system of claim 69, wherein the network server module identifies the link in the play-list being played back on the first terminal and transmits the identified link with a remainder of the links in the play-list to the second terminal, so that the first terminal and the second terminal simultaneously playback the same media files while the links in the play-list are signaled to each of the first terminal and the second terminal.

71. A network enabled device comprising:

a media playback component configured to communicate with a network-side module to receive a first plurality of links, each of the first plurality of links locating a media file on a network;

a web browser component configured to receive a second plurality of links, each of the second plurality of links hosting a media file

located by one of the first plurality of links, the web browser component displaying the web site for each of the second plurality of links that corresponds to the media file being played back by the media playback component.

72. The network enabled device of claim 71, further comprising a user-interface including user-interactive features for controlling media output from media files located by the first plurality of links.

73. The network enabled device of claim 72, wherein the user-interface is displayed in a first window, and the web browser component displays the web site for each of the second plurality of links in a second window.

74. The network enabled device of claim 73, wherein the media playback component is configured to sequentially receive the first plurality of links from the network-side module, and the web browser displays the web sites hosting media files for each of the web sites in the sequence.

75. A system for playing back media from a network, the system comprising:

means for receiving a search criteria from a network enabled device;

means for accessing a database comprising a plurality of network addresses, the database associating each address with one or more classes of information, each address accessing a media resource;

means for selecting at least one address in the database using the search criteria;

means for signaling the selected address to the network enabled device; and

means for controlling the network enabled device so as to automatically access and play back the media resource of the selected address

76. A system for playing back media from a network, the system comprising:

means for receiving a request for media playback from a network enabled device;

means for accessing a database comprising a plurality of network addresses, each address accessing a media resource;

means for identifying at least two addresses from the database;

means signaling each identified address to the network enabled device; and

means for controlling the network enabled device to access and automatically play back the media resources of each of the signaled addresses.

77. A method to locate web resources on the Internet, the method comprising:

accessing a web site;

identifying a plurality of links using a web browser component, each of the plurality of links being selectable to open a corresponding web resource of a specified data type on the web site; and

making the plurality of links available to a plurality of Internet enabled devices that select one or more of the links.

78. The method of claim 77, further comprising arranging the plurality of links in a database that is accessible over the Internet to the plurality of Internet enabled devices.

79. The method of claim 78, further comprising identifying one or more classes of information about each of the plurality of links using a media playback component, and storing each of the plurality of links in association with the one or more classes of information.

80. The method of claim 79, further comprising making the one or more classes of information available to the plurality of Internet enabled devices.

81. The method of claim 77, wherein accessing a web site includes accessing a web site identified by a metacrawler.

82. The method of claim 77, wherein identifying a plurality of links includes identifying links that only access web resources including audio data types, video data types, or a combination of audio and video types.

83. The method of claim 77, wherein identifying a plurality of links using a web browser component includes reconfiguring a commercially available web browser.

84. The method of claim 77, wherein identifying a plurality of links using a web browser component includes programmatically controlling the web browser component through an application programmable interface of a web browser to access the web resource for each of the plurality of links.

85. The method of claim 84, wherein programmatically controlling the web browser through an application programmable interface includes programming the web browser to bypass a shell of the web browser.

86. The method of claim 85, wherein programmatically controlling the web browser through an application programmable interface includes programming the web browser to reduce functionality of the web browser in displaying and translating data structures on each web site.

87. The method of claim 84, wherein programmatically controlling the web browser component through an application programmable interface further comprises using the web browser component to parse a web page that provides access to each link in the plurality of links to identify the plurality of links programmatically.

88. The method of claim 77, further comprising verifying that each of the plurality of links are selectable to open the corresponding web resource of the specified data type upon being selected.

89. The method of claim 88, wherein verifying that each of the plurality of links are selectable includes verifying that the web resources of each available on the network.

90. The method of claim 89, wherein verifying that each of the plurality of links are selectable to open the corresponding web resource of the specified data type includes loading each of the plurality of media web resources into a media playback component.

91. A system for locating web resources on the Internet, the system comprising:

a web browser component;

a database;

a search module that controls the web browser component to access at least one web site, the search module controlling the web browser component to identify a plurality of links to media web resources at the web site, each of the plurality of links being selectable to open a media web resource, the search module storing the plurality of links in the database.

92. The system of claim 91, wherein the search module signals an application programmable interface of the web browser an address of the web site so as to cause the web browser component to load and parse the web site for the plurality of links to media web resources.

93. The system of claim 91, wherein the search module signals an application programmable interface of the web browser an address of the web site so as to cause the web browser component to load and parse the web site for the plurality of links to media web resources without displaying the media web resources.

94. The system of claim 92, wherein the search module signals the application programmable interface of the web browser the address of the web site so as to cause the web browser component to load and parse the web site for the plurality of links to media web resources of a video data type, an audio data type, or a combination of the audio and video data types.

95. The system of claim 94, wherein the search module causes the web browser component to load and parse the plurality of links to media web resources of data types including animation and/or still images

96. The system of claim 91, further comprising a metacrawler module to locate a plurality of web sites for the search module.

97. The system of claim 91, wherein the search module controls a media playback component to extract metadata about the media web resources of each of the plurality of links.

98. A method to locate web resources on the Internet, the method comprising:

accessing a database including a plurality of links, the plurality of links being selectable to open a corresponding web media resources;

programmatically identifying metadata information about the web media resource corresponding to each of the plurality of links; and

making the plurality of links accessible to a plurality of Internet enabled devices, the plurality of Internet enabled devices being able to select one or more of the links to open the corresponding media web resource.

99. The method of claim 98, wherein programmatically identifying metadata information about the web media resource corresponding to each of the plurality of links includes signaling each link to a media playback component so as to cause the media playback component to load the corresponding media resource.

100. The method of claim 99, wherein signaling each link to a media playback component includes loading streaming audio media into the media playback component for sound recordings.

101. The method of claim 99, wherein signaling each link to a media playback component includes loading streaming video media in the media playback component for video recordings, including video recording having sound.

102. The method of claim 100, wherein signaling each link to a media playback unit includes determining at least one of a duration of the web media resource, and a title of the web media resource.

103. The method of claim 100, wherein signaling each link to a media playback unit includes determining a broadcast quality of a web media resource.

104. The method of claim 100, wherein signaling each link to a media playback unit includes determining an image size of a web media resource having video or image.

105. The method of claim 100, wherein signaling each link to a media playback unit includes determining at least one of an artist, a genre, and a data type of the web media resource.

106. The method of claim 98, further comprising manually extracting the metadata information after programmatically identifying the metadata information.

107. The method of claim 106, further comprising storing the identified and extracted metadata information with each of the plurality of links in a database, and then making the database available to the plurality of Internet enabled devices.

108. A method to locate web resources on the Internet, the method comprising:

accessing a database including a plurality of links to media web resources;

programmatically verifying whether each of the plurality of links opens a corresponding web media resource; and

making each verified link in the plurality of links accessible to a plurality of Internet enabled devices that select one or more of the links to open the corresponding media web resource.

109. The method of claim 108, wherein programmatically verifying whether each of the plurality of links opens a corresponding web media resource includes loading each link into a media playback component.

110. The method of claim 109, programmatically verifying whether each of the plurality of links opens a corresponding web media resource includes verifying each of the plurality of links makes available a web media resource for playback on one of the Internet enabled devices.

111. The method of claim 108, wherein programmatically verifying whether each of the plurality of links opens a corresponding web media resource includes loading each link into a web browser component

112. The method of claim 108, further comprising programmatically identifying metadata information about the web media resource corresponding to each of the plurality of links using the media playback component.

113. The method of claim 112, wherein programmatically identifying metadata information includes loading each of the verified links into the media playback component and then receiving editorial input about the web media resource loaded onto the media playback component.

114. A system for locating web resources on the Internet, the system being accessible by a plurality of Internet enabled devices, the system comprising:

a first indexed data structure comprising a plurality of links;

a media playback component coupleable to the database, the media playback component loading each of the plurality of links to verify whether the link is selectable to open a media web resource;

a second indexed data structure stores each verified link in the plurality of links, the second indexed data structure being available to the plurality of Internet enabled devices.

115. The system of claim 114, wherein the media playback component identifies one or more classes of information about the web media resource upon loading the link corresponding to the web media resource.

116. The system of claim 114, further comprising a search module that signals each of the plurality of links in the first indexed data structure to the media playback component, and wherein for each verified link, the search module signals the verified link to the second indexed data structure.

117. The system of claim 112, further comprising an editor interface to receive an editor input, the editor input including metadata information that was not identified from the media playback component loading the link.

118. The system of claim 117, further comprising an editor interface to receive an editor input, the editor input including metadata information identified from the media playback component loading the link.

119. The system of claim 118, further comprising an editor interface to receive an editor input, the editor input including metadata information identified from the media playback component loading the link, wherein the search module signals the metadata information about that verified link to the second indexed data structure, so that each verified link is associated with the corresponding metadata received from the editor input.

120. A method for providing links for use in a media search engine, the method comprising:

identifying a plurality of internal links on a network site;

determining whether the network site makes a network resource of a specific data type accessible for a network enabled device;

extracting the internal links that are selectable to open the network resource of the specific data type;

storing the external link in a database; and

automatically signaling one or more of the links to a media playback component in response to receiving a search request from the network enabled device.

121. The method of claim 120, wherein extracting the internal links that are selectable to open the network resource of the specific data type includes using a web browser component.

122. The method of claim 120, wherein determining whether the network site makes a network resource of a specific data type accessible for a network enabled device includes using a media playback component.

123. The method of claim 120, including extracting the internal links that are selectable to open the network resource of the specific data type for playing back media.

124. A method for providing links for use in a media search engine, the method comprising

a) receiving from a first indexed data structure a first external link to a first network site;

b) initializing a second data structure to be empty;

c) determining if the first network site contains at least one internal link; and

d) storing the at least one internal link contained on the first network site that is not in the first indexed data structure and not in the second indexed data structure as another external link in the first indexed data structure;

e) identifying the internal links contained on the first network site that are selectable to open a network resource of a specific data type or types;

f) moving the first external link from the first indexed data structure to the second indexed data structure; and

g) repeating steps a) through f) until the first indexed data structure is empty.

125. The method of claim 124, wherein prior to receiving from a first indexed data structure a first link to a first site, adding one or more of the first plurality of links to the first indexed data structure using an editor interface.

126. The method of claim 125, wherein prior to receiving from a first indexed data structure a first link to a first site, adding one or more of the first plurality of links to the first indexed data structure using a metacrawler.

127. A computer system to search for links to streaming media playback on a network, the network being accessible to a network enabled device, the computer system comprising:

a metacrawler to locate one or more media sites containing streaming media;

a media search module coupled to the metacrawler be signaled the one or more media sites, the media search module being able to identify a plurality of media links located by the one or more media sites, each of the plurality of media links being selectable to open streaming media network resource;

a metadata extraction module that accesses each media link identified by the media search engine to extract metadata about the identified media link; and

a database comprising the plurality of media links identified by the media search engine, and the metadata extracted about each identified media link, the database enabling the network enabled device to access the plurality of media links.

128. The computer system of claim 127, wherein the metacrawler locates one or more media sites in media directories, each media directory comprising a plurality of media sites.

129. The computer system of claim 127, where the metadata extraction module comprises a media playback component that loads the streaming media network resource.

130. The computer system of claim 127, wherein the metadata extracted from each identified link is sorted in the database according to one or more classes of information.

131. The computer system of claim 130, wherein the metadata extracted is sorted into one or more classes of information selected from classes consisting of genre, sub-genre, artist, and title.

132. The computer system of claim 131, further comprising a verification module that verifies each media link identified by the media link module opens the corresponding streaming media network resource.

133. A computer system to search for links to streaming media playback on a network, the network being accessible to a network enabled device, the computer system comprising:

means for accessing a web site;

means for identifying a plurality of links using a web browser component, each of the plurality of links being selectable to open a corresponding web resource of a specified data type on the web site; and

making the plurality of links available to a plurality of Internet enabled devices that select one or more of the links.

134. A system for providing media from a network to a terminal, the terminal including a media playback component, the system comprising:

a first network site and a second network site, each network site locating one or more media network resources, each media network resource being locatable on the network by a corresponding address that accesses the media network resource; and

a network server module that communicates with the media playback component, the network server module identifying a first media network resource from the first network site and a second media network resource from the second network site, the network server module signaling the corresponding address of the first media network resource to the media playback component with control signals to cause the playback component to automatically load the first media network resource, the network server module automatically signaling the corresponding address of the second media network resource to the media playback component with control signals to cause the playback component to automatically load the second media network resource.

135. The system of claim 134, wherein the network server module signals the corresponding addresses of the first and second media network resource to the terminal with control signals to automatically playback the first media network resource and then the second media network resource on the terminal.

136. The system of claim 134, further comprising a database including the corresponding addresses of the one or more media network resources on each of the first and second network sites, wherein the network server module selects the first media network resource and the second media network resource from the database using a selection criteria.

137. The system of claim 134, wherein the network server module is coupleable to the user terminal through the network.

138. The system of claim 134, wherein the network server module is located on the user terminal.

139. The system of claim 136, wherein the database is coupleable to the user terminal through the network.

140. The system of claim 136, wherein the database is located on the user terminal.

141. The system of claim 136, wherein the database includes metadata about each of the media network resources, and wherein the network server module selects the first network media resource and the second network media resource using metadata associated with the corresponding address of the first media network resource and the second media network resource.

142. The system of claim 141, wherein the network server module identifies the first and second media network resources by matching a criteria signaled from the terminal to metadata information provided in the database.

143. The system of claim 134, wherein the network server module identifies the first media network resource and the second media network resource through a random selection.

144. The system of claim 134, wherein the network server module signals the first media network resource, the second media network resource, and other media network resources to the terminal in a predetermined order, the other media network resources being located on the first network site, the second network site, or an other network site.

145. The system of claim 144, wherein the network server module signals the terminal to access a next media network resource in the predetermined order automatically if any of the first media network resource, the second media network resource, or the other media network resources are unavailable.

146. The system of claim 134, wherein the first media network resource and the second media network resource are locatable over the Internet.

147. The system of claim 146, wherein the first media network resource includes an Internet addresses having a first domain, and the second media network resource includes an Internet address having a second domain.

148. The system of claim 134, wherein the first media network resource and the second media network resource include a combination of music and/or video.

149. The system of claim 134, wherein the corresponding addresses of the one or more media network resources on the first network site and on the second network site each contain no internal links.

150. A media playback system for the Internet, the system comprising:
an end terminal including a media playback component; and
a web server module coupleable to the end terminal through the Internet,
the web server module having access to one or more media web resources on a first web site, and to one or more media web resources on a second web site,
the web server module signaling a first link that locates a first media web resource on the first web site, and a second link

that locates a second media web resource on the second web site;

the web server module providing control signals to the end terminal to cause the end terminal to access and load the first media web resource and the second media web resource into the media playback component.

151. The system of claim 150, wherein the web server module provides control signals to the playback component of the end terminal to cause the end terminal to playback the first media web resource after loading the first media web resource, and to playback the second media web resource after loading the second media web resource.

152. The system of claim 151, wherein the end terminal includes a web browser, the web browser receiving the first link and the control signals from the web server module to cause the web server module to display a web page of the first web site concurrently while the first media web resource is being played back, the web browser receiving the second link and the control signals from the web server module to cause the web server module to display a web page of the second web site concurrently while the second web media resource is being played back.

153. A media playback system for the Internet, the system comprising:

a user terminal including a media playback component; and

a web server module coupleable to the user terminal through the Internet, the web server module having access to a plurality of web sites including a first web site and a second web site, each of the plurality of web sites including one or more media web resources, the web server module signaling a first link to a first media web resource on the first web site and a second link to a second media web resource on the second web site, the web server module providing control signals to the user terminal to cause the user terminal to access and load the first media web resource and the second media web resource; and

a database including links to each of the plurality of media web resources, the web server module identifying the first link and the second link from the database.

154. The system of claim 153, wherein each of the plurality of links in the database are selectable to open a corresponding media web resource in the plurality of media web resources.

155. The system of claim 154, wherein the database includes metadata about each of the plurality of media web resources, and wherein the web server module identifies the first link by using metadata associated with the first media web resource, and the web server module identifies the second link by using metadata associated with the second media web resource.

156. The system of claim 155, wherein the web server module identifies at least the first link by matching a criteria signaled from the terminal to metadata information in the database corresponding to the first media web resource.

157. The system of claim 155, wherein the web server module identifies at least the first link to the first media web resource and the second link to the second media web resource through a random selection.

158. The system of claim 153, wherein the web server module signals the terminal to access another media web resource automatically if an accessed media web resource is unavailable, the other media web resource being located on either the first web site, the second web site, or a third web site.

159. A media playback system for the Internet, the system comprising:
a terminal including a media playback component and a user-interface;
a web server module coupleable to the user terminal through the Internet, the web server module having access to a plurality of links, each of the plurality of links locating a media web resource, the plurality of links being accessible on a plurality of web sites, the web server module signaling the plurality of links to the user terminal in a designated order to cause the terminal to load the media web

resource located by each of the plurality of links into the media playback component; and

a database comprising the plurality of links, the database being accessible to signal the plurality of links to the web server module in the designated order;

wherein the user-interface signals one or more inputs from a user to the web server module, the one or more inputs directing the web server to alter the designated order in which the database signals the plurality of links to the web server module.

160. The system of claim 159, wherein the user-interface signals a first input from the user to skip a subsequent link in the designated order.

161. The system of claim 160, wherein the user-interface signals a second input from the user to cause the web server module to replace a first designated order with a second designated order.

162. The system of claim 161, wherein the first designated order includes a selection of links stored in the database belonging to a first category, and the second designated order includes a selection of links stored in the database belonging to a second category.

163. The system of claim 162, wherein the web server module selects at least some of the plurality of media web resources by matching a criteria signaled from the terminal to metadata information stored in the database, the metadata being sorted to correspond to one or more of the plurality links.

164. The system of claim 159, wherein the web server module randomly selects at least some of the plurality of links.

165. The system of claim 159, wherein the web server module signals another link in the plurality of links to the terminal to as to cause the terminal to access another media web resource automatically if an accessed media web resource is unavailable.

166. A system for providing media play-back on a network, the system comprising:

a terminal coupleable to the network;

a play-list module coupleable to the terminal, the play-list module storing a first play-list signaled from the terminal, the first play-list comprising a plurality of network addresses, including a first network address that locates a first media network resource on a first network site, and a second network address that locates a second media network resource on a second network site;

a network server module coupleable to the terminal and to the play-list module, the network server module signaling the first play-list to the terminal, the network server module controlling the terminal to cause the terminal to access the media network resource associated with each network address in the first play-list, and to automatically load each respective media network resources into the media playback component.

167. The system of claim 166, wherein the play-list module receives and stores a plurality of play-lists from a plurality of terminals, each play-list comprising a plurality of network addresses, including a first network address that locates a first media network resource on a first network site, and a second network address that locates a second media network resource on a second network site, wherein the network server module responds to a request from a second terminal for a select play-list in the plurality of play-lists by signaling the plurality of network address in the select play-list to the second terminal.

168. The system of claim 167, wherein the media network resource located by each network address in one of the plurality of play-lists is loaded into a playback component on the requesting terminal to playback media having a combination of music and/or video.

169. A method for providing media to a terminal coupled to a network, the terminal comprising a media playback component, the method comprising:

programmatically directing the terminal to access a first network site in the plurality of network sites;

causing the media playback component on the terminal to automatically load a first media web resource located at the first network site to playback a first media;

programmatically directing the terminal to access a second network site in the plurality of network sites; and

causing the media playback component on the terminal to automatically load a second media web resource located at the second network site to playback a second media.

170. The method of claim 169, further comprising:

programmatically directing the terminal to access one or more additional network sites in the plurality of network sites; and

causing the media playback component on the terminal to automatically load each media web resource located on each of the one or more additional network sites so as to sequentially playback media from each of the network sites accessed by the media playback component.

171. The method of claim 170, wherein programmatically directing the terminal to access a first network site in the plurality of network sites includes loading a first web address for the first network site into a web browser component of the terminal, and wherein programmatically directing the terminal to access a second network site in the plurality of network sites includes loading a second web address for the second network site into the web browser component of the terminal.

172. The method of claim 169, wherein programmatically directing the terminal to access a second network site in the plurality of network sites includes programmatically directing the terminal to access the second network site having an address that is external to the first address.

173. The method of claim 169, wherein programmatically directing the terminal to access the first and second network sites in the plurality of network

sites includes programmatically directing a web browser component and the media playback component from a web server module coupled to the terminal via the network.

174. A method for providing media to a terminal coupled to the Internet, the method comprising:

accessing a database comprising a plurality of links, each link opening a corresponding media web resource;

selecting a first link from the database, the first link being located on a first network site;

selecting a second link from the database, the second link being located in a second network site, the second network site being external to the first network site;

signaling the selected links to a media playback component on the terminal to sequentially access the media web resources associated with the selected links; and

automatically signaling the media playback component on the terminal to load each of the media web resource accessed from the selected links so as to playback a media corresponding to each media web resource.

175. The method of claim 174, wherein accessing a database comprising a plurality of links to media web resources includes accessing the database comprising metadata information about the plurality of links, and selecting the first and second links from the database includes selecting the one or more links using the metadata information.

176. The method of claim 174, further comprising detecting if the media playback component fails to load one of the media web resource in the selected media web resources, and then signaling the media playback component to use another selected link from the database to load another media web resource.

177. The method of claim 175, further comprising detecting if the media playback component fails to playback a media corresponding to one of the media web resource in the selected media web resources, and then signaling the

media playback component use another link to load another selected link from the database to load another media web resource.

178. A system for providing media to a terminal coupled to a network, the method comprising:

means for accessing a plurality of links, each link opening a corresponding media network resource;

selecting a first link from the database, the first link being located on a first network site;

selecting a second link from the database, the second link being located on a second network site;

means for sequentially accessing the media network resources associated with the selected links; and

means for automatically playing back media from the media network resources.

179. A rating system for rating media network resources on a network, the network being coupleable to a plurality of terminals, the rating system comprising:

a database comprising a plurality of addresses, each address locating a corresponding media network resource on the network;

a network server module coupleable to the plurality of terminals, the network server module being able to access the database to signal one or more addresses from the database to the plurality of terminals; and

a rating module coupleable to the plurality of terminals, the rating module being able to receive a rating input from each of the plurality of terminals, the rating module associating the rating input with a selected address in the database.

180. The rating system of claim 179, wherein the database includes a rating associated with each of the plurality of addresses

181. The rating system of claim 179, wherein the rating module accesses the database and reconfigures the rating associated with the selected address in response to receiving the rating input for the selected address.

182. The rating system of claim 179, wherein the database further includes one or more classes of information associated with each of the plurality of addresses.

183. The rating system of claim 179, further comprising a play-list module, the play-list module selecting a combination of the plurality of addresses to form a play-list, the network server module accessing the play-list to signal the combination of addresses to one or more of the terminals.

184. The rating system of claim 183, wherein the rating module receives the rating input from one or more of the terminals for each address that comprises the play-list signaled to that terminals.

185. The rating system of claim 183, wherein the rating module receives a play-list rating input for the play-list from one or more of the terminals receiving the play-list.

186. The system of claim 183, wherein the play-list module selects the combination of addresses using the rating associated with each address in the database.

187. The system of claim 183, wherein the play-list module selects the combination of addresses using the rating of each address in the database that share a same class of information.

188. The system of claim 187, wherein the same class of information is selected from a class group consisting of genre, sub-genre, title, and artist.

189. The system of claim 187, wherein the play-list module selects the combination of addresses using the rating of each address in the database that share two or more of the same classes of information, each same class of

information being selected from a group consisting of genre, sub-genre, title, and artist.

190. The rating system of claim 179, wherein the rating associated with each of the plurality of addresses is a ranking, including a maximum ranking and a minimum ranking.

191. The rating system of claim 190, wherein the rating module receives the ranking from one of the terminals, accesses an existing ranking from the database, and uses an averaging formula to reconfigure the ranking in the database.

192. The rating system of claim 191, wherein the averaging formula is a weighted average.

193. The rating system of claim 191, wherein the averaging formula is a moving average.

194. A rating system for rating media network resources on a network, the network being coupleable to a plurality of terminals, the rating system comprising:

a database comprising a plurality of addresses, each address locating a corresponding media network resource on the network, the database including one or more classes of information associated with each of the plurality of addresses;

a network server module coupleable to the plurality of terminals, the network server module communicating with each of the plurality of terminals to receive a search request, the network server module signaling the database to retrieve one or more addresses from the database in response to the search request, the retrieved addresses being associated with a class of information matching the search request; and

a rating module coupleable to the plurality of terminals, the rating module being able to receive a rating input from each of the plurality

of terminals, the rating module associating the rating input with a selected address in the database.

195. The rating system of claim 194, wherein the network module signals the database to retrieve one or more addresses from the database in response to the search request by matching a criteria in the search request with a parameter included with the one or more classes of information.

196. The rating system of claim 195, wherein the one or more classes of information stored in the database with the plurality of addresses is a rating.

197. The rating system of claim 194, wherein the search request also includes a rating standard that selects addresses in the database using a rating associated with each address.

198. A rating system for rating media network resources available over a network, the media network resources being located on the network by a plurality of terminals, the rating system comprising:

a database comprising a plurality of addresses, each address locating a corresponding media network resource on the network, the database including a rating associated with each of the plurality of addresses;

a network server module coupleable to each of the plurality of terminals, the network server module being able to access the database to signal one or more addresses from the database to the plurality of terminals;

a rating module coupleable to each of the plurality of terminals, the rating module being able to receive a rating input from one of the terminals for each of the plurality of addresses in the database, wherein in response to receiving the rating input from one of the plurality of terminals for a selected address in the database, the rating module accesses the database and reconfigures the rating associated with the selected address; and

a play-list module, the play-list module accessing the addresses to select one or more combinations of addresses, each combination of addresses forming a play-list, wherein the play-list module signals

the play-list to the network server module as addresses to be signaled to one or more of the plurality of terminals.

199. The rating system of claim 198, wherein the play-list module forms the play-list by using the ranking of the addresses in the database.

200. The rating system of claim 198, wherein the play-list module forms the play-list by arranging each address in the play-list in a designated order so that the addresses in the play-list are accessed by the one or more terminals in the designated order.

201. The rating system of claim 199, wherein the designated order is determined by a ranking of each of the addresses in the play-list relative to rankings of the other addresses in the play-list.

202. The rating system of claim 200, wherein the designated order is determined by arranging each of the addresses in the play-list according to a ranking from highest to lowest.

203. The rating system of claim 198, wherein the database further includes one or more classes of information associated with each of the plurality of addresses, and the play-list module forms a plurality of play-lists using the one or more classes of information.

204. The rating system of claim 198, wherein the play-list module forms a plurality of play-lists by arranging a combination of addresses in the plurality of addresses together in one play-list, wherein the combination of addresses share a same parameter of the one or more classes of information.

205. The rating system of claim 199, wherein the play-list module arranges the addresses in the play-list according to an order determined by a ranking of each of the addresses forming the play-list.

206. A method for ranking media sources on a network, the method comprising:

accessing a database comprising a plurality of addresses, each address locating a media resource on the network and each address being associated with a rating;

signaling a selected address from the database to a terminal coupled to the network;

receiving a rating input from the terminal after signaling the selected address to the terminal; and

adjusting the rating associated for the selected address in response to receiving the rating input.

207. The method of claim 206, wherein adjusting the rating associated for the selected address in response to receiving the rating input includes averaging the rating input with an existing rating for the selected address in the database.

208. The method of claim 207, wherein averaging the rating input with an existing rating includes implementing a weighted average between the rating input and the existing rating.

209. The method of claim 206, further comprising signaling one or more selected addresses to a plurality of terminals coupled to the network, and receiving a rating input from each of the plurality of the terminals after signaling the one or more selected addresses to the terminal.

210. The method of claim 209, further comprising adjusting the rating associated for each of the one or more selected addresses in response to receiving a rating input from each terminal by calculating a weighted average reflecting an aggregate of the plurality of terminals.

211. The method of claim 206, wherein each address locates a music source on the Internet.

212. The method of claim 206, wherein the rating input corresponds to a ranking.

213. A method for ranking media sources on a network, the method comprising:

accessing a database comprising a plurality of addresses, each address locating a media resource on the network and each address being associated with a rating;

selecting a combination of addresses to form a play-list;

signaling the play-list to a terminal coupled to the network;

receiving a ranking from the terminal after signaling the one or more of the addresses in the play-list to the terminal; and

adjusting the rating of each address signaled to the terminal from the play-list in response to receiving the ranking.

214. The method of claim 213, wherein selecting a combination of addresses for a play-list includes selecting multiple addresses from the database that share one or more classes of information.

215. The method of claim 213, wherein selecting a combination of addresses for a play-list includes arranging each address in the play-list in an order, the order being determined by the ranking of each address in the play-list.

216. A method for ranking media sources on a network, the method comprising:

accessing a database comprising a plurality of addresses, each address locating a media resource on the network and each address being associated with a rating;

signaling a selected address from the database to a terminal coupled to the network;

receiving a ranking from the terminal after signaling the selected address to the terminal; and

adjusting the rating associated for the selected address in response to receiving the ranking.

217. The method of claim 216, wherein each address locates a music source.

218. The method of claim 216, wherein each address locates a video or animation source.

219. A rating system for rating media network resources available over a network, the media network resources being located on the network by a plurality of terminals, the rating system comprising:

means for accessing a database comprising a plurality of addresses, each address locating a media resource on the network and each address being associated with a rating;

means for signaling a selected address from the database to a terminal coupled to the network;

means for receiving a ranking from the terminal after signaling the selected address to the terminal; and

means for adjusting the rating associated for the selected address in response to receiving the ranking.

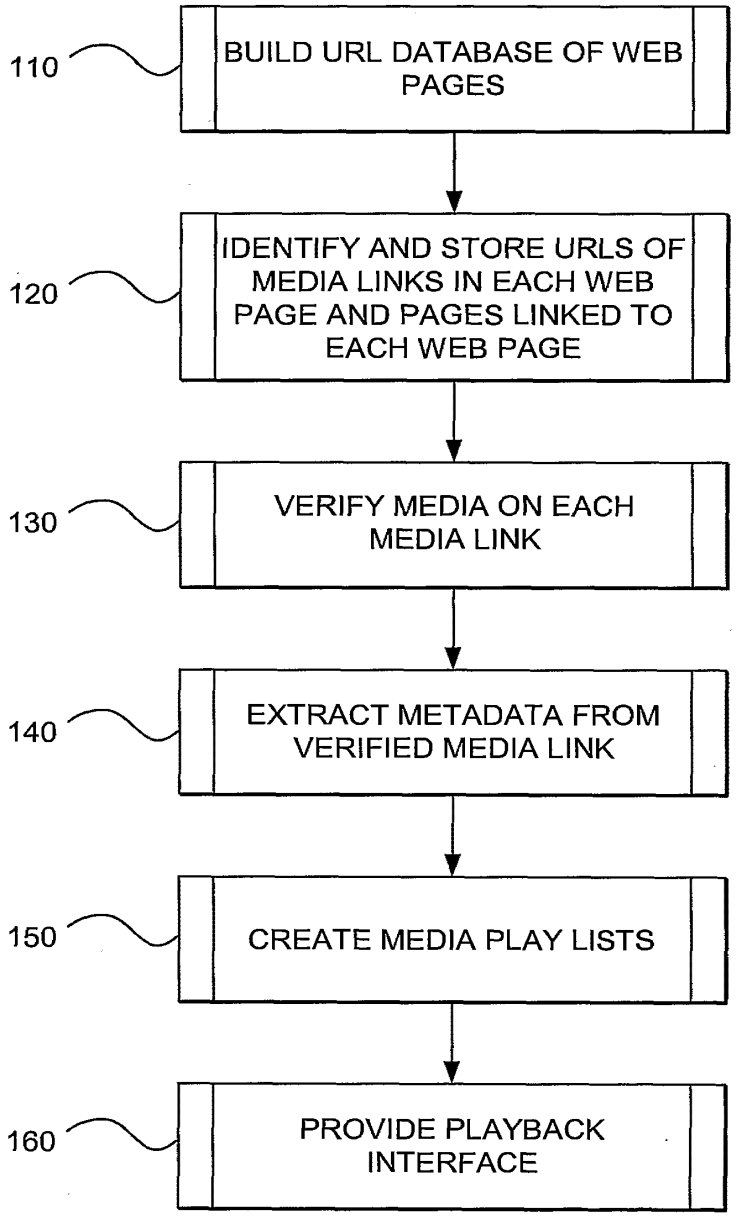

110
BUILD URL DATABASE OF WEB PAGES
120
IDENTIFY AND STORE URLS OF MEDIA LINKS IN EACH WEB PAGE AND PAGES LINKED TO EACH WEB PAGE
130
VERIFY MEDIA ON EACH MEDIA LINK
140
EXTRACT METADATA FROM VERIFIED MEDIA LINK
150
CREATE MEDIA PLAY LISTS
160
PROVIDE PLAYBACK INTERFACE

FIG. 1

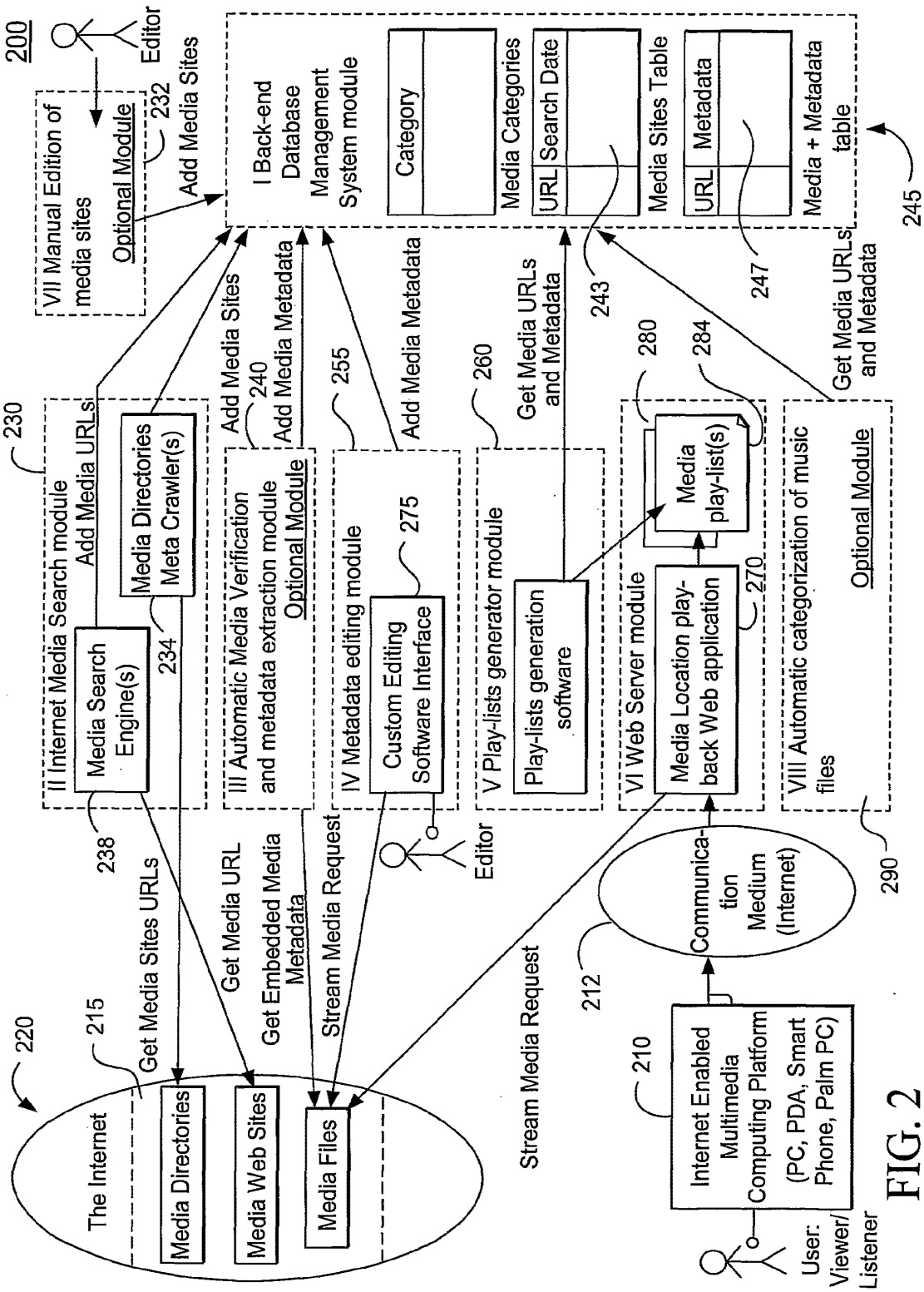

200
Editor
VII Manual Edition of media sites
Optional Module
232
Add Media Sites
I Back-end Database Management System module
Category
Media Categories
URL
Search Date
Media Sites Table
URL
Metadata
Media + Metadata table
245
230
II Internet Media Search module
Add Media URLs
Media Search Engine(s)
234
Media Directories
Meta Crawler(s)
Add Media Sites
240
Add Media Metadata
III Automatic Media Verification and metadata extraction module
Optional Module
255
Add Media Metadata
IV Metadata editing module
275
Custom Editing Software Interface
Editor
260
Get Media URLs and Metadata
V Play-lists generator module
Play-lists generation software
243
247
280
284
Media play-list(s)
VI Web Server module
Media Location play-back Web application
270
Get Media URLs and Metadata
VIII Automatic categorization of music files
Optional Module
290
238
Get Media Sites URLs
Get Media URL
Get Embedded Media Metadata
Stream Media Request
Stream Media Request
212
Communication Medium (Internet)
220
215
The Internet
Media Directories
Media Web Sites
Media Files
210
Internet Enabled Multimedia Computing Platform (PC, PDA, Smart Phone, Palm PC)
User: Viewer/ Listener

FIG. 2

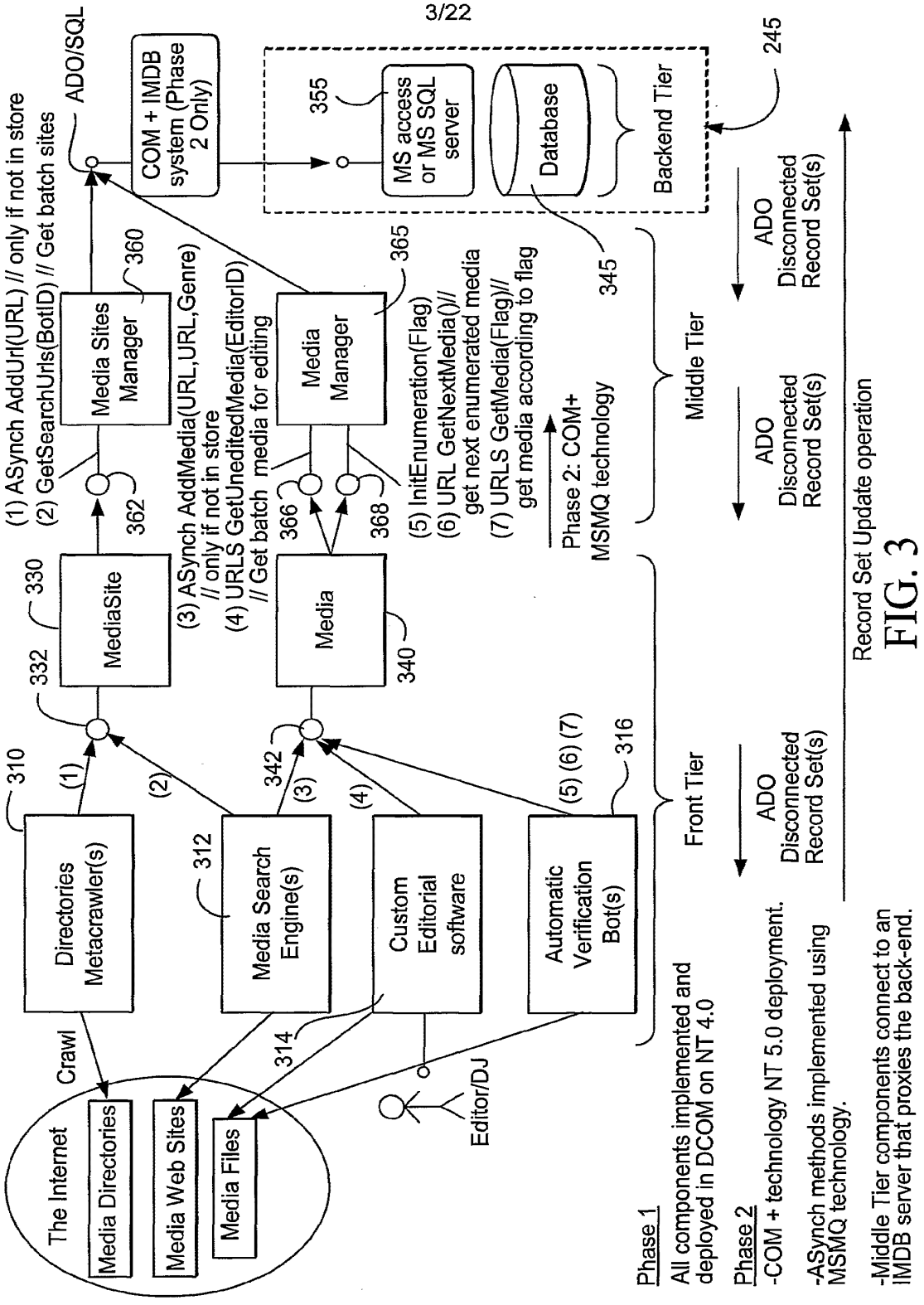

(1) ASynch AddUrl(URL) // only if not in store
(2) GetSearchUrls(BotID) // Get batch sites
ADO/SQL
COM + IMDB system (Phase 2 Only)
355
MS access or MS SQL server
Database
Backend Tier
245
Media Sites Manager
360
Media Manager
365
345
(3) ASynch AddMedia(URL,URL,Genre) // only if not in store
(4) URLS GetUneditedMedia(EditorID) // Get batch media for editing
(5) InitEnumeration(Flag)
(6) URL GetNextMedia()// get next enumerated media
(7) URLS GetMedia(Flag)// get media according to flag
362
366
368
Phase 2: COM+ MSMQ technology
Middle Tier
ADO Disconnected Record Set(s)
MediaSite
330
332
Media
340
310
(1)
(2)
342
(3)
(4)
(5) (6) (7)
316
Directories Metacrawler(s)
312
Media Search Engine(s)
Custom Editorial software
Automatic Verification Bot(s)
Front Tier
Crawl
314
The Internet
Media Directories
Media Web Sites
Media Files
Editor/DJ
Record Set Update operation
Phase 1
All components implemented and deployed in DCOM on NT 4.0
Phase 2
-COM + technology NT 5.0 deployment.
-ASynch methods implemented using MSMQ technology.
-Middle Tier components connect to an IMDB server that proxies the back-end.

FIG. 3

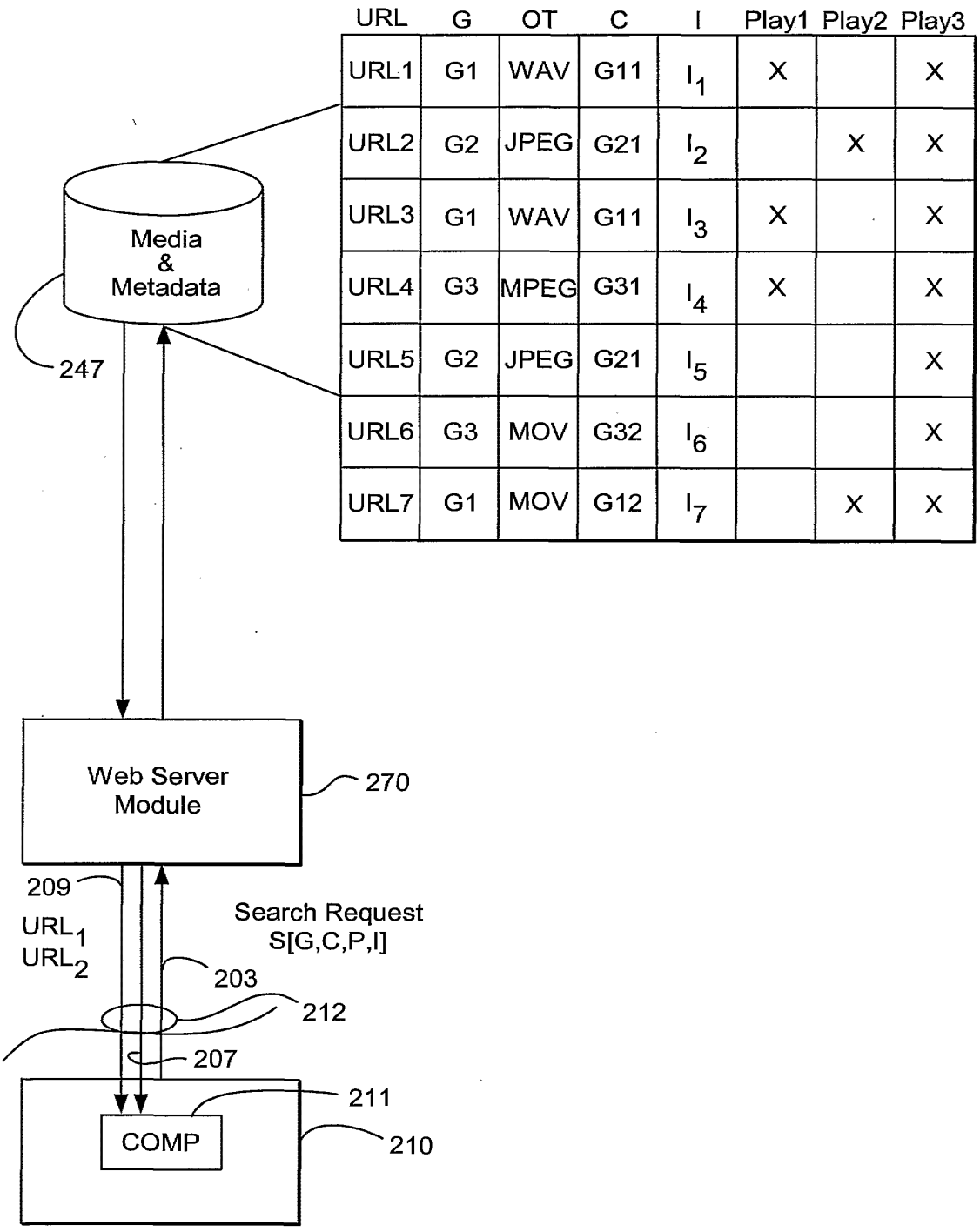

URL G OT C I Play1 Play2 Play3
URL1 G1 WAV G11 I_1 X X
URL2 G2 JPEG G21 I_2 X X
URL3 G1 WAV G11 I_3 X X
URL4 G3 MPEG G31 I_4 X X
URL5 G2 JPEG G21 I_5 X
URL6 G3 MOV G32 I_6 X
URL7 G1 MOV G12 I_7 X X
Media & Metadata
247
Web Server Module
270
209
URL_1
URL_2
Search Request S[G,C,P,I]
203
212
207
211
COMP
210

FIG. 4

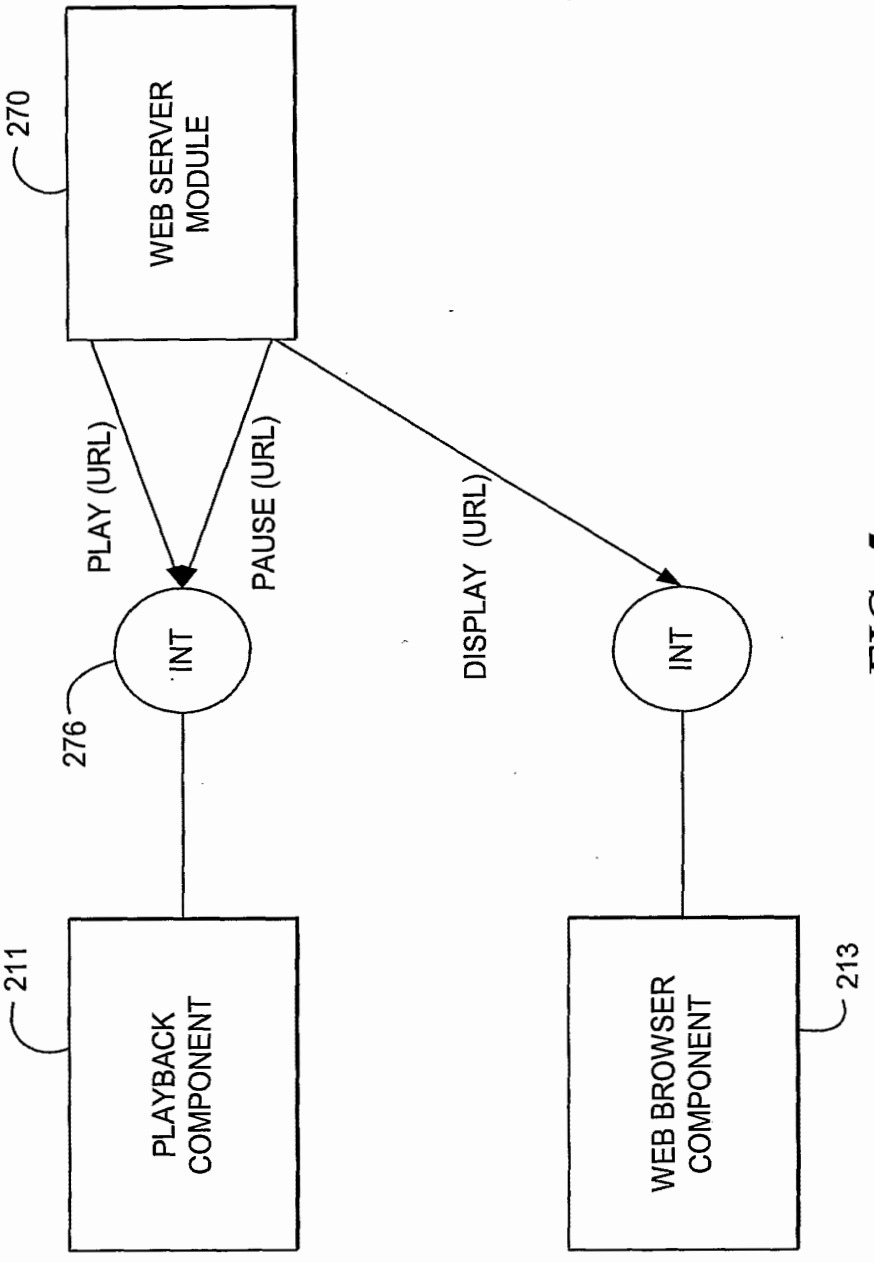

270
WEB SERVER MODULE
PLAY (URL)
PAUSE (URL)
DISPLAY (URL)
276
INT
INT
211
PLAYBACK COMPONENT
WEB BROWSER COMPONENT
213

FIG. 5

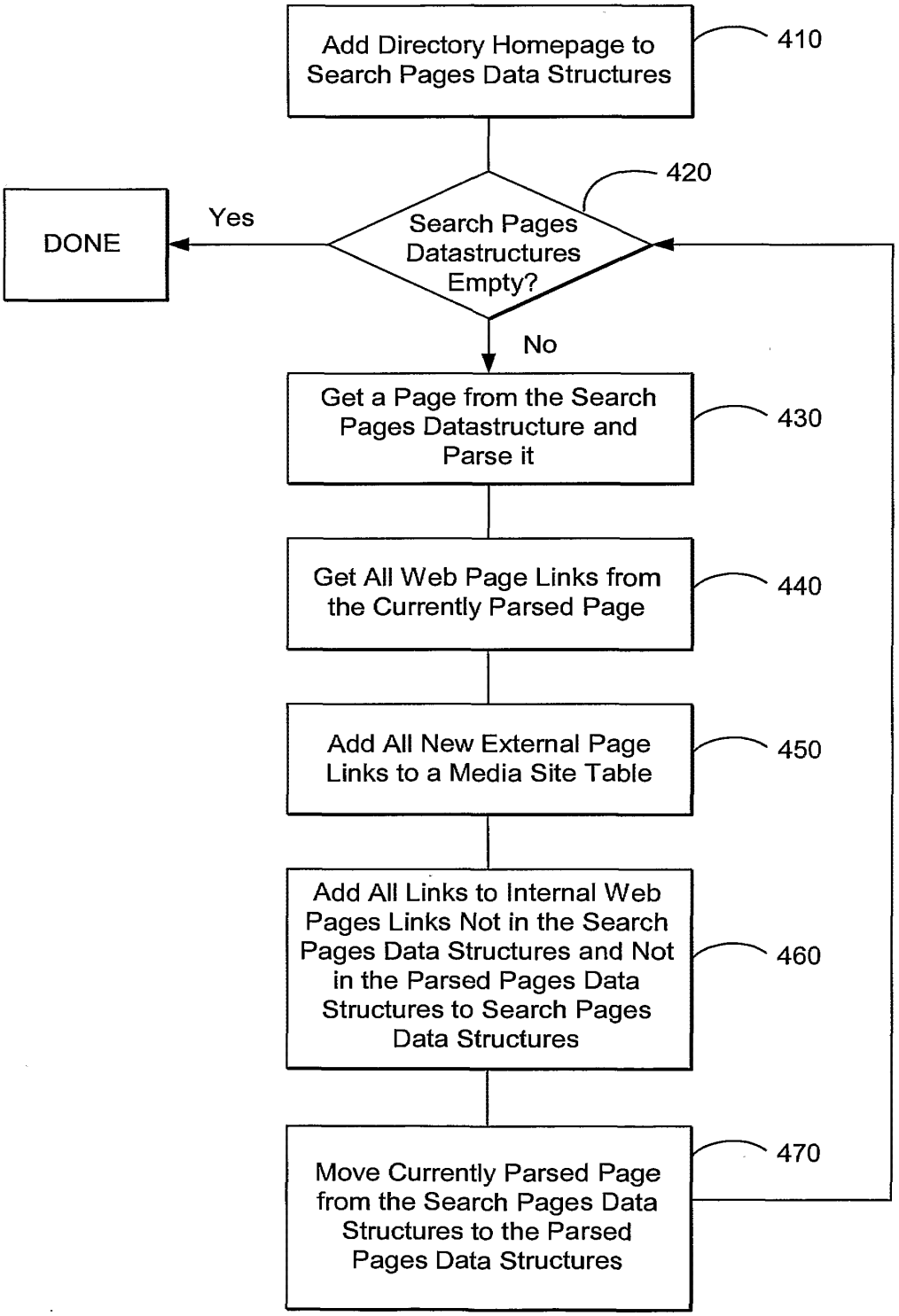

Add Directory Homepage to Search Pages Data Structures
410
Search Pages Datastructures Empty?
420
Yes
DONE
No
Get a Page from the Search Pages Datastructure and Parse it
430
Get All Web Page Links from the Currently Parsed Page
440
Add All New External Page Links to a Media Site Table
450
Add All Links to Internal Web Pages Links Not in the Search Pages Data Structures and Not in the Parsed Pages Data Structures to Search Pages Data Structures
460
Move Currently Parsed Page from the Search Pages Data Structures to the Parsed Pages Data Structures
470

FIG. 6

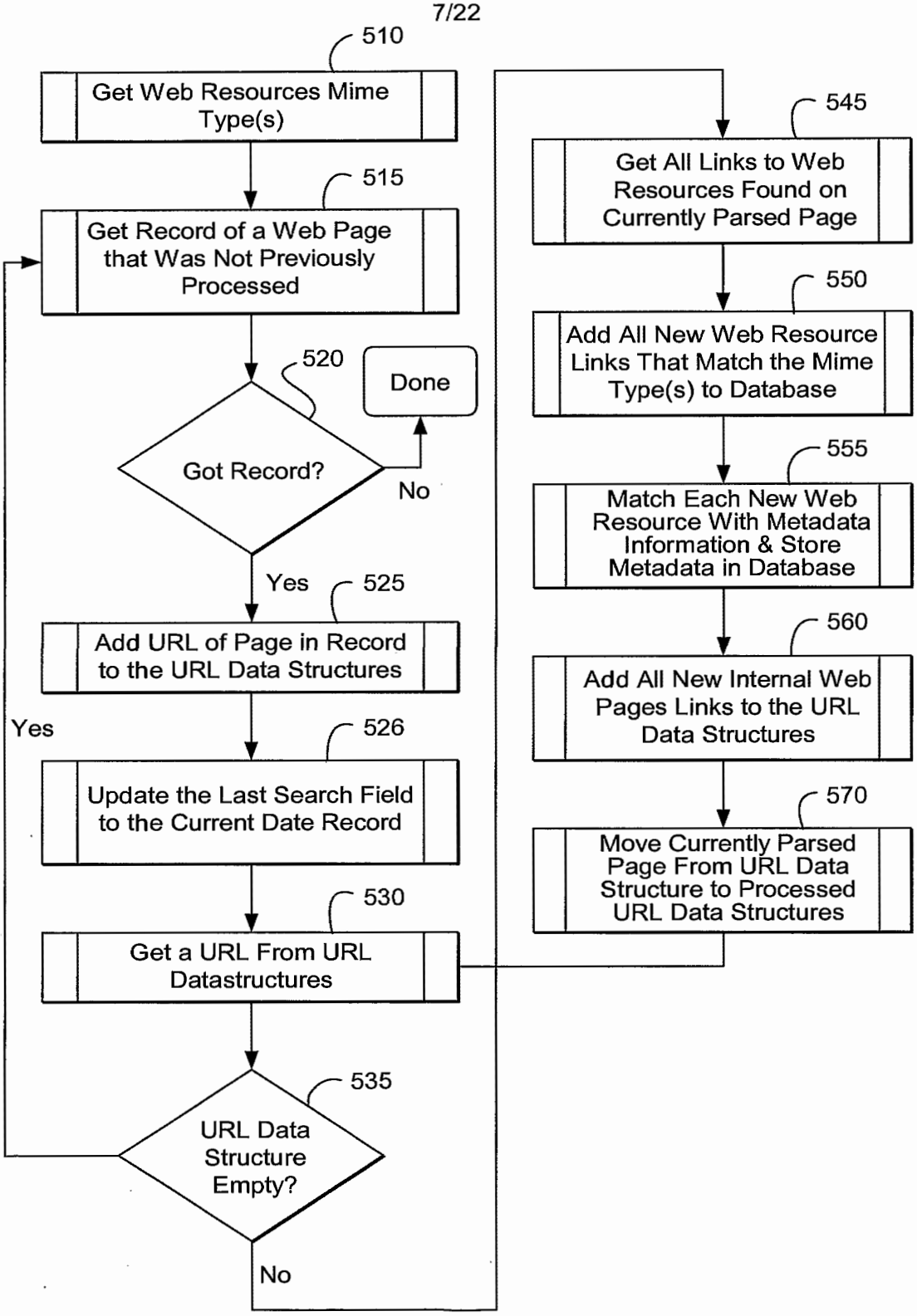


FIG. 7

SUBSTITUTE SHEET (RULE 26)

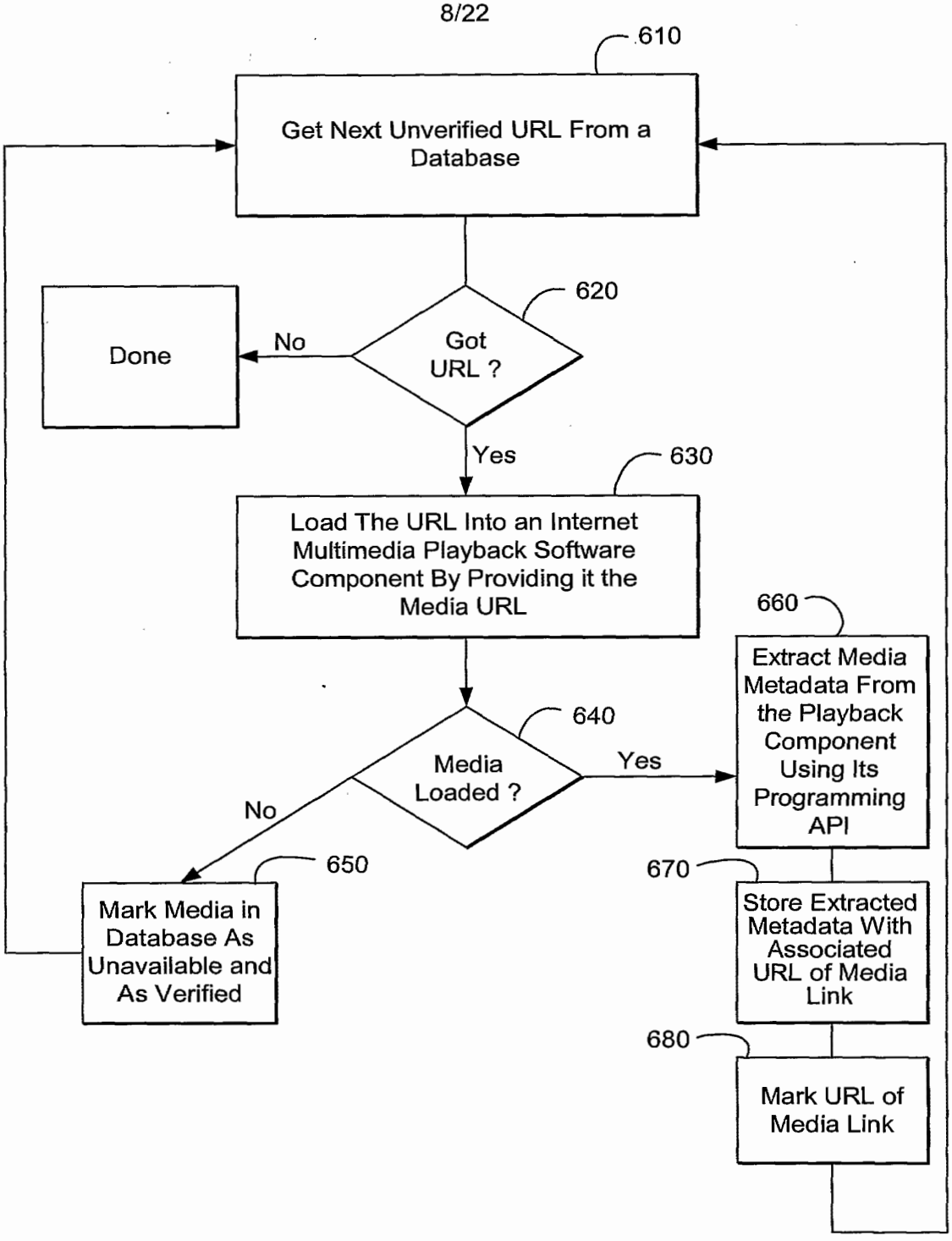

610
Get Next Unverified URL From a Database
620
Got URL ?
No
Done
Yes
630
Load The URL Into an Internet Multimedia Playback Software Component By Providing it the Media URL
640
Media Loaded ?
No
Yes
650
Mark Media in Database As Unavailable and As Verified
660
Extract Media Metadata From the Playback Component Using Its Programming API
670
Store Extracted Metadata With Associated URL of Media Link
680
Mark URL of Media Link

FIG. 8

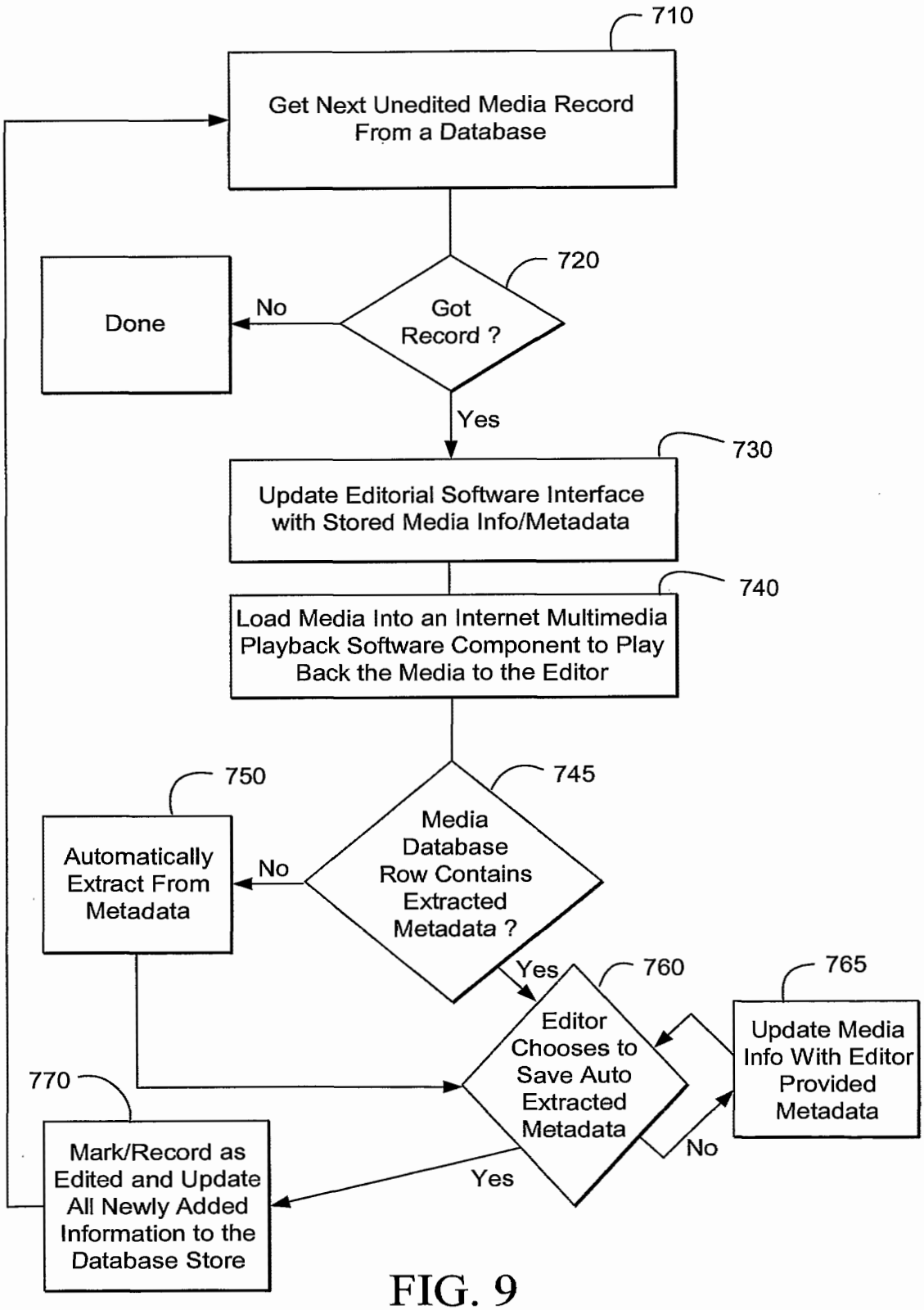

710
Get Next Unedited Media Record From a Database
720
Got Record ?
No
Done
Yes
730
Update Editorial Software Interface with Stored Media Info/Metadata
740
Load Media Into an Internet Multimedia Playback Software Component to Play Back the Media to the Editor
745
Media Database Row Contains Extracted Metadata ?
No
750
Automatically Extract From Metadata
Yes
760
Editor Chooses to Save Auto Extracted Metadata
765
Update Media Info With Editor Provided Metadata
No
Yes
770
Mark/Record as Edited and Update All Newly Added Information to the Database Store

FIG. 9

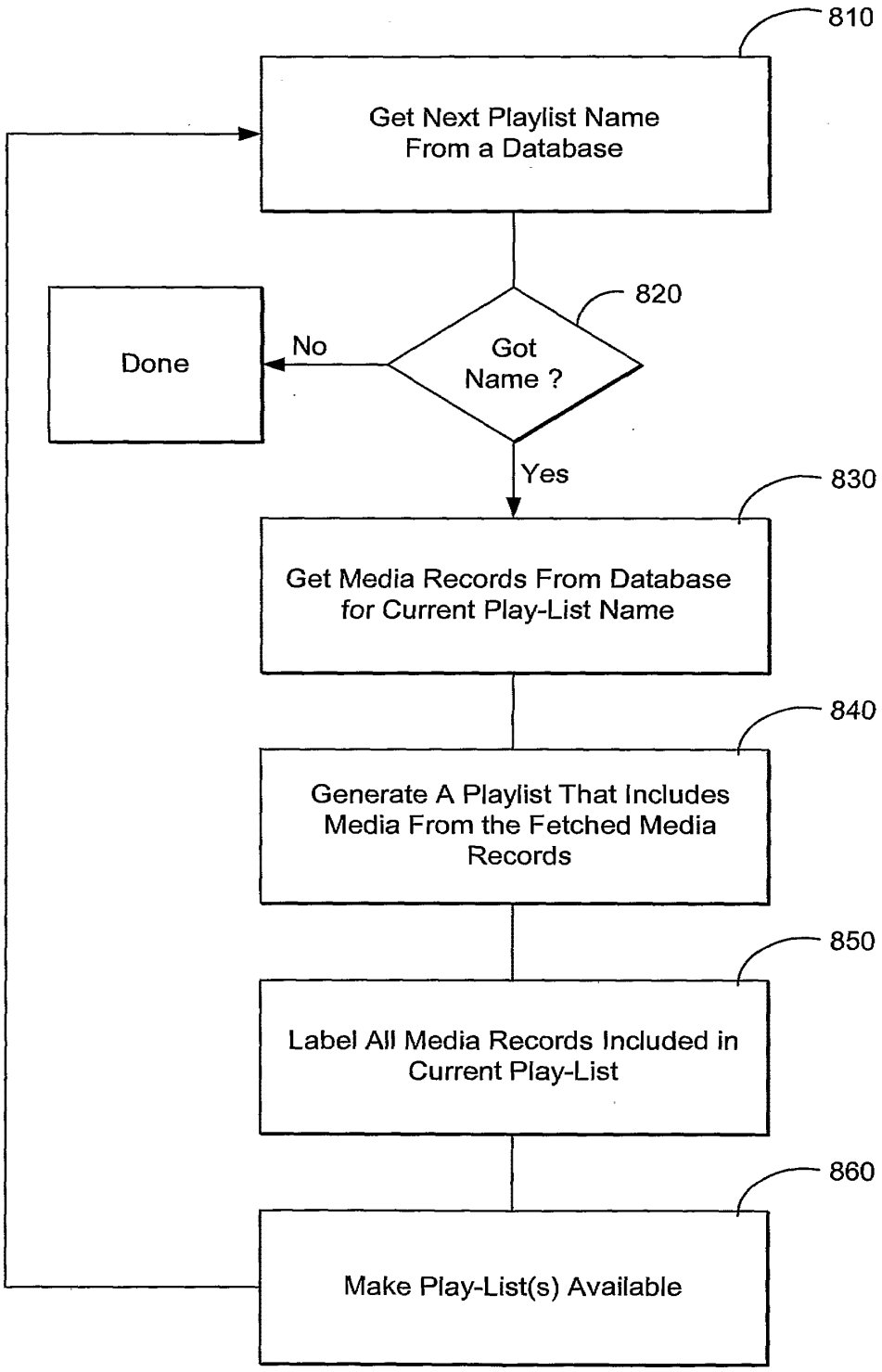

810
Get Next Playlist Name From a Database
820
Got Name ?
No
Done
Yes
830
Get Media Records From Database for Current Play-List Name
840
Generate A Playlist That Includes Media From the Fetched Media Records
850
Label All Media Records Included in Current Play-List
860
Make Play-List(s) Available

FIG. 10

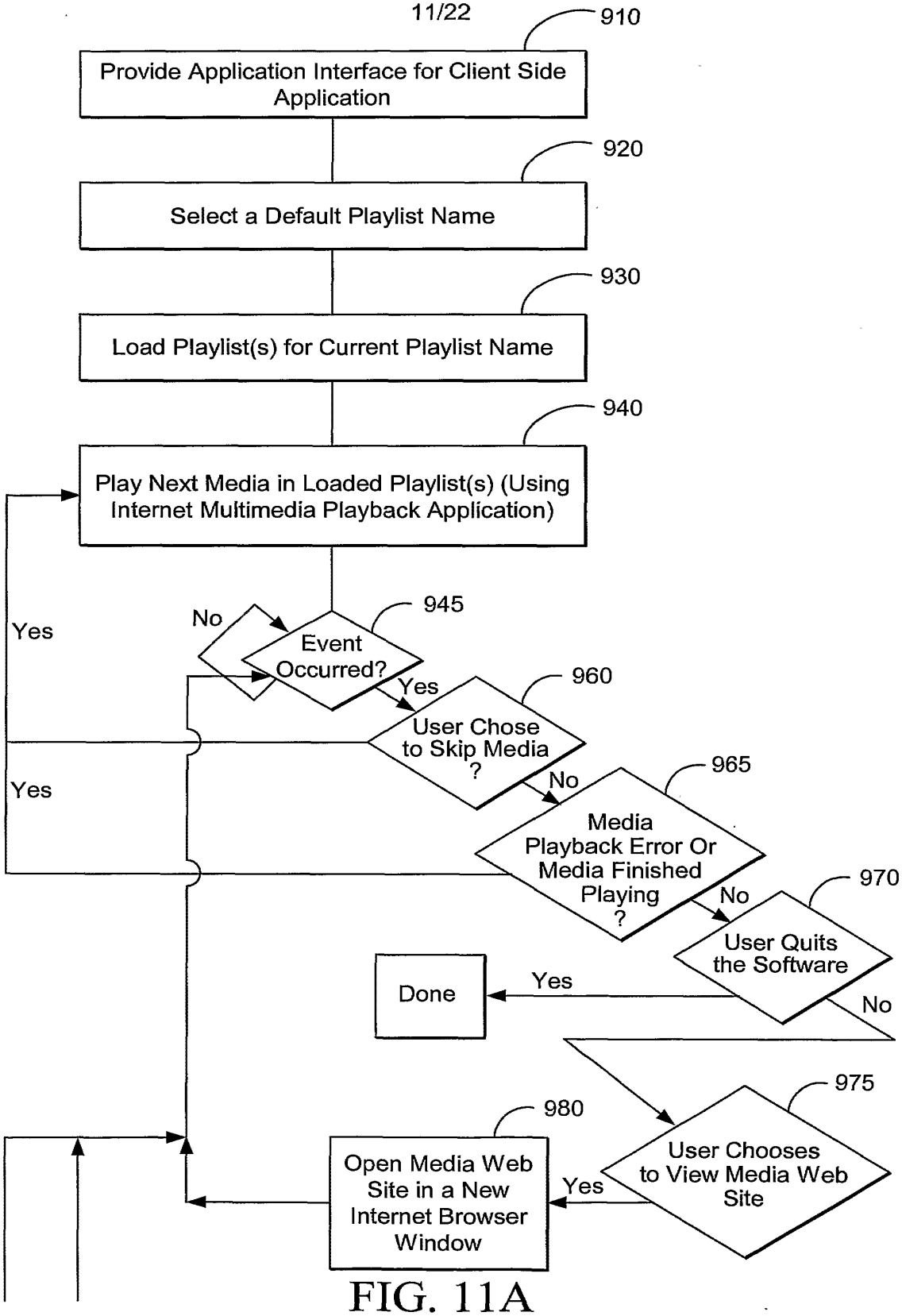


FIG. 11A

SUBSTITUTE SHEET (RULE 26)

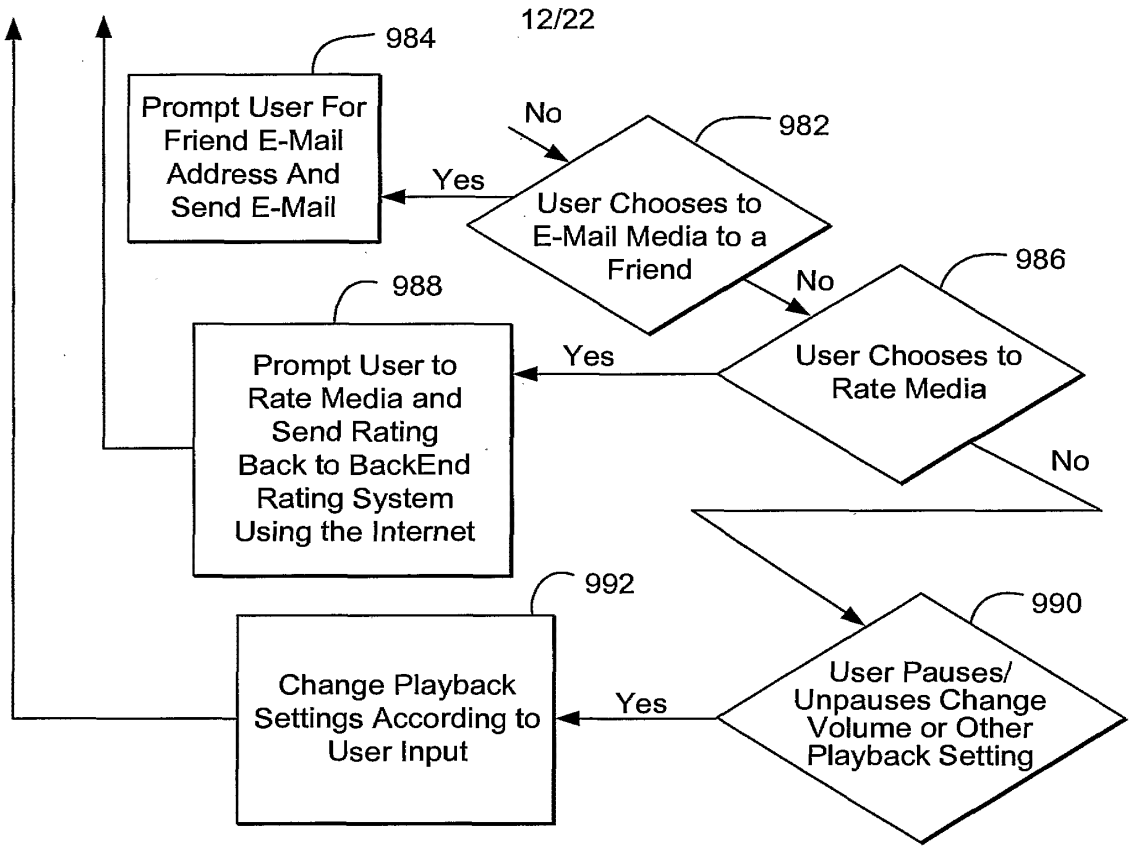
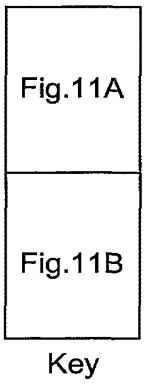

984
Prompt User For Friend E-Mail Address And Send E-Mail
No
982
Yes
User Chooses to E-Mail Media to a Friend
No
986
988
User Chooses to Rate Media
Yes
Prompt User to Rate Media and Send Rating Back to BackEnd Rating System Using the Internet
No
992
990
User Pauses/ Unpauses Change Volume or Other Playback Setting
Yes
Change Playback Settings According to User Input

FIG. 11B


Fig.11A
Fig.11B

Key

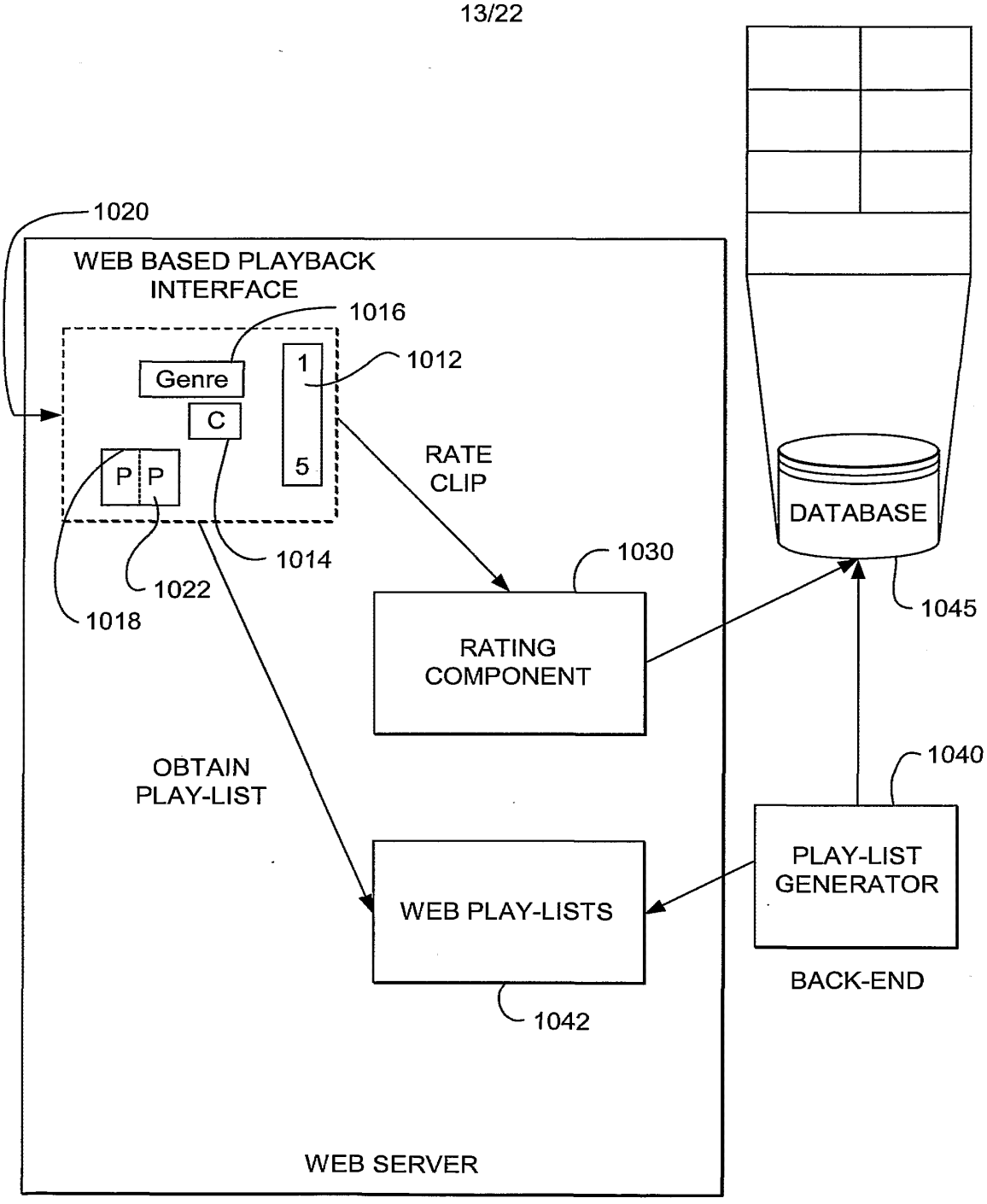

1020
WEB BASED PLAYBACK INTERFACE
1016
Genre
C
1
5
1012
P P
RATE CLIP
1014
1022
1018
1030
RATING COMPONENT
OBTAIN PLAY-LIST
WEB PLAY-LISTS
1042
WEB SERVER
DATABASE
1045
1040
PLAY-LIST GENERATOR
BACK-END

FIG. 12

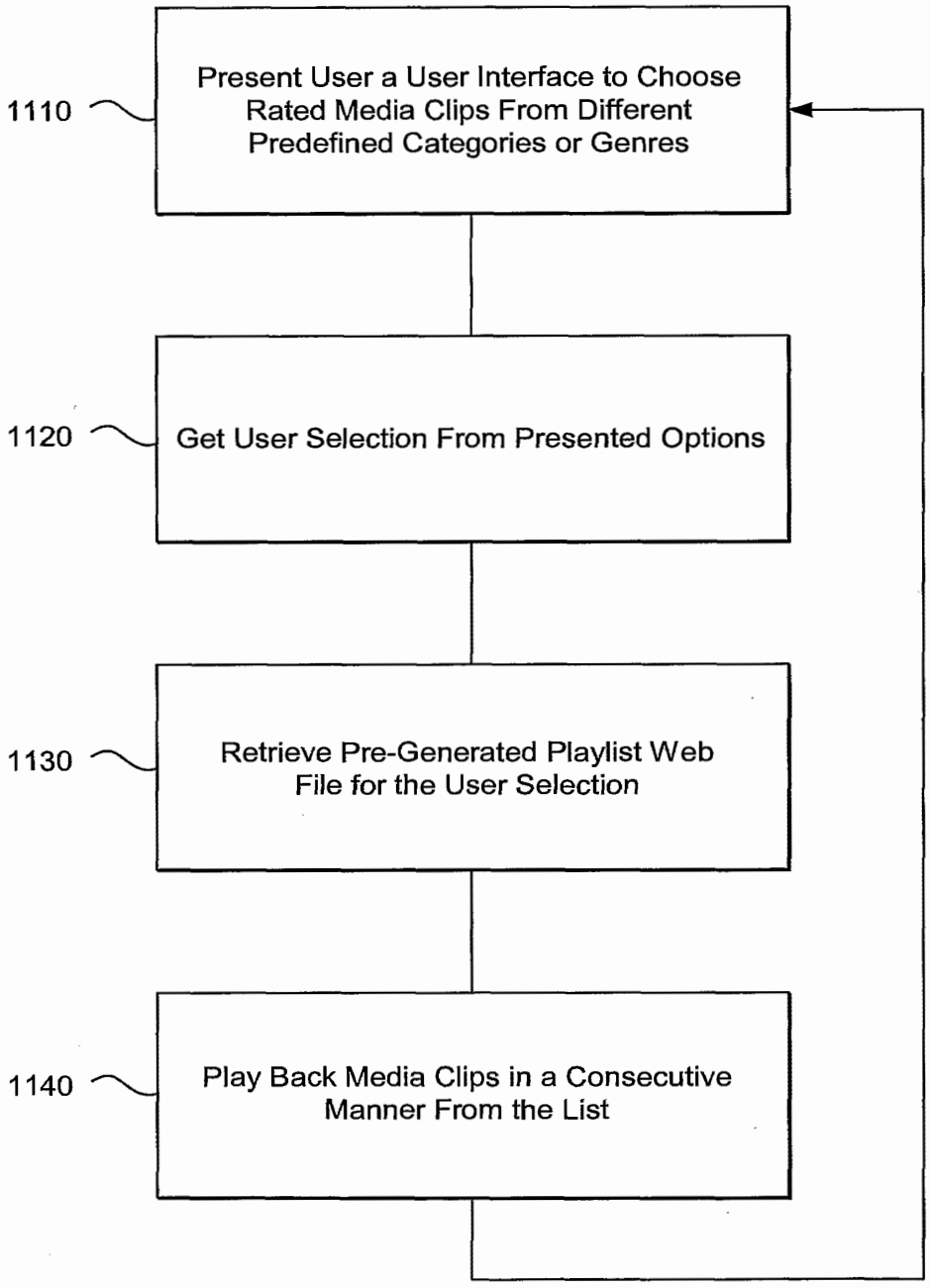

1110
Present User a User Interface to Choose Rated Media Clips From Different Predefined Categories or Genres
1120
Get User Selection From Presented Options
1130
Retrieve Pre-Generated Playlist Web File for the User Selection
1140
Play Back Media Clips in a Consecutive Manner From the List

FIG. 13

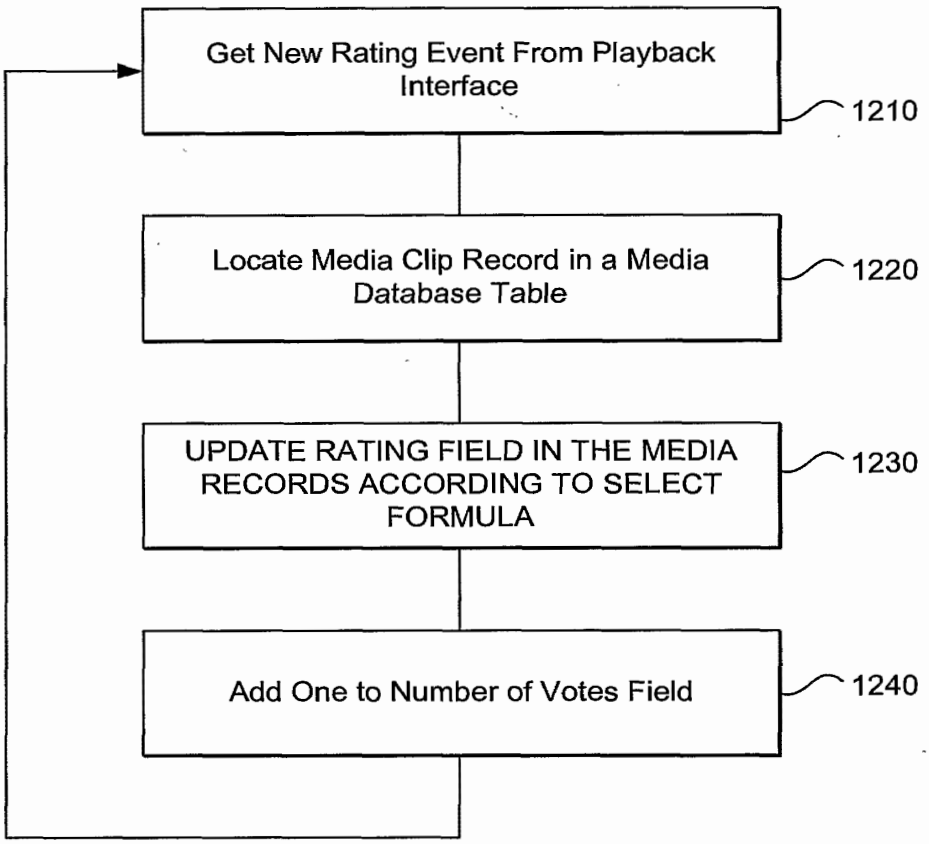


FIG. 14

MEDIA DATABASE TABLE

Media URL	Number of Votes	Rating	Additional Info
URL	O . . . N	O . . . Max Rating	

FIG. 15

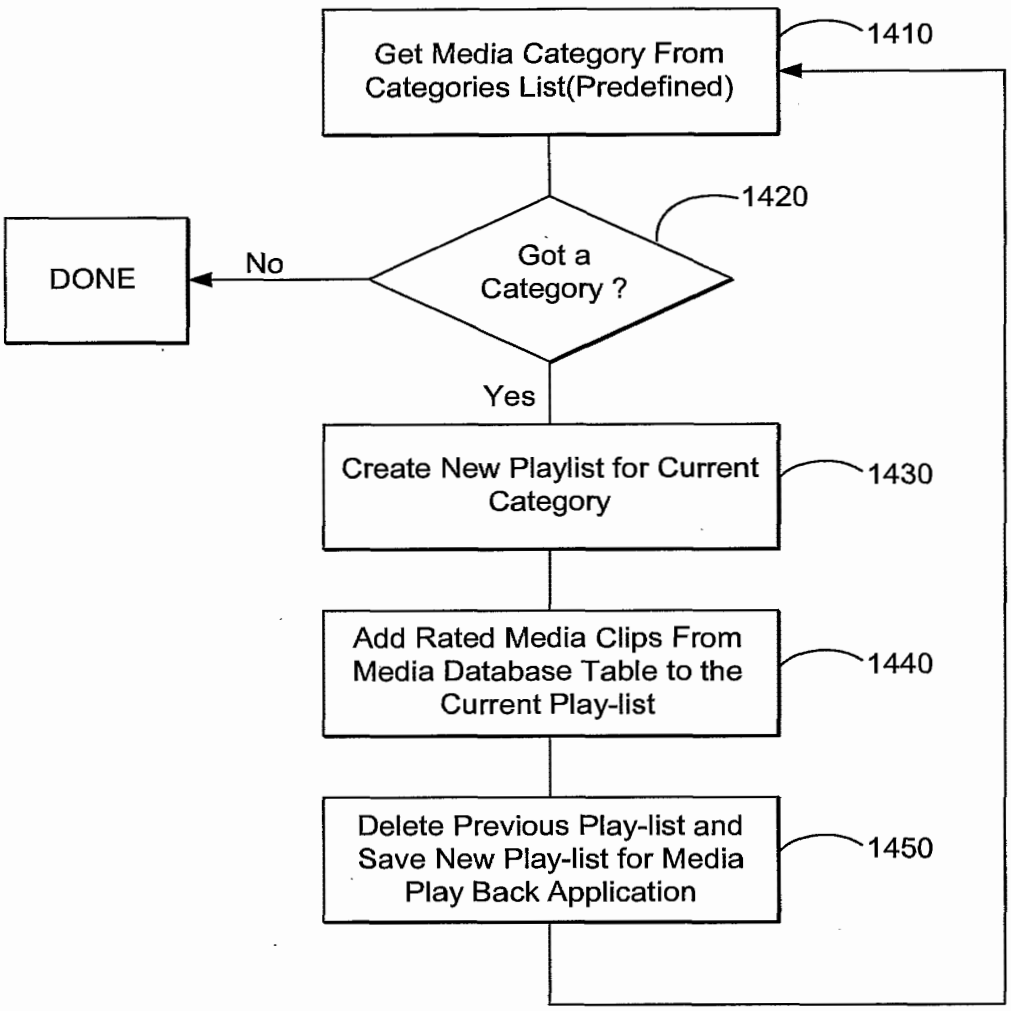

Get Media Category From Categories List(Predefined)
1410
1420
Got a Category ?
No
DONE
Yes
Create New Playlist for Current Category
1430
Add Rated Media Clips From Media Database Table to the Current Play-list
1440
Delete Previous Play-list and Save New Play-list for Media Play Back Application
1450

FIG. 16

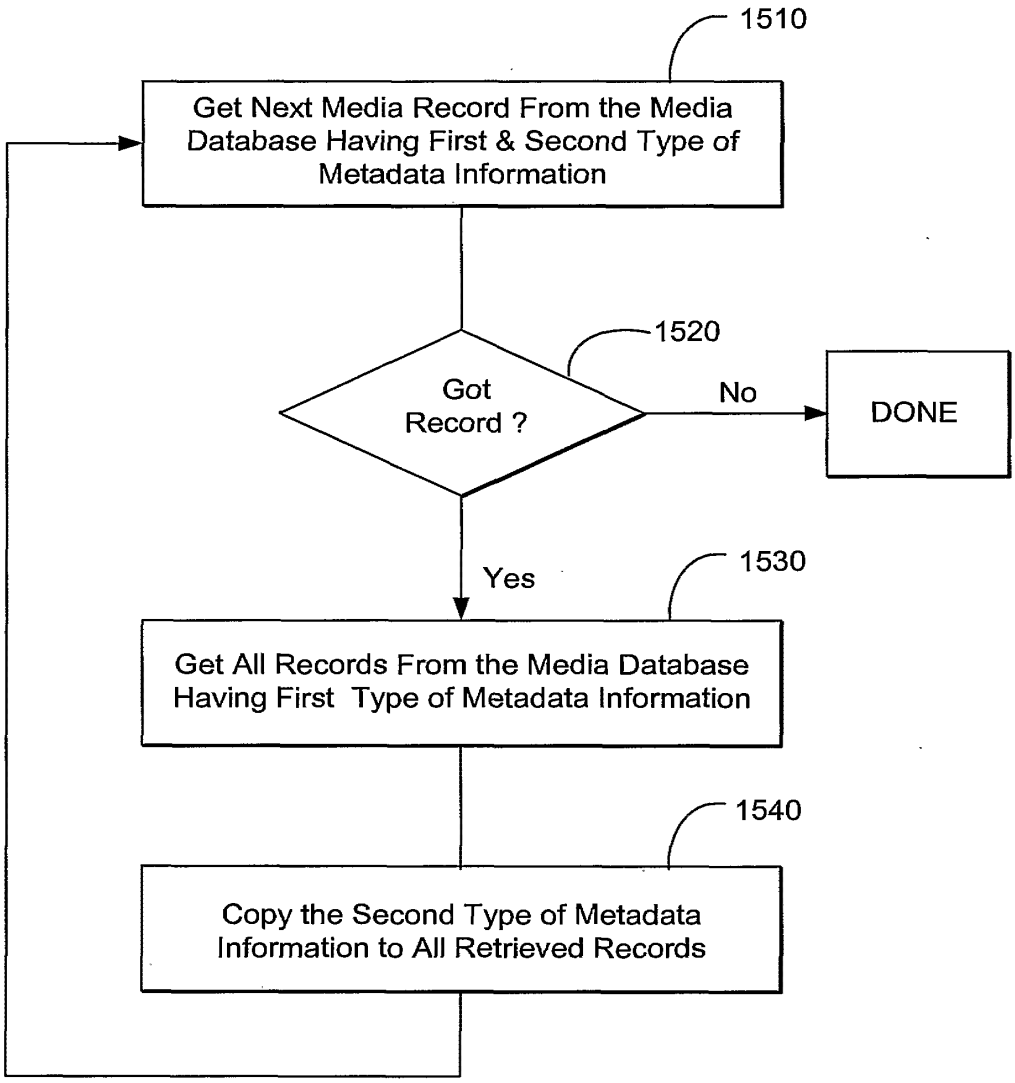

1510
Get Next Media Record From the Media Database Having First & Second Type of Metadata Information
1520
Got Record ?
No
DONE
Yes
1530
Get All Records From the Media Database Having First Type of Metadata Information
1540
Copy the Second Type of Metadata Information to All Retrieved Records

FIG. 17

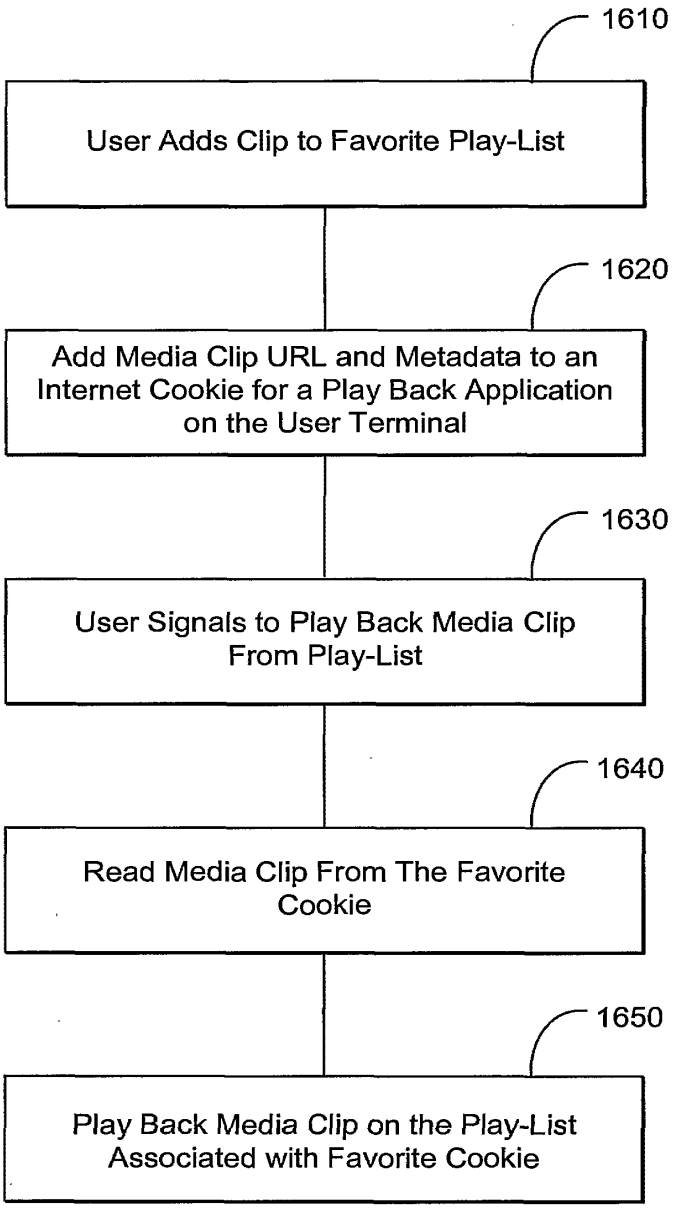

1610
User Adds Clip to Favorite Play-List
1620
Add Media Clip URL and Metadata to an Internet Cookie for a Play Back Application on the User Terminal
1630
User Signals to Play Back Media Clip From Play-List
1640
Read Media Clip From The Favorite Cookie
1650
Play Back Media Clip on the Play-List Associated with Favorite Cookie

FIG. 18

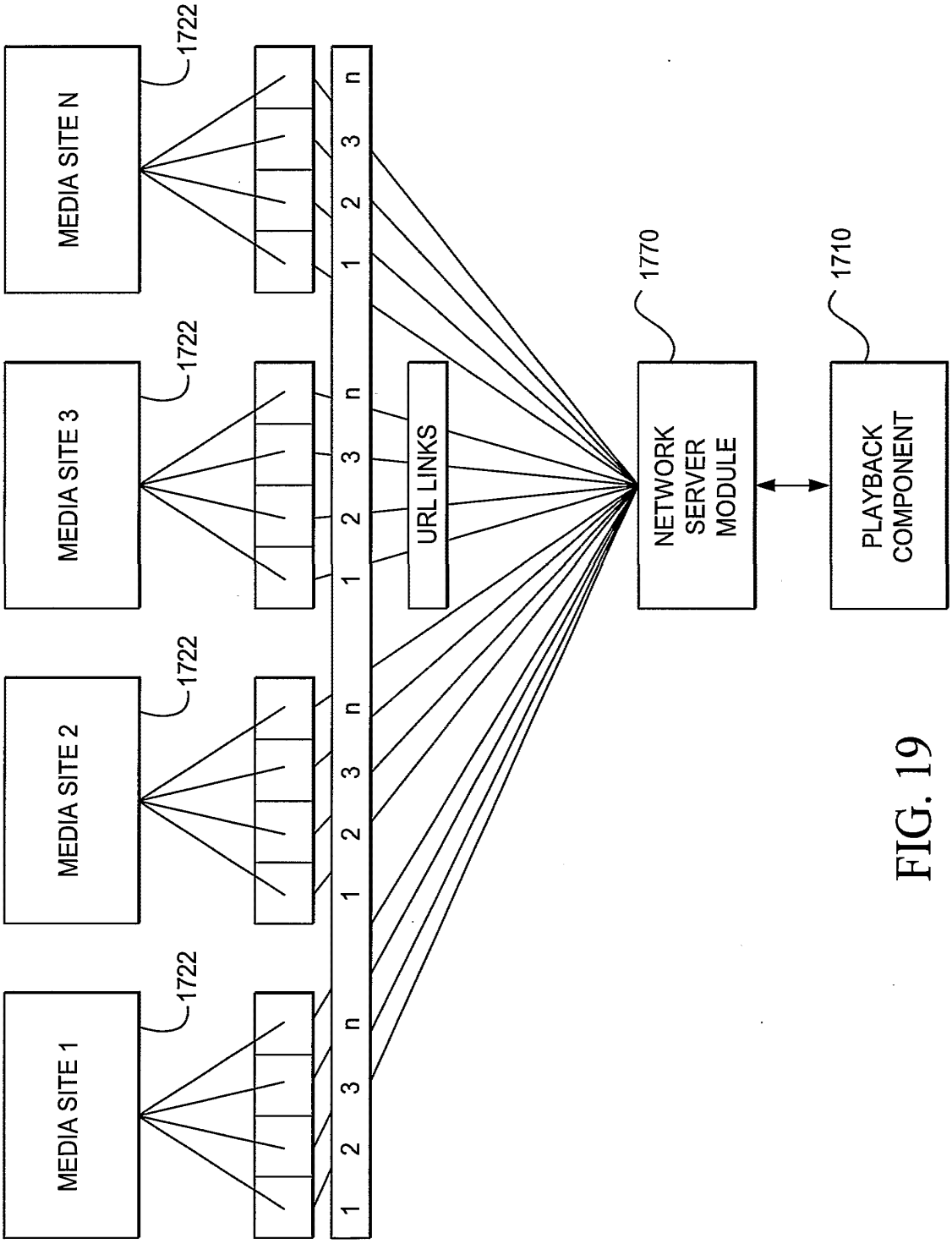

MEDIA SITE N
MEDIA SITE 3
MEDIA SITE 2
MEDIA SITE 1
1722
1722
1722
1722
1 2 3 n
1 2 3 n
1 2 3 n
1 2 3 n
URL LINKS
1770
NETWORK SERVER MODULE
1710
PLAYBACK COMPONENT

FIG. 19

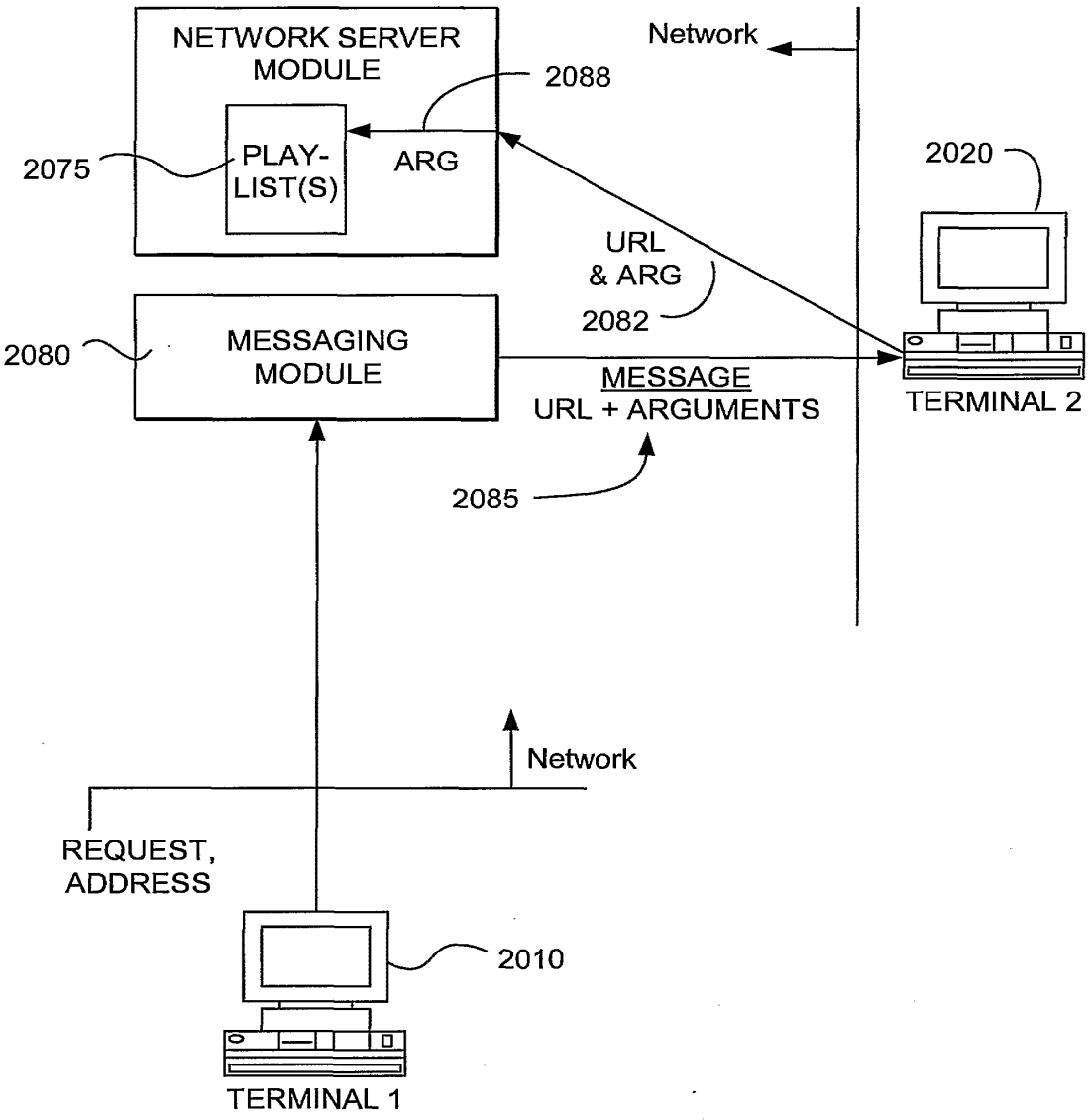

NETWORK SERVER MODULE
2088
Network
2075
PLAY-LIST(S)
ARG
2020
URL & ARG
2082
2080
MESSAGING MODULE
MESSAGE
URL + ARGUMENTS
TERMINAL 2
2085
Network
REQUEST, ADDRESS
2010
TERMINAL 1

FIG. 20

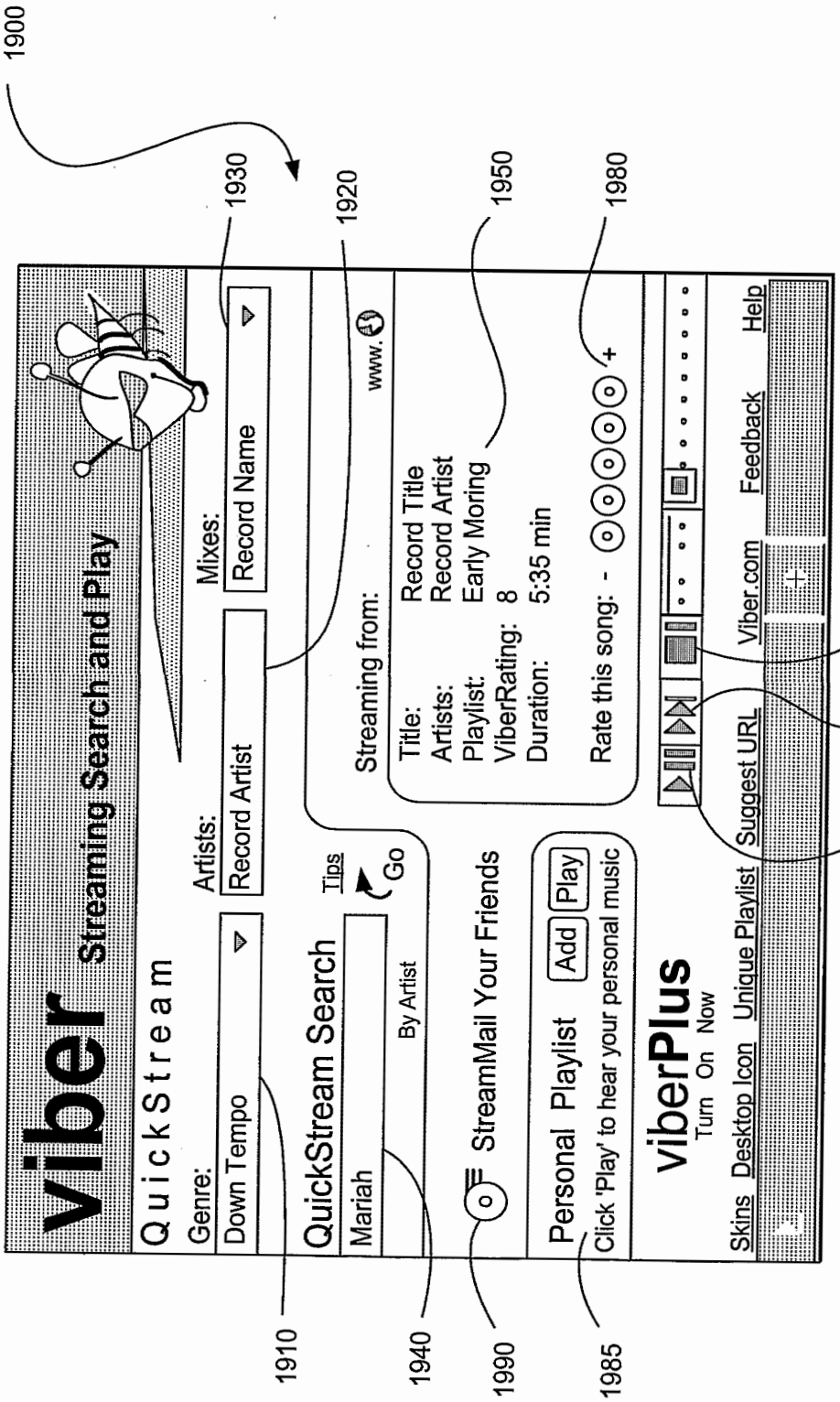

1900
viber Streaming Search and Play
QuickStream
Genre:
Down Tempo
Artists:
Record Artist
Mixes:
Record Name
QuickStream Search
Mariah
By Artist
Tips
Go
StreamMail Your Friends
Personal Playlist
Add
Play
Click 'Play' to hear your personal music
Streaming from:
www.
Title: Record Title
Artists: Record Artist
Playlist: Early Moring
ViberRating: 8
Duration: 5:35 min
Rate this song: -
viberPlus
Turn On Now
Skins Desktop Icon Unique Playlist
Suggest URL
Viber.com
Feedback
Help
1910
1920
1930
1940
1950
1972
1974
1976
1980
1985
1990

FIG. 21

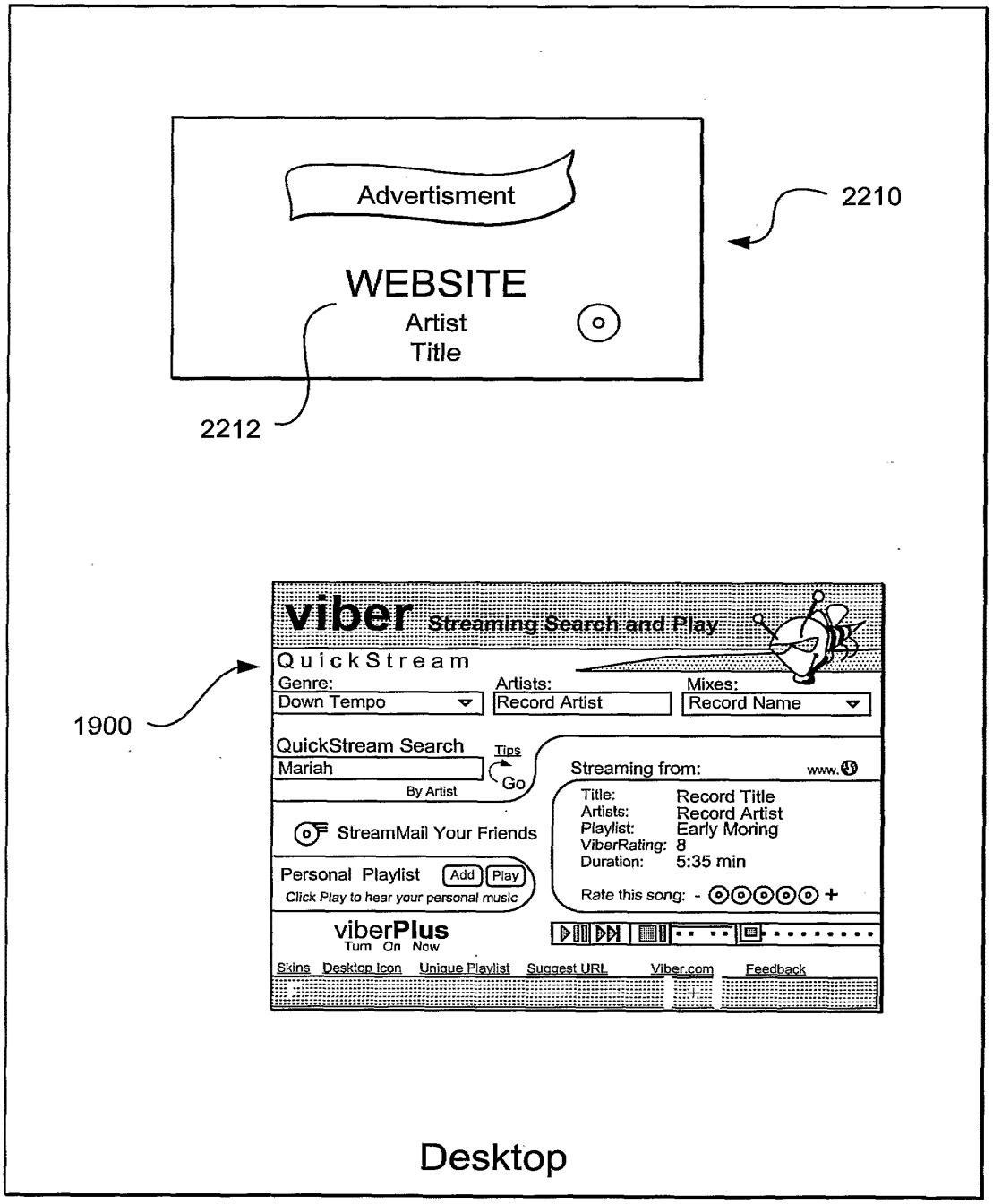

Advertisment
WEBSITE
Artist
Title
2210
2212
1900
viber Streaming Search and Play
QuickStream
Genre:
Down Tempo
Artists:
Record Artist
Mixes:
Record Name
QuickStream Search
Mariah
By Artist
Tips
Go
Streaming from:
www.
Title: Record Title
Artists: Record Artist
Playlist: Early Moring
ViberRating: 8
Duration: 5:35 min
Rate this song: - +
StreamMail Your Friends
Personal Playlist
Add
Play
Click Play to hear your personal music
viberPlus
Turn On Now
Skins
Desktop Icon
Unique Playlist
Suggest URL
Viber.com
Feedback
Desktop

FIG. 22

PTO/SB/08a (01-10)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

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	1	5696896		1997-12-09	BADOVINATZ; Peter Richard et al.	
	2	5787249		1998-07-28	BADOVINATZ; Peter Richard et al.	
	3	6839752		2005-01-04	MILLER; Robert et al.	
	4	6907458		2005-06-14	TOMASSETTI; Stephen Robert et al.	
	5	7412499		2008-08-12	CHANG; Chun-Shi et al.	
	6	7743009		2010-06-22	HANGARTNER; Rick et al.	
	7	8020023		2011-09-13	MILLINGTON; Nicholas A.J. et al.	
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	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

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	1	20010027498		2001-10-04	VAN; De Meulenhof Dennis et al.	
	2	20020184310		2002-12-05	TRAVERSAT; Bernard A. et al.	
	3	20030055892		2003-03-20	HUITEMA; Christian et al.	
	4	20030204273		2003-10-30	DINKER; Darpan et al.	
	5	20030204509		2003-10-30	DINKER; Darpan et al.	
	6	20030227478		2003-12-11	CHATFIELD; Keith M.	
	7	20040133689		2004-07-08	VASISHT; Samrat	
	8	20050216556		2005-09-29	MANION; Todd R. et al.	
	9	20070192156		2007-08-16	GAUGER; Derek K.	
	10	20090193345		2009-07-30	WENSLEY; Paul et al.	

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	Application Number	13864249
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	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

	11	20130197682		2013-08-01	MILLINGTON; Nicholas A. J.	

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	2	2003101958	JP		2003-04-04	TOSHIBA CORP		☐
	3	02073851	WO		2002-09-19	PULSE-LINK, INC.		☐

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	2	"JAPANESE INTELLECTUAL PROPERTY OFFICE, "Decision of Rejection," issued in connection with Japanese patent application No.2012-178711, mailed on July 4, 2014, 3 pages".	☐
	3	"JAPANESE INTELLECTUAL PROPERTY OFFICE, "Office Action Summary," issued in connection with Japanese patent application No. 2012-178711, mailed on November 19, 2013, 5 pages".	☐

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	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

	4	"Non-Final Office Action mailed 19 April 2010 for U.S. Application No. 11/801468 filed 09 May 2007, 16 pages".	☐
	5	"Non-Final Office Action mailed 25 July 2014 for U.S. Application No. 14/184526 filed 19 February 2014".	☐
	6	"Non-Final Office Action mailed 29 November 2010 for U.S. Application No. 11/801468 filed 09 May 2007, 17 pages".	☐
	7	"Non-Final Office Action mailed 31 July 2014 for U.S. Application No. 13/533105 filed 26 June 2012".	☐
	8	"Notice of Allowance mailed 06 May 2011 for U.S. Application No. 11/801468 filed 09 May 2007, 10 pages".	☐

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, NICHOLAS A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Robert J. Irvine III/	Date (YYYY-MM-DD)	2014-08-11
Name/Print	Robert J. Irvine III	Registration Number	41865

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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EFS ID:	19851135
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
Filer Authorized By:	
Attorney Docket Number:	SNS-71301US11 (13-0402)
Receipt Date:	14-AUG-2014
Filing Date:	17-APR-2013
Time Stamp:	17:27:50
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	no

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Warnings:	
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2	Foreign Reference	JP2003101958.pdf	950403 7831b89a239a5dd9c19be87e7ea69120d63f97ab	no	12
Warnings:					
Information:					
3	Foreign Reference	WO02073851A1.pdf	916609 6920fe9531909d9f0d7af0933a26248436978166	no	26
Warnings:					
Information:					
4	Non Patent Literature	10816217AdvisoryAction09-18-08.pdf	312262 897746fab6918e88f71ff5ae0615cc3935b0c3fa	no	8
Warnings:					
Information:					
5	Non Patent Literature	JP2012-17811-DecisionofRejection7-8-14.pdf	82313 a679627963f695ead81556e982639ff783490ac1	no	3
Warnings:					
Information:					
6	Non Patent Literature	JP2012-17811OfficeActionSummary-11-19-13.pdf	145837 0747263e6ba99a33fdd3382a19ab12154cfe1cb1	no	5
Warnings:					
Information:					
7	Non Patent Literature	11801468-Non-FinalOA04-19-10.pdf	655403 1615233f75130acc4090e548f6575832611c595a	no	16
Warnings:					
Information:					
8	Non Patent Literature	14184526-Non-FinalOA-07-25-14.pdf	259390 246899dd54263c7304b05966e7032010d6795cf6	no	9
Warnings:					
Information:					
9	Non Patent Literature	11801468Non-FinalOA11-29-10.pdf	692235 7382d1289f9bcf6333083af286322028ec2bd558	no	17
Warnings:					
Information:					
10	Non Patent Literature	13533105-Non-FinalOA07-31-14.pdf	1034996 66ae4ac9d0c13b66770b7ae5a3a519233973e89d	no	31
Warnings:					
Information:					

11	Non Patent Literature	11801468NOA05-06-11.pdf	451323 f4346fdd7726aa5033684c6ed8e8e6844ff8c93e	no	10
Warnings:					
Information:					
12	Information Disclosure Statement (IDS) Form (SB08)	SNS-71301US11-SuppIDS-AUG2014.pdf	707824 8f879baf53426ef60a72b2d61c3cf96c1150b87a	no	6
Warnings:					
Information:					
		Total Files Size (in bytes):	7933219		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Espacenet

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NETWORK SYSTEM, OUTPUT DEVICE, AND METHOD FOR SYNCHRONIZING NETWORK SYSTEM

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Classification: - international: ***G06F1/14; G06F13/00; H04B1/20; H04L12/28; H04L12/413; H04L7/00; H04N7/62; H04S3/00;*** *H04J3/06; H04L12/56;* (IPC1-7): G06F1/14; G06F13/00; H04L7/00

- cooperative: **G06F1/14**; **H04B1/205**; **H04L12/2803**; **H04L12/2807**; **H04L12/2838**; **H04L47/28**; **H04N21/4305**; **H04S3/008**; H04J3/0638

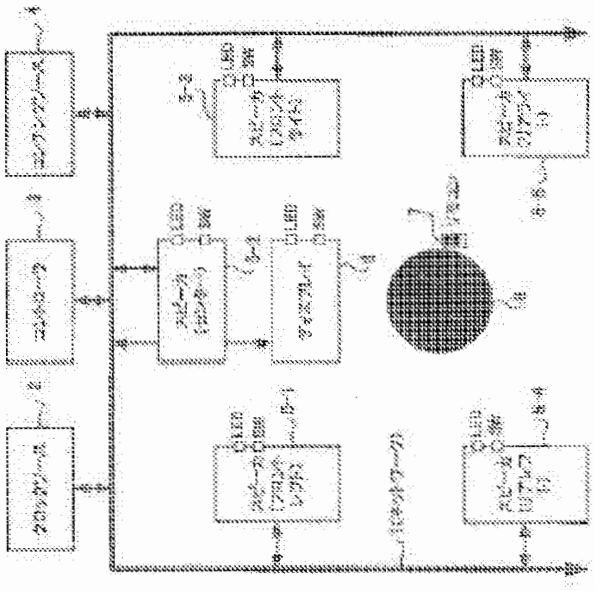
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Abstract of JP2003037585 (A)

PROBLEM TO BE SOLVED: To provide a clock synchronized between reproducing devices con nected to the digital network. SOLUTION: A clock is transmitted to a sink device group like speakers 5 (5-1 to 5-5) connected to a network 1 and a display 6. And also this network system is equipped with a clock source 2 which transmits time information per prescribed time, a contents source 4 which provides the contents for the sink device group through the network 1, and a controller 3 which provides for the contents source 4 the delay time based on the network delay when the content data are transmitted to the sink device group and the decode delay in the sink device group when reproducing the contents.



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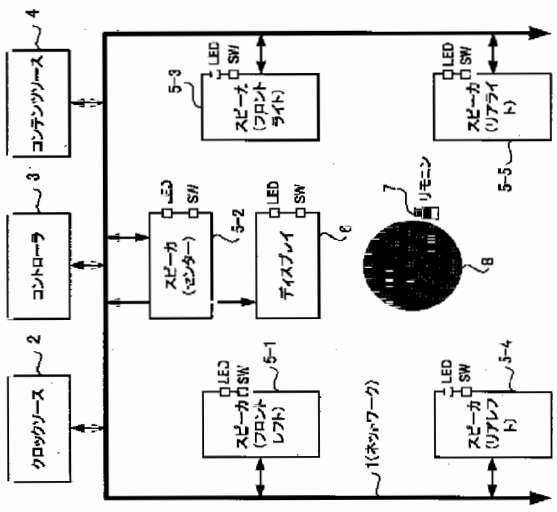
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(54)【発明の名称】　ネットワークシステム、出力機器、およびネットワークシステムの同期方法

(57)【要約】
【課題】　ディジタルネットワークに接続された各再生機器の間において、クロックと位相の同期をとる。
【解決手段】　ネットワーク１に接続されるスピーカ５(５－１～５－５)やディスプレイ６等のシンク機器群に対してクロックを送信すると共に所定時間ごとに時刻情報を送信するクロックソース２と、このシンク機器群に対してネットワーク１を介してコンテンツを提供するコンテンツソース４と、コンテンツを再生するにあたり、コンテンツデータがシンク機器群に送られるときのネットワークディレイとシンク機器群におけるデコードディレイとに基づく遅延時間をコンテンツソース４に対して提供するコントローラ３とを備えた。



【特許請求の範囲】
【請求項１】　複数の機器がディジタルネットワークに接続されるネットワークシステムであって、
前記複数の機器に対してクロックを配信すると共に時刻情報を配信するクロック配信手段と、
前記クロック配信手段により配信された前記クロックおよび前記時刻情報に基づき、各々の機器においてクロックを調整するクロック調整手段と、
前記ディジタルネットワーク上をストリームが通信される際に生じるネットワークディレイを考慮して前記複数の機器に対してディレイ補正を施すディレイ補正手段とを備えたことを特徴とするネットワークシステム。
【請求項２】　前記ディレイ補正手段は、前記複数の機器が前記ストリームに関する変換に際して生じる変換ディレイを考慮してディレイ補正を施すことを特徴とする請求項１記載のネットワークシステム。
【請求項３】　前記ディレイ補正手段は、前記機器が置かれた位置によって生じるディレイ補正を含むことを特徴とする請求項１記載のネットワークシステム。
【請求項４】　ディジタルネットワークに接続されるシンク機器群に対してクロックを送信するクロックソースと、
前記ディジタルネットワークに接続される前記シンク機器群に対して当該ディジタルネットワークを介してコンテンツを提供するコンテンツソースと、
前記コンテンツを再生するにあたり、コンテンツデータが前記シンク機器群に送られるときのネットワークディレイと当該シンク機器群におけるデコードディレイとに基づく遅延時間を前記コンテンツソースに対して提供するコントローラとを備えたことを特徴とするネットワークシステム。
【請求項５】　前記クロックソースは、前記シンク機器群に対して所定時間ごとに時刻情報を送信することを特徴とする請求項４記載のネットワークシステム。
【請求項６】　前記コンテンツソースは、前記コントローラから提供された前記遅延時間に基づく遅延情報メッセージを作成し、コンテンツデータに伴って前記シンク機器群に対して配信することを特徴とする請求項４記載のネットワークシステム。
【請求項７】　ディジタルネットワークに接続され、当該ディジタルネットワークを介して提供されるコンテンツデータをデコードする出力機器であって、
前記ディジタルネットワークを介して受信した基準時刻信号に基づいてクロックを再生するクロック再生手段と、
前記ディジタルネットワークを介して受信した前記コンテンツデータに対して必要なディレイを施し、デコードして出力するストリーム再生手段とを備えたことを特徴とする出力機器。
【請求項８】　内部にて用いられるクロックを発振するクロック発振手段とを更に備え、
前記クロック再生手段は、受信された前記基準時刻信号と前記クロック発振手段からの出力の値とを比較して、当該クロック発振手段の発振周波数を調整することにより、前記クロックを再生することを特徴とする請求項７記載の出力機器。
【請求項９】　前記ストリーム再生手段は、前記コンテンツデータに伴って受信される当該コンテンツデータを出力すべき時刻情報から、自らのデコードディレイ時間を考慮してデコードを開始することを特徴とする請求項７記載の出力機器。
【請求項１０】　ディジタルネットワークに接続される複数の機器にて入力または出力の同期をとるためのネットワークシステムの同期方法であって、
前記複数の機器に対してクロックと共に時刻情報を配信し、
配信される前記クロックと前記時刻情報とに基づいて、共通な時計を前記複数の機器で動作させ、
ネットワークディレイおよび前記複数の機器における変換ディレイを考慮して前記時計の時刻を用いた入力タイミングまたは出力タイミングを当該複数の機器に使用し、
使用された前記入力タイミングまたは前記出力タイミングと各々の機器における変換ディレイとに基づいて、当該各々の機器における変換を開始することを特徴とするネットワークシステムの同期方法。
【請求項１１】　前記入力タイミングまたは前記出力タイミングは、前記ネットワークディレイの最大時間に、前記複数の機器における前記変換ディレイの最大時間を加えて決定されることを特徴とする請求項１０記載のネットワークシステムの同期方法。
【請求項１２】　ディジタルネットワークに接続される複数の機器にて出力の同期をとるためのネットワークシステムの同期方法であって、
前記ディジタルネットワークを介してクロックと共に時刻情報を受信し、
受信した前記クロックおよび前記時刻情報に基づいてクロックを調整し、
コンテンツデータと共に当該コンテンツデータの再生を開始する時刻を示す情報を受信し、
受信した前記情報に基づき、前記コンテンツデータをデコードする際に生じるディレイに基づいてデコードの開始タイミングを決定し、
決定した前記開始タイミングによりデコードを開始して前記コンテンツデータを再生することを特徴とするネットワークシステムの同期方法。
【請求項１３】　前記ディジタルネットワークを介してコンテンツソースとしてのネットワークアドレスの指定を受け、
前記ネットワークアドレスに対してなされるディレイの

指示に基づいて前記開始タイミングを決定することを特徴とする請求項１２記載のネットワークシステムの同期方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、複数の機器を備えたネットワークシステム等に係り、特に、ネットワークに接続された複数の機器において同期をとるネットワークシステム等に関する。

【０００２】

【従来の技術】近年、通信ネットワークが企業、学校、家庭に浸透しつつ有り、このインフラを利用してオーディオビデオのコンテンツを配信しようという試みがなされている。　これをもう一歩進めて、家庭内のオーディオビデオの配線をネットワークで置き換えることが当然考えられる。しかしながら、新しい技術分野であるために、未だ充分な検討が行われていなかった。

【０００３】家庭内のオーディオビデオの配線を通信ネットワークで置き換えることは、例えばＤＶＤ(Digital Versatile Disk)、ディスプレイ、スピーカなどをそれぞれ通信ネットワークに接続することを意味する。例えば、ＤＶＤを再生すると、ディジタル通信ネットワークを介してディスプレイ、スピーカからそれぞれ動画と音声が出力されるということになる。

【０００４】

【発明が解決しようとする課題】しかしながら、現在の通信ネットワークでは、その上を流れるデータにおいて、配信されるタイミングが保証されないという問題点がある。即ち、複数の入出力機器間の入出力位相関係(時間的前後関係)にて、現在のディジタルネットワークでは、伝送遅延が固定ではないことから、十分に小さい位相誤差で出力されるという保証がない。また、ディジタル通信ネットワークを介した場合に、アナログ接続に比べて遅延の絶対値が大きくなる。かかる場合、上記の例では、ＤＶＤから発信されたコンテンツにおいて、ディスプレイや複数存在するスピーカに到着する時刻がまちまちになってしまう。これをそのまま再生すると、結果としてまちまちなタイミングで再生が行われることになる。

【０００５】これは、即ち、アナログケーブルで接続されていた場合に実現されていた出力信号の同期が達成されないということになる。ディジタルネットワーク化によるメリットは数多く存在するが、ディスプレイとスピーカ、あるいはスピーカ同士の出力位相、更にはマイクとカメラの入力位相を合わせることが出来なければ、家庭内におけるオーディオビデオの配線をディジタル通信ネットワークで置き換えることは困難となる。

【０００６】本発明は、以上のような技術的課題を解決するためになされたものであって、ディジタルネットワークに接続された各機器の間において、クロックを同期させると共に、入出力位相を一致させることを主たる目的とする。

【０００７】

【課題を解決するための手段】かかる目的のもと、本発明は、複数の機器がディジタルネットワークに接続されるネットワークシステムであって、複数の機器に対してクロックを配信すると共に時刻情報を配信するクロック配信手段と、配信されたクロックおよび時刻情報に基づき各々の機器においてクロックを調整するクロック調整手段と、ディジタルネットワーク上をストリームが通信される際に生じるネットワークディレイ、複数の機器がストリームに関する変換に際して生じる変換ディレイを考慮して複数の機器に対してディレイ補正を施すディレイ補正手段とを備えたことを特徴としている。

【０００８】また、本発明が適用されるネットワークシステムは、ディジタルネットワークに接続されるシンク機器群に対してクロックを送信するクロックソースと、このシンク機器群に対してディジタルネットワークを介してコンテンツを提供するコンテンツソースと、コンテンツを再生するにあたり、コンテンツデータがシンク機器群に送られるときのネットワークディレイとシンク機器群におけるデコードディレイとに基づく遅延時間をコンテンツソースに対して提供するコントローラとを備えたことを特徴としている。

【０００９】ここで、このクロックソースは、シンク機器群に対して所定時間ごとに時刻情報を送信することを特徴とすれば、位相調整の前提として、クロックを同期させることができる点で好ましい。また、このコンテンツソースは、コントローラから提供された遅延時間に基づく遅延情報メッセージを作成し、コンテンツデータに伴ってシンク機器群に対して配信することを特徴とすれば、各シンク機器群では、自らのデコードディレイを考慮してデコードを開始することで、シンク機器群の間における再生タイミングを合わせることが可能となる。

【００１０】他の観点から把握すると、本発明は、ディジタルネットワークに接続され、このディジタルネットワークを介して提供されるコンテンツデータをデコードする出力機器であって、ディジタルネットワークを介して受信した基準時刻信号に基づいてクロックを再生するクロック再生手段と、ディジタルネットワークを介して受信したコンテンツデータに対して必要なディレイを施し、デコードして出力するストリーム再生手段とを備えたことを特徴としている。

【００１１】ここで、内部にて用いられるクロックを発振するクロック発振手段とを更に備え、クロック再生手段は、受信された基準時刻信号とクロック発振手段からの出力の値とを比較して、クロック発振手段の発振周波数を調整することにより、クロックを再生することを特徴とすることができる。

【００１２】一方、本発明を方法のカテゴリから把える

と、本発明は、ディジタルネットワークに接続される複数の機器にて入力または出力の同期をとるためのネットワークシステムの同期方法であって、複数の機器に対してクロックと共に時刻情報を配信し、配信されるクロックと時刻情報とに基づいて、共通な時計を複数の機器で動作させ、ネットワークディレイおよび複数の機器におけるデコードディレイやエンコードディレイ等の変換ディレイを考慮して時計の時刻を用いた入力タイミングまたは出力タイミングを複数の機器に使用し、使用された入力タイミングまたは出力タイミングと各々の機器における変換ディレイとに基づいて、各々の機器における変換を開始することを特徴とすることができる。

【００１３】また、本発明は、ネットワークに接続されるシンク機器にて適用される発明として把握できる。即ち、本発明におけるネットワークシステムの同期方法は、ディジタルネットワークを介してクロックと共に時刻情報を受信し、受信したクロックおよび時刻情報に基づいてクロックを調整し、コンテンツデータと共にコンテンツデータの再生を開始する時刻を示す情報を受信し、受信した情報に基づき、コンテンツデータをデコードする際に生じるディレイに基づいてデコードの開始タイミングを決定し、決定した開始タイミングによりデコードを開始してコンテンツデータを再生することを特徴としている。

【００１４】

【発明の実施の形態】以下、添付図面に示す実施の形態に基づいて本発明を詳細に説明する。図１は、本実施の形態におけるネットワークシステムの全体像を示した構成図である。図１に含まれる各機器は、ネットワーク１により相互に接続されている。リスニングポジション８は、特定の機器ではないが、このネットワークシステムにおけるユーザの存在位置を模式的に示したものである。ユーザは、リスニングポジション８にて操作用のリモコン７を用いてネットワークシステムに対する指令を行うことができる。

【００１５】ネットワーク１には、システムにクロックを供給するクロックソース２、システム全体を制御するコントローラ３、コンテンツデータ(信号)を送り出すコンテンツソース４、ユーザに対して音声信号を供給する５つのスピーカ５(５－１～５－５)、ユーザに対し映像信号を供するディスプレイ６、の各入出力機器が接続されている。ここで、ディスプレイ６とスピーカ５とを、コンテンツソース４に対して(コンテンツ)シンク機器群と呼ぶことができる。また、各スピーカ５は、図１に示すような位置、即ち、フロントレフト(５－１)、センター(５－２)、フロントライト(５－３)、リアレフト(５－４)、リアライト(５－５)の各位置に設置されている。各スピーカ５およびディスプレイ６は、各々ＬＥＤとプッシュスイッチを備えており、ＬＥＤを用いたユーザへの働きかけとプッシュスイッチによるユーザからの反応を得ることができる。

【００１６】図２は、クロックソース２における第１の構成例を示した図である。この第１の構成例におけるクロックソース２は、クロック発振器１１、カウンタ１２、タイマ１３、ラッチ１４、およびネットワークインタフェース１５を備えており、このネットワークインタフェース１５を介してネットワーク１と接続されている。クロック発振器１１の出力はカウンタ１２とタイマ１３に各々入力される。カウンタ１２の出力(時刻信号)はラッチ１４に入力される。またラッチ１４の出力はネットワークインタフェース１５に入力される。更に、タイマ１３の出力(トリガ信号)は、ラッチ１４のラッチ信号端子とネットワークインタフェース１５の送信信号端子に入力されている。クロックソース２は、ネットワーク１によって相互に接続された機器に対し、このような構成を用いてクロックを送信している。

【００１７】図３は、クロックソース２における第２の構成例を示した図である。この第２の構成例におけるクロックソース２は、クロック発振器２１、カウンタ２２、タイマ２３、およびラッチ２４を備えている。またクロックソース２は、制御装置としてのＣＰＵ２５、ＲＯＭ２７、ＲＡＭ２８を備えており、ネットワークインタフェース２６を介してネットワーク１と接続されている。このＣＰＵ２５とＲＯＭ２７、ＲＡＭ２８は、システムバス２０により相互に接続されたマイクロコンピュータを構成している。また、ネットワークインタフェース２６はシステムバス２０に接続されている。クロック発振器２１の出力はカウンタ２２とタイマ２３に入力される。カウンタ２２の出力(時刻信号)はラッチ２４に入力される。ラッチ２４の出力はシステムバス２０に接続されている。またタイマ２３の出力(トリガ信号)はラッチ２４のラッチ信号端子とＣＰＵ２５の割り込み端子に入力される。クロックソース２は、ネットワーク１によって相互に接続された機器に対し、このような構成を用いてクロックを送信している。

【００１８】図４は、図１に示したコントローラ３の構成を説明するための図である。本実施の形態におけるコントローラ３は、ＣＰＵ３１、ＲＯＭ３２、およびＲＡＭ３３を備えており、これらはシステムバス３４により相互に接続されてマイクロコンピュータを構成している。また、コントローラ３は、システムバス３４に接続されるネットワークインタフェース３５を備え、このネットワークインタフェース３５を介してネットワーク１と接続されている。またコントローラ３はリモコン受光部３６を有しており、リモコン受光部３６はシステムバス３４に接続されている。このコントローラ３は、図１のシステム全体を制御する役割を担っており、具体的な制御は、システムの構成の設定や、システムの動作(コンテンツの再生)の制御等である。特に本実施の形態では、コンテンツ再生時におけるディレイの設定が機能と

して重要である。

【００１９】図５は、図１に示したコンテンツソース４の構成を説明するための図である。本実施の形態におけるコンテンツソース４は、ネットワーク１に接続された機器に、ネットワーク１を経由して、コンテンツストリームを供給している。図５に示すように、コンテンツソース４は、ＣＰＵ４１、ＲＯＭ４２、およびＲＡＭ４３を備えており、これらはシステムバス４４により相互に接続されマイクロコンピュータを構成している。また、コンテンツソース４は、ネットワークインタフェース４５を介してネットワーク１と接続されている。ネットワークインタフェース４５はシステムバス４４に接続されている。

【００２０】更に、本実施の形態におけるコンテンツソース４は、クロック発振器４６とカウンタ４７を備えている。クロック発振器４６の出力はカウンタ４７に入力されている。クロック発振器４６とカウンタ４７はそれぞれシステムバス４４に接続されている。また、コンテンツソース４は、ハードディスク装置４８、ビットストリーム解析器４９、バッファ５０を備えている。ハードディスク装置４８は、自身に格納されているコンテンツストリームをビットストリーム解析器４９に入力している。ビットストリーム解析器４９の出力はバッファ５０に入力され、その出力はシステムバス４４に供給されている。また、ハードディスク装置４８およびビットストリーム解析器４９は、それぞれシステムバス４４に接続されている。

【００２１】尚、コンテンツソース４は、デコーダを持たないためデコードディレイという値には意味は無いが、デコードディレイとして０を持っている。このデコードディレイ値は、ＲＯＭ４２に記録され、ＣＰＵ４１から読み出すことができるようになっている。また、コンテンツソース４は、自身の種別を知っており、その種別は「コンテンツソース」である。この種別はＲＯＭ４２に記録され、ＣＰＵ４１から読み出すことができるようになっている。本実施の形態における種別として、ディスプレイ６は「ディスプレイ型」、各スピーカ５は「モノラルスピーカ型」の種別を持つものとする。この他にも、例えば「ステレオスピーカ型」、「ディスプレイ＋ステレオスピーカ一体型」、「スーパーウーファー型」、「オーディオソース型」などの種別が考えられる。

【００２２】コンテンツソース４は、内部にクロックの再生機能を持ち、クロックソース２から供給される基準時刻信号からクロックを再生している。また、コントローラ３の制御を受けて、内部に蓄えているコンテンツストリームを供給している。このとき、コントローラ３から指定されるディレイ値と再生したクロックから、ストリームにタイムスタンプを付加する機能を備えている。

【００２３】図６は、図１に示したスピーカ５（５－１～５－５）の構成を説明するための図である。この図６に示す構成は、図１に示す５本のスピーカ５（５－１～５－５）の全てに共通しており、これらは同一の内部構造（および動作）を備えている。スピーカ５は、ＣＰＵ５１、ＲＯＭ５２、およびＲＡＭ５３を備えており、これらはシステムバス５４により相互に接続されマイクロコンピュータを構成している。また、スピーカ５は、システムバス５４に接続されているネットワークインタフェース５５を介して、ネットワーク１と接続されている。

【００２４】このスピーカ５は、システムバス５４に接続されるクロック発振器５６とカウンタ５７とを備えており、このクロック発振器５６の出力はカウンタ５７に入力されている。更に、スピーカ５は、バッファ５９、タイムスタンプ抽出器６０、デコーダ６１、アンプ６２、およびスピーカ６３を備えている。スピーカ５を流れるストリームデータは、システムバス５４からバッファ５９、タイムスタンプ抽出器６０を経てデコーダ６１に入力されてデコードされる。デコーダ６１の出力は、アンプ６２を経てスピーカ６３により、音声信号に変換されて出力される。タイムスタンプ抽出器６０、デコーダ６１、およびアンプ６２は、各々システムバス５４に接続されている。このデコーダ６１の内部は、後述するＭＰＥＧデコーダの構成をなしている。具体的にはデマルチプレクサ、オーディオバッファ、オーディオデコーダで構成されている。

【００２５】スピーカ５は、更に、ボタン/ＬＥＤ操作器５８を備えている。ＣＰＵ５１は、システムバス５４経由で、ボタン/ＬＥＤ操作器５８のボタンが押されたか否かの情報を読み出すことができる。また、ＣＰＵ５１は、システムバス５４経由でボタン/ＬＥＤ操作器５８におけるＬＥＤの点滅を制御することができる。

【００２６】ここで、スピーカ５は、自身のデコーダ６１におけるデコードディレイを知っている。ここでデコードディレイとは、デコーダ６１にデータが入力されてからデコードされたデータが出力されるまでの時間であり、各種のディレイである変換ディレイの中で代表的なものである。このデコードディレイ値はＲＯＭ５２に記録され、ＣＰＵ５１から読み出すことができるようになっている。また、スピーカ５は自身の種別を知っており、このスピーカ５の種別は「モノラルスピーカ」である。この種別はＲＯＭ５２に記録され、ＣＰＵ５１から読み出すことができるようになっている。

【００２７】スピーカ５にて実行される動作は大きく３つに分けられる。この３つの動作とは、（１）クロックの再生、（２）ユーザインタフェース対応、（３）ストリームの再生、である。これらの動作は、ＣＰＵ５１上で動作するタスクと、それぞれ必要な構成要素とが組み合わされて成り立っている。なお、ＣＰＵ５１上で動作するこれらの３つのタスクは、ＣＰＵ５１で動作するマルチタスクオペレーティングシステムの上で独立に動作してい

るものとする。

【００２８】上述した第１の動作である、(1)クロックの再生、では、クロックソース２から発信された基準時刻信号により、スピーカ５の内部にクロックが再生される。第２の動作である、(2)ユーザインタフェース対応、では、例えばコントローラ３の指示により内部のＬＥＤを発光させ、内部のボタンが押されたか否かの情報をコントローラ３に戻す動作がなされる。第３の動作である、(3)ストリームの再生、では、受け取ったコンテンツデータに必要なディレイが施され、デコードして出力される。

【００２９】図７は、図１に示したディスプレイ６の構成を説明するための図である。このディスプレイ６の内部構成は、図６で説明したスピーカ５の内部構成に、ＯＳＤ(On Screen Display)８２、表示装置８３を加えたものとして把握することができる。即ち、図７に示すディスプレイ６は、ＣＰＵ７１、ＲＯＭ７２、およびＲＡＭ７３を備えており、これらはシステムバス７４により相互に接続されマイクロコンピュータを構成している。また、ディスプレイ６は、システムバス７４に接続されているネットワークインタフェース７５を介して、ネットワーク１と接続されている。

【００３０】このディスプレイ６は、それぞれシステムバス７４に接続されているクロック発振器７６とカウンタ７７を備えており、クロック発振器７６の出力は、カウンタ７７に入力されている。更に、ディスプレイ６はバッファ７９、タイムスタンプ抽出器８０、デコーダ８１、ＯＳＤ８２、および表示装置８３を備えている。ディスプレイ６を流れるストリームデータは、システムバス７４からバッファ７９、タイムスタンプ抽出器８０を経てデコーダ８１に入力されてデコードされる。デコーダ８１からの出力は、ＯＳＤ８２の出力と混合された後に、表示装置８３に表示される。このタイムスタンプ抽出器８０、デコーダ８１およびＯＳＤ８２は、それぞれシステムバス７４に接続されている。尚、デコーダ８１の内部は、後述するＭＰＥＧデコーダの構成をなしている。具体的にはデマルチプレクサ、ビデオバッファ、ビデオデコーダで構成されている。

【００３１】また、ディスプレイ６は、ボタン/ＬＥＤ操作器７８を備えている。ＣＰＵ７１は、システムバス７４経由でボタンが押されたか否かの情報を読み出すことができる。また、ＣＰＵ７１は、システムバス７４経由でＬＥＤの点滅を制御することができる。ディスプレイ６は自身のデコーダ８１におけるデコードディレイを知っている。ここでデコードディレイとは、デコーダ８１にデータが入力されてから、デコードされたデータが出力されるまでの時間である。このデコードディレイ値はＲＯＭ７２に記録され、ＣＰＵ７１から読み出すことができるようになっている。また、ディスプレイ６は、自身の種別を知っている。ディスプレイ６の種別は「ディスプレイ」である。この種別はＲＯＭ７２に記録され、ＣＰＵ７１から読み出すことができるように構成されている。

【００３２】ディスプレイ６の行う動作は大きく３つに分けられる。この３つの動作とは、スピーカ５の動作と同様であり、(1)クロックの再生、(2)ユーザインタフェース対応、(3)ストリームの再生、である。これらの動作は、ＣＰＵ７１上で動作するタスクと、それぞれ必要な構成要素とが組み合わされて成り立っている。なお、ＣＰＵ７１上で動作するこれらの３つのタスクは、ＣＰＵ７１で動作するマルチタスクオペレーティングシステムの上で独立に動作しているとする。

【００３３】この(1)クロックの再生、とは、クロックソース２から発信された基準時刻信号により、ディスプレイ６の内部にクロックを再生することである。(2)ユーザインタフェース対応、とは、例えばコントローラ３の指示により内部のＬＥＤを発光させ、内部のボタンが押されたか否かの情報をコントローラ３に戻すことである。(3)ストリームの再生、とは、受け取ったコンテンツデータに必要なディレイを施した後、デコードして出力することである。

【００３４】次に、本実施の形態が適用されるネットワークシステムの全体の動作について説明する。図１に示すクロックソース２は、ネットワーク１で相互に接続された機器に対して、クロックを送信している。より具体的には、一定時間ごとの時刻情報(ここでは基準時刻信号'Ｔｓ')を送信している。但し、この時刻情報の送信は、必ずしも決まった時間間隔である必要はなく、所定時間ごとに送信されるものとすることができる。クロックの受信側(スピーカ５(５－１～５－５)、ディスプレイ６、コンテンツソース４)では、受け取った基準時刻情報と内部発振回路の出力の値とが比較されて、内部発振回路の発振周波数が調整され、クロックが再現される。

【００３５】図１に示すコントローラ３は、システム構成を設定している。この動作は、コントローラ３の指示に従いディスプレイ６にて表示されるメッセージや、コントローラ３の指示に従い各スピーカ５が発光させるＬＥＤに反応して、ユーザが各スピーカ５の持つスイッチを押す事により達成される。また、コントローラ３は、ストリーム再生を制御している。この動作は、コントローラ３の指示に従い、コンテンツソース４がストリームを出力し、各スピーカ５およびディスプレイ６がストリームをデコードすることにより行われる。また、コントローラ３の指示により各スピーカ５の音声出力を調整することも行われる。

【００３６】次に、クロックソース２が行うクロック配信について説明する。ここでは、図２および図３に示した２種類の構成のそれぞれに対して説明を行う。まず、図２に示すクロックソース２の動作を説明する。ここで

クロック発振器１１の発振周波数を'Ｕ'［Ｈｚ］とする。クロック発振器１１で発信されたクロックは、カウンタ１２とタイマ１３のそれぞれに入力される。カウンタ１２は、入力されたクロックにより自身のカウンタ１２をインクリメントし、時刻情報'Ｔ'を生成する。入力されるクロックが'Ｕ'［Ｈｚ］であるため、時刻情報'Ｔ'は'Ｕ'［Ｈｚ］の周波数でインクリメントされる。カウンタ１２の出力(時刻情報'Ｔ')は、ラッチ１４に入力される。ラッチ１４は、ラッチ信号が入力された時に入力信号をラッチして出力する。ラッチ信号が入力されない場合には、直前にラッチした信号が保持される。

【００３７】タイマ１３は、入力されたクロックを計数し、あらかじめ設定された設定値'Ｓ'ごとにトリガ信号を出力している。ここで、タイマ１３への入力クロックは'Ｕ'［Ｈｚ］であるので、トリガ信号は'Ｓ／Ｕ'［秒］ごとに出力される。言い換えると、トリガ信号の周期は'Ｓ／Ｕ'［秒］、あるいはトリガ信号の周波数は'Ｕ／Ｓ'［Ｈｚ］となる。タイマ１３から出力されるトリガ信号は、ラッチ１４のラッチ信号端子に入力されると同時に、ネットワークインタフェース１５の送信信号端子に入力される。

【００３８】ラッチ１４は、ラッチ信号端子にタイマ１３からのトリガ信号が入力された時点で、カウンタ１２から入力されている時刻信号'Ｔ'をホールドして出力する。ラッチ１４の出力は、次のラッチ信号が入力されるまで変化しない。この値を基準時刻信号'Ｔｓ'とする。送信信号端子にトリガ信号を受け取ったネットワークインタフェース１５は、入力されているラッチ１４の出力信号'Ｔｓ'を読み取り、ブロードキャストパケットに格納してネットワーク１に送り出す。ブロードキャストパケットは宛先を指定しないために、ネットワーク１に接続されている各機器に到着する。

【００３９】次に、図３に示すクロックソース２の動作を説明する。ここでクロック発振器２１の発振周波数を'Ｕ'［Ｈｚ］とする。クロック発振器２１で発信されたクロックは、カウンタ２２とタイマ２３のそれぞれに入力される。カウンタ２２は、入力されたクロックにより自身のカウンタをインクリメントして時刻情報'Ｔ'を生成する。入力されるクロックが'Ｕ'［Ｈｚ］であるため、時刻情報'Ｔ'は、'Ｕ'［Ｈｚ］の周波数でインクリメントされる。カウンタ２２の出力(時刻情報'Ｔ')はラッチ２４に入力される。ラッチ２４は、ラッチ信号が入力された時に入力信号をラッチして出力する。ラッチ信号が入力されない場合には、直前にラッチした信号が保持される。

【００４０】タイマ２３は、入力されたクロックを計数し、あらかじめ設定された設定値'Ｓ'ごとにトリガ信号を出力している。ここでタイマ２３への入力クロックは'Ｕ'［ＨＩｚ］であるので、トリガ信号は'Ｓ／Ｕ'［秒］ごとに出力される。言い換えると、トリガ信号の周期は'Ｓ／Ｕ'［秒］、あるいはトリガ信号の周波数は'Ｕ／Ｓ'［Ｈｚ］となる。タイマ２３から出力されるトリガ信号は、ラッチ２４のラッチ信号端子に入力されると同時にＣＰＵ２５の割り込み端子に入力される。ラッチ２４は、ラッチ信号端子にタイマ２３からのトリガ信号が入力された時点で、カウンタ２２から入力されている時刻信号'Ｔ'をホールドして出力する。ラッチ２４の出力は、次のラッチ信号が入力されるまで変化しない。この値を基準時刻信号'Ｔｓ'とする。

【００４１】割り込み端子にトリガ信号を受け取ったＣＰＵ２５は、システムバス２０を介して、ラッチ２４の値、即ち基準時刻信号'Ｔｓ'を読み出す。さらにＣＰＵ２５は、システムバス２０経由でネットワークインタフェース２６に指令し、ネットワーク１に接続されている各機器に対して、ラッチ２４から読み出した基準時刻信号'Ｔｓ'を送信させる。ネットワークインタフェース２６は、ＣＰＵ２５から受け取った指令に従い、基準時刻信号'Ｔｓ'をブロードキャストパケットに格納して、ネットワーク１に送り出す。ブロードキャストパケットは宛先を指定しないために、ネットワーク１に接続されている各機器に到着する。尚、ＣＰＵ２５は、ＲＯＭ２７に蓄えられているプログラムによりＲＡＭ２８を利用して動作している。

【００４２】図８は、クロック配信におけるクロックソース２の動作を説明するための図である。ここでは、横軸に時刻をとり、縦軸はそれぞれの信号の値が割り当てられている。クロック発振器１１(あるいはクロック発振器２１)は、'Ｕ'［Ｈｚ］の周波数で発信している。カウンタ１２(あるいはカウンタ２２)の出力、即ち時刻情報'Ｔ'は、同じく'Ｕ'［Ｈｚ］の周波数でインクリメントされる。図８の横軸の原点'ｔ０'をタイマ１３(あるいはタイマ２３)のトリガ信号が出力された時刻にとり、その時点での時刻情報'Ｔ'を'Ｔ０'とする。

【００４３】次のトリガ信号は、時刻'ｔ０'からクロック'Ｕ'の周波数で周期'Ｓ'だけ計数した時刻'ｔ１'に出力され、この時の時刻情報'Ｔ'は'Ｔ０＋Ｓ'となる。このとき、同時に時刻情報'Ｔ'はラッチ１４(あるいはラッチ２４)によりラッチされ、基準時刻信号'Ｔｓ'は'Ｔ０＋Ｓ'となる。その後、トリガ信号は'Ｕ'の周波数でクロック周期'Ｓ'ごとに出力され、基準時刻情報'Ｔｓ'はそれぞれ'Ｔ０＋２Ｓ'、'Ｔ０＋３Ｓ'と変化して行く。基準時刻信号'Ｔｓ'は、トリガ信号が発生する度にネットワーク１に対してブロードキャストされる。

【００４４】次に、クロック再生の動作について、スピーカ５(５－１～５－５)を例に挙げて説明する。このクロック再生は、コンテンツソース４およびディスプレイ６においても実行される。ここで「クロックの再生」とは、クロックソース２から送られたクロックをクライアント機器内部で再び発生させることを示している。

【００４５】通常状態において、図６に示すクロック発

振器５６の出力はカウンタ５７に入力され、カウンタ５７は、入力されたクロックにより自身のカウンタをインクリメントして時刻情報'Ｔｔ'を生成する。ＣＰＵ５１は、バス５４を経由してカウンタ５７の値(時刻情報'Ｔｔ')を読み込むことができる。時刻情報'Ｔｔ'は、ＣＰＵ５１により読み出され、デコードのタイミング調整に使用される。クロック発振器５６は可変周波数発振器であり、ＣＰＵ５１がシステムバス５４を経由して指示を行うことにより、発振周波数を一定の範囲で変化させることができる。また、ＣＰＵ５１は、システムバス５４を経由して、カウンタ５７に所望の値を設定することができる。

【００４６】クロックソース２からの基準時刻信号'Ｔｓ'は、例えば一定時刻ごとに受信され、その際、ＣＰＵ５１は、以下で説明する時計合わせのタスクを実行する。カウンタ５７は、クロック発振器５６の自走クロックで時刻情報'Ｔｔ'を生成する。クロックソース２の発信した基準時刻信号'Ｔｓ'は、スピーカ５のネットワークインタフェース５５で受信される。ネットワークインタフェース５５は、ＣＰＵ５１に基準時刻信号'Ｔｓ'の到着を伝える。ＣＰＵ５１では、この信号により時計合わせのタスクが起動される。

【００４７】図９は、クロック再生における時刻合わせの処理を説明するためのフローチャートである。ＣＰＵ５１は、まず、ネットワークインタフェース５５に到着した基準時刻信号'Ｔｓ'を読み出す(ステップ１０１)。その後、カウンタ５７から時刻情報'Ｔｔ'を読み出す(ステップ１０２)。次に、基準時刻信号'Ｔｓ'と時刻信号'Ｔｔ'の差分を計算し('Ｔｓ'－'Ｔｔ')、変数 'ｄｉｆｆ'に代入する(ステップ１０３)。ＣＰＵ５１は、'ｄｉｆｆ'の絶対値と定数ｋを比較し(ステップ１０４)、'ｄｉｆｆ'の絶対値の方が大きいと判断された場合には、'Ｔｓ'の値をカウンタ５７に代入して(ステップ１０５)、処理を終了する。ステップ１０４にて'ｄｉｆｆ'の絶対値の方が大きいと判断されなかった場合には、ステップ１０６に進む。

【００４８】ステップ１０６にて、ＣＰＵ５１は、'ｄｉｆｆ'の値が０(ゼロ)であるか否かを確認し、'ｄｉｆｆ'の値が０でない場合にはステップ１０７へ進み、'ｄｉｆｆ'の値が０である場合には処理を終了する。ステップ１０７にて、ＣＰＵ５１は、'ｄｉｆｆ'の値と０(ゼロ)とを比較し、'ｄｉｆｆ'の値が０(ゼロ)より大きいと判断された場合('Ｔｓ'＞'Ｔｔ')にはステップ１０９に進み、そうでない('Ｔｓ'＜'Ｔｔ')と判断された場合にはステップ１０８へ進む。ステップ１０８において、ＣＰＵ５１は、クロック発振器５６に対して発振周波数を遅くするよう指令した後、処理を終了する。また、ステップ１０９においてＣＰＵ５１は、クロック発振器５６に対して発振周波数を速くするよう指令した後、処理を終了する。

【００４９】以上のようなＣＰＵ５１のタスクにより、受信した基準時刻信号'Ｔｓ'と内部時刻情報'Ｔｔ'の差が大きい場合には受信した基準時刻信号'Ｔｓ'を内部時刻カウンタに代入し、内部時刻情報'Ｔｔ'が少し進んでいる時にはクロックを遅くし、また内部時刻情報'Ｔｔ'が少し遅れている時にはクロックを速める。これらの動作により、基準時刻信号'Ｔｓ'にあわせた内部時刻情報'Ｔｔ'を再生することができる。尚、上記の例では、クロック配信に際してブロードキャスト通信を使用したが、ユニキャスト(一対一通信)の通信を用いることも可能である。

【００５０】次に、コントローラ３を中心に行われるシステム構成設定の動作について説明する。図１０および図１１は、ネットワーク１に各機器が接続された直後からの処理を示したフローチャートである。図１０に示すように、まず、コントローラ３は、物理的にネットワーク１に接続されて電源が投入されると、ネットワーク１への接続を確認する。即ち、図４に示すコントローラ３のＣＰＵ３１は、まず、ネットワークインタフェース３５に対してネットワーク１に接続したことを確認させる(ステップ２０１)。そして、ネットワーク１に接続したと判断されるとステップ２０３に進み、ネットワーク１に接続したと判断されない場合にはステップＳ２０１に戻って確認を繰り返す(ステップ２０２)。

【００５１】ステップ２０３において、ＣＰＵ３１は、「応答リクエストメッセージ」を作成し、ネットワークインタフェース３５に指令して、ネットワーク１に対して送信させる。この「応答リクエストメッセージ」は所定の文字列で構成されている。ネットワークインタフェース３５は、ＣＰＵ３１から受け取った指令に従い、「応答リクエストメッセージ」をブロードキャストパケットに格納してネットワーク１に送り出す。ブロードキャストパケットは、宛先を指定していないために、「応答リクエストメッセージ」はネットワーク１に接続されている各機器に到着する。「応答リクエストメッセージ」を受け取った各機器は、自身の種別およびデコードディレイ値を返答する。種別およびデコードディレイ値は各機器のＲＯＭに記録されている。例えばスピーカ５において、このメッセージはネットワークインタフェース５５に到着し、ＣＰＵ５１は、このメッセージを解読して、ＲＯＭ５２から種別とデコードディレイを読み取り、「応答」メッセージを作成し、ネットワークインタフェース５５に指令してコントローラ３に対して送信させる。各機器の返答したメッセージは、ネットワークインタフェース３５で受信され、ネットワークインタフェース３５は、ＣＰＵ３１にメッセージの到着を伝える。

【００５２】ステップ２０４においてメッセージが到着していると判断される場合には、コントローラ３のＣＰＵ３１は、ステップ２０５に進む。メッセージが到着していないと判断された時には、ステップ２０８に進む。

ステップ２０５において、ＣＰＵ３１は、ネットワークインタフェース３５に到着したメッセージを読み出す。その後、ＣＰＵ３１は、読み出したメッセージが各機器から返答された所定の「応答」であるかどうかを確認する(ステップ２０６)。所定の「応答」であった場合にはステップ２０７へ進む。所定の「応答」ではなかった場合には、ステップ２０８へ進む。

【００５３】ステップ２０７において、ＣＰＵ３１は、受け取った「応答」をＲＡＭ３３に置かれた機器データベースに記録する。図１２は、機器データベースの構造を示した図である。機器データベースの先頭には、登録されているエントリの数が記録され、引き続いて、エントリの数だけ各機器のレコードが記録されている。機器のレコードには、その機器をネットワーク上で特定するためのネットワークアドレス、種別、役割、デコードディレイがそれぞれ記録される。「応答」を機器データベースに記録する際には、まず、エントリ数を１だけインクリメントする。そして、新しいレコードをリストの終りに追加する。その後、新しく追加したレコードに対して、受け取った「応答」の送り先の機器を特定するためのネットワークアドレス、種別、デコードディレイを記録する。役割の項はシステム構成設定動作の後半で記録される。

【００５４】ステップ２０８において、ＣＰＵ３１では、ステップ２０３の「応答リクエストメッセージ」を送信してから、所定の時間が経過したかどうかが判断される。所定時間が経過したと判断された場合には、図１１に示すステップ２１０に進む。まだ所定時間が経過していないと判断された場合には、ステップ２０４に戻って、これまでの動作を繰り返す。

【００５５】図１１に示すステップ２１０において、ＲＡＭ３３に置かれている機器データベースの内容は、図１３に示すような内容になっており、そのエントリの数は7となっている。7つあるレコードの内訳としては、まず、ディスプレイ６を示すネットワークアドレスを持ち、種別がディスプレイとなっているレコードが置かれる。また、５つのスピーカ５(５－１～５－５)の各々を示すネットワークアドレスを持ち、種別がモノラルスピーカとなっているレコードが計５つ置かれている。最後に、コンテンツソース４を示すネットワークアドレスを持ち、種別がコンテンツソースとなっているレコードが置かれている。尚、レコードの順番は一例として示したものであり、図１３に示す順番になるものと決まっているものではない。

【００５６】ステップ２１０において、ＣＰＵ３１は、ＲＡＭ３３に置かれている機器データベースから種別がディスプレイとなっているものを探す。この例では、図１３に示すように、最初に記録されているレコードの種別がディスプレイとなっている。ＣＰＵ３１は、最初のレコードに記録されているネットワークアドレスを持つ機器がディスプレイであることを認識する。その後、ＣＰＵ３１は、「システムを設定開始する」旨のメッセージを作成し、ネットワーク１経由でディスプレイ６に指令して表示させる(ステップ２２０)。前のステップにてディスプレイ手段を持つ機器としてディスプレイ６を認識したので、ＣＰＵ３１は、直接、ディスプレイ６(を示すネットワークアドレスを持つ機器)に対して指令を行う。具体的には、ＣＰＵ３１は、メッセージを作成し、ネットワークインタフェース３５に指令してディスプレイ６に対して送信させる。ディスプレイ６では、図７に示すネットワークインタフェース７５がメッセージを受信し、ＣＰＵ７１によってそのメッセージが読み取られて解読され、ＯＳＤ８２に指令してメッセージを出力して表示装置８３に表示させる。

【００５７】次に、コントローラ３のＣＰＵ３１により「フロントレフト」が指定される(ステップ２３０)。即ち、「フロントレフトの位置に有るスピーカのスイッチを押して下さい」という旨のメッセージが作成され、ネットワーク１を経由してディスプレイ６に表示される。

【００５８】その後、コントローラ３は、「ＬＥＤ点滅／ボタン待ち」を指令するメッセージを作成し、ＲＡＭ３３に置かれている機器データベースから種別がモノラルスピーカになっている機器の全て(スピーカ５(５－１～５－５))に対して送出する。この「ＬＥＤ点滅／ボタン待ち」のメッセージを受信した機器は、ＬＥＤを点滅させ（ステップ２３１)、ボタンが押されることを待ち受ける。スピーカ５においては、このメッセージはネットワークインタフェース５５に到着し、ＣＰＵ５１はこのメッセージを解読して、ボタン/ＬＥＤ操作器５８に指令してＬＥＤを点滅させる。またＣＰＵ５１は、ボタン/ＬＥＤ操作器５８にてボタンが押されたことを探知したら、コントローラ３に返答を返すべく、待ち受ける。

【００５９】ユーザは、ＬＥＤの点滅しているスピーカ５(５－１～５－５)の中から、フロントレフトの位置にあたるスピーカ５－１のスイッチを押す。スピーカ５－１では、ボタンを押されたことをボタン/ＬＥＤ操作器５８が感知し、ＣＰＵ５１に伝える。ＣＰＵ５１は、「ボタン押下」のメッセージを作成し、ネットワークインタフェース５５に指令してコントローラ３に対して送信させる。コントローラ３のＣＰＵ３１は、ステップ２３２にて「ボタン押下」のメッセージが受信されるまで待ち(ステップ２３２)、受信するとスピーカ５－１のＬＥＤを消灯する(ステップ２３３)。

【００６０】その後、ＣＰＵ３１は、ネットワークインタフェース３５からメッセージを読み出し、「ボタン押下」メッセージ発信元のネットワークアドレスを読み取り、ＲＡＭ３３に記録されている機器データベースのレコードの中で、ネットワークアドレスが一致するもの、即ち、図１３の例では第２番目のレコードを探し出し、

該当するレコードの役割のフィールドに「フロントレフト」の属性を書き込んで設定する(ステップ２３４)。最後にＣＰＵ３１は、役割のフィールドの内容、ここでは「フロントレフト」の属性を記述した「役割メッセージ」を作成し、ネットワーク１を経由して「ボタン押下」メッセージの発信元に送り返す(ステップ２３５)。「ボタン押下」メッセージの発信元(ここではスピーカ５－１)は、「役割メッセージ」を受信し、役割(ここでは「フロントレフト」の属性)を取り出してＲＡＭ５３に格納する。即ち、このメッセージは、ネットワークインタフェース５５に到着し、ＣＰＵ５１は、このメッセージを解読して、ＲＡＭ５３に記録する。以上のようなステップ２３０からステップ２３５の操作によって、「フロントレフト」の位置に設置されたスピーカ５はスピーカ５－１であるということがコントローラ３の機器データベースに記録される。また、スピーカ５－１は、自身の役割(ここではフロントレフト)を知り、自身のＲＡＭ５３に記録する。

【００６１】以下同様に、ステップ２４０からステップ２４５の操作により「フロントライト」、ステップ２５０からステップ２５５の操作により「センター」、ステップ２６０からステップ２６５の操作により「リアレフト」、ステップ２７０からステップ２７５の操作により「リアライト」のそれぞれの位置に設置されたスピーカ５を知ることができる。更に、各スピーカ５(５－２～５　５)は、自身の役割を知り自身のＲＡＭ５３に記録する。

【００６２】最後に、コントローラ３のＣＰＵ３１は「システム設定が終了した」という旨のメッセージを作成し、ネットワーク１経由でディスプレイ６に指令して表示させる(ステップ２８０)。以上の手順により、物理的な配置とネットワーク１上でのアドレスの対応をとることができる。尚、ここでは説明しなかったが、ディスプレイ６が複数、存在する場合には、ディスプレイ６が持つボタン/ＬＥＤ操作器７８、あるいはリモコン７と画面表示などを用いて、上記と同様の設定を行うことができる。

【００６３】次に、スピーカ５(５－１～５－５)のデコーダ６１やディスプレイ６のデコーダ８１にて構成されるＭＰＥＧデコーダについて説明する。図１４は、ＭＰＥＧ２システム(ISO13818－1)に準拠したデコーダシステムの概略を示した図である。図１４に示すデコーダシステムでは、ストリーム入力９１からストリームが入力され、デマルチプレクサ９２にてビデオストリームとオーディオストリームとに振り分けられる。ビデオストリームは、ビデオバッファ９３に入力され、所定のディレイ時間を経過した後にビデオデコーダ９４に入力され、デコードされてビデオ出力９７から出力される。オーディオストリームは、オーディオバッファ９５に入力され、所定のディレイ時間を経過した後にオーディオデコーダ９６に入力され、デコードされてオーディオ出力９８から出力される。

【００６４】図１５は、ＭＥＰＧデコーダに供給されるデータフォーマットの一例を示した図である。このフォーマットは、ＭＰＥＧ２の多重化ビットストリーム(ProgramStream)として規定されているものである。図１５に示すように、多重化ビットストリームは、１つ以上のパック(PACK)で構成され、各パックは１つ以上のパケット(PACKET)で構成される。パックの先頭にはパックヘッダ(PACK HEADER)が配置され、このパックヘッダにはパックの開始点を示すパックスタートコード(PACK START CODE)、ＳＣＲ(System Clock Reference)およびＭＵＸ ＲＡＴＥが配置されている。ＳＣＲは、その最後のバイトがデマルチプレクサ９２に入力される時刻を表わしている。ＭＵＸ ＲＡＴＥは、転送レートを示すものである。

【００６５】図１５に示す例においては、パックヘッダに続いて、ビデオパケット(VIDEO PACKET)とオーディオパケット(AUDIO PACKET)とが配置されている。これらのパケットの先頭にもパケットヘッダが配置され、これらのパケットヘッダは、ビデオまたはオーディオのパケットの開始点を表すビデオパケットスタートコード(VIDEO PACKET START CODE)またはオーディオパケットスタートコード(AUDIO PACKETSTART CODE)と、ビデオまたはオーディオデータのデコード(表示)開始時刻を示すＤＴＳ(V)(ＰＴＳＶ(ＰＴＳｖｉｄｅｏ))またはＤＴＳ(Ａ)(ＰＴＳＡ(ＰＴＳａｕｄｉｏ))が配置されている。そして、この各パケットヘッダの次に、ビデオデータあるいはオーディオデータが配置されている。尚、これらＳＣＲ、ＰＴＳ(ＰＴＳＶまたはＰＴＳＡ)などのタイミングデータは、９０ｋＨｚの周波数からなるクロックのカウント値で表わされ、３３ビットの有効数字を有している。更に、システム表現のための簡略モデル化を行っているため、デコードにかかる時間は０となっている。このためデコード開始時刻と表示開始時刻が等しい。

【００６６】図１６は、ＳＣＲとＰＴＳＶ(ＰＴＳｖｉｄｅｏ)、ＳＣＲとＰＴＳＡ(ＰＴＳａｕｄｉｏ)の関係を示した図である。パックヘッダがデマルチプレクサ９２を通過した時刻がｔ１であり、該当するパックに含まれるビデオとオーディオの表示時間がそれぞれｔ２とｔ３となる。ここでは、ＳＣＲからＰＴＳａｕｄｉｏまでの時間をΔＴａとし、ＳＣＲからＰＴＳｖｉｄｅｏまでの時間をΔＴｖとしている。ΔＴａとΔＴｖは、エンコード時に決まる任意の時間である。該当するパックがデマルチプレクサ９２に入力される時刻がＳＣＲであり、該当するパックに含まれるビデオデータとオーディオデータは、それぞれビデオバッファ９３とオーディオバッファ９５で所定の時間、遅延するために、そのデコード(表示)開始時刻はＳＣＲより遅くなる。また、一般的にビデオバッファ９３での遅延はオーディオバッファ９５

での遅延より大きいため、同じタイミングでデマルチプレクサ９２を通過した場合でも、ビデオのデコード(表示)時刻はオーディオのデコード(表示)開始時刻より遅くなる。尚、前述したように、デコードにかかる時間は０であるので、ここでの遅延は、それぞれビデオバッファ９３とオーディオバッファ９５で発生している。

【００６７】次に、本実施の形態におけるディレイ補償の考え方について説明する。コントローラ３は、コンテンツの再生を行うにあたり、Δｔを設定してコンテンツソース４に知らせる。コンテンツソース４は、コンテンツデータの送信時刻に対して、Δｔだけ遅らせた時刻にコンテンツの出力されるべき時刻を設定してコンテンツデータを送り出す。コンテンツのシンク機器群(スピーカ５(５－１～５－５)、ディスプレイ６)では、受け取ったコンテンツデータを指定された時刻に出力する。

【００６８】Δｔは、コンテンツソース４からコンテンツのシンク機器群(スピーカ５(５－１～５－５)、ディスプレイ６)に、コンテンツデータが送られた時のネットワークディレイ(通信ディレイ)のうち最大となる時間と、コンテンツのシンク機器群(スピーカ５(５－１～５－５)、ディスプレイ６)の実際のデコードディレイのうち最大となる時間とを加えたものである。場合によっては、マージンを増やすために幾分かの余裕を加える場合がある。また、この２つ以外の要因によるディレイを加える場合もある。例えば、サブネットをまたぐ場合のルーターのディレイ等が考えられる。

【００６９】更に、Δｔの値はシンク機器群の組み合わせによって変化することがある。即ち、コンテンツのシンク機器群の組み合わせが変化すると、その中での最大のネットワークディレイと最大のデコードディレイは変化する可能性がある。シンク機器群の組み合わせによってΔｔをその都度変えて制御する場合と、システム内で起こり得る最大のネットワークディレイと最大のデコードディレイとを用いて、即ち、Δｔの最大値を見積もってそれを使用する場合の二つの方法が考えられる。

【００７０】図１７は、本実施の形態におけるディレイを説明するための図である。コンテンツソース４がストリーム先頭に対する発信を開始した時刻をｔ１０とする。ｔ１０に最大の通信ディレイ(ネットワークディレイ)を加えた時刻をｔ１１とする。コンテンツソース４から発信されたコンテンツデータは、遅くともｔ１１までには全てのコンテンツのシンク機器群(スピーカ５(５－１～５－５)、ディスプレイ６)に到着している。即ち、通信のディレイに関しては、配信時刻から再生時刻を最大の通信ディレイだけ遅らせることで補償可能である。

【００７１】次に、ｔ１１に最大のデコードディレイを加えた時刻、即ち、ｔ１０にΔｔを加えた時刻をｔ１２とする。ＭＰＥＧ系の多重化ストリームの場合には、デコード開始とはビットストリームの処理開始、即ちデマルチプレクス開始ということになる。このため、時刻ｔ１２は、該当するビットストリームのＳＣＲが対応することになる。図１６に示した数値を当てはめて考えると、デコーダではｔ１２がＳＣＲの時刻となるから、オーディオの出力開始時刻ＰＴＳａｕｄｉｏは、ｔ１２にΔＴａを加えた時刻ｌ２０となり、ビデオの出力開始時刻ＰＴＳｖｉｄｅｏは、ｔ１２にΔＴｖを加えた時刻ｔ２２となる。

【００７２】ここで、実際のデコードディレイを考える。ディスプレイ６のデコーダ８１のデコードディレイをＤｖ、スピーカ５のデコーダ６１のデコードディレイをＤａとすると、ｔ２０にオーディオを出力するためには、ｌ２０よりＤａだけさかのぼった時刻ｌ２１にオーディオのデコードを開始する必要がある。また、同様に、ｔ２２にビデオを出力するためには、ｔ２２からＤｖだけさかのぼった時刻ｔ２３にビデオのデコードを開始する必要がある。

【００７３】このとき、ΔＴａあるいはΔＴｖが非常に小さく与えられたとすると、ｔ２０あるいはｔ２２はｔ１２に限りなく近付くので、ｔ２１あるいはｔ２３はｔ１２からデコードディレイ分さかのぼった時刻になる。このため、ｔ１２から最大のデコードディレイ分をさかのぼった時刻が、ｔ１１の後になっていれば良い。繰り返すと、ｔ１１までデコード開始を待てばネットワークによるディレイは無視できる。更に、見かけ上のデコード開始時刻(ｔ１２、ＳＣＲ)を、ｔ１１から実際のデコードディレイにおける最大のものだけ遅らせることにより、デコードディレイの影響も無視できるようになる。このために、Δｔには最大のデコードディレイが加算されている。

【００７４】次に、ストリーム再生動作について説明する。図１にて、ユーザがリモコン７を使用して、再生モードの指定をコントローラ３に対して与えた場合を考える。ここではディスプレイ６とスピーカ５(５－１～５－５)を使用するサラウンド再生を指定したものとする。このとき、リモコン信号は、コントローラ３のリモコン受光部３６で受信される。リモコン受光部３６は、ＣＰＵ３１に対して再生モード指定のコマンドを伝える。ＣＰＵ３１は、ＲＡＭ３３に記録されている機器データベースを参照し、シンク機器(スピーカ５(５－１～５－５)、ディスプレイ６)から、デコードディレイの最大値を選び出し、更に、予め決まっているネットワークのディレイをＲＯＭ３２から読み出して加算し、Δｔとする。

【００７５】ここで、ユーザがリモコン７を使用して、コンテンツ再生の命令をコントローラ３に対して与えた場合を考える。このリモコン信号は、コントローラ３のリモコン受光部３６で受信される。リモコン受光部３６は、ＣＰＵ３１にコンテンツ再生のコマンドを伝える。ＣＰＵ３１は、ＲＡＭ３３に記録されている機器データ

ベースを参照して、コンテンツソースを探し出す。ここではコンテンツソース４を発見し、ネットワークアドレスを得る。コントローラ３は、コンテンツソース４に対して「コンテンツ再生開始」のメッセージを送出する。このとき、Δｔの値も同時に与える。また、通常では、ここでコンテンツの指定がなされる。

【００７６】即ち、ＣＰＵ３１は、「コンテンツ再生開始メッセージ」を作成し、その中でΔｔを指定する。そして、ＣＰＵ３１は、ネットワークインタフェース３５に指令して、「コンテンツ再生開始メッセージ」をコンテンツソース４に対して送信させる。この「コンテンツ再生開始メッセージ」は、所定の文字列で構成される。

【００７７】コントローラ３は、今回のシンク機器群（スピーカ５（５－１～５－５）、ディスプレイ６）に対して、コンテンツソース４からのコンテンツデータを再生するように指示する。即ち、ＣＰＵ３１は、「コンテンツソース指定メッセージ」を作成し、その中でコンテンツソース４のネットワークアドレスを指定する。ＣＰＵ３１は、ネットワークインタフェース３５に指令して、今回のシンク機器群（スピーカ５（５－１～５－５）、ディスプレイ６）に対して、一つづつ順番に「コンテンツソース指定メッセージ」を送信させる。この「コンテンツソース指定メッセージ」は、所定の文字列で構成される。

【００７８】同時に、コントローラ３は、今回のシンク機器群の中で、スピーカ５群（スピーカ５　１～５　５）に対してボリュームを設定する。即ち、ＣＰＵ３１は、「ボリューム設定メッセージ」を作成し、その中でボリュームの値を指定する。ＣＰＵ３１は、ネットワークインタフェース３５に指令して、シンク機器群の中の指定されたシンク機器であるスピーカ５（５－１～５－５）に対して、一つづつ順番に「ボリューム設定メッセージ」を送信させる。この「ボリューム設定メッセージ」は、所定の文字列で構成されている。

【００７９】次に、コンテンツソース４の動作について説明する。コンテンツソース４は、「コンテンツ再生開始メッセージ」を受信する。即ち、ネットワークインタフェース４５にメッセージが到着し、ＣＰＵ４１はこのメッセージを解読し、Δｔの値を受け取ると共に、コンテンツの再生を開始する。まず、ＣＰＵ４１は、ハードディスク装置４８に対して所定のコンテンツの出力を指示する。ハードディスク装置４８から出力したストリームは、ビットストリーム解析器４９にて解析され、先頭のＳＣＲの値が読み出される。ＳＣＲの数値はＣＰＵ４１によって読み出され、ストリームはそのままバッファ５０へ進む。

【００８０】このとき、コンテンツソース４での時刻情報'Ｔｔ'が'Ｔ１０'、ストリーム先頭のＳＣＲの値が'Ｓ１０'であったとする。即ち、ビットストリームの'Ｓ１０'の値を持つタイムスタンプが、スピーカ５におけるデコーダ６１内の図示せぬデマルチプレクサ、あるいはディスプレイ６のデコーダ８１内の図示せぬデマルチプレクサにて処理される時刻'Ｔ１２'は、現在時刻'Ｔ１０'にコントローラ３より与えられた'Δｔ'を加えた時刻となる。

Ｔ１２＝Ｔ１０＋Δｔ

コンテンツソース４のＣＰＵ４１は、「タイムスタンプオフセットメッセージ」を作成し、'Ｓ１０'の値と'Ｔ１２'の値を指定する。ＣＰＵ４１は、ネットワークインタフェース４５に指令して、「タイムスタンプオフセットメッセージ」をネットワーク１にブロードキャストする。これにより、全てのシンク機器は、ＭＰＥＧ２のタイムスタンプと'クロック'の関係を知ることになる。

【００８１】コンテンツソース４のＣＰＵ４１は、ネットワークインタフェース４５に指定して、バッファ５０の内容（ストリーム）をネットワーク１にブロードキャストさせる。ここではネットワーク１に対してブロードキャストするが、ユニキャスト（一対一通信）でも構わない。その際には、コントローラ３が、シンク機器の一覧をコンテンツソース４に伝える必要が有り、コンテンツソース４は、その一覧データに従ってデータを送信する。

【００８２】次に、本実施の形態におけるスピーカ５の動作について説明する。スピーカ５のＣＰＵ５１は、コントローラ３の発信した「コンテンツソース指定メッセージ」のメッセージを受け取る。ＣＰＵ５１は、コンテンツソースとして指定されたネットワークアドレスをＲＡＭ５３に格納する。スピーカ５は、コントローラ３の指示により、コンテンツソース４からのコンテンツデータを待ち受ける。このメカニズムにより、同一ネットワーク上に、コンテンツソースとシンク機器の組み合わせが複数存在することができる。

【００８３】また、スピーカ５のＣＰＵ５１は、コントローラ３の発信した「ボリューム設定メッセージ」のメッセージを受け取る。ＣＰＵ５１はアンプ６２に対してボリュームを設定する。更にスピーカ５は、コンテンツソース４の発信した「タイムスタンプオフセットメッセージ」を受け取る。この「タイムスタンプオフセットメッセージ」は、コンテンツデータに伴って送られるものであり、スピーカ５は、予めコンテンツソース４からのコンテンツデータを待ち受けていたので、このメッセージを受け入れた。この「タイムスタンプオフセットメッセージ」からＭＰＥＧのタイムスタンプと時刻情報の関係が判る。スピーカ５のＣＰＵ５１は、差分オフセット値＝Ｓ１０－Ｔ１２を計算する。これによりスピーカ５での時刻情報'Ｔｔ'にオフセット値を加えることで、ＭＰＥＧの時計であるところのＳＴＣ（システムタイムクロック）の値を計算することができる。また、ＭＰＥＧ系のタイムスタンプからオフセットを減じることで、時刻情報'Ｔｔ'の値を求めることができる。

【００８４】スピーカ５は、コンテンツソース４の発信したストリームを受け取り、バッファ５９に入力する。バッファ５９に入ったストリームは、タイムスタンプ抽出器６０を経てデコーダ６１に入力される。ＣＰＵ５１は、タイムスタンプ抽出器６０からＳＣＲとＰＴＳａｕｄｉｏを読み出す。また、ＣＰＵ５１はデコードディレイＤａの値を知っている。デコーダ６１にはデコードディレイがあるために、名目上の出力開始時刻からＤａだけさかのぼって(前に)デコードを開始する必要がある。この調整を行うために、スピーカ５のＣＰＵ５１は以下の処理を行う。

【００８５】まず、Ｔ１２からＤａだけさかのぼった時刻をＴ１１(実際のデマルチプレクス開始時刻)とする。ストリームの最初のＰＴＳａｕｄｉｏ(名目上のオーディオデコード/表示開始)をＴ２０とし、Ｔ２０からＤａだけさかのぼった時刻をＴ２１とする。即ちＴ１２は名目上のデマルチプレクス開始時刻であり、Ｔ１１はデコードディレイの分、前倒しにした実際のデマルチプレクス開始時刻となる。また、Ｔ２０は、ストリームの最初のＰＴＳａｕｄｉｏにおける名目上のデコード(表示)開始時刻であり、Ｔ２１はデコードディレイの分、前倒しにした実際のデコード開始時刻となる。ＣＰＵ５１はカウンタ５７から再生された時刻情報'Ｔｔ'を読み出し、時刻がＴ１１に等しくなった時点でデマルチプレクスを開始する。引き続いて時刻がＴ２１になった時点でデコードを開始する。これにより、Ｔ２０にオーディオの出力を開始することができる。

【００８６】次に、本実施の形態におけるディスプレイ６の動作について説明する。ディスプレイ６のＣＰＵ７１は、コントローラ３の発信した「コンテンツソース指定メッセージ」のメッセージを受け取る。ＣＰＵ７１は、コンテンツソースとして指定されたネットワークアドレスをＲＡＭ７３に格納する。ディスプレイ６は、コントローラ３の指示により、コンテンツソース４からのコンテンツデータを待ち受ける。この仕掛けにより、同一ネットワーク上に、コンテンツソースとシンク機器の組み合わせが複数存在することができる。

【００８７】ディスプレイ６は、コンテンツソース４の発信した「タイムスタンプオフセットメッセージ」を受け取る。この「タイムスタンプオフセットメッセージ」は、コンテンツデータに伴って送られるものであり、ディスプレイ６は、予めコンテンツソース４からのコンテンツデータを待ち受けていたのでこのメッセージを受け入れた。この「タイムスタンプオフセットメッセージ」からＭＰＥＧのタイムスタンプと時刻情報の関係が判る。ディスプレイ６のＣＰＵ７１は、差分オフセット値＝Ｓ１０－Ｔ１２を計算する。これによりディスプレイでの時刻情報'Ｔｔ'にオフセット値を加えることで、ＭＰＥＧの時計であるところのＳＴＣ(システムタイムクロック)の値を計算することができる。また、ＭＰＥＧ系のタイムスタンプからオフセットを減じることで、時刻情報'Ｔｔ'の値を求めることができる。

【００８８】ディスプレイ６は、コンテンツソース４の発信したストリームを受け取り、バッファ７９に入力する。バッファ７９に入ったストリームは、タイムスタンプ抽出器８０を経てデコーダ８１に入力する。ＣＰＵ７１は、タイムスタンプ抽出器８０からＳＣＲとＰＴＳｖｉｄｅｏを読み出す。また、ＣＰＵ７１はデコードディレイＤｖの値を知っている。デコーダ８１にはデコードディレイがあるために、名目上の出力開始時刻からＤｖだけさかのぼって(前に)デコードを開始する必要がある。この調整を行うために、ディスプレイ６のＣＰＵ７１は以下の処理を行う。

【００８９】まず、Ｔ１２からＤｖだけさかのぼった時刻をＴ１１(実際のデマルチプレクス開始時刻)とする。ストリームの最初のＰＴＳｖｉｄｅｏ(名目上のビデオデコード/表示開始)をＴ２２とし、Ｔ２２からＤｖだけさかのぼった時刻をＴ２３とする。即ちＴ１２は名目上のデマルチプレクス開始時刻であり、Ｔ１１はデコードディレイの分、前倒しにした実際のデマルチプレクス開始時刻となる。また、Ｔ２２はストリームの最初のＰＴＳｖｉｄｅｏにおける名目上のデコード(表示)開始時刻であり、Ｔ２３はデコードディレイの分、前倒しにした実際のデコード開始時刻となる。ＣＰＵ７１は、カウンタ７７から再生された時刻情報'Ｔｔ'を読み出し、時刻がＴ１１に等しくなった時点でデマルチプレクスを開始する。引き続いて時刻がＴ２３になった時点でデコードを開始する。これにより、Ｔ２２にビデオの出力を開始することができる。

【００９０】最後に、位置補償の方法について説明する。上記の例では、Δｔの要素として、ネットワークによるディレイとデコードディレイの二つを考えたが、このほかにもスピーカ５(５－１～５－５)の位置によるディレイ調整が考えられる。例えば、スピーカ５－４がスピーカ５－５より１．７メートルだけリスニングポジション８に近いとする。音速はおよそ３４０メートル毎秒なので、１．７メートルの距離を進むのに約５ミリ秒かかる。即ち、スピーカ５－４とスピーカ５－５を同時に発した音は、スピーカ５－４からの音が５ミリ秒だけ早くリスニングポジション８に到達する。これを補償するために、スピーカ５－４に対して５ミリ秒のディレイを加えるという方法がある。言い換えれば、スピーカ５－４だけが１．７メートルだけリスニングポジション８に近い場合に、スピーカ５－４以外のスピーカに対して５ミリ秒だけ早く出力させるということになる。

【００９１】本実施の形態では、かかる方法にも対応することが可能である。具体的には、上記例においてΔｔを計算する際に、「ネットワークディレイの最大値」と「デコードディレイの最大値」に加えて「位置補償ディレイの最大値」を加算する。即ち、上記例よりもΔｔは

５ミリ秒だけ大きくなる。また、コントローラ３は、スピーカ５－４に対して０ミリ秒のディレイを指示し、スピーカ５－４以外のスピーカに対して５ミリ秒の前倒しを指示する。このとき、コントローラ３から発信される「コンテンツソース指定メッセージ」によって指定されたネットワークアドレスに基づいて、シンク機器毎にディレイの指示を受けることが可能である。また、コントローラ３のＣＰＵ３１により各スピーカ５の「位相補償ディレイ設定メッセージ」が作成され、各スピーカ５に送られることで、シンク機器毎にディレイを指示するように構成することも可能である。

【００９２】図１８は、位置補償ディレイの最大値を考慮した場合のディレイを説明するための図である。コンテンツソース４は、コンテンツの送り出し時刻ｔ１０に対してΔｔを加え、名目上のデマルチプレクス開始時刻としてｔ１２を指定する。リアレフトであるスピーカ５－４では、最初のＳＣＲにあたるｔ１２から”デコードディレイＤａ＋０ミリ秒”だけさかのぼった時刻ｔ１１にデマルチプレクスを開始し、最初のＰＴＳａｕｄｉｏにあたるｔ２０から”デコードディレイＤａ＋０ミリ秒”だけさかのぼった時刻ｔ２１にデコードを開始する。これによって、ｔ２０に音声出力することができる。

【００９３】スピーカ５－４以外のスピーカ５では、最初のＳＣＲにあたるｔ１２から”デコードディレイＤａ＋５ミリ秒”だけさかのぼった時刻ｔ３１にデマルチプレクスを開始し、最初のＰＴＳａｕｄｉｏにあたるｔ２０から”デコードディレイＤａ＋５ミリ秒”だけさかのぼった時刻ｔ３２にデコードを開始する。するとｔ２０から５ミリ秒前に音声出力することができる。即ち、これらの操作によりスピーカ５－４以外のスピーカ５からの出力は、スピーカ５－４からの出力よりも５ミリ秒だけ早く出力することができる。このようにしてスピーカ位置の補償が可能となる。

【００９４】以上、詳述したように、本実施の形態では、まず、ソース機器とシンク機器における動作クロックの関係(結びつき)について対策を施している。即ち、両者のクロックが非同期である場合、両者のデータ処理速度、即ち同一サンプル数に対する処理時間が異なるため、結果として二つの機器の間に存在するバッファには破綻(アンダーフロー、オーバーフロー)をきたすことになる。本実施の形態では、クロックの配信を行い、受信した基準時刻信号と内部時刻情報との差が大きい場合には受信した基準時刻信号を内部時刻カウンタに代入し、内部時刻情報が進んでいるときにはクロックを遅くし、遅れているときにはクロックを速めるように構成した。これによって、ディジタルネットワークに接続された機器におけるクロックの同期をとることが可能となる。

【００９５】また、ネットワークに接続された複数の入出力機器間の位相(タイミング)の関係について、ディジタルネットワークでは伝送遅延が固定ではないことから、十分に小さい位相誤差にて出力されるという保証が無い。また、アナログ接続に比べて遅延の絶対値が大きくなる。しかしながら、本実施の形態によれば、まず、上記のように、同じ時計を各機器で動作させ、入出力タイミングをその時計の時刻で指定することで、位相情報(入出力時刻/タイミング)配信を行っている。また、ネットワーク(通信)ディレイと末端機器におけるデコードディレイを考慮し、コンテンツの再生に際して生じるディレイ分を補正するように構成した。これによって、理想状態で位相を合わせた上で実際の位相調整を行うことが可能となる。

【００９６】尚、本実施の形態にて説明したデコードディレイに代表される変換ディレイには、例えば、サンプリング周波数変換、ノイズフィルタ、また、サラウンド機能を通した場合のディレイ等の各種ディレイを含むことができる。また、本実施の形態では、ストリームを再生して出力するデコーダを備える出力機器を中心に説明したが、例えば、ディジタルカメラやマイク、リモコン操作等を行うスイッチ等、各種入力機器がディジタルネットワークに接続された態様に対しても適用することができる。かかる態様の場合には、エンコードしてストリームを生成する際に生じるエンコードディレイを考慮し、位相の同期が図られる。

【００９７】

【発明の効果】以上説明したように、本発明によれば、ディジタルネットワークに接続された各機器の間において、同期をとることが可能となる。

【図面の簡単な説明】

【図１】　本実施の形態におけるネットワークシステムの全体像を示した構成図である。

【図２】　クロックソースにおける第１の構成例を示した図である。

【図３】　クロックソースにおける第２の構成例を示した図である。

【図４】　図１に示したコントローラの構成を説明するための図である。

【図５】　図１に示したコンテンツソースの構成を説明するための図である。

【図６】　図１に示したスピーカの構成を説明するための図である。

【図７】　図１に示したディスプレイの構成を説明するための図である。

【図８】　クロック配信におけるクロックソースの動作を説明するための図である。

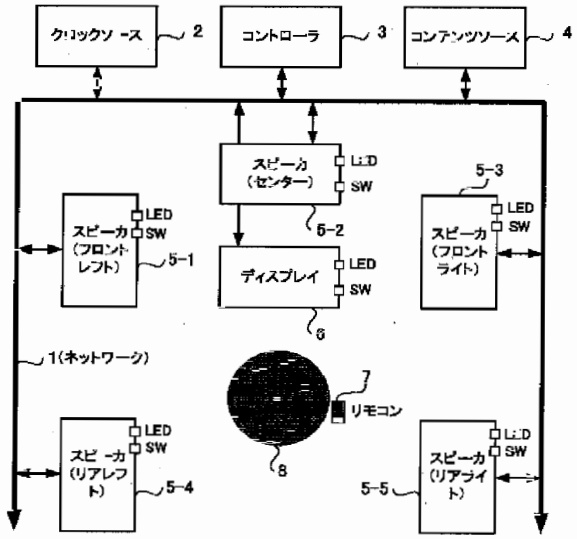
【図９】　クロック再生における時刻合わせの処理を説明するためのフローチャートである。

【図１０】　ネットワークに各機器が接続された直後からの処理を示したフローチャートである。

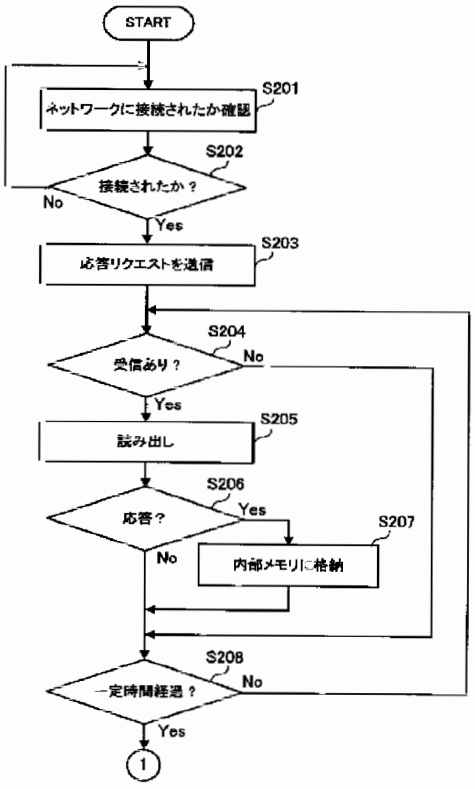
【図１１】　ネットワークに各機器が接続された直後からの処理を示したフローチャートである。

【図１２】　機器データベースの構造を示した図である。
【図１３】　コントローラのＲＡＭに置かれている機器データベースの内容を示した図である。
【図１４】　ＭＰＥＧ２システム(ISO13818－1)に準拠したデコーダシステムの概略を示した図である。
【図１５】　ＭＥＰＧデコーダに供給されるデータフォーマットの一例を示した図である。
【図１６】　ＳＣＲとＰＴＳＶ(ＰＴＳｖｉｄｅｏ)、ＳＣＲとＰＴＳＡ(ＰＴＳａｕｄｉｏ)の関係を示した図である。
【図１７】　本実施の形態におけるディレイを説明するための図である。
【図１８】　位置補償ディレイの最大値を考慮した場合のディレイを説明するための図である。
【符号の説明】
１…ネットワーク、２…クロックソース、３…コントローラ、４…コンテンツソース、５(５－１～５－５)…スピーカ、６…ディスプレイ、１１…クロック発振器、１２…カウンタ、１３…タイマ、１４…ラッチ、１５…ネットワークインタフェース、２０…システムバス、２１…クロック発振器、２２…カウンタ、２３…タイマ、２４…ラッチ、２５…ＣＰＵ、２６…ネットワークインタフェース、３１…ＣＰＵ、３２…ＲＯＭ、３３…ＲＡＭ、３４…システムバス、３５…ネットワークインタフェース、４１…ＣＰＵ、４４…システムバス、４５…ネットワークインタフェース、４６…クロック発振器、４７…カウンタ、４８…ハードディスク装置、４９…ビットストリーム解析器、５０…バッファ、５１…ＣＰＵ、５４…システムバス、５５…ネットワークインタフェース、５６…クロック発振器、５７…カウンタ、５９…バッファ、６０…タイムスタンプ抽出器、６１…デコーダ、７１…ＣＰＵ、７５…ネットワークインタフェース、７６…クロック発振器、７７…カウンタ、７９…バッファ、８０…タイムスタンプ抽出器、８１…デコーダ

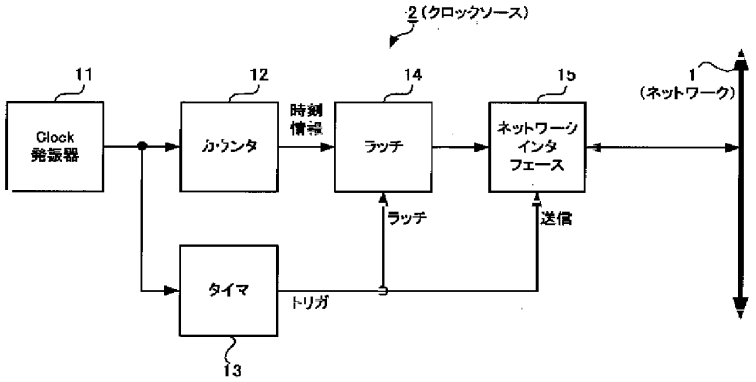
【図１】



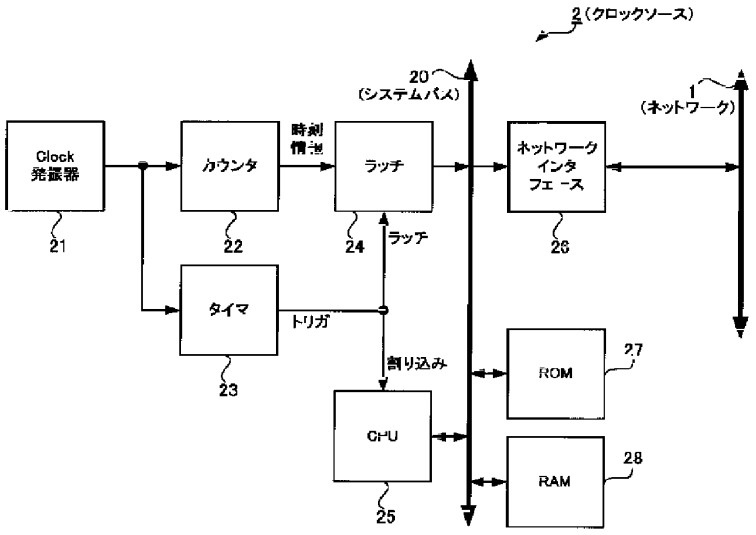
【図１０】



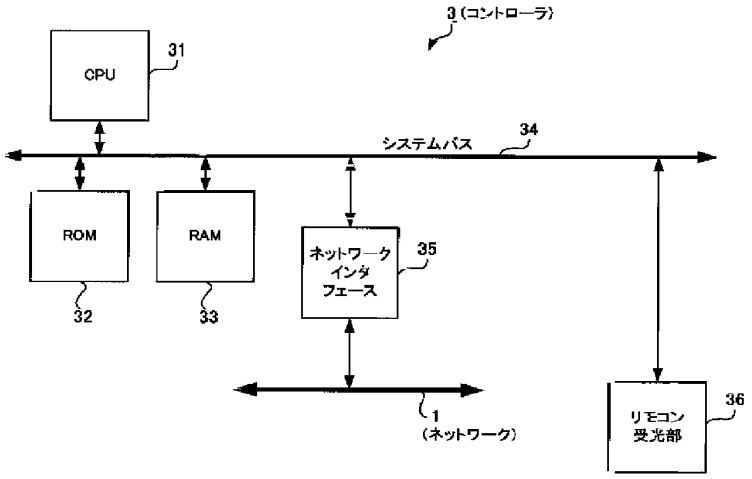
【図２】


2（クロックソース）
11
12
14
15
1
（ネットワーク）
Clock
発振器
カウンタ
時刻
情報
ラッチ
ネットワーク
インタ
フェース
ラッチ
送信
タイマ
トリガ
13

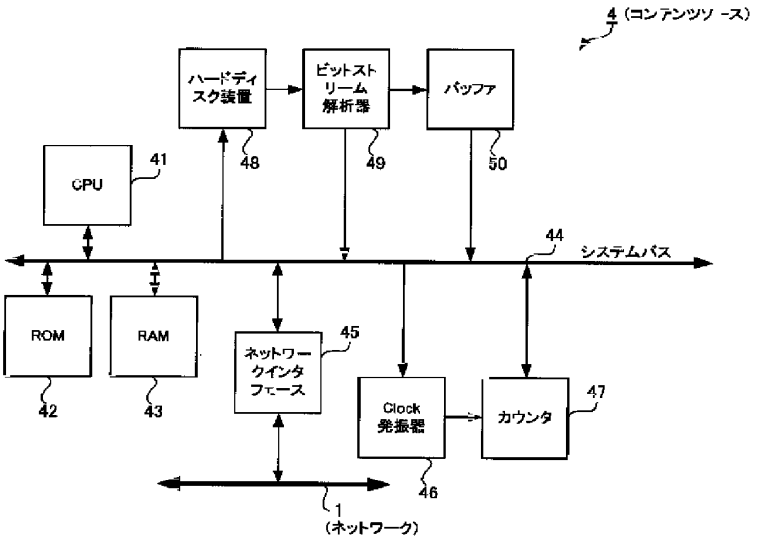
【図３】


2（クロックソース）
20
（システムバス）
1
（ネットワーク）
Clock
発振器
カウンタ
時刻
情報
ラッチ
ネットワーク
インタ
フェース
21
22
24
ラッチ
26
タイマ
トリガ
割り込み
ROM
27
CPU
RAM
28
23
25

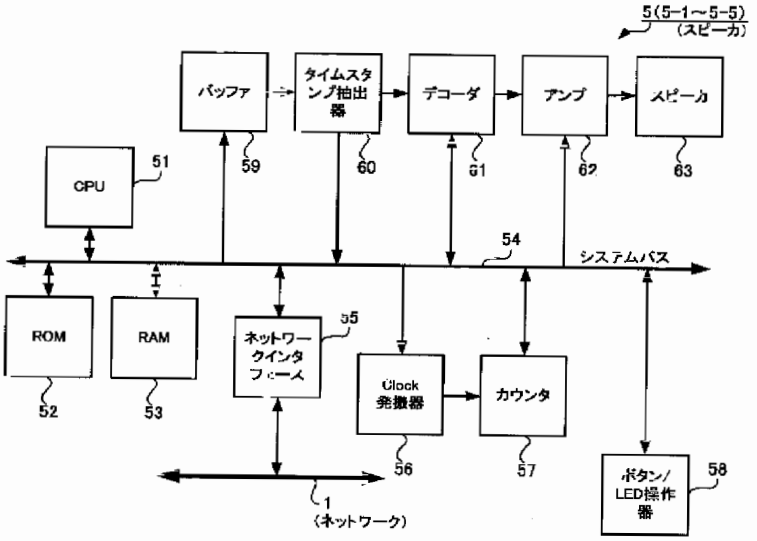
【図４】


3（コントローラ）
CPU
31
システムバス
34
ROM
RAM
ネットワークインタフェース
35
32
33
1
（ネットワーク）
リモコン受光部
36

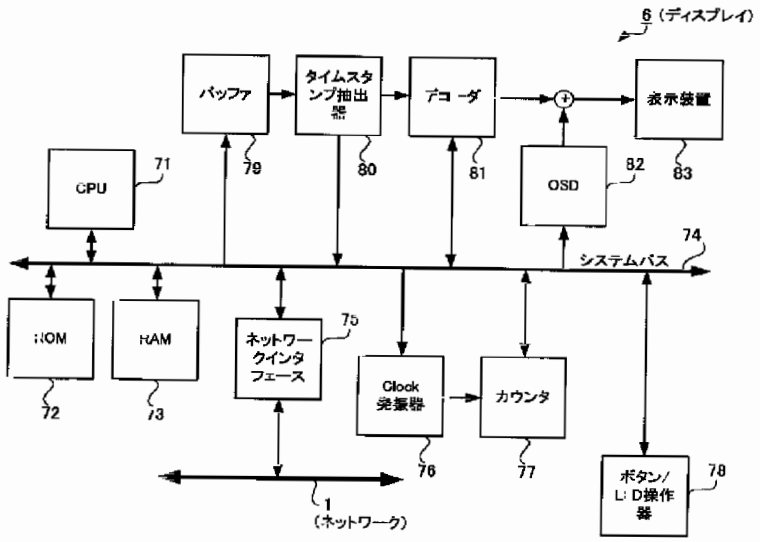
【図５】


4（コンテンツソース）
ハードディスク装置
ビットストリーム解析器
バッファ
48
49
50
CPU
41
44
システムバス
ROM
RAM
ネットワークインタフェース
45
Clock発振器
カウンタ
47
42
43
46
1
（ネットワーク）

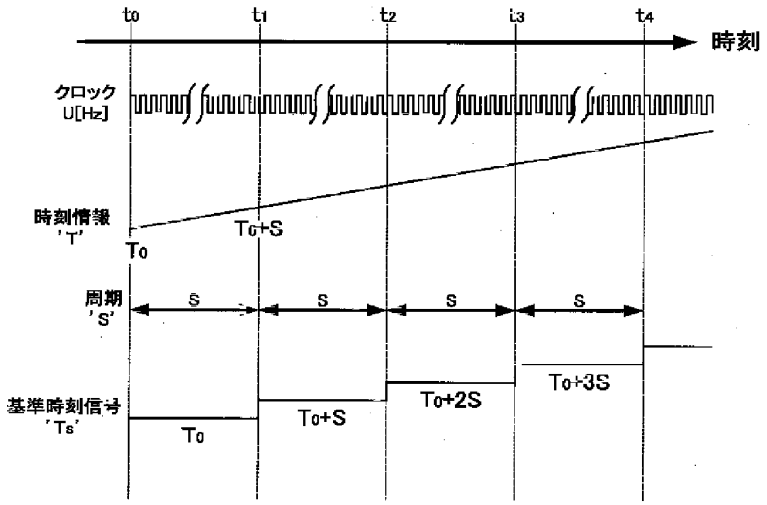
【図6】


5(5-1～5-5)
(スピーカ)
バッファ
タイムスタンプ抽出器
デコーダ
アンプ
スピーカ
59
60
61
62
63
CPU
51
54
システムバス
ROM
RAM
ネットワークインタフェース
55
Clock発振器
カウンタ
52
53
56
57
ボタン/LED操作器
58
1
(ネットワーク)

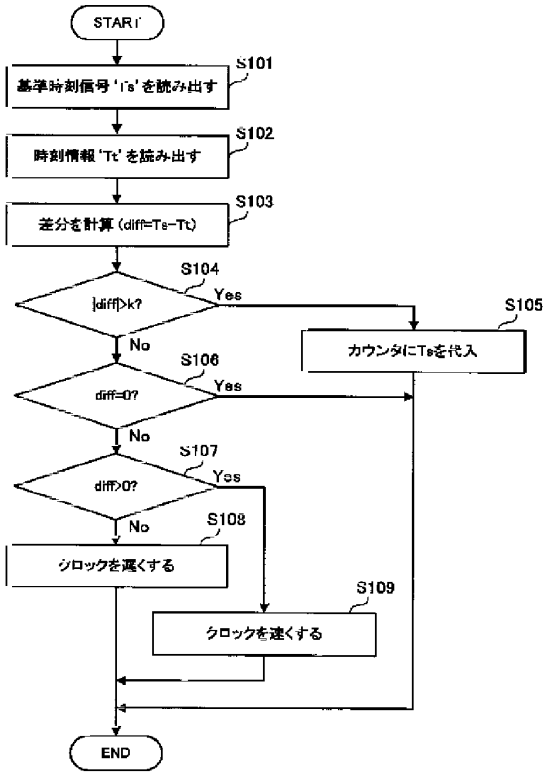
【図7】


6 (ディスプレイ)
バッファ
タイムスタンプ抽出器
デコーダ
表示装置
79
80
81
83
CPU
71
OSD
82
74
システムバス
ROM
RAM
ネットワークインタフェース
75
Clock発振器
カウンタ
72
73
76
77
ボタン/LED操作器
78
1
(ネットワーク)

【図８】



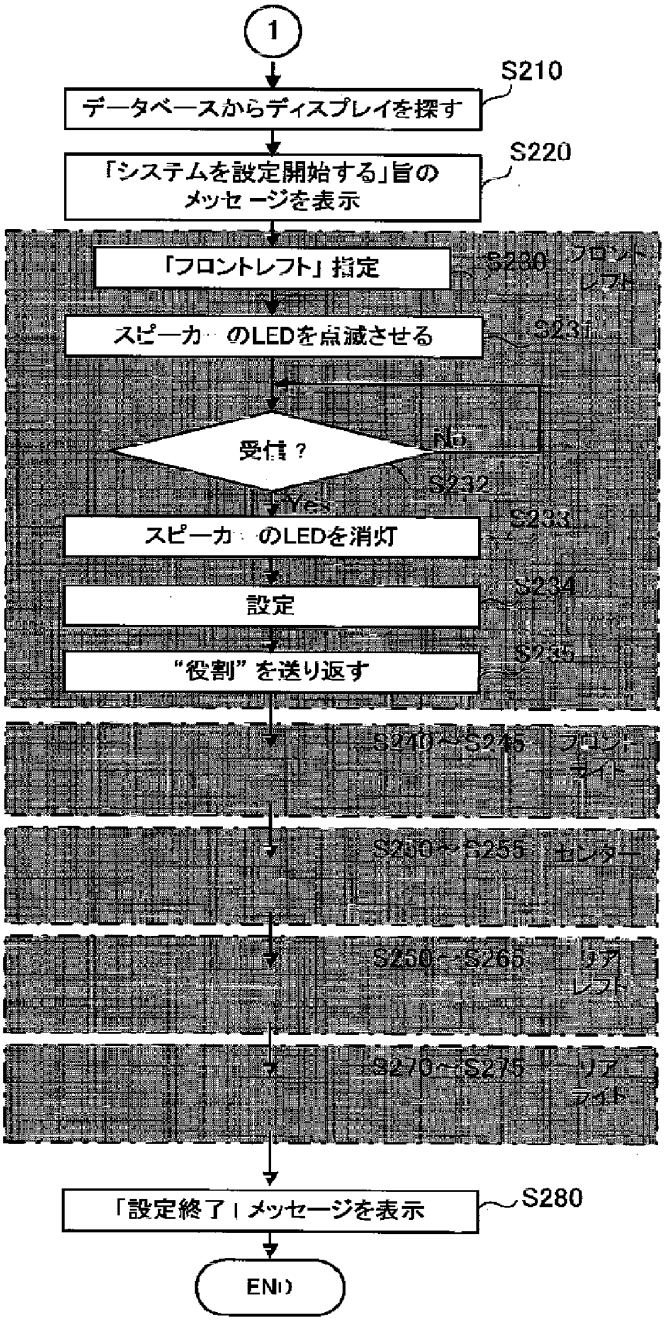
【図９】



【図１２】

エントリ数		N
第1番目	ネットワークアドレス	xxx.xxx.xxx.xxx
	種別	ディスプレイ
	役割	—
	デコードディレイ	xx.x
第2番目	ネットワークアドレス	xxx.xxx.xxx.xxx
	種別	モノラルスピーカ
	役割	—
	デコードディレイ	xx.x
第3番目	ネットワークアドレス	xxx.xxx.xxx.xxx
	種別	モノラルスピーカ
	役割	—
	デコードディレイ	xx.x

【図１１】

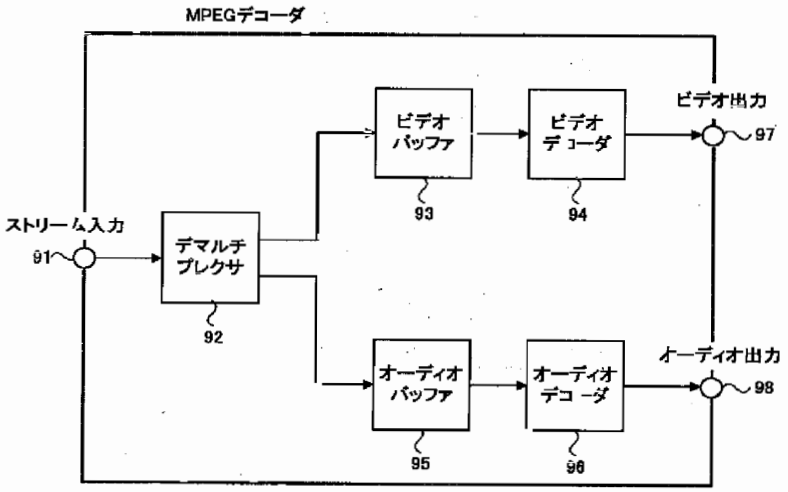

1
S210
データベースからディスプレイを探す
S220
「システムを設定開始する」旨の
メッセージを表示
「フロントレフト」指定
S230
フロント
レフト
スピーカのLEDを点滅させる
S231
受信？
No
S232
Yes
スピーカのLEDを消灯
S233
設定
S234
“役割”を送り返す
S235
S240～S245
フロント
ライト
S250～S255
センター
S260～S265
リア
レフト
S270～S275
リア
ライト
「設定終了」メッセージを表示
S280
END

【図１３】

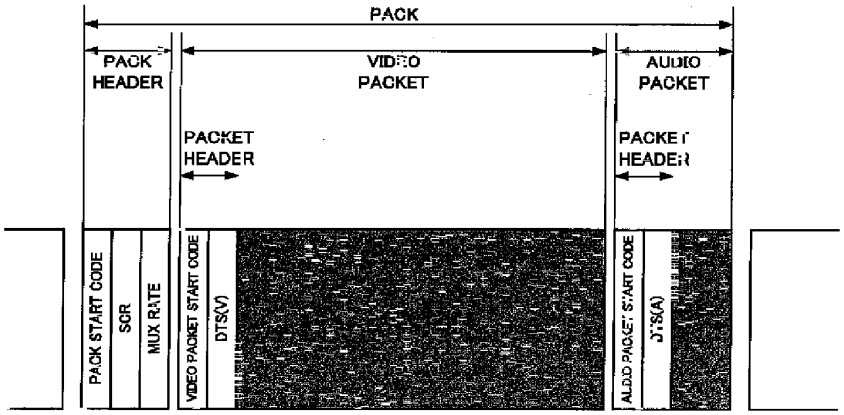
エントリ数	7

ネットワークアドレス	種別	役割	デコードディレイ	(参考)
xxx.xxx.xxx.xxx	ディスプレイ	—		(ディスプレイ 6)
xxx.xxx.xxx.xxx	モノラルスピーカ	—		(スピーカ 5-1)
xxx.xxx.xxx.xxx	モノラルスピーカ	—		(スピーカ 5-2)
xxx.xxx.xxx.xxx	モノラルスピーカ	—		(スピーカ 5-3)
xxx.xxx.xxx.xxx	モノラルスピーカ	—		(スピーカ 5-4)
xxx.xxx.xxx.xxx	モノラルスピーカ	—		(スピーカ 5-5)
xxx.xxx.xxx.xxx	コンテンツソース	—		(コンテンツソース 4)

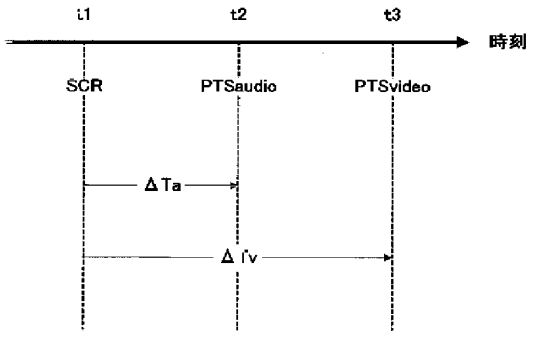
【図１４】



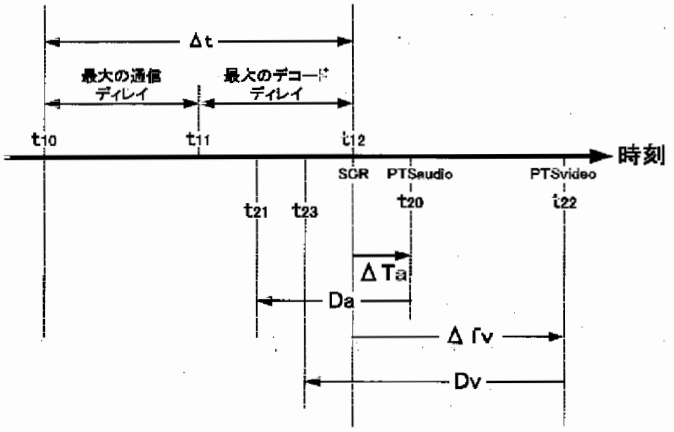
【図15】


PACK
PACK HEADER
VIDEO PACKET
AUDIO PACKET
PACKET HEADER
PACKET HEADER
PACK START CODE
SCR
MUX RATE
VIDEO PACKET START CODE
DTS(V)
AUDIO PACKET START CODE
DTS(A)

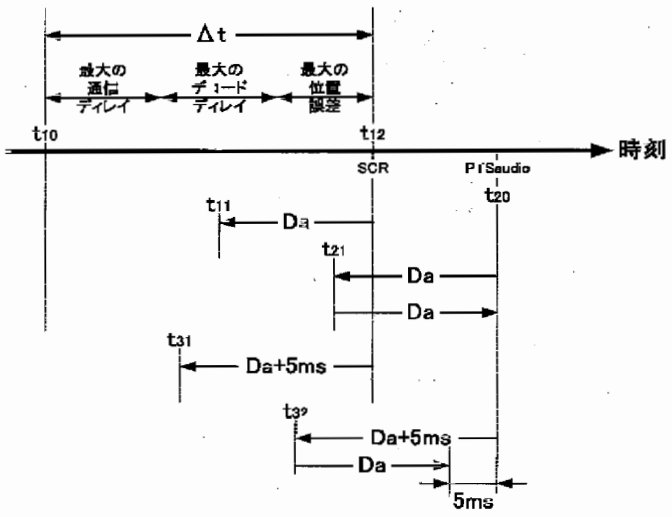
【図16】


t1
t2
t3
時刻
SCR
PTSaudio
PTSvideo
ΔTa
ΔTv

【図17】


Δt
最大の通信ディレイ
最大のデコードディレイ
t10
t11
t12
時刻
SCR
PTSaudio
PTSvideo
t21
t23
t20
t22
ΔTa
Da
ΔTv
Dv

【図18】


Δt
最大の通信ディレイ
最大のデコードディレイ
最大の位置誤差
t10
t12
時刻
SCR
PTSaudio
t20
t11
Da
t21
Da
Da
t31
Da+5ms
t32
Da+5ms
Da
5ms

Espacenet

Bibliographic data: JP2003101958 (A) — 2003-04-04

METHOD AND DEVICE FOR SYNCHRONOUS REPRODUCTION

Inventor(s): IDE KENICHI ± (IDE KENICHI)

Applicant(s): TOSHIBA CORP ± (TOSHIBA CORP)

Classification: **- international:** ***H04B1/16; H04L7/00; H04N5/93;***
(IPC1-7): H04B1/16; H04L7/00; H04N5/93
- cooperative:

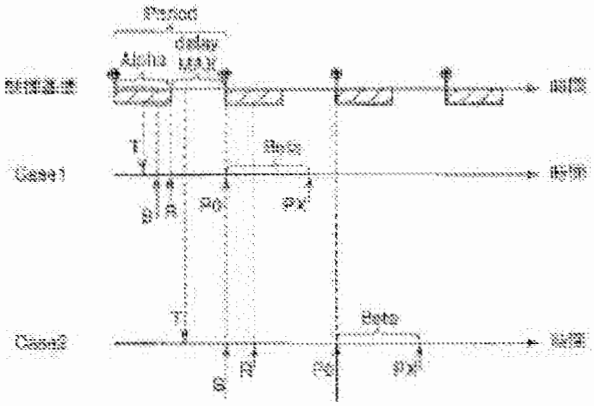
Application number: JP20010287375 20010920

Priority number(s): JP20010287375 20010920

Also published as: JP3544963 (B2)

Abstract of JP2003101958 (A)

PROBLEM TO BE SOLVED: To synchronize information synchronized with each other such as a moving picture and sound accompanying the moving picture in different devices and to reproduce the information without transmitting information about reproducing time. SOLUTION: A maximum estimation value of the total delay time including the transmission delay time of data and a processing delay time needed for decoding processing, etc., is defined as delayMax. A value Period larger than the delayMax is defined, and a reproduction start reference point is provided on a time base with an interval Period. An alpha is defined by (Period-delayMax), and the section between the reproduction start reference point and the Alpha is defined as a transmission commenceable section. A transmitting side device starts to transmit data within the transmission commenceable section.; After the data reach a receiving side device, the existence range of a time R when the data can be reproduced after being subjected to processing such as decoding is limited to a range existing after a transmission start time S and up to the first reproduction start reference point to come after passing the transmission commenceable section. The transmitting side device and the receiving side device individually start reproduction by taking the reproduction start reference point P0 as a reference.


Period
delay
Alpha
Beta
Case1
Case2

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特開2003－101958
（P2003－101958A）
(43)公開日　平成15年４月４日(2003.4.4)

(51)Int.Cl.[7]	識別記号	Ｆ Ｉ		テーマコード（参考）
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Ｈ０４Ｂ　1/16		Ｈ０４Ｌ　7/00	Ｚ	５Ｋ０４７
Ｈ０４Ｌ　7/00		Ｈ０４Ｎ　5/93	Ａ	５Ｋ０６１

審査請求　有　　請求項の数18　ＯＬ　（全 10 頁）

(21)出願番号　特願2001－287375(P2001－287375)

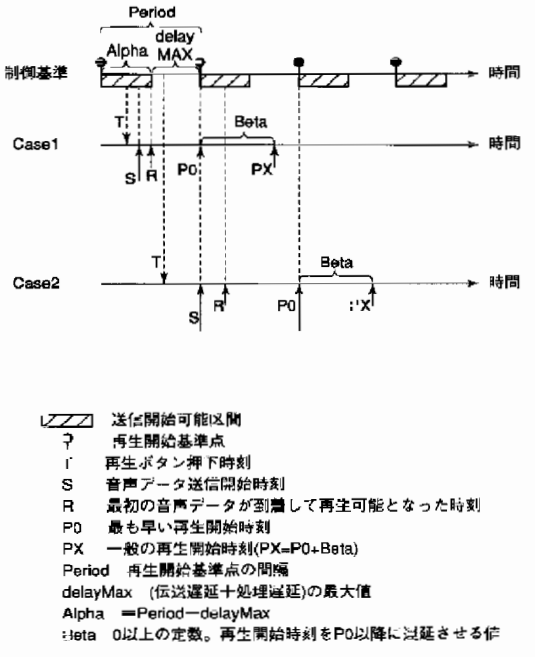
(22)出願日　平成13年９月20日(2001.9.20)

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弁理士　鈴江　武彦　（外６名）

Ｆターム(参考)　5C053 FA24 GB21 JA01 JA22 JA26 KA24 LA05 LA06 LA20
5K047 AA03 AA18 BB01 DD01 DD02 JJ08 MM23
5K061 AA15 EF06

(54)【発明の名称】　同期再生のための方法および装置

(57)【要約】
【課題】再生時刻に関する情報を送信することなく、動画とそれに付随する音声のように互いに同期した情報を異なる機器で同期して再生する。
【解決手段】データの伝送遅延時間と復号処理などに要する処理遅延時間を含む合計の遅延時間の最大見積もり値をdelayMaxとする。そして、delayMaxよりも大きい値Periodを定め、間隔Periodで時間軸上に再生開始基準点を設ける。また、Alphaを（Period － delayMax）と定め、前記再生開始基準点からAlphaの区間を送信開始可能区間とする。送信側機器は送信開始可能区間内にデータ送信を開始する。このデータが受信側機器に届いた後、復号などの処理を経て再生可能になる時刻Ｒの存在範囲は送信開始時刻Ｓ以降で、送信開始可能区間経過後に最初に到来する再生開始基準点までの範囲に限定される。この再生開始基準点をＰ０を基準として、送信側機器および受信側機器がそれぞれ再生を開始する。



送信開始可能区間
再生開始基準点
T　再生ボタン押下時刻
S　音声データ送信開始時刻
R　最初の音声データが到着して再生可能となった時刻
P0　最も早い再生開始時刻
PX　一般の再生開始時刻(PX=P0+Beta)
Period　再生開始基準点の間隔
delayMax　(伝送遅延＋処理遅延)の最大値
Alpha　＝Period－delayMax
Beta　0以上の定数。再生開始時刻をP0以降に遅延させる値

【特許請求の範囲】
【請求項１】　第一のデータの再生を行いかつ同期して再生すべき第二のデータを通信路を介して送信する第一の機器と前記第一の機器から送信された第二のデータを受信して再生する第二の機器との間で、前記第一および第二のデータの再生タイミングを同期させるための同期再生方法であって、
前記第二のデータの送信は、前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に開始し、
前記第一および第二のデータの再生は、前記第二のデータの送信を開始した送信開始可能区間後の最初の基準点を基に開始することを特徴とする同期再生方法。
【請求項２】　前記第二のデータの送信を開始する前に、前記第一の機器と前記第二の機器との間で、前記第一および第二の機器がそれぞれ前記基準点を定める時間軸の時刻基準となる時計を同期させる同期処理を実行することを特徴とする請求項１記載の同期再生方法。
【請求項３】　前記第一のデータは動画データであり、前記第二のデータは音声データであることを特徴とする請求項１記載の同期再生方法。
【請求項４】　前記第一のデータは音声データであり、前記第二のデータは動画データであることを特徴とする請求項１記載の同期再生方法。
【請求項５】　前記第一および第二のデータの再生は、前記第二のデータの送信を開始した送信開始可能区間後の最初の基準点から予め定められた時間が経過した時点で開始することを特徴とする請求項１記載の同期再生方法。
【請求項６】　前記通信路は、無線通信路であることを特徴とする請求項１記載の同期再生方法。
【請求項７】　第一のデータの再生を行いかつ同期して再生すべき第二のデータの再生開始を指示する再生開始コマンドを通信路を介して送信する第一の機器と前記第一の機器から送信された再生開始コマンドに応答して前記第二のデータの再生を行う第二の機器との間で、前記第一および第二のデータの再生タイミングを同期させるための同期再生方法であって、
前記再生開始コマンドの送信は、前記再生開始コマンドを送信してから受信側で前記再生開始コマンドに応答した再生処理を開始可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に開始し、
前記第一および第二のデータの再生は、前記再生開始コマンドの送信を開始した送信開始可能区間後の最初の基準点を基に開始することを特徴とする同期再生方法。
【請求項８】　前記再生開始コマンドの送信を開始する前に、前記通信路を介して前記第一の機器から前記第二の機器に前記第二のデータの送信を開始することを特徴とする請求項７記載の同期再生方法。
【請求項９】　第一のデータの再生を行いかつ同期して再生すべき第二のデータを通信路を介して送信する第一の機器と前記第一の機器から送信された第二のデータを受信して再生する第二の機器とを含む同期再生システムであって、
前記第一の機器は、
前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に、前記第二のデータの送信を開始する手段と、前記第二のデータの送信を開始した送信開始可能区間後の最初の基準点を基に、前記第一のデータの再生を開始する手段とを具備し、
前記第２の機器は、
前記第二のデータを受信する手段と、
前記時間間隔で時間軸上に一意に定められた前記複数の基準点を管理し、前記受信した第二のデータの再生開始可能後の最初の基準点を基に、前記第二のデータの再生を開始する手段とを具備することを特徴とする同期再生システム。
【請求項１０】　第一のデータの再生を行いかつ同期して再生すべき第二のデータの再生開始を指示する再生開始コマンドを通信路を介して送信する第一の機器と前記第一の機器から送信された再生開始コマンドに応答して前記第二のデータの再生を行う第二の機器とを含む同期再生システムであって、
前記第一の機器は、
前記再生開始コマンドを送信してから受信側で前記再生開始コマンドに応答した再生処理を開始可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に、前記再生開始コマンドの送信を開始する手段と、
前記再生開始コマンドの送信を開始した送信開始可能区間後の最初の基準点を基に、前記第一のデータの再生を開始する手段とを具備し、
前記第二の機器は、
前記再生開始コマンドを受信する手段と、
前記時間間隔で時間軸上に一意に定められる前記複数の基準点を管理し、前記再生開始コマンドに応答して再生処理が開始可能になった後の最初の基準点を基に、前記第二のデータの再生を開始する手段とを具備することを特徴とする同期再生システム。
【請求項１１】　第一のデータの再生を行いかつ同期して再生すべき第二のデータを通信路を介して受信側の装置に送信可能な再生装置であって、

前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に、前記第二のデータの送信を開始する手段と、
前記第二のデータの送信を開始した送信開始可能区間後の最初の基準点を基に、前記第一のデータの再生を開始する手段とを具備することを特徴とする再生装置。
【請求項１２】　第一のデータを再生する送信側装置から通信路を介して送信される第二のデータを受信して再生する再生装置であって、
前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に前記送信側装置によって送信が開始された前記第二のデータを受信する手段と、
前記時間間隔で時間軸上に一意に定められた前記複数の基準点を管理し、前記受信した第二のデータの再生開始可能後の最初の基準点を基に、前記第二のデータの再生を開始する手段とを具備することを特徴とする再生装置。
【請求項１３】　第一のデータの再生を行いかつ同期して再生すべき第二のデータの再生開始を指示する再生開始コマンドを通信路を介して受信側の装置に送信可能な再生装置であって、
前記再生開始コマンドを送信してから受信側で前記再生開始コマンドに応答した再生処理を開始可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に、前記再生開始コマンドの送信を開始する手段と、
前記再生開始コマンドの送信を開始した送信開始可能区間後の最初の基準点を基に、前記第一のデータの再生を開始する手段とを具備することを特徴とする再生装置。
【請求項１４】　第一のデータを再生する送信側装置から通信路を介して送信される再生開始コマンドに応答して、前記第一のデータと同期して再生すべき第二のデータを再生する再生装置であって、
前記再生開始コマンドを送信してから受信側で前記再生開始コマンドに応答した再生処理を開始可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に前記送信側装置が送信を開始した前記再生開始コマンドを受信する手段と、
前記時間間隔で時間軸上に一意に定められる前記複数の基準点を管理し、前記再生開始コマンドに応答して再生処理が開始可能になった後の最初の基準点を基に、前記第二のデータの再生を開始する手段とを具備することを特徴とする再生装置。
【請求項１５】　コンピュータに第一のデータを再生させ且つ前記第一のデータと同期して再生すべき第二のデータを通信路を介して受信側の装置に送信させるコンピュータプログラムであって、
前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に、前記第二のデータの送信を前記コンピュータに開始させる手順と、
前記第二のデータの送信を開始した送信開始可能区間後の最初の基準点を基に、前記第一のデータの再生を前記コンピュータに開始させる手段とを具備することを特徴とするコンピュータプログラム。
【請求項１６】　第一のデータを再生する送信側装置から通信路を介して送信される第二のデータをコンピュータに再生させるコンピュータプログラムであって、
前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に前記送信側装置によって送信が開始された前記第二のデータを前記コンピュータに受信させる手順と、
前記時間間隔で時間軸上に一意に定められた前記複数の基準点を前記コンピュータに管理させ、前記受信した第二のデータの再生開始可能後の最初の基準点を基に、前記第二のデータの再生を前記コンピュータに開始させる手順とを含むことを特徴とするコンピュータプログラム。
【請求項１７】　コンピュータに第一のデータを再生させ且つ前記第一のデータと同期して再生すべき第二のデータの再生開始を指示する再生開始コマンドを通信路を介して受信側の装置に送信させるコンピュータプログラムであって、
前記再生開始コマンドを送信してから受信側で前記再生開始コマンドに応答した再生処理を開始可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に、前記再生開始コマンドの送信を前記コンピュータに開始させる手順と、
前記再生開始コマンドの送信を開始した送信開始可能区間後の最初の基準点を基に、前記第一のデータの再生を前記コンピュータに開始させる手順とを具備することを特徴とするコンピュータプログラム。
【請求項１８】　第一のデータを再生する送信側装置から通信路を介して送信される再生開始コマンドに応答して、コンピュータに前記第一のデータと同期して再生すべき第二のデータを再生させるコンピュータプログラム

であって、
前記再生開始コマンドを送信してから受信側で前記再生開始コマンドに応答した再生処理を開始可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に前記送信側装置が送信を開始した前記再生開始コマンドを前記コンピュータに受信させる手順と、
前記時間間隔で時間軸上に一意に定められる前記複数の基準点を前記コンピュータに管理させ、前記再生開始コマンドに応答して再生処理が開始可能になった後の最初の基準点を基に、前記第二のデータの再生を前記コンピュータに開始させる手順とを具備することを特徴とするコンピュータプログラム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は例えば動画データと音声データのように同期して再生する必要がある第一及び第二のデータを再生するための方法および装置に関し、特に第一及び第二のデータを互いに異なる機器で同期して再生するための方法および装置に関する。
【０００２】
【従来の技術】動画データ、音声データのようなストリームデータを送信側機器から受信側機器へ伝送して、予め定められた時刻に処理させる方法としては、例えば特開平１１　３１７７４８号公報に開示された手法に見られるように、送信するデータに処理されるべき時刻情報を付加して送信し、受信側では受信したデータに含まれる処理すべき時刻の到来を待ってデータを処理する方法が知られている。
【０００３】
【発明が解決しようとする課題】しかし、上記手法ではデータを処理すべき時刻を示すタイムスタンプをデータの他に送信する必要があった。このため、データを送信する手順やデータ形式とあわせて、データを処理すべき時刻を示すタイムスタンプについてもそれを送信する手順や形式が定められている必要がある。よって、これらが定められていない通信規約を用いる場合には適用できないという問題があった。
【０００４】本発明は上述の事情を考慮してなされたもので、再生時刻に関する情報を送信することなく、動画とそれに付随する音声のように互いに同期した情報を異なる機器で同期して再生することが可能な方法および装置を提供することを目的とする。
【０００５】
【課題を解決するための手段】上述の課題を解決するため、本発明は、第一のデータの再生を行いかつ同期して再生すべき第二のデータを通信路を介して送信する第一の機器と前記第一の機器から送信された第二のデータを受信して再生する第二の機器との間で、前記第一および第二のデータの再生タイミングを同期させるための同期再生方法であって、前記第二のデータの送信は、前記第二のデータを送信してから受信側で再生可能になるまでの最大遅延時間に所定の送信開始可能区間を加えた時間間隔で時間軸上に一意に定められる複数の基準点の内、いずれかの基準点から始まる送信開始可能区間内に開始し、前記第一および第二のデータの再生は、前記第二のデータの送信を開始した送信開始可能区間後の最初の基準点を基に開始することを特徴とする。
【０００６】このように、最大遅延時間に所定の送信開始可能区間を加えた時間間隔で予め時間軸上に複数の基準点を定め、これら複数の基準点の内のいずれかの基準点から始まる送信開始可能区間内に第二のデータの送信を開始することで、次の基準点以前に第二のデータが受信側で再生可能になることを保証することができる。よって、送信側と受信側が予め定められた同一の規則で複数の基準点それぞれの時刻を定めるだけで、再生時刻に関する情報を何等送信することなく、動画とそれに付随する音声のように互いに同期した情報を異なる機器で同期して再生することが可能となる。
【０００７】
【発明の実施の形態】以下、図面を参照して本発明の実施の形態を説明する。図１には、本発明の一実施形態に係る同期再生システムが示されている。この同期再生システムは音声が付随した動画データを再生するシステムであり、図１に示すように２台の機器から構成されている。第一の機器（送信側機器）１１は動画データおよびそれに付随する音声データが記録されている記憶装置を備え、動画データを再生してディスプレイ上に再生すると同時に、第二の機器（受信側機器）１４に通信路１３を介して音声データを送信する。この第一の機器１１は例えば携帯情報端末、ビデオプレーヤ、パーソナルコンピュータなどの電子機器から構成される。一方、第二の機器１４は、音声データの受信部と受信した音声データを再生する機構を備えており、第一の機器１１から受信した音声データを再生する。この第二の機器１４も第一の機器１１と同様に様々な電子機器として実現できるが、その典型的な一例としてはヘッドフォンである。
【０００８】このシステムでは通信路１３として無線通信路が用いられており、例えばＢｌｕｅｔｏｏｔｈ（２．４ＧＨｚ　ＩＳＭ帯を用いる短距離無線通信方式）を用いることによって動画表示を行う機器と音声の再生を行う機器とを無線接続することによって、便利な視聴システムを実現している。
【０００９】ここで、第一の機器１１で再生される動画データの呈示と第二の機器１４で再生される音声データの発音を同期させることによっていわゆるリップシンク(lipsync)を実現したいと考える。
【００１０】次に、上記の要求を実現するために必要な技術的要素について説明する。動画データとそれに付随

する音声データは、それらをディジタルデータとして取り込む際に、互いの時間関係を保存することが既に行われている。例えばパーソナルコンピュータ上の音声つき動画データの形式として用いられているＡＶＩ形式（Audio Video Interleave Format）では、動画および音声のメディア毎に、サンプリングレートが記録されており、かつ、記録されている各々のメディアの再生開始時刻が一致しているという仕組みになっている。このため、各々の再生を同時に開始し、かつ、各々のメディアの再生速度を、単一の時計あるいは正確に同期した時計とサンプリングレートに従って決めることによって、リップシンク（lip sync）を保つことができる仕組みになっている。

【００１１】また、複数のメディアの再生を同期させる他の方法としては、インターネット上のストリーミング伝送で用いられるＲＴＰ（Real time Transfer Protocol,インターネット上で動画,音声などのメディアデータを送受信するための方式。IETFのRFC1889等で規格化されている。）に見られるように、一群のメディアデータ毎にタイムスタンプを付与すると共にサンプリングレートに関する情報を付与するなどの方法も用いられている。

【００１２】このように、互いに同期して再生されるべき複数のメディアデータを同期して再生するためには、進み方が正確な時計と例えばメディアデータの呈示開始時刻を一致させる手段が必要である。

【００１３】ここで本発明が解決しようとする状況では、動画および音声データは異なる機器上で再生される。そこで、前述の要件を満たすためには、各々の機器の時計間で時刻の同期をとり、さらに、各々のメディアデータの再生開始時刻を２台の機器同上で示し合わせることが必要となる。

【００１４】まず、時刻の同期をとる件については、例えばＮＴＰ（Network Time Protocol、インターネット上で計算機同士の時刻あわせを行うための方式。IETFのRFC1305等で規格化されている。）と呼ばれる時刻合わせ方式を用いることで実現可能である。あるいは、例えば特開２０００－３３２８０２号公報に開示されているように、時刻情報を送信側機器から受信側機器へ送り、受信側機器の時計を送信側機器に合わせることによっても実現可能である。これら２例の他にも、方式によって実現可能な時刻あわせの精度が異なるものの、様々な時刻あわせ手法が知られており、これらの内の任意の手法を用いることが可能である。

【００１５】次に、再生開始時刻を示しあわせる件については、本実施形態では次のような方法を使用する。

【００１６】本実施形態では再生開始時刻に関する情報を機器間で伝送せずに、再生開始時刻を合わせることが特徴である。まず、前提条件として以下の条件を設ける。

前提条件：

・２台の機器１１，１４の時計は互いに同期している。

・送信側機器１１から受信側機器１４へ最初のメディアデータを送信する時刻Ｓを送信側機器１１は制御できる。

・送信側機器１１から受信側機器１４へのメディアデータ送信から、受信されたデータが再生されるまでの所要時間delayMax(伝送遅延、メディアデータのデコード処理などに必要な処理遅延時間を含む)の最大値を見積もり可能。

【００１７】上記の前提条件の下で、以下に示す方法によって再生開始時刻を同期させる。

同時刻に再生を開始する方法：送信側機器１１および受信側機器１４がメディアデータ、例えば動画と音声データを再生開始可能な時刻（再生開始基準点）は、予め定められた離散的な時刻に限る。各々の時刻の間隔はPeriod (= Alpha + delayMax)とする。Period, Alpha, delayMaxの定義は以下の通りである。

【００１８】

・delayMax　(伝送遅延+処理遅延)の最大見積もり値

・Period　再生開始基準点の間隔

・Alpha　(= Period - delayMax)

送信側機器１１がメディアデータを受信側機器１４へ送信開始する時刻Ｓは、各再生開始基準点以降Alphaの区間内に限る。すなわち、送信側機器１１および受信側機器１４ではそれぞれ同一の規則を用いて、互いに同期した時間軸上にPeriodの間隔で再生開始基準点を定める処理が行われる。そして、送信側機器１１から受信側機器１４への音声データの送信は、いずれかの再生開始基準点からAlphaの区間内に開始される。つまりAlphaが送信開始可能区間となる。

【００１９】図２は図１に示した各々の機器のシステム構成図である。まず、送信側機器１１について説明する。送信側機器１１は、図示のように、動画/音声記憶部２１、動画/音声分離部２２、動画復号部２３、動画一時記憶部２４、動画表示部２５、送信データ一時記憶部２６、音声データ送信部２７、制御部２８、時刻管理部２９、および制御データ送受信部２Ａから構成されている。

【００２０】動画/音声記憶部２１には送信側機器１１で再生される動画データと受信側機器１４で再生される音声データが記憶されている。これらのデータはたとえば前述のＡＶＩ形式で保存されており、動画と音声の対応関係を知るために必要な情報とともに記憶されている。また、一般に動画や音声のデータは圧縮されて保存されることが多く、本実施形態の場合も適当な形式で圧縮された上でＡＶＩ形式で保管されているものとする。

【００２１】動画/音声分離部２２は動画/音声記憶部２１から読み込まれたＡＶＩ形式の動画/音声データを動画データと音声データに分離する。動画復号部２３は圧

縮形式の動画データを復号して動画表示部２５で表示可能な形式に変換する。動画一時記憶部２４は復号された動画データを、表示される時点に達するまでの間、一時的に記憶する。一般に動画の復号処理は時間がかかるため、予め復号処理を行って動画一時記憶部２４に保存しておくことによって、表示すべき時刻の到来時に即座に表示することが可能になる。

【００２２】動画表示部２５は動画一時記憶部２４に記憶されている動画データを制御部２８からの指示に従って表示する。送信データ一時記憶部２６は音声データが送信されるべき時刻が来るまでの間、一時的に音声データを記憶する。音声データ送信部２７はＢｌｕｅｔｏｏｔｈなどの無線通信インタフェースを用いて受信側機器１４へ音声データを送信する。

【００２３】制御データ送受信部２ＡはＢｌｕｅｔｏｏｔｈなどの無線通信インタフェースを介して受信側機器１４との間で制御情報をやりとりする。時刻管理部２９は受信側機器１４の時刻と同期した時刻を刻み、動画再生や音声データの送信の基準となる時刻情報を提供する。受信側機器１４の時刻との同期は制御部２８および制御データ送受信部２Ａと連携して前述のＮＴＰ方式などの時刻合わせ手順を実行することで行う。

【００２４】制御部２８は送信側機器１１全体の連携制御を行う。制御部２８は例えば汎用ＣＰＵとＲＡＭ，ＲＯＭで構成されるマイクロコンピュータとして実現することが可能である。また、制御部２８以外の前述した機能モジュールも基本的にマイクロコンピュータにその動作を行わせる形での実現が可能である。

【００２５】受信側機器１４は、図示のように、音声データ受信部２Ｂ、音声復号部２Ｃ、音声データ一時記憶部２Ｄ、音声再生部２Ｅ、制御部２Ｆ、制御データ送受信部２Ｇ、時刻管理部２Ｈから構成されている。

【００２６】音声データ受信部２Ｂは送信側機器１１から送信された音声データを受信する。音声復号部２Ｃは圧縮されている音声データの復号を行い、音声再生部２Ｅで再生可能な形式に変換する。

【００２７】音声データ一時記憶部２Ｄは復号した音声データを再生すべき時刻に達するまでの間、一時的に保存する。一般に音声データは圧縮された形式で伝送される場合が多く、復号には時間がかかるため、予め復号を行って音声データ一時記憶部２Ｄに記憶しておくことによって、再生時刻の到来時に即座に発音させることが可能になる。

【００２８】時刻管理部２Ｈは送信側機器１１の時刻と同期した時刻を刻み、音声データの再生の基準となる時刻情報を提供する。送信側機器１１の時刻との同期は制御部２Ｆおよび制御データ送受信部２Ｇと連携して送信側機器１１と前述のＮＴＰ方式などの時刻合わせ手順を実行することで行う。制御部２Ｆは受信側機器１４全体の連携制御を行う。制御部２Ｆは例えば汎用ＣＰＵとＲＡＭ，ＲＯＭで構成されるマイクロコンピュータとして実現することが可能である。また、制御部２Ｆ以外の前述した機能モジュールも基本的にマイクロコンピュータにその動作を行わせる形での実現が可能である。

【００２９】次に、図３を用いて本実施形態のシステムの動作の概要を説明する。受信側機器１４は通常は待機モードで動作しており、送信側機器１１からの電源ＯＮ指示を受けて待機モードから通常の動作モードへ移行する。待機中は電力消費が非常に低い状態であり、電源ＯＮ指示のみに反応することが可能である。ユーザが送信側機器１１の操作パネル１２の電源オンボタンを操作することにより（Ｓ３８）、電源ＯＮ指示（Ｓ３１）が送信側機器１１から受信側機器１４に送信される。電源ＯＮの後、双方の機器１１，１４は通信路確立処理（Ｓ３２）を行う。

【００３０】次に、時刻あわせ処理（Ｓ３３）を前述のＮＴＰ方式などにより行う。送信側機器１１と受信側機器１４との間の時刻あわせが完了すると、送信側機器１１および受信側機器１４でそれぞれ上述の送信開始可能区間および再生開始基準点が設定されて同期再生を行うための準備が行われる。

【００３１】ユーザが送信側機器１１の操作パネル１２の再生ボタンを押下すると（Ｓ３９）、送信側機器１１では音声データの送信と動画データの再生が行われる。受信側機器１４では受信した音声データの再生が行われる。これらの動作は動画と音声の同期をとるために本発明で提案する手法に従って行われる。この処理の詳細については図４で後述するが、基本的には、送信側機器１１から受信側機器１４への音声データの送信は送信開始可能区間内でのみ開始され、そして、送信側機器１１および受信側機器１４それぞれにおける動画データおよび音声データの再生は、音声データが送信開始された送信開始可能区間後の最初の再生開始基準点を基準とすることにより、同時に開始されることになる。

【００３２】ユーザが操作パネル１２の電源ＯＦＦボタンを押下すると（Ｓ４０）、通信路切断および電源ＯＦＦ処理が行われ、受信側機器１３は待機状態に移行し、送信側機器１１は電源ＯＦＦ状態になる。

【００３３】次に図４を用いて本実施形態の特徴とする同期再生の方法を説明する。

【００３４】データの伝送遅延時間と復号処理などに要する処理遅延時間を含む合計の遅延時間の最大見積もり値をdelayMaxとする。このdelayMaxの値は、予め測定を行うことによって決められる値である。そして、delayMaxよりも大きい値Periodを定め、間隔Periodで時間軸上に再生開始基準点を設ける。また、Alphaを（Period－delayMax）と定め、前記再生開始基準点からAlphaの区間を送信開始可能区間とする。これらの情報は予め決めておくことにより、容易に双方の機器で再生開始基準点の周期を一致させることが可能である。例えば、delayM

axが100msecである場合にPeriodを200msecに定め、200msecの整数倍の時刻を再生開始基準点とするという具合である。時刻合わせを行っているので、双方の機器で各再生開始基準点の時刻は一致する。

【００３５】ここで、図４中のCase1およびCase2の場合を例にあげ、送信開始時刻および再生開始時刻の決め方を説明する。

【００３６】Case1は、送信開始可能区間内の時刻Tにユーザが再生ボタンを押下した場合を示している。この場合は、直ちにデータの送信を開始する。図では時刻Ｓで送信している。このデータが受信側機器１４に届いた後、復号などの処理を経て再生可能になる時刻をＲとすれば、前述のdelayMaxの定義からＲの存在範囲は時刻Ｓ以降で、前記送信開始可能区間経過後に最初に到来する再生開始基準点までの範囲に限定される。この再生開始基準点をＰ０とするとＰ０は送信側機器１１においても、受信側機器１４においても一意に定まる。送信側機器１１においては送信開始時刻を把握しているため自明であり、受信側機器１４においてはＲの存在範囲から時刻R以降の最初の再生可能基準点をＰ０と判断すれば良い。要するに、受信側機器１４では受信データの再生が可能になってから最初の再生開始基準点がＰ０である。

【００３７】そこで、Ｐ０に予め定めた値Betaを加算した時刻ＰＸも一意に定まり、時刻ＰＸに両方の機器で再生を開始することによって、再生開始時刻を一致させることができる。Betaは０以上の値が可能であるが、０にした場合にユーザの再生ボタン押下に対する反応が一番速い。

【００３８】Case2は、送信可能区間外の時刻Tにユーザが再生ボタンを押下した場合を示している。この場合は、データの送信開始は時刻Tの直後に到来する送信開始可能区間まで待たされる。送信開始可能区間の到来と共に時刻Ｓにデータの送信を開始する。なお、データの送信開始はこの送信開始可能区間内であれば良い。受信側１４でデータが再生可能になる時刻Ｒの存在範囲は、時刻Ｓ以降で、時刻Ｓが含まれる送信開始可能区間経過後の最初の再生開始基準点までの範囲に限定される。この再生開始基準点をＰ０とするとP0は送信側機器１１においても受信側機器１４においても一意に定まる。送信側機器１１においては送信開始時刻を把握しているため自明であり、受信側機器１４においてはＲの存在範囲から時刻R以降の最初の再生可能基準点をP0と判断すれば良い。そこで、Ｐ０に予め定めた値Betaを加算した時刻ＰＸも一意に定まり、時刻ＰＸに両方の機器で再生を開始することによって、再生開始時刻を一致させることができる。Betaの値はCase1の場合と同様、０の場合にユーザの再生ボタン押下に対する反応が一番速い。

【００３９】なお、Beta＝０とした場合には、Case1の場合のユーザの再生ボタン押下から再生開始までの最大遅延はPeriodとなり、Case2の場合のユーザの再生ボタン押下から再生開始までの最大遅延は(delayMax+Period)となる。

【００４０】次に図５のフローチャートを用いて、再生開始ボタン押下時の送信側機器１１の処理手順を説明する。

【００４１】ユーザが再生ボタンを押すと図５に示す処理が起動される。Step51では現在の時刻を取得する。これは送信側機器１１の時刻管理部２９に問い合わせを行うことにより行う。次にStep52に進み、現在、送信開始可能区間の内部であるか否かを判定する。送信開始可能区間に関する情報は時刻管理部２９が保持している。ここで、現在、送信開始可能区間の内部である場合にはStep53に進み、直ちに音声データの送信処理を起動する。引き続きStep54に進み、動画再生準備処理を起動した後、処理を終了する。動画再生準備処理では圧縮されている動画データの復号を表示に先行して行い、動画一時記憶部２４に蓄積する。この段階では表示は行われない。動画表示部２５への表示開始は、後述する動画データ再生開始判定処理の中で起動される。Step52で送信開始可能区間外と判定された場合はStep55に進み、既定の時間待機した後にStep51へ進み、再度、前述の処理を行う。

【００４２】次に図６のフローチャートを用いて、動画データ再生開始判定処理について説明する。

【００４３】この処理は図５のStep54から起動される。まず、Step61では現在の時刻を取得する。次にStep62に進み、現在、再生開始可能時刻（Ｐ０）に達しているか否かを判定する。再生開始可能時刻（Ｐ０）に関する情報は時刻管理部29が保持している。ここで、現在、再生開始可能時刻（Ｐ０）に達している場合はStep63へ進み、動画データの再生処理を起動する。Step62で再生開始時刻に達していないと判定された場合はStep64へ進み、既定の時間待機した後Step61へ進み、再度、前述の処理を行う。Step63で起動された動画データの再生処理では、時刻管理部２９の刻む時刻と動画データのフレームレートに従って再生を行う。

【００４４】次に、図７を用いて受信側機器１４における音声データの再生開始処理について説明する。この処理は例えば、最初の音声データを受信した時に起動される。Step71では現在の時刻を取得する。次にStep72に進み、現在、再生開始時刻（Ｐ０）に達しているかを判定する。再生開始時刻に達している場合はStep73へ進み、音声データの再生処理を起動する。Step72で再生開始時刻に達していないと判定された場合はStep74へ進み、既定の時間待機した後Step71へ進み、再度、前述の処理を行う。Step73で起動された音声データの再生処理では、時刻管理部２Ｈの刻む時刻と音声データのサンプリングレートに従って再生を行う。

【００４５】このように、本方式によれば送信開始時刻に関する情報を伝送路を介して送らなくとも、再生指示

から再生までの遅延時間が高々(delayMax+Period)で、同時に再生を開始することが可能になる。再生開始タイミングを揃えることで、後は、動画データおよび音声データそれぞれのサンプリングレートに従って再生処理を行うことで、リップシンク（lip sync）を保つことができる。

【００４６】なお、以上の説明では、音声データの送信開始を送信開始可能区間内に限定したが、これに代えて、送信側機器１１から受信側機器１４に対して再生開始を指示するための再生開始コマンドの送信開始時刻を、送信開始可能区間内に限定してもよい。つまり、音声データについては例えば再生開始ボタンが押された時点で送信し始めておき、再生開始コマンドの送信は、最初の送信開始可能区間で開始する。なお、この場合、delayMaxは、再生開始コマンドの送信を開始してから受信側機器１４がその再生開始コマンドに応答して再生処理を開始可能となるまでの最大時間となり、これは再生開始コマンドの伝送遅延時間とそのコマンド解釈処理などに要する処理遅延時間を含む合計の遅延時間の最大見積もり値として規定される。また、この場合には、音声データを記憶した記憶装置を受信側機器１４に用意しておくことも可能となる。他の点については音声データの送信開始タイミングを制御する場合と全く同じ方法が用いられる。

【００４７】また、上記の例では動画データを送信側機器１１で再生し、動画データと同期再生すべき音声データを送信側機器１１から受信側機器１４に送信したが、これとは逆に、音声データを送信側機器１１で再生し、音声データと同期再生すべき動画データを送信側機器１１から受信側機器１４に送信しても良い。この再生システムの一例を図８に示す。

【００４８】図８のシステムでは、携帯型オーディオプレイヤ１０１は、動画データおよびそれに付随する音声データが記録されている記憶装置を備えており、音声データを再生してイヤホン１０３から出力すると共に、携帯型ＬＣＤなどの表示装置１０２に無線通信路を介して動画データを送信する。

【００４９】また、本実施形態の同期再生方法は、同期再生する必要がある２つの動画データ同士を２つの異なる機器で再生する場合や、同期再生する必要がある２つの音声データ同士を２つの異なる機器で再生する場合にも適用可能である。２つの音声データを２つの異なる機器で同期再生するシステムの一例を図９に示す。

【００５０】図９のシステムは、ＤＶＤプレイヤ２０１を用いた視聴システムであり、ＤＶＤプレイヤ２０１によって再生される動画データはＴＶなどのモニタ２０３に表示される。またＤＶＤプレイヤ２０１から出力される複数チャネルの音声データはオーディオアンプ２０２に送られる。オーディオアンプ２０２はメインのＬ，Ｒチャネルの音声データを再生してＬ，Ｒのフロントスピーカ２０４，２０５から再生すると共に、サラウンド用のＬ，Ｒチャネルの音声データを無線通信路などを介してＬ，Ｒのバックスピーカシステム２０６，２０７に送信する。オーディオアンプ２０２とバックスピーカシステム２０６，２０７にそれぞれ本実施形態の方法を適用することで、音声データ同士の同期再生を容易に実現することが出来る。

【００５１】また、本実施形態の同期再生方法で使用する送信側機器および受信側機器それぞれの機能はすべてコンピュータプログラムによって実現することができるので、そのコンピュータプログラムが記憶されたコンピュータ読み取り可能な記憶媒体を通じてそのコンピュータプログラムを通常のコンピュータに導入して実行するだけで、本実施形態と同様の効果を容易に得ることが出来る。

【００５２】また、本発明は、上記実施形態に限定されるものではなく、実施段階ではその要旨を逸脱しない範囲で種々に変形することが可能である。例えばPeriodは常に一定である必要はなく、delayMaxよりも長ければ、予め決められたパターンで変化させるようにしても良い。同様に、Alphaの値も一定である必要はなく、予め決められたパターンで変化させるようにしても良い。また、delayMaxの値を通信環境に合わせて最適化する仕組みなどを用意することで、delayMaxの値も可変にすることが可能となる。

【００５３】更に、上記実施形態には種々の段階の発明が含まれており、開示される複数の構成要件における適宜な組み合わせにより種々の発明が抽出され得る。例えば、実施形態に示される全構成要件から幾つかの構成要件が削除されても、発明が解決しようとする課題の欄で述べた課題が解決でき、発明の効果の欄で述べられている効果が得られる場合には、この構成要件が削除された構成が発明として抽出され得る。

【００５４】

【発明の効果】以上説明したように、本発明によれば、再生時刻に関する情報を送信することなく、動画とそれに付随する音声のように互いに同期した情報を異なる機器で同期して再生することが可能となる。

【図面の簡単な説明】

【図１】本発明の一実施形態に係る再生システムの構成の一例を示すブロック図。

【図２】同実施形態の再生システムを構成する送信側機器と受信側機器それぞれの構成を示すブロック図。

【図３】同実施形態の再生システムの動作を示す図。

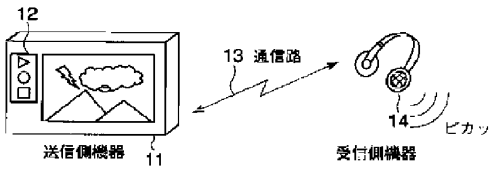
【図４】同実施形態の再生システムにおける同期再生処理のタイミングを説明するための図。

【図５】同実施形態の再生システムにおける再生開始ボタン押下時の送信側機器の処理手順を示すフローチャート。

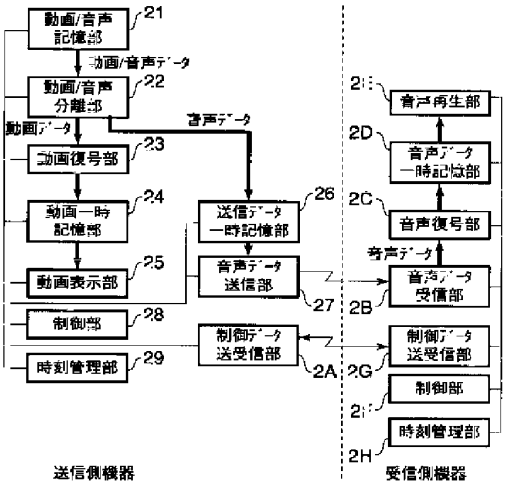
【図６】同実施形態の再生システムにおける送信側機器

の動画データ再生開始判定処理の手順を示すフローチャート。
【図７】同実施形態の再生システムにおける受信側機器の音声データ再生開始判定処理の手順を示すフローチャート。
【図８】本発明の一実施形態に係る再生システムの他の構成の一例を示すブロック図。
【図９】本発明の一実施形態に係る再生システムのさらに他の構成の一例を示すブロック図。
【符号の説明】
１１…送信側機器
１２…操作パネル
１３…通信路
１４…受信側機器
２１…動画/音声記憶部
２２…動画/音声分離部
２３…動画復号部
２４…動画一時記憶部
２５…動画表示部
２６…送信データ一時記憶部
２７…音声データ送信部
２８…制御部
２９…時刻管理部
２Ａ…制御データ送受信部
２Ｂ…音声データ受信部
２Ｃ…音声復号部
２Ｄ…音声データ一時記憶部
２Ｅ…音声再生部
２Ｆ…制御部
２Ｇ…制御データ送受信部
２Ｈ…時刻管理部

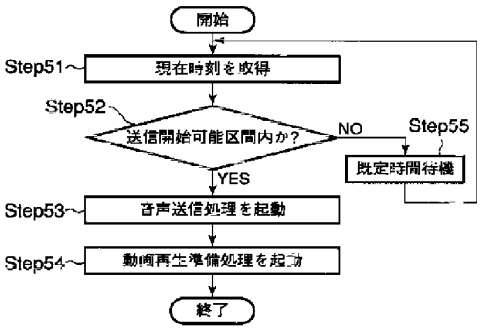
【図１】



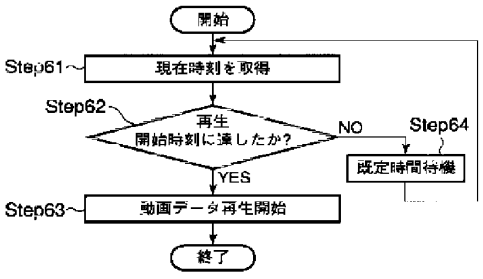
【図２】



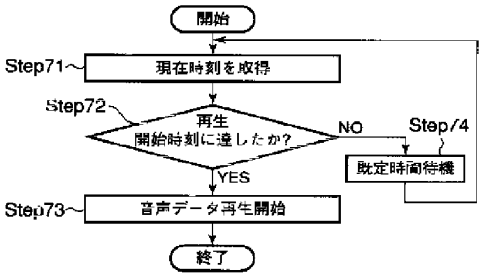
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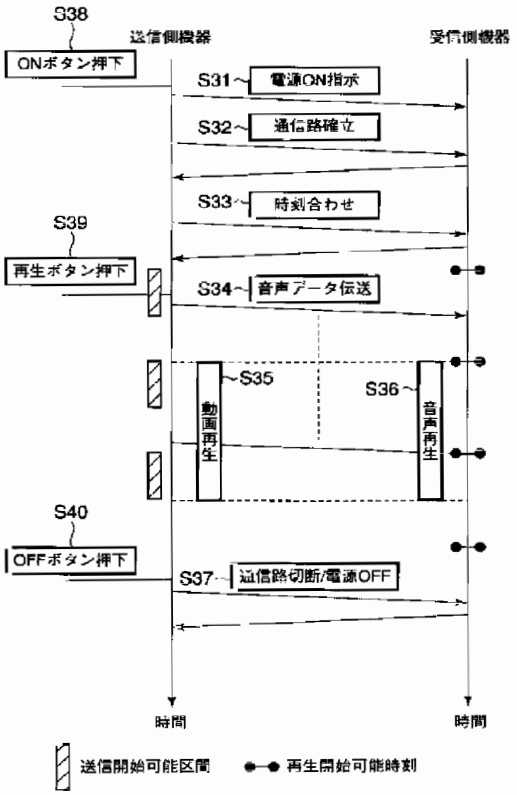
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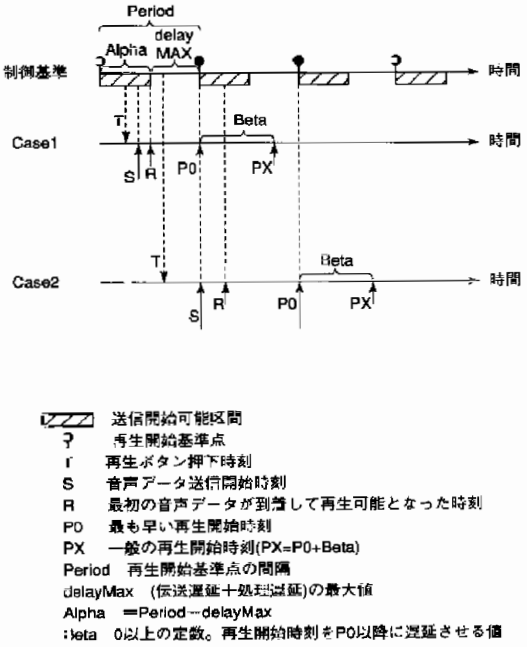
【図７】



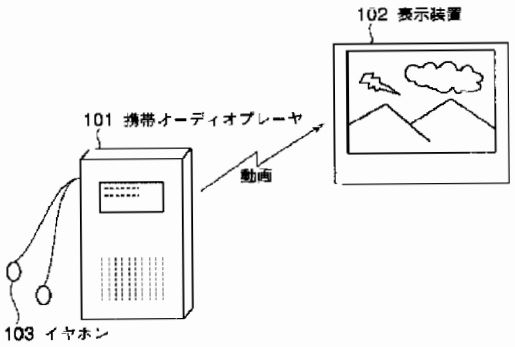
【図3】


S38
送信側機器
受信側機器
ONボタン押下
S31
電源ON指示
S32
通信路確立
S33
時刻合わせ
S39
再生ボタン押下
S34
音声データ伝送
S35
動画再生
S36
音声再生
S40
OFFボタン押下
S37
通信路切断/電源OFF
時間
時間
送信開始可能区間
再生開始可能時刻

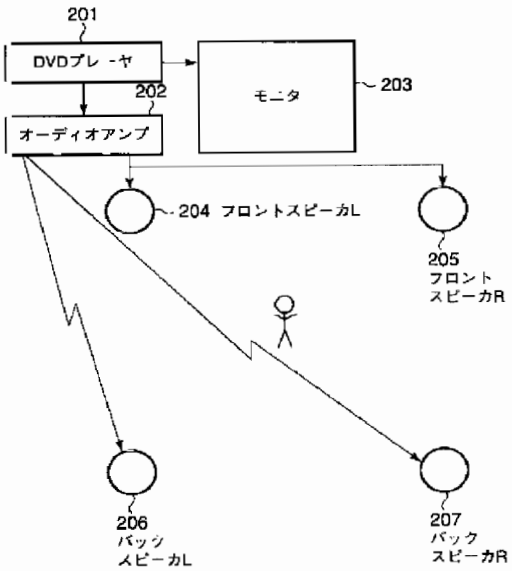
【図4】


Period
Alpha
delay MAX
制御基準
時間
T
Beta
Case1
時間
S
R
P0
PX
T
Beta
Case2
時間
S
R
P0
PX
送信開始可能区間
再生開始基準点
再生ボタン押下時刻
音声データ送信開始時刻
最初の音声データが到着して再生可能となった時刻
最も早い再生開始時刻
一般の再生開始時刻(PX=P0+Beta)
Period 再生開始基準点の間隔
delayMax (伝送遅延+処理遅延)の最大値
Alpha =Period−delayMax
Beta 0以上の定数。再生開始時刻をP0以降に遅延させる値

【図8】


102 表示装置
101 携帯オーディオプレーヤ
動画
103 イヤホン

【図9】


201
DVDプレーヤ
202
オーディオアンプ
モニタ
203
204 フロントスピーカL
205
フロント
スピーカR
206
バック
スピーカL
207
バック
スピーカR

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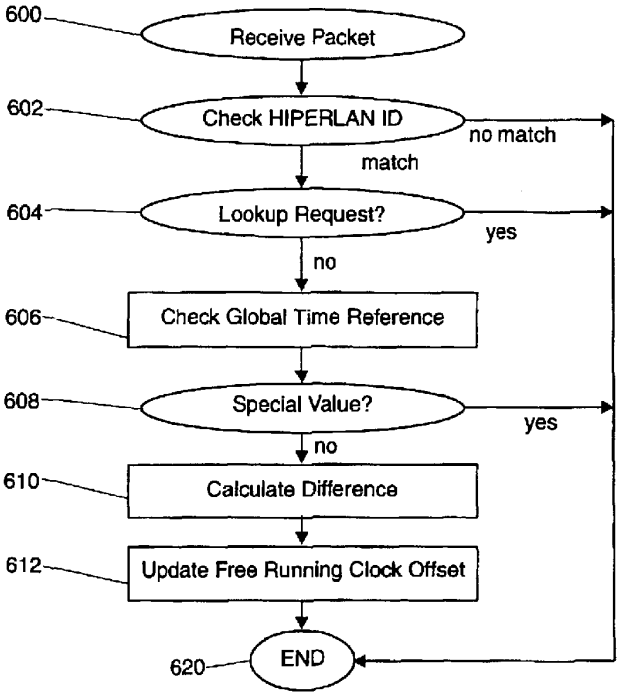
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(54) **Title:** MAINTAINING A GLOBAL TIME REFERENCE AMONG A GROUP OF NETWORKED DEVICES



(57) **Abstract:** Synchronization is maintained among a plurality of network devices (102,...) having local clocks. A first packet including global time reference (606) derived from local clock is broadcast from a first network device to other devices. The clocks of the network devices are adjusted. The difference between a free running clock and a first network global time reference is determined (610). A first network offset is calculated (612). Similarly, a second network offset is calculated to account for the difference between the free running clock and the second network global time reference.

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MAINTAINING A GLOBAL TIME REFERENCE AMONG A GROUP OF NETWORKED DEVICES

FIELD OF THE INVENTION

The present invention relates generally to networks of devices. More specifically, maintaining a global time reference in an ad hoc wireless network is disclosed.

BACKGROUND OF THE INVENTION

Wireless networks are becoming increasingly important as solutions for transferring data among devices that move, are located in a home, or are otherwise situated so that it is desirable to connect the devices without wires. Numerous physical and MAC layer solutions have been proposed. For example, a baseband ultra wideband wireless network is described in U.S. Patent Application No. 09/393,126 "Baseband Wireless Network for Isochronous Communication" by Aiello, et. al., which is herein incorporated by reference. An ultra wide band network transmits a signal that covers a very large portion of the frequency spectrum but transmits at a very low power in any individual frequency band.

Wireless networks are sometimes referred to as ad hoc networks because the network is comprised of devices that happen to be within the broadcast vicinity of the other devices in the network. Devices may join or leave the network as they are powered up or move out of range. A particular ad hoc network is described in the HIPERLAN Type 1, Functional Specification, ETS 300 652 published by the European Telecommunications Standards Institute. It is available at www.etsi.org.

Figure 1 is a block diagram illustrating a set of wireless devices that communicate together in a wireless ad hoc network. Video player 102 transmits an audio signal to speakers 106a, 106b, 106c and 106d. Video player 102 also transmits a video signal to screen 104. Screen 104 and speakers 106 may also transmit information to each other or to video player 102.

For an application such as the one shown in Figure 1, it is readily seen that synchronization among the various devices is important to achieve a desirable result. Different amounts of delay or jitter may exist in the signal paths between video player 102, speakers 106a and 106b, and screen 104. If the difference in delay is significant, then the

video presentation shown on screen 104 may not be properly synchronized with the audio being played on the speakers. Even worse, if speaker 106a and speaker 106b are not properly synchronized, then the left and right stereo audio channels could become separated in time, resulting in an unpleasant audio experience. Thus, it would be useful if a method of synchronizing the devices in such a wireless network could be developed.

SUMMARY OF THE INVENTION

Accordingly, a system and method for maintaining a global time reference among a group of wireless devices participating in a wireless network is disclosed. It should be noted that the techniques described herein may also be applied to other networks including certain networks that transmit signals partially or wholly using wires, fiberoptic cables or other means. For the purposes of example, this specification will describe in detail a wireless network and in particular a wireless ad hoc network that uses the HIPERLAN standard. It should be appreciated that the invention is not limited to such a network and that the techniques described are applicable to many different types of networks.

In one embodiment, each device in a network maintains its own clock. Instead of designating the clock of one particular device as the master clock, each device transmits its own clock signal or part of its own clock signal when it sends a packet to other devices in the network. The devices receiving the packet read the clock signal and adjust their own clocks to the transmitted value. This clock adjustment is made in a manner that causes the clocks to smoothly approach a common value without oscillating in an unstable manner.

It should be appreciated that the present invention can be implemented in numerous ways, including as a process, an apparatus, a system, a device, a method, or a computer readable medium such as a computer readable storage medium or a computer network wherein program instructions are sent over optical or electronic communication links. Several inventive embodiments of the present invention are described below.

In one embodiment, synchronization is maintained among a plurality of network devices having local clocks that participate in a network. A first packet is broadcast from a first network device to other network devices that participate in the network. The first packet includes a global time reference derived from the local clock of the first network device. The clocks of the network devices that receive the first packet are adjusted to be closer to the local clock of the first network device.

In one embodiment, a first network local time reference and a second network local time reference are maintained for a device that participates in a first network and a second network. A free running clock is maintained on the device. The difference between the free running clock and a first network global time reference is determined. A first network offset is calculated to account for the difference between the free running clock and the first network global time reference. The difference between the free running clock and a second network global time reference is determined. A second network offset is calculated to account for the difference between the free running clock and the second network global time reference.

These and other features and advantages of the present invention will be presented in more detail in the following detailed description and the accompanying figures which illustrate by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

Figure 1 is a block diagram illustrating a set of wireless devices that communicate together in a wireless ad hoc network.

Figure 2 is a diagram illustrating in some detail how a channel may introduce delay and jitter into the timing of packets sent from a transmitter to a receiver.

Figure 3 is a diagram illustrating how the timestamp, referred to as the global time reference is inserted into a packet header.

Figure 4A is a diagram illustrating how the global time reference is split into a most significant part and a least significant part.

Figure 4B is a diagram illustrating a memory register that stores the free running clock. The free running clock is a 32 bit clock.

Figure 4C is a diagram illustrating a memory register that stores the free running clock offset.

Figure 5 is a diagram illustrating an embodiment where devices belong to two different ad hoc networks and a new device is joining one of the networks.

Figure 6 is a flow chart illustrating a process that a network device executes when a

packet that includes a global time reference is received to determine whether to adjust the network device local time reference.

Figure 7A is a flow chart illustrating a process for including a global time reference in a packet.

Figure 7B is a flow chart illustrating a process executed by a receiver to prepare to update its free running clock offset.

DETAILED DESCRIPTION

A detailed description of a preferred embodiment of the invention is provided below. While the invention is described in conjunction with that preferred embodiment, it should be understood that the invention is not limited to any one embodiment. On the contrary, the scope of the invention is limited only by the appended claims and the invention encompasses numerous alternatives, modifications and equivalents. For the purpose of example, numerous specific details are set forth in the following description in order to provide a thorough understanding of the present invention. The present invention may be practiced according to the claims without some or all of these specific details. For the purpose of clarity, technical material that is known in the technical fields related to the invention has not been described in detail so that the present invention is not unnecessarily obscured.

Figure 2 is a diagram illustrating in some detail how a channel may introduce delay and jitter into the timing of packets sent from a transmitter to a receiver. Transmitter 200 sends packets in an isochronous manner. That is, each packet begins transmission at a regular interval. The difference in time between t_1, t_2, t_3, and t_4 is constant. Channel 202 introduces delay and jitter into the transmission so that Δ_1, Δ_2, Δ_3, and Δ_4 time delays are added to each of the times that the respective packets are received by the receiver 204. Thus, the evenly spaced transmitted packets are not evenly spaced when they are received.

So long as there is only one transmitter and one receiver, the inter packet timing can be corrected at the receiver if a timestamp is included at the beginning of each packet. The difference between each of the timestamps would indicate the correct relative time spacing of the packets enabling the receiver to reposition or perhaps even reorder the packets in time.

When there are more than two devices, then simply timestamping the packets will

not synchronize the display of data among the devices. It should also be noted that even when there are only two devices, the timestamp can adjust the relative spacing between packets but it does not facilitate making sure that events occur on the receiver at a specific time relative to an event occurring at the transmitter. Referring back to the example shown in Figure 1, even if packets sent from video player 102 to left and right speakers 106a and 106b are timestamped, there may still be a time offset between the left and right stereo channels. The timestamp on the packets only serves to enable each of the channels to correctly position in time the packets that it receives.

In order to synchronize the video or audio display of information received in packets over the wireless network or otherwise coordinate the use of information received from packets, a clock is maintained on each of the network devices that is in synchronization with the clocks on each of the other network devices.

In one embodiment, a clock is specified for each network device that needs to be correct only to about 5 parts per million. In order to maintain acceptable synchronization between all of the device clocks on the network, each time one of the devices transmits a packet, the device includes in the packet header at a well defined point the value or, as described below, part of the value of its clock. When the other devices receive that packet, they adjust each of their respective clocks toward the time indicated by the timestamp. As described below, in one embodiment, the time adjustment is implemented by calculating a clock offset and the clock offset is calculated by taking half the difference between the device clock and the timestamp.

Figure 3 is a diagram illustrating how the timestamp, referred to as the global time reference is inserted into a packet header. Packet header 300 includes a clock sync sequence 302. Clock sync sequence 302 is chosen to be an appropriate sequence to facilitate the receiver acquiring a clock signal used to sample the remainder of the packet. Frame sync sequence 304 is included next for the purpose of precisely identifying the beginning of encoded data in the packet. Thus, the end of the frame sync sequence precisely determines the beginning of a frame. Any number of well known frame sync sequences may be used. In one embodiment, a 13 bit Barker code is used. As soon as the frame sequence is sent, the transmitter records its local time reference.

It should be noted that ideally, the local time reference of the transmitter will agree with the local time reference kept at each of the devices participating in the network. If that

is the case, then each of the local time references actually is a global time reference because it is in agreement with every other local time reference in the system. For the purpose of this explanation, the local time reference that the transmitter records and then inserts in the packet will be referred to as the global time reference. That is because the transmitter asserts it to be the global time reference and it is the time that all receiving devices will adjust their own local time references toward. It should also be noted that each device considers its own local time reference to be the global time reference and asserts that its own local time reference is the global time reference it transmits a packet. Thus, each transmitting device asserts its local time reference as the global time reference when it includes its local time reference in a packet that it broadcasts to the other devices. Over time, as enough packets are sent, all of the local time references converge to the same global time and the broadcast global time reference results in only small, if any, changes by receiving devices.

Global time reference 306 is inserted in the packet after frame sync sequence 304. In the embodiment shown, the global time reference is inserted immediately after the frame sync sequence, but that is not required. The receiver notes its local time reference at the time when the frame sync sequence is detected and the frame sync sequence signal is asserted. The global time reference from the packet may be read immediately or it may be read much later, so long as it is compared to the time when the frame sync sequence signal is asserted. Thus, global time reference 306 may occur in the packet immediately following frame sync sequence 304 or may occur at a later point in the packet. The remainder of the packet 308 is then sent. The remainder of the packet will likely include further information for the packet header as well as finally the packet payload of data.

It should be noted that in one embodiment, the entire global time reference is not included in the packet. Instead, only the least significant bits, referred to as the least significant part, of the global time reference is included. It is sufficient to include just the least significant part of the global time reference so long as the difference between the clocks is less than the amount of time counted by the least significant part of the global time reference. This condition is met if the amount of drift between the clocks before an adjustment is made is not enough to move the clocks out of synchronization by more than the maximum amount of time that can be represented by the least significant part. In one embodiment, a 32 bit global time reference is used and the least significant part that is

transmitted with each packet is the least significant 12 bits of the 32 bit global time reference.

In the embodiment described above, the relative clock drift of the clocks being used is about 5 parts per million (ppm) and the clock rate is 1 MHz. The least significant part of the global time reference can count up to 2^{12} microseconds. Therefore, the clocks would need to be updated before a 2^{12} microsecond error could accumulate. For a 1 MHz clock with 5 ppm accuracy, the maximum time interval between updates would be on the order of about 5 minutes, depending on the method of updating used. Of course, the maximum time interval varies in different systems depending on the speed and accuracy of the clock and the number of bits transmitted with the least significant part of the clock. If more of the global time reference is provided in the least significant part, then the frequency of update is lower. For example, if 14 bits are used, then the least significant part of the global time reference can accurately represent a cumulative drift of up to 2^{14} microseconds. Assuming that the relative clock drift is unchanged, then updates would be required only one fourth as often.

One advantage of the described arrangement where the global time reference is included along with every packet sent by one of the devices participating in the network is that as the amount of network traffic increases, updates of the local time references occur more frequently. This decreases the variance among the local time references.

Figure 4A is a diagram illustrating how the global time reference is split into a most significant part and a least significant part. As mentioned above, the most significant part is, in one embodiment, 20 bits and the least significant part is 12 bits. The size of the least significant part may be increased to reduce the required frequency of updates at the cost of requiring more overhead for transmission. It should also be noted that, in addition to the least significant part being included in packets that are sent by each of the devices, periodically a MAC layer protocol prompts one or more of the devices to broadcast the entire global time reference, that is both the most significant part and the least significant part. In one embodiment, the global time reference is broadcast every 20 seconds. The reason for periodically broadcasting the entire global time reference is to allow for an error that occurred in one of the devices that changed the global time reference by more than the maximum time represented by the least significant part of the global time reference to be corrected.

In different embodiments, the task of broadcasting the entire global time reference may be performed by either one or all of the devices participating in the network. For example, each device may be directed to broadcast the global time reference periodically. The periodic broadcast may be staggered. Alternatively, the MAC layer protocol may direct a designated device to broadcast the entire global time reference at certain intervals.

Figure 4B is a diagram illustrating a memory register that stores the free running clock. The free running clock is a 32 bit clock. As mentioned previously, in one embodiment, the clock is a 1 megahertz clock. In other embodiments, the clock rate may be set as desired. Preferably, the free running clock is read only. That is, adjustments to the global time reference are not written to the clock. Rather, a free running clock offset is defined such that the global time reference is equal to the sum of the free running clock plus the free running clock offset.

Figure 4C is a diagram illustrating a memory register that stores the free running clock offset. Like the free running clock, the free running clock offset is a 32 bit register. However, the free running clock offset may be written as well as read. Each time a global time reference is received from one of the other devices, the free running clock is adjusted so that the sum of the free running clock and the free running clock offset converges toward the global time reference specified by the broadcasting device.

In different embodiments, adjustments to the local time reference based on the received global time reference are made according to different schemes. In one embodiment, a linear adjustment to the local time reference is made based on the difference between the received global time reference and the local time reference. The adjustment may be represented by the equation:

$$\Delta FRCO=(GTR-LTR) * L.$$

Where ΔFRCO is the change in the free running clock offset. GTR is the global time reference received with a packet. LTR is the current value of the local time reference stored by the device. As mentioned above, after several packets are received and adjustments are made, the local time references stored on each of the devices will converge toward a single value and that value will be the global time reference. L is a linear factor that adjusts the amount that the free running clock offset is adjusted compared to the difference between the global time reference and the local time reference that is computed. In one embodiment, L is equal to .5 and the adjustment to the free running clock offset is equal to half the

difference between the received global time reference and the stored local time reference.

Adjustment schemes are used in different embodiments that make non-linear adjustments to the free running clock offset based on the difference between the global time reference and the local time reference. In one embodiment, the change to the free running clock offset is equal to a scaling factor times the square of the difference between the global time reference and the local time reference. Squaring the difference between the two references has the advantage of making greater changes to the free running clock offset if the difference between the global time reference and the local time reference is large. If the square of the difference is used, then the sign of the difference between the global time reference and the local time reference is computed and applied to the difference so that the free running clock offset is adjusted in the proper direction.

In another embodiment, another non-linear adjustment scheme is implemented to allow the system to be more robust. The difference between the global time reference and the local time reference is computed. If the difference is greater than a threshold, then no adjustment is made to the local time reference. If the difference is less than a threshold, then the adjustment is made. Thus, if one of the devices in the network malfunctions or a new device signing on to the network attempts to assert a global time reference that is incorrect and would perturb the global time reference agreed upon by the current devices in the network, that device's assertion of the global time reference may be ignored.

In some embodiments, the threshold test can be turned off under certain circumstances. For example, if more than a certain number of changes are rejected by a device, then the threshold function may be temporarily turned off. This would be appropriate since a device that is receiving a large number of global time references that differ from its local time reference by a great amount most likely is actually incorrect by a large amount. A counter may be used to count the number of recent times that the difference between a received global time reference and the local time reference exceeds the threshold. In one embodiment, the counter is programmed to only count global time references from unique sources so that a single inaccurate source broadcasting repeatedly will be ignored. Both the threshold and the number of times that the threshold must be exceeded to turn off the threshold test may be programmed or may be preset.

Figure 5 is a diagram illustrating an embodiment where devices belong to two different ad hoc networks and a new device is joining one of the networks. Devices 502,

504, 506, and 508 all belong to a first ad hoc network 530. Device 508 along with devices 512 and 514 also belong to an ad hoc network 540. Device 522 is requesting to join network 530. As mentioned above, in one embodiment, the HIPERLAN protocol is utilized by the wireless ad hoc networks. In such an embodiment, each network has its own HIPERLAN ID. The HIPERLAN ID is included in packets sent by devices.

The two separate networks can have two separate independent clocks with a device such as device 508 that participates in both networks maintaining two separate clocks. More precisely, the device need only maintain a single free running clock and keep track of two free running clock offsets. Changes are applied to each of the respective free running clock offsets to keep track of the two different global times for the networks. Thus, device 508 may have a single free running clock but two registers used to calculate two different free running clock offsets to adjust the free running clock time to the global time of whichever network it is participating in at a given moment.

Other aspects of the HIPERLAN specification are used to facilitate the implementation of a global time reference shared among the devices of an ad hoc network. For example, the entire global time reference may be periodically broadcast using a Hello packet as described in the specification. The standard Hello procedure is modified to carry the full global time reference. The Hello procedure is described more fully in the HIPERLAN Type 1, Functional Specification, ETS 300 652 at 6.5.4 Neighbour Information Declaration. See also 6.1.14 Neighbour Information Base and 6.1.15 Hello Information Base.

As described above, a device may use the HIPERLAN ID to determine whether a packet belongs to its network and therefore whether to adjust its local time reference toward the global time reference specified in the packet. Also, a reserved network management ID may be used by devices joining the network. Network devices may be configured to ignore time references included in HIPERLAN lookup requests.

Various methods may be implemented to avoid a stable network global time reference from being perturbed by a new device. In one embodiment, new devices are instructed to provide a global time reference of all 0's which is a special value that is ignored by all network devices. Also, a new device is preferably configured to initially set its local time reference to equal a received global time reference instead of adjusting its local reference as described above. Specification of conventions for new devices, however,

does not protect against rogue devices that do not observe the correct conventions or devices that belong to other networks. For that reason, other procedures such as checking the HIPERLAN ID or rejecting certain large changes may also be implemented.

Figure 6 is a flow chart illustrating a process that a network device executes when a packet that includes a global time reference is received to determine whether to adjust the network device local time reference. The process starts at 600. In step 602, the HIPERLAN ID is checked. If there is no match, then the process ends at 620. If there is a match, then control is transferred to step 604 and it is determined whether the packet is a look up request. If the packet is a look up request, then the process ends at 620. If the packet is not a lookup request, then control is transferred to step 606 and the global time reference is checked. In step 608, it is determined whether the global time reference is a special value. If it is, then control is transferred to 620 and the process ends. If the global time reference is not a special value, then control is transferred to step 610 and the difference between the global time reference and the local time reference is calculated. Then, in step 612, the free running clock offset is updated. The free running clock may be updated according to any of the linear or nonlinear schemes described above or any other appropriate scheme. The process then ends at 620.

Figure 7A is a flow chart illustrating a process for including a global time reference in a packet. The process starts at 700 when a clock sync sequence is written. Next, in step 702, the frame sync sequence is written. As soon as the frame sync sequence is completed the local time reference of the transmitting device is read in step 704. This value will be inserted into the packet as the global time reference corresponding to the time that the frame sync sequence was finished. Next, in step 706, the global time reference is written into the packet. It should be noted that other steps may intervene between steps 704 and 706. The key point is that the global time reference is stored either immediately after or at some specific time after the frame sync sequence is completed so that the receiving device can compare its local time reference to the transmitted global time reference at a specific reference point.

Figure 7B is a flow chart illustrating a process executed by a receiver to prepare to update its free running clock offset. The process starts at 710 when the frame sync sequence is detected. The local time is immediately stored in step 712. It should be noted that although it is preferred that the local time be stored immediately, it is also possible to

store the local time at a set period of time after the assertion of the frame sync signal. Then, in step 714, the global time reference is read from the packet. In this manner, the transmitted global time and the local time are stored at a specific point in time referenced to the writing of the frame sync sequence and the detection of the frame sync sequence, respectively. In this manner, the local time reference and the global time reference can be compared and the free running clock offset can be appropriately adjusted.

Maintaining a global time reference in an ad hoc network has been disclosed. Each device maintains a local free running clock and a local free running clock offset, which together comprise a local time reference. Each free running clock is adjusted toward a received global time reference that is the local time reference of whatever device happens to be broadcasting. In this manner, eventually all of the local time references of devices in the network converge. A device may participate in more than one network by keeping track of one free running clock offset for each network.

Although the foregoing invention has been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications may be practiced within the scope of the appended claims. It should be noted that there are many alternative ways of implementing both the process and apparatus of the present invention. Accordingly, the present embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalents of the appended claims.

WHAT IS CLAIMED IS:

1. A method of maintaining synchronization among a plurality of network devices having local clocks that participate in a network comprising:

broadcasting a first packet from a first network device to other network devices that participate in the network wherein the first packet includes a global time reference derived from the local clock of the first network device; and

adjusting the clocks of the network devices that receive the first packet to be closer to the local clock of the first network device.

2. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 further including:

broadcasting a second packet from a second network device to other network devices that participate in the network wherein the second packet includes a global time reference derived from the local clock of the second network device; and

adjusting the clocks of the other network devices network devices that receive the second packet to be closer to the local clock of the second network device.

3. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein the global time reference includes the least significant part of the local clock of the first network device and does not include the most significant part of the local clock of the first network device.

4. A method of maintaining synchronization among a plurality of network devices as recited in claim 3 wherein the most significant part of one of the network device local clocks is broadcast periodically and the most significant parts of all local clocks are conformed to the broadcast most significant part.

5. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein adjusting the clocks of the network devices that receive the first packet to be closer to the local clock of the first network device includes adjusting the clocks of the network devices according to a linear function of the difference between the unadjusted value of the clock being adjusted and the broadcast global time reference.

6. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein adjusting the clocks of the network devices that receive the first packet to be closer to the local clock of the first network device includes adjusting the

clocks of the network devices by approximately one half the difference between the broadcast global time reference and the unadjusted value of the clock being adjusted.

7. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein adjusting the clocks of the network devices that receive the first packet to be closer to the local clock of the first network device includes adjusting the clocks of the network devices according to a nonlinear function of the difference between the unadjusted value of the clock being adjusted and the broadcast global time reference.

8. A method of maintaining synchronization among a plurality of network devices as recited in claim 7 wherein the nonlinear function of the difference between the unadjusted value of the clock being adjusted and the broadcast global time reference causes substantially no adjustment to the clock being adjusted when the difference between the unadjusted value of the clock being adjusted and the broadcast global time reference is greater than a maximum adjustable difference.

9. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein the global time reference is derived from the local clock of the first network device immediately after a frame synchronization portion of a packet is transmitted.

10. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein adjusting the clocks of the network devices that receive the first packet to be closer to the local clock of the first network device includes comparing the local clock of a receiving network device at the instant that frame synchronization is detected to the transmitted global time reference.

11. A method of maintaining synchronization among a plurality of network devices as recited in claim 1 wherein all data packets broadcast by any network device that participates in the network includes a global time reference derived from the local clock of the broadcasting network device so that as more data is transmitted, the local clocks of the receiving network devices are updated more frequently.

12. A method of maintaining a first network local time reference and a second network local time reference for a device that participates in a first network and a second network comprising:

maintaining a free running clock on the device;

determining the difference between the free running clock and a first network global

time reference;

calculating a first network offset to account for the difference between the free running clock and the first network global time reference;

determining the difference between the free running clock and a second network global time reference; and

calculating a second network offset to account for the difference between the free running clock and the second network global time reference.

13. A receiving network device configured to maintain synchronization with a transmitting network device comprising:

a receiving network device local clock;

an interface configured to receive a first packet from the transmitting network device wherein the first packet includes a global time reference derived from a transmitting network device local clock; and

a processor configured to adjust the receiving network device local clock to be closer to the transmitting network device local clock.

14. A receiving network device configured to maintain synchronization with a transmitting network device as recited in claim 13 wherein the receiving network device local clock includes a free running clock and a free running clock offset.

15. A transmitting network device configured to maintain synchronization with a receiving network device comprising:

a transmitting network device local clock;

an interface configured to transmit a first packet wherein the first packet includes a global time reference derived from the transmitting network device local clock and wherein the global time reference is used by the receiving network device to adjust the receiving network device local clock to be closer to the transmitting network device local clock.

16. A network of devices comprising:

a transmitting network device configured to transmit a first packet wherein the first packet includes a global time reference derived from a transmitting network device local clock; and

a receiving network device configured to receive the first packet from the transmitting network device and to adjust a receiving network device local clock to be closer to the global time reference.

17. A network device comprising:

a free running clock;

a processor configured to:

determine the difference between the free running clock and a first network global time reference;

calculate a first network offset to account for the difference between the free running clock and the first network global time reference;

determine the difference between the free running clock and a second network global time reference; and

calculate a second network offset to account for the difference between the free running clock and the second network global time reference.

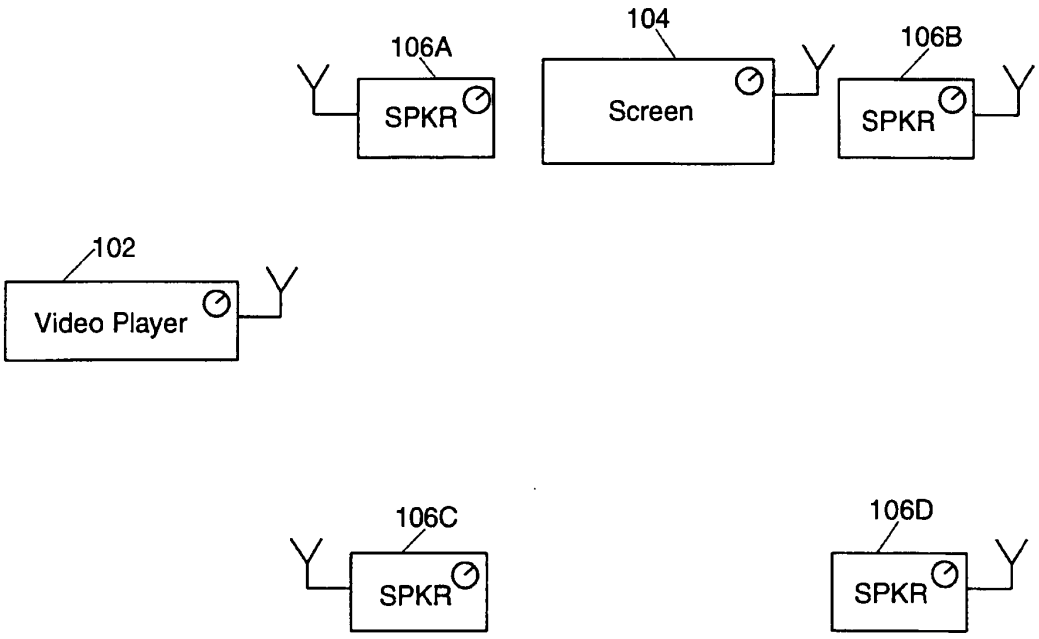

104
106A
106B
SPKR
Screen
SPKR
102
Video Player
106C
106D
SPKR
SPKR

FIG. 1

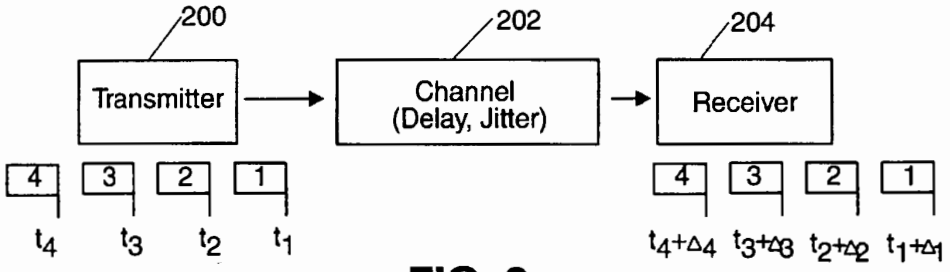

200
202
204
Transmitter
Channel
(Delay, Jitter)
Receiver
4
3
2
1
t_4
t_3
t_2
t_1
4
3
2
1
$t_4+\Delta_4$
$t_3+\Delta_3$
$t_2+\Delta_2$
$t_1+\Delta_1$

FIG. 2

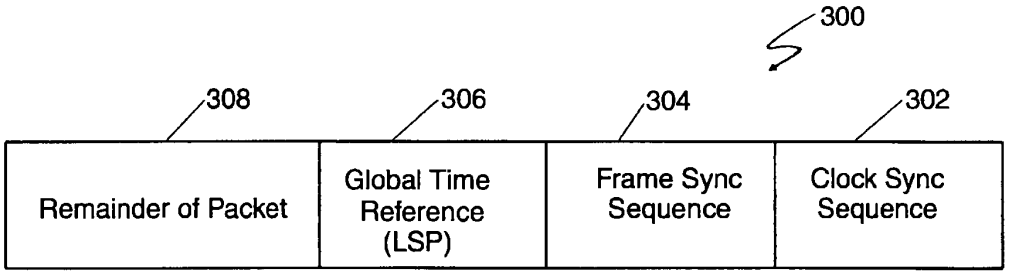

300
308
306
304
302
Remainder of Packet
Global Time Reference (LSP)
Frame Sync Sequence
Clock Sync Sequence

FIG. 3

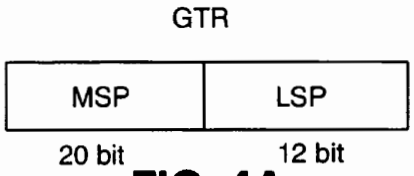


FIG. 4A

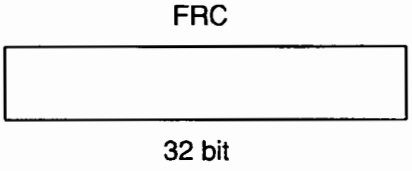
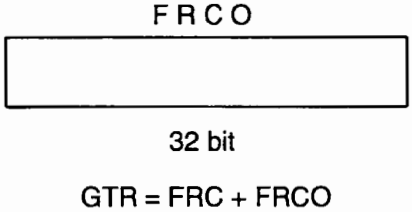


FIG. 4B



GTR = FRC + FRCO

FIG. 4C

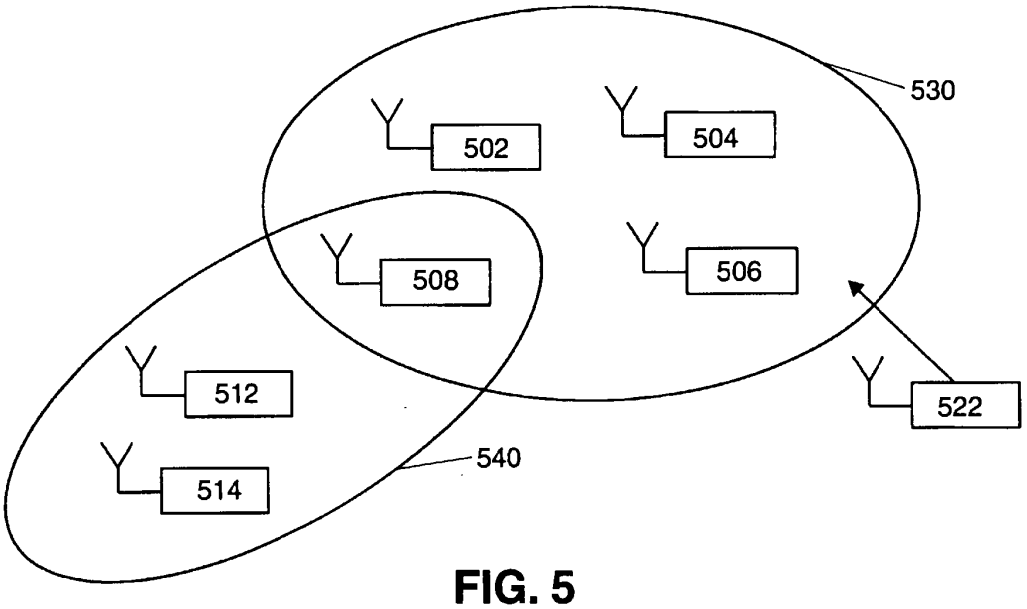


FIG. 5

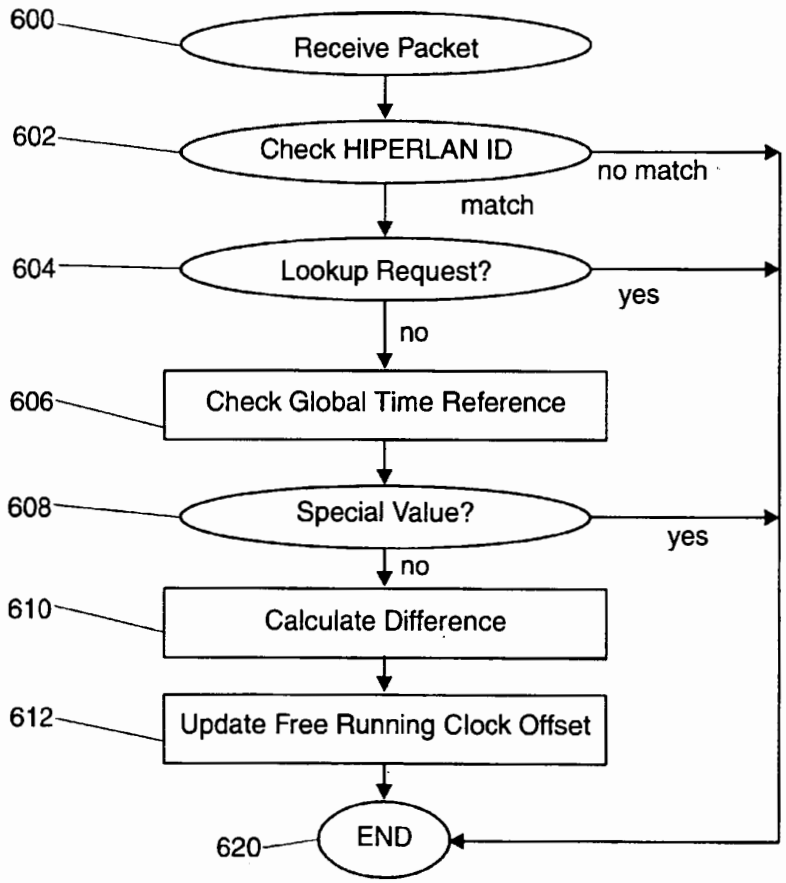

600
Receive Packet
602
Check HIPERLAN ID
no match
match
604
Lookup Request?
yes
no
606
Check Global Time Reference
608
Special Value?
yes
no
610
Calculate Difference
612
Update Free Running Clock Offset
620
END

FIG. 6

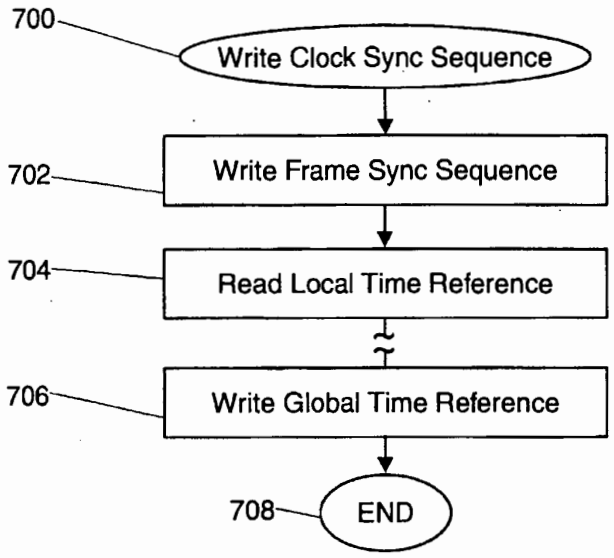

700
Write Clock Sync Sequence
702
Write Frame Sync Sequence
704
Read Local Time Reference
706
Write Global Time Reference
708
END

FIG. 7A

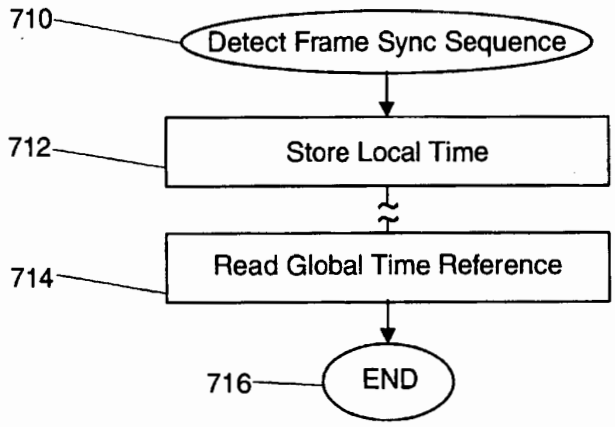

710
Detect Frame Sync Sequence
712
Store Local Time
714
Read Global Time Reference
716
END

FIG. 7B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/07082

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : H04J 3/06
US CL : 370/350, 432, 503, 516; 375/356; 455/265
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 370/350, 390, 432, 503, 516; 375/356; 455/208, 265; 709/248, 249

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST, WEST, IEEE, DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 5,334,975 A (WACHOB et al.) 02 August 1994, col. 1, lines 35-52, col. 2, lines 10-68, col. 3, lines 1-40.	1-17
Y,P	US 6,285,873 B1 (QUICK, Jr.) 04 September 2001, col. 4, lines 5-19, col. 6, lines 31-67, col. 7, lines 1-67, col. 8, lines 1-7, 54-63	1-17
Y,P	US 6,347,084 B1 (HULYALKAR et al.) 12 February 2002, col. 1, lines 37-48, 66-67, col. 2, lines 1-12, col. 6, lines 53-67, col. 7, lines 1-4, col. 8, lines 21-32, 43-64.	1-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
13 June 2002 (13.06.2002)

Date of mailing of the international search report
11 JUL 2002

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	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, Nicholas A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

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	2	20020062406		2002-05-23	CHANG; William Ho et al.	
	3	20100004983		2010-01-07	DICKERSON; Stephanie et al.	

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	2	"Non-Final Office Action mailed 05 January 2012 for U.S. Patent Application No. 13/298090 filed on 16 November 2011, 40 pages".	☐
	3	"Non-Final Office Action mailed 17 June 2014 for U.S. Application No. 14/176808 filed 10 February 2014".	☐
	4	"Non-Final Office Action mailed 18 December 2013 for U.S. Application No. 13/907666 filed 31 May 2013".	☐
	5	"Non-Final Office Action mailed 27 May 2014 for U.S. Application No. 14/186850 filed 21 February 2014".	☐
	6	"Yamaha DME Designer software manual: Copyright 2004", p.1-250.	☐
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	Application Number	13864249
	Filing Date	2013-04-17
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	Attorney Docket Number	SNS-71301US11 (13-0402)

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	Filing Date	2013-04-17
	First Named Inventor	MILLINGTON, Nicholas A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301US11 (13-0402)

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☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Robert J. Irvine III/	Date (YYYY-MM-DD)	2014-07-02
Name/Print	Robert J. Irvine III	Registration Number	41865

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EFS ID:	19484223
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
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Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	07-JUL-2014
Filing Date:	17-APR-2013
Time Stamp:	21:38:11
Application Type:	Utility under 35 USC 111(a)

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Warnings:					
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Warnings:					
Information:					
4	Non Patent Literature	13907666-Non-FinalOA121813FIXED.pdf	2878882 6dbe0eebc708b6c0f5e1a9df2045902e4545b544	no	12
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Warnings:					
Information:					
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Warnings:					
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13864249
Filing Date	2013-04-17
First Named Inventor	MILLINGTON, Nicholas A. J.
Art Unit	2442
Examiner Name	SURVILLO, OLEG
Attorney Docket Number	SNS-71301US11(13-0402)

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020095460		2002-07-18	BENSON; Michael	
	2	20050168630		2005-08-04	YAMADA; Norihiko et al.	
	3	20080126943		2008-05-29	PARASNIS; Shashank Mohan et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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	Application Number	13864249
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	First Named Inventor	MILLINGTON, Nicholas A. J.
	Art Unit	2442
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	1	"Final Office Action mailed 27 March 2014 for U.S. Application No. 13/533105 filed 26 June 2012".	☐
	2	"Non-Final Office Action mailed 01 May 2014 for U.S. Application No. 14/184522 filed 19 February 2014".	☐
	3	"Non-Final Office Action mailed 06 May 2014 for U.S. Application No. 13/705176 filed 05 December 2012".	☐
	4	"Non-Final Office Action mailed 12 May 2014 for U.S. Application No. 14/184528 filed 19 February 2014".	☐
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	Art Unit	2442
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	Attorney Docket Number	SNS-71301US11(13-0402)

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☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Robert J. Irvine III/	Date (YYYY-MM-DD)	2014-05-21
Name/Print	Robert J. Irvine III	Registration Number	41865

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EFS ID:	19088392
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
Filer Authorized By:	
Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	23-MAY-2014
Filing Date:	17-APR-2013
Time Stamp:	21:43:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	SNS-71301US11SupplementalIDS-MAY2014.pdf	706930 674d2eeae58da64c5f4e68b3aa538c3ed220b5d4	no	4

Warnings:
Information:

2	Non Patent Literature	13533105FinalOA32714.pdf	951725 50db79854ca7b844590e839e6dd5cebef2e9a089	no	29
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3	Non Patent Literature	14184522Non-FinalOA5114.pdf	1042059 3e0d22e91cd5d85ad3f946ad4a7897db11c7df09	no	31
Warnings:					
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4	Non Patent Literature	13705176Non-FinalOA5614.pdf	824173 c505030fa0f9e7ca2746c7bcf8c561a5a580308e	no	23
Warnings:					
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5	Non Patent Literature	14184528Non-FinalOA51214.pdf	784767 cedc7adc69fbf2021f105c90f100487cc3feb203	no	23
Warnings:					
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6	Non Patent Literature	13848932Non-FinalOA51414.pdf	461919 e2e7f62a13e4121e1416e89a9fd5fc441e0196d4	no	14
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<u>New International Application Filed with the USPTO as a Receiving Office</u>
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	Millington, Nicholas A. J.
	Art Unit	2442
	Examiner Name	SURVILLO, OLEG
	Attorney Docket Number	SNS-71301.US.11 (13-0402)

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5956088		1999-09-21	SHEN; Paul et al.	
	2	7143141		2006-11-28	MORGAN; Jeffrey A. et al.	
	3	7574274		2009-08-11	HOLMES; Stephen G.	
	4	7657644		2010-02-02	ZHENG; Qinghua	
	5	7676142		2010-03-09	HUNG; Andy Chao	
	6	8169938		2012-05-01	DUCHSCHER; Rob et al.	
	7	8290603		2012-10-16	LAMBOURNE; Robert A.	
	8	8588949		2013-11-19	LAMBOURNE; Robert A. et al.	
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020049843		2002-04-25	BARONE; Samuel T. et al.	
	2	20020168938		2002-11-14	CHANG; Chin-Chi	
	3	20020194309		2002-12-19	CARTER; Harry Nick et al.	
	4	20030002609		2003-01-02	FALLER; Christof et al.	
	5	20030043924		2003-03-06	HADDAD; Semir S. et al.	
	6	20040032348		2004-02-19	LAI; Angela C. W. et al.	
	7	20040041836		2004-03-04	ZANER; Melora et al.	
	8	20040066736		2004-04-08	KROEGER; Brian William	
	9	20040075767		2004-04-22	NEUMAN; Darren et al.	

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	Attorney Docket Number	SNS-71301.US.11 (13-0402)

	10	20040078383		2004-04-22	MERCER; Ian Cameron et al.	
	11	20050021590		2005-01-27	DEBIQUE; Kirt A. et al.	
	12	20060119497		2006-06-08	MILLER; Kevin L. et al.	
	13	20070143493		2007-06-21	MULLIG; Richard M. et al.	
	14	20070180137		2007-08-02	RAJAPAKSE; Ravi	
	15	20080022320		2008-01-24	VER; Steeg William C.	
	16	20120290621		2012-11-15	HEITZ III; Geremy A. et al.	
	17	20130174100		2013-07-04	SEYMOUR; Eric T. et al.	
	18	20130197682		2013-08-01	MILLINGTON; Nicholas A. J.	

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	Attorney Docket Number	SNS-71301.US.11 (13-0402)

	1	1122931	EP	A2	2001-08-08			☐
	2	2284327	GB	A	1995-05-31			☐
	3	03093950	WO	A2	2003-11-13			☐

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	BLAKOWSKI G. et al., "A Media Synchronization Survey: Reference Model, Specification, and Case Studies", January 1996, Vol. 14, No. 1, 5-35.	☐
	2	"European Extended Search Report for Application No. 13184747.7 mailed on 28 February 2014, 8 pages".	☐
	3	"Final Office Action mailed 3 July 2012 for U.S. Patent Application No. 13/298090 filed on 16 November 2011".	☐
	4	"Final Rejection mailed on 21 January 2010 for U.S. Application No. 11/906,702 filed on 2 October 2007".	☐
	5	"Maniactools, "Identify Duplicate Files by Sound," 09/28/2010, http://www.maniactools.com/soft/music-duplicate-remover/identify-duplicate-files-by-sound.shtml".	☐
	6	"Non-Final Office Action mailed 05 December 2013 for U.S. Application No. 13/827653 filed 14 March 2013".	☐

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	Art Unit	2442
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	Attorney Docket Number	SNS-71301.US.11 (13-0402)

	7	"Non-Final Office Action mailed 19 March 2013 for U.S. Application No. 13/724048 filed 21 December 2012".	☐
	8	"Non-Final Office Action mailed 30 April 2012 for U.S. Patent Application No. 13/204511 filed 5 August 2011".	☐
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SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Robert J. Irvine III/	Date (YYYY-MM-DD)	2014-04-11
Name/Print	Robert J. Irvine III	Registration Number	41865

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1	Foreign Reference	EP1122931A2.pdf	697874 c3e62931711416d6eda01a8838040629079cd066	no	14

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(54) Real-time media content synchronization and transmission in packet network apparatus and method

(57) A system for transmitting and synchronizing real-time multimedia content includes a multimedia server (62) for generating a multimedia packet (64) having multimedia audio/visual information therein in a play sequence, and for transmitting the multimedia packet; a packet-based communication network (66) connected to the multimedia server (62) for receiving the multimedia packets therefrom; the network having multiple routers (68, 70) therein to route the multimedia packets to plural destinations; means for inserting total delay information (TDI) into the multimedia packets, wherein the TDI includes total end-to-end delay (TED) and cumulative network delay (CND); and plural multimedia receivers (80, 82, 84) for receiving the multimedia packets having TDI therein, wherein each multimedia receiver (80, 82, 84) includes a buffer for storing received multimedia packets, a sequencing means for retrieving stored multimedia packets from the buffer and sequencing the multimedia packets in the play sequence, and a playing mechanism for playing the retrieved, sequenced multimedia packets at time TED after the multimedia packet has been transmitted by the multimedia server (62). A method of transmitting and synchronizing real-time multimedia content includes loading multimedia audio/visual into plural multimedia packets (64); inserting total delay information (TDI) into at least one of the multimedia packets (64), wherein TDI includes total end-to-end delay (TED) and cumulative network delay (CND); transmitting the multimedia packets to plural multimedia receivers (80, 82, 84) over a packet-based network (66) in a play sequence; buffering the multimedia packets in each multimedia receiver (80, 82, 84); recalling the multimedia packets in play sequence; and playing the multimedia packets (64) at each receiver (80, 82, 84) at time TED.

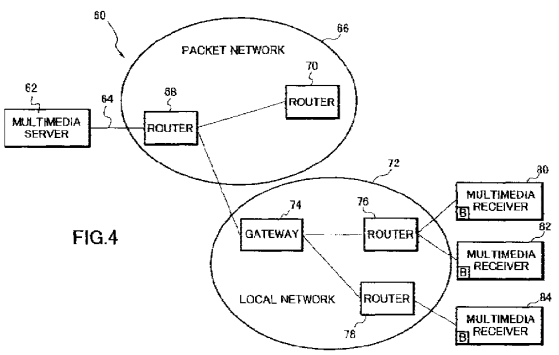


FIG.4

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Description

Field of the Invention

[0001] This invention relates to multimedia networks, and specifically to the synchronization of multicast distributed media content when played by multiple multimedia devices, e.g., monitors and audio systems.

Background of the Invention

[0002] In some situations, such as at conventions and in exhibition halls, it is required to play the same video contents synchronized at multiple video monitors. Generally, it is also required to synchronize audio and video between separately located monitors and speakers. Current real-time media transmission technology allows transferring an audio/video stream over non-guaranteed quality of service (QoS) packet networks with reasonable quality and at a lower cost than provided by higher quality networks. Thus, there will be a demand for playing multimedia contents, delivered to a plurality of receivers over packet network, in synchronized manner.

[0003] Fig. 1 depicts a prior art multimedia content delivery system, generally at 10, which uses a packet network. A multimedia server 12 generates a stream of multimedia packets 14 that contain multimedia audio/video contents. Normally, server, or source, 12 generates multimedia packets at a constant rate (packet rate); *e.g.*, one packet every 20 ms. Packet size depends on the multimedia codec, which may result in fixed size or variable sized packets. The generated multimedia packets are then transferred through a packet network 16, having plural routers, or nodes, 18, 20, 22, 24, 26, 28 and 30 therein, and are delivered to a plurality of multimedia receivers, 32, 34, 36 and 38. The mechanism for delivery to multiple devices is well known as "multicast." All the receivers that wish to receive multimedia contents from the server join a multicast group. The routers in packet network 16 are aware of the multicast group, and transfer received multimedia packet to multiple routes. Each receiver is equipped with a speaker and/or a video display, and each plays the contents in the received multimedia packet in real-time. The multimedia receivers may buffer received multimedia packets for some duration in order to absorb the variance in delay caused by the network, and to playback multimedia packets in right order.

[0004] In conventional packet network, such as an IP network, packets are queued in each router. How long a packet stays in a queue depends on the amount of traffic that a particular router is handling. Hence, each multimedia packet delivered to each multimedia receiver has an unpredictable delay. As a result, the audio/video contents may be played at multiple locations without synchronization.

[0005] As previously noted, real-time multimedia transmission technology currently allows transferring an audio/video stream over non-guaranteed quality of service (QoS) packet networks with reasonable quality. As mobile Internet access increases, with its data transfer over bandlimited communication channels, such as wireless data networks, the technology to transmit real-time multimedia packets requiring minimum bandwidth becomes essential and of increases importance.

[0006] A packet-based real-time media transmission system is illustrated in Fig. 2, generally at 40. A multimedia source, or server, 42, periodically transmits multimedia packets 44 having audio/video multimedia contents to a packet network 46. In packet network 46, each multimedia packet is routed by a plurality of network nodes, or routers, 48, 50, 52 and 54, and delivered to a receiver 56. Each multimedia packet includes timing information that is used to set timing for playback at a receiver 56. The multiple routers and receivers of Fig. 1 are not shown in Fig. 2 for the sake of clarity.

[0007] Packet network 46 causes a variable length delay in the delivery of each multimedia packet. In addition, network 46 does not guarantee the delivery of the multimedia packets in the same order as transmitted. Thus, a receiver is normally equipped with a buffer to handle delay variances and/or disorders in multimedia packet receipt. However, due to the real-time property of the contents, the receiver will discard a received multimedia packet if the delay in its arrival exceeds a certain value, or if the multimedia packet does not arrive by the time it is to be played.

[0008] Fig. 3 shows an example of packets received and played back by the receiver, where each packet contains the timing information. Line I depicts seven multimedia packets transmitted in sequential order by server 42. Line II depicts the order of receipt of the multimedia packets at a receiver. Line III depicts a play order by the receiver. The figure depicts that the multimedia packet with timing information 3 is discarded due to an excessive delay. Basically, the routers in the prior art packet network are not aware of delays in packets transmission and receipt, nor are they aware of disordering of packet transmission. Thus, each router re-directs every received real-time multimedia packet to the next router or the receiver, even if the multimedia packet may not have any chance of being played at the receiver. If a physical link between some two routers, or the physical link between the receiver and the adjacent router has limited bandwidth, the transmission of the multimedia packets which will be discarded at the receiver possibly wastes substantial portion of valuable bandwidth on the link. Delay and disordering is illustrated by the variable routing of multimedia packets from router 48 through router 50, router 52 and router 54, or directly from router 48 to router 54.

[0009] U.S. Patent No. 4,506,358, for *Time stamping for a packet switching system*, to Montgomery, granted March

19, 1985, describes a method of measuring the network delay in a packet network by including an information field in each packet that indicates the cumulative network delay, time stamping each packet's arrival and re-transmission in each network node, and updating the information field in each network node for each packet by adding the delay occurring in each node, *i.e.*, re-transmission time - arrival time.

[0010] U.S. Patent No. 4,530,091, for *Synchronization of real-time clocks in a packet switching system*, to Crockett, granted July 16, 1985, describes a means to synchronize a remote real-time clock to a standard real-time clock via an X.25 (CCITT) network, but does not teach or suggest how to synchronize a multimedia stream, and does not consider network delay caused in a packet network.

[0011] U.S. Patent No. 4,918,687 for *Digital packet switching networks*, to Bustini *et al.*, granted April 17, 1990, describes a method to avoid consecutive packet loss by clipping voice packets whose contents indicate whether the packet is eligible for clipping, if required, in a node queue within the network.

[0012] U.S. Patent No. 5,432,790 for *Method for allocating internodal link bandwidth in a packet oriented communication network to guarantee delay quality-of-service*, to Hluchyj *et al.*, granted July 11, 1995, describes a method to allocate bandwidth on internodal links such that worst case maximum delays and worst case average delays are guaranteed while providing statistical gains in maintaining predetermined end-to-end delay QoS.

[0013] U.S. Patent No. 5,444,709 for *Protocol for transporting real time data*, to Riddle, granted August 22, 1995, describes a method to maintain the isochronous nature of the real-time data transmission by discarding data that is not timely received.

[0014] U.S. Patent No. 5,450,394 for *Delay monitoring of telecommunication networks*, to Gruber *et al.*, granted September 12, 1995, describes a means to measure a round-trip delay of network transit time, however, the delay which must be known for multimedia transmission and synchronization is a one-way network delay.

[0015] U.S. Patent No. 5,557,724 for *User interface, method, and apparatus selecting and playing channels having video, audio, and/or text streams*, to Sampat *et al.*, granted September 17, 1996, describes a user interface in a computer system to playback multimedia streams.

[0016] U.S. Patent No. 5,594,660 for *Programmable audio-video synchronization method and apparatus for multimedia systems*, to Sung *et al.*, granted January 14, 1997, describes a means to playback an audio and video stream synchronously to a single network-based receiver.

[0017] U.S. Patent No. 5,598,352 for *Method and apparatus for audio and video synchronizing in MPEG playback systems,* to Rosenau *et al.*, granted January 28, 1997, describes a means to playback an audio and video stream synchronously to a single network-based receiver.

[0018] U.S. Patent No. 5,623,483 for *Synchronization system for networked multimedia streams,* to Agrawal *et al.*, granted April 22, 1997, describes a means for a receiving device to determine the total end-to-end delay from a statistical network delay distribution and the synchronization of the two media streams from different sources through the provision of a synchronization clock located in each server and in each receiver.

[0019] U.S. Patent No. 5,629,936 for *Control of consecutive packet loss in a packet buffer*, to Lee *et al.*, granted May 13, 1997, describes a method for dropping packets to control consecutive packet loss based on a desired packet gap.

[0020] U.S. Patent No. 5,675,573 for *Delay-minimizing system with guaranteed bandwidth delivery for real-time traffic*, to Karol *et al.*, granted October 7, 1997, describes a bandwidth allocation mechanism based on individual guaranteed bandwidth requirements associated with each traffic flow.

[0021] U.S. Patent No. 5,682,384 for *Apparatus and methods achieving multiparty synchronization for real-time network application,* to Zarros, granted October 28, 1997, describes a means to playback contents from multiple sources synchronously to a single receiver on a network.

[0022] U.S. Patent No. 5,768,527 for *Device, system and method of real-time multimedia streaming,* to Zhu *et al.*, granted June 16, 1998, describes a method to recover lost packets by retransrnission.

[0023] U.S. Patent No. 5,802,060 for *Data network and a process for real time transmission of data packets in a data network*, to Fischbach *et al.*, granted September 1, 1998, describes a method to prioritize packet transmissions for stations whose network access is controlled by token exchanges.

[0024] U.S. Patent No. 5,815,634 for *Stream synchronization method and apparatus for MPEG playback system,* to Daum *et al.*, granted September 29, 1998, describes a means to playback an audio and video stream synchronously to a single network-based receiver.

[0025] U.S. Patent No. 5,844,600 for *Methods, apparatus, and systems for transporting multimedia conference data streams through a transport network,* to Kerr, granted December 1, 1998, describes a means for audio/video conferencing over an ATM network. Audio streams are combined in a network-based mixer and distributed to terminals. At each terminal, the received audio and video streams are played synchronously, however, there is no provision for synchronous play at multiple terminals on a network.

[0026] U.S. Patent No. 5,874,997 for *Measuring and regulating synchronization of merged video and audio data*, to Haigh, granted February 23, 1999, describes a means to playback an audio and video stream synchronously to a single, network-based receiver.

[0027] The Internet Engineering Task Force (IETF) publishes requests for comments (RFC) and comments filed in response thereto.

[0028] RFC 1889: A real-time end-to-end protocol utilizing existing transport layers for data that has real-time properties.

[0029] RFC 2508: Compressing IP/UDP/RTP Headers for Low-Speed Serial Links

[0030] RFC 1144: Compressing TCP/IP Headers for Low-Speed Serial Links,

[0031] Similar to RFC 2508, but for TCP/IP packets.

Summary of the Invention

[0032] A system for transmitting and synchronizing real-time multimedia content includes a multimedia server for generating a multimedia packet having multimedia audio/visual information therein in a play sequence, and for transmitting the multimedia packet; a packet-based communication network connected to the multimedia server for receiving the multimedia packets therefrom; the network having multiple routers therein to route the multimedia packets to plural destinations; means for inserting total delay information (TDI) into the multimedia packets, wherein the TDI includes total end-to-end delay (TED) and cumulative network delay (CND); and plural multimedia receivers for receiving the multimedia packets having TDI therein, wherein each multimedia receiver includes a buffer for storing received multimedia packets, a sequencing means for retrieving stored multimedia packets from the buffer and sequencing the multimedia packets in the play sequence, and a playing mechanism for playing the retrieved, sequenced multimedia packets at time TED after the multimedia packet has been transmitted by the multimedia server. A method of transmitting and synchronizing real-time multimedia content includes loading multimedia audio/visual into plural multimedia packets; inserting total delay information (TDI) into at least one of the multimedia packets, wherein TDI includes total end-to-end delay (TED) and cumulative network delay (CND); transmitting the multimedia packets to plural multimedia receivers over a packet-based network in a play sequence; buffering the multimedia packets in each multimedia receiver, recalling the multimedia packets in play sequence; and playing the multimedia packets at each receiver at time TED.

[0033] An object of the invention is to provide synchronized A/V output at a plurality of receivers over and multimedia carrying network.

[0034] Another object of the invention is to prevent transmissions of any multimedia packets which will not be used by a receiver on the network.

[0035] These and other objects and advantages of the invention will become more fully apparent as the description which follows is read in conjunction with the drawings.

Brief Description of the Drawings

[0036] Fig. 1 depicts a prior art multimedia content delivery system.

[0037] Fig. 2 depicts a packet-based real-time multimedia content transmission system.

[0038] Fig. 3 is a block diagram of packet receipt and playback.

[0039] Fig. 4 depicts a LAN multimedia content delivery system constructed according to the invention.

[0040] Fig. 5 depicts a multimedia content delivery system wherein the video and audio streams are separately routed.

Detailed Description of the Preferred Embodiment

[0041] Synchronization and transmission of multicast multimedia, particularly over packet-based systems is an efficient and inexpensive techniques for distributing information. Prior art systems simply do not consider the problems associated with synchronizing and transmitting a multimedia data stream, from one or more sources, over a packet-based system, to multiple receivers. Although there exist a number of technologies that enable a plurality of correlated media streams, transmitted from different locations, to be played at single receiver in a synchronized manner, the known prior art does not allow media streams generated by a single source, or multiple sources, to be multicast over a packet-based network to be played synchronously at multiple locations. This invention provides a system and method to transmit and synchronously play the same audio/video stream at the different locations, and to eliminate transmission of a multimedia packet when it is apparent that the multimedia packet will not be played at its destination.

[0042] Referring now to Fig. 4, a content synchronized multimedia transmission system constructed according to the invention is depicted generally at 60. System 60 includes a multimedia server 62, which has the means to insert TED and CND information, which is defined and described later herein, into each multimedia packet 64 that passes therethrough. A packet network 66 includes two routers, 68, 70, although many more routers are likely present in such a generalized network. Router 68 is connected to a local area network (LAN) 72, which includes a gateway 74 and

routers 76, 78. Multimedia receivers 80, 82 and 84 are connecter to LAN 72.

[0043] The method of the invention includes loading multimedia information into a series of packets 64, referred to herein as multimedia packets. Multimedia server 62 inserts fields of total end-to-end delay (TED) and cumulative network delay (CND) in each multimedia packet, referred to herein as total delay information (TDI). TED indicates the time from when the multimedia packet is transmitted from the server to when the multimedia packet is to be played at a receiver, whereas CND indicates the actual latency caused by routers in the communications network before the multimedia packet is delivered to a receiver. Multimedia server 62 determines the value of TED from network statistics. When transmitting a multimedia packet, server 62 sets the value of jitter to CND. The jitter is obtained by

$$\text{time interval of transmissions of two consequent packets - packet rate.} \quad (1)$$

For example, if the packet rate is 20 ms and a packet is actually transmitted 30 ms after the previous packet, jitter is 10 ms and the CND of the packet is set to 10 ms.

[0044] Each router in the network, regardless of whether the router is located in packet network 66 or LAN 72, measures the queuing delay of each multimedia packet caused by that router. The queuing delay is obtained from time stamps of reception and transmission of the multimedia packet. When transmitting the multimedia packet, each router updates CND by adding the queuing delay to the current CND value. If the router needs to route a received multimedia packet to multiple routes, *i.e.,* multicast, such as router 68 multicasting to router 70 and gateway 74, the multimedia packet is duplicated, and the queuing delay for the duplicated multimedia packet is handled separately from the original. There may be more than one duplicated packet, and the queuing delay is placed in each duplicated packet.

[0045] Each multimedia receiver includes a buffer "B" to store incoming multimedia packets, and recalls a multimedia packet from the buffer to play the content of a multimedia packet at (TED-CND) after its reception. Thus, a multimedia packet delivered to the multiple multimedia receivers is played at TED after transmitted at the server, regardless of the actual network delay caused in the route to each receiver.

[0046] As described in the previous example, CND contains only a queuing delay, and does not include physical latencies caused by the physical transmission between two routers. The physical latency is assumed to be small and is therefore negligible. Alternatively, a router may be provided with a known physical latency, which may be added to the queuing delay for increased accuracy.

[0047] If all the receivers are aware of the packet rate, performing the procedures described above for the first multimedia packet of the media stream is sufficient, because a receiver receiving a multimedia packet with TED and CND knows when to play the multimedia packets which follow, however, where the first multimedia packet containing TED and CND is "lost," *i.e.*, not received by one or more receivers, the server may be required to include TED and CND in the first several multimedia packets. Alternatively, the server may be required to include TED and CND until it receives an acknowledgement that a multimedia packet having TED and CND has been received by all of the receivers belonging to the multicast group.

[0048] As mentioned earlier, multimedia server 62 determines the value of TED, based on network statistics. TED may be provided to the server by a network administrator, or measured dynamically. The actual determination of TED is beyond of the scope of this invention, however, U.S. Patent No. 5,623,483 provides a technique to determine TED from the statistical distribution of network delay. The overall solution of U.S. Patent No. 5,623,483, however, is that the server and the receivers have synchronized clocks. The server specifies, in each packet, the time at which the receiver is to play the packet content. However, it is unrealistic to expect that the servers and receivers of a packet network maintain precisely the same time on their synchronized clocks.

[0049] It is foreseeable that situations may arise where queuing delays and physical latencies add up to the point where a multimedia packet reaches a receiver, and is "late." In the case of prior art systems, audible and visual discontinuities are perceptible to a user, without any means to correct this situation. The system and method of the invention have provisions to function in the case where one of the receivers detects a CND in a multimedia packet which exceeds the TED for the multimedia packet. In this case, the multimedia packet cannot be played synchronously, because the time for play of the contents of the multimedia packet has already passed. The receiver includes means to request a larger TDI, and sends a message to the server with the value CND-TED. The server then increases the value of TED, and thus TDI, for following multimedia packets.

[0050] In the embodiment shown in Fig. 4, server 62 and all the routers included in packet network 66 and LAN 72 for the multicast group supports TED and CND. As depicted in Fig. 4, all of the multimedia receivers in the multicast group are in a local area network (LAN), however, a multimedia receiver may also be connected to a router in packet network 66. A multimedia server does not have to include special hardware or software to insert TDI into the multimedia packets, as described above. Instead, a gateway, which connects the LAN to the (public) packet network, generates TDI from TED and CND for multimedia packets received from the server. The gateway must be capable of generating the value of TED, and must be supplied with the packet rate. The routers and the receivers in the LAN may perform

the same function. Consequently, the invention may be implemented even if the entire packet network does not support the method presented here. Put another way, the means for inserting TDI may be provided by a multimedia server, a router, or a gateway.

[0051] Another embodiment, illustrated in Fig. 5, generally at 90, includes a multimedia server 92, which generates a video stream 94 and an audio stream 96, a packet network 98, having routers 100, 102, 104, 106 and 108, and a video monitor 110 and a speaker 112. Video stream 94 and audio stream 96 are to be played separately yet synchronously at video monitor 110 and at speaker 112, respectively, which are connected to packet network 98. The destination addresses of video packets and audio packets are the addresses for the video monitor and for the speaker, respectively. Server 92 includes means to insert TDI, including TED and CND, in both video and audio packets. The routers perform the same procedure as shown in the other embodiments.

[0052] The method of U.S. Patent No. 4,506,358 is different from the invention described herein in that the present invention employs an information field in each packet of a type neither taught nor suggested in the prior art, that indicates the time when the audio/video content in the packet should be played. This enables the same content to be played synchronously at multiple receivers, without the necessity of synchronized server/receiver clocks.

[0053] This invention also maximizes the efficiency of bandwidth on physical links among routers and receivers by preventing a router from transmitting multimedia packets that will not be played at the final destination, *i.e.*, a media player, or receiver, as in the case where CND > TED.

[0054] Non-viable multimedia packets may be discarded if it is determined that they are not need, or if it is determined that they will not be used. The following may be used as a stand-alone technique, or in conjunction with the synchronization technique previously described herein. A router places a time stamp and sequence number in every received multimedia packet transferred between the media source and the receiver. Let:

$t_{ts}[n]$: the time stamp of the multimedia packet with sequence number n, and

$t_p[n]$: the timing information included in the multimedia packet with sequence number n, indicating when the content in this multimedia packet is to be played at the receiver. This information provides relative timing information among series of multimedia packets and does not indicate the absolute time.

[0055] At the receipt of the first multimedia packet, having sequence number = n_0, the router stores $t_{ts}[n_0]$ and $t_p[n_0]$ in memory and re-directs the multimedia packet to the next router or the receiver. Now, let

$$T_u = t_u[n_0] \text{ and} \qquad (2)$$

$$T_p = t_p[n_0]. \qquad (3)$$

[0056] At the receipt of every following received multimedia packet with sequence number n, the router examines the values of $t_{ts}[n]$ and $t_p[n]$, and, if

$$t_{ts}[n] - T_{ts} < tp[n] - T_p + D, \qquad (4)$$

where D denotes the maximum TED allowance, including the buffering delay in the receiver, the router re-directs the multimedia packet and sets

$$T_{ts} = t_{ts}[n] \text{ and} \qquad (5)$$

$$T_p = t_p[n]; \qquad (6)$$

and determines that the multimedia packet is a viable packet. Otherwise, the router discards the multimedia packet.

[0057] The value $t_{ts}[n] - T_{ts}$ is the difference between the arrival time of the multimedia packet of interest and the latest successfully re-directed multimedia packet at the router. Similarly, $t_p[n] - T_p$ indicates the time interval at play back between these two multimedia packets. Thus, if

$$t_{ts}[n] - T_{ts} > t_p[n] - T_p + D, \quad (7)$$

the multimedia packet with sequence number *n* has already consumed the entire TED allowance. In this case, there is no chance for the multimedia packet to be played at the receiver, because the multimedia packet will not arrive at the receiver before or at the time it is to be played. By eliminating unnecessary transmission of such a multimedia packet, referred to herein as a non-viable packet, the bandwidth on the physical link between this router and the next entity, regardless of whether the next entity is a router or a receiver, may be utilized efficiently. The router thus includes means to determine whether a multimedia packet is a viable multimedia packet, in which case the multimedia packet is transmitted; or whether the multimedia packet is a non-viable multimedia packet, in which case the multimedia packet is discarded.

[0058] The value of *D* at any router may be provided by: (1) being hard-coded on the node's software or hardware; (2) being manually configured by a system administrator; or (3) being provided in every real-time multimedia packet by the multimedia server. The value is determined by the required QoS and must be greater than the buffering delay in the receiver. *D* will be a small value for delay-sensitive applications, such as two-way voice conversation. The receiver may negotiate the value of *D* with the media source using common communication protocols.

[0059] The transmission method of the invention functions with IP/UDP/RTP header compressor, specified in RFC 2508, wherein the header information of real-time multimedia packets is compressed by a differential coding scheme. The compressor, which may be implemented in a transmitting portion of a router, provides a means to identify a specific real-time media stream between a media source and a receiver, among other traffic. Because of differential coding, the compressor is required to examine the timing information in the header of real-time multimedia packets in any packet-based network, and the extra processing power required to implement the method of the invention is minimal.

[0060] Thus, a system and method for transmitting and synchronizing real-time, multimedia packet-based content over a packet-based network has been disclosed. Although several variations of the system and method of the invention have been disclosed, it will be appreciated that further variations and modification may be made thereto without departing from the scope of the invention as defined in the appended claims.

Claims

1. A system (60) for transmitting and synchronizing real-time multimedia content, comprising:

   a multimedia server (62) for generating a multimedia packet (64) having multimedia audio/visual information therein in a play sequence, and for transmitting said multimedia packet (64);
   a packet-based communication network (66) connected to said multimedia server (62) for receiving said multimedia packets therefrom; said network having multiple routers (68, 70) therein to route said multimedia packets (64) to plural destinations;
   means for inserting total delay information (TDI) into said multimedia packets (64), wherein said TDI includes total end-to-end delay (TED) and cumulative network delay (CND); and
   plural multimedia receivers (80, 82, 84) for receiving said multimedia packets (64) having TDI therein, wherein each multimedia receiver (80, 82, 84) includes a buffer for storing received multimedia packets, a sequencing means for retrieving stored multimedia packets from said buffer and sequencing said multimedia packets in said play sequence, and a playing mechanism for playing the retrieved, sequenced multimedia packets at time TED after said multimedia packet (64) has been transmitted by said multimedia server.

2. The system (60) of claim 1 wherein said means for inserting is located in said multimedia server (62).

3. The system (60) of claim 1 wherein said means for inserting is located in a router (68, 70).

4. The system (60) of claim 1 which further includes a local area network (LAN) (72) located between said packet-based network (66) and at least some of said multimedia receivers (80, 82, 84), wherein said LAN (72) includes a gateway (74).

5. The system (60) of claim 4 wherein said means for inserting is located in said gateway (74).

6. The system (60) of claim 1 wherein at least one of said routers (68, 70) includes duplication means for duplicating multimedia packets (64), wherein said means for inserting is located in said router (68, 70), and wherein said router

(68, 70) inserts TDI into each duplicated multimedia packet.

7. The system (60) of claim 1 which further includes means to determine whether a multimedia packet (64) is a viable packet or whether a multimedia packet is a non-viable packet, and wherein said non-viable packets are discarded.

8. The system (60) of claim 1 wherein said multimedia receivers (80, 82, 84) includes means to request a larger TDI from said means for inserting.

9. A method of transmitting and synchronizing real-time multimedia content, comprising:

loading multimedia audio/visual into plural multimedia packets (64);
inserting total delay information (TDI) into at least one of the multimedia packets (64), wherein TDI includes total end-to-end delay (TED) and cumulative network delay (CND);
transmitting the multimedia packets (64) to plural multimedia receivers (80, 82, 84) over a packet-based network (66) in a play sequence;
buffering the multimedia packets (64) in each multimedia receiver (80, 82, 84);
recalling the multimedia packets (64) in play sequence; and
playing the multimedia packets (64) at each receiver (80, 82, 84) at time TED.

10. The method of claim 9 wherein said inserting includes inserting TDI in a multimedia server (62).

11. The method of claim 9 wherein said inserting includes inserting TDI in a router (68, 70) located in the packer-based network (66).

12. The method of claim 9 wherein said inserting includes inserting TDI in a gateway (74) located in a local area network (LAN) (72) which is located between the packet-based network (66) and a multimedia receiver (80, 82, 84).

13. The method of claim 9 which includes duplicating a multimedia packet (64) for multicasting to plural multimedia receivers (80, 82, 84), and wherein said duplicating includes inserting TDI into at some of the duplicated multimedia packets.

14. The method of claim 9 which includes discarding a multimedia packet (64) if at any time during said transmitting CND>TED.

15. The method of claim 14 which includes increasing the value of TED if CND>TED.

16. The method of claim 9 which includes determining whether a multimedia packet (64) is a viable packet or a non-viable packet, and which further include discarding any non-viable packets.

17. A method of transmitting and synchronizing real-time multimedia content, comprising:

determining whether a multimedia packet (64) is a viable packet or a non-viable packet; and
discarding any non-viable packets.

18. The method of claim 17 which further includes:

loading multimedia audio/visual into plural multimedia packets (64);
inserting total delay information (TDI) into at least one of the multimedia packets (64), wherein TDI includes total end-to-end delay (TED) and cumulative network delay (CND);
transmitting the multimedia packets (64) to plural multimedia receivers (80, 82, 84) over a packet-based network (66) in a play sequence;
discarding a multimedia packet (64) if at any time during said transmitting CND>TED;
buffering the multimedia packets (64) in each multimedia receiver (80, 82, 84);
recalling the multimedia packets (64) in play sequence; and
playing the multimedia packets (64) at each receiver (80, 82, 84) at time TED.

19. The method of claim 18 wherein said inserting includes inserting TDI in a multimedia server (62).

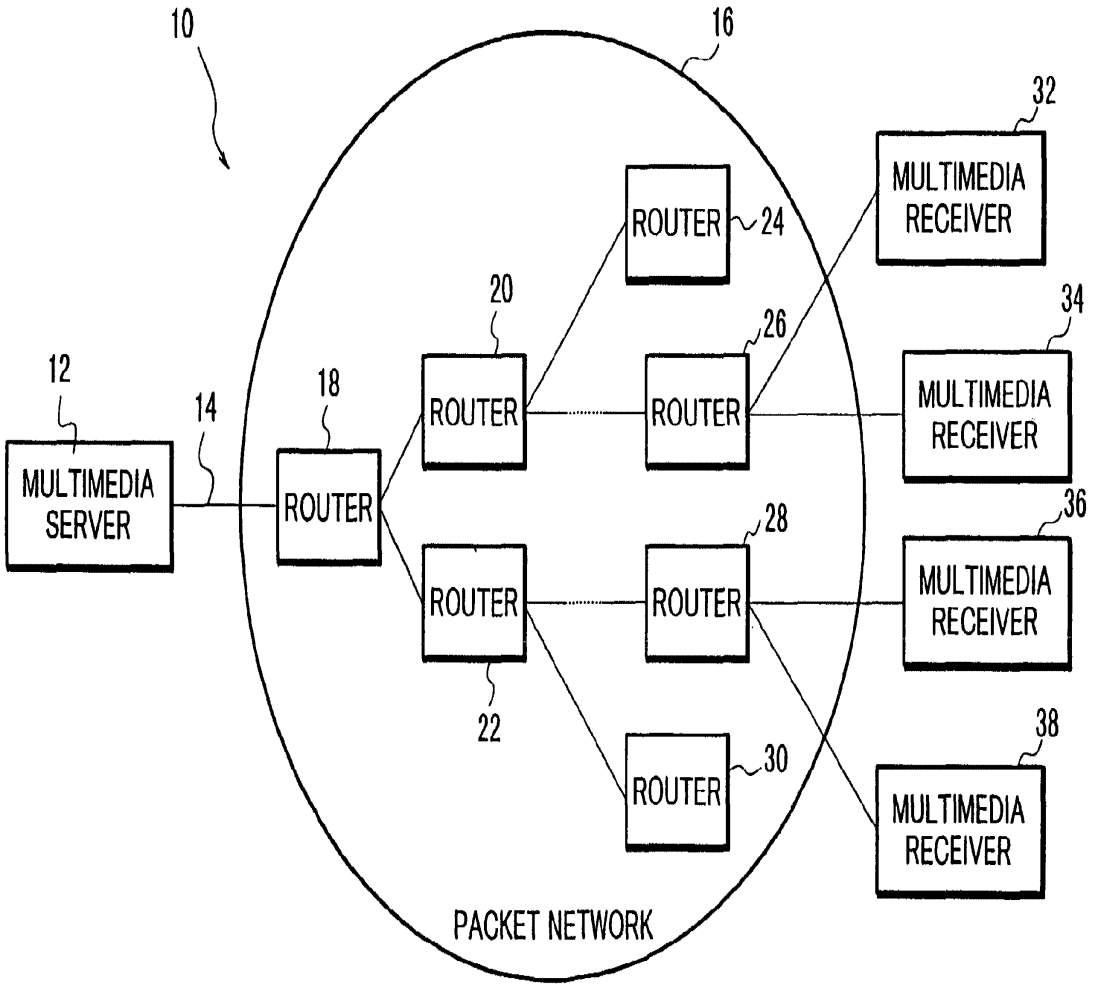
20. The method of claim 18 wherein said inserting includes inserting TDI in a router (68, 70) located in the packet-based network (66).

21. The method of claim 18 wherein said inserting includes inserting TDI in a gateway (74) located in a local area network (LAN) (72) which is located between the packet-based network (66) and a multimedia receiver (80, 82, 84).

22. The method of claim 18 which includes duplicating a multimedia packet (64) for multicasting to plural multimedia receivers (80, 82, 84), and wherein said duplicating includes inserting TDI into at some of the duplicated multimedia packets.

23. The method of claim 18 which includes increasing the value of TED if CND>TED.

FIG.1
(PRIOR ART)



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FIG.2

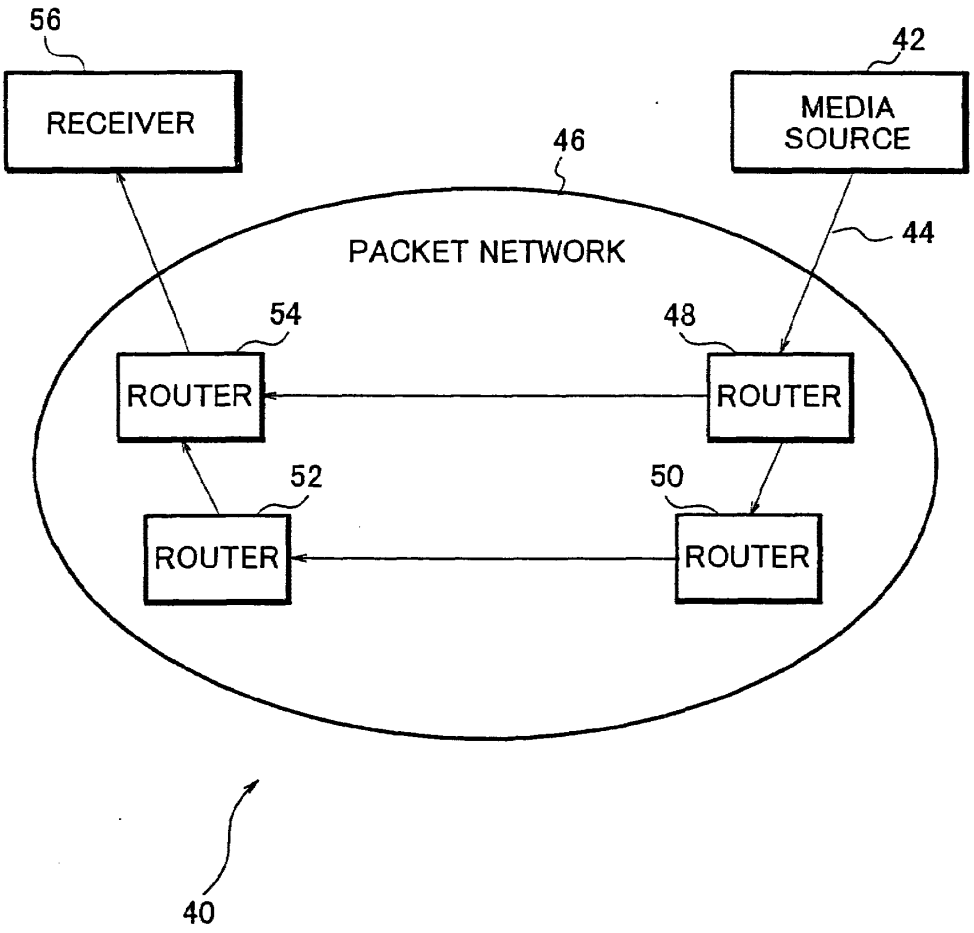
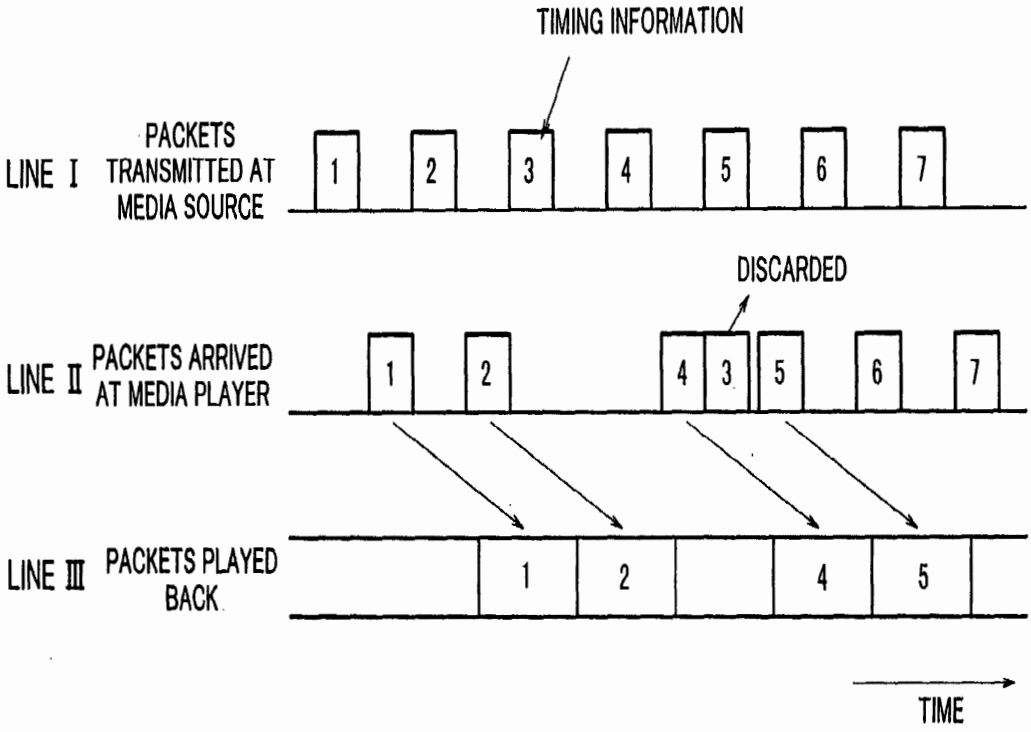

56
RECEIVER
42
MEDIA SOURCE
46
PACKET NETWORK
44
54
48
ROUTER
ROUTER
52
50
ROUTER
ROUTER
40

FIG.3



12

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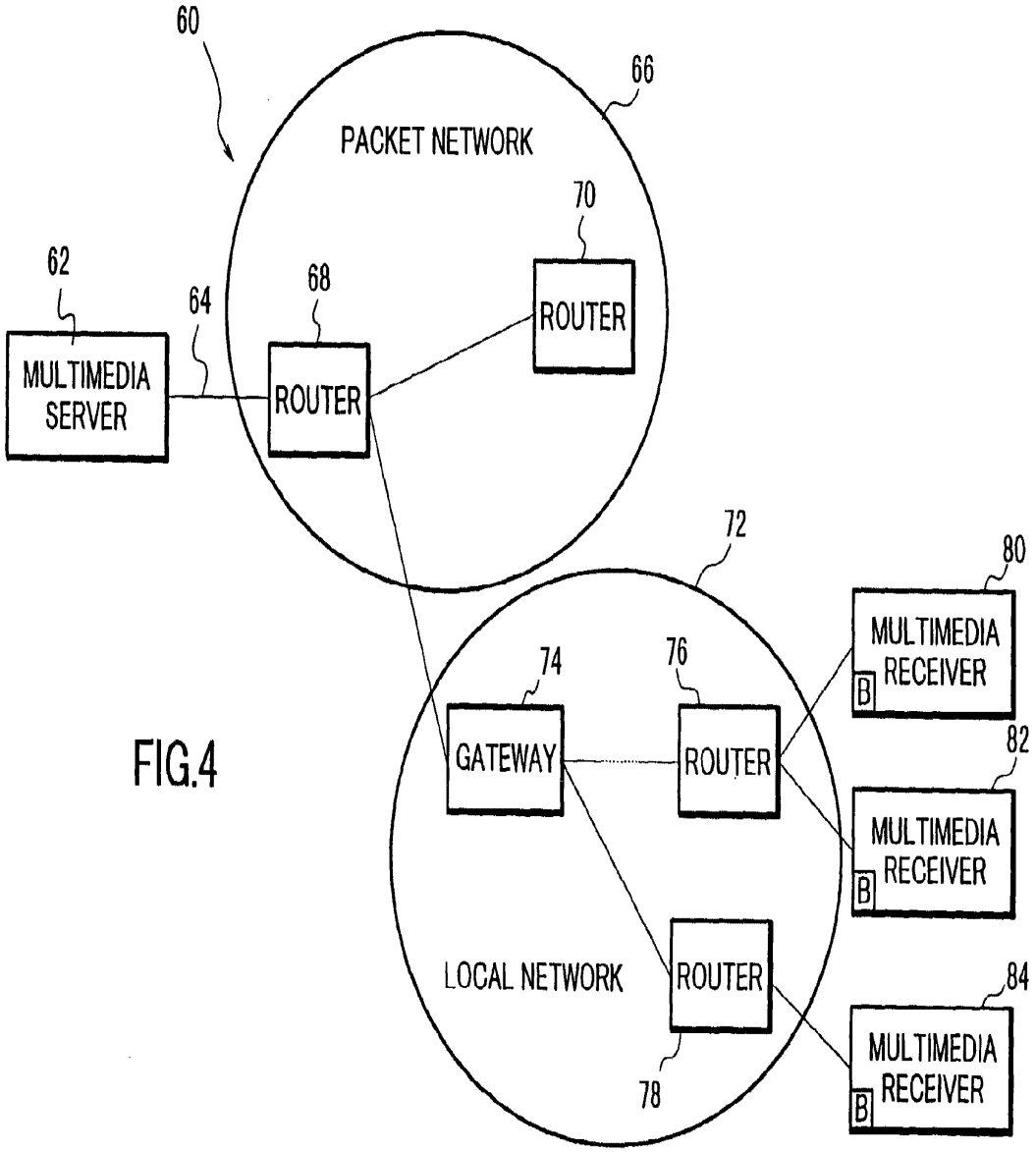
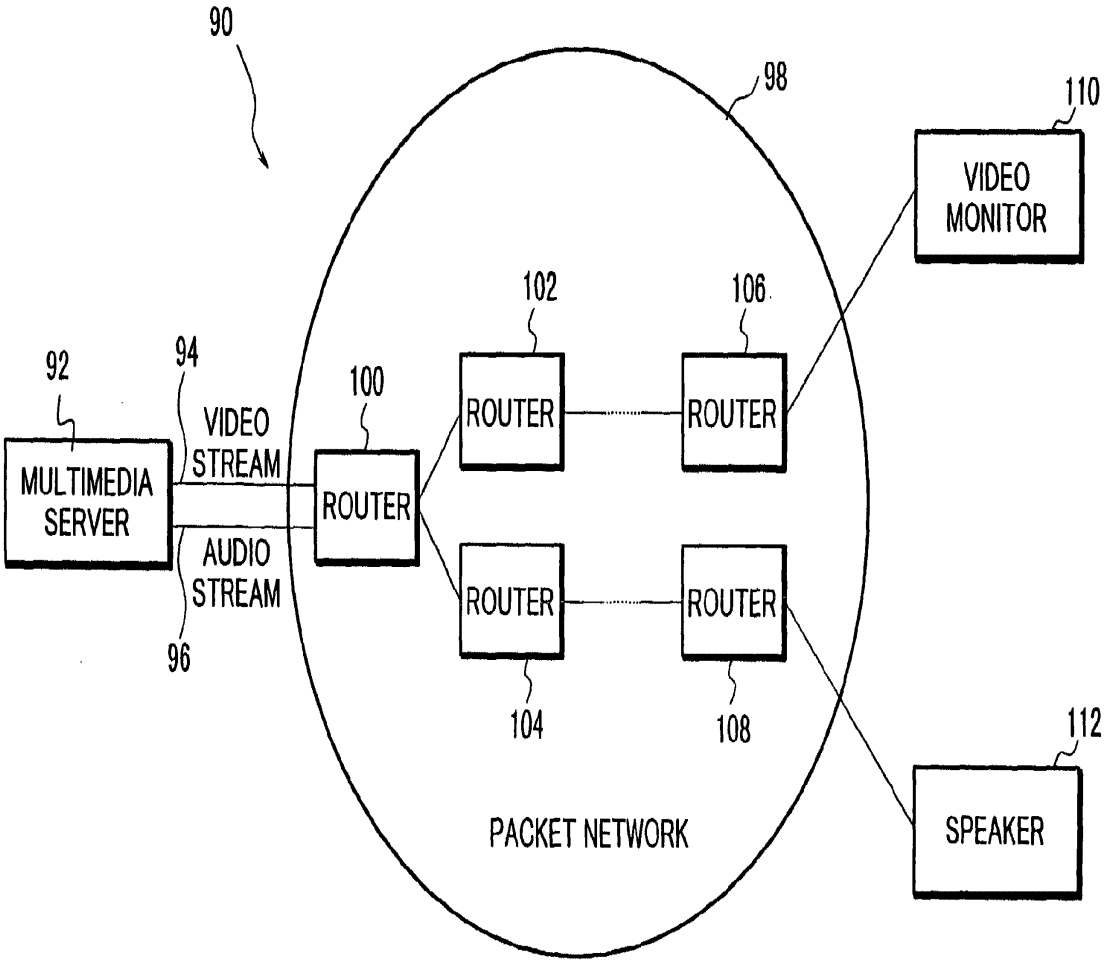

60
66
PACKET NETWORK
70
62
64
68
ROUTER
MULTIMEDIA SERVER
ROUTER
72
80
MULTIMEDIA RECEIVER
B
74
76
GATEWAY
ROUTER
82
MULTIMEDIA RECEIVER
B
LOCAL NETWORK
ROUTER
84
MULTIMEDIA RECEIVER
B
78

FIG.4

FIG.5


90
98
110
VIDEO MONITOR
102
106
92
94
100
ROUTER
ROUTER
MULTIMEDIA SERVER
VIDEO STREAM
ROUTER
AUDIO STREAM
96
ROUTER
ROUTER
104
108
112
PACKET NETWORK
SPEAKER

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H04L 7/10

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H4P PPF

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(54) **Synchronizing multiple independent data streams in a networked computer system**

(57) Multiple independent data streams 318 transferred across a communication medium from a server computer system 310, 312 to a client computer system 320, 322 are synchronised by 1) capturing information into a data packet, the capturing step being performed by the server system; 2) storing time information into the data packet, the time information indicating when the capturing step is complete; 3) transferring the data packet to the client system across the communication medium; 4) initializing a virtual server system clock if the data packet is a first data packet in the data stream; 5) retrieving the time information from the data packet; 6) comparing the time information with the virtual server system clock; and 7) processing the information in the data packet if the time information indicates a time equal to a time indicated by the virtual server system clock. The present invention further includes the steps of: 1) scheduling processing of the information in the data packet if the time information indicates a time later than a time indicated by the virtual server system clock; and 2) discarding the data packet if the time information indicates a time earlier than a time indicated by the virtual server system clock.

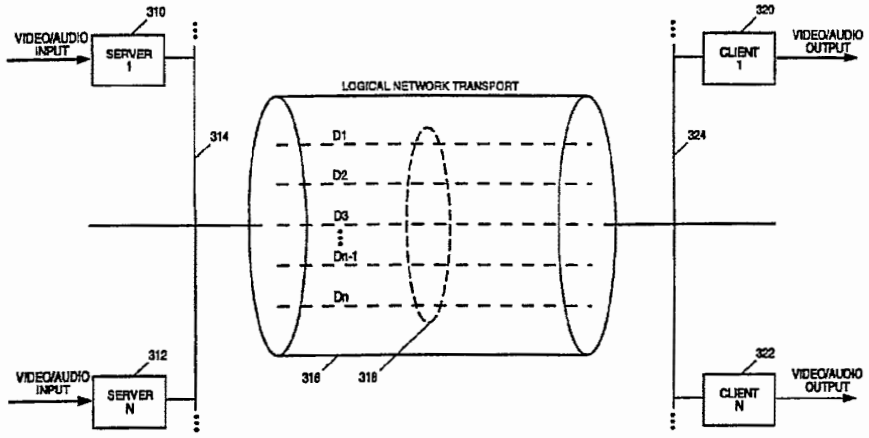


FIG.3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 284 327 A

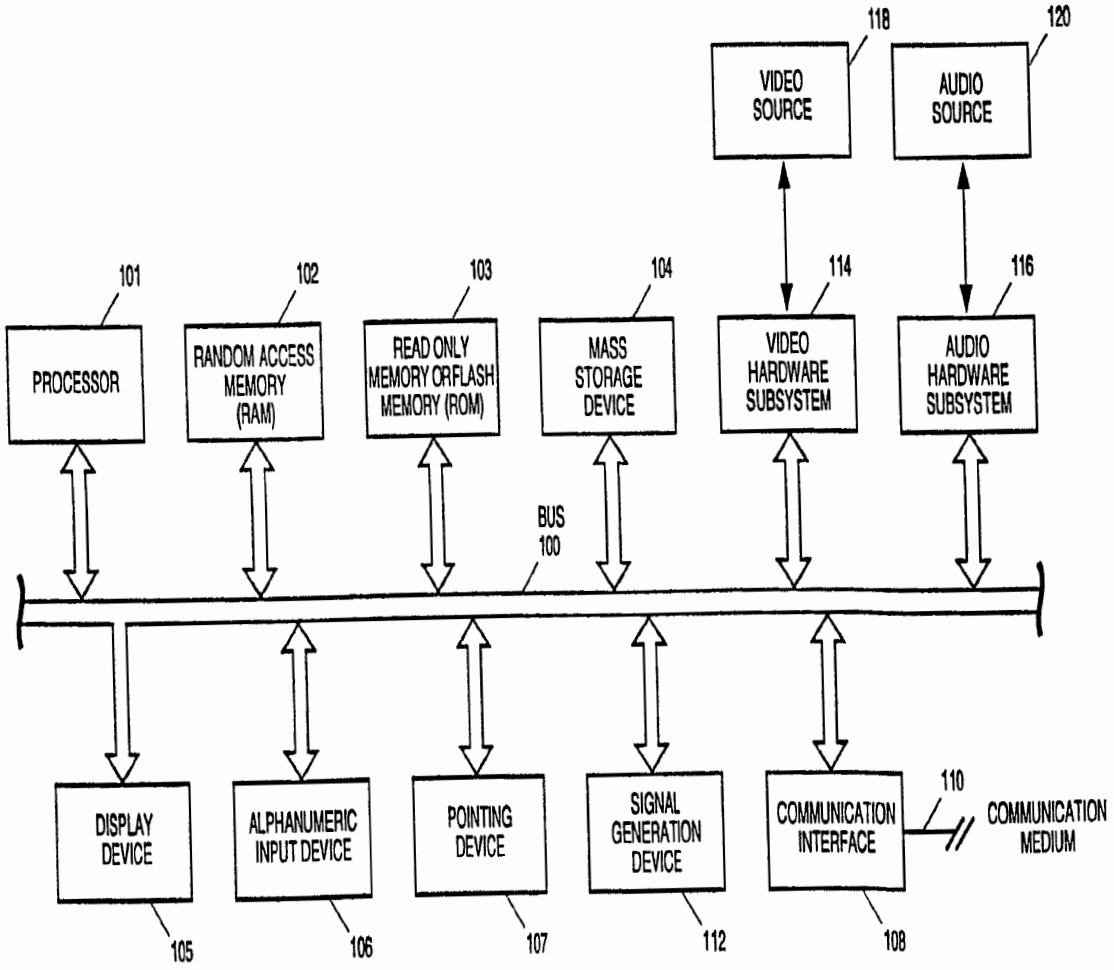

118
120
VIDEO SOURCE
AUDIO SOURCE
101
102
103
104
114
116
PROCESSOR
RANDOM ACCESS MEMORY (RAM)
READ ONLY MEMORY ORFLASH MEMORY (ROM)
MASS STORAGE DEVICE
VIDEO HARDWARE SUBSYSTEM
AUDIO HARDWARE SUBSYSTEM
BUS
100
DISPLAY DEVICE
ALPHANUMERIC INPUT DEVICE
POINTING DEVICE
SIGNAL GENERATION DEVICE
COMMUNICATION INTERFACE
110
COMMUNICATION MEDIUM
105
106
107
112
108

FIG.1

1/9

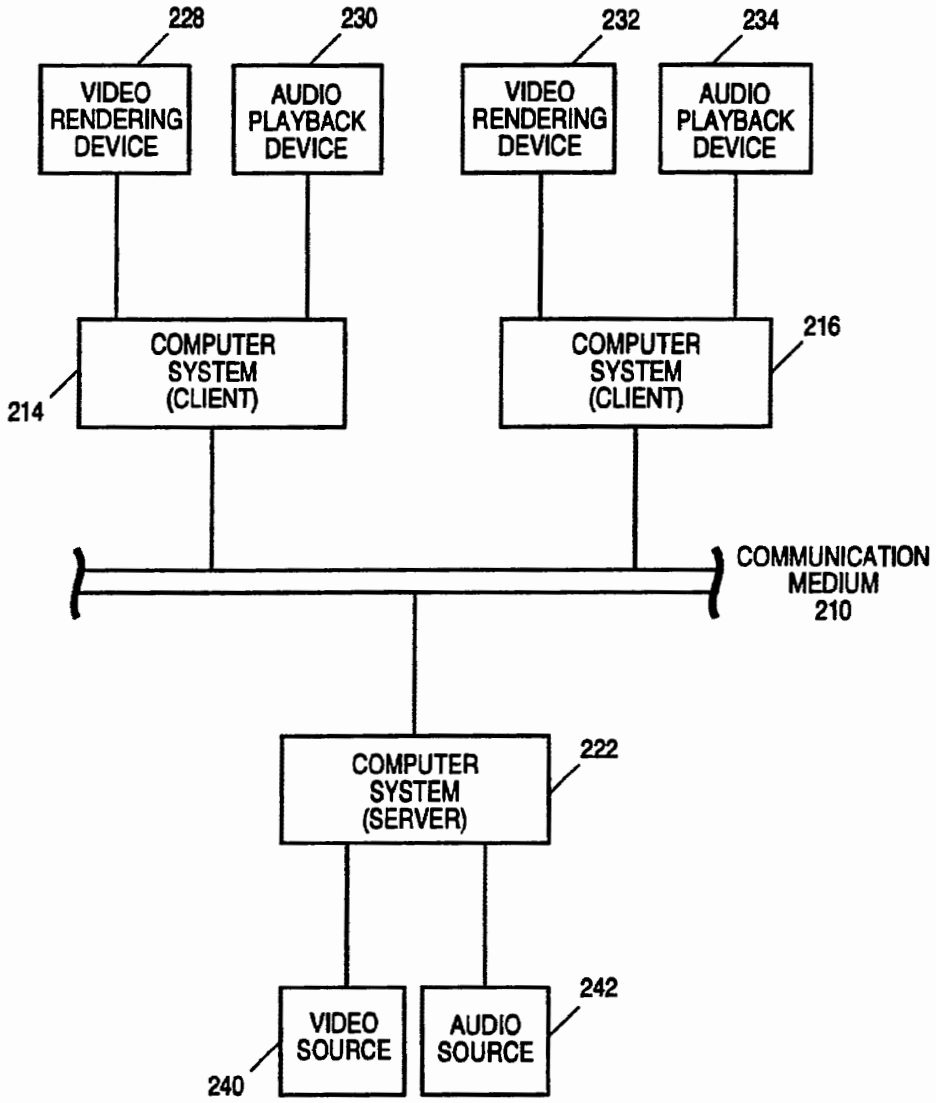

228
230
232
234
VIDEO RENDERING DEVICE
AUDIO PLAYBACK DEVICE
VIDEO RENDERING DEVICE
AUDIO PLAYBACK DEVICE
COMPUTER SYSTEM (CLIENT)
214
COMPUTER SYSTEM (CLIENT)
216
COMMUNICATION MEDIUM 210
COMPUTER SYSTEM (SERVER)
222
VIDEO SOURCE
240
AUDIO SOURCE
242

FIG.2

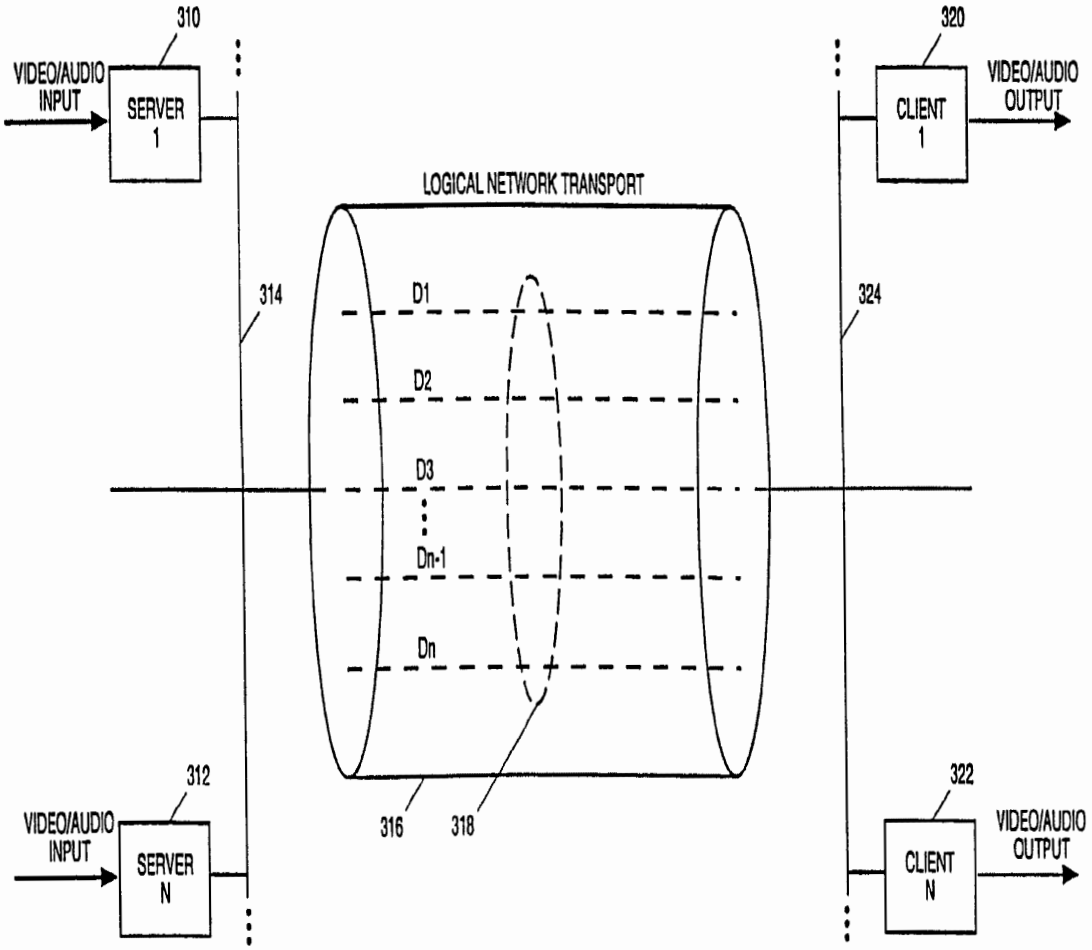

310
VIDEO/AUDIO INPUT
SERVER 1
320
CLIENT 1
VIDEO/AUDIO OUTPUT
LOGICAL NETWORK TRANSPORT
314
324
D1
D2
D3
Dn-1
Dn
312
VIDEO/AUDIO INPUT
SERVER N
316
318
322
CLIENT N
VIDEO/AUDIO OUTPUT

FIG.3

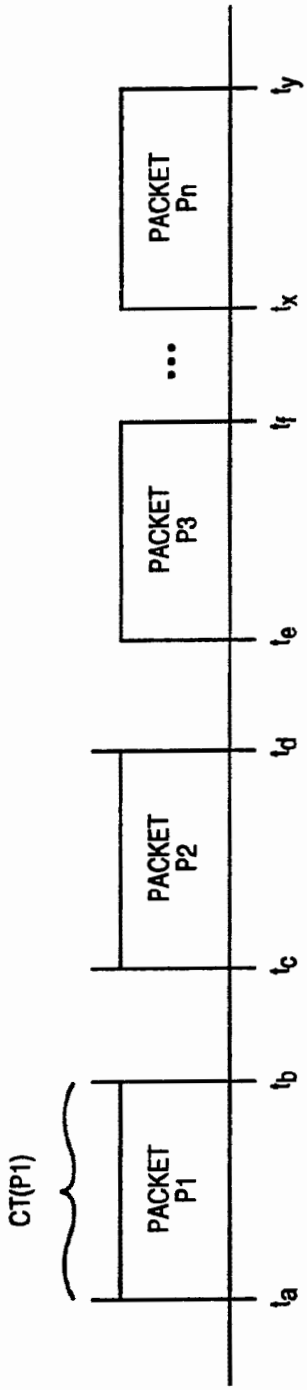

CT(P1)
PACKET P1
PACKET P2
PACKET P3
PACKET Pn
t_a
t_b
t_c
t_d
t_e
t_f
t_x
t_y
$t_b = t_a + CT(P1)$
$t_a = t_b - CT(P1)$

FIG.4

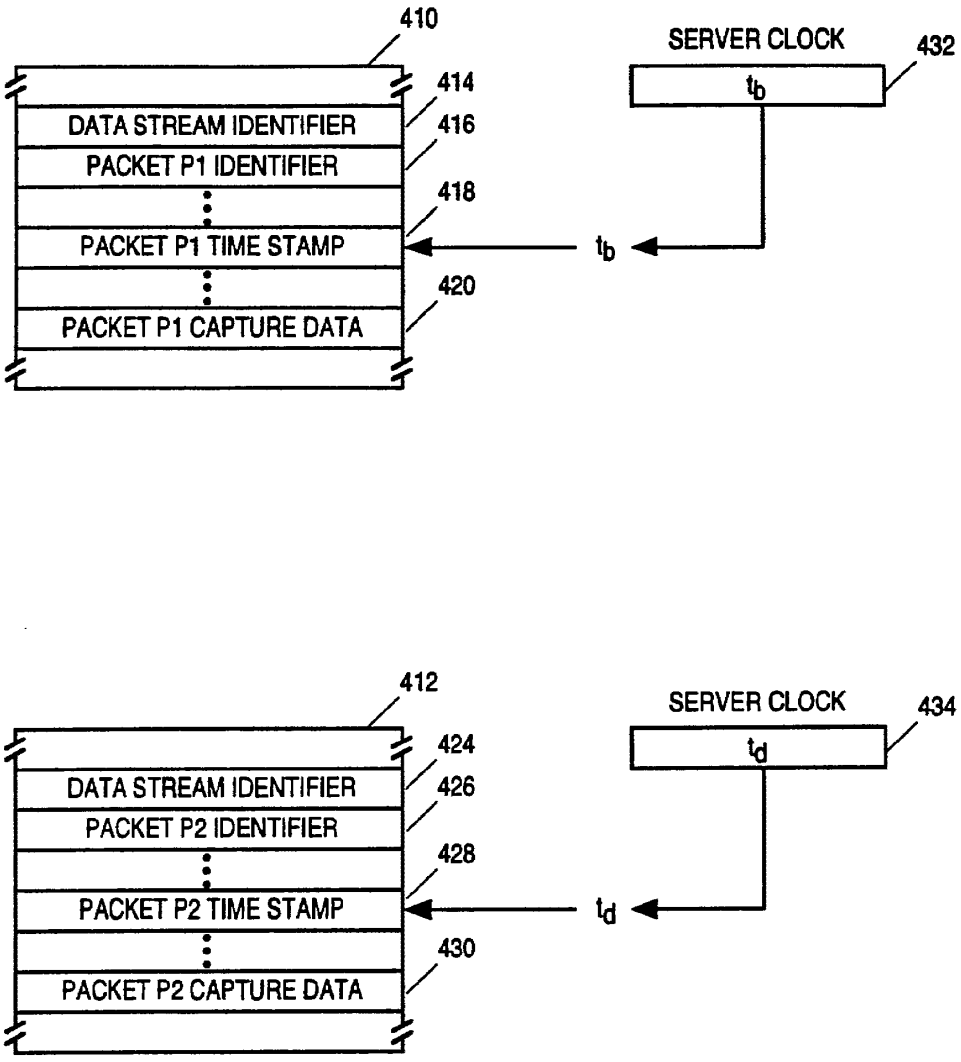

410
414
DATA STREAM IDENTIFIER
416
PACKET P1 IDENTIFIER
418
PACKET P1 TIME STAMP
420
PACKET P1 CAPTURE DATA
SERVER CLOCK
432
t_b
t_b
412
424
DATA STREAM IDENTIFIER
426
PACKET P2 IDENTIFIER
428
PACKET P2 TIME STAMP
430
PACKET P2 CAPTURE DATA
SERVER CLOCK
434
t_d
t_d

FIG.5

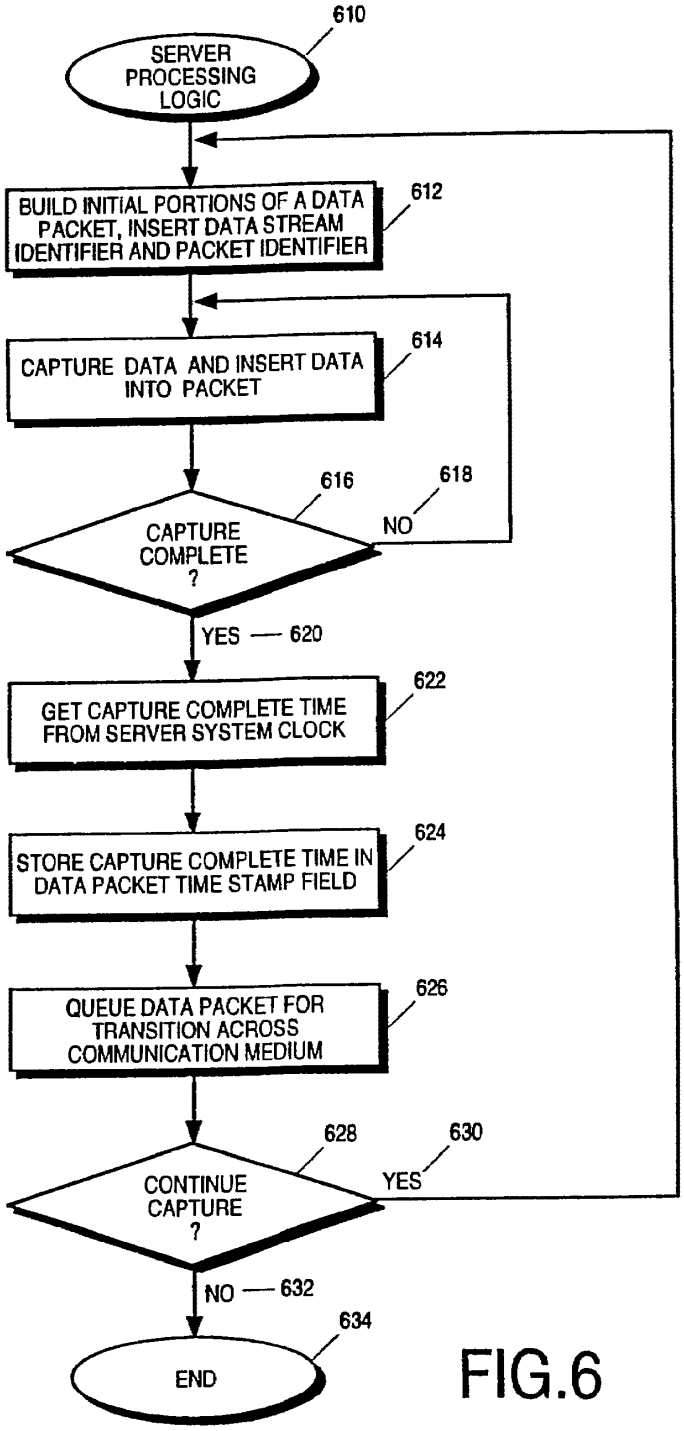

610
SERVER PROCESSING LOGIC
612
BUILD INITIAL PORTIONS OF A DATA PACKET, INSERT DATA STREAM IDENTIFIER AND PACKET IDENTIFIER
614
CAPTURE DATA AND INSERT DATA INTO PACKET
616
CAPTURE COMPLETE ?
618
NO
YES — 620
622
GET CAPTURE COMPLETE TIME FROM SERVER SYSTEM CLOCK
624
STORE CAPTURE COMPLETE TIME IN DATA PACKET TIME STAMP FIELD
626
QUEUE DATA PACKET FOR TRANSITION ACROSS COMMUNICATION MEDIUM
628
CONTINUE CAPTURE ?
630
YES
NO — 632
634
END

FIG.6

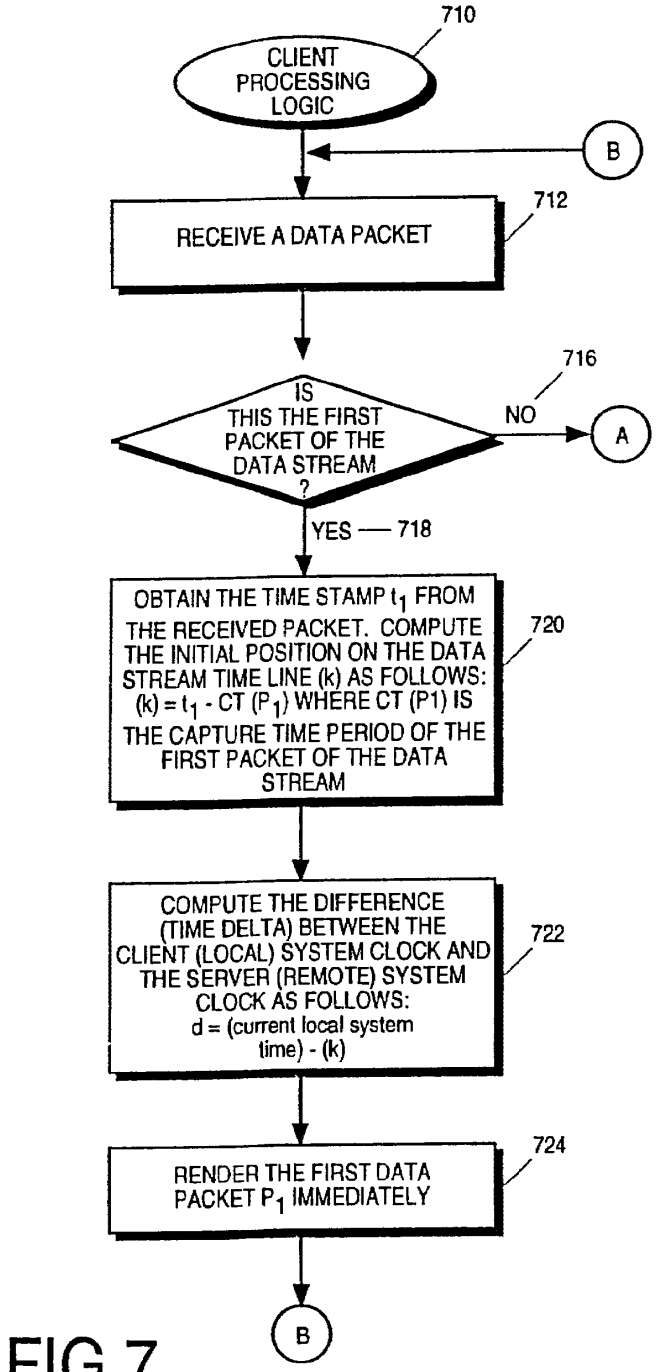

710
CLIENT PROCESSING LOGIC
B
712
RECEIVE A DATA PACKET
716
IS THIS THE FIRST PACKET OF THE DATA STREAM ?
NO
A
YES — 718
OBTAIN THE TIME STAMP t_1 FROM THE RECEIVED PACKET. COMPUTE THE INITIAL POSITION ON THE DATA STREAM TIME LINE (k) AS FOLLOWS: (k) = t_1 - CT (P_1) WHERE CT (P1) IS THE CAPTURE TIME PERIOD OF THE FIRST PACKET OF THE DATA STREAM
720
COMPUTE THE DIFFERENCE (TIME DELTA) BETWEEN THE CLIENT (LOCAL) SYSTEM CLOCK AND THE SERVER (REMOTE) SYSTEM CLOCK AS FOLLOWS: d = (current local system time) - (k)
722
RENDER THE FIRST DATA PACKET P_1 IMMEDIATELY
724
B

FIG.7

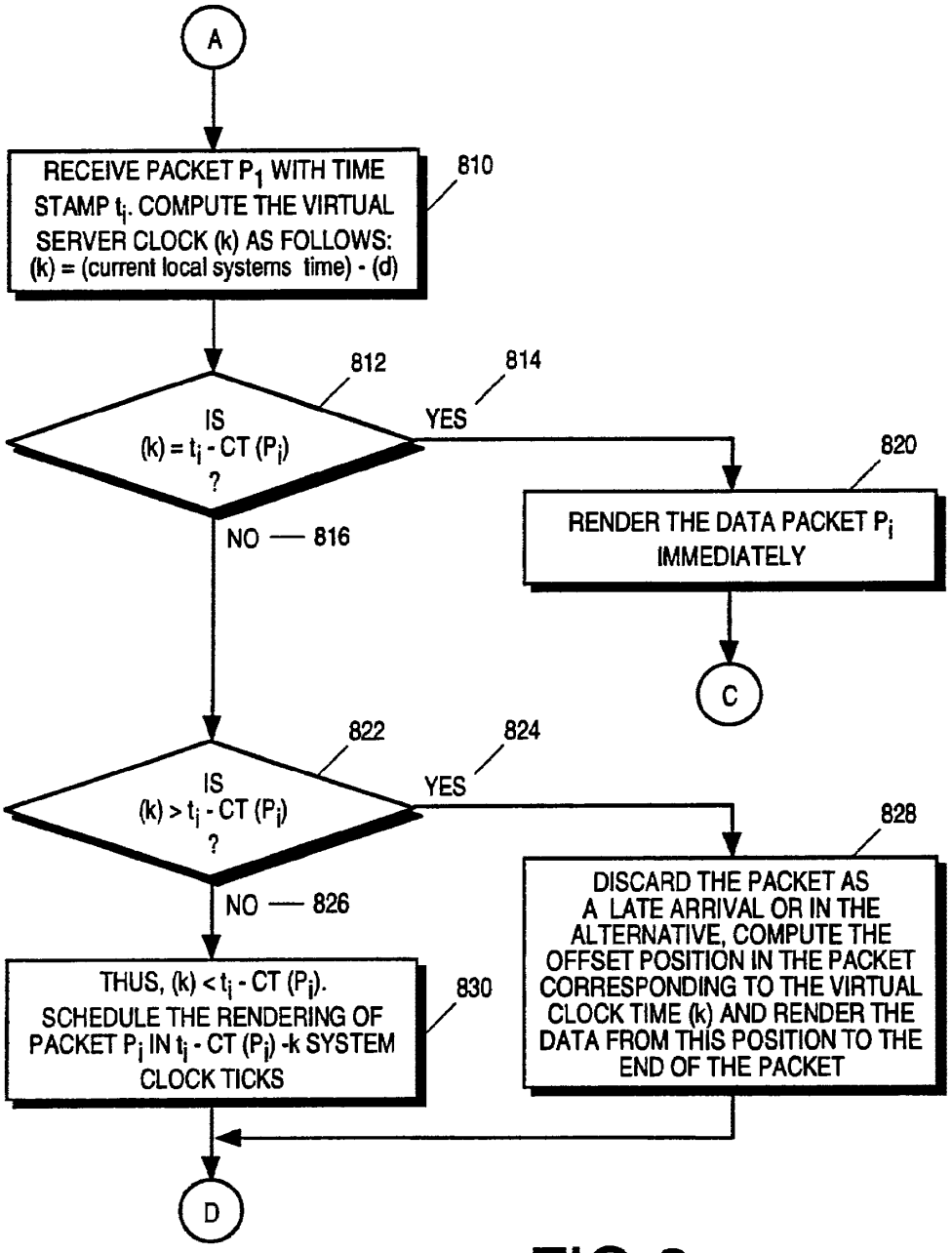

A
RECEIVE PACKET P_1 WITH TIME STAMP t_i. COMPUTE THE VIRTUAL SERVER CLOCK (k) AS FOLLOWS: (k) = (current local systems time) - (d)
810
812
IS (k) = t_i - CT (P_i) ?
814
YES
820
RENDER THE DATA PACKET P_i IMMEDIATELY
C
NO — 816
822
IS (k) > t_i - CT (P_i) ?
824
YES
828
DISCARD THE PACKET AS A LATE ARRIVAL OR IN THE ALTERNATIVE, COMPUTE THE OFFSET POSITION IN THE PACKET CORRESPONDING TO THE VIRTUAL CLOCK TIME (k) AND RENDER THE DATA FROM THIS POSITION TO THE END OF THE PACKET
NO — 826
THUS, (k) < t_i - CT (P_i). SCHEDULE THE RENDERING OF PACKET P_i IN t_i - CT (P_i) -k SYSTEM CLOCK TICKS
830
D

FIG.8

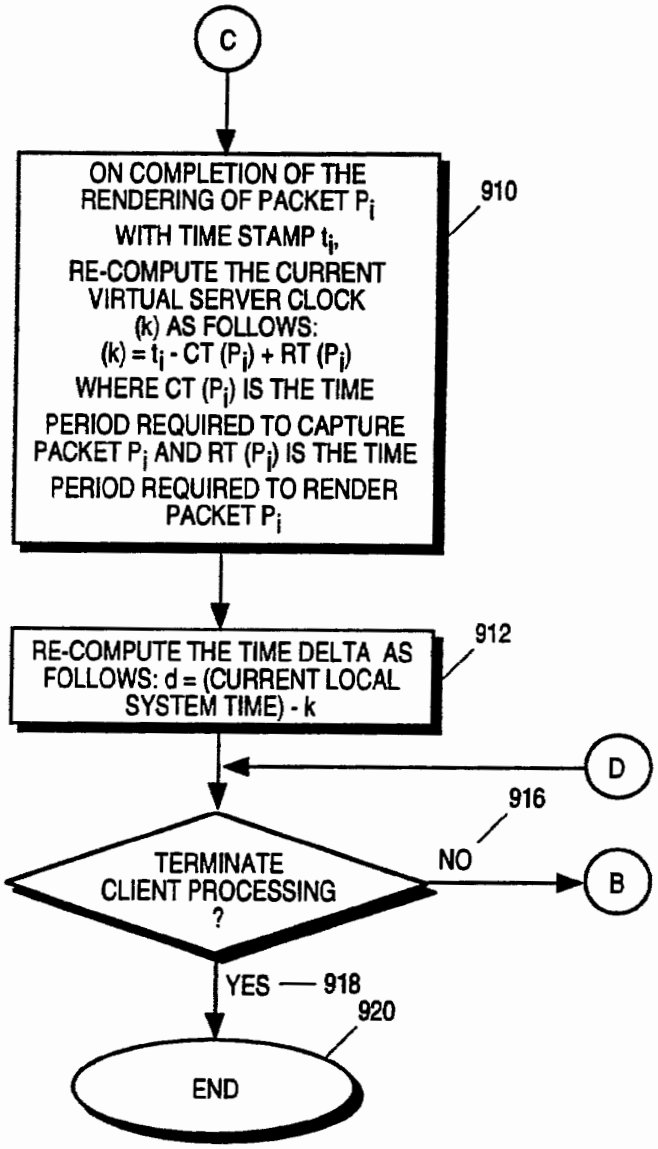

C
ON COMPLETION OF THE RENDERING OF PACKET P_i WITH TIME STAMP t_i, RE-COMPUTE THE CURRENT VIRTUAL SERVER CLOCK (k) AS FOLLOWS: $(k) = t_i - CT(P_i) + RT(P_i)$ WHERE $CT(P_i)$ IS THE TIME PERIOD REQUIRED TO CAPTURE PACKET P_i AND $RT(P_i)$ IS THE TIME PERIOD REQUIRED TO RENDER PACKET P_i
910
RE-COMPUTE THE TIME DELTA AS FOLLOWS: d = (CURRENT LOCAL SYSTEM TIME) - k
912
D
916
TERMINATE CLIENT PROCESSING ?
NO
B
YES
918
920
END

FIG.9

A METHOD AND APPARATUS FOR SYNCHRONIZING MULTIPLE INDEPENDENT DATA STREAMS IN A NETWORKED COMPUTER SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of a networked computer system. Specifically, the present invention relates to the transfer and synchronization of multiple data streams across a computer network or various types of communication media.

2. Description of Related Art

In a networked computer system, it is often necessary to send multiple streams of data to a remote network site. Typically, the streams of data must be processed in the correct order and synchronized with respect to each data stream. For example, audio and video streams in a teleconferencing application must be synchronized to provide the correct relationship between the audio and video data. Conventional systems implement data streams as a plurality of data packets that can be independently transferred across a network. Currently, packetized data streams may be synchronized by interleaving the data packets that make up the streams in such a way that the packets are sent to the network in synchronized order. This interleaving method has several drawbacks. First, not all networks can guarantee an in-order delivery of data packets. The synchronization between data streams may be lost by a network that randomly delays the transfer of a data packet. Secondly, even if in-order delivery of packets is guaranteed, the interleaving method does not allow synchronization of data streams where the data

stream cannot be sent in a single interleaved stream. For example, where the data streams are sent on different network channels, two different network addresses, or on different networks, the data streams cannot be sent in a single interleaved stream. In other situations, multiple originators or producers of data streams (i.e. servers) may exist on a network. In this case, data streams from a single server must be synchronized with respect to each other; but, synchronization from one server to another may not be required. In other situations it may be necessary to mix a set of data streams originated by multiple servers into one unified data stream for delivery to a client network node. For example, instead of two servers each sending an audio and video stream to a client node for processing, it may be more efficient to mix the audio signals into a unified stream which then must be synchronized with both video streams. Conventional systems are incapable of providing these multiple levels of data stream synchronization.

Thus, a better method for synchronizing multiple independent data streams in a networked computer system is needed.

SUMMARY OF THE INVENTION

The present invention is an apparatus and method for synchronizing multiple independent data streams in a networked computer system. In a computer network having a plurality of computer systems coupled by a communication medium, one of the plurality of computer systems being a server system, a different one of the plurality of computer systems being a client system, a method for synchronizing a data stream transferred from the server system to the client system, the method comprising the steps of: 1) capturing information into a data packet, the capturing step being performed by the server system; 2) storing time information into the data packet, the time information indicating when the capturing step is complete; 3) transferring the data packet to the client system across the communication medium; 4) initializing a virtual server system clock if the data packet is a first data packet is the data stream; 5) retrieving the time information from the data packet; 6) comparing the time information with the virtual server system clock; and 7) processing the information in the data packet if the time information indicates a time equal to a time indicated by the virtual server system clock. The present invention further includes the steps of: 1) scheduling processing of the information in the data packet if the time information indicates a time later than a time indicated by the virtual server system clock; and 2) discarding the data packet if the time

information indicates a time earlier than a time indicated by the virtual server system clock.

It is therefore an advantage of the present invention to provide a means and method for time stamping packets of a data stream. It is a further advantage of the present invention to provide a means and method for synchronizing data streams arriving from one server and providing them to a client in the same time sequence as they were captured. It is a further advantage of the present invention to provide a data stream synchronization means and method wherein data streams may take independent paths across a network. It is a further advantage of the present invention to provide a means and method for mixing a plurality of data streams for playback in one unified stream.

These and other advantages of the present invention are fully described in the following detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram illustrating the computer system hardware used in the preferred embodiment.

Figure 2 illustrates a typical network environment in which the present invention operates.

Figure 3 illustrates a multiple server, multiple client network environment.

Figure 4 illustrates a time line with associated data packets of a data stream.

Figure 5 illustrates the data structure of a data packet.

Figures 6 through 9 are flow charts illustrating the processing logic of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is an apparatus and method for synchronizing multiple independent data streams in a networked computer system. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that these specific details need not be used to practice the present invention. In other circumstances, well known structures, materials, circuits, and interfaces have not been shown or described in detail in order to not unnecessarily obscure the present invention.

Referring now to Figure 1, a block diagram of the computer system hardware used in the preferred embodiment is illustrated. The computer system used in the preferred embodiment comprises a Bus 100 for communicating information between computer system components. These components coupled to Bus 100 include Processor 101. Processor 101 may be implemented as any of a variety of commonly available microprocessors such as the 386 brand, i486 brand, or Pentium brand microprocessors manufactured by Intel Corporation, Santa Clara, California. The Intel, 386, i486, and Pentium marks are trademarks of Intel Corporation. It will be apparent of ordinary skill in the art that other equivalent processors may be used with the present invention. Other system components include Random Access Memory (RAM)

102, Read Only Memory (ROM) 103, and mass storage device or disk drive 104. The computer system of the preferred embodiment also includes a display device 105 coupled to the Bus 100 for displaying information to a computer user, an alphanumeric input device 106 coupled to the Bus 100 for communicating information and command selections to the Processor 101, a pointing device or cursor control device 107 coupled to the Bus 100 for communicating information and command selections to Processor 101, and a signal generation device 112 coupled to the Bus 100 for communicating command selections to the Processor 101. Display device 105 may be a liquid crystal device, a cathode ray tube, or other suitable display device. Alphanumeric input device 106 is typically an alphanumeric or function key keyboard. Pointing device or cursor control device 107 is typically a mouse, trackball, or stylus device allowing the computer user to dynamically signal the two dimensional movement of a visible symbol (i.e., cursor) on the display screen of display device 105. Many implementations of the cursor control device 107 are well known in the art including trackball systems, mouse systems, joy sticks, stylus, or special keys on the alphanumeric input device 106 capable of signaling movement in a given direction. Signal generation device 112 is typically implemented as a button or switch located on or near the cursor control device 107.

The computer system used in the preferred embodiment includes a communication interface 108 coupled to Bus 100. Communication

interface 108 is also coupled to a communication medium 110. Communication interface 108 provides a means for the computer system to communicate with a network of other computer systems. A variety of networks or communication media are well known in the art. These communication media 110 include well known Local Area Networks (LAN) such as Ethernet, Wide Area Networks (WAN), telephone modem links, or other well known and conventional computer networking technology.

The computer system of the preferred embodiment also includes video hardware subsystem 114 and audio hardware subsystem 116 both coupled to Bus 100. A video source 118, such as a video camera or video tape player, is coupled to video hardware subsystem 114. An audio source 120, such as a microphone or audio tape player, is coupled to audio hardware subsystem 116. Video hardware subsystem 114 provides a means by which the computer system of the preferred embodiment may receive video signals and convert the video signals for transfer to other system components as a stream of digital video information via Bus 100. Similarly, audio hardware subsystem 116 provides a means by which the present invention may receive audio signals and convert the audio signals to a stream of digital audio information for transfer to other system components via Bus 100. In a similar manner, the video data streams provided by video hardware subsystem 114 and the audio data streams provided by audio hardware

subsystem 116 may be transferred under control of Processor 101 to other networked computer systems via communication interface 108 and communication medium 110. The present invention provides a means and method for synchronizing these data streams in a networked computer system. Except as described herein, the configuration and interconnection of computer system components as illustrated in Figure 1 are well known to those of ordinary skill in the art.

Referring now to Figure 2, a typical environment in which the present invention operates is illustrated. The present invention operates in an environment comprising a set of computer systems linked in a network topology by a communication medium 210. It will be apparent to those of ordinary skill in the art that any arbitrary number of computer systems may be so linked. In the example network environment illustrated in Figure 2, each computer system 214, 216 and 222 is shown coupled to communication medium 210. Each of these computer systems comprise components such as those illustrated in Figure 1. Computer systems 214 and 216 may be coupled to video rendering devices, such as a display, and audio playback devices. Computer system 222 may be coupled to a video source and an audio source. For example, computer system 214 is coupled to video rendering device 228 and audio playback device 230. Similarly, computer system 222 is coupled to video source 240 and audio source 242. It is not necessary for each computer system coupled to

communication medium 210 to have video rendering devices, video sources, audio playback devices, and/or audio sources connected to them. In a variety of configurations, computer systems coupled to communication medium 210 may independently be coupled to a video source or rendering device and an audio source or playback device, a video source only, an audio source only, or neither a video source or audio source. A single video source or audio source may also be shared between two computer systems. In any of these configurations, the video source provides a stream of video data which a computer system may provide to other computer systems via communication medium 210. Similarly, an audio source provides a steam of audio data which may be provided to other computer systems via communication medium 210. It will be apparent to one of ordinary skill in the art that data types other than video or audio may equivalently be supported.

A computer system on which video or audio data steams originate is called a server for the data streams. In the example of Figure 2, computer system 222 is a server. When acting as a server, computer system 222 receives video signals via video source 240 and audio signals via audio source 242 and converts these signals to video and audio data streams, which are provided to other computer systems via communication medium 210. These data streams are transferred on communication medium 210 by server 222 and transported to remote computer systems such as computer system 214 and 216. Any remote

computer system receiving data streams from a server and rendering or playing the data to a local user is known as a client system for the data streams. Thus, in general, a server system is an originator of data streams and a client system is a receiver or consumer of data streams. The client system is responsible for synchronizing the data streams arriving from a server and for rendering the data streams to a local user in the same time sequence as the data streams were captured by the server system. It is not essential to the present invention that the data streams from the server arrive on the same network media. It is only important that the data streams are provided in some way to a client computer system via a communication medium. The client system may then synchronize the data streams and render them to a local user using the technique taught herein.

Although the example illustrated in Figure 2 shows a single server system 222, the present invention is applicable to network environments wherein multiple servers and multiple clients exist on the network at one time. A multiple server, multiple client network configuration is illustrated in Figure 3.

Referring to Figure 3, servers 310 and 312 are coupled to clients 320 and 322 via communication medium 314, 316 and 324. A portion of network medium 316 is blown up in Figure 3 to illustrate the multiple independent data streams 318 concurrently being transferred across network medium 316 from servers 310 and 312 to clients 320 and 322.

Each data stream of data streams 318 consist of a sequence of data packets. Each data packet comprises a portion of information captured by a server system. This information may represent a captured video image, or portion thereof, a captured audio representation or any other collection of information that may be represented as binary information. In a typical implementation, the video hardware subsystem of a server system captures a video image and creates a sequence of data packets that are transferred across network 316 as one of data streams 318. Similarly, other data streams of data steams 318 are generated by other server systems. In the synchronization process of the present invention, the client system seeks to establish the same time line or synchronization for rendering the data packets as was present during the capturing of the data packets performed by the corresponding server system. In this manner, the client system is able to render information in a manner corresponding to the way the information was captured by a server system. This synchronization can occur regardless of the manner by which the information is transferred between the server and client systems. Moreover, the present invention can be used to synchronize data streams with respect to each other. In this manner, a video stream may be synchronized with an audio stream and rendered by a client system appropriately. Further details of the synchronization process of the present invention follow.

Referring now to Figure 4, data packets P_1 to P_n are shown on a time line. Data packets P_1 through P_n represent the data packets of a data stream such as data stream D_1 illustrated in Figure 3. Each packet comprises information collected or captured during a time frame defined by a beginning capture time and an ending capture time. For example, referring to Figure 4, packet P_1 comprises information captured between time t_a and time t_b. A function CT defines the capture time for a particular packet of a data stream. As illustrated in Figure 4, the capture time for packet P_1, CT (P_1) is defined as the time period between t_a and t_b. In one embodiment of the present invention, the capture time for each data packet of a data stream is identical and preset to some fixed value. In an alternative embodiment of the present invention, the capture time for each data packet of a data stream may be different. Thus, function CT is used to determine the capture time for a particular data packet. As indicated by the equations in Figure 4, the ending capture time, t_b, may be determined by knowing the beginning capture time, t_a, and the capture time CT (P_1). Similarly, the beginning capture time, t_a, may be determined if the ending capture time, t_b, and the capture time CT (P_1) is known. Similar computations may be performed for each data packet P_1 through P_n of a data stream.

In support of the synchronization process of the present invention, a time stamp is applied to each data packet of a data stream. When a server computer system captures data into data packets, the server

stamps its system clock time into each packet of the data stream. In the preferred embodiment, this time stamp represents the system clock time at the data packet ending capture time. Thus, for the example illustrated in Figure 4, the time stamp applied to packet P_1 is t_b. The computer system clock is assumed to be a monotonically increasing count of the system clock ticks. Thus, CT (P_1) equals the number of system clock ticks between t_a and t_b. Each data packet generated by a server is stamped with the ending capture time of the packet. Thus, packet P_2 is stamped with time t_d, packet P_3 is stamped with time t_f, and packet P_n is time stamped with time t_y. In this manner, each data packet of a data stream is referenced to a unique position on a data stream time line, such as the one illustrated in Figure 4. Each data packet is thereby associated with a fixed moment in time on the server system clock.

Referring now to Figure 5, the data structure of two data packets 410 and 412 are illustrated. In the example of Figure 4, data packet 410 corresponds to packet P_1 and data packet 412 corresponds to packet P_2.

Each data packet in a data stream comprises a data steam identifier 414, a packet identifier 416, a packet time stamp 418, and packet capture data 420 as illustrated in Figure 5. Data stream identifier 414 uniquely identifies the data stream of which the data packet is a member. The data stream identifier 414 may include an encoded value representing the source of capture data 420 or the identity of the server that generated the data packet 410. It will be apparent to one of ordinary

skill in the art that other means for uniquely identifying a particular data stream may be employed and encoded into data stream identifier 414. Packet identifier 416 is used to uniquely identify a particular data packet within a data stream identified by data stream identifier 414. In the preferred embodiment, packet identifier 416 is a consecutively numbered sequence integer that defines a particular data packet's relative position in a data stream relative to other data packets in the data stream. Packet time stamp 418 is a binary value corresponding to the time at which the capture of capture data 420 was completed by a server system. For the example illustrated in Figure 4, capture for packet P_1 was completed at time t_b. Referring again to Figure 5, the time t_b is present on the server system clock 432 at the time capture is complete for packet P_1. During the process of building packet P_1, a server system captures data into region 420 of packet 410. When capture for this packet is complete, the time from server clock 432 is retrieved and stored in time stamp field 418. For the example of data packet P_1, the time in server clock 432 will be t_b. Having completed the generation of packet 410, the server system queues packet 410 for transmission across a communication medium and begins to generate the next data packet 412 in the data stream. In this case, the data stream identifier 424 will be the same as data stream identifier 414 in the previous data packet 410. Packet identifier 426 will uniquely identify data packet 412. A new set of capture data will be stored in capture data

region 430. When capture for data packet 412 is complete, the server clock 434 is read and the capture complete time (t_d) is stored in time stamp field 428. In this manner, a server system generates a data stream of data packets with a time stamp in each data packet that defines a capture data time line for the data stream.

Referring now to Figure 6, a flowchart illustrates the processing logic of the server system. The server processing starts by building the initial portions of a data packet (processing block 612). The data stream identifier, the packet stream identifier, and any other initial fields of the data packet are filled in processing block 612. The server system captures data and inserts the data into the data packet in processing block 614. For example, digitized video information may be stored into the capture data area 420 of the data packet in processing block 614. The capture and storage of data into the data packet continues until either a predetermined time period has elapsed or the capture data area 420 of the data packet is full. When this occurs, capture is complete and processing path 620 is taken. If capture is not complete, processing path 618 is taken and the data capture process continues at processing block 614.

Once capture is complete, the capture complete time is read from the server system clock in processing block 622. The capture complete time is stored in the data packet in time stamp field 418 in processing block 624. The data packet is queued for transmission across the

communication medium in processing block 626. As long as the capture process is not terminated, processing path 630 is taken to processing block 612 where a new data packet is generated. Processing for the server system terminates through processing path 632 at end bubble 634.

In the synchronization process of the present invention, the client system seeks to establish the same data packet time line for rendering the data packet that was established by the server system during the capture process. Because the transfer of data packets across the communication medium may occur at any arbitrary time or in any arbitrary sequence, the client system must rebuild the data stream into the same form and synchronization as the data stream generated by the server system.

Referring now to Figures 7 through 9, the processing logic for the client system is illustrated. Referring now to Figure 7, the client system receives a data packet in processing block 712. If this data packet is the first packet received by the client system for this data stream, processing path 718 is taken to processing block 720. Otherwise, processing path 716 is taken to the bubble labeled A and illustrated in Figure 8.

In processing block 720, the time stamp t_1 is retrieved from the received first data packet. The virtual server clock or the initial position on the data stream time line (k) is computed in processing block 720. The value (k) is a variable residing in and maintained by the client system that represents the virtual clock of the server system. The

variable (k) represents the value of the server system's clock at the current position in the rendered data stream. The value of (k) is initially set to the time stamp of the first data packet (t_1) less the capture time period of the first data packet of the data stream, CT (P_1). Another value (d) is computed in processing block 722. The variable (d) contains a time delta representing the difference between the client system clock and the virtual server system clock represented by the variable (k). The value of (d) is computed as the difference between the client's current local system time and the virtual server system clock (k). The values in variables (k) and (d) are used extensively during the synchronization process of the present invention as will be described in more detail below.

Once the initial processing for the first data packet is completed, the first data packet P_1 is rendered by the client's system in processing block 724. Rendering a data packet comprises extracting the capture data contained in the data packet and converting the data to a form suitable for transfer to an appropriate output device, such as a display device, a print device, an audio device, or other device compatible with the type of information contained in the data packet. Means and methods for rendering data from a data packet are well known to those of ordinary skill in the art.

On completion of the rendering step in processing block 724, processing control loops back to the top of the processing flow

illustrated in Figure 7 at the bubble labeled B. The next data packet is received in processing block 712. In this case, this data packet will not be the first data packet in the data stream. Therefore, processing path 716 is taken to the bubble labeled A illustrated in Figure 8.

Referring now to Figure 8, the capture system processing logic continues at the bubble labeled A. The next packet received in processing block 712 (P_i) contains time stamp t_i. The value of the virtual server clock (k) is computed in processing block 810. The virtual server clock (k) is set to the client current local system time less the time delta (d). The value of (k) now represents the current position on the data stream time line. The time stamp t_i is used to determine where on this time line the received packet P_i should be placed. The beginning capture time for packet P_i is computed and used for this process. The beginning capture time of packet P_i is the time stamp value t_i less the capture time CT of packet P_i. If the virtual server clock (k) is equal to the starting capture time of packet P_i, processing path 814 is taken to processing block 820 where packet P_i is immediately rendered. Processing for this packet then continues at the bubble labeled C illustrated in Figure 9. If, however, the virtual server clock is not equal to the starting capture time of packet P_i, processing path 816 is taken to decision block 822. If the virtual server clock (k) is greater than the starting capture time of packet P_i, processing path 824 is taken to processing block 828. In this case, the current position in the data

stream time line has already passed the position corresponding to this data packet. Thus, the packet P_i is discarded as a late arrival.

In an alternative embodiment, a portion of a single packet is discarded while the remainder of the packet is rendered. The starting capture time of packet P_i can be used to generate an offset into the packet that corresponds to the virtual sever clock time (k). If the number of samples in the packet is known or if the starting capture time of a subsequent packet is known, the offset into the current packet is generated as an interpolation of these values with the virtual server clock time (k). In this manner, the offset into the packet corresponding to (k) is computed. The portion of the packet P_i from the starting capture time to the offset value is discarded. The portion of packet P_i from the offset value to the and of the packet is rendered.

Processing then continues at the bubble labeled D illustrated in Figure 9. If the virtual server clock is less than the start capture time of packet P_i, processing path 826 is taken to processing block 830 where the rendering of packet P_i is scheduled for a future time corresponding to a number of client system clock ticks in advance of the current time. This future time is computed as a number of client system clock ticks equal to time stamp t_i less the capture time CT of packet P_i less virtual server clock value (k). Means and methods for scheduling the execution of an event at a particular time in a computer is well known to those of

ordinary skill in the art. Processing for the client system continues at the bubble labeled D illustrated in Figure 9.

Referring now to Figure 9, client processing logic continues at the bubble labeled C. On completion of the rendering of packet P_i with a time stamp t_i, the current virtual server clock (k) is recomputed in processing block 910. The value of the virtual server clock (k) is set to the time stamp t_i less the capture time CT of packet P_i plus the time required to render RT packet P_i. The time required to render a packet is represented by the function RT (P_1). The time delta (d) is recomputed in processing block 912. Time delta (d) is set to the client current local system time less the value of a virtual server clock (k). If client processing is selected to continue, processing path 916 is taken to the bubble labeled B illustrated in Figure 7 where the next data packet of the data stream is received. If client processing is selected for termination, processing path 918 is taken and capture processing terminates at end bubble 920.

The process of the present invention described above maintains the virtual server clock (k) and ensures that data packets are rendered by the client system at the same time with respect to the virtual server clock as they were captured. The virtual server clock variable (k) is efficiently maintained in the present invention in that (k) is not updated on every local system clock tick. Rather, a time delta (d) is maintained as the difference between the client local system clock and the virtual server

clock (k). Therefore, as the local system clock is updated, the virtual server clock (k) is also updated. The offset between the clocks is recalculated for each correctly rendered packet to avoid clock skew introduced if the local client clock runs slightly faster or slower than the server system clock.

The process of the present invention described above details an effective method of synchronization of a data stream arriving from one server. The same basic process may be used if there are multiple servers supplying data streams to a single client system. In one case, the streams from one server must be synchronized, but no synchronization is required between streams from different servers. In this case, the client system maintains a set of virtual clock offsets d_1 to d_n, one for each server. In addition, a virtual server clock value k_i is maintained for each server system. When a data packet arrives from a particular server, that server's virtual clock, k_i, is calculated from the correct offset d_i. When a packet is finished rendering, the virtual clock offset d_i for that particular server is updated in a manner similar to the process described above.

In some environments, it is necessary to mix a set of data streams into one unified stream for playback. For example, instead of two servers each sending an audio and video stream to a client for rendering, it may be more efficient to mix the audio into a unified stream which then must be synchronized with both video streams. In this case, the

client system must maintain a set of virtual clock offsets for more than one server. The mixed audio stream must preserve the time stamps from all of the originating servers. Therefore, the time stamp of a packet in the mixed stream is a set of server identifiers and time stamp pairs. The decision to render a packet is now made as a consensus of whether the time stamps for each of the servers is ahead of or behind the virtual clock value for that server. A mixed data packet is scheduled for rendering at a time which satisfies one or more of the virtual clocks. When a mixed packet has been rendered, the virtual clock offsets for all of the servers contributing to the mixed packet are updated.

Thus, an apparatus and method for synchronizing multiple independent data streams in a networked computer system is disclosed. Although the present invention is described herein with reference to a specific preferred embodiment, many modifications and variations therein will readily occur to those of ordinary skill in the art. Accordingly, all such variations and modifications are included within the intended scope of the present invention as defined by the following claims.

CLAIMS

1. In a computer network having a plurality of computer systems coupled by a communication medium, one of said plurality of computer systems being a server system, a different one of said plurality of computer systems being a client system, a method for synchronizing a data stream transferred from said server system to said client system, said method comprising the steps of:

capturing information into a data packet, said capturing step being performed by said server system;

storing time information into said data packet, said time information indicating when said capturing step is complete;

transferring said data packet to said client system across said communication medium;

initializing a virtual server system clock if said data packet is a first data packet is said data stream;

retrieving said time information from said data packet;

comparing said time information with said virtual server system clock; and

processing said information in said data packet if said time information indicates a time equal to a time indicated by said virtual server system clock.

2. The method as claimed in claim 1 further including the step of:

scheduling processing of said information in said data packet if said time information indicates a time later than a time indicated by said virtual server system clock.

3. The method as claimed in claim 1 further including the step of:

discarding said data packet if said time information indicates a time earlier than a time indicated by said virtual server system clock.

4. The method as claimed in claim 1 further including the steps of:

calculating an index into said information in said data packet corresponding to a value in said virtual server system clock;

discarding a first portion of said data packet from a beginning position in said data packet to a position in said data packet indicated by said index; and

processing a second portion of said data packet from a position in said data packet indicated by said index to an ending position of said data packet.

5. In a computer network having a plurality of computer systems coupled by a communication medium, one of said plurality of computer systems being a server system, a different one of said plurality of computer systems being a client system, a method for synchronizing

data streams transferred from said server system to said client system, said method comprising the steps of:

capturing information into a first set of data packets, said capturing step being performed by said server system;

capturing information into a second set of data packets, said capturing step being performed by said server system;

storing time information into said first set of data packets, said time information indicating when said capturing step is complete;

storing time information into said second set of data packets, said time information indicating when said capturing step is complete;

transferring said first set of data packets to said client system across said communication medium in a first data stream;

transferring said second set of data packets to said client system across said communication medium in a second data stream;

initializing a virtual server system clock if a data packet is a first data packet is a data stream;

retrieving said time information from data packets of said first set or said second set of data packets;

comparing said time information with said virtual server system clock; and

processing said information from data packets of said first set or said second set of data packets if said time information indicates a time equal to a time indicated by said virtual server system clock.

6. The method as claimed in claim 5 further including the step of:

scheduling processing of said information from data packets of said first set or said second set of data packets if said time information indicates a time later than a time indicated by said virtual server system clock.

7. The method as claimed in claim 5 further including the step of:

discarding data packets of said first set or said second set of data packets if said time information indicates a time earlier than a time indicated by said virtual server system clock.

8. The method as claimed in claim 5 further including the steps of:

calculating an index into said information in data packets of said first set or said second set of data packets corresponding to a value in said virtual server system clock;

discarding a first portion of data packets of said first set or said second set of data packets from a beginning position in said data packets to a position in said data packets indicated by said index; and

processing a second portion of data packets of said first set or said second set of data packets from a position in said data packets indicated by said index to an ending position of said data packets.

9. The method as claimed in claim 1 wherein said information captured in said data packet comprises either video or audio information.

10. The method as claimed in claim 5 wherein said information captured in said first set of data packets comprises video information and said information captured in said second set of data packets comprises audio information.

11. In a computer network having a plurality of computer systems coupled by a communication medium, one of said plurality of computer systems being a server system, a different one of said plurality of computer systems being a client system, an apparatus for synchronizing a data stream transferred from said server system to said client system, said apparatus comprising:

means for capturing information into a data packet, said means for capturing residing in said server system;

means for storing time information into said data packet, said time information indicating when said means for capturing is finished;

means for transferring said data packet to said client system across said communication medium;

means for initializing a virtual server system clock if said data packet is a first data packet is said data stream;

means for retrieving said time information from said data packet;

means for comparing said time information with said virtual server system clock; and

means for processing said information in said data packet if said time information indicates a time equal to a time indicated by said virtual server system clock.

12. The apparatus as claimed in claim 11 further including:

means for scheduling processing of said information in said data packet if said time information indicates a time later than a time indicated by said virtual server system clock.

13. The apparatus as claimed in claim 11 further including:

means for discarding said data packet if said time information indicates a time earlier than a time indicated by said virtual server system clock.

14. The apparatus as claimed in claim 11 further including:

means for calculating an index into said information in said data packet corresponding to a value in said virtual server system clock;

means for discarding a first portion of said data packet from a beginning position in said data packet to a position in said data packet indicated by said index; and

means for processing a second portion of said data packet from a position in said data packet indicated by said index to an ending position of said data packet.

15. In a computer network having a plurality of computer systems coupled by a communication medium, one of said plurality of computer systems being a server system, a different one of said plurality of computer systems being a client system, an apparatus for synchronizing data streams transferred from said server system to said client system, said apparatus comprising:

means for capturing information into a first set of data packets, said means for capturing residing in said server system;

means for capturing information into a second set of data packets, said means for capturing residing in said server system;

means for storing time information into said first set of data packets, said time information indicating when said means for capturing is finished;

means for storing time information into said second set of data packets, said time information indicating when said means for capturing is finished;

means for transferring said first set of data packets to said client system across said communication medium in a first data stream;

means for transferring said second set of data packets to said client system across said communication medium in a second data stream;

means for initializing a virtual server system clock if a data packet is a first data packet is a data stream;

means for retrieving said time information from data packets of said first set or said second set of data packets;

means for comparing said time information with said virtual server system clock; and

means for processing said information from data packets of said first set or said second set of data packets if said time information indicates a time equal to a time indicated by said virtual server system clock.

16. The apparatus as claimed in claim 15 further including:

means for scheduling processing of said information from data packets of said first set or said second set of data packets if said time information indicates a time later than a time indicated by said virtual server system clock.

17. The apparatus as claimed in claim 15 further including:

means for discarding data packets of said first set or said second set of data packets if said time information indicates a time earlier than a time indicated by said virtual server system clock.

18. The apparatus as claimed in claim 15 further including:

means for calculating an index into said information in data packets of said first set or said second set of data packets corresponding to a value in said virtual server system clock;

means for discarding a first portion of data packets of said first set or said second set of data packets from a beginning position in said data packets to a position in said data packets indicated by said index; and

means for processing a second portion of data packets of said first set or said second set of data packets from a position in said data packets indicated by said index to an ending position of said data packets.

19. The apparatus as claimed in claim 11 wherein said information captured in said data packet comprises either video or audio information.

20. The apparatus as claimed in claim 15 wherein said information captured in said first set of data packets comprises video information and said information captured in said second set of data packets comprises audio information.

21. A computer network having a plurality of computer systems, substantially as hereinbefore described, with reference to the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) 34	Application number GB 9416276.5
Relevant Technical Fields (i) UK Cl (Ed.M) H4P (PPF, PSB, PPS) (ii) Int Cl (Ed.5) H04L 7/10, 7/00, 12/56	Search Examiner J P Coules Date of completion of Search 21 September 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES : WPI, INSPEC	Documents considered relevant following a search in respect of Claims :- 1-21

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
A	EP 0234861 A2	(AMERICAN TELEPHONE AND TELEGRAPH CO) see Figure 11, page 28	1,5,11,15
A	EP 0059821 A1	(FOUR DEE AKTIEBOLOG) see time marker clock 20	1,5,11,15

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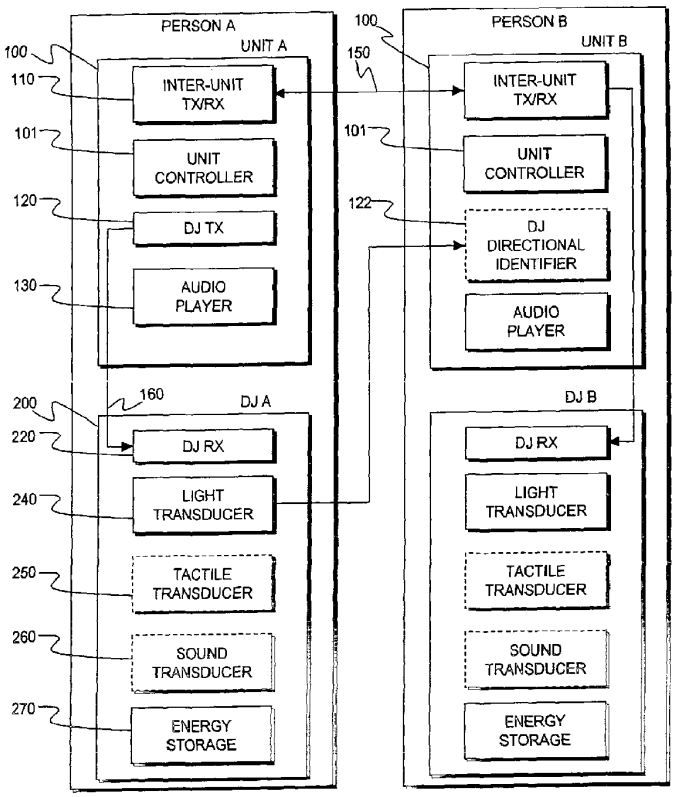
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(54) Title: LOCALIZED AUDIO NETWORKS AND ASSOCIATED DIGITAL ACCESSORIES



(57) Abstract: Individuals share music through portable audio devices that synchronously play music by transmitting music signals from one device to the other. Upon request, other individuals can join such a sharing group as a member, and these new members can either be accepted automatically, or through voting by existing group members. So that members of a group can converse, the fraction of ambient sound admitted by the earphones of the portable device can be manually set. In order to enhance the enjoyment of the music, wearable transducers, such as light emitting diodes, respond to signals related to the beat of the music. Signals can be automatically generated, or manually specified, and signals thereafter stored for playback with the music to which it is related. Wearable transducers associated with individuals at a large music event can be set to receive common signals such that the transducers respond in synchrony with one another

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LOCALIZED AUDIO NETWORKS AND ASSOCIATED DIGITAL ACCESSORIES

Cross Reference To Related Patent Applications

This application is related to and claims priority from Provisional Patent Application No. 60/378,415, filed May 6, 2002, titled "Localized Audio Networks and Associated Digital Accessories," and from Provisional Patent Application No. 60/388,887, filed June 14, 2002, titled " Localized Audio Networks and Associated Digital Accessories," and from Provisional Patent Application No. 60/452,230, filed March 4, 2003, titled " Localized Audio Networks and Associated Digital Accessories," the contents of each of which are incorporated herein by reference.

Technical Field

The present invention relates to localized wireless audio networks for shared listening of recorded music, and wearable digital accessories for public music-related display, which can be used in conjunction with one another.

Background

Portable audio players are popular consumer electronic products, and come in a variety of device formats, from cassette tape "boom boxes" to portable CD players to digital flash-memory and hard-disk MP3 players. While boom boxes are meant to make music to be shared among people, most of the portable audio players are designed for single person use. While some of this orientation to personal music listening is due to personal preference, other important considerations are the technical difficulties of reproducing music for open area listening with small, portable devices, as well as the social imposition of listening to music in public places with other people who do not wish to listen to the same music, or who are listening to different music that would interfere with one's own music.

There are numerous audio devices that are designed to allow the transfer of music from one portable audio device to another, especially through those that store music in the MP3 audio format. These devices suffer from two main difficulties: firstly, listeners still do not hear the music simultaneously, which is the optical manner to share music, and secondly, there are serious copyright issues associated with the transfer of music files. Thus, it would be preferable for the transfer of the music for simultaneous enjoyment, and which did not

result in a permanent transfer of the music files between the devices, so as not to infringe on the intellectual property rights of the music owners.

Given the sharing of music, listeners will on occasion want to purchase the music for themselves. In such case, it would be beneficial for the user to have a way to obtain the music with minimal effort. It would further be desirable for there to be a way to keep track of the person from whom the listener heard the music, so that the person could be in some way encouraged or compensated.

The earphones associated with a portable music player admit a relatively constant fraction of ambient sound. If listening to music with a shared portable music device, however, one might at times want to talk with a friend, and at times listen to music without outside audible distraction. In such case, it would be desirable to have an earphone for which the amount of external ambient sound could be manually set.

Furthermore, many people like to show their individual preferences, to exhibit themselves, and to demonstrate their group membership. Furthermore, music preferences and listening to music together are among the more important means by which individuals express their individual and group identities. It would be beneficial for there to be a way for individuals to express themselves through their music, and for groups of individuals listening to music together, to be able to demonstrate their group enjoyment of the music.

One means for a person to express their identity through motion would be through having wearable transducers wherein the transduction signal is related to the music. If the transducer were a light transducer, this would result in a display of light related to the music that was being listened to. It would be further beneficial if there were means by which a person could generate control signals for the transducer so that instead of a wholly artificial response to the music, the transducer showed a humanly interpreted display. It would be preferable if these signals could be shared between people along with music files, so that others could entertain or appreciate the light display so produced.

At popular music concerts, there is often a "light show" that pulsates in rough relation to the music. In contrast to the generally vigorous light show, the patrons at the concerts often have light bracelets or other such static displays which are used to join with the displays on the stage. It would be beneficial for there to be a way in which patrons could participate in the light show in order to enhance their enjoyment of the concert.

It is to the solution of these and other problems that the present invention is directed.

Summary of the Invention

It is an object of the present invention to provide users a means of listening to music together using mobile devices.

It is also an object of the present invention to provide users a means of choosing with whom to listen to music.

It is additionally an object of the present invention to provide users the ability to monitor the people that are listening together.

It is furthermore an object of the present invention to provide users a means of expressing their enjoyment of the music they are listening to through visual displays of wearable accessories.

It is yet another object of the present invention to provide users a means of demonstrating their identity with other people they are listening to music with.

It is still further an object of the present invention to provide users to provide users with means to choreograph the visual displays.

Additional objects, advantages and novel features of this invention shall be set forth in part in the description that follows, and will become apparent to those skilled in the art upon examination of the following specification or may be learned through the practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities, combinations, and methods particularly pointed out in the appended claims.

To achieve the foregoing and other objects and in accordance with the purposes of the present invention, as embodied and broadly described therein, the present invention is directed to a method for sharing music from stored musical signals between a first user with a first music player device and at least one second user with at least one second music player device. The method includes the step of playing the musical signals for the first user on the first music player device while essentially simultaneously wirelessly transmitting the musical signals from the first music player device to the at least one second music player device. The method additionally includes receiving the musical signals by the at least one second player device, such that the musical signals can be played on the at least one second player device essentially simultaneously with the playing of the musical signals on the first music player device. In this method, the first and the at least one second users are mobile and maintain less than a predetermined distance.

The present invention is also related to a system of music sharing for a plurality of users. The system includes a first sharing device and at least one second sharing device, each comprising a musical signal store, a musical signal transmitter, a musical signal receiver, and a musical signal player. Furthermore, the system comprises a broadcast user operating the first sharing device and at least one member user operating the at least one second sharing device. The broadcast user plays the musical signal for his own enjoyment on the first sharing device and simultaneously transmits the musical signal to the receiver of the at least one second sharing device of the at least one member user, on which the musical signal is played for the at least one member user. The broadcast user and the at least one member user hear the musical signal substantially simultaneously.

The present invention yet further is related to a wireless communications system for sharing audio entertainment between a first mobile device and a second mobile device in the presence of a non-participating third mobile device. The system includes an announcement signal transmitted by the first mobile device for which the second mobile device and the third mobile device are receptive. In addition, the system includes a response signal transmitted by the second mobile device in response to the announcement signal for which the first mobile device is receptive and for which the third mobile device is not receptive. Also, the system includes an identifier signal transmitted by the first mobile device to the second mobile device in response to the response signal, and which is not receptive to the third mobile device. Finally, the system includes a broadcast signal comprising audio entertainment that is transmitted by the first mobile device, and which is receptive by the second mobile device on the basis of the reception of the identifier signal.

The present invention additionally is related to an audio entertainment device. The device includes a signal store that stores an audio entertainment signal, a transmitter that can transmit the stored audio entertainment signal, a receiver that can receive the transmitted audio entertainment signal from a transmitter of another such device, and a player that can play audio entertainment from a member selected from the group of stored audio entertainment signals or audio entertainment signals transmitted from the transmitter of another such device.

The present invention yet still is related to a system for identifying a first device that introduces a music selection to a second device. The system includes a mobile music transmitter operated by the first device and a mobile music receiver operated by the second device. In addition, the system includes a music signal comprising the music selection transmitted by the transmitter and received by the receiver, an individual musical identifier

that is associated with the music selection, and an individual transmitter identifier that identifies the transmitter. The transmitter identifier and the individual music identifier are stored in association with each other in the receiver.

The present invention is still further related to an audio entertainment device. The device includes a wireless transmitter for the transmission of audio entertainment signals and a wireless receiver for the reception of the transmitted audio entertainment signals from a transmitter of audio entertainment signals. A first manually-separable connector for electrically connecting with an audio player allows transfer of audio entertainment signals from the player to the device. The device also includes a second connector for connecting with a speaker and a control to manually switch between at least three states. In the first state the speaker plays audio entertainment signals from the audio player and the transmitter does not transmit the audio entertainment signals. In the second state the speaker plays audio entertainment signals from the audio player and the transmitter essentially simultaneously transmits the audio entertainment signals. In the third state the speaker plays audio entertainment signals received by the receiver.

The present invention also still is related to a system for the sharing of stored music between a first user and a second user. The system includes a first device for playing music to the first user, comprising a store of musical signals. A first controller prepares musical signals from the first store for transmission and playing, and a first player takes musical signals from the first controller and plays the signals for the first user. A transmitter is capable of taking the musical signals from the controller and transmitting the musical signals via wireless broadcast. A second device for playing music to the second user comprises a receiver receptive of the transmissions from the transmitter of the first device, a second controller that prepares musical signals from the receiver for playing, and a second player that takes musical signal from the second controller and plays the signals for the second user. The first user and the second user hear the musical signals at substantially the same time.

The present invention also is related to an earphone for listening to audio entertainment allowing for the controlled reception of ambient sound by a user. The earphone includes a speaker that is oriented towards the user's ear and an enclosure that reduces the amount of ambient noise perceptive to the user. In addition, a manually-adjustable characteristic of the enclosure adjusts the amount of ambient sound perceptive to the user.

The present invention is further related to a mobile device for the transmission of audio entertainment signals. The mobile device includes an audio signal store for the storage

of the audio entertainment signals, and an audio signal player for the playing of the audio entertainment signals. The device also includes a wireless transmitter for the transmission of the audio entertainment signals and a transmitter control to manually switch between two states consisting of the operation and the non-operation of the audio transmitter.

The present invention yet still is related to a mobile device for the reception of digital audio entertainment signals. The mobile device includes an audio signal store for the storage of the digital audio entertainment signals and an audio receiver for the reception of external digital audio entertainment signals from a mobile audio signal transmitter located within a predetermined distance of the audio receiver. The device also includes a receiver control with at least a first state and a second state. An audio signal player plays digital audio entertainment signals from the audio signal store when the receiver control is in the first state, and plays digital audio entertainment signals from the audio receiver when the receiver control is in the second state.

The present invention furthermore relates to a method for the shared enjoyment of music from stored musical signals between a first user with a first music player device and at least one second user with at least one second music player device. The method includes the step of playing the musical signals for the first user on the first music player device while essentially simultaneously wirelessly transmitting synchronization signals from the first music player device to the at least one second music player device. The method also includes receiving the synchronization signals by the at least one second player device. The synchronization signals allow the musical signals on the at least one second player device to be played essentially simultaneously with the playing of the musical signals on the first music player device. The first and the at least one second users are mobile.

The present invention yet furthermore relates to a wireless communications system for sharing audio entertainment between a first mobile device and a second mobile device. The system includes a broadcast identifier signal transmitted by the first mobile device to the second mobile device. A personal identifier signal is transmitted by the second mobile device to the first mobile device. A broadcast signal comprising audio entertainment is transmitted by the first mobile device of which the second device is receptive. The first mobile device and the second mobile device have displays which can display the identifier signal that they receive and the second mobile device can play the audio entertainment from the broadcast signal that it receives.

The present invention also relates to a method for enhancing enjoyment of a musical selection. The method includes the steps of obtaining control signals related to the musical

selection, transmitting the control signals wirelessly, receiving the control signals, and converting the control signals to a humanly-perceptible form.

The present invention further yet relates to a method for generating and storing control signals corresponding to musical signals. The method includes the steps of playing musical signals for a user and receiving manual input signals from the user that are produced substantially in synchrony with the music. The method also includes the steps of generating control signals from the input signals, and storing the control signals so that they can be retrieved with the musical signals.

The present invention still additionally relates to a wearable personal accessory. The accessory includes an input transducer taken from the group consisting of a microphone and an accelerometer. The transducer generates a time-varying input transduction signal. The accessory also includes a controller that accepts the input transduction signal, and generates an output transducer signal whose signal varies in amplitude with time. An output transducer receptive of the output transducer signal provides a humanly-perceptible signal. An energy source powers the input transducer, controller and output transducer.

The present invention also still relates to a wearable personal accessory controlled via wireless communications. The accessory includes a wireless communications receiver that is receptive of an external control signal. The accessory also includes a controller that accepts the external control signal and that generates a time-varying visual output transducer signal. A visual output transducer is receptive of the output transducer signal, and provides a humanly-perceptible visual signal. An energy store powers the receiver, controller and output transducer. The visual output transducer generates visually-perceptive output.

The present invention still further relates to a device for converting user tactile responses to stored music into a stored control signal. The device includes a player that plays stored music audible to the user and a manually-operated transducer that outputs an electrical signal. The transducer is actuated by the user in response to the music. A controller receives the electrical signal and outputs a control signal and a store receives the control signal and stores it.

The present invention furthermore relates to a music player that wirelessly transmits control signals related to the music, wherein the control signals control a wearable electronic accessory. The music player includes a store of music signal files and a controller that reads a musical signal file from the store and generates audio signals. The controller further generates the control signals. A transducer converts the audio signals into sound audible to

the user and a wireless transmitter transmits the control signal to the wearable electronic accessory.

The present invention yet relates to a music player that wirelessly transmits control signals related to the music, wherein the control signals control a wearable electronic accessory. The music player includes a store of music signal files and a second store of control signal files associated with the music signal files. A controller reads a musical signal file from the store and generates audio signals. The controller further reads an associated control signal file. A transducer converts the audio signals into sound audible to the user, and a wireless transmitter transmits the control signals from the associated control signal file to the wearable electronic accessory.

The present invention also relates to a system for exhibition of music enjoyment. The system includes a source of music signals, a controller that generates control signals from the music signals, and a transmitter of the control signals. The transmission of the control signals is synchronized with the playing of the music signals. In addition, the system includes a receiver of the control signals and a transducer that responds to the control signals.

The present invention further relates to a method for transferring a wearable-accessory control file stored on a first device to a second device in which an associated music file is stored. The method includes the steps of storing on the first device the name of the music file in conjunction with the control file with which it is associated and requesting by the second device of the first device for a control file stored in conjunction with the name of the music file. In addition, the method includes the step of transferring the control file from the first device to the second device. The control file is stored on the second device in conjunction with the name of the associated music file.

The present invention also relates to a device for transmitting control signals to a wearable accessory receptive of such control signals. The device includes a manually-separable input connector for connecting to an output port of an audio player. Audio signals are conveyed from the audio player to the device across the connector. The device also includes a controller for generating control signals from the audio signals and a transmitter for transmitting the control signals.

Brief Description Of The Drawings

Figure 1 is a schematic block diagram of a local audio network comprised of two linked audio units operated by two persons, and associated digital jewelry conveyed by the two persons.

Figure 2A is a schematic block diagram of a DJ with multiple independently controlled LED arrays.

Figure 2B is a schematic block diagram of a DJ with an LED array with independently controlled LEDs.

Figures 3A-C are schematic block diagrams of unit elements used in inter-unit communications.

Figure 4 is a schematic flow diagram of DJ entraining.

Figures 5A-B are schematic block diagrams of DJs associated with multiple people bound to the same master unit.

Figure 6 is a schematic block diagram of a cluster comprising a broadcast unit and multiple receive units, with an external search unit.

Figure 7 is a schematic diagram of a broadcast unit transmission.

Figure 8A is a schematic block diagram of audio units with self-broadcast so that audio output is highly synchronized.

Figure 8B is a schematic flow diagram for synchronous audio playing with multiple rebroadcast.

Figures 9A and 9B are schematic block diagrams of hierarchically-related clusters.

Figure 10 is a top perspective view of an earphone with manually adjustable external sound ports.

Figures 11 A and B are cross-sectional diagrams of a earpiece with an extender to admit additional ambient sound.

Figure 12A is a schematic diagram of a modular audio unit.

Figure 12B is a schematic diagram of modular digital jewelry.

Figure 12C is a schematic block diagram of a modular transmitter that generates and transmits control signals for digital jewelry from an audio player.

Figure 13A is a schematic cross-section through a search unit and a broadcast unit in which communications are provided via visible or infrared LED emission in search transmission mode.

Figure 13B is a schematic cross-section through a search unit and a broadcast unit n which communications are provided via a visible or infrared laser in search transmission mode.

Figure 13C is a schematic cross-section through a search unit and a broadcast unit in which communications are provided via visible or infrared emission from a digital jewelry element in broadcast transmission mode.

Figure 13D is a schematic cross-section through a search unit and a broadcast unit in which communications are provided via contact in mutual transmission mode.

Figure 13E is a schematic cross-section through a search unit and a broadcast unit in which communications are provided via sonic transmissions in broadcast transmission mode.

Figure 13F is a schematic cross-section through a search unit and a broadcast unit in which communications are provided via radio frequency transmissions in broadcast transmission mode.

Figure 14A is a schematic block diagram of the socket configurations on the broadcast unit and the receive unit.

Figure 14B is a schematic block flow diagram of using IP sockets for establishing and maintaining communications between a broadcast unit and the receive unit, according to the socket diagram of Figure 14A.

Figure 15 is a schematic block diagram of the IP socket organization used with clusters comprising multiple members.

Figure 16 is a schematic block flow diagram of transfer of control between the broadcast unit and the first receive unit.

Figure 17 is a matrix of DJ and searcher preferences and characteristics, illustrating the matching of DJ and searcher in admitting a search to a cluster.

Figure 18A is a screenshot of an LCD display of a unit, taken during normal operation.

Figure 18B is a screenshot of an LCD display of a unit, taken during voting for a new member.

Figure 19 is a table of voting schemes for the acceptance of new members into a cluster.

Figure 20 is a time-amplitude trace of an audio signal automatically separated into beats.

Figure 21A is a block flow diagram of a neural network method of creating DJ transducer control signals from an audio signal as shown in Figure 20.

Figure 21B is a block flow diagram of a deterministic signal analysis method of creating DJ transducer control signals from an audio signal as shown in Figure 20.

Figure 21C is a schematic flow diagram of a method to extract fundamental musical patterns from an audio signal to create DJ control signals.

Figure 21D is a schematic flow diagram of an algorithm to identify a music model resulting in a time signature.

Figure 22A is a top-view diagram of an audio unit user interface, demonstrating the use of buttons to create DJ control signals.

Figure 22B is a top-view diagram of a hand-pad for creating DJ control signals.

Figure 22C is a schematic block diagram of a set of drums used for creating DJ control signals.

Figure 23A is a schematic block flow diagram of the synchronized playback of an audio signal file with a DJ control signal file, using transmission of both audio and control signal information.

Figure 24 is a schematic block diagram of a DJ unit with associated input transducers.

Figure 25 is a schematic flow diagram indicating music sharing using audio devices, providing new means of distributing music to customers.

Figure 26 is a schematic diagram of people at a concert, in which DJs conveyed by multiple individuals are commonly controlled.

Figure 27 is a schematic block flow diagram of using a prospective new member's previous associations to determine whether the person should be added to an existing cluster.

Figure 28 is a block flow diagram indicating the steps used to maintain physical proximity between the broadcast unit and the receive unit via feedback to the receive unit user.

Figures 29A is a schematic block diagram of the connection of an Internet-enabled audio unit with an Internet device through the Internet cloud, using an Internet access point.

Figures 29B is a schematic block diagram of the connection of an Internet-enabled audio unit with an Internet device through the Internet cloud, with an audio unit directly connected to the Internet cloud.

Figure 30 comprises tables of ratings of audio unit users.

Figure 31 is tables of DJ, song and transaction information according to the methods of Figure 25.

Figure 32A is a schematic block diagram of maintaining privacy in open transmission communications.

Figure 32B is a schematic block diagram of maintaining privacy in closed transmission communication.

Figure 33 is a schematic block diagram of a hierarchical cluster, as in Figure 9A, in which communications between different units is cryptographically or otherwise restricted to a subset of the cluster members.

Figure 34A is a schematic block flow diagram of the synchronization of music playing from music files present on the units 100.

Figure 34B is a schematic layout of a synchronization record according to Figure 34A.

Figure 35 is a schematic block diagram of DJ switch control for both entraining and wide-area broadcast.

Figure 36 is a schematic block diagram of mode switching between peer-to-peer and infrastructure modes.

Best Mode for Carrying-Out the Invention

Overview

Figure 1 is a schematic block diagram of a local audio network comprised of two linked audio units 100 operated by two persons, and associated digital jewelry 200 conveyed by the two persons. The persons are designated Person A and Person B, their audio units 100 are respectively Unit A and Unit B, and their digital jewelry 200 are denoted respectively DJ A and DJ B. In this patent specification, "DJ" is used to denote either the singular "digital jewel" or the plural "digital jewelry".

Each unit 100 is comprised of an audio player 130, and an inter-unit transmitter/receiver 110. In addition, each unit 100 comprises a means of communication with the digital jewelry, which can be either a separate DJ transmitter 120 (Unit A), or which can be part of the inter-unit transmitter/receiver 110 (Unit B). Furthermore, unit 100 can optionally comprise a DJ directional identifier 122, whose operation will be described below. Also, unit 100 will generally comprise a unit controller 101, which performs various operational and executive functions of intra-unit coordination, computation, and data transfers. The many functions of the controller 101 will not be discussed separately below, but will be described with respect to the general functioning of the unit 100.

In operation, Unit A audio player 130 is playing recorded music under the control of a person to be designated User A. This music can derive from a variety of different sources and storage types, including tape cassettes, CDs, DVDs, magneto-optical disks, flash memory, removable disks, hard-disk drives or other hard storage media. Alternatively, the audio signals can be received from broadcasts using analog (e.g. AM or FM) or digital radio receivers. Unit A is additionally broadcasting a signal through DJ transmitter 120, which is received by DJ 200 through a DJ receiver 220 that is worn or otherwise conveyed by User A.

It should be noted that the audio signals can be of any sound type, and can include spoken text, symphonic music, popular music or other art forms. In this specification, the terms audio signal and music will be used interchangeably.

The DJ 200 transduces the signal received by the DJ receiver 220 to a form perceptible to the User A or other people near to him. This transduced form can include audio, visual or tactile elements, which are converted to their perceptible forms via a light transducer 240, and optionally a tactile transducer 250 or an audio transducer 260. The transducers 240, 250 and 260 can either directly generate the perceptible forms directly from the signals received by the DJ receiver 220, or can alternatively incorporate elements to filter or modify the signals prior to their use by the transducers.

When a second individual, User B, perceives the transduced forms produced by User A DJ 200, he can then share the audio signal generated by the audio player 130 of Unit A, by use of the inter-unit transmitter/receiver 110 of Unit A and a compatible receiver 110 of Unit B. Audio signals received by Unit B from Unit A are played using the Unit B audio player 130, so that User A and User B hear the audio signals roughly simultaneously. There are a variety of means by which the Unit B can select the signal of Unit A, but a preferred method is for there to be a DJ directional identifier 122 in Unit B, which can be pointed at the DJ of User A and which receives information needed to select the Unit A signal from the User A DJ, whose transduced signal is perceptible to User B.

Given the audio signal now being exchanged between Unit A and Unit B, User A and User B can experience the same audio signal roughly simultaneously. Within the spirit of the present invention, it is preferable for the two users to hear the audio signals within 1 second of one another, and more preferable for the users to hear the audio signals within 200 milliseconds of one another, and most preferable for the users to hear the audio signals within 50 milliseconds of one another. Furthermore, DJs 200 being worn by User A and User B can receive signals from their respective units, each emitting perceptible forms of their signals. Preferably, the transduced forms expressed by the DJs 200 are such as to enhance the personal or social experience of the audio being played.

Unit 100 Structure

Units 100 comprise a device, preferably of a size and weight that is suited for personal wearing or transport, which is preferably of a size and format similar to that of a conventional portable MP3 player. The unit can be designed on a "base" of consumer electronics products

such as cell phones, portable MP3 players, or personal digital assistants (PDAs), and indeed can be configured as an add-on module to any of these devices.

In general, the unit 100 will comprise, in addition to those elements described in Figure 1, other elements such as a user interface (e.g. an LCD or OLED screen, which can be combined with a touch-sensitive screen, keypad and/or keyboard), communications interfaces (e.g. Firewire, USB, or other serial communications ports), permanent or removable digital storage, and other components.

The audio player 130 can comprise one or more modes of audio storage, which can include CDs, tape, DVDs, removable or fixed magnetic drives, flash memory, or other means. Alternatively, the audio can be configured for wireless transmission, including AM/FM radio, digital radio, or other such means. Output of the audio signal so generated can comprise wireless or wired headphones or wired or wireless external speakers.

It is also within the spirit of the present invention that the unit 100 can have only receive capabilities, without having separate audio information storage or broadcast capabilities. In concept, such a device can have as little user interface as an on/off button, a button to cause the unit 100 to receive signals from a new "host", and a volume control. Such devices can be very small and be built very inexpensively.

Unit 100 Audio Output

One of the goals of the present invention is to assist communications between groups of people. In general, with mobile audio devices, the music is listened to through headphones. Many headphones are designed so as to reduce to the extent possible the amount of sound which is heard from outside of the headphones. This, however, will have the general effect of reducing the verbal communications between individuals.

In order to avoid this potential problem, it is within the teachings of the present invention that headphones or earphones be provided that allow ambient sound, including a friend's voice, to be easily perceptible to the wearer of the headphones, and that such headphones can be provided that variably allow such sound to be accessible for the headphone's wearer. Such arrangement of the headphones can be obtained either through physical or electronic means. If through electronic means, the headphones can have a microphone associated with them, through which signals received are played back in proportion through the headphone speakers, said proportion being adjustable from substantially all sound being from the microphone to substantially no sound being from the microphone. This microphone can also be a part of a noise cancellation system, such that the

phase of the playback is adjustable – if the phase is inverted relative to the ambient sound signal, then the external noise is reduced, whereas if the phase is coincident with the ambient sound signal, then the ambient sounds are enhanced.

Figure 10 is a top perspective view of an earphone 900 with adjustable external sound ports. A speaker element 940 is centrally located, and the outside circumferential surface is a rotatable sound shield 910 in which sound ports 930 are placed. The sound ports 930 are open holes to admit sound. Beneath the sound shield 930 is a non-rotatable sound shield in which fixed sound ports 920 are placed in a similar arrangement. As the sound shield 910 is rotated manually by the user, the sound ports 930 and the fixed sound ports 920 come into registration, so that open ports between sources of ambient noise and the outer ear chamber is created, increasing the amount of ambient sound that the user perceives.

Figures 11 A and B are cross-sectional diagrams of an earpiece with an extender 980 that admits additional ambient sound. In Figure 11A, the face of a speaker 960 with a cord 970 is covered with a porous foam block 950 that fits snugly into the ear. While some ambient sound is accessible to the ear through the foam block 950, the majority of the sound is input is impeded. In Figure 11B, the foam extender 980 is placed over the foam block 950 so that a formed shape at the distal end of the extender 980 fits snugly into the ear. A hollow cavity 982 can be allowed in the extender 980 so as to reduce the sound impedance from the speaker 960 to the ear. Ambient sound is allowed into the space between the speaker 960 and the distal end of the extender 980 (shown by the arrows).

Many other arrangements are allowed within the spirit of the present invention to allow ambient sound to more easily access the user's ear, including adjustable headphones or earplugs as in Figure 10, or accessories that can modify the structure of existing earphones and headphones, as in Figure 11B. Such effects can include increasing the number of apertures admitting ambient sound, increasing the size of an aperture (e.g. by adjusting the overlap between two larger apertures), changing the thickness or number of layers in the enclosure, or by placing a manually detachable cup that covers the earphone and ear channel so as to reduce ambient sound.

DJ 200 Transducers

DJs 200 will have a number of common elements, including communications elements, energy storage elements, and control elements (e.g. a manual ON/OFF switch or a switch to signal DJ entraining, as will be described below). In this section, the structure and function of transducers will be described.

Light Transducers 240

The DJ 200 transducers are used to create perceptible forms of the signals received by the receiver 220. Light transduction can include the use of one or more light-emitting devices, which can conveniently be colored LEDs, OLEDs, LCDs, or electroluminescent displays, which can be supplemented with optical elements, including mirrors, lenses, gratings, and optical fibers. Additionally, motors, electrostatic elements or other mechanical actuators can be used to mechanically alter the directionality or other properties of the light transducers 240. There can be either a single device or an array of devices, and if more than a single device, can display in synchrony, or can be "choreographed" to display in a temporal and/or spatial pattern.

Figure 2A is a schematic block diagram of a DJ 200 with multiple independently controlled LED arrays, wherein the number of LED arrays is preferably between 2 and 8, and is even more preferably between 2 and 4. The signal received from unit 100 via the DJ receiver 220 is passed to a multi-port controller 242 with two ports 294 and 296 connected respectively with two separate arrays 290 and 292 of LEDs 246. These arrays 290 and 292 can be distinguished by spatial placement, color of emitted light, or the temporal pattern of LED illumination. The signal is converted via analog or digital conversion into control signals for the two arrays 290 and 292, which are illuminated in distinct temporal patterns.

It should be noted that the signal received by receiver 220 from the unit 100 can comprise either a signal already in the form required to specify the array and temporal pattern of LED 246 activity, or it can alternatively be converted from a differently formatted signal into temporal pattern signals. For example, the unit 100 can transmit a modulated signal whose amplitude specifies the intensity of LED light amplitude. For multiple LED arrays, signals for the different arrays can be sent together and decoded by the DJ receiver 220, such as through using time multiplexing, or transmission on different frequencies.

Alternatively, the signal could be not directly related to the transduction intensity, such as in the direct transmission of the audio signal being played by the unit 100. In such case, the controller 242 can modify the signal so as to generate appropriate light transduction signals. For example, low frequency bandpass filters could provide the signals for the first array 290, whereas high-frequency bandpass filters could provide the signals for the second array 292. Such filtering could be accomplished by either analog circuitry or digital software within a microprocessor in the controller 242. It is also within the spirit of the present

invention for the different arrays to respond differently to the amplitude of the signal within a frequency band or the total signal.

An alternative control of LED arrays is presented in Figure 2B, a schematic block diagram of a DJ 200 with an LED array with independently controlled LEDs. In this case, the control signal received by the receiver 200 is passed through a single-port, multiple ID controller 243 to a single array of LEDs, each responsive only to signals with a particular characteristic or identifier. One or more of the LEDs 246 can have the same identifier or be responsive to the same characteristic so as to constitute a virtual array of LEDs.

As mentioned above, the transduced light signal can alternatively or additionally comprise multi-element arrays, such as an LED screen. In such case, the signal received by the receiver 220 can be either a specification of image elements to be displayed on the LED screen, or can be as before, a signal unrelated to the light transduction output. For example, many audio players on computers (e.g. Windows Media player) come with pattern generators that are responsive to the frequency and amplitude of the audio signal. Such pattern generators could be incorporated into the controllers 242 or 243.

Alternatively, the light transducer 240 can be a single color illuminated panel, whose temporal pattern of illumination was similar to that of the LEDs of Figures 2A and 2B. In such case, users can partially cover the panel with opaque or translucent patterns, such as a dog or a skull or a representation of a favorite entertainer.

Whereas the receiver 220 and the light controllers 242 or 243 can be hidden from view, either behind the light transducers or separated from the transducers by a wire, for example, the light transducers are meant to be perceptible to other people. For this purpose, the light transducers can be fashioned into fashion accoutrements such as bracelets, brooches, necklaces, pendants, earrings, rings, hair clips (e.g. barrettes), ornamental pins, netting to be worn over clothing, belts, belt buckles, straps, watches, masks, or other objects. Additionally, the light transducers can be fashioned into clothing, such as arrays of lighting elements sewn onto the outside of articles of clothing such as backpacks, wallets, purses, hats, or shoes. For those articles of clothing that are normally washed, however, the lighting transducers and associated electronics will preferably be able to withstand cleaning agents (e.g. water or dry cleaning chemicals), or will be used in clothing such as scarves and hats that do not need to be washable.

It is also convenient for there to be modular lighting arrangements in which the configuration can easily changed by a user. One example of such a modular arrangement is a light pipe made of a flexible plastic cable or rod, at one or both ends of which is positioned

a light source that directs light into the rod. At predetermined locations along the rod, the rod surface can be roughened so as to allow a certain amount of light to escape, on which transparent glass or plastic pieces can be clipped, and that are lighted when the pipe is lighted. Alternatively, the light can be uniformly smooth, and transparent pieces of roughly index of refraction matching material can be clipped onto the rod, allowing some fraction of the light to be diverted from the rod into the pieces. The light sources and associated energy sources used in such an arrangement can be relatively bulky and be carried in a backpack, pouch or other carrying case, and can brightly illuminate a number of separate items.

It should be noted that the transducers require an energy store 270, which is conveniently in the form of a battery. The size of the battery will be highly dependent on the transduction requirements, but can conveniently be a small "watch battery". It is also convenient for the energy store 270 to be rechargeable. Indeed, all of the electric devices of the present invention will need energy stores or generators of some sort, which can comprise non-rechargeable batteries, rechargeable batteries, motion generators that can convert energy from the motion of the user into electrical energy that can be used or stored, fuel cells or other such energy stores or converters as are convenient.

Sound Transducers 260

Sound transducers 260 can supplement or be the primary output of the audio player of the unit 100. For example, the unit 100 can wirelessly transmit the audio signal to DJ 200 comprising a wireless headphone sound transducer. This would allow a user to listen to the audio from the audio player without the need for wires connecting the headphones to the unit 100. Such sound transducers can comprise, for example, electromagnetic or piezoelectric elements.

Alternative to headphone or earphone audio production, external speakers, which can be associated with light transducers 240 or tactile transducers 250, can be used to enhance audio reproduction from external speakers associated with the unit 100. In addition or alternative to simple reproduction of the audio signal output by the audio player 130, the sound transducers 260 can play modified or accompanying signals. For example, frequency filters can be used to select various frequency elements from the music (for low bass), so as to emphasize certain aspects of the music. Alternatively, musical elements not directly output from the audio player 130 can be output to complete all instrumental channels of a piece of music, for example.

Tactile Transducers 250

DJs 200 can be configured with tactile transducers, which can provide vibrational, rubbing, or pressure sensation. As before, signals of a format that control these transducers can be sent directly from the DJ transmitter 120, or can be filtered, modified or generated from signals of an unrelated format that are sent from the transmitter 120. As before, the signal can be the audio signal from the audio player 130, which can, for example, be frequency filtered and possibly frequency converted so that the frequency of tactile stimulation is compatible with the tactile transducer. Alternatively, signals that are of the sort meant for light transduction can be modified so as to be appropriate for tactile transduction. For example, signals for light of a particular color can be used to provide vibrational transduction of a particular frequency, or light amplitudes can be converted into pressure values.

The tactile transducer can comprise a pressure cuff encircling a finger, wrist, ankle, arm, leg, throat, forehead, torso, or other body part. The tactile transducer can alternatively comprise a rubbing device, with an actuator that propels a tactile element tangentially across the skin. The tactile transducer can also alternatively comprise a vibrational device, with an actuator that drives an element normally to the skin. The tactile transducer can further alternatively comprise elements that are held fixed in relation to the skin, and which comprise moving internal elements that cause the skin to vibrate or flex in response to the movement of the internal element.

The tactile transducer can lack any moveable element, and can confer tactile sensation through direct electrical stimulation. Such tactile elements are best used where skin conductivity is high, which can include areas with mucus membranes.

Tactile transduction can take place on any part of the body surface with tactile sensation. In addition, tactile transduction elements can be held against the skin overlying bony structures (skull, backbone, hips, knees, wrists), or swallowed and conveyed through the digestive tract, where they can be perceived by the user.

Input Transducers

It should also be understood that the DJ 200 can comprise input transducers in order to create control signals from information or stimuli in the local environment. Figure 24 is a schematic block diagram of a DJ unit 200 with associated input transducers. The input-enabled DJ 1320 comprises energy storage 270, a controller 1322, output transducers 1324, a

DJ receiver 220 and input transducers 1326. The input transducers 1326 can comprise one or more of a microphone 1328 and an accelerometer 1330.

In operation, the energy storage 270 provides energy for all other functions in the DJ 1320. The controller 1322 provides control signals for the output transducers 1324, which can comprise tactile transducers 250, sound transducers 260, and/or light transducers 240. Input to the controller can be provided via the input transducers 1326, optionally along with input from the DJ receiver 220.

For example, on a dance floor, the microphone 1328 can provide electrical signals corresponding to the ambient music. These signals can be converted into transducer 1324 control signals in a manner similar to that described below for the automatic generation of control signals according to Figures 21 A-C, as will be described below. This allows the use of the DJ functionality in the absence of an accompanying audio unit 100, expanding the applications of the DJ 200. An automatic gain filter can be applied so as to compensate for the average volume level – because the user can be close or far from the sources of ambient music and the music can vary in volume, the strength of the DJ 200 transduction can be normalized. In addition, it can also be preferable for there to be a manual amplitude control 1323, such as a dial or two position rocker switch, by which the average intensity of the DJ 200 control signals can be varied to suit the taste of the user. The amplitude control 1323 can operate through modulating the input transducer 1326 output or as an input to the controller 1322 as it generates the signals for the output transducers 1324.

Alternatively, the accelerometer 1330 can track the movement of the person wearing the DJ 100, such that a signal indicating acceleration in one direction can be converted by the controller 1322 into signals for a channel of output transducers 1324. The accelerometer 1330 can be outfitted with sensors for monitoring only a single axis of motion, or alternatively for up to three independent directions of acceleration. Thus, the controller 1322 can convert sensed acceleration in each direction into a separate channel, horizontal axes of acceleration could be combined into a single channel and the vertical axis into a second channel, or other such linear or non-linear combination of sensed acceleration can be combined in aesthetic fashion.

It is also within the spirit of the present invention that multiple input signals be combined by the controller 1322 to create control signals for aesthetic output from the output transducers 1324. For example, one channel can be reserved for control signals generated from accelerometer signals, another channel for control signals generated from microphone signals, and yet a third channel from control signals generated from DJ receiver 220 input. In

general, the information from the DJ receiver 220 and from the microphone 1328 will be of the same type (i.e. generated from audio signals), so that the most common configurations will be control signals from a combination of the microphone 1328 and accelerometer 1330, and signals from a combination of the DJ receiver 220 and the accelerometer 1330.

The input transducers 1326 can further comprise a light sensor, such that the DJ would mimic light displays in its environment, making it appear that the DJ is part of the activity that surrounds it. In this case, the controller 1322 would preferably generate control signals based on rapid changes in the ambient lighting, since it would be less aesthetic to have the DJ transducers provide constant illumination. Furthermore, slowly changing light (on the order of tens or hundreds of milliseconds) will be created naturally by the movement of the user, whereas changes in the lighting (e.g. strobes, laser lights, disco balls) will be of much faster change (on the order of milliseconds). Thus, to match the ambient dance lighting, it is aesthetic for the DJ 200 to respond most actively to ambient light that is changing in intensity a predetermined percentage in a predetermined time, wherein the predetermined percentage is at least 20% and the predetermined time is 20 milliseconds or less, and even more preferably for the predetermined percentage to be at least 40% and the predetermined time is 5 milliseconds or less.

Unit to Unit Communication

Units 100 transfer audio signals from the audio player in one unit 100 to the audio player 130 of another unit 100. Figures 3A-C are schematic block diagrams of unit 100 elements used in inter-unit communications. Each diagram presents communications between a Unit A and a Unit B, with Unit A transmitting audio signals to Unit B. Dashed connectors and elements indicate elements or transfers that are not being utilized in that unit 100, but are placed to indicate the equivalence of the transmitting and receiving units 100.

In Figure 3A, compressed audio signals (e.g. in MP3 format or MPEG4 format for video transfers, as described below) stored in a compressed audio storage 310 are transferred to a signal decompressor 302, where the compressed audio signal is converted into an uncompressed form suitable for audio output. In Unit A, this decompressed signal is passed both to the local speaker 300, as well as to the inter-unit transmitter/receiver 110. The Unit B inter-unit transmitter-receiver 110 receives the uncompressed audio signal, which is sent to its local speaker for output. Thus, both Unit A and Unit B play the same audio from the Unit A storage, in which uncompressed audio is transferred between the two units 100.

In Figure 3B, compressed audio signals from the Unit A compressed audio storage 310 are sent both to the local signal decompressor 302 and to the inter-unit transmitter/receiver 110. The Unit A decompressor 302 conditions the audio signal so that it is suitable for output through the Unit A speaker 300. The compressed audio signal is sent via Unit A transmitter-receiver 110 to the Unit B transmitter/receiver 110, where it is passed to the Unit B decompressor 302 and thence to the Unit B speaker 300. In this embodiment, because compressed audio signals are transmitted between the units 100 transmitter/receivers 302, lower bandwidth communications means can be used in comparison with the embodiment of Figure 3A.

In Figure 3C, compressed audio signals from the Unit A compressed audio storage 310 are sent to the Unit A signal decompressor 302. These decompressed signals are sent to both the local speaker 300 as well as to a local compressor 330, which recompresses the audio signal to a custom format. In addition to decompressed audio signal input, the compressor also optionally utilizes information from a DJ signal generator 320, which generates signals to control DJ transducers 240, 250 and 260, which can be sent in conjunction with the audio signal. The signal generator 320 can include analog and/or digital filtering or other algorithms that analyze or modify the audio signals, or can alternatively take manually input transducer control signals input as described below. The custom compression can include multiplexing of the audio signals with the transducer control signals.

The custom compressed audio signals, are then passed to the Unit A inter-unit transmitter/receiver 110, which are then transferred to the Unit B inter-unit transmitter/receiver 110, and thence to the Unit B signal decompressor 302 and speaker 300.

Given the time delays in signal transfer between the units 100, custom compression that takes place in the sending unit, and any subsequent decompression that takes place in the receiving unit 100, it can be convenient to place a delay on the local (i.e. Unit A) speaker output of tens of milliseconds, so that both units 100 play the audio through their speakers at roughly the same time. This delay can include limited local digital storage between the local signal decompression and speaker 300 output.

Various hardware communications protocols will be discussed below with respect to unit-to-unit communications, but in general it is required that the distance between the units that must be maintained be preferably at least 40 feet, and more preferably at least 100 feet, and most preferably 500 feet, in order to allow units 100 sharing music to be able to move reasonably with respect to one another (e.g. for a user to go to the bathroom without losing contact), or to find each other in a large venue such as a shopping mall.

Communications Protocols

Communication between the inter-unit transmitter/receivers 110 can involve a variety of protocols within the teachings of the present invention, and can include IP protocol-based transmissions mediated by such physical link layers as 802.11a, b or g, WDCT, HiperLAN, ultra-wideband, 2.5 or 3G wireless telephony communications, custom digital protocols such as Bluetooth or Millennial Net i-Beans. Indeed, it is not even necessary for the transmissions to be based on Internet protocol, and conventional analog radio-frequency or non-IP infrared transmissions are also within the spirit of the present invention. Each unit 100 will generally have both transmission and reception capabilities, though it is possible for a unit to have only reception capabilities. While the bandwidth of the broadcast is dependent on the compression of the audio signal, it is preferable for the transmission bandwidth to be larger than 100 kb/sec, and even more preferable for the transmission bandwidth to be greater than 250 kb/sec.

While the distance of transmission/reception is not bounded within the teachings of the present invention, it will generally be less than a few hundred meters, and often less than 50 meters. The distance of communication is limited in general by the amount of power required to support the transmission, the size of antennae supported by portable devices, and the amount of power allowed by national regulators of broadcast frequencies. Preferably, however, the range of transmission will be at least 10 meters, and even more preferably at least 30 meters, in order to allow people sharing communications to move some distance from one another without communications being lost.

The unit 100 is characterized generally by four sets of roughly independent characteristics: playing audio or not playing audio, transmitting or not transmitting, receiving or not receiving, searching or not searching.

Units 100 will often function in conditions with large numbers of other units 100 within the communications range. For example, in a subway car, a classroom, bicycling, or at a party, a unit 100 can potentially be within range of dozens of other units. A unit 100 that is playing audio from local compressed audio storage 310 can, at the user's prerogative, choose to broadcast this audio to other units 100. A unit 100 that is currently "listening" to a broadcast or is searching for a broadcast to "listen" to will require a specific identifier roughly unique to a broadcaster in order to select that broadcaster signal from among the other possible broadcasters. Some of the communications protocols listed above, such as those based on IP protocols, 2.5G or 3G wireless, or Bluetooth communications, have such

identifiers as part of the protocols. Custom radio frequency based protocols will require protocols to allow signals to be tagged with specific identifiers.

A unit 100 that is transmitting signals can, within the spirit of the present invention, be prevented from simultaneously receiving signals. Preferably, however, units 100 can both transmit and receive simultaneously. One example of the use of simultaneous transmission and reception is for a unit 100 that is receiving a signal to send a signal indicating its reception to the transmitting unit 100. This allows the transmitting unit to determine the number of units 100 that are currently receiving its broadcast. In return, this information could be sent, along with the audio signal, so that all of the users with units 100 receiving the broadcast can know the size of the current reception group. Alternatively, a user with a unit 100 that is currently broadcasting can be searching for other broadcasting units, so that the user can decide whether to continue broadcasting or whether to listen to the broadcast of another unit.

Unit to DJ Communication

Communication between the unit 100 and the DJ 200 can be either through the inter-unit transmitter/receiver 110, or through a separate system. In general, the requirement of the DJ 200 is for reception only, although it is permissible for the DJ 200 to include transmission capabilities (e.g. to indicate to the unit 100 when the DJ 200 energy storage 270 is near depletion).

The signals for which the DJ 200 is receptive is dependent on how the transduction control signals are generated. For example, for a controller 242 that incorporates a filter or modifier that takes the audio signal as its input, the DJ receiver 220 would receive all or a large fraction of the audio signal. In this case, the communication between the unit 100 and the DJ 200 would require a bandwidth comparable to that of inter-unit communication, as described above.

However, if the signals are either generated in the unit 100, or pre-stored along with the stored compressed audio signal, then the communications bandwidth can be quite modest. Consider a DJ 200 with 2 arrays 290 and 292 of LEDs 246, which flash with a frequency of no more than 10 Hertz, and that the LEDs are in either an ON or an OFF state, without intermediate amplitudes. In such case, the maximum bandwidth required would be only 20 bits/second, in addition to the DJ control signals.

The range of unit to DJ communications need not be far. In general, the unit 100 and the DJ 200 will be carried by the same user, so communications ranges of 10 feet can be

adequate for many applications. Some applications (see below) can require, however, somewhat larger ranges. On the other hand, longer communications ranges will tend to confer the possibility of overlap and interference between two different units 100 to their respective DJs 200. In general, for the application of unit to DJ communications, it is preferable for the minimum range of communications to be at least 1 foot, and more preferably for the minimum range of communications to be at least 10 feet, and most preferably for the minimum range of communications to be at least 20 feet. Also, for the application of unit to DJ communications, it is preferable for the maximum range of communications to be no more than 500 feet, and more preferably for the maximum range of communications to be no more than 100 feet, and most preferably for the maximum range of communications to be no more than 40 feet. It should be noted that these communications ranges refer primarily to the transmission distance of the units 100, especially with regard to the maximum transmission distance.

Because there can be multiple unit 100/DJ 200 ensembles within a relatively short distance, communications between a unit 100 and a DJ 200 preferably comprise both a control signal as well as a unit identification signal, so that each DJ 200 receives its control signals from the correct unit 100. Because the unit 100 and the DJ 200 will not, in general, be purchased together, or that a user can buy a new unit 100 to be compatible with already owned DJs 200, it is highly useful to have a means of "entraining" a DJ 200 to a particular unit 100, called its "master unit", and a DJ 200 entrained to a master unit is "bound" to that unit.

Figure 4 is a schematic flow diagram of DJ entraining. To entrain a DJ 200, the DJ is set into entraining mode, preferably by a physical switch on the DJ 200. The master unit 100 to which the DJ 200 is to be entrained is then placed within communications range, and the unit 100 transmits through the DJ transmitter 120 an entraining signal that includes the master unit 100 identifier. Even should there be other units 100 transmitting in the vicinity, it is unlikely that they would be transmitting the entraining signal, so that entraining can often take place in a location with other active units 100. Verification that the entraining took place can involve a characteristic sequence of light output (for light transduction), audio output (for sound transduction) or motion (for tactile transduction). After verification, the DJ 100 is reset to its normal mode of operation, and will respond only to control signals accompanied by the identifier of its master unit 200.

It should be noted that there can be multiple DJ's 200 bound to the same master unit 100. Thus, a single person can have multiple light transducing DJs 200, or DJs 200 of various modes (light, sound, tactile) transduction.

While DJs 200 will generally be bound to a master unit associated with the same person, this is not a requirement of the present invention. Figures 5A-B are schematic block diagrams of DJs 200 associated with multiple people bound to the same master unit. In Figure 5A, DJ A 200and DJ B 200 are both bound to the same DJ transmitter 120, even though DJ A 200 and DJ B 200 are carried by different persons. This is particularly useful if the control signals are choreographed manually or through custom means by one person, so that multiple people can then share the same control signals. Such a means of synchronization is less necessary if the DJ 200 control signals are transmitted between units 100 through the inter-unit transmitter/receiver 110 along with the audio signals. Furthermore, in this case, it is better for the range of unit-to-DJ communication to be in the range of the inter-unit communication described above.

In the case of sound transducers 260, the DJ B 200 can comprise a wireless audio earpiece, allowing users to share music, played on a single unit 100, privately. Consider Figure 5A, configured with sound transducers 260 (see, for example, Figure 1) in DJ A 200 and DJ B 200. Signals from the audio player 130 are transmitted by the DJ transmitter 120, where they are received by DJs 200 – DJ A and DJ B – that are carried by Person A and Person B, respectively. In this case, both persons can listen to the same music.

Figure 5B shows the operation of a wide-area broadcast unit 360, which is used primarily to synchronize control of a large number of DJs 200, such as might happen at a concert, party or rave. In this case, the audio player 130 is used to play audio to a large audience, many of whom are wearing DJs 200. In order to synchronize the DJ output, a relatively high-power broadcast transmitter 125 broadcasts control signals to a number of different DJs 200 carried by Person A, Person B and other undesignated persons. The entraining signal can be automatically sent on a regular basis (e.g. whenever music is not being played, such as between songs, or interspersed within compressed or decompressed songs) so that patrons or partygoers could entrain their DJs 200 to the broadcast unit 360. The broadcast unit 360 can also transmit inter-unit audio signals, or can only play the audio through some public output speaker that both Person A and Person B can enjoy.

Figure 26 is a schematic diagram of people at a concert, in which DJs 200 conveyed by multiple individuals are commonly controlled. At a concert venue 1370, music is produced on a stage 1372, and concert patrons 1376 are located on the floor of the venue.

Many of the patrons have DJs 200 which are receptive to signals generated by a broadcast DJ controller 1374. The broadcast DJ controller creates signals as described below, in which the music is automatically converted into beats, where microphones are used to pick up percussive instruments, and/or where individuals use a hand-pad to tap out control signals. These control signals are either broadcast directly from the area of the broadcast DJ controller 1374, or alternatively are broadcast from a plurality of transmitters 1380 placed around the venue 1370, and which are connected by wires 1378 to the controller 1374 (although the connection can also be wireless within the spirit of the present invention). It should be understood that the protocol for transmitting DJ control signals can be limited either by hardware requirements or by regulatory standards to a certain distance of reception. Thus, to cover a sufficiently large venue, multiple transmitters can be necessary to provide complete coverage over the venue 1370. In general, it is preferable for the maximum transmission distance of transmission from the transmitters to be at least 100 feet, and more preferably at least 200 feet, and most preferably at least 500 feet, so as to be able to cover a reasonable venue 1370 size without needing too many transmitters 1380.

An alternative embodiment of unit 100 to DJ 200 communications is the use of radio frequency transmitters and receivers, such as those used in model airplane control, which comprise multi-channel FM or AM transmitters and receivers. These components can be very small (e.g. the RX72 receivers from Sky Hooks and Riggings, Oakville, Ontario, Canada), and are defined by the crystal oscillators that determine the frequency of RF communications. Each channel can serve for a separate channel of DJ control signals. In such cases, an individual can place a specific crystal in their audio unit 100, and entraining the DJ 200 is then carried out through the use of the same crystal in the DJ 200. Because of the large number of crystals that are available (e.g. comprising approximately 50 channels in the model aircraft FM control band), interference with other audio units 100 can be minimized. Furthermore, control of many DJs 200 within a venue, as described above, can take place by simultaneously transmitting over a large number of frequencies.

As described above, the wide-area broadcast transmitter 125 can transmit entriaing signals to which the DJs 200 can be set to respond. However, there are a number of other preferred means by which DJs 200 can be used to respond to control signals to which they have not been entrained. For example, the DJs 200 can be set to respond to controls signals to which they have not been entrained should there be no entrained control signals present (e.g. the corresponding unit 100 is not turned on).

Figure 35 is a schematic block diagram of DJ 200 switch control for both entraining and wide-area broadcast. The DJ 200 comprises a three-way switch 1920. In a first state 1922, the DJ 200 is entrained to the current control signal as described above. Thereafter, in a second state 1924, the DJ 200 responds to control signals corresponding to the entraining signal encountered in the step 1922. In a third state 1926, the DJ 200 responds to any control signal for which its receiver is receptive, and can therefore respond to a wide-area broadcast, thereby providing the user with manual control over the operational state of the DJ 200. It should be noted that the switch 1920 can be any physical switch with at least three discreet positions, or can alternatively be any manual mechanism by which the user can specify at least three states, including a button presses that have a visible user interface or a voice menu.

Figure 12B is a schematic drawing of modular digital jewelry 201. The modular jewelry 201 is comprised of two components: an electronics module 1934 and a display module 1932. These modules 1934 and 1932 can be electrically joined or separated through an electronics module connector 1936 and a display module connector 1938. The value of the modular arrangement is that the electronics module 1934 comprises, in general, relatively expensive components, whose combined price can be many-fold that of the display module 1932. Thus, if a user wants to change the appearance of the jewelry 201 without having to incur the cost of additional electronics components such as the energy storage 270, receiver 220 or controller 1322, they can simply replace the display module 1932 with its arrangement of output transducers 1324 with an alternative display module 1933 with a different arrangement of output transducers 1325.

The transmitter for DJ 200 control signals has been previously discussed primarily in terms of its incorporation within a unit 100. It should be understood, however, that the transmitter can be used in conjunction with a standard audio player unrelated to unit-to-unit communications. Figure 12C is a schematic block diagram of a modular digital jewelry transmitter 143 that generates and transmits control signals from an audio player 131. The modular transmitter 143 is connected to the audio player 131 via audio output port 136 through the cable 134 to the audio input port 138 of the modular transmitter 143. The modular transmitter 143 comprises the the DJ transmitter 120, which can send unit-to-DJ communications. The output audio port 142 is connected to the earphone 901 via cable 146. The earphone 901 can also be a wireless earphone, perhaps connected via the DJ transmitter 120.

The audio output from the player 131 is split both to the earphone 901 and to the controller 241 (except, perhaps where the DJ transmitter transmits to a wireless earphone).

The controller 241 automatically generates control signals for the DJ 200 in a manner to be described in detail below. These signals are then conveyed to the DJ transmitter 120. It should be understood that this arrangement has the advantage that the digital jewelry functionality can be obtained without the const of the components for the audio player 131, and in addition, that the modular transmitter 143 can then be used in conjunction with multiple audio players 131 (either of different types or as the audio players are lost or broken).

Inter-unit Audio Sharing

Overview

Inter-unit communication involves the interactions of multiple users, who may or may not be acquaintances of each other. That is, the users can be friends who specifically decide to listen to music together, or it can be strangers who share a transient experience on a subway train. The present invention supports both types of social interaction.

An important aspect of the present invention is the means by which groups of individuals join together. Figure 6 is a schematic block diagram of a cluster 700 of units 100, indicating the nomenclature to be used. The cluster 700 is comprised of a single broadcast unit 710, and its associated broadcast DJ 720, as well as one or more receive units 730 and their associated DJs 740. The broadcast unit 710 transmits music, while the receive unit 730 receives the broadcasted music. A search unit 750 and its associated search DJ 760 are not part of the cluster 700, and comprise a unit 100 that is searching for a broadcast unit 710 to listen to or a cluster 700 to become associated with.

It should be noted that many communications systems can be operated alternatively in two modes: one that supports peer-to-peer communications and one that requires a fixed infrastructure such as an access point. Figure 35 is a schematic block diagram of mode switching between peer-to-peer and infrastructure modes. A mode switch 1950 is made by the user, either manually, or automatically – for example, that the user chooses between different functions (listening or broadcasting, file transfers, browsing the Internet) and the system determine the optimal mode to use. A peer-to-peer mode 1952 is well configured for mutual communications between mobile units 100 that are within a predetermined distance, and is well-suited for short-range wireless communications and audio data streaming 1954. Alternatively, the mode switch 1950 enables an infrastructure mode 1956, which is of particular usefulness in gaining access to a wide area network such as the Internet, through

which remote file transfer 1958 (e.g. downloading and uploading) and remote communications such as Internet browsing can be made through access points to the fixed network.local wireless audio streaming.

It should be noted, however, that certain communications systems, such as many modes of telephony, do not distinguish between mobile communications and communications through fixed access points, and that both file transfer 1958 and audio streaming 1954 can be available through the same mode. Even in those cases, however, it can be convenient to have two modes in order to make optimal use of the advantages of the different modes. In such cases, however, the two modes can alternatively be supported by multiple hardware and software systems within the same device – for example, for remote communications to be made through a telephony system (e.g. GSM or CDMA), while the local audio streaming 1954 can be made through a parallel communications system (e.g. Bluetooth or 802.11) – indeed, the two systems can operate simultaneously with one another.

Inter-unit Transmission Segmentation

Preferably, the broadcast unit 710 and the receive units 730 exchange information in addition to the audio signal. For example, each user preferably has indications as to the number of total units (broadcast units 710 and receive units 730) within a cluster, since the knowledge of cluster 700 sizes is an important aspect of the social bond between the users. This also will help search units 750 that are not part of the cluster determine which of the clusters 700 that might be within their range are the most popular.

The additional information shared between members of a cluster 700 would include personal characteristics that a person might allow to be shared (images, names, addresses, other contact information, or nicknames). For example, the broadcast unit 710 will preferably, along with the music, transmit their nickname, so that other users will be able to identify the broadcast unit 710 for subsequent interactions, and a nickname is significantly easier to remember than a numerical identifier (however, such numerical identifier can be stored in the unit 100 for subsequent searching).

Such additional information can be multiplexed along with the audio signal. For example, if the audio signal is transferred as an MP3 file, assuming that there is additional bandwidth beyond that of the MP3 file itself, the file can be broken into pieces, and can be interspersed with other information. Figure 7 is a schematic diagram of a broadcast unit 710 transmission 820. The transmission is comprised of separate blocks of information, each represented in the figure as a separate line. In the first line, a block code 800 is transmitted,

which is a distinctive digital code indicating the beginning of a block, so that a search unit 750 receiving from the broadcast unit 710 for the first time can effectively synchronize itself to the beginning of a digital block. Following the block code 800 is a MP3 block header 802, which indicates that the next signal to be sent will be from a music file (in this case an MP3 file). The MP3 block header 802 includes such information as is needed to interpret the following block of MP3 file block 804, including such information as the length of the MP3 block 804, and characteristics of the music (e.g. compression, song ID, song length, etc.) that are normally located at the beginning of a MP3 file. By interspersing this file header information at regular intervals, a user can properly handle music files that are first received in the middle of the transmission of an MP3 file. Next, the MP3 block 804 containing a segment of a compressed music file is received.

Dependent on the amount of music compression and the bandwidth of the inter-unit communications, other information can be sent, such as user contact information, images (e.g. of the user), and personal information that can be used to determine the "social compatibility" of the user with the broadcast unit 710 and the receive unit 730. This information can be sent between segments of MP3 files or during "idle" time, and is generally preceded by a block code 800, that is used to synchronize transmission and reception. Next, a header file is transmitted, which indicates the type of information to follow, as well as characteristics that will aid in its interpretation. Such characteristics could include the length of information, descriptions of the data, parsing information, etc. In Figure 7, an ID header 806 is followed by an ID block 808, which includes nicknames, contact information, favorite recording artists, etc. Later, an image header 810 can be followed by an image block with an image of the user. The image header 810 includes the number of rows and columns for the image, as well as the form of image compression.

It should be understood that the communications format described in Figure 7 is only illustrative of a single format, and that a large number of different formats are possible within the present invention. Also, the use of MP3 encoding is just an example, and other forms of digital music encoding are within the spirit of the present invention, and can alternatively comprise streaming audio formats such as Real Audio, Windows Media Audio, Shockwave streaming audio, QuickTime audio or even streaming MP3 and others. Furthermore, these streaming audio formats can be modified so as to incorporate means for transmitting DJ 200 control signals and other information.

Transmitting Dynamic Data and Control Information

As described above, there are benefits to two-way communications between the broadcast unit 710 and the receive unit 730. There are many methods of carrying out this communication, even if the inter-unit transmitter/receiver 110 does not permit simultaneous transmission and reception. For example, additional transmission and reception hardware could be included in each unit 100. Alternatively, in the transmission 820 above, specific synchronization signals such as the block code 800 can be followed by specific intervals during which the inter-unit transmitter/receiver 110 that is transmitting switches into receive mode, while the inter-unit transmitter/receiver 110 that was receiving switches to transmit mode. This switch in communications direction can be for a specific interval, or can be mediated through conventional handshake methods of prior art communications protocols.

It should be noted that in addition to transfer of static information (e.g. identifiers, contact information, or images), dynamic information and control information can also be transferred. For example, the user at the receive unit 730 can be presented with a set of positive and negative comments (e.g. "Cool!" "This is awful!") that can be passed back to the broadcast unit 710 with the press of a button. Such information can be presented to the user of the broadcast unit 710 either by visual icon on, for example, an LCD screen, by a text message on this screen, or by artificial voice synthesis generated by the broadcast unit 710 and presented to the user in conjunction with the music.

Alternatively, the user of the receive unit 730 can speak into a microphone that is integrated into the receive unit 730, and the user voice can be sent back to the broadcast unit 710. Indeed, the inter-unit communications can serve as a two-way or multi-way communications method between all units 100 within range of one another. This two-way or multi-way voice communication can be coincident with that of the playing of the audio entertainment, and as such, it is convenient for there to be separate amplitude control over the audio entertainment and the voice communication. This can be implemented either as two separate amplitude controls, or alternatively as an overall amplitude control, with a second control that sets the voice communications amplitude as a ratio to that of the audio entertainment. In this latter mode, the overall level of audio output by the unit is relatively constant, and the user then selects only the ability to hear the voice communication over the audio entertainment.

In order to express their feelings and appreciation about the music they are hearing, users within a cluster 700 can also press buttons on their units 100 that will interrupt or

supplement the control signals being sent to their respective DJs 200, providing light shows that can be made to reflect their feelings. For example, it can be that all lights flashing together (and not in synchrony with the music) can express dislike for music, whereas intricate light displays could indicate pleasure.

It is also possible to send control requests between units 710. For example, a receive unit 730 can make song requests (e.g. "play again", "another by this artist") that can show on the broadcast unit 710 user interface. Alternatively, the user of a receive unit 730 can request that control be switched, so that the receive unit 730 becomes the broadcast unit 710, and the broadcast unit 710 becomes a receive unit 730. Such requests, if accepted by the initial broadcast unit 710 user, will result in the memory storage of the identifier of the broadcast unit 710 being set in all units in the cluster 700 to that of the new broadcast unit 730. Descriptions of the communications resulting in such a transfer of control will be provided below.

Additionally, it is also possible for users of units 100 to privately "chat" with other users while they are concurrently receiving their audio broadcasts. Such chat can be comprised of input methods including keyboard typing, stylus free-form writing/sketching, and quickly selectable icons.

It should be understood that within the spirit of the present invention that the functional configuration can be supported by the extension of certain existing devices. For example, the addition of certain wireless transmitter and receiver, as well as various control and possibly display functionality to a portable audio player would satisfy some embodiments of the present invention. Alternatively, by the addition of music storage and some wireless transmitter and receiver functionality, a mobile telephone would also allow certain embodiments of the present invention. In such case, the normal telephony communications, perhaps supported by expanded 3G telephony capabilities, could serve to replace aspects of the IP communications described elsewhere in this specification.

IP Socket Communication Embodiments

A standard set of protocols for inter-unit communications is provided through IP socket communications, which is widely supported by available wireless communications hardware, including 820.11a, b and g (Wi-Fi). An embodiment of inter-unit communications is provided in Figures 14A-B. Figure 14A is a schematic block diagram of the socket configurations on the broadcast unit 710 and the receive unit 730.

In the discussion below, transfer of the different messages and audio information are provided, generally but not always, through an Internet protocol. At the transport layer of such protocols, there will generally be used either a connectionless protocol or a connection-oriented protocol. Among the most common of these protocols are respectively the User Datagram Protocol (UDP) and the Transmission Control Protocol (TCP), and wherever these protocols are used below, it should be noted that any like protocol (connectionless or connection-oriented), or the entire class of protocol can generally be substituted in the discussion.

The broadcast unit 710, prior to the membership of the receive unit 730, broadcasts the availability of the broadcast on a broadcast 1050, which is generally a TCP socket. The annunciator 1050 broadcasts on a broadcast address with a predetermined IP address and port. The receive unit 730 has a client message handler 1060 that is also a TCP socket that is looking for broadcasts on the predetermined IP address and port. When it receives the broadcast, a handshake creates a private server message handler 1070 on a socket with a new address and port on the broadcast unit 710. The broadcast unit 710 and the receive unit 730 can now exchange a variety of different messages using the TCP protocol between the server message handler 1070 and the client message handler 1060. This information can comprise personal information about the users of the broadcaster unit 710 and the receive unit 730. Alternatively or additionally, the broadcast unit 710 can transfer a section of the audio signal that is currently being played, so that the user of the receive unit 730 can "sample" the music that is being played on the broadcast unit 710. It should be noted that, in general, the broadcast unit 710 continues its broadcast on the broadcast annunciator 1050 for other new members.

Once it is established that the broadcast unit 710 and the receiver unit 730 are mutually desirous of providing and receiving an audio broadcast, respectively, sockets optimized for broadcast audio are created both on the broadcast unit 710 and the receiver unit 730. These sockets will often be UDP sockets – on the broadcast unit 710, a multicast out socket 1080 and on the receiver unit 730, a multicast in socket 1090.

Figure 14B is a schematic block flow diagram of using IP sockets for establishing and maintaining communications between a broadcast unit 710 and the receive unit 730, according to the socket diagram of Figure 14A. In a step 1100, the broadcast annunciator 1050 broadcasts the availability of audio signals. In a step 1102, the receiver unit 730 searches for a broadcast annunciator 1050 on the client message handler 1060 socket. Once a connection is initiated in a step 1104, the broadcast unit 710 creates the message handler

socket 1070 in a step 1106, and the receiver unit 730 retasks the message handler socket 1060 for messaging with the broadcast unit 730. The broadcast annunciator 1050 continues to broadcast availability through the step 1100.

In a step 1110, the broadcast unit 710 and the receiver unit 730 exchange TCP messages in order to establish the mutual interest in audio broadcasting and reception. Should there not be mutual acceptance, then the system returns to the original state in which the broadcast unit 710 is transmitting the broadcast annunciation in the step 1100, and the receive unit 730 searches for broadcasts in the step 1102. Given that the receive unit 730 and the broadcast unit 710 will be within communications distance, and that the broadcast unit 710 is transmitting an annunciation for which the receive unit 730 is receptive, the broadcast unit 710 will be set into a state where it will not establish communications with the receive unit 730 in the step 1106. This can occur either by not creating the message socket in the step 1106 when connection is made with the receiver unit 730, or that the annunciator 1050 remains silent for a predetermined period, perhaps for a period of seconds.

If the broadcast unit 710 and the receiver unit 730 do mutually accept a multicasting relationship, the broadcast unit 710 creates the multicast out UDP socket 1080 in a step 1112 and the receiver unit 730 creates the multicast in UDP socket 1090 in the step 1114, and multicast audio transmission and reception is initiated in a step 1116. It should be noted that should the broadcast unit 710 already be multicasting audio to a receiver unit 730 prior to the step 1112, the multicast out socket 1080 is not created, but that the address of this existing socket 1080 is communicated to the new cluster member.

Given that a cluster can comprise many members, the system of Figures 14A-B must be able to expand to include multiple members. Figure 15 is a schematic block diagram of the IP socket organization used with clusters comprising multiple members. The broadcast unit 710 includes a broadcast annunciator 1050 indicating broadcast availability for new members. For each member in the cluster, the broadcast unit further comprises a message handler 1070 dedicated to the specific member, whose receive unit 730 in turn comprises a message handler 1060, generally in a one-to-one relationship. The broadcast unit comprises N messaging sockets 1070 for the N receive units of the cluster, while each member has only a single socket 1060 connected to the broadcast unit. Thus, when a member wishes to send a message to the other members of the cluster, the message is sent via the receive unit message handler 1060 to the broadcast unit message handler 1070, and which is then multiply sent to the other receive unit message handlers 1060. It is also within the teachings of the present invention for each member of the cluster to have direct messaging capabilities with each

other member, assisted in the creation of the communications by the broadcast unit 710, which can share the socket addresses of each member of the cluster, such that each member can assure that it is making connections with other members of the cluster rather than units of non-members. The broadcast unit 710 also comprises a multicast out socket 1080 which transfers audio to individual receiver sockets 1090 on each of the members of the cluster.

Members of the cluster may come and go, especially since members will frequently move physically outside of the transmission range of the broadcast unit 710. In order for the broadcast unit 710 to determine the current number of members of its cluster, it is within the teachings of the present invention for the broadcast unit 710 to use the messaging sockets 1060 and 1070 to "ping" the receive units 730 from time to time, or otherwise attempt to establish contact with each member of the cluster 700. Such communications attempts will generally be done at a predetermined rate, which will generally be more frequent than once every ten seconds. Information about the number of members of a cluster can be sent by the broadcast unit 710 to the other members of the cluster, so that the users can know how many members there are. Such information is conveniently placed on a display on the unit (see, for example, Figures 18A-B).

Music Synchronization

It will be generally desirable that the synchronicity of the audio playback on the broadcast unit 710 and the receive units 730 be highly synchronized, preferably within 1 second (i.e. this provides a low level functionality of listening to music together), more preferably within 100 milliseconds (i.e. near-simultaneous sharing of music, but an observer would be able to hear – or see through DJ 200 visible cues – the non-synchronicity), and most preferably within 20 milliseconds of one another. In a simple embodiment of the present invention, all members of a cluster 700 must communicate directly with the broadcast unit 710, without any rebroadcast. In such cases, making playback on the two units 710 and 730 as similar as possible will tend to synchronize their audio production.

Figure 8A is a schematic block diagram of audio units 100 with self-broadcast so that audio output is highly synchronized. Two audio units 100 are depicted, including a broadcast unit 710 and a receive unit 730. The organization of audio unit 100 elements is chosen to highlight the self-broadcast architecture. The audio media 1500, which can be compressed audio storage 310, stores the audio signals for broadcast. The output port 1502, which can comprise the inter-unit transmitter/receiver 110, transmits a broadcast audio signal, provided by the audio media 1500. The audio media comprise a variety of different storage protocols

and media, including mp3 files, .wav files, or .au files which are either compressed or uncompressed, monoaural or stereo, 8-bit, 16-bit or 24-bit, and stored on tapes, magnetic disks, or flash media. It should be understood that the spirit of the present invention is applicable to a wide variety of different audio formats, characteristics, and media, of which the ones listed above are given only by way of example. This broadcast audio signal transmitted from the output port 1502 is received at the input port 1504, which can also comprise aspects of the inter-unit transmitter/receiver 110. The signal so received is then played to the associated user via the audio output 1508.

It should be noted that the audio output is normally connected to the audio media 1500 for audio playing when the unit 710 is not broadcasting to a receive unit 730. In such case, there is no need for the audio signals to go to the output port 1502 and thence to the input port 1504. Indeed, even when broadcasting, the audio signal within the broadcast unit 710 can go both directly to the audio output 1508 as well as to be broadcast from the output port 1502.

However, in order to assure the synchronicity of the audio output on the broadcast unit 710 and the receive unit 730, the broadcast unit 710 can present all audio signal from the audio media 1500 for output on the output port 1502. The signal will be received not only on the receiver 730 input port 1504, but also on the input port 1504 of the broadcast unit 710. This can take place either through the physical reception of the broadcast audio signal on a radio frequency receiver, or through local feedback loops within the audio unit 100 (e.g. through employment of IP loopback addresses).

In the receive unit 730, the audio signal received at the input port 1504 goes directly to the audio output 1508, and the other elements of the unit 100 depicted are not active. In the broadcast unit 710, however, if means are used to transfer audio signal between the output port 1502 and the input port 1504 are utilized, and if such transfer means requires less time than that taken for transmitting signal from the output port 1502 of the broadcast unit 710 to the input port 1504 of the receive unit 730, then a delay means 1506 is introduced to provide a constant delay between the input port 1504 and the audio output 1508. This delay can comprise a digital buffer if the signal is digitally encoded, or an analog delay circuit if the signal is analog. Generally, the delay introduced into the audio playback will be a predetermined amount based on the characteristics of the unit hardware and software.

Alternatively, in the case of a digital signal, the delay can be variably set according to the characteristics of the communications system. For example, if there are IP-based communications between the units, the units can "ping" one another in order to establish the

time needed for a "round-trip" communications between the systems. Alternatively, each receive unit 730 of a cluster 700 can transmit to the broadcast unit 710 a known latency of the unit based on its hardware and transmission characteristics. It should be noted that in order to handle different delays between multiple members of a cluster, a delay can be introduced into both the broadcast unit 710 and the receive unit 730, should a new member to the cluster have a very long latency in communications.

Note that the delay 1506 can serve a second purpose, which is to buffer the music should there be natural interruptions in the connections between the members of the cluster 700 (for example, should the receive units 730 move temporarily outside of the range of the broadcaster unit 710). In such case, should enough audio signal be buffered in the delay 1506, there would not be interruption of audio signal in the receive unit 730. Even in such cases, however, in order to accommodate the differences in time to play audio between units and within a unit, the delays in the broadcast unit 710 can be larger than those in the receive unit 730.

If the music compression and the bandwidth of the inter-unit communications are large enough, it can be that the broadcast unit 710 will broadcast less than half of the time. This will generally allow the receive unit 730 to rebroadcast the information from an internal memory store, allowing the effective range of the broadcast signal to potentially double. This can allow, through multiple rebroadcasts, for a very large range even if each individual unit 100 has a small range, and therefore for a potentially large number of users to listen to the same music.

In order to synchronize those that listen to the music through first, second and Nth rebroadcast, a scheme for multi-broadcast synchronization is presented in Figure 8B, a schematic flow diagram for synchronous audio playing with multiple rebroadcast. In such a case, the cluster 700 is considered to be all units 100 that synchronize their music, whether from an original broadcast or through multiple rebroadcasts. In a first step 780, a unit 100 receives a music broadcast along with two additional data. The first data is the current "N", or "hop" of the broadcast it receives, where "N" represents the number of rebroadcasts from the original broadcast unit 710. Thus, a unit 100 receiving music from the original broadcast unit 710 would have an "N" of "1" (i.e. 1 hop), while a unit 100 that received from that receiving unit 100 would have an "N" of "2" (2 hops), and so on. A second piece of information would be the "largest N" that was known to a unit 100. That is, a unit 100 is in contact generally with all units 100 with which it either receives or transmits music, and each send the "largest N" with which it has been in contact.

In a second step 782, the unit 100 determines the duration between signals in the broadcasts it is receiving. Then, two actions are taken. In a step 786, the unit 100 rebroadcasts the music it has received, marking the music with both its "N" and the largest "N" it knows of (either from the unit from which it received its broadcast or from a unit to which it has broadcast).

Also, in a step 784, the music that has been received is played after a time equal to the duration between signals and the "largest N" minus the unit's "N". This will allow for all units 100 to play the music simultaneously. Consider, for example the original broadcast unit 710. It's "N" is "0", and its "largest N" is the maximum number of rebroadcasts in the network. It will store music for a period of "largest N" (equals "largest N" minus "0") times the duration of a rebroadcast cycle, and then play it. For a unit 100 at the furthest rebroadcast, it's "N" and "largest N" will be equal to one another, so that it will store music for no time (i.e. "largest N" minus "N" = 0), but will play it immediately. This will allow all units 100 in the cluster to play music simultaneously. The limitation, however, is that there is memory in each unit 100 to store the music for a sufficient period of time. The units 100 on the system, however, can transfer the amount of storage that is available with the other information, and the number of rebroadcasts can be limited to the amount of memory available within the units 100 that comprise the cluster 700.

As the size of this multi-broadcast cluster 700 changes, the "largest N" can vary, and it will take generally on the order of "largest N" steps for the system to register "largest N". In such cases, there can be temporary gaps in the music on the order of the duration between signals, which will generally be on the order of tens of milliseconds, but which can be longer.

It should be noted that the synchronization of music does not need to accompany the transfer of an actual music signal. Figure 34A is a schematic block flow diagram of the synchronization of music playing from music files present on the units 100. In this embodiment, in a step 1900, the broadcast unit establishes the presence or absence of the music file comprising the music signals to be played on the receive unit. The music file can be referenced either with respect to the name of the file (e.g. "Ooops.mp3"), or a digital identifier that is associated with the music file.

If the music file is not present, then transfer of the music file from the broadcast unit to the receive units can automatically proceed through a file transfer mechanism such as peer-to-peer transfer in a step 1904. If the file was already present, or if the file has been transferred, or alternatively, if the file transfer has begun and enough of the file is present to

allow the simultaneous playing of music between the two units 100, transmission of synchronization signals between the two units 100 can commence in a step 1902.

These synchronization signals can comprise many different forms. For example, the synchronization signal can be the time stamp from the beginning of the music file to the current position of the music file being played on the broadcast unit. Alternatively, the broadcast unit can send the sample number that is currently being played on the broadcast unit 100. In order to allow receiving units to begin synchronous playing in the middle of a transmission from a broadcast unit, the synchronization signals will preferably include information about the song being played, such as the name of the file or the digital identifier associated with the file.

Transmission of this synchronization signal continues until the termination of the song, or until a manual termination (e.g. by actuating a Pause or Stop key) is caused (the frequency of transmission of the synchronization signal will be discussed below). At this point, the broadcast unit can send a termination, pause or other signal in a step 1906. Note that this method of synchronization can operate when the receiving unit establishes connection with the broadcast unit even in the middle of a song.

Figure 34B is a schematic layout of a synchronization signal record 1910 according to Figure 34A. The order and composition of the fields can vary according to the types of music files used, the means of establishing position, the use of digital jewelry, the desire for privacy, and more.

The position field 1912 (SAMPLE#) which contains an indicator of position in a music file – in this case the sample number within the file. The music file identifier field 1914 (SONGID) comprises a textual or numerical identifier of the song being played. The third field is the sample rate field 1916 (SAMPLERATE), and is primarily relevant if the position field 1912 is given in samples, which allows a conversion into time. Given that the same audio entertainment can be recorded or saved at different sample rates, this allows the conversion from a potentially relative position key (samples) to one independent of sample rate (time). The jewelry signal field 1918 (JEWELSIGNAL) is used to encode a digital jewelry 200 control signal for controlling the output of the digital jewelry 200, should the receiver unit be associated with jewelry 200. The order and composition of the fields can vary according to the types of music files used, the means of establishing position, the use of digital jewelry, the desire for privacy, and more.

The frequency with which the record 1910 is broadcast can vary. The time of reception of the record 1910 sets a current time within the song that can adjust the position of

the music playing on the receiver unit. It is possible for the record to be broadcast only once, at the beginning of the song, to establish synchronization. This, however, will not allow others to join in the middle of the music file. Furthermore, if the record 1910 is received or processed at different times for the single record, the music can be poorly synchronized. With multiple synchronization signals, the timing can be adjusted to account for the most advanced reception of the signal – that is, the music playing will be adjusted forward for the most advanced signal, but not be adjusted back for a more laggard signal.

If the record further contains a jewelry signal field 1918, the frequency with which the record 1910 should be sent should be comparable or faster than the rate with which these signals change, and should be preferably at least 6 times a second, and even more preferably at least 12 times a second. If less frequent record 1910 transmission is desired, then multiple jewel signal fields 1918 can be included in a single record 1910.

It should be noted that given units 100 of different design or manufacture, there can be different intrinsic delays between reception of music and/or synchronization signals and the playing of the music. Such delays can result from different speeds of MP3 decompression, different sizes of delay buffers (such as delay 1506), different speeds of handling wireless transmission, differing modes of handling music (e.g. directly from audio media 1500 to audio output 1508 on the broadcast unit, but requiring transmission through an output port 1502 and input port 1504 for the receiver unit), and more. In such cases, it is preferable for receiver units to further comprise a manual delay switch that can adjust the amount of delay on the receiver unit. This switch will generally have two settings: to increase the delay and to decrease the delay, and can conveniently be structured as two independent switches, a rocker switch, a dial switch or equivalent. It is useful for the increments of delay determined by the switch be adjustable so as to allow users to sense the music from the broadcast unit and the receiver unit as being synchronous, and it is preferable for the increments of delay to be less than 50 milliseconds, and even more preferable for the increments of delay to be less than 20 milliseconds, and most preferable for the units of delay to be less than 5 milliseconds.

Creation and Maintenance of Clusters

Search units 750 can be playing music themselves, or can be scanning for broadcast units 710. Indeed, search units 750 can be members of another cluster 700, either as broadcast unit 710 or receive unit 730. To detect a different cluster 700 in which it might desire membership, the search unit 750 can either play the music of the broadcast unit 710 to

the search unit 750 user, or it can scan for personal characteristics of the broadcast unit 710 user that are transmitted in the ID block 808. For example, a user can establish personal characteristic search criteria, comprising such criteria as age, favorite recording artists, and interest in skateboarding, and respond when someone who satisfies these criteria approaches.

Alternatively, the search unit 750 user can also identify a person whose cluster he wishes to join through visual contact (e.g. through perceiving the output of the person's light transducer 240).

Before a search unit 750 user can establish contact, it is preferable for a broadcast unit 710 user, or a receive unit 730 user, to provide permissions for others to join the cluster. For example, each unit 100 will generally be able to changeably set whether no one can join with their unit 100, whether anyone can join with their unit 100, or whether permission is manually granted for each user who wishes to join with their unit into a cluster. For a cluster 700, membership in the cluster can be provided either if any one member of the cluster 700 permits a search unit 750 user to join, or it can be set that all members of a cluster 700 need to permit other users to join, or through a variety of voting schemes. The permissions desired by each member will generally be sent between units 100 in a cluster as part of the ID block 808 or other inter-unit communications. Furthermore, these permissions can be used to establish the degree to which others can eavesdrop on a unit 100 transmission. This can be enforced either through the use of cryptography, which can only provide decryption keys as part of becoming a cluster 700 member, through provision of a private IP socket address or password, through standards agreed by manufacturers of unit 100 hardware and software, or by unit 100 users limiting the information that is sent through the ID block 808 through software control.

The search unit 750 user can then establish membership in the group in a variety of ways. For example, if the search unit 750 is scanning music or personal characteristics of the unit 100 user, it can alert the search unit 750 user about the presence of the unit 100. The search unit 750 user can then interact with the search unit 750 interface to send the unit 100 user a message requesting membership in the cluster 700, which can be granted or not. This type of request to join a cluster 700 does not require visual contact, and can be done even if the search unit 750 and cluster are separated by walls, floors, or ceilings.

Another method of establishing contact between a search unit 750 user and a cluster 700 member is for the search unit 750 user to make visual contact with the cluster 700 member. In such case that physical contact or physical proximity is easily made between the unit 100 of the cluster member and the search unit 750, digital exchange can be easily made

either through direct unit 100 contact through electrical conductors, or through directional signals through infra-red LEDs, for example. For example, the search unit 750 user can point his unit 100 at the cluster 700 member unit, and then if the cluster member wishes the search unit 750 user to join the cluster, could point his unit 100 at the search unit 100, and with both pressing buttons, effect the transfer of IDs, cryptography keys, IP socket addresses or other information that allows the search unit 750 user to join the cluster 700.

Alternatively, the broadcast DJ 720 (or the receive DJ 740) can present digital signals through the light transducer. For example, most DJ 720 light transduction will be modulated at frequencies of 1-10 Hz, with human vision not being able to distinguish modulation at 50 Hz or faster. This means that digital signals can be displayed through the light transducer 240 at much higher frequencies (kHz) that will not perceived by the human eye, even while lower frequency signals are being displayed for human appreciation. Thus, the broadcast DJ 720 can receive a signal from the broadcast unit 710 DJ transmitter 120 containing information needed for a search unit 750 to connect to the broadcast unit's cluster 700. This information will be expressed by the light transducer 240 of the broadcast DJ 720 in digital format. The search unit 750 can have an optical sensor, preferably with significant directionality, that will detect the signal from the light transducer 240, so that the search unit 750 is pointed in the direction of the broadcast DJ 720, and the identifier information required for search unit 750 to become a member of cluster 700. This optical sensor serves as the DJ directional identifier 122 of Figure 1. At this point, if desired, the broadcast unit 710 user can determine if they want the search unit 750 user to join the cluster 700.

A summary of means to effect joining of a cluster is provided in Figures 13A through E, which display means for a search unit 750 to exchange information prior to joining a cluster 700 via a broadcast unit 710. It is also within the teachings of the present invention for the search unit 750 to institute communications with a receive unit 730 for the purposes of joining a cluster in a similar fashion, particularly since it may be difficult for a person outside of the cluster 700 to determine which of the cluster 700 members is the broadcast unit 710, and which is a receiver unit 730.

If should be noted in the Figures 13A-G that limited range and directionality are preferred. That is, there can be a number of broadcast units 710 within an area, and being able to select that one broadcast unit 710 whose cluster one wishes to join requires some means to allow the search unit 750 user to select a single broadcast unit 710 among many. This functionality is generally provided either by making a very directional communication between the two devices, or by depending on the physical proximity of the search unit 750

and the desired broadcast unit 710 (i.e. in a greatly restricted range, there will be fewer competing broadcast units 710). In the following description, the "broadcaster" denotes the user using the broadcast unit 710, and the "searcher" denotes the user using the search unit 750.

In the Figures 13A-G, the selection of the cluster by the searcher occurs in three ways, that will referred to as "search transmission mode", "broadcast transmission mode", and "mutual transmission mode", according to the entity that is conveying information. In search transmission mode, the searcher sends an ID via the search unit 750 to the broadcast unit 710. This ID can comprise a unique identifier, or specific means of communication (e.g. an IP address and port for IP-based communication). With this ID, the broadcast unit can either request the searcher to join, or can be receptive to the searcher when the searcher makes an undifferentiated request to join local units within its wireless range. In broadcast transmission mode, the broadcaster sends an ID via the broadcast unit 710 to the search unit 750. With this ID, the searcher unit can then make an attempt to connect with the broadcast unit 710 (e.g. if the ID is an IP address and port), or the search unit can respond positively to a broadcast from the broadcast unit 710 (e.g. from a broadcast annunciator 1050), wherein the ID is passed and checked between the units early in the communications process. Mutual transmission mode comprises a combination of broadcast transmission mode and search transmission mode, in that information and communication is two way between the broadcaster and the searcher.

Figure 13A is a schematic cross-section through a search unit 750 and a broadcast unit 710 in which communications are provided via visible or infrared LED emission in search transmission mode. On the right of the figure, a LED 1044 with an associated lens 1046 (the two of which can be integrated) transmits a directional signal from the unit case 1000. This light can optionally pass thorough a window 1048 that is transparent to the light. On the left of the figure, a lens element 1040 collects light through a broad solid angle and directs it onto a light sensing element 1042, which is conveniently a light-sensing diode or resistor. The directionality of the communication is conferred by the transmitting lens 1046 and the collecting lens 1040.

Alternatively, the LED 1044 can be replaced by a visible laser. Figure 13B is a schematic cross-section through a search unit 750 and a broadcast unit 710 in which communications are provided via a visible or infrared laser in search transmission mode. The search unit 750 comprises a diode laser 1041 that is conditioned by a lens 1043 to form a beam that is sensed by the light sensing element 1042 on the broadcast unit 710. Because a

collimated laser beam can be difficult to aim with precision at a photosensing element carried by a person, the optics can comprise a two focus lens 1043 that has a portion that produces a collimated beam 1045, and a second portion that produces a diverging beam 1047. The collimated beam is used by the user of the search unit 750 as a guide beam to direct the pointing of the unit 750, while the divergent beam provides a spread of beam so that the human pointing accuracy can be relatively low. The means for creating the two focus lens 1043 can include the use of a lens with two different patterns of curvature across its surface, or the use of an initial diverging lens whose output intersects a converging lens across only a part of its diameter, where the light that encounters the second lens is collimated, and the light that does not encounter the second lens remains diverging. It is also within the teachings of the present invention for the lens to be slowly diverging without a collimating portion, such that the user does not get visible feedback of their pointing accuracy. In such case, the laser can emit infrared rather than visible wavelengths.

Figure 13C is a schematic cross-section through a search unit 750 and a broadcast unit 710 in which communications are provided via visible or infrared emission from a digital jewelry element 200 in broadcast transmission mode. The digital jewelry 200 is carried by the broadcaster on a chain 1033, with the digital jewelry 200 visible. The digital jewelry is emitting through a light transducer 1031 a high frequency signal multiplexed within the visible low frequency signal. The search unit 750 is pointed in the direction of the digital jewelry 200, and receives a signal through the light-sensing element 1042. This manner of communication is convenient because the searcher knows, via the presence of the visible signal on the digital jewelry 200, that the broadcaster is receptive to cluster formation.

Figure 13D is a schematic cross-section through a search unit 750 and a broadcast unit 710 in which communications are provided via contact in mutual transmission mode. In this case, the broadcast unit 710 and the search unit 750 both comprise a contact transmission terminus 1030, and electronic means by which contact transmission is performed. This means can operate either inductively (via an alternative current circuit), through direct electrical contact with alternating or direct current means, or other such means that involves a direct physical contact (indicated by the movement of the search unit 750 to the position of the unit depicted in dotted lines). The search unit 750 or the broadcast unit 710 can, via automatic sensing of the contact or manual control, initiate communications transfer. Given the mutuality of contact as well as the physical equivalence of the two units 710 and 750, information transfer is possible in both directions. It should be noted that in the case of direct

current connection, the termini 1030 will comprise two contact points, both of which must make electrical contact in order for communications to occur.

Figure 13E is a schematic cross-section through a search unit 750 and a broadcast unit 710 in which communications are provided via sonic transmissions in broadcast transmission mode. The broadcaster (or receivers) will be listening to the audio information generally through headphones 1020 or earphones, all of which comprise speakers 1022 that, to one extent or another, leak sonic energy. The use of audio output devices as depicted in Figure 10 and Figures 11A and 11B that admit external sound, will also increase the amount of sound energy lost. This sound energy can be detected by the searcher via a directional speaker comprising a sound collector 1024 and a microphone 1026. This system requires that the sound output of the broadcast unit 710 and the receiver unit 750 also output an ID encoded in the sound. Such sound can be conveniently output at inaudible frequencies, such as 3000-5000 Hz, which carry sufficient bandwidth to encode short messages or identifiers (e.g. an IP address and port number can be carried in 5 bytes). Sound energy, especially at higher frequencies, can be quite directional, depending on the shape of the collector 1024 and the structure of the microphone 1024, allowing good directional selection by the searcher.

Figure 13F is a schematic cross-section through a search unit 750 and a broadcast unit 710 in which communications are provided via radio frequency transmissions in broadcast transmission mode. The radio frequency transmissions are not strongly directional (and for the purposes of the broadcast of audio information, are designed to be as directionless as possible). In order to distinguish a desired cluster 700 to join and an undesired cluster 700, a number of strategies can be employed. For example, the strengths of the various signals can be measured and the strongest chosen for connection. Alternatively, if there are multiple broadcast connections available, the search unit 750 can sequentially attempt a connection with each broadcast unit 710. When the attempt is made, the broadcast unit 710 can, prior to alerting the broadcaster of the attempted joining by a new member, cause the digital jewelry 200 associated with the broadcast unit 710 to visibly flash a characteristic signal. The searcher can then verify by pressing the appropriate button on the search unit 750 his desire to join the cluster 700 of the broadcast digital jewelry 200 that had just flashed. If the searcher decided not to join that cluster 700, the search unit 750 could search for yet another unit broadcast unit 750 within range, and attempt to join.

At any time, the members of a cluster 700 can share personal characteristics (nickname, real name, address, contact information, face or tattoo images, favorite recording artists, etc.) through selection of choices of the unit 100 interface, with all such characteristics

or a subset thereof to be stored on the units 100. In order to assist cluster 700 members in determining whether or not to accept a person into their cluster 700, a search unit 750 member can display either the total number of people with whom he has shared personal characteristics, or he can alternatively allow the cluster members to probe his store of persons with whom personal characteristics have been stored to see whether a particular trusted person or group of common acquaintances are present therein. It is also within the spirit of the present invention for individuals to rate other individual members of their cluster, and such ratings can be collated and passed from person to person or cluster to cluster, and can be used for a cluster 700 to determine whether a search unit 750 person should be added to the cluster 700.

Figure 17 is a matrix of broadcaster and searcher preferences and characteristics, illustrating the matching of broadcaster and searcher in admitting a searcher to a cluster. A broadcaster preference table 1160 includes those characteristics that the broadcaster wishes to see in a new member of a cluster. These characteristics can include gender, age, musical "likes" and "dislikes", the school attended, and more. The searcher similarly has a preference table 1166. The searcher preference table 1166 and broadcaster preference table 1160 are not different in form, as the searcher will at another time function as the broadcaster for another group, and his preference table 1166 will then serve as the broadcaster preference table.

The broadcaster preference table 1160 can be automatically matched with a searcher characteristics table 1162. This table 1162 comprises characteristics of the searcher, wherein there will be characteristics that overlap in type (e.g. age, gender, etc.) which can then be compared with the parameters in the broadcaster preference table. This matching occurs during the period when the searcher is interrogating the cluster with interest in joining. Similarly, there is a broadcaster characteristics table 1164 indicating the characteristics of the broadcaster, which can be matched against the searcher preferences tale 1166.

The algorithm used in approving or disapproving of an accord between a preference table and a characteristics table can be varied and set by the user – whether by the broadcaster to accept new members into a cluster, or by a searcher to join a new cluster. For example, the user could require that the gender be an exact match, the age within a year, and the musical preferences might not matter. The user can additionally specify that an accord is acceptable if any one parameter matches, specify that an accord be unacceptable if any one parameter does not match, specify an accord be acceptable based on the overlap of a majority of the individual matches, or other such specification.

It should be noted that the broadcaster preferences table 1160 and the broadcaster characteristics table 1164 (and likewise with the searcher tables 1162 and 1166) can be a single table, according to the notion that a person will prefer people who are like themselves. Each user could then express the acceptable range of characteristics of people with which to join as a difference from their own values. For example, the parameter "same" could mean that the person needs to match closely, whereas "similar" could indicate a range (e.g. within a year) and "different" could mean anyone. In this way, there would not be the burden on the user to define the preference table 1160 or 1166 in a very detailed manner.

In the case of a cluster, the transfer of information between the searcher and the cluster can, as mentioned above, involve not only the broadcaster, but also other members of the cluster (especially since the searcher may not know the identity of a cluster's broadcaster from external observation). The cluster can also make communal decisions about accepting a new member. That is, if there are 4 members of a cluster, and a searcher indicates an interest in joining the cluster, there can be voting among the members of a cluster regarding the acceptance of the new member. The procedure of voting will normally be done by messaging among the members, which can be assisted by structured information transfer as will be described below.

A number of such voting schemes are described in Figure 19, a table of voting schemes for the acceptance of new members into a cluster. The first column is the name of the rule, and the second column describes the algorithm for evaluation according to the rule. In the "BROADCASTER" rule, the broadcaster decides whether or not the new member will be accepted. The new member is accepted when the broadcaster indicates "yes" and is otherwise rejected.

In the "Majority" rule, the members are polled, and whenever a majority of the members vote either acceptance or rejection, the new member is accordingly accepted or rejected. It should be noted that this rule (as well as the rules to follow) depends on the broadcaster or other member of the cluster having knowledge of the number of members in the cluster, which will generally be the case (e.g. in an IP socket based system, the broadcaster can simply count the number of socket connections). Thus, if the number of members in a cluster is given as N_{mem}, as soon as $(N_{mem}/2) + 1$ members have indicated the same result, that result is then communicated to the broadcaster, the members and the prospective new member. If the number of members is even, and there is a split vote, the result goes according to the broadcaster's vote.

According to the "Unanimous" rule, a new member is accepted only on unanimous decision of the members. Thus, the prospective new member is rejected as soon as the first "no" vote is received, and is accepted only when the votes of all members of the cluster are received, and all of the votes are positive.

The "Timed Majority" rule is similar to that of the "Majority" rule, except that a timer is started when the vote is announced, the timer being of a predetermined duration, and in a preferred embodiment, is indicated as a count down timer on the unit 100 of each member of the cluster 700. The vote is completed when $(N_{mem}/2)+1$ members vote with the same indication ("yes" or "no") if the timer has not completed its predetermined duration. If all of the members have voted, and the vote is a tie, the result goes in accordance with that of the broadcaster. If the timer has expired, and the vote has not been decided, the number of members that have voted is considered a quorum of number Q. If (Q/2)+1 members have voted in some fashion, that is the result of the vote. Otherwise, in the case of a tie, the result goes according to the vote of the broadcaster. If the broadcaster has not voted, the vote goes according to the first vote received.

The "Synchronized Majority" rule is similar to the Timed Majority rule, but instead of initiating the vote, and then waiting a predetermined period for members to vote, the vote is announced, and then there is a predetermined countdown period to the beginning of voting. The voting itself is very limited in time, generally for less than 10 seconds, and preferably for less than 3 seconds. Counting votes is performed only for the quorum of members that vote, and is performed according to the rules for the Timed Majority.

There are many different voting schemes consistent with creating, growing and maintaining clusters within the spirit of the present invention. For instance, in cases where there are close votes, the voting can be reopened for individuals to change their vote. In cases, members can request a new round of voting. Furthermore, the voting can be closed ballot, in which the votes of individuals are not known to the other members, or open voting, in which the identity of each member's vote is publicly displayed on each unit 100.

In addition, the voting can be supported and enhanced by information made available to each member through displays on the units 100. Figure 18A is a screenshot of an LCD display 1170 of a unit 100, taken during normal operation. The display 1170 is comprised of two different areas, an audio area 1172 and a broadcaster area 1174. The audio area 1172 includes information about the status of the audio output and the unit 100 operation, which can include battery status, the name of the performer, the title of the piece of music, the time the audio has been playing, the track number and more. The broadcaster area 1174 comprises

information about the status of the cluster 700. In the example given, the broadcaster area includes the number "5", which represents the number of people current in the cluster, the text "DJ", which indicates that the unit 100 on which the display 1170 is shown is currently the broadcaster of the cluster 700, and the text "OPEN", which indicates that the cluster is open for new members to join (the text "CLOSED" would indicate that no new members are being solicited or allowed).

Figure 18B is a screenshot of an LCD display 1170 of a unit 100, taken during voting for a new member. The audio area 1172 is replaced by a new member characteristics area 1176, in which characteristics of the prospective new member are displayed. Such characteristics can include the name (or nickname) of the prospective new member, their age, and their likes (hearts) and dislikes (bolts). In the broadcaster area 1174, the digit "3" indicates that there are three current members of the cluster 700, and an ear icon indicates that the current unit 100 is being used to receive from the broadcaster rather than being a broadcaster, and the name [ALI] indicates the name of the current broadcaster. The text "VOTE-MAJ" indicates that the current vote is being done according to the Majority rule. The broadcaster area 1174 and the new member characteristics areas 1176 provide the information needed by the existing member to make a decision about whether to allow the prospective new member to join.

The displays 1170 of Figures 18A-B are indicative only of the types of information that can be placed on a display 1170, but it should be appreciated that there are many pieces of information that can be placed onto the displays 1170 and that the format of the display can be very widely varied. Furthermore, there need not be distinct audio areas 1172 and broadcaster areas 1174, but the information can be mixed together. Alternatively, especially with very small displays 1170, the display 1170 can be made to cycle between different types of information.

It is also within the spirit of the present invention for individuals to rate other individual members of their cluster, and such ratings can be collated and passed from person to person or cluster to cluster, and can be used for a cluster 700 to determine whether a search unit 750 person should be added to the cluster 700. Figure 27 is a schematic block flow diagram of using a prospective new member's previous associations to determine whether the person should be added to an existing cluster.

In a step 1400, from a search unit 750, the prospective new member places an external communication request with an operational broadcast annunciator 1050 by a broadcast unit 710. In a step 1402, a temporary message connection is established through which

information can be passed mutually between the search unit 750 and the broadcast unit 710. The broadcast unit 710 requests personal and cluster ID's from the search unit 750. The personal ID is a unique identifier that can be optionally provided to every audio unit 100, and which can further be optionally hard-encoded into the hardware of the unit 100. The cluster IDs represent the personal ID's of other units 100 with which the search unit 750 has been previously associated in a cluster. In a step 1406, the broadcast unit 710 matches the incoming personal IDs and cluster IDs with personal ID's and cluster IDs that are stored in the memory of the broadcast unit 710. If there exist a sufficient number of matches, which can be computed as a minimum number or as a minimum fraction of the IDs stored in the broadcast unit 710, the new member of the search unit 750 can be accepted into the cluster. In a step 1412, the search unit 750 can then store the ID of the broadcast unit 710 and the other members of the existing cluster 700 into his cluster IDs, and the broadcast unit 750 and the other receive units 730 of the cluster can then store the personal ID of the search unit 750 into their cluster IDs. If there does not exist a sufficient number or quality of matches, the broadcast unit 710 will reject the prospective new member, optionally send a message of rejection, and then close the socket connection (or other connection that had been created) between the broadcast unit 710 and the search unit 750. No new IDs are stored on either unit 710 or 750.

It is also within the spirit of the present invention for other information associated with the personal and cluster IDs to be shared and used in the algorithm for determining whether to accept or reject a prospective new member into a cluster 700. This information can include rating information, the duration of association with another cluster 700 (i.e. the longer the association, the more suitable the social connection of that person with the cluster 700 would have been), the size of the cluster 700 when the searcher was a member of a particular cluster 700, the popularity of a cluster 700 (measured by the number of cluster IDs carried by the broadcast unit 710), and more. The matching program, likewise, would weight the existence of a match by some of these quality factors in order to determine the suitability of the searcher to join the cluster.

While the comparisons can be made between a search unit 750 personal and cluster IDs and those from the broadcast unit 710, representing the personal experience of the owners of the respective units, it is also possible that the reputation or desirability of individuals with a given personal ID can be posted to or retrieved from trusted people. For example, two friends can swap the information of which IDs are to be trusted or not between two units 100, or alternatively, can be posted onto or retrieved from the Internet. For

example, after a bad personal experience with a unit 100 with a personal ID of 524329102, a person could post that ID on the Internet to share with friends, so that the friends could avoid allowing that person to join, or avoid joining a cluster with that person.

It should be noted that publishing a list of personal IDs allows people to establish the breadth of their contacts. By posting their contacts on web sites, people can demonstrate their activity and popularity. This also encourages people to join clusters, in order to expand the number of people with whom they have been associated. Furthermore, the personal ID serves as a "handle" by which people can further communicate with one another. For example, on the Internet, a person can divulge a limited amount of information (e.g. an email address) that would allow other people with whom they have been in a cluster together to contact them.

It should be noted that the formation and maintenance of a cluster 700 requires the initial and continued physical proximity of the broadcast unit 710 and the receive unit 730. In order to help maintain such physical proximity conducive to cluster maintenance, feedback mechanisms can be used to alert the users to help them maintain the required physical proximity, as will be discussed below.

Figure 28 is a block flow diagram indicating the steps used to maintain physical proximity between the broadcast unit 710 and the receive unit 730 via feedback to the receive unit user. In a step 1530, the wireless connection between the broadcast unit 710 and the receive unit 730 is established. In a step 1532, the connection between the two units 710 and 730 is tested. There are a number of different means by which this testing can take place. For example, in IP-based communications, the receive unit 730 can from time to time – though generally less than every 10 seconds, and even more preferably less than every 1 second – use the "ping" function to test the presence and speed of connection with the broadcast unit 710. Alternatively, the receive unit 730 will be receiving audio signals wirelessly almost continuously from the broadcast unit 710, and a callback alert function can be instituted such that loss of this signal determined at a predetermined repeat time – which is conveniently less than 5 seconds, and even more preferably less than every 1 second – and which is then reported to the system.

While the methods above determine the absolute loss of a signal, they do not anticipate loss of signal. A method that does anticipate signal issues prior to loss is the measurement of signal strength. This can be done directly in the signal reception hardware by measuring the wireless signal induced current or voltage.

In a step 1534, the results of the connection testing performed in the step 1532 is analyzed in order to determine whether the signal is adequate. It should be noted that a temporary loss of signal, lasting even seconds, may or may not be of importance. For example, the broadcast unit 710 user and receive unit 730 users could walk on opposite sides of a metallic structure, enter a building at different times, change their body posture such that the antennae are not optimally situated with respect to one another, etc. Thus, an algorithm is generally used to time average the results of the step 1532, with the results conveniently time averaged over a matter of seconds.

Whatever the results of the signal test of the step 1534, the step 1532 is continuously repeated as long as the connection between the broadcast unit 710 and the receive unit 730 is present. If the signal is deemed inadequate, however, feedback to that effect is provided to the receive unit 730 user in a step 1536. The user feedback can occur through a variety of mechanisms, including visual (flashing lights) and tactile (vibration) transducers, emanating either from the audio unit 100 or the digital jewelry 200. For example, the receiver unit 730 can send a signal to the associated digital jewelry 200 to effect a special sequence of light transducer output.

It is most convenient, however, for the audio output of the receiver unit 730 as heard by the user to be interrupted or overlain with an audio signal to alert the user to the imminent or possible loss of audio signal. This audio signal can include clicks, beeps, animal sounds, closed doors, or other predetermined or user selected signals heard over silence or the pre-existing signal, with the signal possibly being somewhat reduced in volume such that the combination of the pre-existing signal and the feedback signal is not unpleasantly loud.

It should be noted that the flow diagram of Figure 28 refers specifically to alerting the receive unit 730 user of potential communications issues. Such alerting can also be usefully transferred to or used by the broadcast unit 710. For example, with knowledge of the communications issues, the broadcast unit 710 user can move more slowly, make sure that the unit is not heavily shielding, that any changes in posture that could relate to the problems are reversed, etc. The broadcast unit 710 can perform communications tests (as in the step 1532) or analyze the tests to determine if the communications are adequate (as in the step 1534) – particularly through use of the messaging TCP channels. Given that there can be multiple receive units 730 connected to s single broadcast unit 710, it is generally preferable for the tests to be performed on the receive units 730, and problems to be communicated to the broadcast unit 710 – provided, however, that communications still exist for such communication.

In order to overcome this deficiency, it is possible for the receiver unit 730 to communicate potential problems in communications to the broadcast unit 710 at an early indication. The broadcast unit 710 then starts a timer of predetermined length. If the broadcast unit 710 does not receive a "release" from the receive unit 730 before the timer has completed its countdown, it can then assume that communications with the receive unit 730 have been terminated, and it can then send feedback to the broadcast unit 710 user.

It is also within the teachings of the present invention for both the broadcast unit 710 and the receive unit 730 to independently monitor the connections with each other, and alert their respective users of communications problems.

It should be noted that the use of audio alerts can be used more generally within the user interface of the audio units 100. Thus, audio alerts can be conveniently used to inform the user of the joining of new members to the cluster 700, the initiation of communications with search units 750 outside of the group, the leaving of the group by existing cluster 700 members, the request by a receive unit 730 to become the broadcast unit 710, the transfer of cluster control from a broadcast unit 710 to a receive unit 730, and more. These alerts can be either predetermined by the hardware (e.g. stored on ROM), or can be specified by the user. Furthermore, it can be convenient for the broadcast unit 710 to temporarily transfer to new members of the cluster custom alerts, so that the alerts are part of the experience that the broadcast unit 710 user shares with the other members of the cluster. Such alerts would be active only as long as the receive units were members of the cluster 700, and then would revert back to the alerts present before becoming cluster members.

Cluster Hierarchy

A receive unit 730 can also be the broadcast unit 710 of a separate cluster 700 from the cluster 700 of which it is a member. This receive unit is called a broadcasting receiver 770. In such case, it is convenient for the receive units 730 that are associated with the broadcasting receiver 770 to become associated with the cluster 700 of which the broadcasting receiver 770 is a member. This can conveniently be accomplished in two different ways. In a first manner, the receive units 730 that are associated with the broadcasting receiver 770 can become directly associated with the broadcast unit 710, so that they are members only of the cluster 700, and are no longer associated with the broadcasting receiver 770. In a second manner, the receive units 730 associated with the broadcasting receiver 770 can remain primarily associated with the broadcasting receiver 770, as shown in Figures 9A and 9B, which are schematic block diagrams of hierarchically-related clusters. In

Figure 9A, the receive units 730 that are members of a sub-cluster 701 of which the broadcast unit is a broadcast receive unit 770, can receive music directly from the broadcast receive unit 710, while retaining their identification with the broadcasting receiver 770, such that if the broadcasting receiver 770 removes itself or is removed from the cluster 700, these receive units 730 similarly are removed from the cluster 700. In order to provide this form of hierarchical control, the sub-cluster 701 receive units 730 can obtain an identifier, which can be an IP socket address, from the broadcast receive unit 770, indicating the desired link to the broadcast unit 710. The sub-cluster receive units 730, however, maintain direct communications with the broadcast receive unit 770, such that on directive from the unit 770, they break their communications with the unit 710, and reestablish normal inter-unit audio signal communications with the broadcast receive unit 770. In an embodiment using IP addressing and communications, this can involve the maintenance of TCP messaging communications between the sub-cluster 701 receive units 730 with the broadcast receive unit 770, during the time that the sub-cluster 701 is associated with the cluster 700.

In Figure 9B, the receive units 730 of the sub-cluster 701 receive music directly from the broadcasting receiver 770, which itself receives the music from the broadcast unit 710. In such case, as the broadcasting receiver 770 is removed from the cluster 700, the receive units 730 of the sub-cluster 701 would also not be able to hear music from the cluster 700.

It would be apparent that such an arrangement can be hierarchically arranged, such that the receive unit 730 of the sub-cluster 701 can itself be the broadcast receiver 770 of another sub-cluster 701, and so forth. The advantage of this arrangement is that people that are associated with one another, forming a cluster 700, can move as a group from cluster to cluster, maintaining a separate identity.

It should be also noted that the configuration of communications between members of a hierarchical cluster can be variously arranged, not only as shown in Figures 9A and 9B. For example, every member of the cluster 700 can have a direct link between every other member of the cluster 700, such that no re-broadcast of messages needs to take place. Furthermore, given that there are different inter-unit communications (for example, messaging versus audio broadcast), it is within the teachings of the present invention that the configuration for the different modes of communication can be different – for example direct communications between the broadcast unit 710 for audio broadcast, but peer-to-peer communications between individual units for messaging.

Maintaining Private Communications

In order to restrict membership in a cluster 700, either the information transfer must be restricted, such as by keeping private the socket IP addresses or passwords or other information that is required for a member to receive the signal, or the signal can be transmitted openly in encrypted form, such that only those members having been provided with the encryption key can properly decode the signal so sent. Both of these mechanisms are taught within the present invention, and are described at various points within this specification.

Figure 32A is a schematic block diagram of maintaining privacy in open transmission communications. In this case, the transmission is freely available to search units 750 in a step 1830, such as would occur with a digital RF broadcast, or through a multicast with open a fixed, public socket IP address available in certain transmission protocols. In this case, the broadcast audio signal or information signal is made in encrypted form, and membership in the cluster is granted through transfer of a decoding key in a step 1832.

Figure 32B is a schematic block diagram of maintaining privacy in closed transmission communication. In a step 1834, the broadcast unit 710 makes a closed transmission broadcast, such as through a socket IP address, that is not publicly available. In a step 1836, the broadcast unit 710 provides the private address to the search unit 750, which can now hear the closed transmission from the step 1834, which is not encrypted. Alternatively, or in addition to the provision of the private address in the step 1836, the establishment of the connection through the private, closed transmission is effected via a password provided in a step 1838. This password can, for example, be used in the step 1110 (e.g. see Figure 14B) to determine whether the broadcast unit 710 accepts the search unit 750 for audio multicasting.

In this section, the encryption of the musical signal and/or associated information about personal characteristics of members of the cluster 700 is described. The custom compressor 330 of the unit 100 can perform the encryption. In such a case, before joining a cluster, the search unit 750 can only receive some limited information, such as characteristics of the music being heard or some limited characteristics of the users in the cluster 700. If the search unit 750 user requests permission to join the cluster 700 and it is granted, the broadcast unit 710 can then provide a decryption key to the search unit 750 that can be used to decrypt the music or provide a private IP address for multicasting, as well as supply additional information about the current members of cluster 700.

It should be noted that in certain cases, it can be useful to have multiple forms of privacy protection. For example, a broadcast unit 710 can provide a search unit 750 access to audio signals and information for the cluster 700, but can reserve certain information based on encryption to only some members of the cluster 700. For example, if a group of friends comprise a cluster 700, and accept some new members into the cluster 700, access to more private information about the friends, or communications between friends, can be restricted on the basis of shared decryption keys.

Figure 33 is a schematic block diagram of a hierarchical cluster, as in Figure 9A, in which communications between different units is cryptographically or otherwise restricted to a subset of the cluster members. Thus, there are three types of communication that are used in the communication: channel A, which takes place between the members of the original cluster; channel B, which takes place between the members of the original cluster (mediated through the broadcast unit 710) and members of the sub-cluster 701; and channel C, which takes place between the members of the sub-cluster 701. Thus, a communications originating from the broadcast unit 710 can be directed either through channel A or channel B, and likewise, a communications originating from the broadcast receive unit 770 can be directed either at members only of the sub-cluster 701 through channel C, or to all members of the cluster 700 through both channels C and B, which is then communicated trough channel A.

A number of means can be used to maintain such independent channels. For example, separate socket communications can be established, and the originators of the communications can determine that information which is carried on each separate channel. For example, given an open transmission scheme such as digital RF signal, the information can be encoded with separate keys for the different channels of communication – thus, the cryptographic encoding determines each channel. A given unit 100 can respond to more than one encoding. Indeed, a channel identifier can be sent with each piece of information indicating the ID of the decoding key. If a unit 100 does not have the appropriate decoding key, then it is not privy to that channel communications.

Alternatively, if the communications is IP socket based, then each channel is determined by IP socket addresses. Furthermore, access to those addresses can be, for example, password controlled. Also, the socket communications can be broadcast so that any unit 100 can receive such broadcast, but that decoding of the broadcast can be mediated through cryptographic decoding keys.

It should be noted that there can be multiple forms of communication, which can comprise messaging communications using the TCP/IP protocols, versus multicasting using

UDP protocols, and also DJ 200 control signals using yet another protocol. The access to each of these communications can be controlled via different privacy hierarchies and techniques. For example, the audio multicasting will be available to all members within a cluster, while the messaging may retain different groupings of privacy (e.g. hierarchical), while the DJ control signals will generally be limited to communications between a given unit 100 and its corresponding DJs 200.

Broadcast Control Transfer

The dynamics of cluster 700 can be such that it will be desirable for a receive unit 730 to become the broadcast unit for the cluster. Such a transfer of broadcast control will generally require the acquiescence of the broadcast unit 710 user. To effect such a transfer, the user of the receiver unit 730 desiring such control will send a signal to the broadcast unit 710 expressing such intention. If the user of the broadcast unit 710 agrees, a signal is sent to all of the members of the cluster indicating the transfer of broadcast control, and providing the identifier associated with the receive unit 730 that is to become the broadcast unit 710. The broadcast unit 710 that is relinquishing broadcast control now becomes a receive unit 730 of the cluster 700.

It should be noted that the transfer of control as described above requires the manual transfer of control, such as actuation of a DJ switch. This switch can be limited to this function, or can be part of a menu system, in which the switch is shared between different functions. It is also within the spirit of the present invention that there be voice-activated control of the unit 100, in which the unit 100 further comprises a microphone for input of voice signals to a suitable controller within the unit 100, wherein the controller has voice-recognition capabilities.

In the case of a cluster 700 whose broadcast unit 710 is no longer broadcasting (e.g. it is out of range of the receive units 730, or it is turned off), the cluster can maintain its remaining membership by selecting one of the receive units 730 to become the new broadcast unit 710. Such a choice can happen automatically, for example by random choice, by a voting scheme, or by choosing the first receive unit 730 to have become associated with the broadcast unit 710. If the users of the cluster-associated units deem this choice to be wrong, then they can change the broadcast unit 710 manually as described above.

The receive unit 730 that is chosen to become the broadcast unit 710 of the cluster 700 will generally prompt its user of the new status, so that the newly designated broadcast unit 710 can make certain that it is playing music to the rest of the cluster 700. It can be

further arranged so that a newly-designated broadcast unit 710 will play music at random, from the beginning, or a designated musical piece in such case.

An embodiment of a transfer of broadcast control using IP socket communications protocols is described here. Figure 16 is a schematic block flow diagram of transfer of control between the broadcast unit 710 and the first receive unit 730. In a step 1130, the receive unit 730 requests broadcast control (designated here as "DJ" control). In a step 1132, the user of the broadcast unit 710 decides whether control will be transferred. The decision is then transferred back to the first receive unit 730 via the TCP messaging socket. If the decision is affirmative, the first receive unit 730 severs its UDP connection to the broadcast unit 710 multicast. The reason for this is to allow the receive unit 730 opportunity to prepare the beginning of its broadcast, if such time is required, and the user cannot both listen to the multicast as well as prepare its own audio selections, which occurs in a step 1136. In a step 1138, the receive unit 730 creates a multicast UDP socket with which it will later broadcast audio to other members of the cluster, while in a step 1140, the receive unit 730 creates a broadcast annunciator TCP socket with which to announce availability of the cluster, as well as to accept transfers of members from the broadcast unit 710 to itself as the new broadcast unit.

When the two new sockets (multicast and annunciator) are created, the receive unit 730 transmits the new socket addresses to the broadcast unit 710 in a step 1142. Since the other members of the cluster are guaranteed to be in contact with the broadcast unit, they can get addresses of the new, soon-to-be broadcast unit from the existing broadcast unit. In a step 1144, the original broadcast unit 710 transmits to the other cluster members (receive units 730 numbers 2-N) the addresses of the sockets on the receive 1 unit 730 that is now the new broadcast unit 710, and terminates its own multicast. The termination is performed here because the other receive units will be transferring to the new multicast, and because the original broadcast unit 710 is now becoming a receive unit 730 in the reconstituted cluster. In the step 1148, multicast of audio is now provided by the receive 1 unit 730 that has now become the new broadcast unit 710), and the original broadcast unit is listening to audio provided not by itself, but rather by the new broadcast unit.

In a step 1146, performed roughly synchronously with the step 1144, the original broadcast unit 710 transmits the socket addresses of the message handler TCP sockets of the other members of the cluster 700 (i.e. the receive units 730 numbers 2-N). In the subsequent step 1150, the original broadcast unit 710 and the receive units 730 numbers 2-N establish new messaging connections with the receive 1 unit 730 that is now the new broadcast unit

710. While there can be a set of criteria for the acceptance of a new member to a cluster, because the receive 1 unit 730 has received the message socket addresses of the other members of the cluster in the step 1144, the receive 1 unit 730 accepts new members with the socket addresses received. It should be noted that instead of socket addresses being the identifiers passed, the identifiers can also be unique machine IDs, random numbers, cryptograpically encoded numbers, or other such identifiers that can be transmitted from one member of the cluster to another.

It should be noted in certain embodiments, that there can be insufficient time for the new broadcast unit 710 to determine a set of music to broadcast to the members of its cluster. It is within the spirit of the present invention for a user to set a default collection of music that is broadcast when no other music has been chosen. This set of music can comprise one or more discrete audio files.

Audio and DJ Choreography

One of the attractions of the present invention is that it allows users to express themselves and share their expressions with others in public or semi-public fashion. Thus, it is highly desirable for users to be able to personalize aspects of both the audio programming as well as the displays of their DJs 200.

Audio

Audio personalization comprises the creation of temporally linked collections of separate musical elements in "sets." These sets can be called up by name or other identifier, and can comprise overlapping selections of music, and can be created either on the unit 100 through a visual or audio interface, or can be created on a computer or other music-enabled device for downloading to the unit 100.

In addition, the unit 100 or other device from which sets are downloaded can comprise a microphone and audio recording software whereby commentary, personal music, accompaniment, or other audio recordings can be recorded, stored, and interspersed between commercial or pre-recorded audio signals, much in the manner that a radio show host or "disc jockey" might alter or supplement music. Such downloads can be accessible from a variety of sources including Internet web sites and private personal computers.

Automatic Generation of DJ 200 Control Signals

In this section, we will describe the automatic and manual generation of control signals for the DJ 200 transducers. The control signals are generally made to correspond to

audio signals played on the units 100, although it is within the spirit of the present invention for such control signals to be made separate from audio signals, and to be displayed on the digital jewelry independently of audio signals played on the unit 100. Figure 20 is a time-amplitude trace of an audio signal automatically separated into beats. Beats 1180, 1182 and 1183 are denoted by vertical dashed and dotted lines and, as described below, are placed at locations on the basis of their rapid rise in low-frequency amplitude relative to the rest of the trace. As can be seen, the beats 1180 are generally of higher amplitude than the other beats 1182 and 1183, and represent the primary beats of a 4/4 time signature. The beat 1183 is of intermediate nature between the characteristics of the beats 1180 and 1182. It represents the third beat of the second measure. Overall, the audio signal thus displayed can be orally represented as ONE-two-Three-four-ONE-two-Three-four ("one" is heavily accented, and the "three" is more lightly accented), which is common in the 4/4 time signature.

Processing of this data can proceed via a number of different methods. Figure 21A is a block flow diagram of a neural network method of creating DJ 200 transducer control signals from an audio signal as shown in Figure 20. In a step 1200, audio data is received either at the unit 100 or the DJ 200. It should be noted that the creation of control signals from audio signals can, within the present invention, take place at either the unit 100 or the DJ 200, or even at a device or system not part of or connected to the unit 100 or DJ 200 (as will be described in more detail below). In an optional step 1202, the data is low pass filtered and/or decimated so that the amount of data is reduced for computational purposes. Furthermore, the data can be processed for automatic gain to normalize the data for recording volume differences. Furthermore, the automatic gain filtering can provide control signals of significant or comparable magnitude throughout the audio data.

In general, the creation of the audio signal depends on audio representing a period of time, which can be tens of milliseconds to tens of seconds, depending on the method. Thus, the audio data from the step 1202 is stored in a prior data array 1204 for use in subsequent processing and analysis. At the same time, the current average amplitude, computed over an interval of preferably less than 50 milliseconds, is computed in a step 1208. In broad outline, the analysis of the signal compares the current average amplitude against the amplitude history stored in the prior data analysis. In the embodiment of Figure 21A, the comparison takes places through neural network processing in a step 1206, preferably with a cascading time back propagation network which takes into account a slowly varying time signal (that is, the data in the prior data array changes only fractionally at each computation, with most of the data remaining the same). The use of prior steps of neural network processing in the

current step of neural network processing is indicated by the looped arrow in the step 1206. The output of the neural network is a determination whether the current time sample is a primary or a secondary beat. The neural network is trained on a large number of different music samples, wherein the training output is identified manually as to the presence of a beat.

The output of the neural network is then converted into a digital jewelry signal in a step 1210, in which the presence of a primary or secondary beat determines whether a particular light color, tactile response, etc., is activated. This conversion can be according to either fixed, predetermined rules, or can be determined by rules and algorithms that are externally specified. Such rules can be according to the aesthetics of the user, or can alternatively be determined by the specific characteristics of the transducer. For example, some transducers can have only a single channel or two or three channels. While light transducers will generally work well with high frequency signals, other transducers, such as tactile transducers, will want signals that are much more slowly varying. Thus, there can be algorithm parameters, specified for instance in configuration files that accompany DJ 200 transducers, that assist in the conversion of beats to transducer control signals that are appropriate for the specific transducer.

Figure 21B is a block flow diagram of a deterministic signal analysis method of creating DJ 200 transducer control signals from an audio signal as shown in Figure 20. The data is received in the step 1200. In this case, a running average over a time sufficient to remove high frequencies, and preferably less than 50 milliseconds, is performed in a step 1212. Alternatively, a low pass filter and/or data decimation as in the step 1202 can be performed.

In a step 1214, the system determines whether there has been a rise of X-fold in average amplitude over the last Y milliseconds, where X and Y are predetermined values. The value of X is preferably greater than two-fold and is even more preferably three-fold, while the value of Y is preferably less than 100 milliseconds and is even more preferably less than 50 milliseconds. This rise relates to the sharp rises in amplitude found in the signal at the onset of a beat, as shown in Figure 20 by the beat demarcations 1180, 1182, and 1183. If there has not been a rise meeting the criteria, the system returns to the step 1200 for more audio input.

If the signal does meet the criteria, it is checked to ensure that the rise in amplitude is not the "tail end" of a previously identified beat. For this, in a step 1216, the system determines whether there has been a previous beat in the past Z milliseconds, where Z is a predetermined value preferably less than 100 milliseconds, and even more preferably less

than 50 milliseconds. If there has been a recent beat, the system returns to the step 1200 for more audio input. If there has not been a recent beat, then a digital jewelry signal is used to activate a transducer. The level of transduction can be modified according to the current average amplitude which is determined in a step 1208 from, in this case, the running average computed in the step 1212.

The embodiment of Figure 21B provides transducer activation signals at each rapid rise in amplitude, with the activation signal modulated according to the strength of the amplitude. This will capture much of the superficial musical quality of the audio signal, but will not capture or express more fundamental patterns within the audio signal.

Figure 21C is a schematic flow diagram of a method to extract fundamental musical patterns from an audio signal to create DJ 200 control signals. In the step 1200, the audio data is received into a buffer for calculations. In a step 1220, a low pass filter is applied to remove high frequency signal. Such high frequency signals can alternatively be removed via decimation, running averages, and other means as set forth in the embodiments of Figures 21A and B. As in the embodiment of Figure 21B, beat onsets are extracted from the audio signal in the steps 1214 and 1216, and a current average amplitude is computed in a step 1208.

The amplitudes and times of the onsets of beats are placed into an array in a step 1222. From this array, a musical model is created in a step 1224. This model is based on the regularity of beats and beat emphasis – as seen in the amplitudes – that is independent of the beats and amplitudes in any one short section of music (corresponding, for instance, to a measure of music).

In general, music is organized into repeating patterns, as represented in a time signature such as 3/4, 4/4, 6/8 and the like. Within each time signature, there are primary and secondary beats. In general, the downbeat to a measure is the first beat, representing the beginning of the measure. The downbeat is generally the strongest beat within a measure, but in any given measure, another beat may be given more emphasis. Indeed, there will be high amplitude beats that may not be within the time signature whatsoever (such as an eighth note in ¾ time that is not on one of the beats). Thus, by correlating the beats to standard amplitude patterns, the output to the music model identifies the primary (down) beats, secondary beats (e.g. the third beat in 4/4 time) and the tertiary beats (e.g. the second and fourth beats in 4/4/ time).

Figure 21D is a schematic flow diagram of an algorithm to identify a music model, resulting in a time signature. In a step 1600, the minimum repeated time interval is

determined, using the array of beat amplitude and onset 1222. This is, over a period of time, the shortest interval for a quarter note equivalent is determined, wherein the time signature beat frequency (i.e. the note value of the denominator of the time signature, such as 8 in 6/8) is preferably limited to between 4 per second and one every two seconds, and even more preferably limited to between 3 per second and 1.25 per second. This is considered the beat time.

From the array of beat amplitudes and onsets 1222, the average and maximum amplitudes over a time period of preferably 3-10 seconds is computed in a step 1604. For the beginning of the audio signal, shorter periods of time can be used, though they will tend to give less reliable DJ 200 control signals. Indeed, in this embodiment, the initial times of an audio signal will tend to follow audio signal amplitude and changes in amplitude more than fundamental musical patterns until the patterns are elicited.

In a step 1606, the amplitude of a beat is compared with the maximum amplitude determined in the step 1604. If the beat is within a percentage threshold of the maximum amplitude, wherein the threshold is preferably 50% and more preferably 30% of the maximum amplitude, the beat is designated a primary beat in a step 1612. In a step 1608, the amplitude of non-primary beats is compared with the maximum amplitude determined in the step 1604. If the beat is within a percentage threshold of the maximum amplitude, wherein the threshold is preferably 75% and more preferably 50% of the maximum amplitude, and the beat is greater than a predetermined fraction of the average amplitude, wherein the fraction is preferably greater than 40% and even more preferably greater than 70% of the average beat amplitude, the beat is designated a secondary beat in a step 1614. The remaining beats are denoted tertiary beats in the step 1610.

In a step 1616, the sequence of the three types of beats is compared with that of established time signatures, such as 4/4, 3/4, 6/8, 2/4 and others, each with their own preferred sequence of primary, secondary and tertiary beats, in order to determine the best fit. This best fit is identified as the time signature in a step 1618.

Returning to Figure 21C, the channels of the DJ are pre-assigned to four different beats in a step 1225. Thus, if there are four channels, each channel is given a separate assignment. With a smaller number of channels, a single channel is assigned multiple beats. Some beats can also be unassigned, thus not being represented in a DJ 200 transducer output. Thus, a high jewelry signal, medium jewelry signal, low jewelry signal and an amplitude dependent signal are each assigned to a channel for DJ 200 transduction.

In a step 1226, a beat determined to be a primary/down beat is assigned to a high jewelry signal 1228. In a step 1230, a beat determined to be a secondary beat is assigned to a medium jewelry signal 1232. In a step 1234, a beat determined to be a tertiary beat is assigned to a low jewelry signal 1236. Beats which are then unassigned, and which will generally be beats that occur not within the music model of the step 1224 (e.g. rapid beats not falling on beats of the time signature) are then assigned in a step 1238 to an amplitude dependent (and not music model dependent) signal 1240.

It should be noted that the computations performed in the flow methods of Figures 21A-C may take time on the order of milliseconds, such that if the computations are made in real time during the playing of music, the activation of the transducers in the DJ 200 are "behind" in time relative to the audio playing of the corresponding music in the audio unit 100. This can be compensated for by carrying out the computations while the audio signal is still in buffers prior to being played in the unit 100, as is described above for numerous embodiments of the present invention. Thus, signals to the DJ 200 can then be made simultaneously with respect to the audio signal to which it corresponds.

It should be noted that many of the parameters described above can conveniently be affected by manual controls either on the DJ 200 or the unit 100 that transmits signals to the DJ 200. For example, if can be convenient for the user to be able to set, for a given DJ 200 response amplitude, the threshold audio amplitude level at which the output transducer (e.g. light transducer 240) responds, or to set the output transducer amplitude corresponding to a maximum audio amplitude, or to set the frequency bands for which different DJ 200 channels respond, or to set other similar parameters. The manual controls for such parameters can comprise dials, rocker switches, up/down button, voice or display menu choices, or other such controls as are convenient for users. Alternatively, these choices can be set on a computer or other user input device, for download onto the unit 100 or DJ 200.

A preferable means of setting the parameters is for the parameters to be stored in a configuration file that can be altered either on the unit 100, the DJ 200 or a computer, so that the same DJ 200 can take on different characteristics dependent on the configuration settings within the file. The configuration settings can then be optimized for a particular situation, or set to individual preference, and be traded or sold between friends or as commercial transactions, for instance over the Internet. For a most preferable use of these configuration files, each file with its set of configurations can be considered to represent a "mode" of operation, and multiple configuration files can be set on the DJ 200 or the unit 100, depending on where the automatic generation of control signals is performed. The user can

then select from the resident configuration files, appearing to the user as different modes, for use of his system, and can change the mode at will. This can be arranged as a series of choices on a voice or display menuing system, as a list toggled through by pressing a single button, or through other convenient user interfaces.

Manual Generation of DJ 200 Control Signals

In the description above, the use of filtering and digital modification of audio signals can be used to create control signals for DJ 200 transducers 240, 250, and 260. In addition, manual choreography of DJ 200 signals can be accomplished. For example, buttons or other interface features (e.g. areas on a touch-screen) on the unit 100 can correspond to different arrays of transducers, such as the LED arrays 290 and 292 of Figure 2A. While playing the audio signal, the user can press the buttons, where pressing of the buttons can correspond to a control signal for a transducer being ON, and otherwise the signal can be off. To aid in choreography where rapid changes in transducers are desired, the audio can be played at less than normal speed.

Figure 22A is a top-view diagram of an audio unit 100 user interface 1250, demonstrating the use of buttons to create DJ 200 control signals. The interface 1250 comprises a display screen (e.g. LCD or oLED), which can display information to the user, such as shown in Figures 18 A-B. Standard music control buttons 1254 for playing, stopping, pausing, and rewinding allow the user to control the audio signal musical output. Buttons 1252 further control aspects of the music output, such as volume control, musical tracks, and downloading and uploading of music. The number of buttons 1252 is conveniently three as shown, but can be more or less than three.

In addition, buttons are provided to allow the user to input DJ 200 control signals, comprising a record button 1256, a first channel button 1258, a second channel button 1260 and a third channel button 1262. The channel buttons 1258, 1260 and 1262 are prominent and accessible, since the user will want to easily depress the buttons. A record button 1256 allows the user to activate the channel buttons 1258, 1260 and 1262, and has a low profile (even below the nominal surface of the interface 1250) so that it is not accidentally activated. The record button can serve various purposes, including recording into a permanent storage file the sequence of DJ control signals relative to music being played, or controlling the DJ transducers in realtime, synchronously with music being played on the audio unit 100.

Pressing the buttons 1258, 1260 and 1262 create DJ control signals for the corresponding channels. The number of buttons is conveniently three as shown, but can also

be two or four or more buttons. If a telephone is being used as the unit 100, keys on the telephone keypad can alternatively be used. The channel buttons will generally be used with thumbs, and the buttons are spaced so that two of the buttons can be depressed with a single thumb, so that all three buttons can be activated with only two fingers. In is also convenient for the two secondary buttons 1260 and 1262 to be spaced more closely together, as it will be a preferred mode of operation that the secondary buttons be operated together from time to time.

To further aid in the choreography of the DJs 200, a separate "keyboard" with the number of keys related to the number of possible arrays can be used. The amplitude of the corresponding transducer signal can be modified either according to the pressure on the keys, according to the length of time that a key is depressed, or according to a foot pedal. Figure 22B is a top-view diagram of a hand-pad 1270 for creating DJ control signals. The hand-pad 1270 comprises a platform 1271, a primary transducer 1272, a secondary transducer 1274 and a tertiary transducer 1276. The platform 1271 has a generally flat top and bottom, and can conveniently be placed on a table, or held in the user's lap. The size of the platform is such that two hands are conveniently placed across it, being preferably more than 6 inches across, and even more preferably more than 9 inches across. The pressure transducers 1272, 1274 and 1276 respond to pressure by creating a control signal, with said control signal preferably capturing both the time and amplitude of the pressure applied to the corresponding transducer. The primary transducer 1272 creates a primary control signal, the secondary transducer 1274 creates a secondary control signal and the tertiary transducer 1276 creates a tertiary control signal. The sizes and placements of the transducers can be varied within the spirit of the present invention, but it is convenient for the primary transducer 1272 to be larger and somewhat separate from that of the other transducers 1274 and 1276. In one more method of user interaction, both hands can be rapidly and alternately used to make closely spaced control signals on the primary transducer 1272. In addition, it can be convenient on occasion for the user to activate both the secondary transducer 1274 and the tertiary transducer 1276 with different fingers on one hand, and thus these can be conveniently placed relatively near to one another. In general, while a single transducer will provide minimal function, it is preferable for there to be at least two transducers, and even more preferable that there be three transducers.

The control signals can be transferred to the audio unit 100 for playing and/or storage, or to the DJ 200 unit directly for playing, either wirelessly, or through wired communication. In addition, the hand-pad can also be configured to create percussive or other sounds, either

directly through the incorporation of hollow chambers in the manner of a drum, or preferably by the synthesis of audio waveform signals that can be played through the audio unit 100 (and other audio units 100 participating in a cluster 700), or directly through speakers within the hand-pad 1270 or attached to the hand-pad 1270 through wired or wireless communications. Such audible, percussive feedback can aid the user in the aesthetic creation of control signals.

It is within the spirit of the present invention for the hand-pad to take on various sizes and configurations. For instance, it is also convenient for the hand-pad 1270 to be configured for the use of index and middle fingers, being of dimensions as small as two by four inches or less. Such a hand-pad is highly portable, and can be battery powered.

Additionally, DJ 200 control signals can also be manually generated live, during broadcast at a party, for example, by a percussionist playing a set of digital drums. Figure 22C is a schematic block diagram of a set of drums used for creating DJ control signals. The set of drums comprises four percussive instruments 1280, 1282, 1284 and 1286, which can include snare drums, foot drums, cymbals, foot cymbals and other percussive musical instruments, such as might be found with a contemporary musical "band". Microphones 1290 are positioned so as to receive audio input primarily from instruments to which they are associated. One microphone can furthermore be associated with multiple instruments, as with the drums 1282 and 1284. The microphones 1290 are connected with a controller 1292 that takes the input and creates DJ control signals therefrom. For example, the drums 1282 and 1284 can be associated with the primary channel, the drum 1280 can be associated with the secondary channel, and the drum 1286 can be associated with the tertiary channel. The association of the microphone input with the channel can be determined in many ways. For example, the jack in the controller 1292 to which each microphone 1290 attaches can correspond to a given channel. Alternatively, the user can associate the jacks in the controller to different channels, with such control being manual through a control panel with buttons or touch control displays, or even through prearranged "sets". That is, a set is a pre-arranged configuration of associations of microphones to channels, and thus a set can be chosen with a single choice that instantiates a group of microphone-channel associations.

In general, the inputs from the microphones 1290 will be filtered in frequency and also to enhance audio contrast. For instance, control signals can be arranged to be the highest when the low-frequency envelope is rising the quickest (i.e. the beat or sound onset). The algorithms for conversion of audio signal to DJ control signal can be pre-configured in the controller 1292, or can be user selectable.

It should be noted that the methods and systems of Figures 22 A-C need to synchronize the control signals so generated with the audio files to which they correspond. This can be accomplished in many ways. For example, the first control signal can be understood to correspond to the first beat within the audio file. Alternatively, the audio unit 100 or other device that is playing the audio signal to which the control signal is to correspond can send a signal to the device that is creating the control signals indicating the onset of playing of the audio file. The control signal can then be related to the time from the onset of the audio file. In addition, with regards to this synchronization, the user manually inputting the control signals will always be listening to the music during the control signal input. If the device on which control signals are being input is the same as the device that is playing the music, a control signal input cam be easily related to the sound that is currently being played by the audio output – many such devices allow information to within less than a millisecond of what sample or time within the audio files is currently being output by the audio device. With the arrangement of the control signal input device being also an audio player, close calibration of the control signals and the audio output is easily accomplished.

DJ 200 Control Signal Files

The control signals can be in a variety of formats within the spirit of the present invention. Such formats include pairs of locations within the associated music file and the corresponding amplitudes of the various DJ channels, and pairs of locations and the amplitudes of those DJ channels which are different from before. The locations can be either time from the start of the song (e.g. in milliseconds) or in terms of sample number. If the location is given in terms of sample number, the sample rate of the music will generally also be provided, since the same song can be recorded at different sample rates, and the invariant in terms of location will generally be time from onset of the music.

Other formats include an amplitude stream, corresponding to each DJ channel, provided in a constant stream with a fixed sample rate, which may be equal to or different from that of the corresponding music file. This format can be stored, for example, as additional channels into the music file, such that one channel corresponds to monoaural sound, two channels correspond to stereo sound, three channels correspond to stereo sound and one channel of control signals, and additional channels correspond to stereo sound plus additional channels of DJ control signals. Another arrangement is to allow for only a small number of states of the transduction in the control signal, so that multiple channels of control signal can be multiplexed into a single transmitted channel for storage and transmission with

the audio signal. For example, if the audio is stored as a 16-bit signal, 3 channels of 5 bit DJ 200 control signal could be stored in a single channel along side the one or two audio channels normally used.

It should be appreciated that these different control signal storage formats are largely interchangeable. For instance, as described above, control signals can be stored as if they are additional audio channels within a music file, but then be extracted from the file for separate transfer (e.g. over the Internet), and then be reintegrated into an audio file at the destination location.

It should be appreciated that there are a number of means by which DJ 200 control signals can be generated, either automatically or manually, and can include the use of devices other than the unit 100 that can have sophisticated digital or analog filtering and modification hardware and software. The control signals so created can be stored in files that are associated with the music files (e.g. MP3) that the control signals are meant to accompany. To aid in their distribution, particularly in reference to limitations on the commercial and private distribution of the corresponding music files, the signal files will generally be separate from the music files, and transferable between units 100 either through inter-unit communication mediated by the inter-unit transmitter/receiver 110, or alternatively through computers or computer networks to which the unit 100 can be connected.

The audio signals and the DJ control signals should also be well synchronized during playback. Figure 23 is a schematic block flow diagram of the synchronized playback of an audio signal file with a DJ control signal file, using transmission of both audio and control signal information. For purposes of convenience in discussion, the audio signal file will be called a "song file" and the "control signal file" will be called a "dance file." In a step 1300, the user is provided a list of song files for display, preferably on the display 1170. In a step 1302, the user then selects a song from the display to play. In a step 1304, the dance files that are associated with the selected song file from the step 1302 are displayed for the user. These song files can be either locally resident on the unit 100, or can alternatively be present on other audio units 100 to which the audio unit 100 is connected, as in a cluster, or can alternatively be on the Internet, if the audio unit 100 is connected to the Internet. If there is a dance file that has been previously preferred in association with the song file, this file can be more prominently displayed than other associated dance files.

In a step 1306, the user selects the dance file to play along with the song file. This association is stored in a local database of song file/dance file associations in a step 1307, to be later used in a subsequent step 1304, should such an association not have been previously

made, or if the preferred association is different from the previously preferred association. If the dance file is not locally resident, it can be copied to the audio unit 100 to ensure that the dance file is available throughout the duration of the song file playback.

In a step 1308, a timer is initialized at the beginning of the song file playback. In the step 1310, the song file is played on the local unit 100, and is also streamed to the other units 100 within the cluster 700. The corresponding DJ control signal accompanies the streaming song, either multiplexed within the song file audio signal, on another streaming socket, or through other communications (e.g. a TCP socket) channels between the two units. In a step 1312, the time advances along with the playback of the music. In a step 1314, this timer information is used to obtain current control signals from the dance file – that is, the dance file is arranged so that at each moment, the status of the different transducer channels can be determined. The control signals to be streamed along with the song file information can be either the current status of each transducer, or alternatively, can only send changes from the current transducer state.

The matching of the files in the database of song file and dance file associations of the step 1307 can be performed both within a machine, but also over a local or wide area network. In such cases, the association can either be external to the file – that is, using the name of the file, that is available the normal system file routines – or can use information internal to one or both files. For example, the dance file can have stored within it a reference to the song to which it is associated, either as the name of the song file, the name and/or other characteristics of the song (such as the recording artist, year of publication, music publisher) or alternatively as a numerical or alphanumerical identifier associated with the song. Then, given a song file, the relationship of the dance file with the song file can be easily determined.

For ease in creating an association, it is convenient for the names of the song files and the associated dance files to have a relationship with one another that is easily understood by casual users. For example, given a song file with the name "oops.mp3", it is convenient for an associated dance file to share the same root (in this case "oops") with a different extension, creating for example the dance file name "oops.dnc". Because of the multiplicity of dance files that will often be associated with a particular song file, the root itself can be extended to allow for either a numerical or descriptive filename, which can be preferably done in conjunction with a known punctuation mark to separate the song file root from the dance file description, such as the file names "oops.david2.dnc" or "oops$wild.dnc". It is

preferable to use a punctuation mark that is allowed within a range of different operating systems.

Dance files can be stored on the Internet or other wide area network in a store for access by users who want dance files associated with a particular song file. In such case, if the storage is through the root of the filename, the user, requesting dance files corresponding to "oops.mps" would then be returned the names of related files such as "oops$wild.dnc". If the dance file internally carries the relationship with "oops.mps" as described above, either through the name or other characteristics, or alternatively, through a numerical or alphanumerical identifier, it is preferable to store the information in a database on the storage computer or unit 100, so that it is not necessary to open the file each time for perusal of the dance file information. Thus, if the music file has a substantially unique identifier associated with it internally, it is also useful for the dance file to also have the same identifier associated internally as well. In such case, the identifier is conveniently used to reference both files within a database.

In operation, a remote user would request a dance file for a particular song file by providing the name of the song file, along possibly with other information about the song file, which could include the name of the choreographer, the number of channels of DJ 200 transduction, the specific brand or type of DJ 200, or other information. The database would then return a listing of the various dance file that met the criteria requested. The remote user would then choose one or more of the files to download to the remote computer, and then the database would retrieve the dance files from storage and then transmits the dance file over the wide area network. On the remote computer or unit 100, the dance file would become associated with the corresponding song file through means such as naming the dance file appropriately or making an association between the song file and the dance file in a database or indexing file. Alternatively, the dance file can be integrated into the song file as mentioned elsewhere within this specification.

It can be useful to preview a dance file for its desirability or suitability. Since the dance files can be retrieved from a wide area network such as the Internet, it is convenient for such an emulator to operate on a computer that may not be portable or have the proper transmitter that allows communications with a DJ 200. In such case, it is preferable to have an emulator which places an image or drawing of a DJ 200 on the screen, and which is provided the name of a song file and a dance file, and which then plays the song file through the audio of the computer and displays appropriate images or drawings of transducers being activated within the emulator image or drawing. The characteristics of the DJ 200 being

emulated (e.g. colors of lights, frequency responses, levels of illumination, arrangement of lights, response to amplitude, etc.) can be simulated by a number of means. For example, the user can move slider controls, set checkboxes and radio boxes, enter numerical values, click-and-drag icons and use other standard user interface controls to make the DJ 200 operate as desired. Alternatively, manufacturers of DJ 200s can create configuration files (including, for example, bitmaps of photos of the actual DJ 200) that can be downloaded for this purpose (and which can also be used by prospective purchasers to view the "virtual" operation of the DJ 200 prior to purchase, for example, through an Internet merchant). The configuration files would contain the information necessary for the emulator to properly display the operation of the specific DJ.

Alternatively, as described above, the dance file information can be stored within the song file as, for example, another channel in place of an audio channel, or alternatively within MP3 header or other file information. In such case, the step 1307 would have the alternative function of looking through song files to find the song file with the particular desired embedded dance file within.

In addition to sending dance files from computers to units 100 or between units 100, the dance files can be streamed from unit 100 to unit 100 through the normal unit-to-unit communications, in the manners described above for audio communications. This is particularly convenient given that DJ 200 displays can be used to show group identification, and such displays can be more effective if the DJs for each user are nearly identical (which might not be the case if the users were using, for example, different dance files). The dance file control signal information can be transmitted in a variety of ways, including multiplexing the control signals into the same packets as the audio information as if it were a different audio channel, alternating packets of control signals with packets of the audio information, or broadcasting control signals on a different UDP socket as the audio. Alternatively, if the receiving unit has a copy of the dance file corresponding to the song file being transferred by unit-to-unit communication, the receiving unit can determine the current time being played, and to extract from the local dance file the control signals for the receiving unit DJ 200.

It should be known that most streaming protocols have relatively small data packets that are communicated, due to the fact that reception at the source is not guaranteed and it is not desirable to lose a large amount of information in any one stream. Thus, it is possible with smaller transmission buffers and higher data rates to send a single DJ control signal in each transmission. For example, with a buffer size of 600 bytes, and an audio rate of 22,050 Hz with two single byte channels, each transmission covers only about 12 milliseconds, and

any signal would therefore be at most 13 milliseconds from its correct time. Alternatively, each control signal can be accompanied by an offset in time from the beginning of the transmitted audio signal. Also, the time or packet number of each transmission buffer can be sent, as well as the time or packet number of the DJ audio signals, so that the audio unit 100 can compute the proper offset.

Stationary Transducers

DJs 200 that have been previously described are portable devices, usually associated with a particular user and unit 100. Figures 5A and 5B indicate the ways in which DJs 200 associated with multiple users can be controlled by a single unit 100.

It is also convenient for transducers to be non-portable and stationary. Consider, for example, a user who is at home listening to music. Instead of a DJ 200 worn by the user, the user can alternatively have a bank of lights or other transducers in fixed locations through the room that operate under the same or similar control signals as to which DJs respond. Such fixed transducers can operate at far higher power than portable DJs 200, and can each incorporate a large number of separate transducers.

Furthermore, in a party, concert or other large social gathering, the effects of portable DJs worn by guests can be supplemented by large transducers that are generally perceptible by most guests. For example, such transducers can include spark or smoke generators, strobe lights, laser painters, arrays of lights similar to Christmas light strings, or mechanical devices with visible (e.g. a flag waving device) or tactile effects (e.g. a machine that pounds the floor). In general, transducers for large gatherings will not communicate with a unit 100, but will be directed by a wide-area broadcast unit 360, as in Figure 5B.

Because of the large area over which such stationary transducers can operate, the communications between the unit 100 and the stationary transducers can be through wired rather than wireless transmission. Furthermore, there can be mixed communication, such as wireless transmission of control signals from a portable unit 100 to a stationary receiver, and thence wired transmission to one or multiple transducers.

Modular Configurations

In the embodiments above, the audio player 130 is directly integrated with the inter-unit and unit-to-DJ communications. This requires both a re-engineering of existing audio players (e.g. CD, MP3, MO and cassette players), and furthermore does not allow the communications functionality to be reused between players.

An alternative embodiment of the present invention is to place the communications functions external to the audio playing functions, and to adjustably connect the two via the audio output port of the audio player. Figure 12A is a schematic diagram of a modular audio unit 132. Audio player 131 is a conventional audio player (e.g. CD or MP3 player) without the functionality of the present invention. Analog audio output is sent via audio output port 136 through the cable 134 to the audio input port 138 of the modular audio unit 132. The modular audio unit 132 comprises the inter-unit transmitter/receiver 110 and the DJ transmitter 120, which can send and receive inter-unit and unit-to-DJ communications in a manner similar to an audio unit 100. A switch 144 chooses between audio signals from the audio player 131 and from the inter-unit transmitter/receiver 110 for output to the output audio port 142 to the earphone 901 via cable 146 (the earphone 901 can also be a wireless earphone, wherein the output port 142 can be a wireless transmitter, which can also be a DJ transmitter 120). A convenient configuration for the switch 144 is a three way switch. In an intermediate position, the unit 132 acts simply as a pass-through, in which output from the audio player 131 is conveyed directly to the earphone 901, and the transmitter/receiver functions of the unit 132 do not operate. In another position, the unit 132 operates as a receiver, and audio from the inter-unit transmitter/receiver 110 is conveyed to the earphone 901.

When the combined system operates as a broadcast unit 710, audio input from the audio unit 131 is directed to the inter-unit transmitter/receiver 110 for transmission to receive units 730, as well as for output to the earphone 901 (which can be direct to the earphone 901 through the switch, or indirectly through the inter-unit transmitter/receiver 110).

When the combined system operates as a conventional audio player, the switch directs audio signals from the input port 138 directly through to the output port 142. In this mode of operation, it can be arranged for the audio output to traverse the modular audio unit 132 without the unit being powered up. In case there is a transmission delay to the receive unit 730 such that audio played locally through the earphone 901 and audio played remotely on the receive unit 730 are not in synchrony, the system can incorporate a time delay in the output port 142 such that the local and remote audio output play with a common time delay, and are thus in synchrony.

When the combined system operates as a receiver unit 730, audio input from the input port 138 is ignored, and signals to the audio output port are delivered solely through the inter-unit transmitter/receiver 110.

It is convenient for the modular audio unit 132 to be able to operate independently of the associated audio player 131. In such a case, the unit 132 must have an independent energy store, such as one or more batteries, which can be rechargeable. In that case, the unit 132 has no audio signals locally to listen to through the earphone 901 or to transmit over the transmitter/receiver 110. However, the unit 132 can in that case receive external audio signals sent by other units 132 or units 100 for listening.

The audio player 131 can be placed in a backpack, purse, or other relatively inaccessible storage location, while the modular audio unit is, like a "remote control", accessible for interaction with other users.

Video

While the units 100 described above have comprised audio players 130, within the spirit of the present invention, such units can also comprise video or audio/visual players (both of which are referred to below as video players). Such video players would be used generally for different entertainment and educational purposes, not limited to films, television, industrial training and music videos. Such video enabled units can operate similarly to audio units, including the capability of sharing video signals, synchronously played, with nearby units through inter-unit communication, as well as the use of DJ's that can produce human-perceptible signals (such as light transduction for accompaniment of audio signals in music videos). It should be noted, however, that there is a larger bandwidth requirement for the inter-unit transmitter/receiver 110 for the communication of video signals as compared with audio signals. In the case of shared video, wire connections (e.g. FireWire) between two units can allow simultaneous viewing of a single video signal.

In addition, text, including language-selectable closed caption and video subtitling, can accompany such video, as well as chat or dubbing to allow the superposition of audio over the audio normally accompanying such video.

Music Distribution Using Audio Units

The music industry is suffering from reduced sales due to the advent of Internet-based music file sharing; in addition, the manufacturers of personal audio devices are bringing to market audio devices that can wirelessly transfer music files between the devices. Such sharing-enabled devices could significantly reduce the sales of music. Audio units of the present invention, however, can be used to provide new means of music distribution and thereby increase the sales of music.

Figure 25 is a schematic flow diagram indicating music sharing using audio devices, providing new means of distributing music to customers. Three entities are involved in the transactions – the DJ (operating a broadcast unit 710), the cluster member (operating a receive unit 730), and the music distributor, and their actions are tracked in separate columns. In this case, the term DJ is used to indicate the person operating a broadcast unit 710, and has no meaning with respect to a DJ unit 200. Indeed, the DJ unit 200 is a part of the system only inasmuch as it provides for heightened pleasure of the DJ and the member in enhancing their experience of the music. For the rest of this section, DJ will refer specifically to the person operating the broadcast unit 710.

In a first step 1340, the DJ registers with the distributor, who places information about the DJ into a database in a step 1342. Part of this information is a DJ identifier (the DJ ID), which is unique to the DJ, and which DJ ID is provided to the DJ as part of the registration process. This ID is stored in the unit 100 for later retrieval. The DJ at some later time broadcasts music of the type distributed by the distributor, in a step 1344. The broadcast of the music by the DJ can be adventitious (that is, without respect to the prior registration of the DJ with the distributor), or the distributor can provide the music to the DJ either free of charge, at a reduced charge, or free of charge for a limited period of time.

In a step 1346, the member becomes a part of the cluster 700 of which the DJ is the broadcaster broadcasting the distributor's music, and has thereby an opportunity to listen to the music. Along with the transfer of the audio signal of the music, in a step 1348, the DJ can send information about the song, which can include a numerical identifier of the music or album from which the music is derived. Furthermore, the DJ ID is provided to the member, and is associated with the music ID and stored in a database on the member unit 100 in a step 1350. In order to prevent this database from becoming too sizable, music IDs and DJ IDs can be purged from it on a regular basis (for example, IDs which are older than 60 or 120 days can be removed).

If the member requests purchase of the music from the distributor in a step 1352, in a step 1354, the distributor stores the member information, the music ID, and the DJ ID associated with the music (i.e. the person who introduced the member to the music). The distributor then completes the transaction with the member, providing a copy of the music in exchange for money, in a step 1356. As the member receives the music copy, he also becomes registered as a DJ as well in a step 1358. Thus, if the member now becomes the DJ of his own cluster, and introduces people to this music, he will also be known to the distributor as an introducer of the music.

In a step 1360, the distributor provides points to the DJ who introduced the member to the music and facilitated the sale of the music. In a step 1362, the DJ accumulates points related to the sale of the music to the member, as well as points related to the sale of other music to other members. These points can at that point or later be redeemed for money, discounted music, free music, gifts, access to restricted activities (e.g. seats at a concert) or other such real or virtual objects of value to the DJ.

In a step 1364, the DJ is optionally further linked to the music and member for whom he has received points. If this member introduces the music to yet other members, who are induced to buy the music from the distributor, the DJ is further awarded points in a step 1366, given that the "chain" of members introduced directly or indirectly to the music includes the original DJ.

This set of interactions does not decrease music sales as does file sharing, but rather increases sales of music, as the DJ has incentives to encourage others to buy the music, and the offering of the music by the DJ through his broadcasts introduces music to people who may not have already had the opportunity to hear the music.

Figure 31 contains tables of DJ, song and transaction information according to the methods of Figure 25. A USER table 1810 comprises information about the USER, which can include the name of the person (Alfred Newman), their nickname/handle ("WhatMeWorry"), their email address (AEN@mad.com), and the machine ID of their unit 100 (B1B25C0). This information is permanently stored in the audio unit 100. A second set of information relates to music that the USER has heard while in other clusters 700 that the USER liked, and which is indicated as the USER's "wish list". This set of information includes a unique ID associated with the song (or other music or audio signal), which is transmitted by the broadcast unit 710 of the cluster 700. This information can alternatively or additionally include other information about the music, such as an album name, an artist name, a track number, or other such information that can uniquely identify the music of interest.

Along with each song ID is a DJ identifier, indicating the unique ID associated with the DJ who introduced the desired music to the USER. Additionally or alternatively, the information can comprise the DJ's email address, personal nickname/handle, name, or other uniquely identifying information.

The Wish List can either be permanent, or it can be that each song entry is dated, and that after a predetermined amount of time, which can be set by the user, the songs that are still on the Wish List are removed. It is also convenient that songs that are purchased

according to the methods of the present invention, such as Figure 25, are also removed from the list automatically.

A DISTRIBUTOR table 1812 comprises information about purchases made by USERS with the DISTRIBUTOR. The table 1812 has numerous records keyed according to unique USER identifiers, which in this case is the MAC ID of the unit 100. A single record from the table is provided, of which there can be hundreds of thousands or millions of such records stored.

The record can include contact information about the USER, including name, email address, or other business related information such as credit card number. In addition, each record comprises a list of all of the songs known to have been purchased through the DISTRIBUTOR, as identified by a unique song ID. In addition, the DJ associated with the purchase of the given song by the USER is also noted. This information was previously transmitted from the USER table 1810, which includes the associated DJ identifier along with the song identifier, at the time of purchase of the song. This association allows the DISTRIBUTOR to compensate the DJ for his part in introducing the USER to the song.

It should also be noted that such an arrangement of information allows the compensation, if desired, of the individual who introduced the DJ to the song, prior to the DJ introducing the USER to the song. For example, when the user purchased the song with song ID 230871C40, points were credited with the DJ whose ID is 42897DD. Looking in the record for the DJ 42897DD, one can determine whether there is another individual (DJ) associated with the purchase of the song 230871C40 by the DJ. If so, that individual can also receive compensation for the purchase of the song by the USER.

Use of Internet Connections

It is within the teachings of the present invention to allow normal Internet connections of the audio unit 100 with non-mobile devices connected with the Internet. Figure 29A is a schematic block diagram of the connection of an Internet-enabled audio unit 100 with an Internet device through the Internet cloud 1708, using an Internet access point 1704. An Internet-enabled audio unit 1700, unit A, is wirelessly connected to an audio unit 100, denoted unit B, as members in a cluster 700. The dashed line connecting the two units A and B indicates that the connection is wireless, whereas the solid connecting lines indicate wired connections. The unit A is connected to a wireless access point 1704, such as an 802.11 access point, which is connected to an Internet device 1706 via wired connections through the Internet cloud 1708.

Figure 29B is a schematic block diagram of the connection of an Internet-enabled audio unit 1702 with an Internet device through the Internet cloud, with an audio unit 1702 directly connected to the Internet cloud 1708. In this case the audio unit 1702 is capable of directly connecting to the Internet cloud 1708, and thence to the Internet device 1706, through a wired connection. This could be through a high speed connection (such as a twisted wire Ethernet connection) or through a lower speed connection (e.g. a serial port connection, or a dial-up modem).

The connection of the unit 1700 or unit 1702 is illustrated in Figure 30, tables of ratings of audio unit 100 users. As described above, members of a cluster can decide whether or not to admit a new member to the cluster using a variety of automatic or manual methods. One method of determining the suitability of a user to become a member of the cluster 700 is to determine the user's ratings by members of other clusters to which the user has previously been a member. In this case, the Internet device 1706 is a computer hosting a database, which can be queried and to which information can be supplied by the unit A (either 1700 or 1702). On the Internet device 1706 are stored ratings of units 100, as indicated by the table 1802. The left hand column is the primary key of the database, and is a unique identifier associated with each unit 100. This ID can be a numerical MAC ID, associated with the hardware and software of each unit 100, a unique nickname or word handle (e.g. "Jen412smash") associated with each audio unit user, or other such unique identifier.

The second and third columns, indicated as numbers with dollar signs, are the total summed positive ratings (column two) and the negative ratings (column three) registered with each user by another member of a cluster 700 with which the user has been associated, and in which the user was operating the broadcast unit 710. This rating can, for example, reflect the perceived quality of music provided by the user. The fourth and fifth columns are the total, summed ratings of the user by other members of clusters 700 with which the user has been associated, in which the user was the operator of a receive unit 730. This rating can, for example, indicate the good spirits, friendliness, dress or other characteristics of the user as perceived by other members of the cluster. The sixth column indicates the largest cluster 700 for which the user has been the broadcaster. This is a good indicator of a broadcaster's popularity, since a poor or unpopular broadcaster would not be able to attract a large group of members for a cluster.

There are many other characteristics that can be stored in such a database, and can also include IDs of other members of groups with which the user has been associated (so that members can accept new members who have been associated with friends of those in the

cluster), specific music that the user has played (in order to determine musical compatibility), information on the individuals making each rating (in order to determine rating reliability), and gradations of ratings (rather than simply a positive or negative response).

The cluster members can access the ratings of the user requesting membership in the cluster 700 in order to determine their desirability and suitability. This would require a connection with the Internet device 1706 at the time that the user was requesting to join, and would preferably involve a wireless connection through an access point, as in Figure 29A. The information from the database on the device 1706 can either be displayed to the members of the cluster 700, or can be used by an automatic algorithm to determine whether the person can join.

The table 1800 represents the ratings of a cluster 700 of 5 total members (comprising a broadcaster with ID 12089AD, and four additional members with IDs E1239AC, F105AA3, B1B25C0, and ED5491B). The ratings are supplied by ED5491B (whose ID is preceded by a zero), and then specific ratings of each member are made. The DJ is indicated by a dollar sign preceding his ID. These ratings can be made by putting the nicknames/handles of the cluster members on a screen, and allowing the member to indicate positive or negative ratings by pressing one of two buttons. A plus in the first column indicates a positive response, and a minus sign indicates a negative response. These ratings can then be sent during either wired communications directly to the Internet device 1706 or via the access point 1704. It should be noted that the ratings, once made, can be stored on the unit 1700 or 1702 indefinitely, until connection with the Internet cloud 1708 can be made. As indicated by the arrow, the information for B1B25C0 can be added to the table 1802 -- in this case, by incrementing the value in the fourth column (a positive rating for a user who is not the broadcaster).

Other applications of connections to Internet devices 1706 include exchanging (via uploading and downloading) dance files with distant individuals, and obtaining music via downloading , which can include transactions with distributors similar to that seen in Figure 25. Such connections also allow the integration of other connectivity, such as telephone and messaging capabilities, expanding the usefulness and attractiveness of audio units 100.

Many Embodiments Within the Spirit of the Present Invention

It should be apparent to one skilled in the art that the above-mentioned embodiments are merely illustrations of a few of the many possible specific embodiments of the present invention. For example, the elements of a unit 100, including the inter-unit transmitter/receiver 110 protocol and hardware, the DJ transmitter 120 and the audio player

130 can be chosen from a range of available technologies, and can be combined with user interface elements (keyboards, keypads, touch screens, and cursor buttons, without significantly affecting the operation of the unit 100. Furthermore, many different transducers can be combined into DJs 200, which can further comprise many decorative and functional pieces (e.g. belt clasps, functional watches, microphones, or wedding rings) within the spirit of the present invention. Indeed, the unit 100, itself, can comprise transducers 240, 250 or 260.

It should also be appreciated that communications protocols provide a nearly uncountable number of arrangements of communications links between units in a cluster, that the links can be of mixed software protocols (e.g. comprising both TCP and UDP protocols, and even non-IP protocols) over a variety of hardware formats, including DECT, Bluetooth, 802.11 a, b, and g, Ultra-Wideband, 3G/GPRS, and i-Beans, and that communications can include not only digital but also analog communications modes. Furthermore, communications between audio units and digital jewelry can further comprise analog and digital communications, and a variety of protocols (both customized as well as well-established IP protocols).

It is important, as well, to note that the inter-unit communication and the unit-to-DJ communication can operate and provide significant benefits independently of one another. For example, members listening to music together gain the benefits of music sharing, even without the use of DJs 200. Alternatively, an individual's appreciation of music and personal expression can be augmented through use of a DJ 200, even in the absence of music sharing. However, the combination of music sharing along with enhanced personal expression through a DJ 200 provides a synergistic benefit to all members sharing the music.

Numerous and varied other arrangements can be readily devised by those skilled in the art without departing from the spirit and scope of the invention. Moreover, all statements herein reciting principles, aspects and embodiments of the present invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e. any elements developed that perform the same function, regardless of structure.

In the specification hereof any element expressed as a means for performing a specified function is intended to encompass any way of performing that function. The invention as defined by such specification resides in the fact that the functionalities provided by the various recited means are combined and brought together in the manner which the

specification calls for. Applicant thus regards any means which can provide those functionalities as equivalent as those shown herein.

Claims

What is claimed is:

1. A method for sharing music from stored musical signals between a first user with a first music player device and at least one second user with at least one second music player device, comprising:

playing the musical signals for the first user on the first music player device while essentially simultaneously wirelessly transmitting the musical signals from the first music player device to the at least one second music player device; and

receiving the musical signals by the at least one second player device, wherein the musical signals can be played on the at least one second player device essentially simultaneously with the playing of the musical signals on the first music player device;

wherein the first and the at least one second users are mobile and maintain less than a predetermined distance.

2. The method of claim 1 wherein the predetermined distance is 40 feet.

3. The method of claim 1 wherein the predetermined distance is 100 feet.

4. The method of claim 1 wherein the predetermined distance is 500 feet.

5. The method of claim 1 wherein the transmitting and receiving involve the use of an Internet protocol.

6. The method of claim 5 wherein the Internet protocol uses a connection-less transport layer.

7. The method of claim 5 wherein the Internet protocol uses a link layer involving a protocol chosen from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

8. The method of claim 1 wherein the transmitting and receiving use analog radio frequency transmission.

9. The method of claim 1 wherein the transmitted music signals are digital.

10. The method of claim 9 wherein the transmitted digital music signals are compressed.

11. The method of claim 1 wherein the first music player device is carried by the first user.

12. The method of claim 1, additionally comprising displaying by the first user a humanly-perceptible light display that is roughly synchronized with the beat of the musical signals.

13. The method of claim 1, additionally comprising communicating an identifier of the at least one second user to the first music player device, and indicating the identifier to the first user on a display located on the first music player device.

14. The method of claim 1, additionally comprising transferring a substantially unique music identifier of the musical signal wherein the personal identifier is stored on the at least one second music player device in association with the musical identifier.

15. The method of claim 14 wherein the user of the at least one second music player device retrieves the musical signal from a remote system by using the music identifier.

16. The method of claim 15 wherein the remote system is located on the Internet.

17. The method of claim 15, additionally comprising a substantially unique personal identifier of the first user wherein the personal identifier is transferred to the at least one second music player device and stored in association with the music identifier of the music transmitted by the first music player device to the at least one second music player device.

18. The method of claim 1, additionally comprising monitoring the strength of the musical signal received by the at least one second music player device and communicating with the at least one second user the strength of the musical signal.

19. A system of music sharing for a plurality of users, comprising:

a first sharing device and at least one second sharing device, each comprising a musical signal store, a musical signal transmitter, a musical signal receiver, and a musical signal player;

a broadcast user operating the first sharing device; and

at least one member user operating the at least one second sharing device, wherein the broadcast user plays the musical signal for his own enjoyment on the first sharing device and simultaneously transmits the musical signal to the receiver of the at least one second sharing device of the at least one member user, on which the musical signal is played for the at least one member user, wherein the broadcast user and the at least one member user hear the musical signal substantially simultaneously.

20. The system of claim 19, additionally comprising a manual switch on at least one second sharing device, wherein actuation of the switch causes the first sharing device to cease transmitting the musical signal and for the second sharing device to begin transmitting musical signal from the musical signal store of the second sharing device, wherein the broadcast user and the at least one member user hear the musical signal from the second sharing device substantially simultaneously.

21. The system of claim 19 wherein the first sharing device and the at least one second sharing device additionally comprise a substantially unique identifier, wherein the first sharing device communicates its substantially unique identifier to the at least one second sharing device and the at least one second sharing device communicates its substantially unique identifier to the first sharing device.

22. The system of claim 21, wherein the identifier includes a least one piece of information about the user of the sharing device taken from the group consisting of the name of the user, the nickname of the user, a numerical identifier, an alphanumerical identifier, the musical preferences of the user, the age of the user, and the educational institution that the user attends.

23. The system of claim 22 wherein the first sharing device and the at least one second sharing device additionally comprise a visual display on which the substantially unique identifiers which have been communicated to the respective device are displayed.

24. The system of claim 19 additionally comprising at least one requesting member user operating an at least one requesting sharing device, wherein the at least one requesting member user requests to receive transmission of the musical signal from the first sharing device.

25. The system of claim 24 wherein the at least one requesting sharing device is associated with a substantially unique identifier which is communicated by the requesting sharing device to the first sharing device and wherein the first sharing device additionally comprises a display on which the identifier is displayed.

26. The system of claim 25 wherein the broadcast user elects whether to transmit the musical signal from the first sharing device to the requesting sharing device.

27. The system of claim 25 wherein the broadcast user and the at least one member user elect through voting whether to transmit the musical signal from the first sharing device, wherein a majority vote is determinative.

28. The system of claim 25 wherein the broadcast user and the at least one member user elect through voting whether to transmit the musical signal from the first sharing device, wherein a unanimous vote is required for transmitting.

29. The system of claim 25 wherein the identifier of the requesting sharing device is compared with identifiers stored in the first device, such that the match of the identifier of the requesting sharing device with a stored identifier allows the first sharing device to transmit the musical signal to the requesting sharing device.

30. The system of claim 29 wherein the stored identifiers are retrieved from the Internet.

31. The system of claim 19 wherein the first sharing device additionally comprises a visual display.

32. The system of claim 31 wherein the visual display indicates the number of member users receiving the musical signal.

33. The system of claim 31 wherein the visual display can display whether the musical being played by the sharing device comes from the musical signal store of the same device, or from the musical signal store another sharing device.

34. The system of claim 19 wherein the first sharing device is mobile.

35. The system of claim 19 wherein the first sharing device is carried by the user.

36. The system of claim 19 wherein the first sharing device and at least one sharing device maintain less than a predetermined distance.

37. The system of claim 36 wherein the predetermined distance is 40 feet.

38. The system of claim 36 wherein the predetermined distance is 100 feet.

39. The system of claim 36 wherein the predetermined distance is 500 feet.

40. The system of claim 19, additionally comprising a substantially unique user identifier associated with the broadcast user and a substantially unique musical signal identifier associated with each musical signal, wherein the user identifier and the musical signal identifier are transmitted from the first sharing device to the at least one second sharing device and stored in association with one another on the at least one second sharing device.

41. A wireless communications system for sharing audio entertainment between a first mobile device and a second mobile device in the presence of a non-participating third mobile device, comprising:

an announcement signal transmitted by the first mobile device for which the second mobile device and the third mobile device are receptive;

a response signal transmitted by the second mobile device in response to the announcement signal for which the first mobile device is receptive and for which the third mobile device is not receptive;

an identifier signal transmitted by the first mobile device to the second mobile device in response to the response signal, and which is not receptive to the third mobile device; and

a broadcast signal comprising audio entertainment that is transmitted by the first mobile device, and which is receptive by the second mobile device on the basis of the reception of the identifier signal.

42. The system of claim 41 wherein the announcement signal is transmitted via an Internet protocol.

43. The system of claim 42 wherein the Internet protocol is a connection-oriented transport protocol.

44. The system of claim 43 wherein the connection-oriented protocol is TCP.

45. The system of claim 42 wherein the Internet protocol further comprises a link layer protocol selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

46. The system of claim 41 wherein the broadcast signal is transmitted via an Internet protocol.

47. The system of claim 46 wherein the Internet protocol is a connectionless transport protocol.

48. The system of claim 47 wherein the connectionless transport protocol is UDP.

49. The system of claim 46 wherein the Internet protocol further comprises a link layer protocol selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

50. The system of claim 41 wherein the broadcast signal is an analog radio frequency signal.

51. The system of claim 41 wherein the broadcast signal is transmitted via telephony.

52. The system of claim 41 wherein the broadcast signal is compressed.

53. The system of claim 52 wherein the compression is MP3.

54. The system of claim 41 wherein the broadcast signal is encrypted.

55. The system of claim 41 wherein the identifier signal is an IP socket address.

56. The system of claim 41 wherein the identifier signal is a decryption code.

57. The system of claim 41 wherein the identifier signal is a digital password.

58. The system of claim 41 wherein the announcement signal and the broadcast signal use different IP transport protocols.

59. The system of claim 41 additionally comprising a transfer signal that is transmitted by the first mobile device upon halting the transmission of its broadcast signal, and which transfer signal is receptive by the second mobile device, such that reception by the second mobile device causes the device to transmit a second broadcast signal comprising audio entertainment for which the first unit is receptive.

60 The system of claim 41 wherein the broadcast signal is transmitted via peer-to-peer communications.

61 The system of claim 60, additionally comprising a switch, wherein actuation of the switch causes the device to toggle between peer-to-peer communications and infrastructure-based communications.

62 The system of claim 41 wherein the broadcast signal is transmitted via infrastructure-based communications.

63. An audio entertainment device, comprising:

a signal store that stores an audio entertainment signal;

a transmitter that can transmit the stored audio entertainment signal;

a receiver that can receive the transmitted audio entertainment signal from a transmitter of another such device; and

a player that can play audio entertainment from a member selected from the group of stored audio entertainment signals or audio entertainment signals transmitted from the transmitter of another such device.

64. The device of claim 63 wherein the transmitter transmits to the receiver of the same device in order to play through the player of that device.

65. The device of claim 63 wherein the player can play audio entertainment from signals obtained from either the receiver or from the audio store.

66. The device of claim 63 additionally comprising a visual display that is perceptive to the user of the device, indicating information about the audio entertainment signal.

67. The device of claim 66 wherein a third device can receive the transmitted audio signal, wherein all such devices transmitting and receiving the same audio entertainment signal constitute a sharing group.

68. The device of claim 67 additionally comprising a substantially unique identifier that identifies the user of the device, wherein at least one device of the sharing group displays the identifier of the user of another device within the sharing group.

69. The device of claim 68 wherein the identifier includes a least one piece of information about the user taken from the group consisting of the name of the user, the nickname of the user, the musical preferences of the user, a numerical identifier, an alphanumerical identifier, the age of the user, or the educational institution that the user attends.

70. The device of claim 68 wherein the identifier is interspersed within the transmitted audio entertainment signal.

71. The device of claim 66 wherein the visual display can display the number of devices in the sharing group.

72. The device of claim 66 wherein the visual display can display whether the audio entertainment being played by a device comes from the audio store of the device of which the display is a part, or from another device.

73. The device of claim 63 wherein the second device provides information to the second user about the strength of the audio signal received by the receiver.

74. The device of claim 73 additionally comprising a visual display, wherein the signal strength information is provided in the visual display

75. The device of claim 73 wherein the signal strength information is provided secondary audio signals played substantially simultaneously with the audio entertainment signal through the player of the device.

76. The device of claim 63 wherein the signal store stores a compressed audio signal.

77. The device of claim 63 wherein the compressed audio signal is transmitted through the transmitter.

78. The device of claim 63 wherein the compressed audio signal is decompressed prior to being transmitted through the transmitter.

79. The device of claim 63 wherein the identifier is interspersed within the transmitted audio signal.

80. The device of claim 63 additionally comprising a delay circuit.

81. The device of claim 80 wherein the playing of the audio entertainment signal is delayed in each device so that the audio entertainment signal in all devices playing from the same stored audio entertainment signal is played substantially simultaneously.

82. The device of claim 63 additionally comprising a manual control with at least three states, wherein in the first state the player plays a stored audio entertainment signal and does not transmit the stored entertainment signal, wherein in the second state the player plays a stored audio entertainment signal and substantially simultaneously transmits the same audio entertainment signal, and wherein in the third state the player plays an audio entertainment signal received by the receiver.

83. The device of claim 63 wherein the ambient sound admitted by the earphone can be manually controlled.

84. The device of claim 63 additionally comprising a microphone wherein the device can transmit vocal sounds from the user of the device.

85. The device of claim 63 additionally comprising a manual control such that actuation transmits a message.

86. The device of claim 63 wherein the device can connect with the telephone network.

87. The device of claim 63 wherein the device is mobile and can be carried by a user.

88. The device of claim 63 additionally comprising a control signal transmitter that transmits control signals that controls a humanly-perceptible display in a wearable accessory.

89. The device of claim 88 wherein the control signal transmitter is the same as the transmitter that transmits stored audio entertainment signals.

90. The device of claim 88, additionally comprising a store of control signals.

91. The device of claim 88, additionally comprising a generator wherein the generator coverts stored audio entertainment signals into control signals.

92. An audio entertainment device comprising:

a wireless transmitter for the transmission of audio entertainment signals;

a wireless receiver for the reception of the transmitted audio entertainment signals from a transmitter of audio entertainment signals;

a first manually-separable connector for electrically connecting with an audio player, wherein the connector allows transfer of audio entertainment signals from the player to the device;

a second connector for connecting with a speaker; and

a control to manually switch between at least three states, wherein in the first state the speaker plays audio entertainment signals from the audio player and the transmitter does not transmit the audio entertainment signals, wherein in the second state the speaker plays audio entertainment signals from the audio player and the transmitter essentially simultaneously transmits the audio entertainment signals, and wherein in the third state the speaker plays audio entertainment signals received by the receiver.

93. The device of claim 92 wherein the first connector connects to the audio player through the audio output jack.

94. The device of claim 92 wherein the speaker is chosen from the group consisting of earphone and headphone.

95. The device of claim 92 wherein the device additionally comprises a control signal generator that converts audio entertainment signals into control signals that control a humanly-perceptible display in a wearable accessory.

96. The device of claim 92 additionally comprising a second transmitter that transmits control signals that control a humanly-perceptible display in a wearable accessory.

97. The device of claim 92 additionally comprising a display that indicates the state of the device.

98. The device of claim 92 wherein the receiver is receptive of the audio entertainment signals transmitted by the transmitter.

99. The device of claim 92 wherein the receiver is operational when the first connector is manually separated from the audio player.

100. A system for the sharing of stored music between a first user and a second user, comprising:

a first device for playing music to the first user, comprising a store of musical signals, a first controller that prepares musical signals from the first store for transmission and playing, a first player that takes musical signals from the first controller and plays the signals for the first user, and a transmitter, that is capable of taking the musical signals from the controller and transmitting the musical signals via wireless broadcast; and

a second device for playing music to the second user, comprising a receiver receptive of the transmissions from the transmitter of the first device, a second controller that prepares musical signals from the receiver for playing, and a second player that takes musical signal from the second controller and plays the signals for the second user;

wherein the first user and the second user hear the musical signals at substantially the same time.

101. The system of claim 100 wherein the store of musical signals comprises compressed digital audio files.

102. The system of claim 100 wherein the compressed digital audio files are in formats taken from the group consisting of mp3, wav, cda, wma, and au.

103. The system of claim 100 wherein the preparation of the musical signals by the first controller comprises decompression of compressed binary files.

104. The system of claim 100 wherein the transmitter transmits via an Internet protocol.

105. The system of claim 104 wherein the Internet protocol has a link level selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

106. The system of claim 100 wherein the first device is a telephone.

107. The system of claim 100 wherein the first device transmits compressed musical signals and the second controller decompresses the compressed musical signals received by the receiver.

108. The system of claim 100 wherein the transmitter additionally transmits an annunciator signal indicating the presence of a transmitter of musical signals.

109. The system of claim 100 wherein the second device receiver becomes receptive of transmissions from the first device by obtaining an identifier from the first device.

110. The system of claim 109 wherein the first device additionally comprises an associated visual transducer and the second device additionally comprises a visual receiver, wherein the visual transducer outputs a visual identifier signal that is received by the visual receiver.

111. The system of claim 109 wherein the first device additionally comprises a first electrical connector and the second device additionally comprises a second electrical connector, wherein the identifier is communicated via an electrical signal passed from the first electrical connector to the second electrical connector.

112. The system of claim 111 wherein the communication of the identifier signal occurs via an inductive coupling between the first connector and the second connector.

113. The system of claim 109 wherein the second device additionally comprises a microphone, wherein the identifier is communicated in an audio signal that is produced by the first player and which is received by the microphone.

114. The system of claim 109 wherein the identifier is transmitted by the transmitter and received by the receiver.

115. The system of claim 100 wherein the second device receiver becomes receptive of transmissions from the first device by transmitting an identifier to the first device.

116. The system of claim 115 wherein the second device additionally comprises a visual transducer and the first device additionally comprises a visual receiver, wherein the visual transducer outputs a visual identifier signal that is received by the visual receiver.

117. The system of claim 115 wherein the first device additionally comprises a first electrical connector and the second device additionally comprises a second electrical connector, wherein the identifier is communicated via an electrical signal passed from the second electrical connector to the first electrical connector.

118. The system of claim 117 wherein the communication of the identifier signal occurs via an inductive coupling between the first connector and the second connector.

119. The system of claim 115 wherein the first device additionally comprises a microphone, wherein the identifier is communicated in an audio signal that is produced by the second player and which is received by the microphone.

120. The system of claim 115 wherein the identifier is transmitted by the transmitter and received by the receiver.

121. The system of claim 100 wherein the first controller additionally generates control signals related to the musical signals.

122. The system of claim 121 wherein the store additionally comprises stored control signals that are used by the first controller.

123. The system of claim 121 wherein the controller generates control signals from the musical signals.

124. The system of claim 123 wherein the controller performs frequency analysis of the musical signals in order to generate the control signals.

125. The system of claim 121 wherein the first device additionally transmits the control signals to the second device using the first transmitter.

126. The system of claim 125 wherein the control signals and the musical signals transmitted by the first device are interspersed within a single digital stream.

127. The system of claim 125 wherein the control signals and the musical signals are transmitted in two digital streams.

128. The system of claim 121 wherein the first device additionally comprises a second transmitter that transmits control signals.

129. The system of claim 128 wherein the second transmitter uses an IP protocol.

130. The system of claim 129 wherein the Internet protocol uses a link layer selected from the group consisting of 802.11, Bluetooth, and ultrawideband.

131. The system of claim 121 wherein the second transmitter uses analog radio frequency transmissions.

132. The system of claim 100, additionally comprising a wearable accessory, comprising a control signal receiver that is receptive of control signals transmitted by the first device, an accessory controller that generates transducer signals from the received control signals, and a transducer that generates humanly-perceptive music accompaniment signals from the transducer signals.

133. The system of claim 132 wherein the music accompaniment signals are visual signals.

134. The system of claim 133 wherein the visual signals are generated by a light emitting diode

135. The system of claim 132 wherein the music accompaniment signals are tactile signals.

136. The system of claim 132 wherein the accessory controller performs frequency analysis on the received control signals.

137. The system of claim 132 wherein the wearable accessory additionally comprises a switch, wherein actuation of the switch causes the accessory to be receptive to an entraining signal from the first device, such that the accessory will accept signals from the first device.

138. An earphone for listening to audio entertainment allowing for the controlled reception of ambient sound by a user, comprising

a speaker that is oriented towards the user's ear;

an enclosure that reduces the amount of ambient noise perceptive to the user; and

a manually-adjustable characteristic of the enclosure that adjusts the amount of ambient sound perceptive to the user.

139. The earphone of claim 138 wherein the manually-adjustable characteristic is the size of apertures in the enclosure that admit ambient sound.

140. The earphone of claim 138 wherein the manually-adjustable characteristic is the number of apertures in the enclosure that admit ambient sound.

141. The earphone of claim 138 wherein the manually-adjustable characteristic is the surface area of the enclosure.

142. The earphone of claim 138 wherein the manually-adjustable characteristic is the thickness of the enclosure.

143. The earphone of claim 138, additionally comprising a spacer that attaches to the earphone and which increases the distance between the speaker and the user's ear.

144. The earphone of claim 138, additionally comprising a secondary enclosure that encloses the enclosure and the speaker, and which is detachable from the earphone.

145. A mobile device for the transmission of audio entertainment signals comprising

an audio signal store for the storage of the audio entertainment signals;

an audio signal player for the playing of the audio entertainment signals;

an wireless transmitter for the transmission of the audio entertainment signals; and

a transmitter control to manually switch between two states consisting of the operation and the non-operation of the audio transmitter.

146. The device of claim 145 wherein the transmitter is connected to the audio jack of the audio signal player.

147. The device of claim 146 wherein the audio signal that is transmitted via the audio jack is subsequently divided between the transmitter and the headphone.

148. The device of claim 146 wherein the transmitter additionally comprises a second jack to which the earphone plug can connect, such that the insertion of the earphone plug into the second jack allows the audio signal to be heard in the earphone

149. A mobile device for the reception of digital audio entertainment signals comprising:

an audio signal store for the storage of the digital audio entertainment signals;

an audio receiver for the reception of external digital audio entertainment signals from a mobile audio signal transmitter located within a predetermined distance of the audio receiver;

a receiver control with at least a first state and a second state; and

an audio signal player that plays digital audio entertainment signals from the audio signal store when the receiver control is in the first state, and that plays digital audio entertainment signals from the audio receiver when the receiver control is in the second state.

150. The device of claim 149, additionally comprising a jack to which a listening device chosen from the group consisting of earphone and headphone can be connected.

151. A method for the shared enjoyment of music from stored musical signals between a first user with a first music player device and at least one second user with at least one second music player device, comprising:

playing the musical signals for the first user on the first music player device while essentially simultaneously wirelessly transmitting synchronization signals from the first music player device to the at least one second music player device; and

receiving the synchronization signals by the at least one second player device, wherein the synchronization signals allow the musical signals on the at least one second player device to be played essentially simultaneously with the playing of the musical signals on the first music player device;

wherein the first and the at least one second users are mobile.

152. The method of claim 151 wherein the same musical signals are stored on the first music player device and the at least one second music player device.

153. The method of claim 152 wherein the musical signals are stored as compressed audio files.

154. The method of claim 151 wherein the synchronization signals comprise the current sample number being played on the first music player device.

155. The method of claim 154 wherein the synchronization signals further comprise the sample rate of the musical signal being played on the first music player device.

156. The method of claim 151 wherein the synchronization signals comprise the current time relative to the beginning of the musical signal being played on the first music player device.

157. The method of claim 151, additionally comprising transferring the musical signals from the first music player device to the at least one second music player device.

158. A wireless communications system for sharing audio entertainment between a first mobile device and a second mobile device, comprising:

a broadcast identifier transmitted by the first mobile device to the second mobile device;

a personal identifier transmitted by the second mobile device to the first mobile device; and

a broadcast signal comprising audio entertainment that is transmitted by the first mobile device of which the second device is receptive;

wherein the first mobile device and the second mobile device have displays which can display the identifier signal that they receive and the second mobile device can play the audio entertainment from the broadcast signal that it receives.

159. The system of claim 158 wherein the identifier signals are transmitted via an Internet protocol.

160. The system of claim 159 wherein the Internet protocol is a connection-oriented transport protocol.

161. The system of claim 159 wherein the Internet protocol further comprises a link layer protocol selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

162. The system of claim 158 wherein the broadcast signal is transmitted via an Internet protocol.

163. The system of claim 162 wherein the Internet protocol is a connectionless transport protocol.

164. The system of claim 162 wherein the Internet protocol further comprises a link layer protocol selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

165. The system of claim 158 wherein the broadcast signal is an analog radio frequency signal.

166. The system of claim 158 wherein the broadcast signal is transmitted via telephony.

167. The system of claim 158 wherein the broadcast signal is compressed.

168. The system of claim 158 wherein the broadcast signal is encrypted.

169. The system of claim 158, additionally comprising a transfer signal that is transmitted by the first mobile device upon halting the transmission of its broadcast signal, and which transfer signal is receptive by the second mobile device, such that reception by the second mobile device causes the device to transmit a second broadcast signal comprising audio entertainment for which the first unit is receptive.

170. The system of claim 158 wherein the broadcast signal is transmitted via peer-to-peer communications.

171. The system of claim 170 additionally comprising a switch, wherein actuation of the switch causes the device to toggle between peer-to-peer communications and infrastructure-based communications.

172. The system of claim 158 wherein the broadcast signal is transmitted via infrastructure-based communications.

173. The system of claim 158 wherein the personal identifier includes a least one piece of information about the user of the second mobile device taken from the group consisting of the name of the user, the nickname of the user, a numerical identifier, an alphanumerical identifier, the musical preferences of the user, the age of the user, and the educational institution that the user attends.

174. The system of claim 158 additionally comprising a third mobile device whose user requests to receive the broadcast signal and additionally comprising a requester identifier signal transmitted by the third mobile device to the first mobile device.

175. The system of claim 174 wherein the requester identifier signal is additionally transmitted by the third mobile device to the second mobile device.

176. The system of claim 174 wherein the requester identifier signal is additionally transmitted by the first mobile device to the second mobile device.

177. The system of claim 174 wherein the requester identifier is displayed on the display of the first mobile device.

178. The system of claim 174 wherein the third mobile device receives the broadcast signal without the affirmative action of the first mobile device.

179. The system of claim 174 wherein the third mobile device must receive the affirmative action of the first mobile device in order to receive the broadcast signal.

180. The system of claim 174 wherein the third mobile device must receive the affirmative action of the first mobile device and all other mobile devices receptive of the broadcast signal.

181. The system of claim 180 wherein the affirmative action is a unanimous vote.

182. The system of claim 180 wherein the affirmative action is a majority vote.

183. The system of claim 158, additionally comprising a substantially unique musical identifier related to the audio entertainment, wherein the musical identifier is transmitted by the first mobile device to the second mobile device in association with the broadcast signal, and the musical identifier is stored on the second mobile device in association with the broadcast identifier.

184. A system for identifying a first device that introduces a music selection to a second device, comprising:

a mobile music transmitter operated by the first device;

a mobile music receiver operated by the second device;

a music signal comprising the music selection transmitted by the transmitter and received by the receiver;

an individual musical identifier that is associated with the music selection; and

an individual transmitter identifier that identifies the transmitter, wherein the transmitter identifier and the individual music identifier are stored in association with each other in the receiver.

185. A method for enhancing enjoyment of a musical selection, comprising:

obtaining control signals related to the musical selection;

transmitting the control signals wirelessly;

receiving the control signals; and

converting the control signals to a humanly-perceptible form.

186. The method of claim 185 wherein the distance over which the control signals are transmitted has a minimum range of at least 1 foot.

187. The method of claim 185 wherein the distance over which the control signals are transmitted has a maximum range of less than 500 feet.

188. The method of claim 185 wherein the humanly-perceptible form is a visually-perceptible form.

189. The method of claim 185 wherein the humanly-perceptible form is a tactilely-perceptible form.

190. The method of claim 185 wherein the transmitting and receiving use radio frequency communications.

191. The method of claim 185 wherein the radio frequency communications use an Internet protocol.

192. The method of claim 185 wherein the Internet protocol involves a link layer chosen from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

193. The method of claim 185 wherein obtaining additionally comprises extracting the musical beat from the musical selection.

194. The method of claim 185 wherein obtaining additionally comprises retrieving the control signals from a store of control signals.

195. The method of claim 185 wherein the control signals are divided into multiple channels.

196. The method of claim 195 wherein the step of converting comprises a step of demultiplexing the control signals.

197. The method of claim 185 wherein the steps of transmitting and receiving are performed using means conveyed by a single person.

198. The method of claim 197 wherein the user is mobile.

199. The method of claim 185 wherein the step of transmitting is performed by a stationary user and the step of receiving is performed by a mobile user.

200. The method of claim 185 wherein the musical selection is provided by musicians in concert playing essentially simultaneously with obtaining control signals.

201. The method of claim 185 wherein the control signals are transmitted with a substantially unique identifier.

202. The method of claim 185 wherein the control signals control the appearance of a wearable device.

203. A method for generating and storing control signals corresponding to musical signals, comprising:

playing musical signals for a user;

receiving manual input signals from the user that are produced substantially in synchrony with the music;

generating control signals from the input signals; and

storing the control signals so that they can be retrieved with the musical signals.

204. The method of claim 203 wherein receiving comprises transducing tactile input from the user.

205. The method of claim 204 wherein the tactile input is produced using a user appendage selected from the group consisting of hand, finger and foot.

206. The method of claim 203 wherein receiving comprises transducing sound output produced by the user.

207. The method of claim 203 wherein storing comprises interleaving control signals within the musical signals.

208. The method of claim 203 wherein storing additionally comprises creating a digital file.

209. The method of claim 203 wherein storing additionally comprises associating the digital file with the musical signals.

210. A wearable personal accessory, comprising:

an input transducer taken from the group consisting of a microphone and an accelerometer, said transducer generating a time-varying input transduction signal;

a controller which accepts the input transduction signal, and which generates an output transducer signal whose signal varies in amplitude with time;

an output transducer receptive of the output transducer signal, and which provides a humanly-perceptible signal; and

an energy source for powering the input transducer, controller and output transducer.

211. The accessory of claim 210 wherein the accelerometer responds to the movements of the user in one axis of movement.

212. The accessory of claim 210 wherein the accelerometer responds to the movements of the user in more than one axis of movement.

213. The accessory of claim 210 wherein the controller performs automatic gain control on the signal from the input transducer.

214. The accessory of claim 210 wherein the output transducer is a light transducer.

215. The accessory of claim 214 wherein the output transducer comprises a light emitting diode.

216. The accessory of claim 214 wherein the output transducer comprises a liquid crystal display.

217. The accessory of claim 214 wherein the output transducer comprises an organic light emitting diode.

218. The accessory of claim 210 wherein the output transducer is a tactile transducer.

219. The accessory of claim 210 wherein the output transducer comprises a first and a second transduction element.

220. The accessory of claim 219 wherein the first transduction element responds preferentially to a first band of frequencies of the input transduction signal and the second transduction element responds preferentially to a second band of frequencies of the input transduction signal.

221. The accessory of claim 219 wherein the first transduction element responds preferentially to a first band of amplitudes of the input transduction signal and the second transduction element responds preferentially to a second band of amplitudes of the input transduction signal.

222. A wearable personal accessory controlled via wireless communications, comprising:

a wireless communications receiver, receptive of an external control signal;

a controller that accepts the external control signal and that generates a time-varying visual output transducer signal;

a visual output transducer that is receptive of the output transducer signal, and which provides a humanly-perceptible visual signal; and

an energy store for powering the receiver, controller and output transducer;

wherein the visual output transducer generates visually-perceptive output.

223. The accessory of claim 222 wherein the external control signal is a time-varying amplitude signal.

224. The accessory of claim 223 wherein the amplitude signal is analog.

225. The accessory of claim 223 wherein the amplitude signal is digital.

226. The accessory of claim 223 wherein the amplitude signal is substantially a musical signal.

227. The accessory of claim 226 wherein the controller performs frequency filtering of the external control signal.

228. The accessory of claim 226 wherein the controller determines the primary beat of the music.

229. The accessory of claim 228 wherein the primary beat of the music is determined according to the positions in the music where the amplitude rises at least a predetermined factor over less than a predetermined time.

230. The accessory of claim 222 wherein the external control signal is a digital signal of pairs comprising positions within the music and the amplitudes to which the output transducers are set at such times.

231. The accessory of claim 230 wherein the positions are chosen from the group of characteristics consisting of samples and times.

232. The accessory of claim 222 wherein the receiver is an analog radio frequency receiver.

233. The accessory of claim 232 wherein the analog radio frequency communications are at a frequency set by a crystal oscillator, wherein the crystal oscillator can be manually exchanged in order to change the frequency of operation.

234. The accessory of claim 222 wherein the receiver receives Internet protocol signals.

235. The accessory of claim 234 wherein the Internet protocol further comprises a link layer selected from the group consisting of Bluetooth, 802.11 and ultrawideband.

236. The accessory of claim 222 wherein the visual output transducer comprises a first light transducer and a second light transducer.

237. The accessory of claim 236 wherein the external control signal comprises a multiplexed first signal and second signal, and wherein the first signal relates to the first light transducer and the second signal relates to a second light transducer.

238. The accessory of claim 237 wherein the controller comprises at least two ports, wherein the first port relates to the first light generating element and the second port related to the second light generating element.

239. The accessory of claim 236 wherein the first light transducer responds preferentially to a first range of frequency in the musical signal, and the second light transducer responds preferentially to a second range of frequency in the musical signal.

240. The accessory of claim 236 wherein the first light transducer responds preferentially to a first range of amplitude in the musical signal, and the second light transducer responds preferentially to a second range of amplitude in the musical signal.

241. The accessory of claim 222 wherein the visual output transducer comprises a light emitting diode.

242. The accessory of claim 222 wherein the visual output transducer comprises an organic light emitting diode.

243. The accessory of claim 222 wherein the visual output transducer comprises a liquid crystal display.

244. The accessory of claim 222 additionally comprising a tactile transducer responsive to the external control signal.

245. The accessory of claim 222 additionally comprising a sound transducer responsive to the external control signal.

246. The accessory of claim 222 wherein the external control signal additional comprises a digital identifier.

247. The accessory of claim 246 wherein the visual output transducer additionally provides an identifier signal that corresponds to the digital identifier, wherein such identifier signal is higher frequency than is humanly perceptible, and wherein the identifier signal is output substantially simultaneously with the humanly-perceptible visual signal.

248. The accessory of claim 222 additionally comprising a manually-separable electrical connection, wherein the connection connects the receiver to the controller.

249. The accessory of claim 222 additionally comprising a manually-separable electrical connection, wherein the connection connects the controller to the output transducer.

250. The accessory of claim 222 wherein the accessory functions as an accoutrement selected from the group consisting of a ring, a pendant, a hair clip, an earring, a necklace, a brooch, a belt buckle, watches, and a bracelet.

251. The accessory of claim 222 wherein the accessory is incorporated into an article of clothing selected from the group consisting of a backpack, a wallet, a purse, a hat and a shoe.

252. The accessory of claim 222 additionally comprising a manual control whose operation sets either a first state and a second state and wherein in the first state the accessory responds exclusively to external control signals comprising a substantially unique identifier.

253. The accessory of claim 252 wherein the identifier to which the accessory responds in the first state is received by the receiver when the accessory is set to the second state.

254. The accessory of claim 253 additionally comprising a third state which is manually set, wherein in the third state, the accessory responds to external control signals in the absence of a substantially unique identifier.

255. A device for converting user tactile responses to stored music into a stored control signal, comprising:

a player that plays stored music audible to the user;

a manually-operated transducer that outputs an electrical signal, wherein the transducer is actuated by the user in response to the music;

a controller that receives the electrical signal and outputs a control signal; and

a store that receives the control signal and stores it.

256. The device of claim 255 wherein the control signal comprises a list of positions, wherein the positions are chosen from the set of characteristics consisting of samples and time relative to the beginning of the stored music.

257. The device of claim 255 wherein the control signal further comprises a list of amplitudes corresponding to the positions.

258. The device of claim 257 additionally comprising a second manually-operated transducer that outputs a second electrical signal, wherein the controller additionally receives the second electrical signal.

259. The device of claim 255 wherein the transducer comprises a musical drum operated by the user whose audible output is received by a microphone that generates the electrical signal received by the controller.

260. The device of claim 255 wherein the controller performs frequency filtering on the electrical signal.

261. The device of claim 255 wherein the transducer is a tactile transducer that is operated by an appendage of the user selected from the group consisting of finger, hand, and foot.

262. The device of claim 255 wherein the store is a file system and the control signal is stored as control file and the stored music is stored as a music file, wherein the control file and the music file are stored in association with each other.

263. The device of claim 255 wherein the control signals are stored in an interleaved fashion with the stored music.

264. The device of claim 71 additionally comprising a visual display on which a visual representation of the control signals is displayed.

265. A music player that wirelessly transmits control signals related to the music, wherein the control signals control a wearable electronic accessory, comprising:

a store of music signal files;

a controller that reads a musical signal file from the store and generates audio signals and that further generates the control signals;

a transducer that converts the audio signals into sound audible to the user; and

a wireless transmitter that transmits the control signal to the wearable electronic accessory.

266. The player of claim 265 wherein the music signal files comprise compressed audio files.

267. The player of claim 265 wherein the controller performs frequency filtering of the external control signal.

268. The player of claim 265 wherein the controller determines the primary beat of the music.

269. The player of claim 268 wherein the primary beat of the music is determined according to the positions in the music where the amplitude rises at least a predetermined factor over less than a predetermined time.

270. The player of claim 265 wherein the control signals are pairs comprising positions within the music and the amplitudes to which the output transducers are set at such times.

271. The player of claim 265 wherein the positions are chosen from the set of characteristics consisting of samples and times.

272. The player of claim 265 wherein the transmitter is an analog radio frequency transmitter.

273. The player of claim 265 wherein the transmitter transmits according to an Internet protocol.

274. The player of claim 273 wherein the Internet protocol has a link layer selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

275. The player of claim 265 additionally comprising a visual transducer that generates visually-preceptive output in response to the control signal, wherein the visual transducer receives the control signal from the controller.

276. The player of claim 275 wherein the visual transducer is a light emitting diode.

277. The player of claim 275 wherein the visual transducer is a liquid crystal display.

278. The player of claim 265 additionally comprising a store of configuration files wherein the configuration files include parameters read by the controller that affect the generation of control signals from the musical signals.

279. A music player that wirelessly transmits control signals related to the music, wherein the control signals control a wearable electronic accessory, comprising:

a store of music signal files;

a second store of control signal files associated with the music signal files;

a controller that reads a musical signal file from the store and generates audio signals and that further reads an associated control signal file;

a transducer that converts the audio signals into sound audible to the user, and

a wireless transmitter that transmits the control signals from the associated control signal file to the wearable electronic accessory.

280. The player of claim 279 wherein the music signal files comprise compressed audio files.

281. The player of claim 279 wherein the transmitter is an analog radio frequency transmitter.

282. The player of claim 279 wherein the transmitter transmits according to an Internet protocol.

283. The player of claim 282 wherein the Internet protocol has a link layer selected from the group consisting of 802.11, Bluetooth, ultrawideband, HiperLAN and WDCT.

284. The player of claim 279 wherein the store of control information comprises at least one binary data file that relates to a single music signal file.

285. The player of claim 279 wherein the store of control information is interleaved with a related music signal file in binary data format.

286. The player of claim 279 additionally comprising a visual transducer that generates visually-preceptive output in response to the electrical control signal, wherein the visual transducer receives the electrical control signal from the controller.

287. A system for exhibition of music enjoyment, comprising:

a source of music signals;

a controller that generates control signals from the music signals;

a transmitter of the control signals, wherein the transmission of the control signals is synchronized with the playing of the music signals;

a receiver of the control signals; and

a transducer that responds to the control signals.

288. The system of claim 287 wherein the source of music signals are stored binary music files.

289. The system of claim 288 wherein the stored binary data files are compressed audio files.

290. The system of claim 288 wherein the music signals are stored on a medium selected from the group consisting of compact disk, digital video disk, hard disk drive, removable disks, flash memory, magneto-optical disk, and audio tape.

291. The system of claim 287 wherein the source of music signals are musicians playing live music.

292. The system of claim 287 wherein the receiver and transducer are worn by a user.

293. The system of claim 287 wherein the receiver and the transducer are physically separated from the transmitter by more than 5 feet.

294. The system of claim 287 wherein the transducer is a visual transducer that generates humanly-perceptible visual signals.

295. The system of claim 294 wherein the visual transducer is a light emitting diode

296. The system of claim 294 wherein the visual transducer is a liquid crystal display

297. The system of claim 287 wherein the transducer is a tactile transducer.

298. The system of claim 287 wherein the minimum range of the transmitter for which the receiver is receptive is at least 1 foot.

299. The system of claim 287 wherein the maximum range of the transmitter for which the receiver is receptive is less than 500 feet.

300. The system of claim 287 wherein the controller determines the primary beat of the music.

301. The system of claim 287 wherein the controller performs frequency filtering.

302. The system of claim 287, additionally comprising a second controller that is electrically connected to the receiver, and which generates transducer control signals from the control signals received by the receiver, wherein the transducer control signals directly control the transducer.

303. The system of claim 302 wherein the control signals are time-varying amplitude signals and wherein the second controller performs frequency filtering.

304. The system of claim 302 additionally comprising a switch that is electrically connected to the second controller such that actuation of the switch places the second controller into entraining mode, wherein the receiver becomes receptive of entraining signals from the transmitter.

305. The system of claim 304 wherein a receiver that is entrained will receive control signals other than from the transmitter in the absence of signals from the transmitter.

306. The system of claim 304 wherein additional actuation of the switch will allow reception of control signals by the receiver from a transmitter to which it is not entrained.

307. The system of claim 287 wherein the transmitter and receiver communicate via an Internet protocol.

308. The system of claim 287 wherein the transmitter and receiver communicate via digital radio frequency communications.

309. The system of claim 287 wherein the transmitter and receiver communicate via analog radio frequency communications.

310. The system of claim 309 wherein the analog radio frequency communications are at a frequency set by a crystal oscillator and wherein the crystal oscillator can be manually replaced.

311. The system of claim 287 additionally comprising a transferror for the transmission of music signals.

312. The system of claim 311 wherein the transmitter and the transferror are the same.

313. The system of claim 311 wherein the transmitter and the transferror are different, and communicate via different communications protocols.

314. The system of claim 287 additionally comprising a second receiver for the reception of music signals, wherein the music signals that are received are played by the music player.

315. A method for transferring a wearable-accessory control file stored on a first device to a second device in which an associated music file is stored, comprising:

storing on the first device the name of the music file in conjunction with the control file with which it is associated;

requesting by the second device of the first device for a control file stored in conjunction with the name of the music file; and

transferring the control file from the first device to the second device, wherein the control file is stored on the second device in conjunction with the name of the associated music file.

316. The method of claim 315 additionally comprising the step of extracting, wherein the control file is stored on the first device interspersed with the music file as a combined file, and the control file is extracted from the music file prior to being transferred to the second device.

317. The method of claim 315 wherein the requesting is performed over a wide area network.

318. The method of claim 315 wherein the name of the control file comprises the root of the name of the associated music file appended with a predetermined extension that is different from that of the music file.

319. The method of claim 315 wherein the control file and the associated music file both comprise the same substantially unique identifier.

320. A device for transmitting control signals to a wearable accessory receptive of such control signals, comprising:

a manually-separable input connector for connecting to an output port of an audio player, wherein audio signals are conveyed from the audio player to the device across the connector;

a controller for generating control signals from the audio signals; and

a transmitter for transmitting the control signals.

321. The device of claim 320 additionally comprising a second connector, wherein a portion of the audio signal conveyed to the device is conveyed to the second connector, and wherein an earphone can connect to the second connector.

322. The player of claim 320 wherein the controller performs frequency filtering of the audio signal.

323. The player of claim 320 wherein the controller determines the primary beat of the audio signal.

324. The player of claim 320 additionally comprising a visual transducer that generates visually-preceptive output in response to the control signals, wherein the visual transducer receives the control signals from the controller.

325. The system of claim 320 wherein the transmitter transmits via an Internet protocol.

326. The system of claim 320 wherein the transmitter transmits via digital radio frequency communications.

327. The system of claim 320 wherein the transmitter transmits via analog radio frequency communications.

328. The system of claim 327 wherein the analog radio frequency communications are at a frequency set by a crystal oscillator and wherein the crystal oscillator can be manually replaced.

329. The system of claim 320 wherein the transmitter additionally transmits the audio signal to wireless earphones.

1/34

Fig. 1

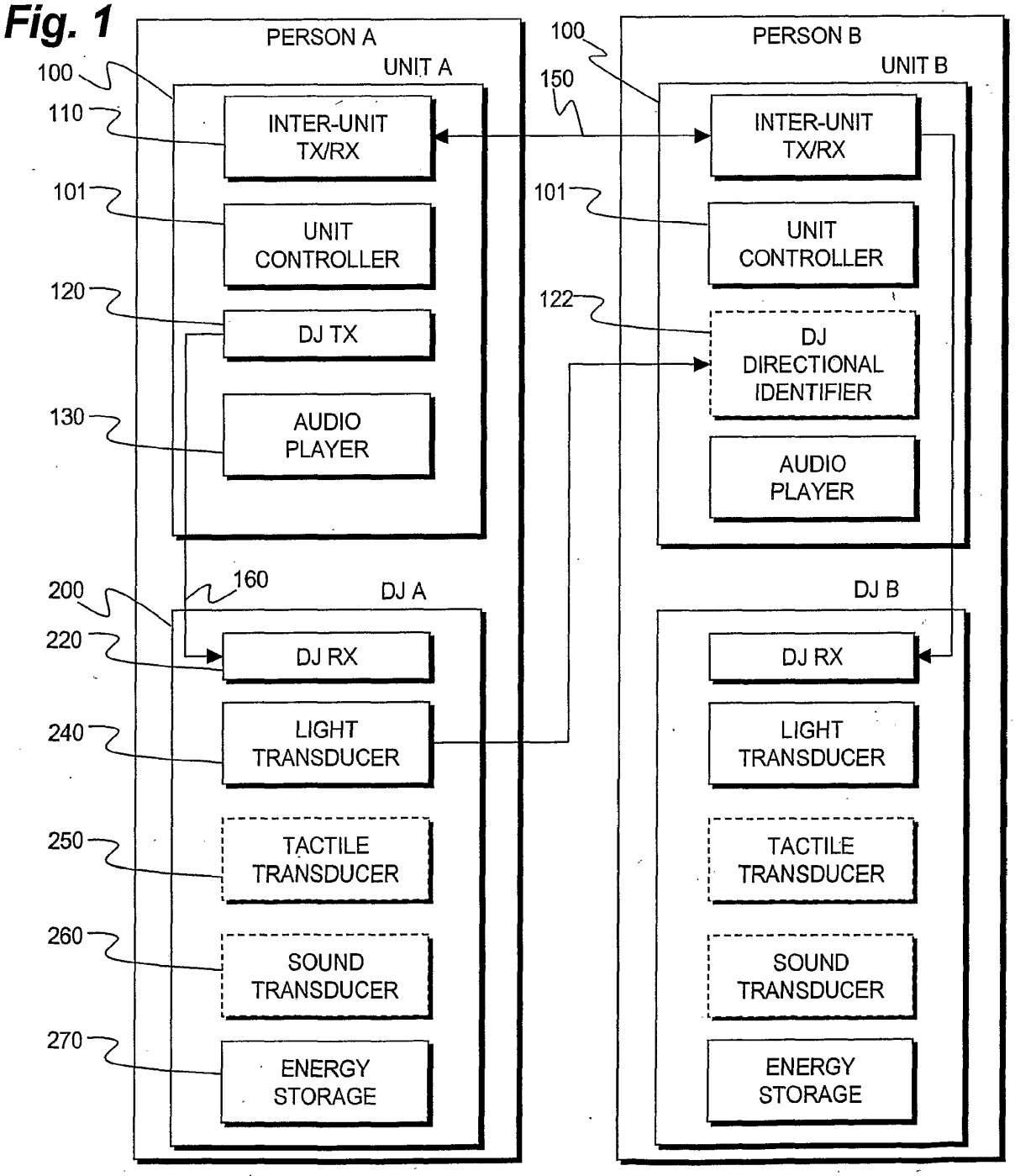

PERSON A
UNIT A
100
110
INTER-UNIT TX/RX
101
UNIT CONTROLLER
120
DJ TX
130
AUDIO PLAYER
160
200
DJ A
220
DJ RX
240
LIGHT TRANSDUCER
250
TACTILE TRANSDUCER
260
SOUND TRANSDUCER
270
ENERGY STORAGE
100
150
PERSON B
UNIT B
INTER-UNIT TX/RX
101
UNIT CONTROLLER
122
DJ DIRECTIONAL IDENTIFIER
AUDIO PLAYER
DJ B
DJ RX
LIGHT TRANSDUCER
TACTILE TRANSDUCER
SOUND TRANSDUCER
ENERGY STORAGE

Fig. 2A

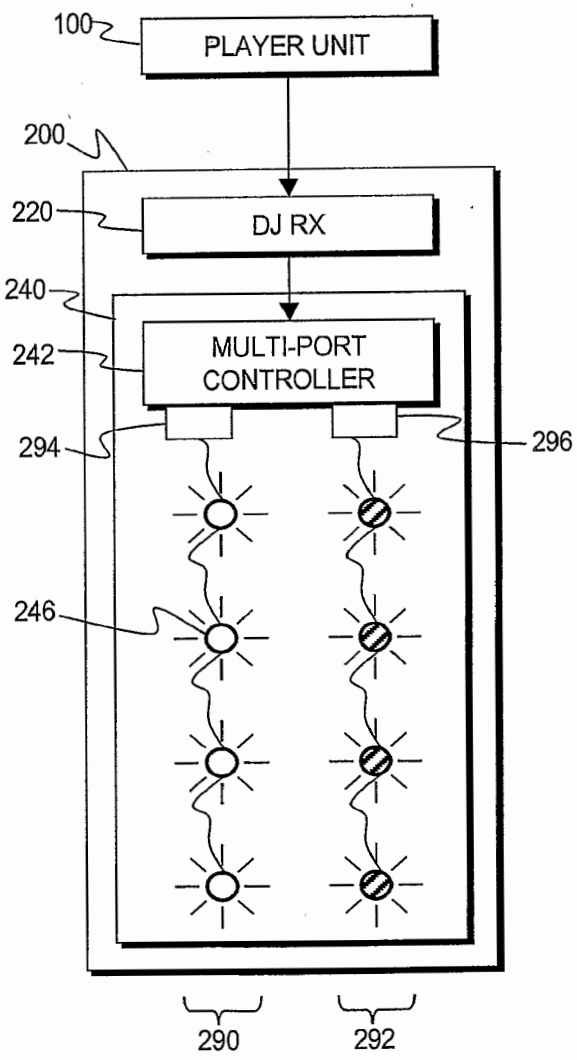

100
PLAYER UNIT
200
220
DJ RX
240
242
MULTI-PORT CONTROLLER
294
296
246
290
292

Fig. 2B

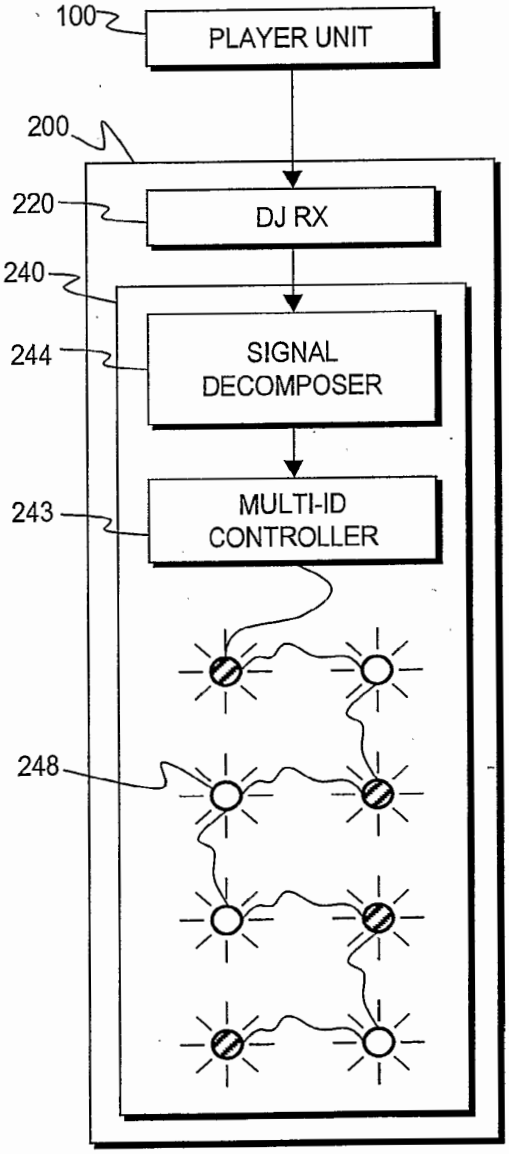

100
PLAYER UNIT
200
220
DJ RX
240
244
SIGNAL DECOMPOSER
243
MULTI-ID CONTROLLER
248

Fig. 3A

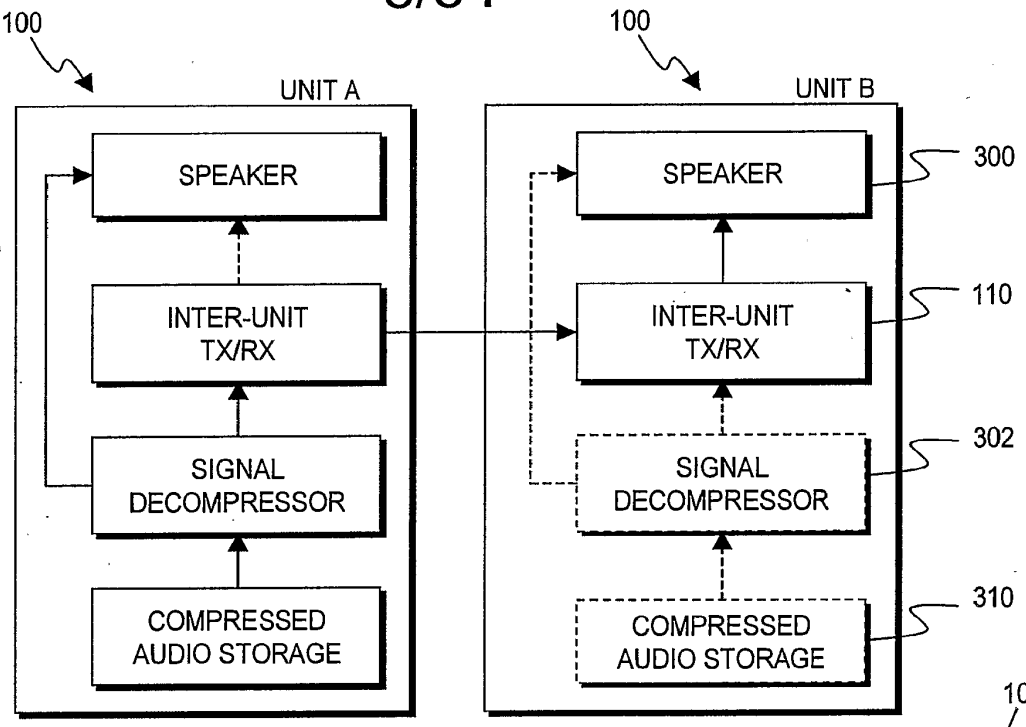

100
UNIT A
SPEAKER
INTER-UNIT TX/RX
SIGNAL DECOMPRESSOR
COMPRESSED AUDIO STORAGE
100
UNIT B
SPEAKER
300
INTER-UNIT TX/RX
110
SIGNAL DECOMPRESSOR
302
COMPRESSED AUDIO STORAGE
310

Fig. 3B

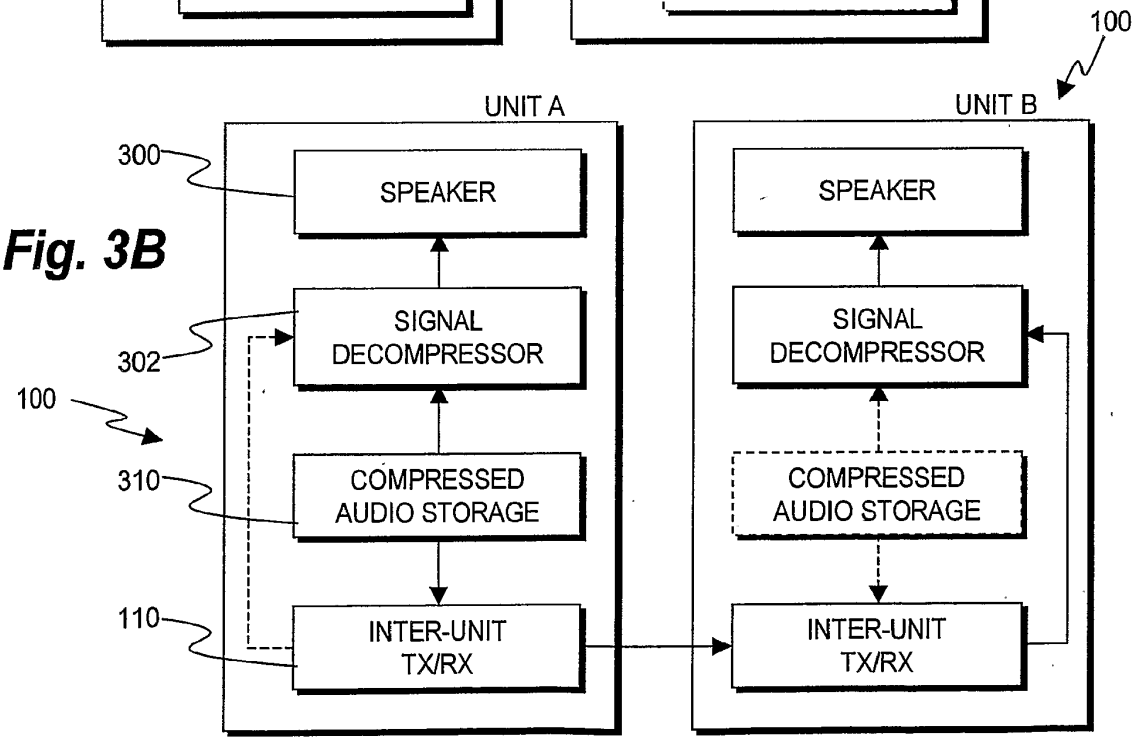

100
UNIT A
UNIT B
300
SPEAKER
SPEAKER
302
SIGNAL DECOMPRESSOR
SIGNAL DECOMPRESSOR
100
310
COMPRESSED AUDIO STORAGE
COMPRESSED AUDIO STORAGE
110
INTER-UNIT TX/RX
INTER-UNIT TX/RX

Fig. 3C

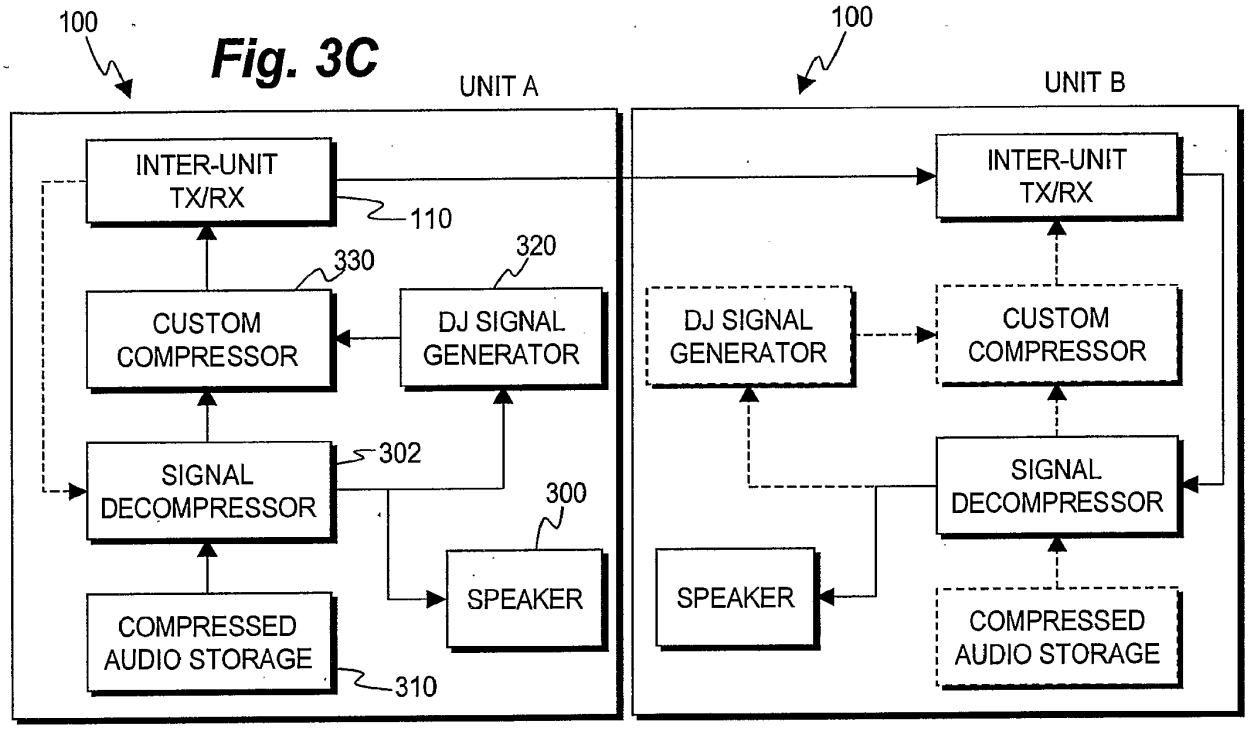

100
UNIT A
INTER-UNIT TX/RX
110
330
320
CUSTOM COMPRESSOR
DJ SIGNAL GENERATOR
SIGNAL DECOMPRESSOR
302
300
SPEAKER
COMPRESSED AUDIO STORAGE
310
100
UNIT B
INTER-UNIT TX/RX
DJ SIGNAL GENERATOR
CUSTOM COMPRESSOR
SIGNAL DECOMPRESSOR
SPEAKER
COMPRESSED AUDIO STORAGE

Fig. 4

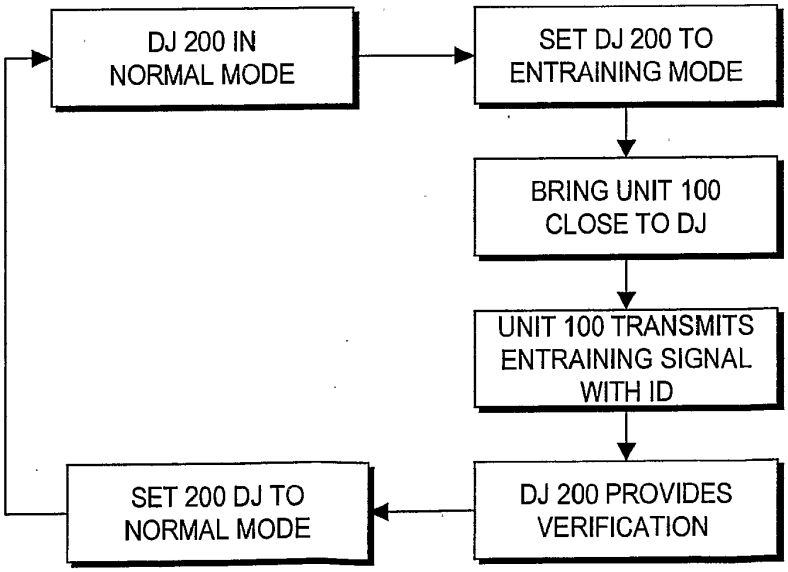

DJ 200 IN NORMAL MODE
SET DJ 200 TO ENTRAINING MODE
BRING UNIT 100 CLOSE TO DJ
UNIT 100 TRANSMITS ENTRAINING SIGNAL WITH ID
DJ 200 PROVIDES VERIFICATION
SET 200 DJ TO NORMAL MODE

Fig. 5A

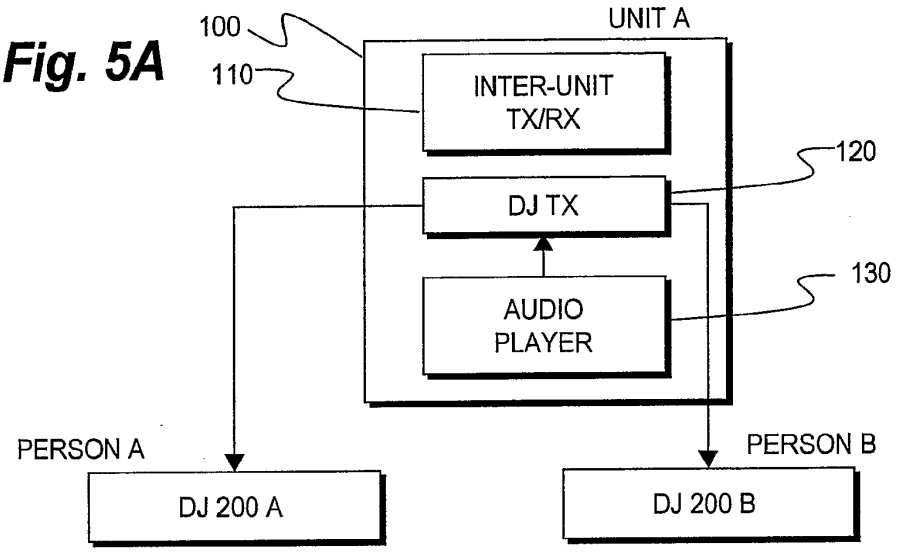

100
110
UNIT A
INTER-UNIT TX/RX
120
DJ TX
130
AUDIO PLAYER
PERSON A
PERSON B
DJ 200 A
DJ 200 B

Fig. 5B

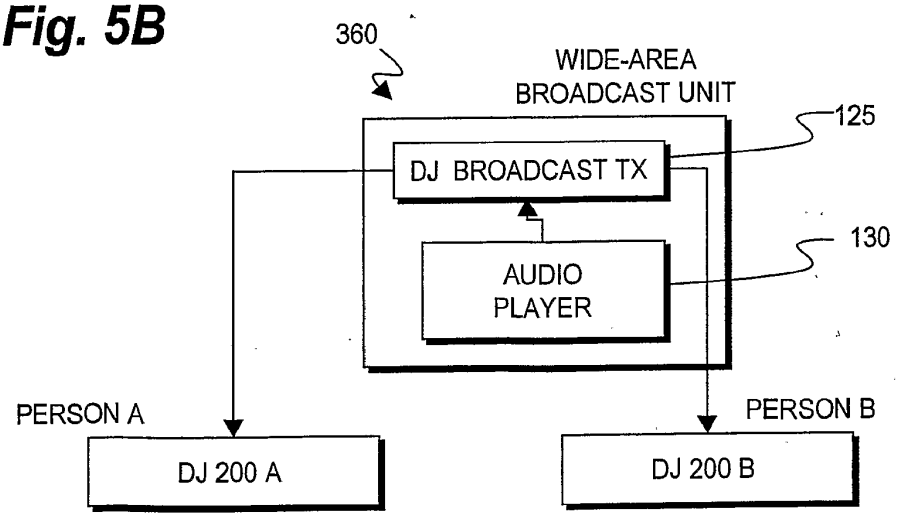

360
WIDE-AREA BROADCAST UNIT
125
DJ BROADCAST TX
130
AUDIO PLAYER
PERSON A
PERSON B
DJ 200 A
DJ 200 B

Fig. 6

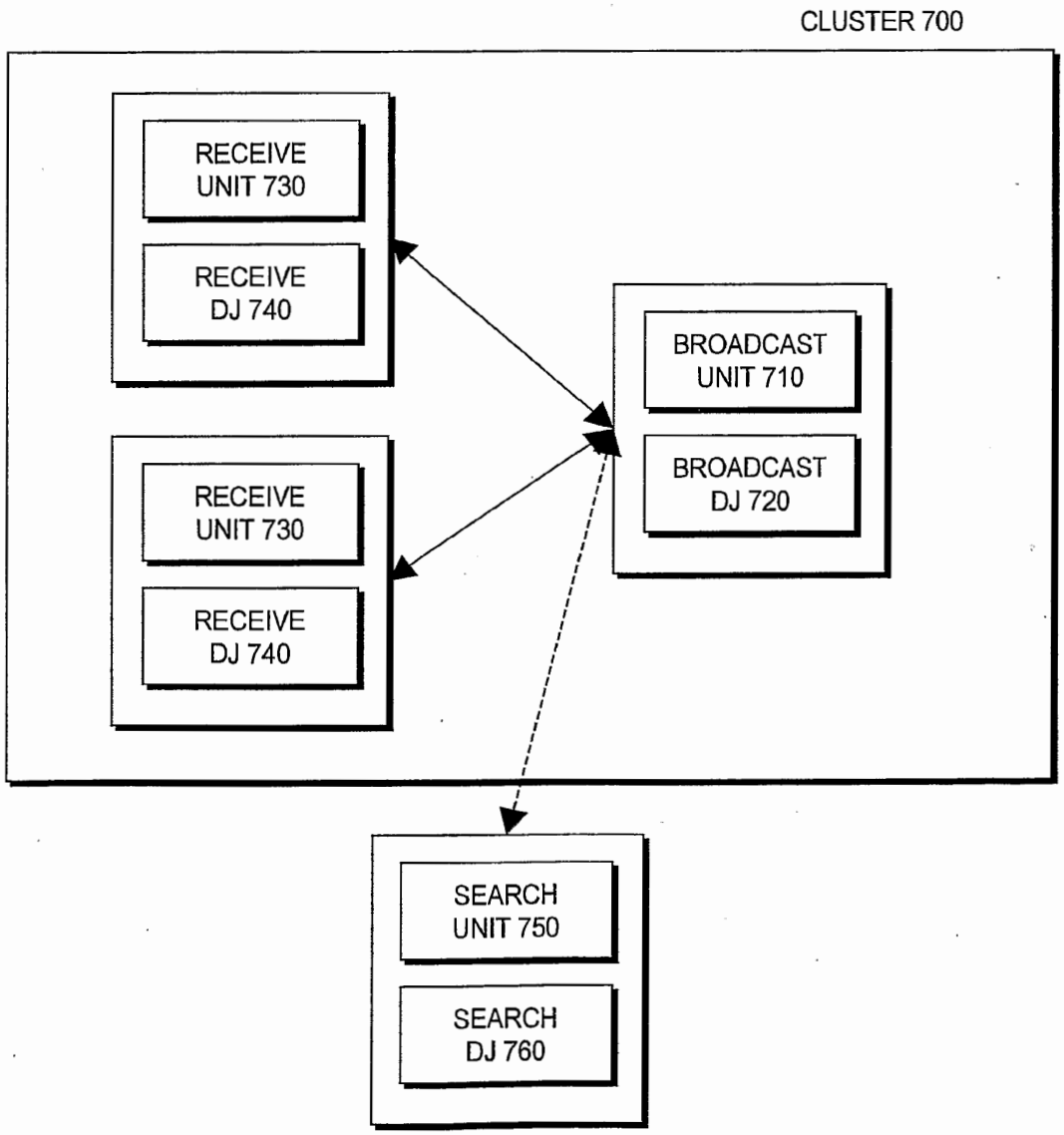

CLUSTER 700
RECEIVE UNIT 730
RECEIVE DJ 740
RECEIVE UNIT 730
RECEIVE DJ 740
BROADCAST UNIT 710
BROADCAST DJ 720
SEARCH UNIT 750
SEARCH DJ 760

Fig. 7

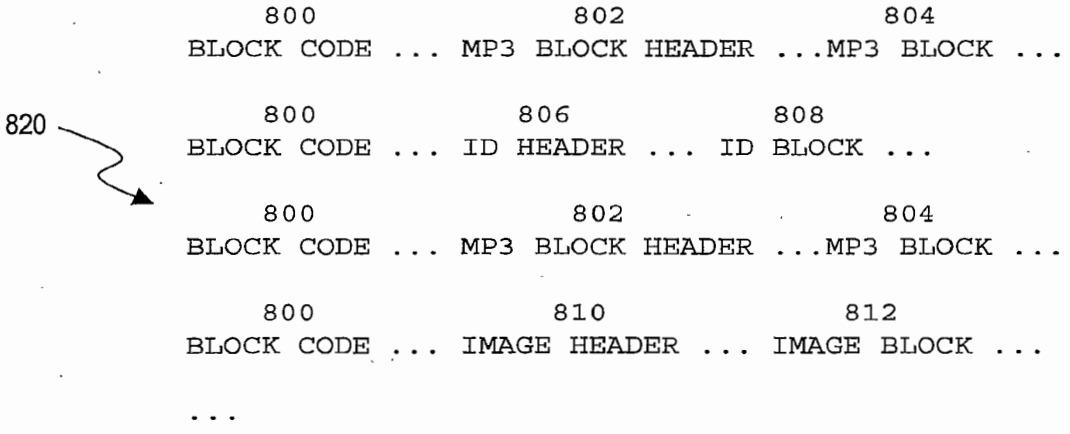

800
802
804
BLOCK CODE ... MP3 BLOCK HEADER ...MP3 BLOCK ...
820
800
806
808
BLOCK CODE ... ID HEADER ... ID BLOCK ...
800
802
804
BLOCK CODE ... MP3 BLOCK HEADER ...MP3 BLOCK ...
800
810
812
BLOCK CODE ... IMAGE HEADER ... IMAGE BLOCK ...
...

Fig. 36

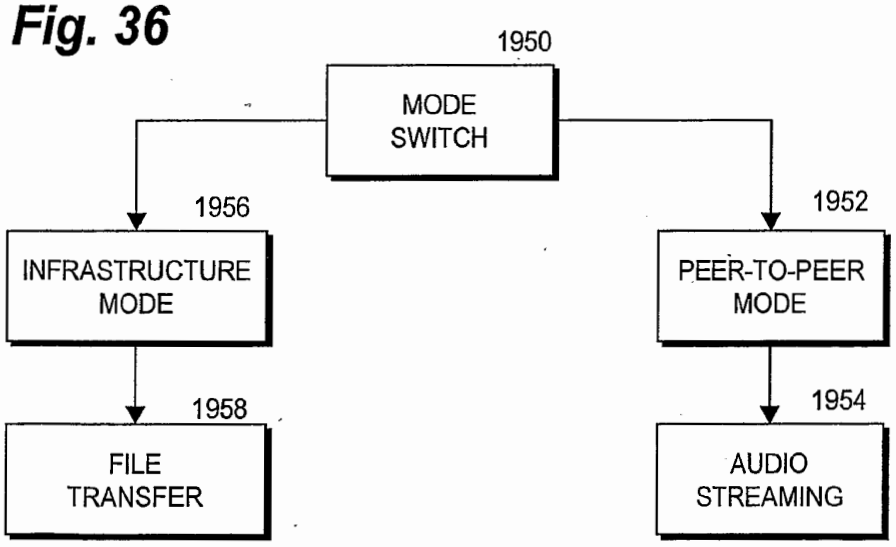

1950
MODE SWITCH
1956
INFRASTRUCTURE MODE
1952
PEER-TO-PEER MODE
1958
FILE TRANSFER
1954
AUDIO STREAMING

Fig. 8A

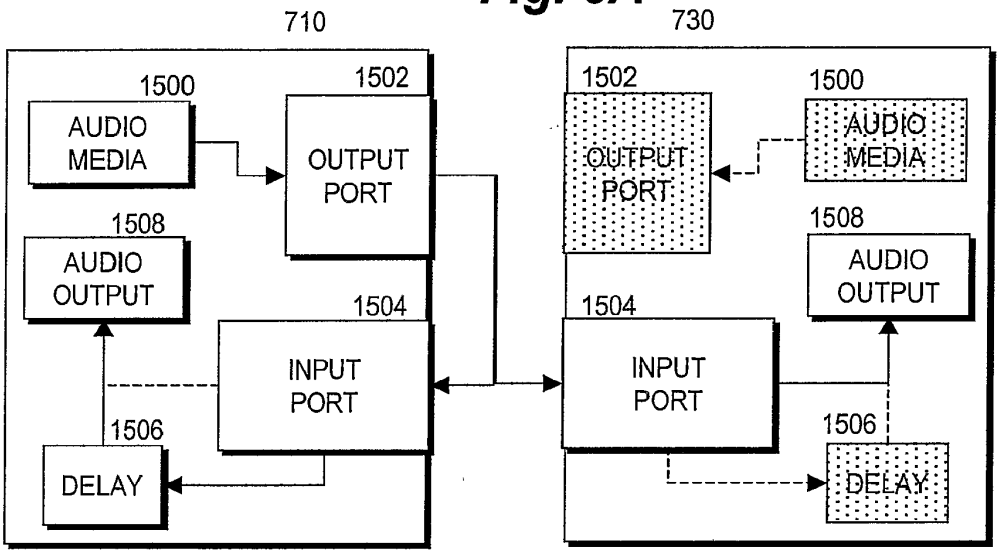

710
730
1500
AUDIO MEDIA
1502
OUTPUT PORT
1508
AUDIO OUTPUT
1504
INPUT PORT
1506
DELAY
1502
OUTPUT PORT
1500
AUDIO MEDIA
1508
AUDIO OUTPUT
1504
INPUT PORT
1506
DELAY

Fig. 8B

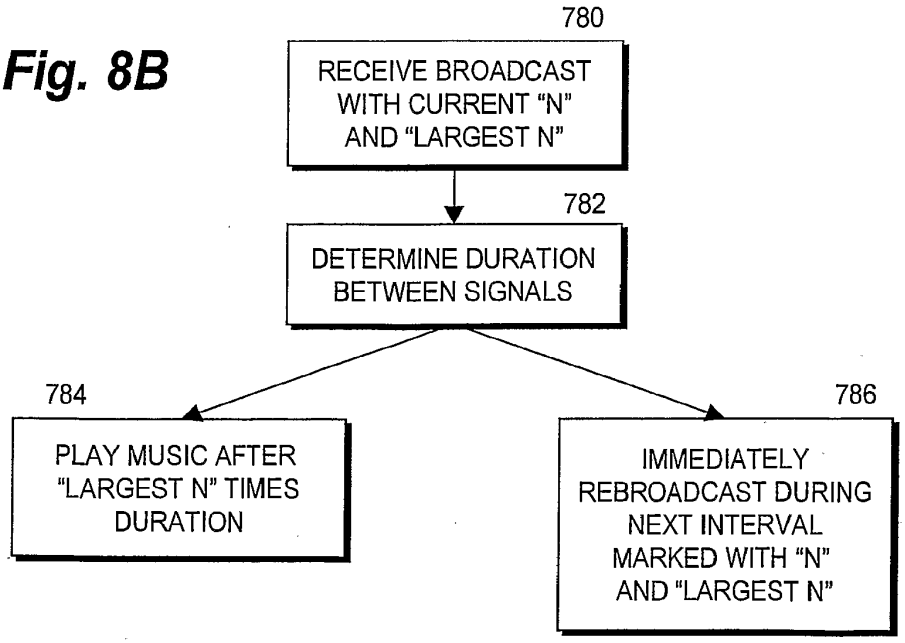

780
RECEIVE BROADCAST WITH CURRENT "N" AND "LARGEST N"
782
DETERMINE DURATION BETWEEN SIGNALS
784
PLAY MUSIC AFTER "LARGEST N" TIMES DURATION
786
IMMEDIATELY REBROADCAST DURING NEXT INTERVAL MARKED WITH "N" AND "LARGEST N"

Fig. 9A

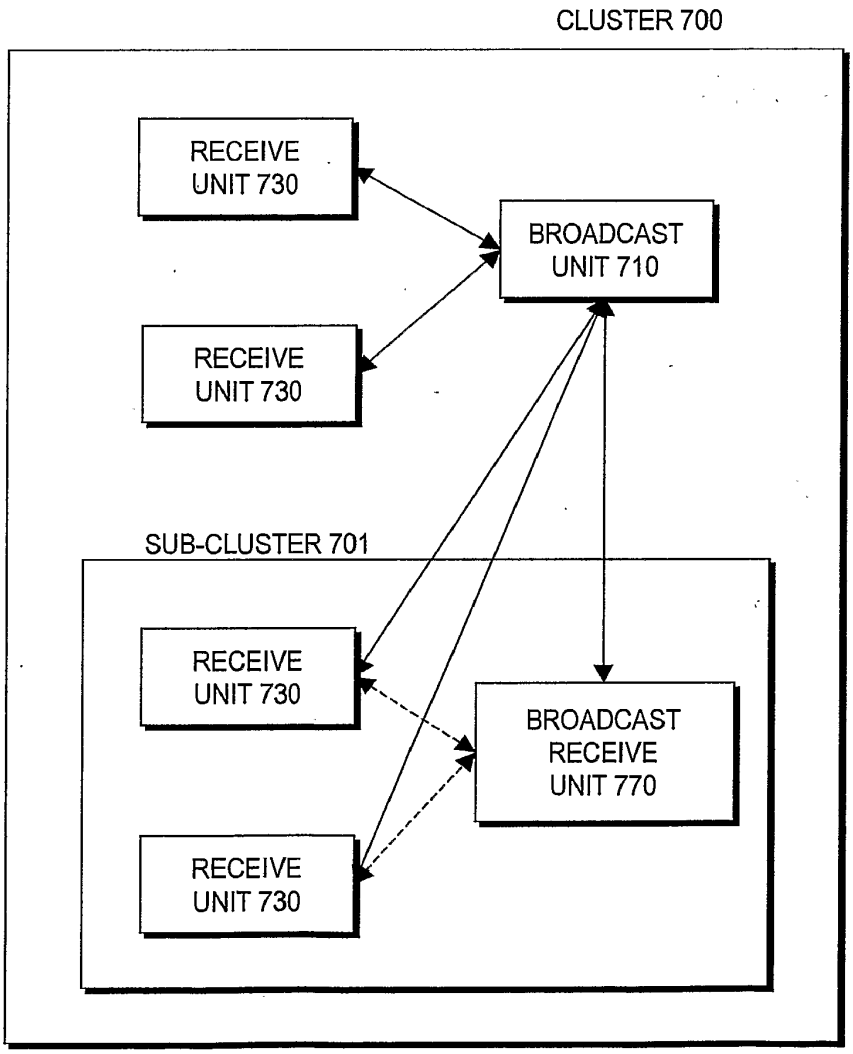

CLUSTER 700
RECEIVE UNIT 730
BROADCAST UNIT 710
RECEIVE UNIT 730
SUB-CLUSTER 701
RECEIVE UNIT 730
BROADCAST RECEIVE UNIT 770
RECEIVE UNIT 730

Fig. 9B

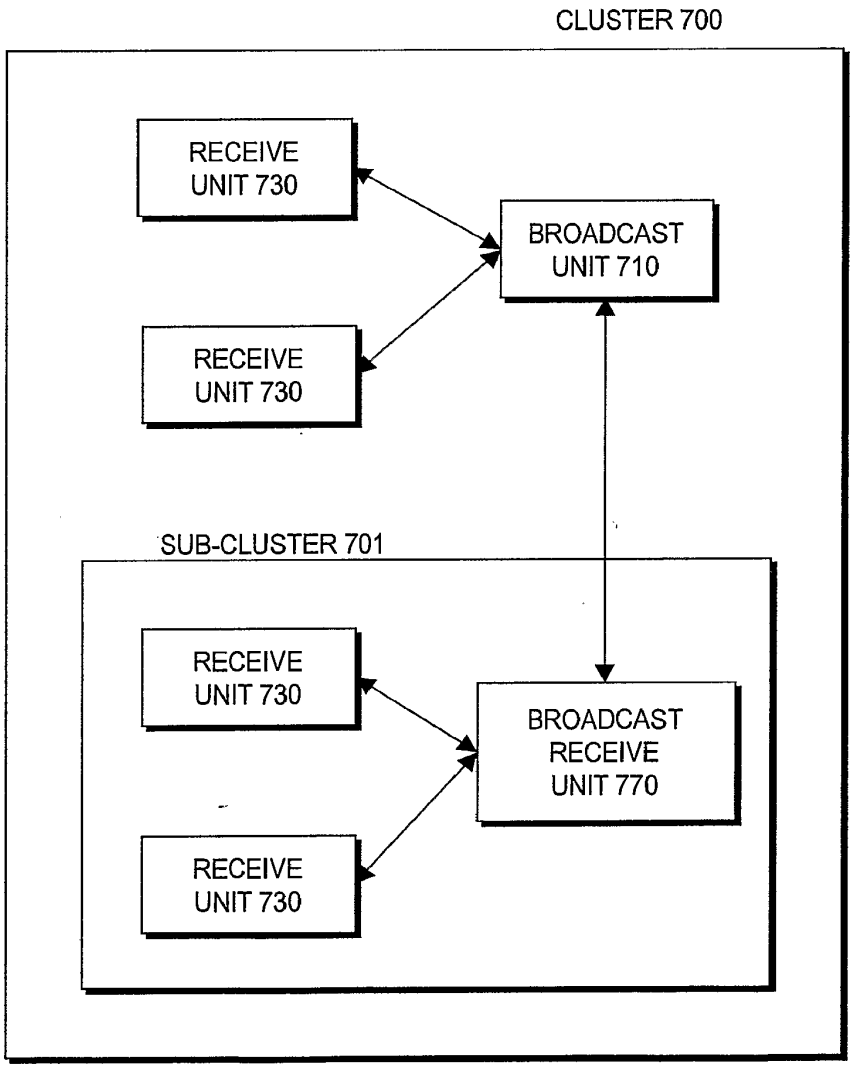

CLUSTER 700
RECEIVE UNIT 730
BROADCAST UNIT 710
RECEIVE UNIT 730
SUB-CLUSTER 701
RECEIVE UNIT 730
BROADCAST RECEIVE UNIT 770
RECEIVE UNIT 730

Fig. 10

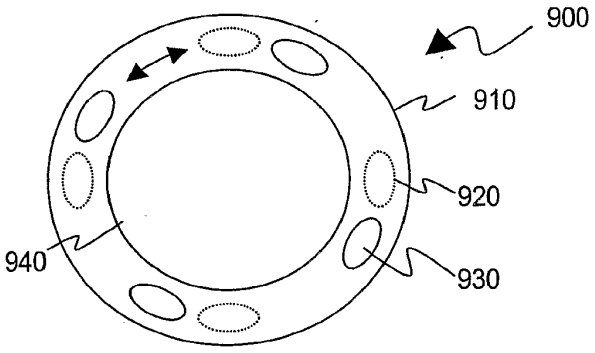


Fig. 11A

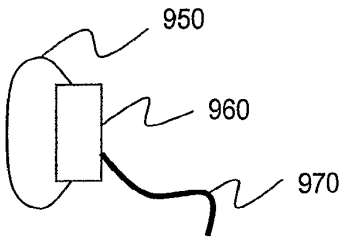


Fig. 11B

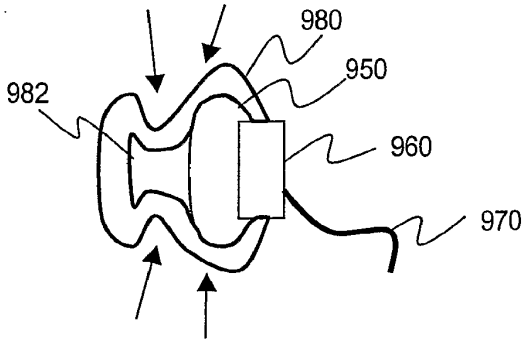


Fig. 12A

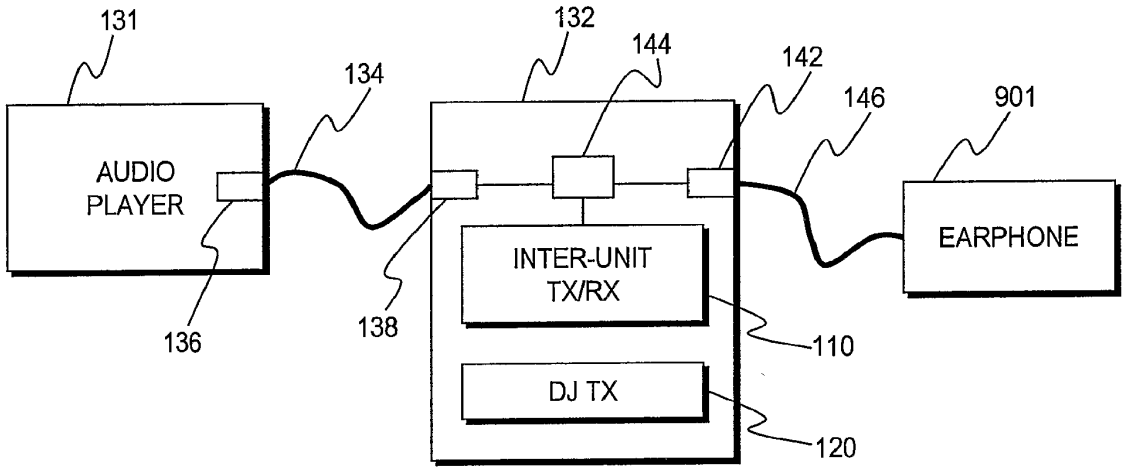


Fig. 12B

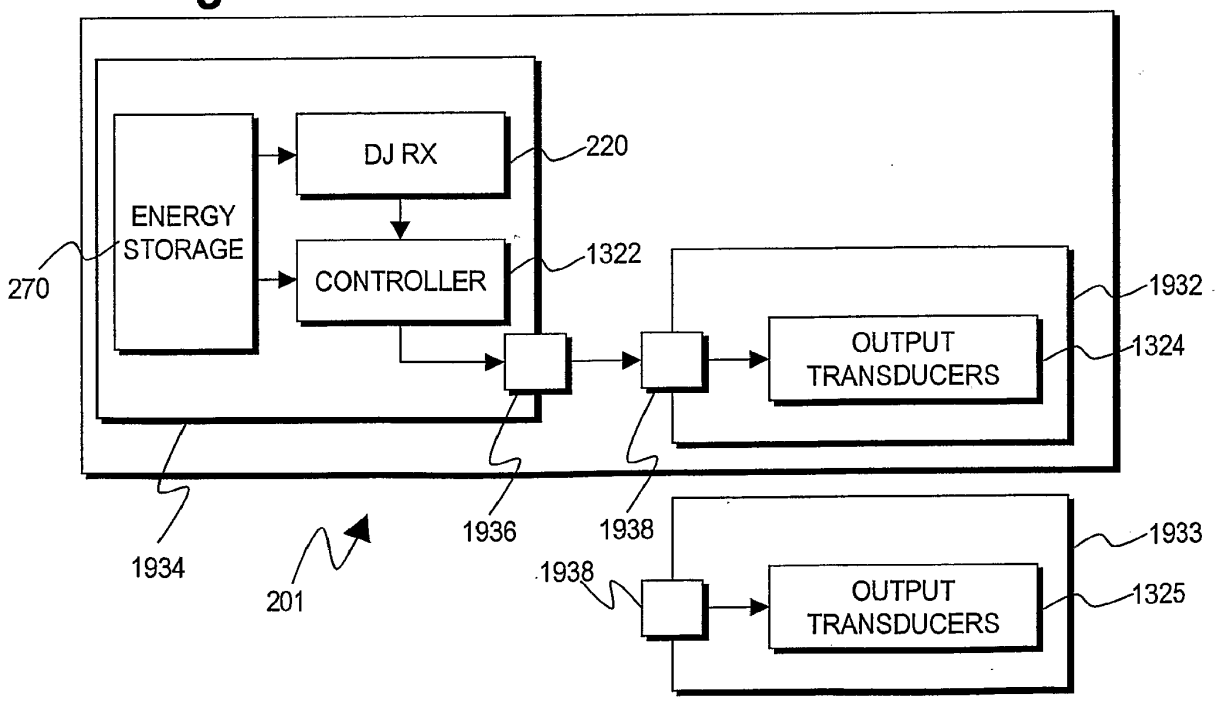


Fig. 12C

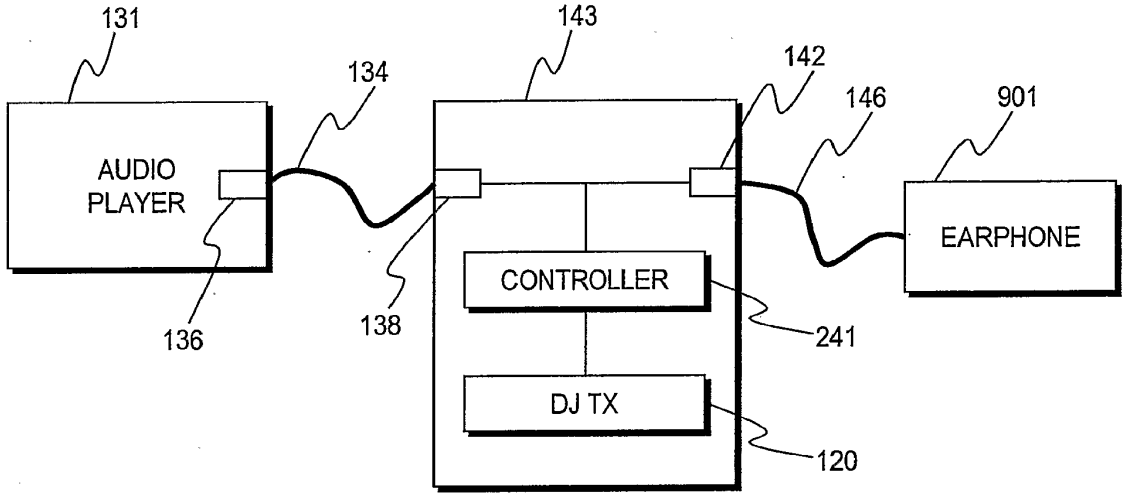

131
134
143
142
146
901
AUDIO PLAYER
EARPHONE
CONTROLLER
DJ TX
136
138
241
120

Fig. 13A

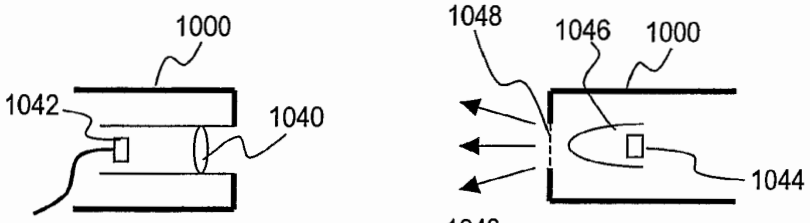


Fig. 13B

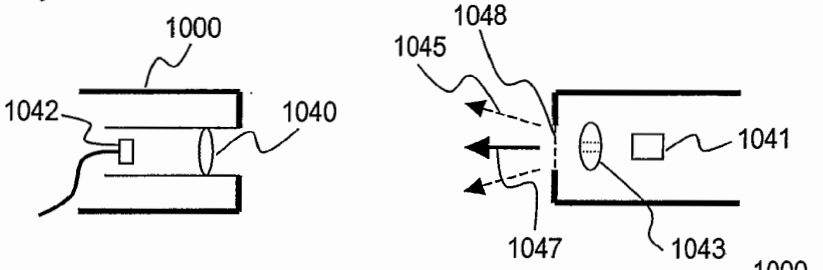


Fig. 13C

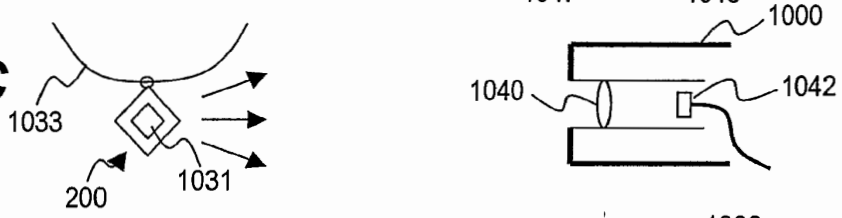


Fig. 13D

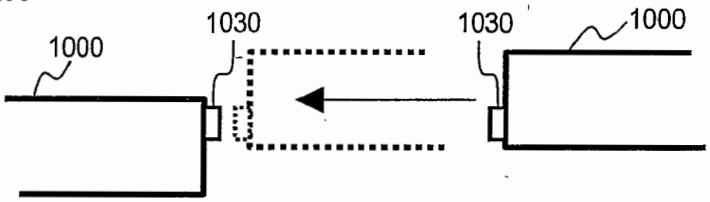


Fig. 13E

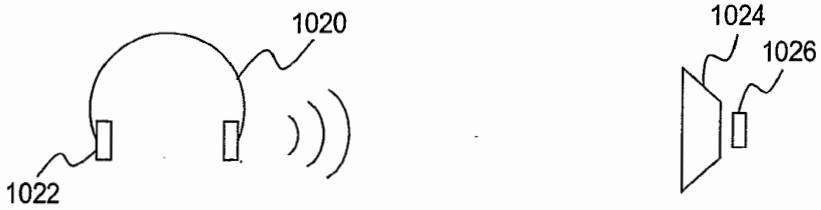


Fig. 13F



Fig. 14A

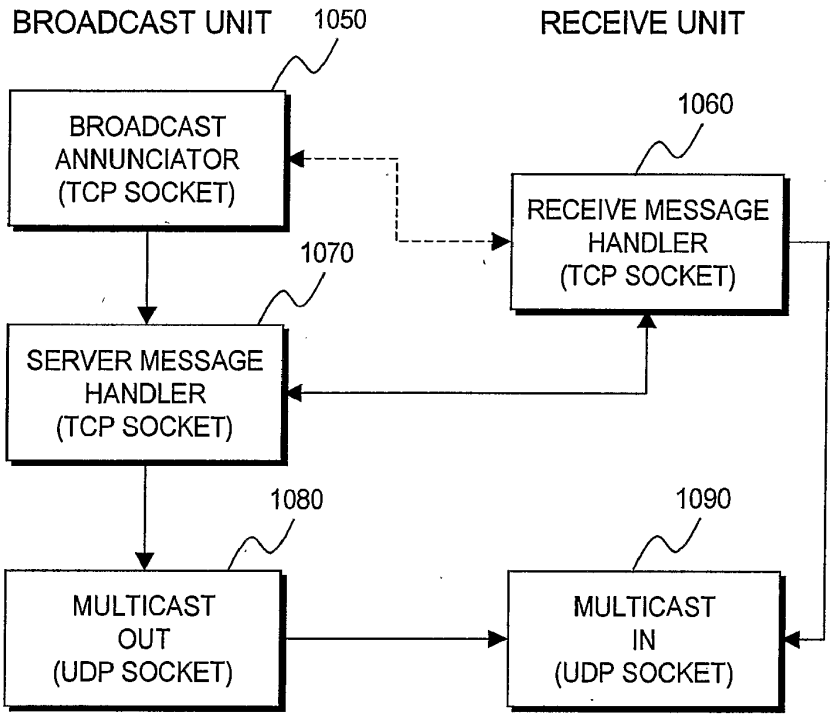

BROADCAST UNIT
1050
RECEIVE UNIT
BROADCAST ANNUNCIATOR (TCP SOCKET)
1060
RECEIVE MESSAGE HANDLER (TCP SOCKET)
1070
SERVER MESSAGE HANDLER (TCP SOCKET)
1080
1090
MULTICAST OUT (UDP SOCKET)
MULTICAST IN (UDP SOCKET)

Fig. 14B

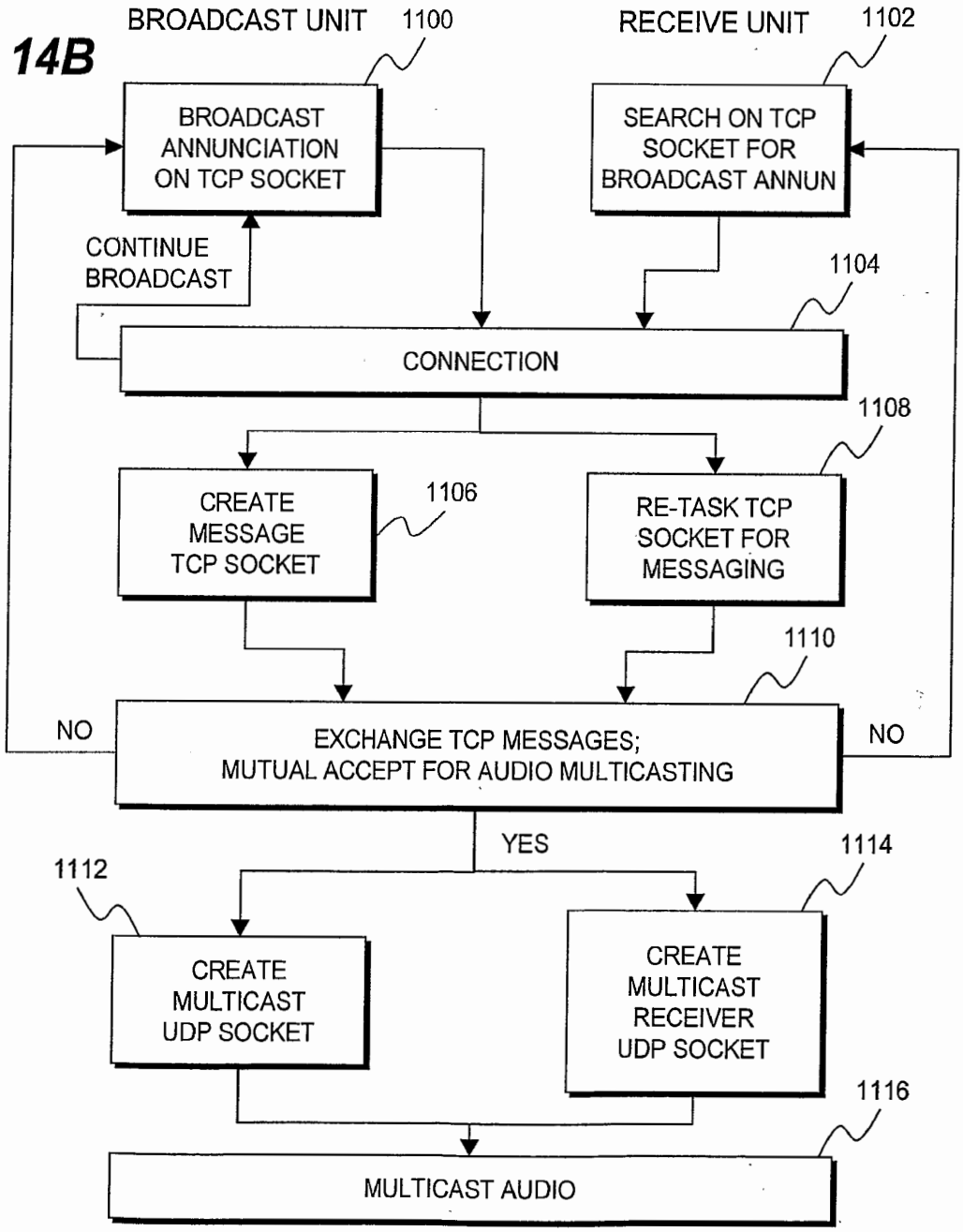

BROADCAST UNIT
1100
RECEIVE UNIT
1102
BROADCAST ANNUNCIATION ON TCP SOCKET
SEARCH ON TCP SOCKET FOR BROADCAST ANNUN
CONTINUE BROADCAST
1104
CONNECTION
1108
CREATE MESSAGE TCP SOCKET
1106
RE-TASK TCP SOCKET FOR MESSAGING
1110
NO
EXCHANGE TCP MESSAGES; MUTUAL ACCEPT FOR AUDIO MULTICASTING
NO
YES
1112
1114
CREATE MULTICAST UDP SOCKET
CREATE MULTICAST RECEIVER UDP SOCKET
1116
MULTICAST AUDIO

Fig. 15

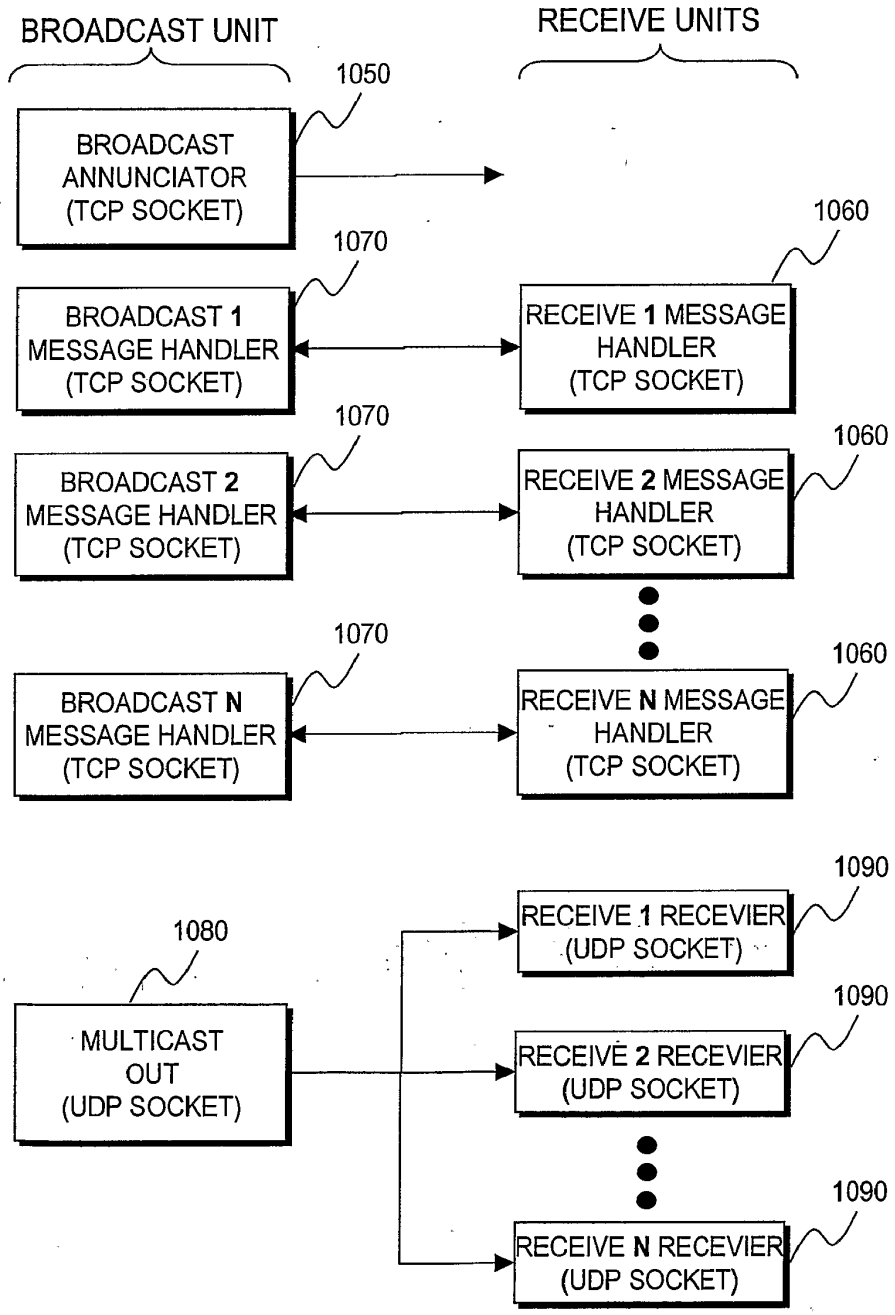

BROADCAST UNIT
RECEIVE UNITS
1050
BROADCAST ANNUNCIATOR (TCP SOCKET)
1060
1070
BROADCAST 1 MESSAGE HANDLER (TCP SOCKET)
RECEIVE 1 MESSAGE HANDLER (TCP SOCKET)
1070
1060
BROADCAST 2 MESSAGE HANDLER (TCP SOCKET)
RECEIVE 2 MESSAGE HANDLER (TCP SOCKET)
1070
1060
BROADCAST N MESSAGE HANDLER (TCP SOCKET)
RECEIVE N MESSAGE HANDLER (TCP SOCKET)
1090
1080
RECEIVE 1 RECEVIER (UDP SOCKET)
MULTICAST OUT (UDP SOCKET)
1090
RECEIVE 2 RECEVIER (UDP SOCKET)
1090
RECEIVE N RECEVIER (UDP SOCKET)

Fig. 16

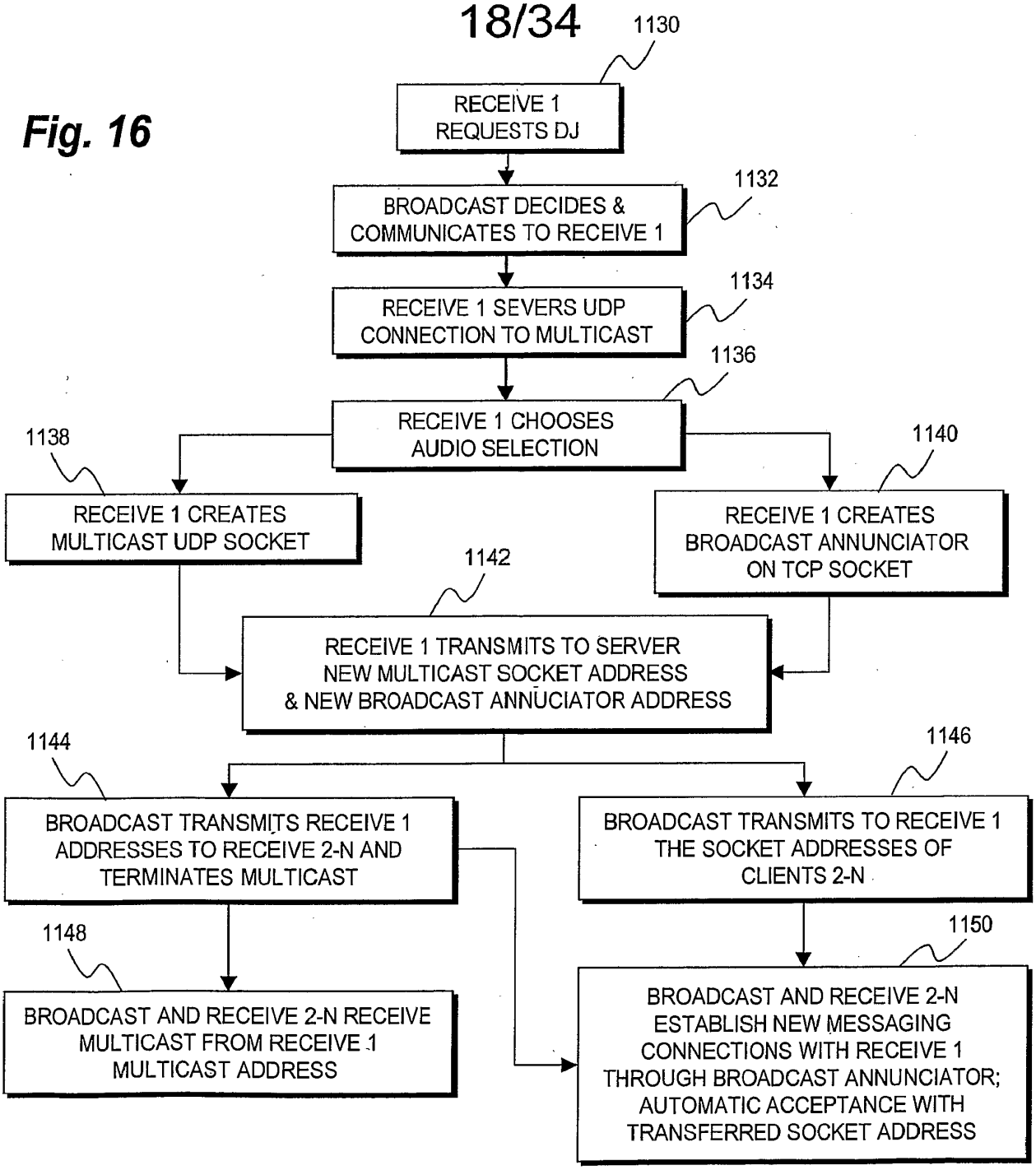

1130
RECEIVE 1 REQUESTS DJ
1132
BROADCAST DECIDES & COMMUNICATES TO RECEIVE 1
1134
RECEIVE 1 SEVERS UDP CONNECTION TO MULTICAST
1136
RECEIVE 1 CHOOSES AUDIO SELECTION
1138
RECEIVE 1 CREATES MULTICAST UDP SOCKET
1140
RECEIVE 1 CREATES BROADCAST ANNUNCIATOR ON TCP SOCKET
1142
RECEIVE 1 TRANSMITS TO SERVER NEW MULTICAST SOCKET ADDRESS & NEW BROADCAST ANNUCIATOR ADDRESS
1144
BROADCAST TRANSMITS RECEIVE 1 ADDRESSES TO RECEIVE 2-N AND TERMINATES MULTICAST
1146
BROADCAST TRANSMITS TO RECEIVE 1 THE SOCKET ADDRESSES OF CLIENTS 2-N
1148
BROADCAST AND RECEIVE 2-N RECEIVE MULTICAST FROM RECEIVE 1 MULTICAST ADDRESS
1150
BROADCAST AND RECEIVE 2-N ESTABLISH NEW MESSAGING CONNECTIONS WITH RECEIVE 1 THROUGH BROADCAST ANNUNCIATOR; AUTOMATIC ACCEPTANCE WITH TRANSFERRED SOCKET ADDRESS

Fig. 17

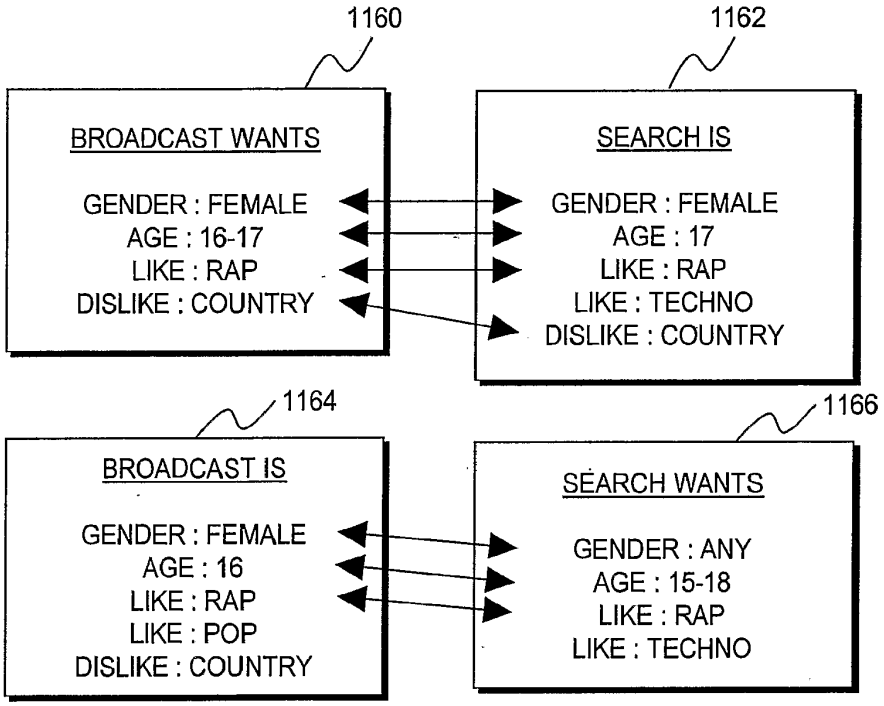


Fig. 18A

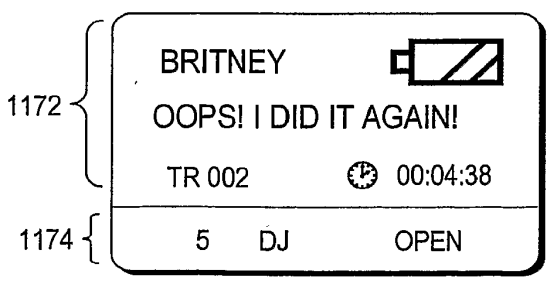


Fig. 18B

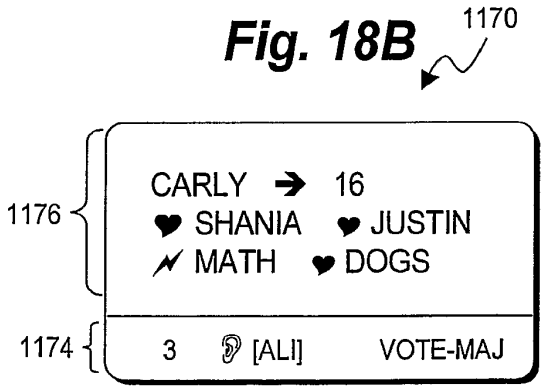


Fig. 19

RULE	METHOD
BROADCASTER	ACCEPTED WHEN BROADCASTER INDICATES "YES". REJECTED WHEN BROADCASTER INDICATES "NO"
MAJORITY	ACCEPTED WHEN (N/2)+1 INDICATE "YES". REJECTED WHEN (N/2) INDICATE "NO".
UNANIMOUS	ACCEPTED WHEN N MEMBERS INDICATE "YES". REJECTED WHEN 1 MEMBER INDICATES "NO".
TIMED MAJORITY	MACHINE INDICATES ONSET OF VOTING, AND COUNTS DOWN TO VOTING TERMINATION. ACCEPTED IF (Q/2)+1 INDICATE "YES" BEFORE TERMINATION; OTHERWISE "NO".
SYNCHRONIZED MAJORITY	MACHINE COUNTS DOWN TO VOTE. ACCEPTED IF (Q/2)+1 INDICATE "YES" WITHIN PREDETERMINED TIME OF COUNTDOWN. OTHERWISE "NO".

Fig. 20

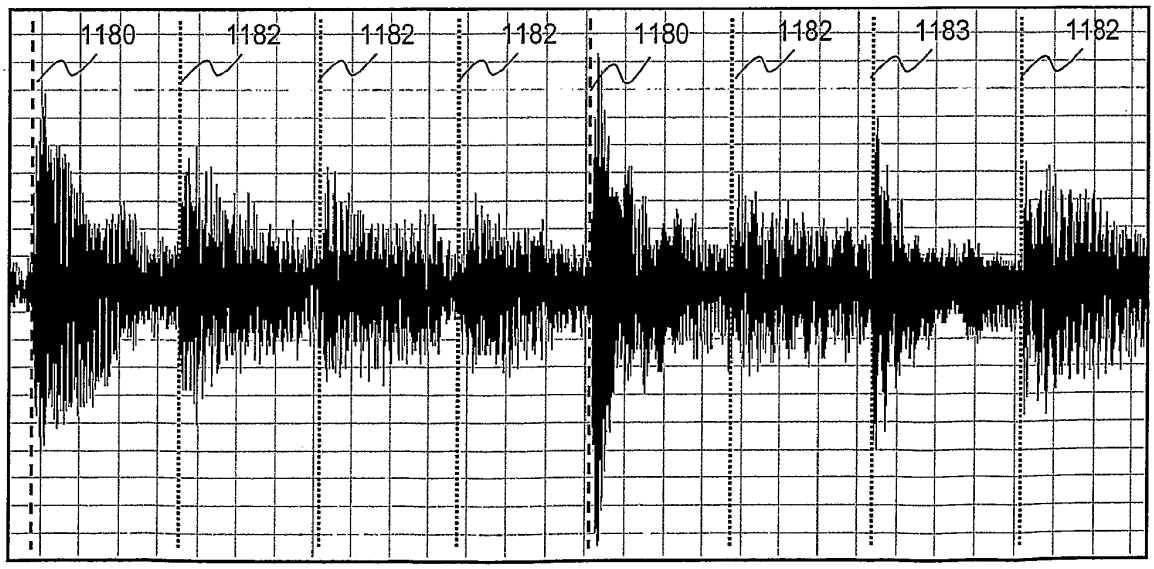


Fig. 21A

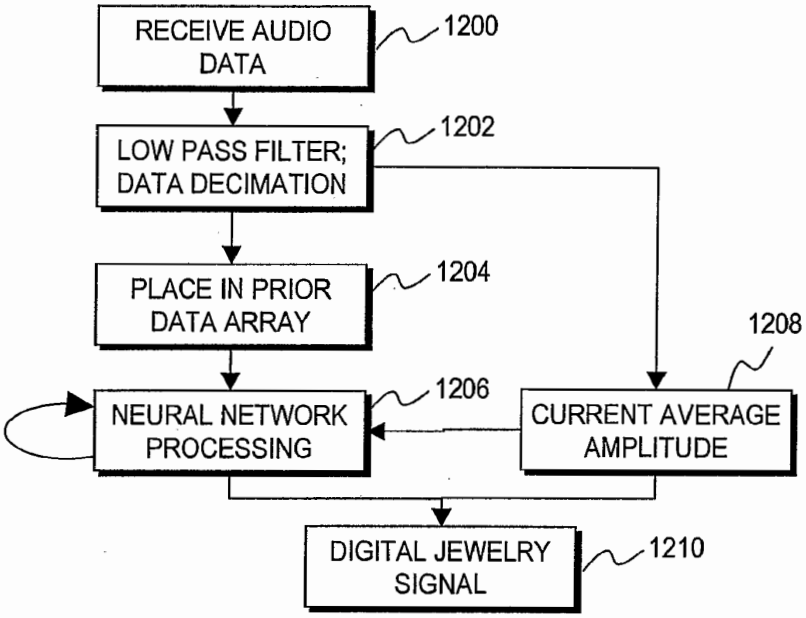
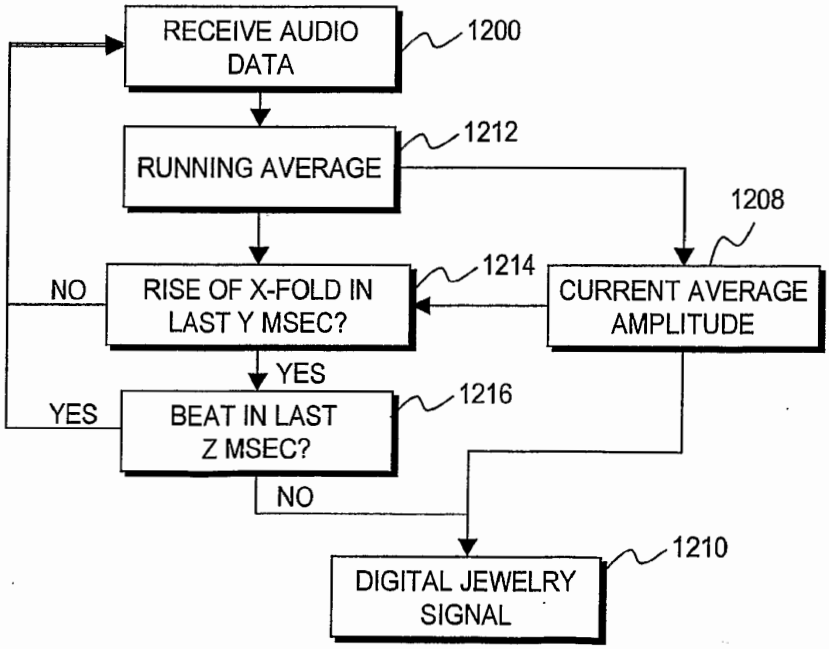


Fig. 21B



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Fig. 21C

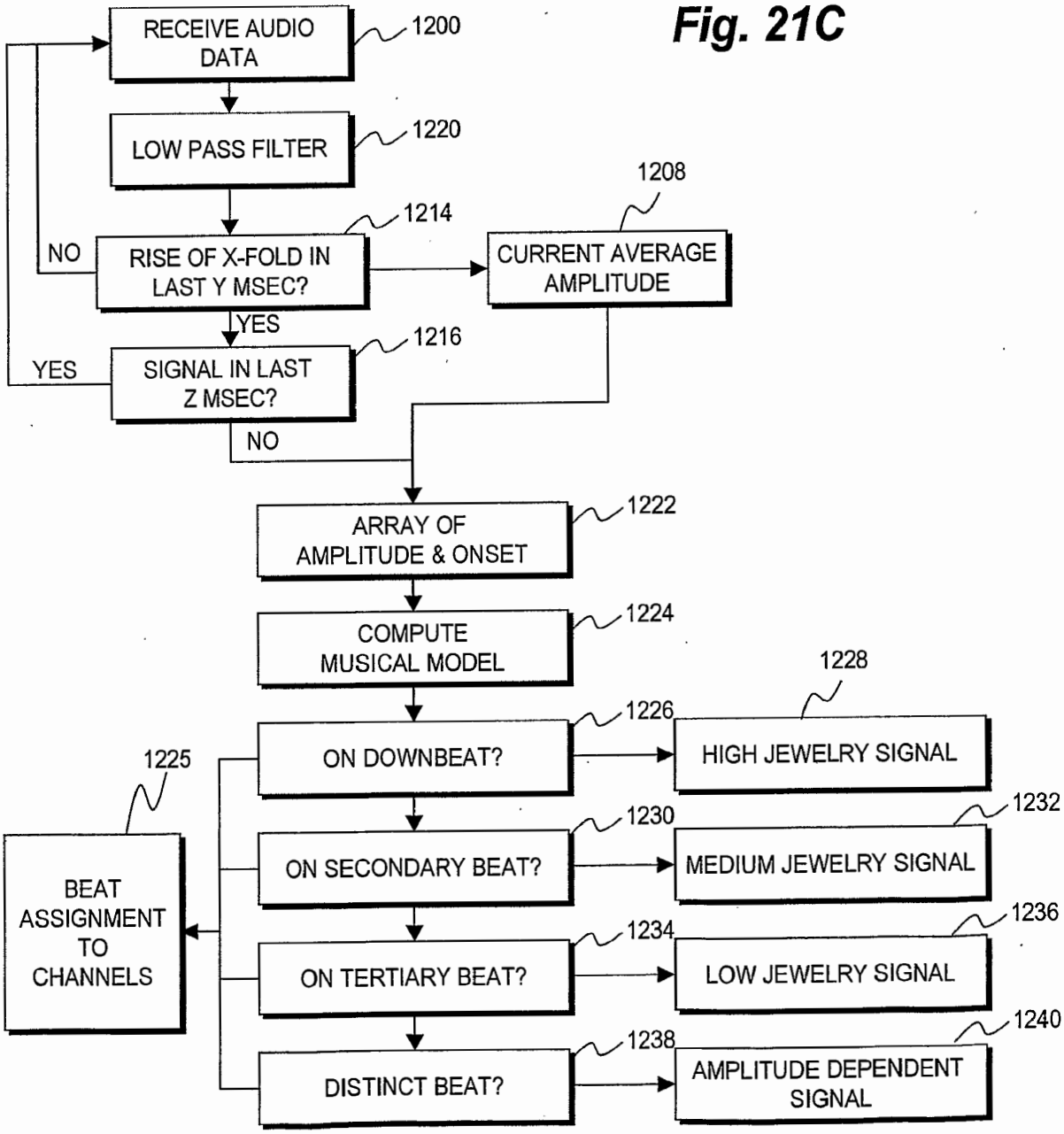
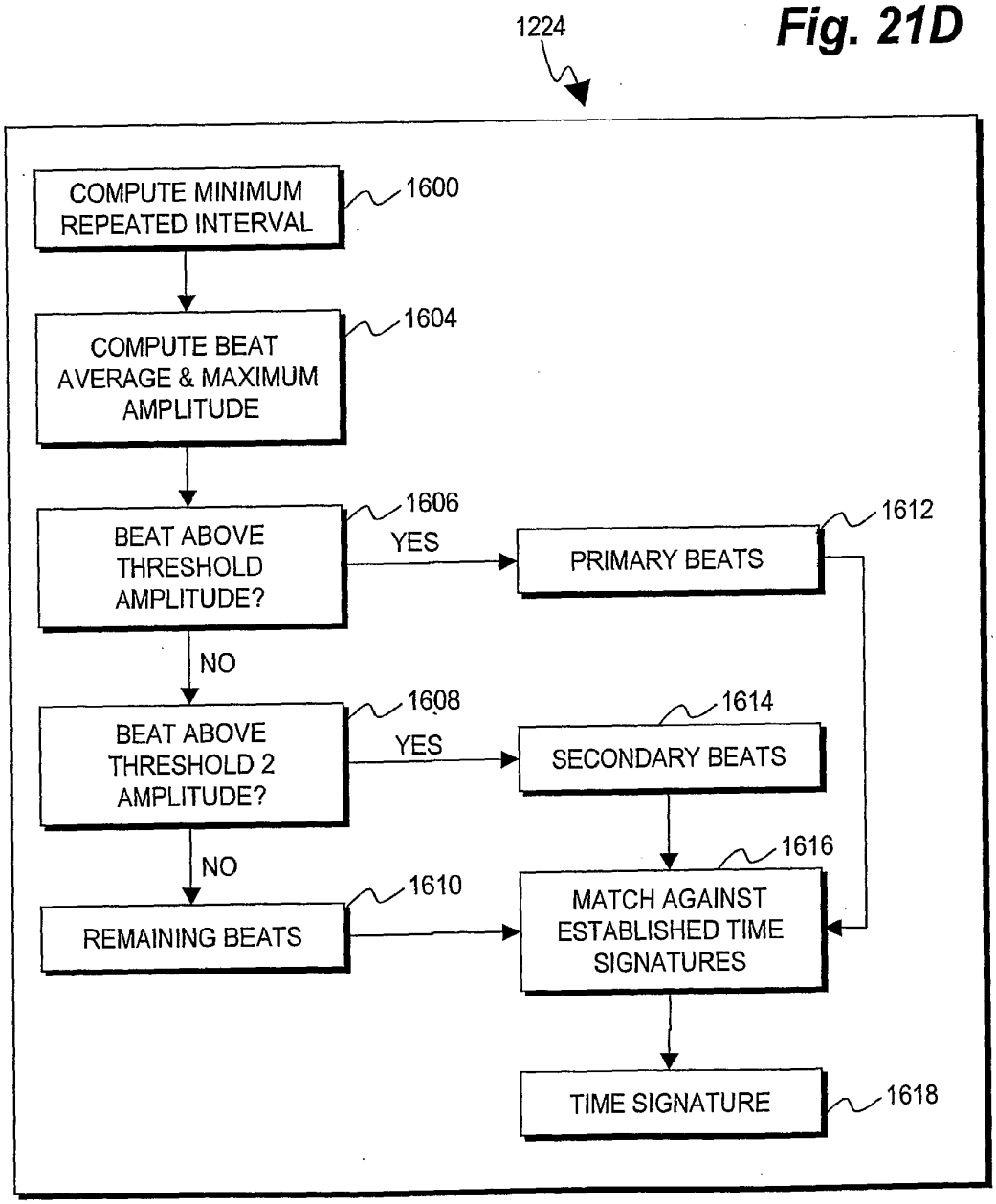

RECEIVE AUDIO DATA
1200
LOW PASS FILTER
1220
1208
1214
NO
RISE OF X-FOLD IN LAST Y MSEC?
CURRENT AVERAGE AMPLITUDE
YES
1216
YES
SIGNAL IN LAST Z MSEC?
NO
1222
ARRAY OF AMPLITUDE & ONSET
1224
COMPUTE MUSICAL MODEL
1228
1226
ON DOWNBEAT?
HIGH JEWELRY SIGNAL
1225
1230
1232
ON SECONDARY BEAT?
MEDIUM JEWELRY SIGNAL
BEAT ASSIGNMENT TO CHANNELS
1234
1236
ON TERTIARY BEAT?
LOW JEWELRY SIGNAL
1238
1240
DISTINCT BEAT?
AMPLITUDE DEPENDENT SIGNAL

Fig. 21D


1224
COMPUTE MINIMUM REPEATED INTERVAL
1600
COMPUTE BEAT AVERAGE & MAXIMUM AMPLITUDE
1604
BEAT ABOVE THRESHOLD AMPLITUDE?
1606
YES
PRIMARY BEATS
1612
NO
BEAT ABOVE THRESHOLD 2 AMPLITUDE?
1608
YES
SECONDARY BEATS
1614
NO
REMAINING BEATS
1610
MATCH AGAINST ESTABLISHED TIME SIGNATURES
1616
TIME SIGNATURE
1618

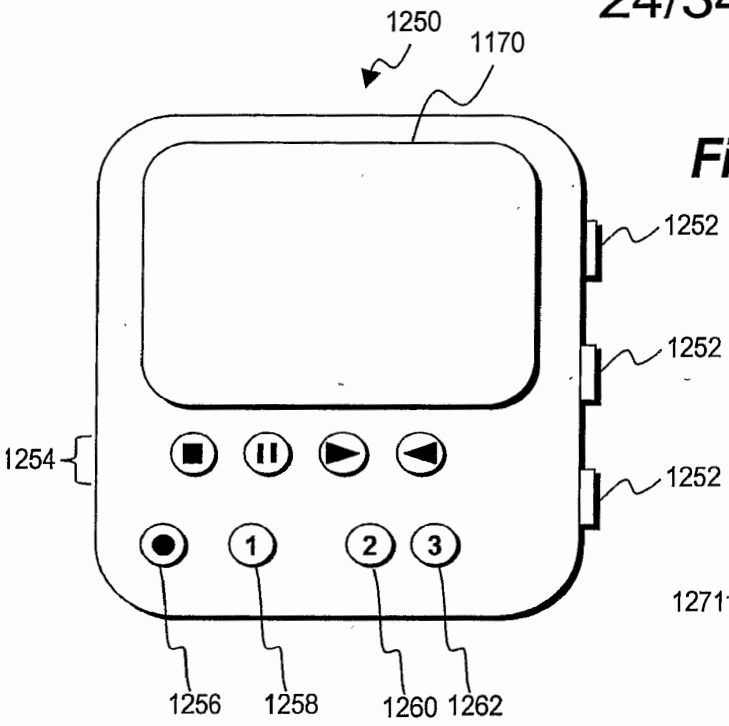


Fig. 22A

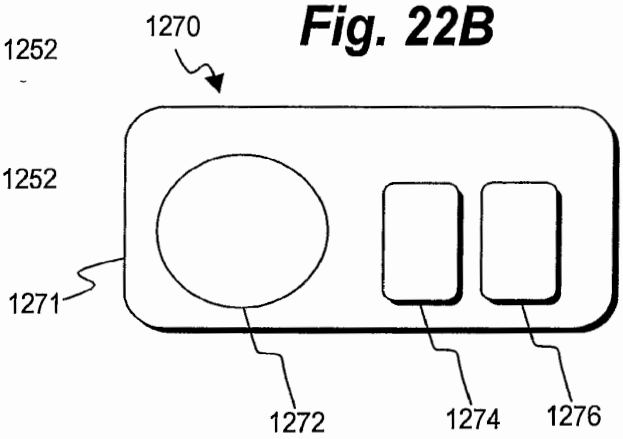


Fig. 22B

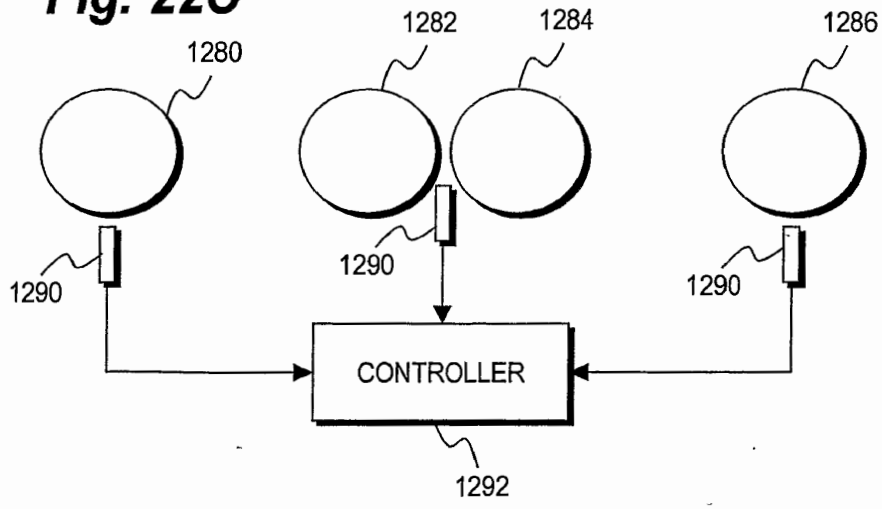


Fig. 22C

Fig. 23

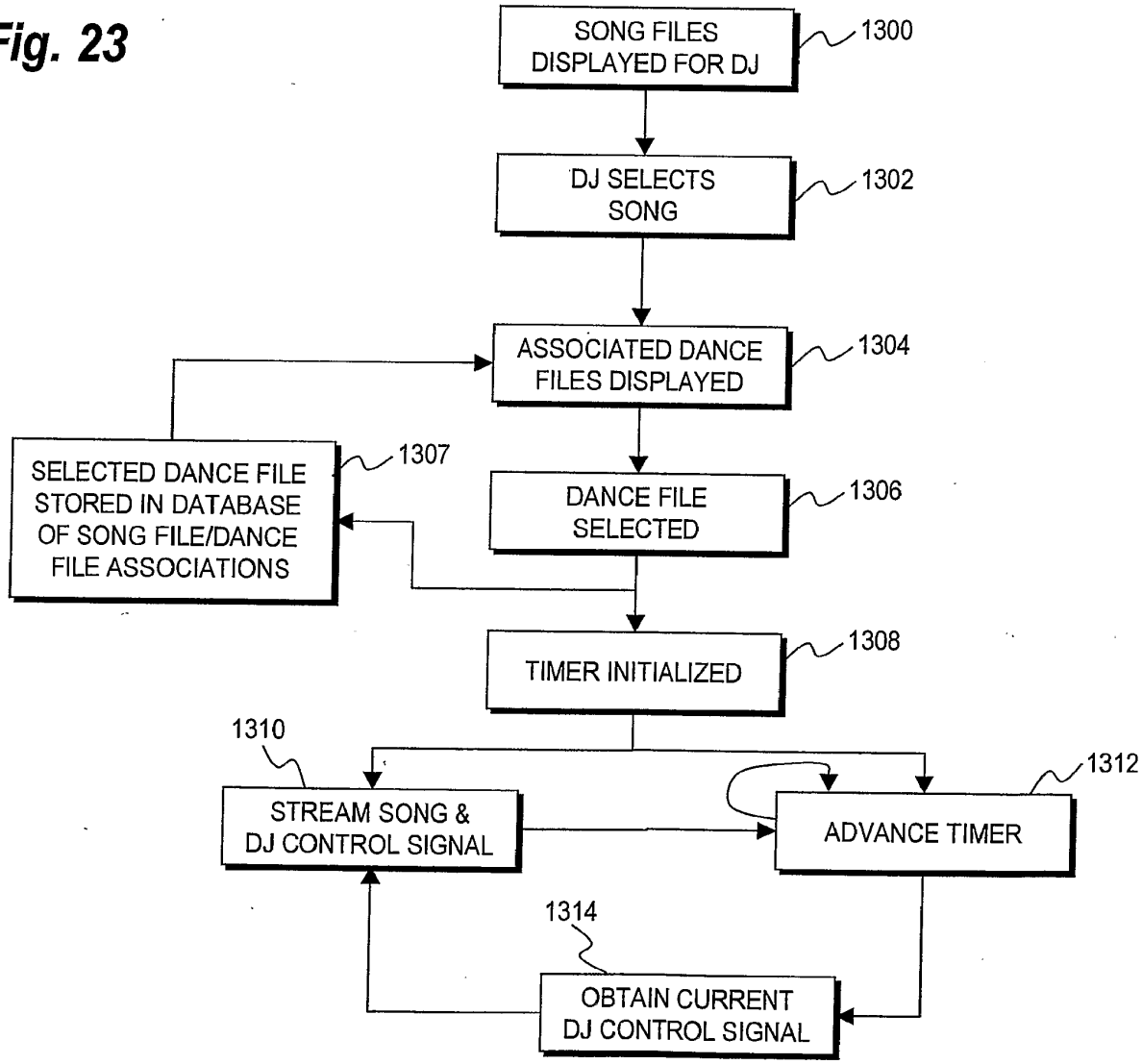

SONG FILES DISPLAYED FOR DJ
1300
DJ SELECTS SONG
1302
ASSOCIATED DANCE FILES DISPLAYED
1304
SELECTED DANCE FILE STORED IN DATABASE OF SONG FILE/DANCE FILE ASSOCIATIONS
1307
DANCE FILE SELECTED
1306
TIMER INITIALIZED
1308
1310
STREAM SONG & DJ CONTROL SIGNAL
1312
ADVANCE TIMER
1314
OBTAIN CURRENT DJ CONTROL SIGNAL

Fig. 24

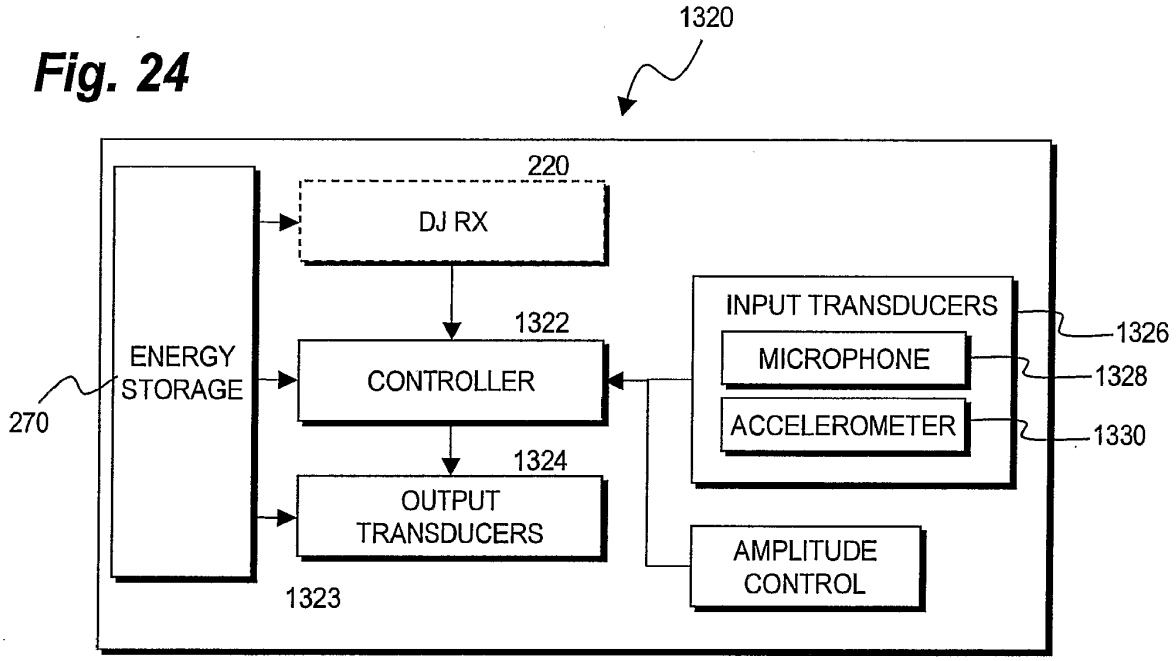

1320
220
DJ RX
1322
ENERGY STORAGE
CONTROLLER
1324
OUTPUT TRANSDUCERS
1323
270
INPUT TRANSDUCERS
MICROPHONE
ACCELEROMETER
1326
1328
1330
AMPLITUDE CONTROL

Fig. 25

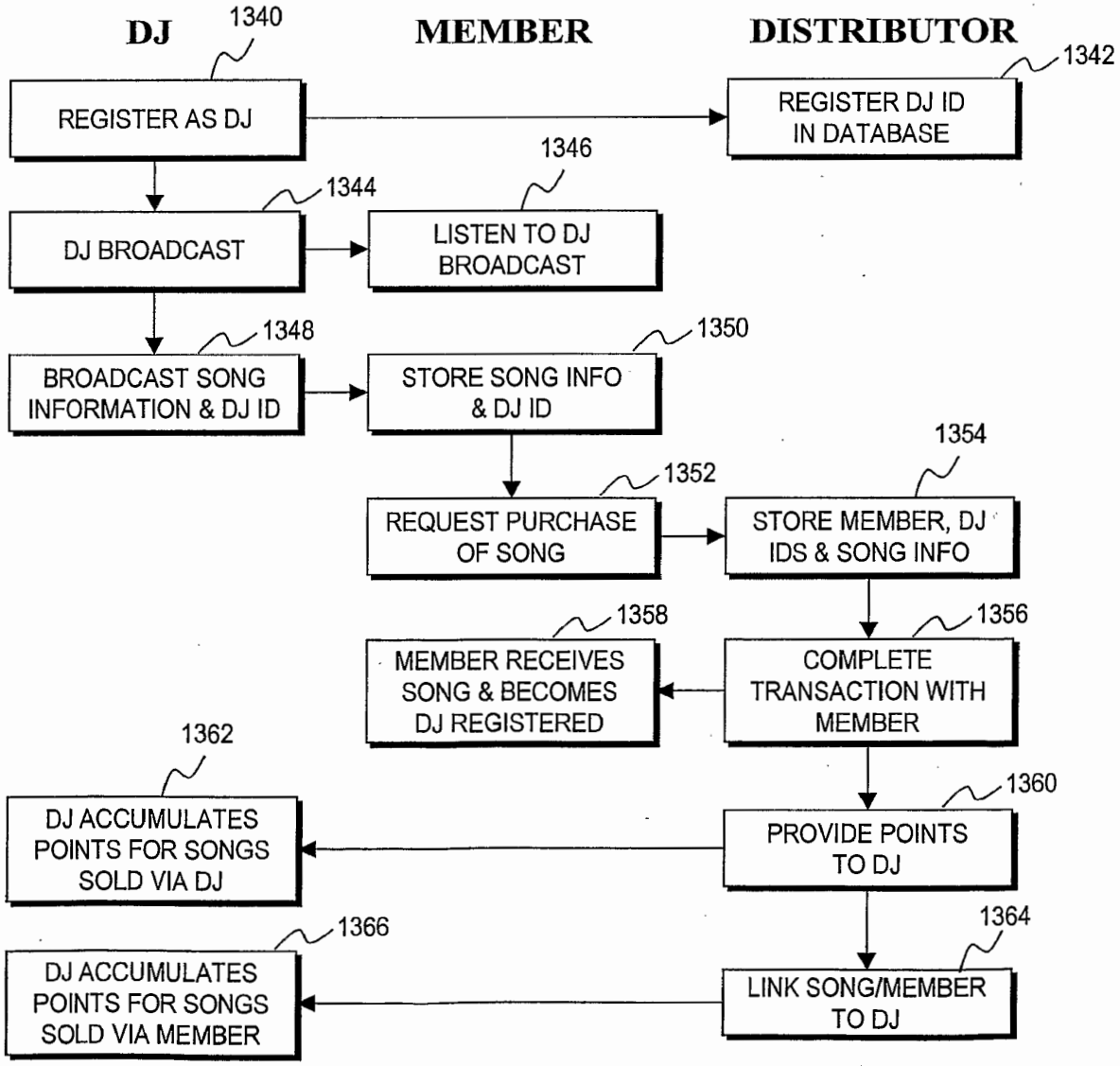

DJ
MEMBER
DISTRIBUTOR
1340
1342
REGISTER AS DJ
REGISTER DJ ID IN DATABASE
1346
1344
DJ BROADCAST
LISTEN TO DJ BROADCAST
1348
1350
BROADCAST SONG INFORMATION & DJ ID
STORE SONG INFO & DJ ID
1354
1352
REQUEST PURCHASE OF SONG
STORE MEMBER, DJ IDS & SONG INFO
1358
1356
MEMBER RECEIVES SONG & BECOMES DJ REGISTERED
COMPLETE TRANSACTION WITH MEMBER
1362
1360
DJ ACCUMULATES POINTS FOR SONGS SOLD VIA DJ
PROVIDE POINTS TO DJ
1366
1364
DJ ACCUMULATES POINTS FOR SONGS SOLD VIA MEMBER
LINK SONG/MEMBER TO DJ

Fig. 26

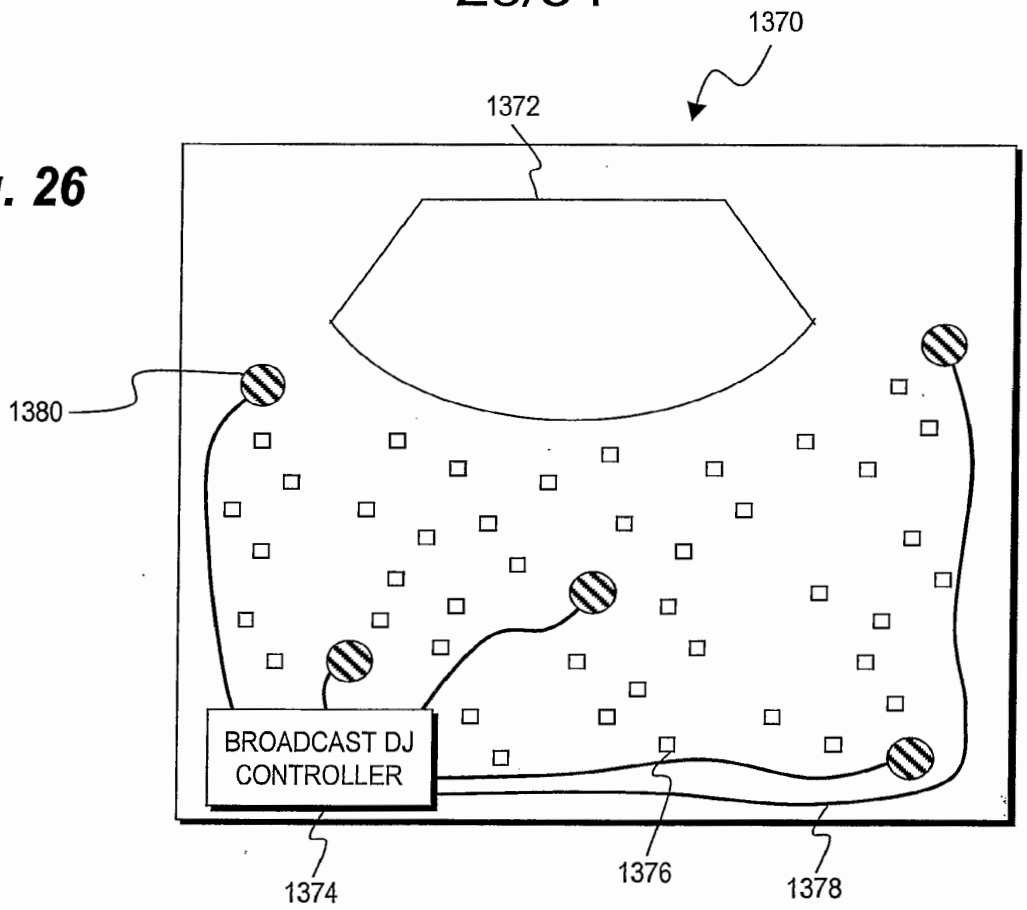

1370
1372
1380
BROADCAST DJ CONTROLLER
1374
1376
1378

Fig. 35

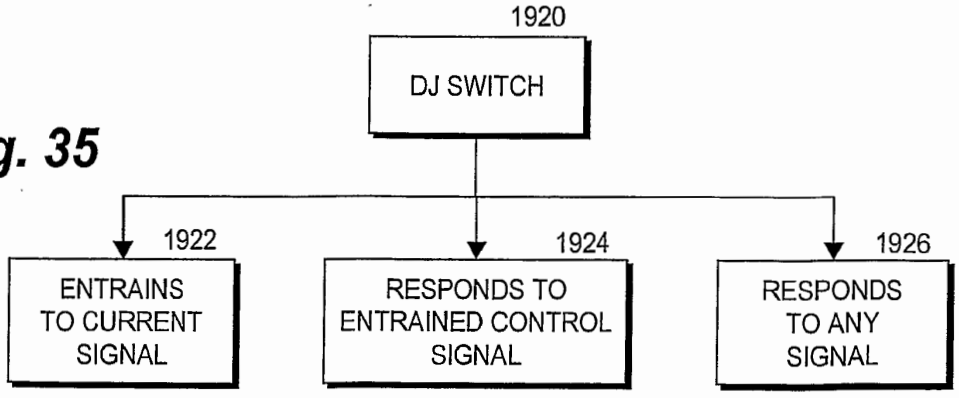

1920
DJ SWITCH
1922
ENTRAINS TO CURRENT SIGNAL
1924
RESPONDS TO ENTRAINED CONTROL SIGNAL
1926
RESPONDS TO ANY SIGNAL

Fig. 27

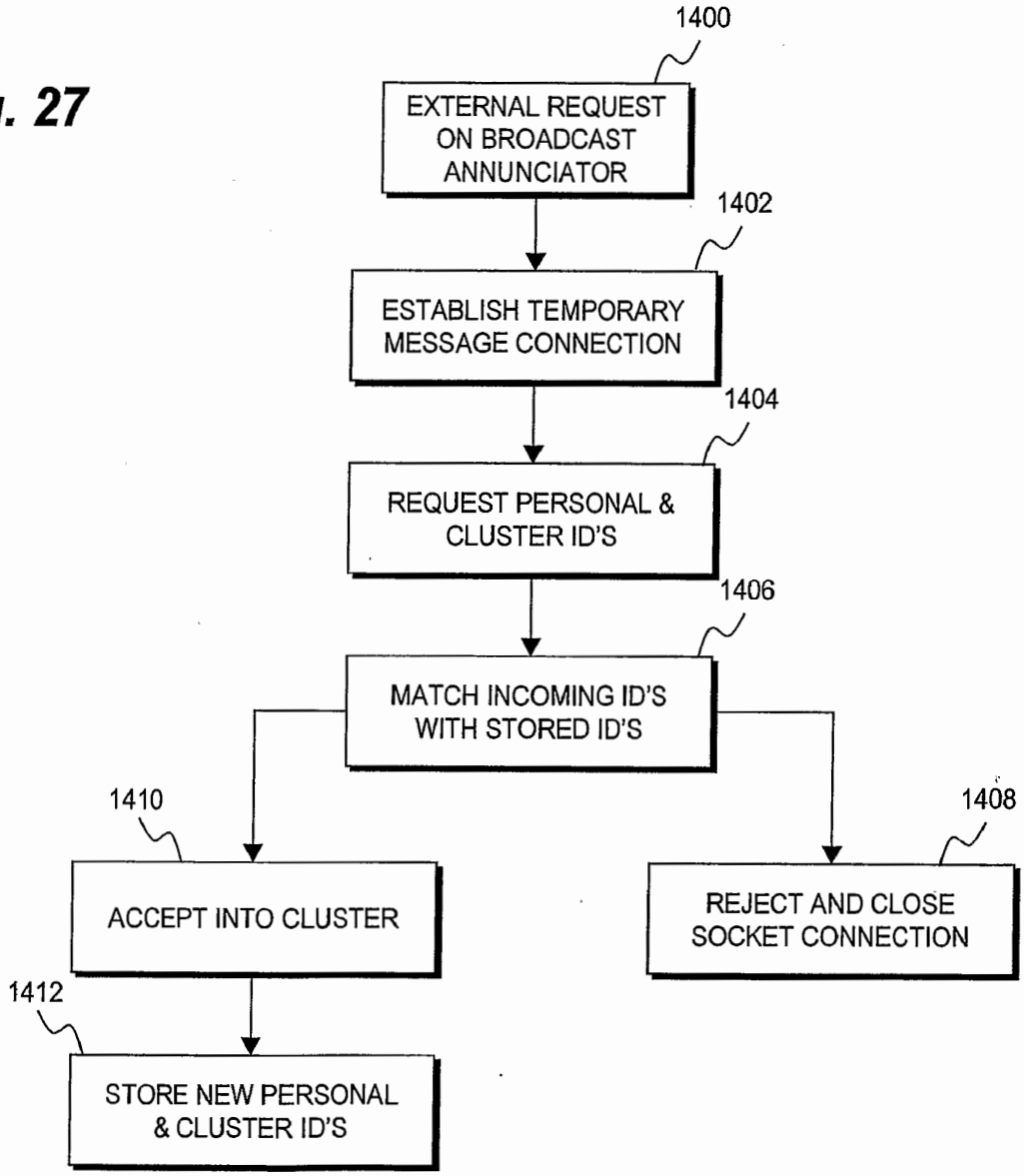

1400
EXTERNAL REQUEST ON BROADCAST ANNUNCIATOR
1402
ESTABLISH TEMPORARY MESSAGE CONNECTION
1404
REQUEST PERSONAL & CLUSTER ID'S
1406
MATCH INCOMING ID'S WITH STORED ID'S
1410
ACCEPT INTO CLUSTER
1408
REJECT AND CLOSE SOCKET CONNECTION
1412
STORE NEW PERSONAL & CLUSTER ID'S

Fig. 28

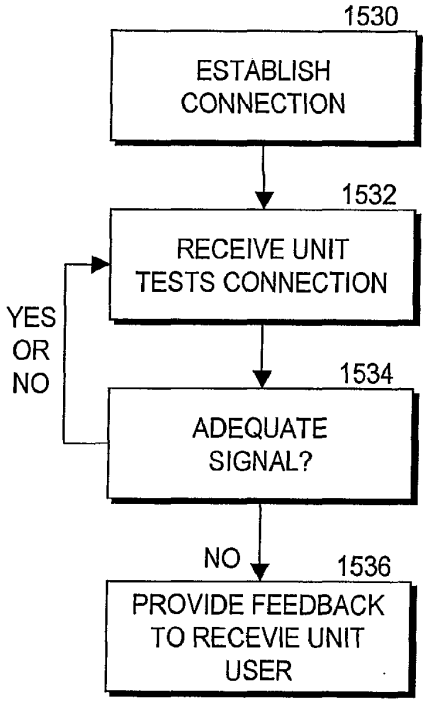

1530
ESTABLISH CONNECTION
1532
RECEIVE UNIT TESTS CONNECTION
YES OR NO
1534
ADEQUATE SIGNAL?
NO
1536
PROVIDE FEEDBACK TO RECEVIE UNIT USER

Fig. 29A

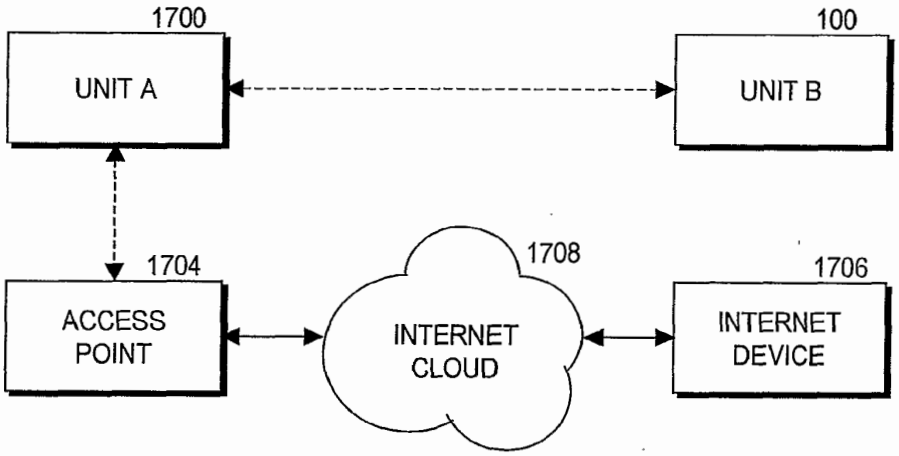


Fig. 29B

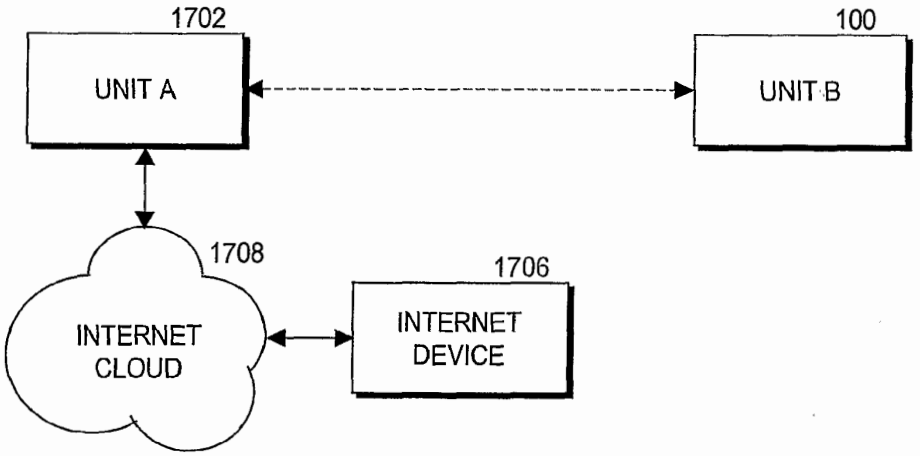


Fig. 30

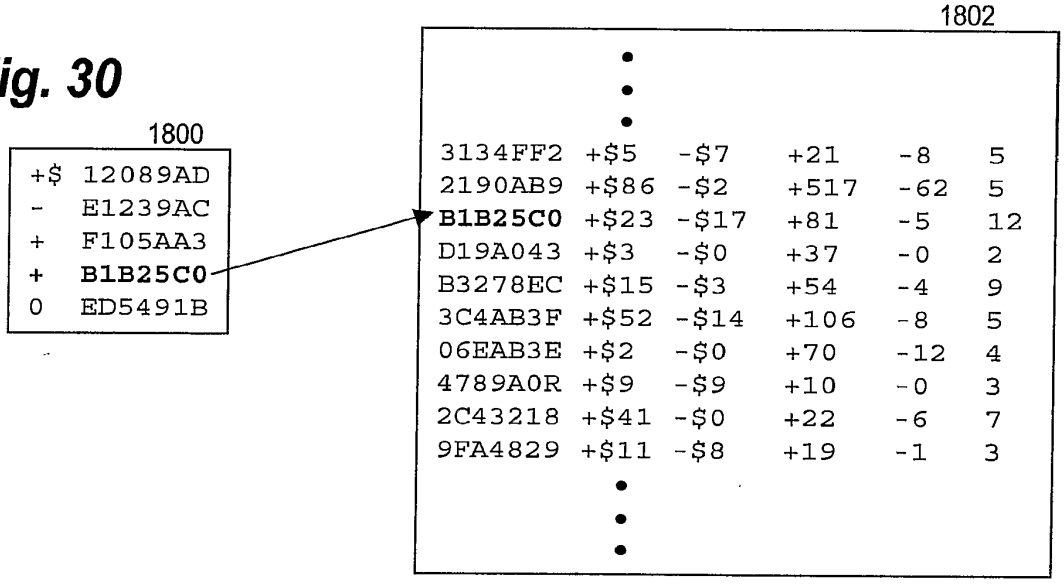

1800
+$ 12089AD
- E1239AC
+ F105AA3
+ B1B25C0
0 ED5491B
1802
3134FF2 +$5 -$7 +21 -8 5
2190AB9 +$86 -$2 +517 -62 5
B1B25C0 +$23 -$17 +81 -5 12
D19A043 +$3 -$0 +37 -0 2
B3278EC +$15 -$3 +54 -4 9
3C4AB3F +$52 -$14 +106 -8 5
06EAB3E +$2 -$0 +70 -12 4
4789A0R +$9 -$9 +10 -0 3
2C43218 +$41 -$0 +22 -6 7
9FA4829 +$11 -$8 +19 -1 3

Fig. 31

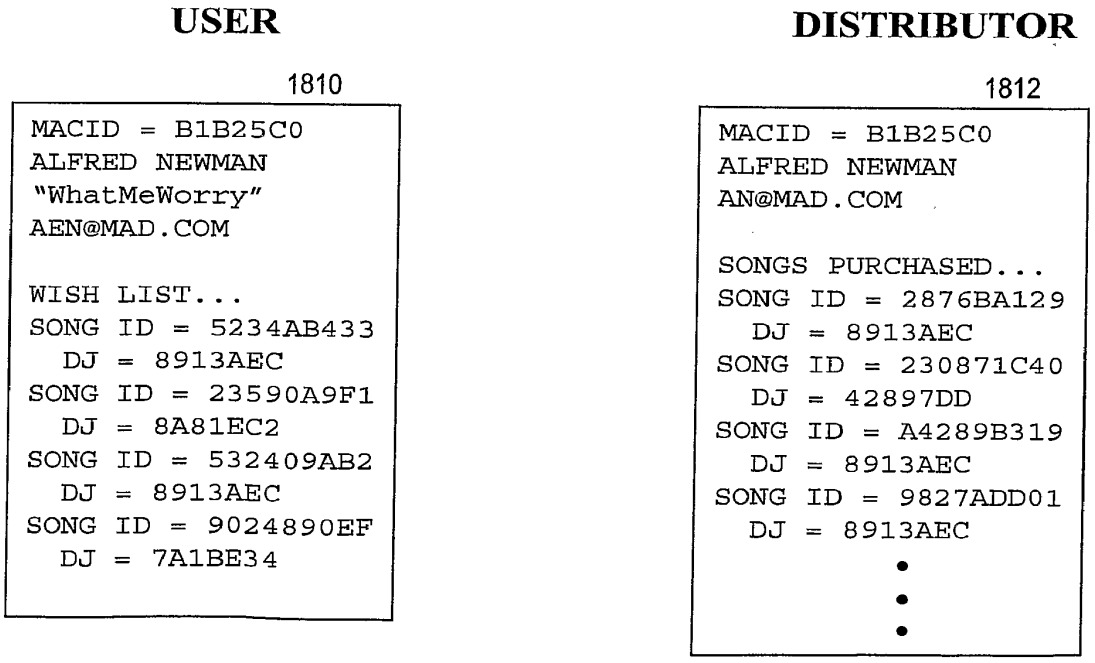

USER
DISTRIBUTOR
1810
MACID = B1B25C0
ALFRED NEWMAN
"WhatMeWorry"
AEN@MAD.COM
WISH LIST...
SONG ID = 5234AB433
DJ = 8913AEC
SONG ID = 23590A9F1
DJ = 8A81EC2
SONG ID = 532409AB2
DJ = 8913AEC
SONG ID = 9024890EF
DJ = 7A1BE34
1812
MACID = B1B25C0
ALFRED NEWMAN
AN@MAD.COM
SONGS PURCHASED...
SONG ID = 2876BA129
DJ = 8913AEC
SONG ID = 230871C40
DJ = 42897DD
SONG ID = A4289B319
DJ = 8913AEC
SONG ID = 9827ADD01
DJ = 8913AEC

Fig. 32A

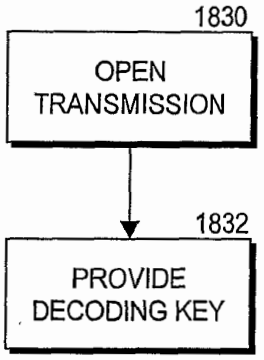


Fig. 32B

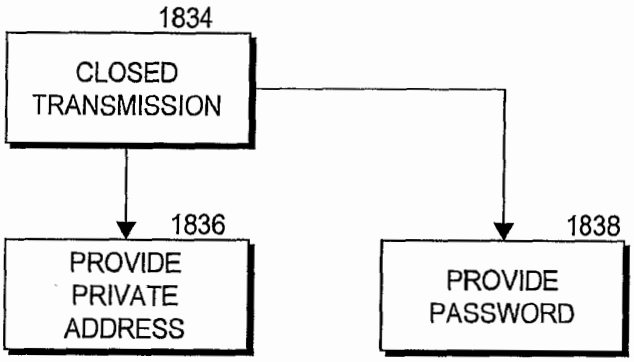
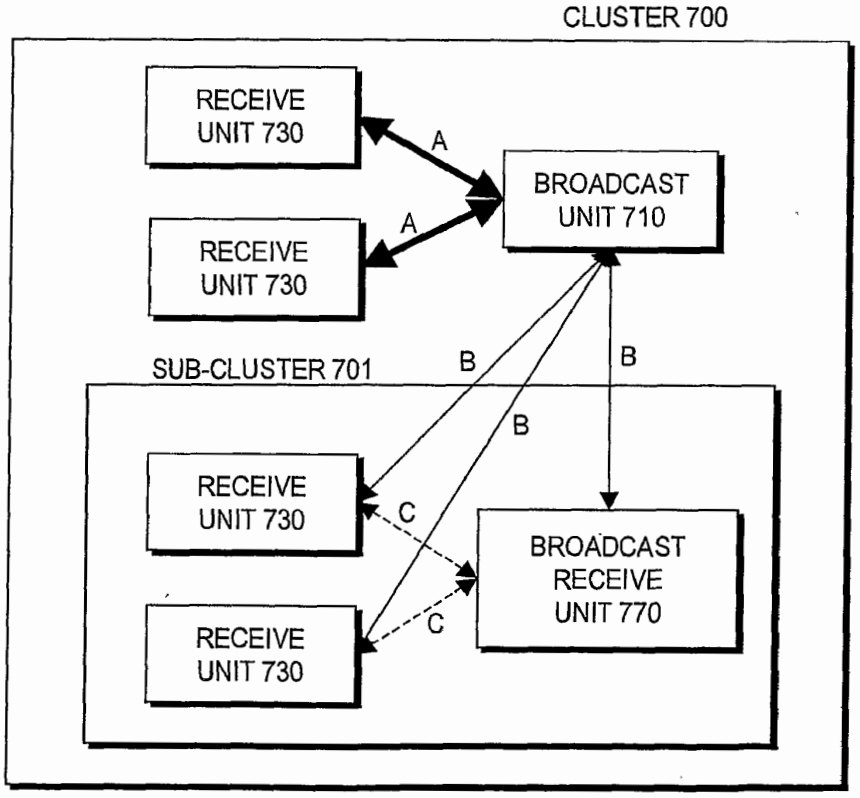


Fig. 33



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Fig. 34A

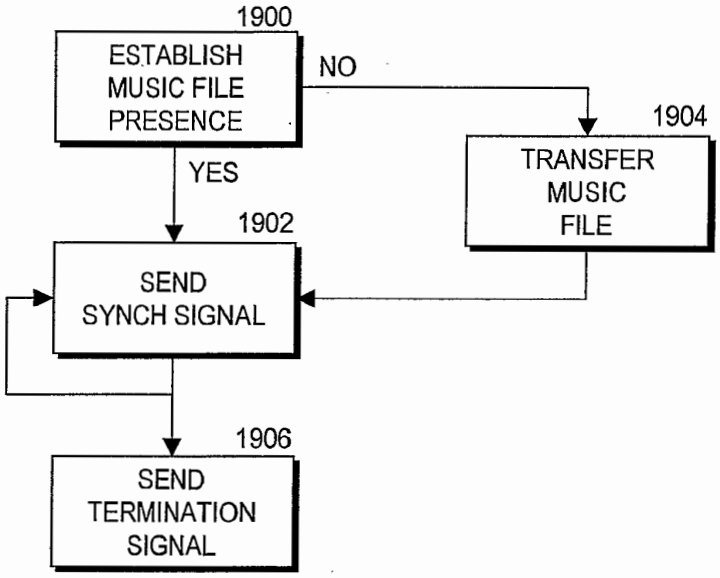
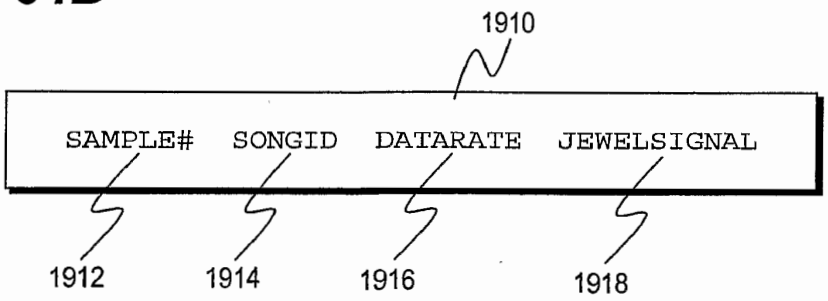


Fig. 34B



PTO/SB/08a (01-10)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	Nicholas A. J. Millington
	Art Unit	2442
	Examiner Name	Oleg Survillo
	Attorney Docket Number	SNS-71301.US.11 (13-0402)

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	2	5299266		1994-03-29	LUMSDEN; John L.	
	3	5751819		1998-05-12	DORROUGH; Michael L.	
	4	5808662		1998-09-15	KINNEY; Daniel Reid et al.	
	5	6108686		2000-08-22	WILLIAMS Jr.; ,Henry R.	
	6	6255961		2001-07-03	VAN; Ryzin John M. et al.	
	7	6349339		2002-02-19	WILLIAMS; Henry R.	
	8	7113999		2006-09-26	PESTONI; Florian et al.	

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	Art Unit	2442
	Examiner Name	Oleg Survillo
	Attorney Docket Number	SNS-71301.US.11 (13-0402)

	9	7218708		2007-05-15	BEREZOWSKI; Andrew G. et al.	
	10	7236739		2007-06-26	CHANG; Chin-Chi	
	11	7293060		2007-11-06	KOMSI; Asko	
	12	7483958		2009-01-27	ELABBADY; Tarek Z. et al.	
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	Art Unit	2442
	Examiner Name	Oleg Survillo
	Attorney Docket Number	SNS-71301.US.11 (13-0402)

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	1	2005013047	WO	A2	2005-02-10	SONOS INC [US], et al.		☐

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	Art Unit	2442
	Examiner Name	Oleg Survillo
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	Art Unit	2442
	Examiner Name	Oleg Survillo
	Attorney Docket Number	SNS-71301.US.11 (13-0402)

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EFS ID:	18327719
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
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Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	04-MAR-2014
Filing Date:	17-APR-2013
Time Stamp:	14:42:11
Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	WO2005013047A2.pdf	9269608 953769d47f04a9db684f7db18a01a31e0aa9bbb1	no	143

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2	Non Patent Literature	ISR-PCTUS2013-046372-82613.pdf	128842 f665a6c13841b22a8c7fd50160dbdfd6f69e00ee	no	3
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(71) Applicant *(for all designated States except US)*: **SONOS, INC.** [US/US]; 506 Chapala, Santa Barbara, CA 93101 (US).

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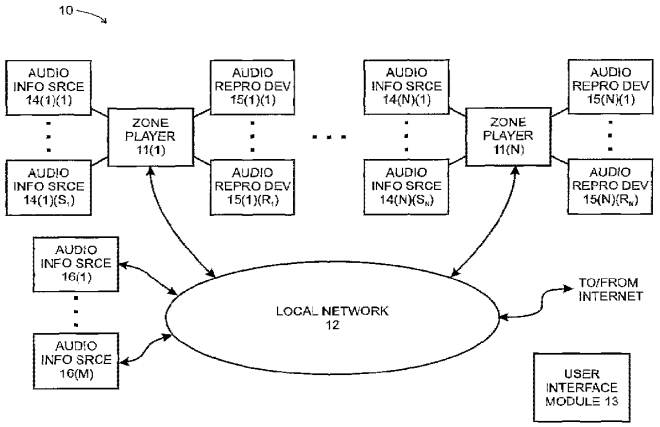
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(54) Title: SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES



(57) Abstract: A system is described for maintaining synchrony of operations among a plurality of devices hat have independent clocking arrangements. The system includes a task distribution device that distributes tasks to a synchrony group comprising a plurality of devices that are to perform the tasks distributed by the task distribution device in synchrony. The task distribution device distributes each task to the members of the synchrony group over a network. Each task is associated with a time stamp that indicates a time, relative to a clock maintained by the task distribution device, at which the members of the synchrony group are to execute the task. Each member of the synchrony group periodically obtains from the task distribution device an indication of the current time indicated by its clock, determines a time differential between the task distribution device's clock and its respective clock and determines therefrom a time at which, according to its respective clock, the time stamp indicates that it is to execute the task.

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SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES

FIELD OF THE INVENTION

The present invention relates generally to the field of digital data processing devices, and more particularly to systems and methods for synchronizing operations among a plurality of independently-clocked digital data processing devices. The invention is embodied in a system for synchronizing operations among a plurality of devices, in relation to information that is provided by a common source. One embodiment of the invention enables synchronizing of audio playback as among two or more audio playback devices that receive audio information from a common information source, or channel.

More generally, the invention relates to the field of arrangements that synchronize output generated by a number of output generators, including audio output, video output, combinations of audio and video, as well as other types of output as will be appreciated by those skilled in the art, provided by a common channel. Generally, the invention will find utility in connection with any type of information for which synchrony among independently-clocked devices is desired.

BACKGROUND OF THE INVENTION

There are a number of circumstances under which it is desirable to maintain synchrony of operations among a plurality of independently-clocked digital data processing devices in relation to, for example, information that is provided thereto by a common source. For example, systems are being developed in which one audio information source can distribute audio information in digital form to a number of audio playback devices for playback. The audio playback devices receive the digital information and convert it to analog form for playback. The audio playback devices may be located in the same room or they may be distributed in different rooms in a residence such as a house or an apartment, in different offices in an office building, or the like. For example, in a system installed in a residence, one audio playback device may be located in a living room, while another audio playback device is be located in a kitchen, and yet other audio playback devices may be located in various bedrooms of a house. In such an arrangement, the audio information that is distributed to various audio playback devices may relate to the same audio program, or the information may relate to different audio programs. If the audio information source provides audio information relating to the same audio program to two or more audio playback devices at the same time, the audio playback devices will generally contemporaneously play the same program. For

example, if the audio information source provides audio information to audio playback devices located in the living room and kitchen in a house at the same time, they will generally contemporaneously play the same program.

One problem that can arise is to ensure that, if two or more audio playback devices are contemporaneously attempting to play back the same audio program, they do so simultaneously. Small differences in the audio playback devices' start times and/or playback speeds can be perceived by a listener as an echo effect, and larger differences can be very annoying. Differences can arise because for a number of reasons, including delays in the transfer of audio information over the network. Such delays can differ as among the various audio playback devices for a variety of reasons, including where they are connected into the network, message traffic and other reasons as will be apparent to those skilled in the art.

Another problem arises from the following. When an audio playback device converts the digital audio information from digital to analog form, it does so using a clock that provides timing information. Generally, the audio playback devices that are being developed have independent clocks, and, if they are not clocking at precisely the same rate, the audio playback provided by the various devices can get out of synchronization.

SUMMARY OF THE INVENTION

The invention provides a new and improved system and method for synchronizing operations among a number of digital data processing devices that are regulated by independent clocking devices. Generally, the invention will find utility in connection with any type of information for which synchrony among devices connected to a network is desired. The invention is described in connection with a plurality of audio playback devices that receive digital audio information that is to be played back in synchrony, but it will be appreciated that the invention can find usefulness in connection with any kind of information for which coordination among devices that have independent clocking devices would find utility.

In brief summary, the invention provides, in one aspect, a system for maintaining synchrony of operations among a plurality of devices that have independent clocking arrangements. The system includes a task distribution device that distributes tasks to a synchrony group comprising a plurality of devices that are to perform the tasks distributed by the task distribution device in synchrony. The task distribution device distributes each task to the members of the synchrony group over a network. Each task is associated with a time stamp that indicates a time, relative to a clock maintained by the task distribution device, at which the members of the synchrony group are to execute the task. Each

member of the synchrony group periodically obtains from the task distribution device an indication of the current time indicated by its clock, determines a time differential between the task distribution device's clock and its respective clock and determines therefrom a time at which, according to its respective clock, the time stamp indicates that it is to execute the task.

In one embodiment, the tasks that are distributed include audio information for an audio track that is to be played by all of the devices comprising the synchrony group synchronously. The audio track is divided into a series of frames, each of which is associated with a time stamp indicating the time, relative to the clock maintained by an audio information channel device, which, in that embodiment, serves as the task distribution device, at which the members of the synchrony group are to play the respective frame. Each member of the synchrony group, using a very accurate protocol, periodically obtains the time indicated by the audio information channel device, and determines a differential between the time as indicated by its local clock and the audio information channel device's clock. The member uses the differential and the time as indicated by the time stamp to determine the time, relative to its local clock, at which it is to play the respective frame. The members of the synchrony group do this for all of the frames, and accordingly are able to play the frames in synchrony.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention is pointed out with particularity in the appended claims. The above and further advantages of this invention may be better understood by referring to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 schematically depicts an illustrative networked audio system, constructed in accordance with the invention;

FIG. 2 schematically depicts a functional block diagram of a synchrony group utilizing a plurality of zone players formed within the networked audio system depicted in FIG. 1;

FIG. 2A schematically depicts two synchrony groups, illustrating how a member of one synchrony group can provide audio information to the members of another synchrony group;

FIG. 3 depicts an functional block diagram of a zone player for use in the networked audio system depicted in FIG. 1; and

FIG. 4 is useful in understanding an digital audio information framing methodology useful in the network audio system depicted in FIG. 1.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

FIG. 1 depicts an illustrative network audio system 10 constructed in accordance with the invention. With reference to FIG. 1, the network audio system 10 includes a plurality of zone players 11(1) through 11(N) (generally identified by reference numeral 11(n)) interconnected by a local network 12, all of which operate under control of one or more user interface modules generally identified by reference numeral 13. One or more of the zone players 11(n) may also be connected to one or more audio information sources, which will generally be identified herein by reference numeral 14(n)(s), and/or one or more audio reproduction devices, which will generally be identified by reference numeral 15(n)(r). In the reference numeral 14(n)(s), index "n" refers to the index "n" of the zone player 11(n) to which the audio information source is connected, and the index "s" ($s=1,...,S_n$) refers to the "s-th" audio information source connected to that "n-th" zone player 11(n). Thus, if, for example, a zone player 11(n) is connected to four audio information sources 14(n)(1) through 14(n)(4), the audio information sources may be generally identified by reference numeral 14(n)(s), with $S_n=4$. It will be appreciated that the number of audio information sources S_n may vary as among the various zone players 11(n), and some zone players may not have any audio information sources connected thereto. Similarly, in the reference numeral 15(n)(r), index "n" refers to the index "n" of the zone player 11(n) to which the audio reproduction device is connected, and the index "r" ($r=1,...,R_n$) refers to the "r-th" audio information source connected to that "n-th" zone player 11(n). In addition to the audio information sources 14(n)(s), the network audio system 10 may include one or more audio information sources 16(1) through 16(M) connected through appropriate network interface devices (not separately shown) to the local network 12. Furthermore, the local network may include one or more network interface devices (also not separately shown) that are configured to connect the local network 12 to other networks, including a wide area network such as the Internet, the public switched telephony network (PSTN) or other networks as will be apparent to those skilled in the art, over which connections to audio information sources may be established.

The zone players 11(n) associated with system 10 may be distributed throughout an establishment such as residence, an office complex, a hotel, a conference hall, an amphitheater or auditorium, or other types of establishments as will be apparent to those skilled in the art or the like. For example, if the zone players 11(n) and their associated audio information source(s) and/or audio reproduction device(s) are distributed throughout a residence, one, such as zone player 11(1) and its associated audio information source(s) and audio reproduction device(s) may be located in a living room, another may be located in a kitchen, another may be located in a dining room, and yet others

may be located in respective bedrooms, to selectively provide entertainment in those rooms. On the other hand, if the zone players 11(n) and their associated audio information source(s) and/or audio reproduction device(s) are distributed throughout an office complex, one may, for example, be provided in each office to selectively provide entertainment to the employees in the respective offices. Similarly, if the zone players 11(n) and associated audio information source(s) and/or audio reproduction device(s) are used in a hotel, they may be distributed throughout the rooms to provide entertainment to the guests. Similar arrangements may be used with zone players 11(n) and associated audio information source(s) and/or audio reproduction device(s) used in an amphitheater or auditorium. Other arrangements in other types of environments will be apparent to those skilled in the art. In each case, the zone players 11(n) can be used to selectively provide entertainment in the respective locations, as will be described below.

The audio information sources 14(n)(s) and 16(m) may be any of a number of types of conventional sources of audio information, including, for example, compact disc ("CD") players, AM and/or FM radio receivers, analog or digital tape cassette players, analog record turntables and the like. In addition, the audio information sources 14(n)(s) and 16(m) may comprise digital audio files stored locally on, for example, personal computers (PCs), personal digital assistants (PDAs), or similar devices capable of storing digital information in volatile or non-volatile form. As noted above, the local network 12 may also have an interface (not shown) to a wide area network, over which the network audio system 10 can obtain audio information. Moreover, one or more of the audio information sources 14(n)(s) may also comprise an interface to a wide area network such as the Internet, the public switched telephony network (PSTN) or any other source of audio information. In addition, one or more of the audio information sources 14(n)(s) and 16(m) may comprise interfaces to radio services delivered over, for example, satellite. Audio information obtained over the wide area network may comprise, for example, streaming digital audio information such as Internet radio, digital audio files stored on servers, and other types of audio information and sources as will be appreciated by those skilled in the art. Other arrangements and other types of audio information sources will be apparent to those skilled in the art.

Generally, the audio information sources 14(n)(s) and 16(m) provide audio information associated with audio programs to the zone players for playback. A zone player that receives audio information from an audio information source 14(n)(s) that is connected thereto can provide playback and/or forward the audio information, along with playback timing information, over the local network 12 to other zone players for playback. Similarly, each audio information source 16(m)

that is not directly connected to a zone player can transmit audio information over the network 12 to any zone player 11(n) for playback. In addition, as will be explained in detail below, the respective zone player 11(n) can transmit the audio information that it receives either from an audio information source 14(n)(s) connected thereto, or from an audio information source 16(m), to selected ones of the other zone players 11(n'), 11(n''),... (n not equal to n', n'',...) for playback by those other zone players. The other zone players 11(n'), 11(n''),... to which the zone player 11(n) transmits the audio information for playback may be selected by a user using the user interface module 13. In that operation, the zone player 11(n) will transmit the audio information to the selected zone players 11(n'), 11(n''),... over the network 12. As will be described below in greater detail, the zone players 11(n), 11(n'), 11(n''),... operate such that the zone players 11(n'), 11(n''),... synchronize their playback of the audio program with the playback by the zone player 11(n), so that the zone players 11(n), 11(n'), 11(n'') provide the same audio program at the same time.

Users, using user interface module 13, may also enable different groupings or sets of zone players to provide audio playback of different audio programs synchronously. For example, a user, using a user interface module 13, may enable zone players 11(1) and 11(2) to play one audio program, audio information for which may be provided by, for example, one audio information source 14(1)(1). The same or a different user may, using the same or a different user interface module 13, enable zone players 11(4) and 11(5) to contemporaneously play another audio program, audio information for which may be provided by a second audio information source, such as audio information source 14(5)(2). Further, a user may enable zone player 11(3) to contemporaneously play yet another audio program, audio information for which may be provided by yet another audio information source, such as audio information source 16(1). As yet another possibility, a user may contemporaneously enable zone player 11(1) to provide audio information from an audio information source connected thereto, such as audio information source 14(1)(2), to another zone player, such as zone player 11(6) for playback.

In the following, the term "synchrony group" will be used to refer to a set of one or more zone players that are to play the same audio program synchronously. Thus, in the above example, zone players 11(1) and 11(2) comprise one synchrony group, zone player 11(3) comprises a second synchrony group, zone players 11(4) and 11(5) comprise a third synchrony group, and zone player 11(6) comprises yet a fourth synchrony group. Thus, while zone players 11(1) and 11(2) are playing the same audio program, they will play the audio program synchronously. Similarly, while zone players 11(4) and 11(5) are playing the same audio program, they will play the audio program

synchronously. On the other hand, zone players that are playing different audio programs may do so with unrelated timings. That is, for example, the timing with which zone players 11(1) and 11(2) play their audio program may have no relationship to the timing with which zone player 11(3), zone players 11(4) and 11(5), and zone player 11(6) play their audio programs. It will be appreciated that, since "synchrony group" is used to refer to sets of zone players that are playing the same audio program synchronously, zone player 11(1) will not be part of zone player 11(6)'s synchrony group, even though zone player 11(1) is providing the audio information for the audio program to zone player 11(6).

In the network audio system 10, the synchrony groups are not fixed. Users can enable them to be established and modified dynamically. Continuing with the above example, a user may enable the zone player 11(1) to begin providing playback of the audio program provided thereto by audio information source 14(1)(1), and subsequently enable zone player 11(2) to join the synchrony group. Similarly, a user may enable the zone player 11(5) to begin providing playback of the audio program provided thereto by audio information source 14(5)(2), and subsequently enable zone player 11(4) to join that synchrony group. In addition, a user may enable a zone player to leave a synchrony group and possibly join another synchrony group. For example, a user may enable the zone player 11(2) to leave the synchrony group with zone player 11(1), and join the synchrony group with zone player 11(6). As another possibility, the user may enable the zone player 11(1) to leave the synchrony group with zone player 11(2) and join the synchrony group with zone player 11(6). In connection with the last possibility, the zone player 11(1) can continue providing audio information from the audio information source 14(1)(1) to the zone player 11(2) for playback thereby.

A user, using the user interface module 13, can enable a zone player 11(n) that is currently not a member of a synchrony group to join a synchrony group, after which it will be enabled to play the audio program that is currently being played by that synchrony group. Similarly, a user, also using the user interface module 13, can enable a zone player 11(n) that is currently a member of one synchrony group, to disengage from that synchrony group and join another synchrony group, after which that zone player will be playing the audio program associated with the other synchrony group. For example, if a zone player 11(6) is currently not a member of any synchrony group, it, under control of the user interface module 13, can become a member of a synchrony group, after which it will play the audio program being played by the other members of the synchrony group, in synchrony with the other members of the synchrony group. In becoming a member of the synchrony group, zone player 11(6) can notify the zone player that is the master device for the synchrony group

that it wishes to become a member of its synchrony group, after which that zone player will also transmit audio information associated with the audio program, as well as timing information, to the zone player 11(6). As the zone player 11(6) receives the audio information and the timing information from the master device, it will play the audio information with the timing indicated by the timing information, which will enable the zone player 11(6) to play the audio program in synchrony with the other zone player(s) in the synchrony group.

Similarly, if a user, using the user interface module 13, enables a zone player 11(n) associated with a synchrony group to disengage from that synchrony group, and if the zone player 11(n) is not the master device of the synchrony group, the zone player 11(n) can notify the master device, after which the master device can terminate transmission of the audio information and timing information to the zone player 11(n). If the user also enables the zone player 11(n) to begin playing another audio program using audio information from an audio information source 14(n)(s) connected thereto, it will acquire the audio information from the audio information source 14(n)(s) and initiate playback thereof. If the user enables another zone player 11(n') to join the synchrony group associated with zone player 11(n), operations in connection therewith can proceed as described immediately above.

As yet another possibility, if a user, using the user interface module 13, enables a zone player 11(n) associated with a synchrony group to disengage from that synchrony group and join another synchrony group, and if the zone player is not the master device of the synchrony group from which it is disengaging, the zone player 11(n) can notify the master device of the synchrony group from which it is disengaging, after which that zone player will terminate transmission of audio information and timing information to the zone player 11(n) that is disengaging. Contemporaneously, the zone player 11(n) can notify the master device of the synchrony group that it (that is, zone player 11(n)) is joining, after which the master device can begin transmission of audio information and timing information to that zone player 11(n). The zone player 11(n) can thereafter begin playback of the audio program defined by the audio information, in accordance with the timing information so that the zone player 11(n) will play the audio program in synchrony with the master device.

As yet another possibility, a user, using the user interface module 13, may enable a zone player 11(n) that is not associated with a synchrony group, to begin playing an audio program using audio information provided to it by an audio information source 14(n)(s) connected thereto. In that case, the user, also using the user interface module 13 or a user interface device that is specific to the audio information source 14(n)(s), can enable the audio information source 14(n)(s) to provide audio information to the zone player 11(n). After the zone player 11(n) has begun playback, or

contemporaneously therewith, the user, using the user interface module 13, can enable other zone players 11(n'), 11(n''),... to join zone player 11(n)'s synchrony group and enable that zone player 11(n) to transmit audio information and timing information thereto as described above, to facilitate synchronous playback of the audio program by the other zone players 11(n'), 11(n'')....

A user can use the user interface module 13 to control other aspects of the network audio system 10, including but not limited to the selection of the audio information source 14(n)(s) that a particular zone player 11(n) is to utilize, the volume of the audio playback, and so forth. In addition, a user may use the user interface module 13 to turn audio information source(s) 14(n)(s) on and off and to enable them to provide audio information to the respective zone players 11(n).

Operations performed by the various devices associated with a synchrony group will be described in connection with FIG. 2, which schematically depicts a functional block diagram of a synchrony group in the network audio system 10 described above in connection with FIG. 1. With reference to FIG. 2, a synchrony group 20 includes a master device 21 and zero or more slave devices 22(1) through 22 (G) (generally identified by reference numeral 22(g)), all of which synchronously play an audio program provided by an audio information channel device 23. Each of the master device 21, slave devices 22(g) and audio information channel device 23 utilizes a zone player 11(n) depicted in FIG. 1, although it will be clear from the description below that a zone player may be utilized both for the audio information channel device for the synchrony group 20, and the master device 21 or a slave device 22(g) of the synchrony group 20. As will be described below in more detail, the audio information channel device 23 obtains the audio information for the audio program from an audio information source, adds playback timing information, and transmits the combined audio and playback timing information to the master device 21 and slave devices 22(g) over the network 12 for playback. The playback timing information that is provided with the audio information, together with clock timing information provided by the audio information channel device 23 to the various devices 21 and 22(g) as will be described below, enables the master device 21 and slave devices 22(g) of the synchrony group 20 to play the audio information simultaneously.

The master device 21 and the slave devices 22(g) receive the audio and playback timing information, as well as the clock timing information, that are provided by the audio information channel device 23, and play back the audio program defined by the audio information. The master device 21 is also the member of the synchrony group 20 that communicates with the user interface module 13 and that controls the operations of the slave devices 22(g) in the synchrony group 20. In addition, the master device 21 controls the operations of the audio information channel device 23 that

provides the audio and playback timing information for the synchrony group 20. Generally, the initial master device 21 for the synchrony group will be the first zone player 11(n) that a user wishes to play an audio program. However, as will be described below, the zone player 11(n) that operates as the master device 21 can be migrated from one zone player 11(n) to another zone player 11(n'), which preferably will be a zone player that is currently operating as a slave device 22(g) in the synchrony group.

In addition, under certain circumstances, as will be described below, the zone player 11(n) that operates as the audio information channel device 23 can be migrated from one zone player to another zone player, which also will preferably will be a zone player that is currently operating as a member of the synchrony group 20. It will be appreciated that the zone player that operates as the master device 21 can be migrated to another zone player independently of the migration of the audio information channel device 23. For example, if one zone player 11(n) is operating as both the master device 21 and the audio information channel device 23 for a synchrony group 20, the master device 21 can be migrated to another zone player 11(n') while the zone player 11(n) is still operating as the audio information channel device 23. Similarly, if one zone player 11(n) is operating as both the master device 21 and the audio information channel device 23 for a synchrony group 20, the audio information channel device 23 can be migrated to another zone player 11(n') while the zone player 11(n) is still operating as the master device 21. In addition, if one zone player 11(n) is operating as both the master device 21 and the audio information channel device 23 for a synchrony group 20, the master device 21 can be migrated to another zone player 11(n') and the audio information channel device can be migrated to a third zone player 11(n").

The master device 21 receives control information from the user interface module 13 for controlling the synchrony group 20 and provides status information indicating the operational status of the synchrony group to the user interface module 13. Generally, the control information from the user interface module 13 enables the master device 21 to, in turn, enable the audio information channel device 23 to provide audio and playback timing information to the synchrony group to enable the devices 21 and 22(g) that are members of the synchrony group 20 to play the audio program synchronously. In addition, the control information from the user interface module 13 enables the master device 21 to, in turn, enable other zone players to join the synchrony group as slave devices 22(g) and to enable slave devices 22(g) to disengage from the synchrony group. Control information from the user interface module 13 can also enable the zone player 11(n) that is currently operating as the master device 21 to disengage from the synchrony group, but prior to

doing so that zone player will enable the master device 21 to transfer from that zone player 11(n) to another zone player11(n'), preferably to a zone player 11(n') that is currently a slave device 22(g) in the synchrony group 20. The control information from the user interface module 13 can also enable the master device 21 to adjust its playback volume and to enable individual ones of the various slave devices 22(g) to adjust their playback volumes. In addition, the control information from the user interface module 13 can enable the synchrony group 20 to terminate playing of a current track of the audio program and skip to the next track, and to re-order tracks in a play list of tracks defining the audio program that is to be played by the synchrony group 20.

The status information that the master device 21 may provide to the user interface module 13 can include such information as a name or other identifier for the track of the audio work that is currently being played, the names or other identifiers for upcoming tracks, the identifier of the zone player 11(n) that is currently operating as the master device 21, and identifiers of the zone players that are currently operating as slave devices 22(g). In one embodiment, the user interface module 13 includes a display (not separately shown) that can display the status information to the user.

It will be appreciated that the zone player 11(n) that is operating as the audio information channel device 23 for one synchrony group may also comprise the master device 21 or any of the slave devices 22(g) in another synchrony group. This may occur if, for example, the audio information source that is to provide the audio information that is to be played by the one synchrony group is connected to a zone player also being utilized as the master device or a slave device for the other synchrony group. This will be schematically illustrated below in connection with FIG. 2A. Since, as noted above, the zone player 11(n) that is operating as the audio information channel device 23 for the synchrony group 20 may also be operating as a master device 21 or slave device 22(g) for another synchrony group, it can also be connected to one or more audio reproduction devices 15(n)(r), although that is not depicted in FIG. 2. Since the master device 21 and slave devices 22(g) are all to provide playback of the audio program, they will be connected to respective audio reproduction devices 15(n)(r). Furthermore, it will be appreciated that one or more of the zone players 11(n) that operate as the master device 21 and slave devices 22(g) in synchrony group 20 may also operate as an audio information channel device for that synchrony group or for another synchrony group and so they may be connected to one or more audio information sources 14(n)(s), although that is also not depicted in FIG. 2. In addition, it will be appreciated that a zone player 11(n) can also operate as a audio information channel device 23 for multiple synchrony groups.

If the audio information channel device 23 does not utilize the same zone player as the master device 21, the master device 21 controls the audio information channel device by exchanging control information over the network 12 with the audio information channel device 23. The control information is represented in FIG. 2 by the arrow labeled CHAN_DEV_CTRL_INFO. The control information that the master device 21 provides to the audio information channel device 23 will generally depend on the nature of the audio information source that is to provide the audio information for the audio program that is to be played and the operation to be enabled by the control information. If, for example, the audio information source is a conventional compact disc, tape, or record player, broadcast radio receiver, or the like, which is connected to a zone player 11(n), the master device 21 may merely enable the zone player serving as the audio information channel device 23 to receive the audio information for the program from the audio information source. It will be appreciated that, if the audio information is not in digital form, the audio information channel device 23 will convert it to digital form and provide the digitized audio information, along with the playback timing information, to the master device 21 and slave devices 22(g).

On the other hand, if the audio information source is, for example, a digital data storage device, such as may be on a personal computer or similar device, the master device 21 can provide a play list to the audio information channel device 23 that identifies one or more files containing the audio information for the audio program. In that case, the audio information channel device 23 can retrieve the files from the digital data storage device and provide them, along with the playback timing information, to the master device 21 and the slave devices 22(g). It will be appreciated that, in this case, the audio information source may be directly connected to the audio information channel device 23, as, for example, an audio information source 14(n)(s), or it may comprise an audio information source 16(m) connected to the network 12. As a further alternative, if the audio information source is a source available over the wide area network, the master device 21 can provide a play list comprising a list of web addresses identifying the files containing the audio information for the audio program that is to be played, and in that connection the audio information channel device 23 can initiate a retrieval of the files over the wide area network. As yet another alternative, if the audio information source is a source of streaming audio received over the wide area network, the master device 21 can provide a network address from which the streaming audio can be received. Other arrangements by which the master device 21 can control the audio information channel device 23 will be apparent to those skilled in the art.

The master device 21 can also provide control information to the synchrony group's audio information channel device 23 to enable a migration from one zone player 11(n) to another zone player 11(n'). This may occur if, for example, the audio information source is one of audio information sources 16 or a source accessible over the wide area network via the network 12. The master device 21 can enable migration of the audio information channel device 23 for several reasons, including, for example, to reduce the loading of the zone player 11(n), to improve latency of message transmission in the network 12, and other reasons as will be appreciated by those skilled in the art.

As noted above, the audio information channel device 23 provides audio and playback timing information for the synchrony group to enable the master device 21 and slave devices 22(g) to play the audio program synchronously. Details of the audio and playback timing information will be described in detail below in connection with FIGS. 3 and 4, but, in brief, the audio information channel device 23 transmits the audio and playback timing information in messages over the network 12 using a multi-cast message transmission methodology. In that methodology, the audio information channel device 23 will transmit the audio and playback timing information in a series of messages, with each message being received by all of the zone players 11(n) comprising the synchrony group 20, that is, by the master device 21 and the slave devices 22(g). Each of the messages includes a multi-cast address, which the master device 21 and slave devices 22(g) will monitor and, when they detect a message with that address, they will receive and use the contents of the message. The audio and playback timing information is represented in FIG. 2 by the arrow labeled "AUD+PBTIME_INF0," which has a single tail, representing a source for the information at the audio information channel device 23, and multiple arrowheads representing the destinations of the information, with one arrowhead extending to the master device 21 and other arrowheads extending to each of the slave devices 22(g) in the synchrony group 20. The audio information channel device 23 may make use of any convenient multi-cast message transmission methodology in transmitting the audio and playback timing information to the synchrony group 20. As will be described in detail in connection with FIG. 4, the audio and playback timing information is in the form of a series of frames, with each frame having a time stamp. The time stamp indicates a time, relative to the time indicated by a clock maintained by the audio information channel device 23, at which the frame is to be played. Depending on the size or sizes of the messages used in the selected multi-cast message transmission methodology and the size or sizes of the frames, a message may contain one frame, or multiple frames, or, alternatively, a frame may extend across several messages.

The audio information channel device 23 also provides clock time information to the master device 21 and each of the slave devices 22(g) individually over network 12 using a highly accurate clock time information transmission methodology. The distribution of the clock time information is represented in FIG. 2 by the arrows labeled "AICD_CLK_INF (M)" (in the case of the clock time information provided to the master device 21) and "AICD_CLK_INF (S_1)" through "AICD_CLK_INF (S_G)" (in the case of audio information channel device clock information provided to the slave devices 22(g)). In one embodiment, the master device 21 and slave devices 22(g) make use of the well-known SNTP (Simple Network Time Protocol) to obtain current clock time information from the audio information channel device 23. The SNTP makes use of a unicast message transfer methodology, in which one device, such as the audio information channel device 23, provides clock time information to a specific other device, such as the master device 21 or a slave device 22(g), using the other device's network, or unicast, address. Each of the master device 21 and slave devices 22(g) will periodically initiate SNTP transactions with the audio information channel device 23 to obtain the clock time information from the audio information channel device 23. As will be described below in more detail, the master device 21 and each slave device 22(g) make use of the clock time information to determine the time differential between the time indicated by the audio information channel device's clock and the time indicated by its respective clock, and use that time differential value, along with the playback time information associated with the audio information and the respective device's local time as indicated by its clock to determine when the various frames are to be played. This enables the master device 21 and the slave devices 22(g) in the synchrony group 20 to play the respective frames simultaneously.

As noted above, the control information provided by the user to the master device 21 through the user interface module 13 can also enable the master device 21 to, in turn, enable another zone player 11(n') to join the synchrony group as a new slave device 22(g). In that operation, the user interface module 13 will provide control information, including the identification of the zone player 11(n') that is to join the synchrony group to the master device 21. After it receives the identification of the zone player 11(n') that is to join the synchrony group, the master device 21 will exchange control information, which is represented in FIG. 2 by the arrows labeled SLV_DEV_CTRL_INF (S_1) through SLV_DEV_CTRL_INF (S_G) group slave control information, over the network 12 with the zone player 11(n') that is identified in the control information from the user interface module 13. The control information that the master device 21 provides to the new zone player 11(n') includes the network address of the zone player 11(n) that is operating as the audio information channel

device 23 for the synchrony group, as well as the multi-cast address that the audio information channel device 23 is using to broadcast the audio and playback timing information over the network. The zone player that is to operate as the new slave device 22(g') uses the multi-cast address to begin receiving the multi-cast messages that contain the audio information for the audio program being played by the synchrony group.

It will be appreciated that, if the zone player 11(n) that is operating as the master device 21 for the synchrony group 20 is also operating the audio information channel device 23, and if there are no slave devices 22(g) in the synchrony group 20, the audio information channel device 23 may not be transmitting audio and playback timing information over the network. In that case, if the new slave device 22(g') is the first slave device in the synchrony group, the zone player 11(n) that is operating as both the master device 21 and audio information channel device 23, can begin transmitting the audio and playback timing information over the network 12 when the slave device 22(g') is added to the synchrony group 20. The zone player 11(n) can maintain a count of the number of slave devices 22(g) in the synchrony group 20 as they join and disengage, and, if the number drops to zero, it can stop transmitting the audio and playback timing information over the network 12 to reduce the message traffic over the network 12.

The new slave device 22(g') added to the synchrony group 20 uses the network address of the audio information channel device 23 for several purposes. In particular, the new slave device 22(g') will, like the master device 21 (assuming the zone player 11(n) operating as the master device 21 is not also the audio information channel device 23), engage in SNTP transactions with the audio information channel device 23 to obtain the clock timing information from the audio information channel device 23. In addition, the new slave device 22(g') can notify the audio information channel device 23 that it is a new slave device 22(g') for the synchrony group 20 and provide the audio information channel device 23 with its network address. As will be described below, in one embodiment, particularly in connection with audio information obtained from a source, such as a digital data storage device, which can provide audio information at a rate that is faster than the rate at which it will be played, the audio information channel device 23 will buffer audio and timing information and broadcast it over the network 12 to the synchrony group 20 generally at a rate at which it is provided by the source. Accordingly, when a new slave device 22(g') joins the synchrony group 20, the playback timing information may indicate that the audio information that is currently being broadcast by the audio information channel device 23 using the multi-cast methodology is to be played back some time in the future. To reduce the delay with which the new slave device 22(g')

will begin playback, the audio information channel device 23 can also retransmit previously transmitted audio and timing information that it had buffered to the new slave device 22(g') using the unicast network address of the slave device 22(g').

The master device 21 can also use the slave device control information exchanged with the slave devices 22(g) for other purposes. For example, the master device 21 can use the slave device control information to initiate a migration of the master from its zone player 11(n) to another zone player 11(n'). This may occur for any of a number of reasons, including, for example, that the master device 21 is terminating playback by it of the audio program and is leaving the synchrony group 20, but one or more of the other devices in the synchrony group is to continue playing the audio program. The master device 21 may also want to initiate a migration if it is overloaded, which can occur if, for example, the zone player 11(n) that is the master device 21 for its synchrony group is also operating as an audio information channel device 23 for another synchrony group.

The user can also use the user interface module 13 to adjust playback volume by the individual zone players 11(n) comprising the synchrony group. In that operation, the user interface module 13 provides information identifying the particular device whose volume is to be adjusted, and the level at which the volume is to be set to the master device 21. If the device whose volume is to be adjusted is the master device 21, the master device 21 can adjust its volume according to the information that it receives from the user interface module 13. On the other hand, if the device whose volume is to be adjusted is a slave device 22(g), the master device 21 can provide group slave control information to the respective slave device 22(g), to enable it to adjust its volume.

The user can also use the user interface module 13 to enable a synchrony group 20 to cancel playing of the track in an audio program that is currently being played, and to proceed immediately to the next track. This may occur, for example, if the tracks for the program is in the form of a series of digital audio information files, and the user wishes to cancel playback of the track that is defined by one of the files. In that case, when the master device 21 receives the command to cancel playback of the current track, it will provide channel device control information to the audio information channel device 23 so indicating. In response, the audio information channel device 23 inserts control information into the audio and playback timing information, which will be referred to as a "resynchronize" command. In addition, the audio information channel device 23 will begin transmitting audio information for the next track, with timing information to enable it to be played immediately. The resynchronize command can also enable playback of a track to be cancelled before it has been played. Details of these operations will be described below.

As noted above, there may be multiple synchrony groups in the network audio system 10, and further that, for example, a zone player 11(n) may operate both as a master device 21 or a slave device 22(g) in one synchrony group, and as the audio information channel device 23 providing audio and playback timing information and clock timing information for another synchrony group. An illustrative arrangement of this will be described in connection with FIG. 2A. With reference to FIG. 2A, that FIG. depicts elements of two synchrony groups, identified by reference numerals 20(1) and 20(2), respectively. For clarity, FIG. 2A does not show a number of elements, the presence of which would be evident from FIGS. 1 and 2 as described above. For example, FIG. 2A does not depict the audio information sources from which audio information is obtained for the synchrony groups or the audio reproduction devices that are used to produce sound for the master and slave devices, which are depicted in both FIGS. 1 and 2. In addition, FIG. 2A does not depict arrows that represent control information provided by the respective master devices to the slave devices in the respective synchrony groups, or to the audio information channel devices that provide audio and timing information for the respective synchrony groups, which are depicted in FIG. 2. In addition, FIG. 2A does not depict the arrows that represent the clock timing information provided by the audio information channel devices to the respective members of the respective synchrony groups, which are also depicted in FIG. 2. As will be noted below, however, FIG. 2A does depict arrows representing the audio and playback timing information provided by the respective audio information channel devices for the respective synchrony groups 20(1), 20(2), to the master and slave devices comprising the respective synchrony groups 20(1), 20(2).

Each synchrony group 20(1), 20(2) comprises elements of a number of zone players. A functional block diagram of a zone player will be described below in connection with FIG. 3. Synchrony group 20(1) includes a master device 21(1) and "K" slave devices 22(1)(1) through 22(K)(1) (the index "1" in reference numeral 21(1) and the last index in reference numeral 22(1)(1) through 21(K)(1) corresponds to the index of the synchrony group 20(1) to which they belong) utilize zone players 11(1) and 11(K+1) respectively. Similarly, synchrony group 20(2) includes a master device 21(2) and "L" slave devices 22(1)(2) through 22(L)(2) that utilize zone players 11(K+2) through 11(K+L+2). In the illustrative arrangement depicted in FIG. 2A, both synchrony groups 20(1) and 20(2) are controlled by the user interface module 13, which can provide control information to, and receive status information from, the master devices 21(1) and 21(2) independently. It will be appreciated that separate user interface modules may be provided to

provide control information to, and receive status information from, the respective master devices 21(1), 21(2).

As noted above, the slave device 22(1)(2) in synchrony group 20(2) utilizes zone player 11(K+3). In the illustrative arrangement depicted in FIG. 2A, the audio information channel device 23(1) that provides audio and playback timing information to the master and slave devices 21(1), 22(1)(1),..., 22(K)(1) of synchrony group 20(1) also utilizes zone player 11(K+3). As noted above, this may occur if, for example, the audio information source that is to provide audio information to be played by the synchrony group 20(1) is connected to the zone player 11(K+3). Thus, when the master device 21(1) of synchrony group 20(1) exchanges channel device control information with the audio information channel device 23(1), it is effectively exchanging channel device control information with the zone player 11(K+3). Similarly, when the master and slave devices 21(1), 22(1)(1),..., 22(K)(1) of synchrony group 20(1) receive audio and playback timing information, as well as clock timing information, from the audio information channel device 23(1), they are effectively receiving the information from the zone player 11(K+3). FIG. 2A depicts a multi-headed arrow representing audio and playback timing information transmitted by the zone player 11(K+3), as audio information channel device 23(1), to the master and slave devices 21(1), 22(1)(1),...,11(K)(1) comprising synchrony group 20(1).

On the other hand, in the illustrative arrangement depicted in FIG. 2A, the synchrony group 20(2) utilizes a zone player 11(K+L+3) as its audio information channel device 23(2). As with synchrony group 20(1), when the master device 21(2) of synchrony group 20(2) exchanges channel device control information with the audio information channel device 23(2), it is effectively exchanging channel device control information with the zone player 11(K+L+3). Similarly, when the master and slave devices 21(2), 22(1)(2),..., 22(L)(2) of synchrony group 20(2) receive audio and playback timing information, as well as clock timing information, from the audio information channel device 23(2), they are effectively receiving the information from the zone player 11(K+L+3). FIG. 2A depicts a multi-headed arrow representing audio and playback timing information transmitted by the zone player 11(K+3) as audio information channel device 23(2) to the master and slave devices 21(2), 22(1)(2),...,22(L)(2) comprising synchrony group 20(2).

In the illustrative arrangement depicted in FIG. 2A, zone player 11(K+L+3), which is the audio information channel device 23(2) for synchrony group 20(2), is not shown as being either a master or a slave device in another synchrony group. However, it will be appreciated that zone player 11(K+L+3) could also be utilized as the master device or a slave device for another synchrony

group. Indeed, it will be appreciated that the zone player that is utilized as the audio information channel device for synchrony group 20(2) may also be a zone player that is utilized as the master device 21(1) or a slave device 22(1)(1),..., 22(K)(1) in the synchrony group 20(1).

A zone player 11(n) that is utilized as a member of one synchrony group may also be utilized as the audio information channel device for another synchrony group if the audio information source that is to supply the audio information that is to be played by the other synchrony group is connected to that zone player 11(n). A zone player 11(n) may also be utilized as the audio information channel device for the other synchrony group if, for example, the audio information source is an audio information source 16(m) (FIG. 1) that is connected to the network 12 or an audio information source that is available over a wide area network such as the Internet. The latter may occur if, for example, the zone player 11(n) has sufficient processing power to operate as the audio information channel device and it is in an optimal location in the network 12, relative to the zone players comprising the other synchrony group (that is the synchrony group for which it is operating as audio information channel device) for providing the audio and playback timing information to the members of the other synchrony group. Other circumstances under which the zone player 11(n) that is utilized as a member of one synchrony group may also be utilized as the audio information channel device for another synchrony group will be apparent to those skilled in the art.

As was noted above, the master device 21 for a synchrony group 20 may be migrated from one zone player 11(n) to another zone player 11(n'). As was further noted above, the audio information channel device 23 for a synchrony group 20 may be migrated from one zone player 11(n) to another zone player 11(n'). It will be appreciated that the latter may occur if, for example, the audio information source that provides the audio program for the synchrony group is not connected to the zone player 11(n) that is operating as the audio information channel device 23, but instead is one of the audio information sources 16(m) connected to the network 12 or a source available over a wide area network such as the Internet. Operations performed during a migration of an audio information channel device 23 from one zone player 11(n) to another zone player 11(n') will generally depend on the nature of the audio information that is being channeled by the audio information channel device 23. For example, if the audio information source provides streaming audio, the zone player 11(n) that is currently operating as the audio information channel device 23 for the synchrony group 20, can provide the following information to the other zone player 11(n') that is to become the audio information channel device 23 for the synchrony group 20:

(a) the identification of the source of the streaming audio information,

(b) the time stamp associated with the frame that the zone player 11(n) is currently forming, and

(c) the identifications of the zone players that are operating as the master device 21 and slave devices 22(g) comprising the synchrony group 20.

After the zone player 11(n') receives the information from the zone player 11(n), it will begin receiving the streaming audio from the streaming audio information source identified by the zone player 11(n), assemble the streaming audio information into frames, associate each frame with a time stamp, and transmit the resulting audio and playback timing information over the network 12. The zone player 11(n') will perform these operations in the same manner as described above, except that, instead of using the time indicated by its digital to analog converter clock 34 directly in generating the time stamps for the frames, the initial time stamp will be related to the value of the time stamp that is provided by the zone player 11(n) (reference item (b) above), with the rate at which the time stamps are incremented corresponding to the rate at which its (that is, the zone player 11(n')'s) clock increments. In addition, the zone player 11(n') will notify the zone players that are operating as the master device 21 and slave devices 22(g) of the synchrony group 20 that it is the new audio information channel device 23 for the synchrony group 20, and provide the multi-cast address that it will be using to multi-cast the audio and playback timing information, as well as its unicast network address. After the members of the synchrony group 20 receive the notification from the zone player 11(n') indicating that it is the new audio information channel device 23 for the synchrony group 20, they will receive the audio and playback timing information from the zone player 11(n') instead of the zone player 11(n), using the multi-cast address provided by the zone player 11(n'). In addition, they can utilize the zone player 11(n')'s unicast network address to obtain current time information therefrom. It will be appreciated that the zone player 11(n') will determine its current time in relation to the time stamp that is provided by the zone player 11(n) (reference item (b) above) or the current time information that it received from the zone player 11(n) using the SNTP protocol as described above.

Generally similar operations can be performed in connection with migrating the audio information channel device from one zone player 11(n) to another zone player 11(n') if the audio information is from one or more audio information files, such as may be the case if the audio information comprises MP3 or WAV files that are available from sources such as sources 16(m) connected to the network 12 or over from sources available over a wide area network such as the Internet, except for differences to accommodate the fact that the audio information is in files. In that

case, the zone player 11(n) that is currently operating as the audio information channel device 23 for the synchrony group 20 can provide the following information to the zone player 11(n') that is to become the audio information channel device 23 for the synchrony group 20:

(d) a list of the audio information files containing the audio information that is to be played;

(e) the identification of the file for which the zone player 11(n) is currently providing audio and playback timing information, along with the offset into the file for which the current item of audio and playback timing information is being generated and the time stamp that the zone player 11(n) is associating with that frame, and

(f) the identifications of the zone players that comprise the master device 21 and slave devices 22(g) comprising the synchrony group 20.

After the zone player 11(n') receives the information from the zone player 11(n), it will begin retrieving audio information from the file identified in item (e), starting at the identified offset. In addition, the zone player 11(n') can assemble the retrieved audio information into frames, associate each frame with a time stamp and transmit the resulting audio and playback timing information over the network 12. The zone player 11(n') will perform these operations in the same manner as described above, except that, instead of using the time indicated by its digital to analog converter clock 34 directly in generating the time stamps for the frames, the value of the initial time stamp will be related to the time stamp that is provided by the zone player 11(n) (reference item (e) above), with the rate at which the time stamps are incremented corresponding to the rate at which its (that is, the zone player 11(n')'s) clock increments. In addition, the zone player 11(n') will notify the zone players that are operating as the master device 21 and slave devices 22(g) of the synchrony group 20 that it is the new audio information channel device 23 for the synchrony group 20, and provide the multi-cast address that it will be using to multi-cast the audio and playback timing information, as well as its unicast network address. After the members of the synchrony group 20 receive the notification from the zone player 11(n') indicating that it is the new audio information channel device 23 for the synchrony group 20, they will receive the audio and playback timing information from the zone player 11(n') instead of the zone player 11(n), using the multi-cast address provided by the zone player 11(n'). In addition, they can utilize the zone player 11(n')'s unicast network address to obtain current time information therefrom. It will be appreciated that the zone player 11(n') will determine its current time in relation to the time stamp that is provided by the zone player 11(n) (reference item (b) above) or the current time information that it received from the zone player 11(n) using the SNTP

protocol as described above. The zone player 11(n') will process successive audio information files in the list that it receives from the zone player 11(n) (reference item (d)).

Operations performed by the zone players 11(n) and 11(n') in connection with migration of the audio information channel device 23 for other types of audio information will be apparent to those skilled in the art. In any case, preferably, the zone player 11(n) will continue operating as an audio information channel device 23 for the synchrony group 20 for at least a brief time after it notifies the zone player 11(n') that it is to become audio information channel device for the synchrony group, so that the zone player 11(n') will have time to notify the zone players in the synchrony group 20 that it is the new audio information channel device 23 for the synchrony group.

Before proceeding further in describing operations performed by the network audio system 10, it would be helpful to provide a detailed description of a zone player 11(n) constructed in accordance with the invention. FIG. 3 depicts a functional block diagram of a zone player 11(n) constructed in accordance with the invention. All of the zone players in the network audio system 10 may have similar construction. With reference to FIG. 3, the zone player 11(n) includes an audio information source interface 30, an audio information buffer 31, a playback scheduler 32, a digital to analog converter 33, an audio amplifier 35, an audio reproduction device interface 36, a network communications manager 40, and a network interface 41, all of which operate under the control of a control module 42. The zone player 11(n) also has a device clock 43 that provides timing signals that control the general operations of the zone player 11(n). In addition, the zone player 11(n) includes a user interface module interface 44 that can receive control signals from the user interface module 13 (FIGS. 1 and 2) for controlling operations of the zone player 11(n), and provide status information to the user interface module 13.

Generally, the audio information buffer 31 buffers audio information, in digital form, along with playback timing information. If the zone player 11(n) is operating as the audio information channel device 23 (FIG. 2) for a synchrony group 20, the information that is buffered in the audio information buffer 31 will include the audio and playback timing information that will be provided to the devices 21 and 22(g) in the synchrony group 20. If the zone player 11(n) is operating as the master device 21 or a slave device 22(g) for a synchrony group, the information that is buffered in the audio information buffer 31 will include the audio and playback timing information that the zone player 11(n) is to play.

The audio information buffer 31 can receive audio and playback timing information from two sources, namely, the audio information source interface 30 and the network communications

manager 40. In particular, if the zone player 11(n) is operating as the audio information channel device 23 for a synchrony group 20, and if the audio information source is a source 14(n)(s) connected to the zone player 11(n), the audio information buffer 31 will receive and buffer audio and playback timing information from the audio information source interface 30. On the other hand, if the zone player 11(n) is operating as the audio information channel device 23 for a synchrony group 20, and if the audio information source is a source 16(m) connected to the network 12, or a source available over the wide area network, the audio information buffer 31 will receive and buffer audio and playback timing information from the network communications manager 40. It will be appreciated that, if the zone player 11(n) is not a member of the synchrony group, the zone player 11(n) will not play this buffered audio and playback timing information.

On yet another hand, if the zone player 11(n) is operating as the master device 21 or a slave device 22(g) in a synchrony group, and if the zone player 11(n) is not also the audio information channel device 23 providing audio and playback timing information for the synchrony group 20, the audio information buffer 31 will receive and buffer audio and playback timing information from the network communications manager 40.

The audio information source interface 30 connects to the audio information source(s) 14(n)(s) associated with the zone player 11(n). While the zone player 11(n) is operating as audio information channel device 23 for a synchrony group 20, and if the audio information is to be provided by a source 14(n)(s) connected to the zone player 11(n), the audio information source interface 30 will selectively receive audio information from one of the audio information source(s) 14(n)(s) to which the zone player is connected and store the audio information in the audio information buffer 21. If the audio information from the selected audio information source 14(n)(s) is in analog form, the audio information source interface 30 will convert it to digital form. The selection of the audio information source 14(n)(s) from which the audio information source interface 30 receives audio information is under control of the control module 42, which, in turn, receives control information from the user interface module through the user interface module interface 44. The audio information source interface 30 adds playback timing information to the digital audio information and buffers the combined audio and playback timing information in the audio information buffer 21.

More specifically, as noted above, the audio information source interface 30 receives audio information from an audio information source 14(n)(s), converts it to digital form if necessary, and buffers it along with playback timing information in the audio information buffer 21. In addition,

the audio information source interface 30 will also provide formatting and scheduling information for the digital audio information, whether as received from the selected audio information source 14(n)(s) or as converted from an analog audio information source. As will be made clear below, the formatting and scheduling information will control not only playback by the zone player 11(n) itself, but will also enable other zone players 11(n'), 11(n''),... that may be in a synchrony group for which the zone player 11(n) is the master device, to play the audio program associated with the audio information in synchrony with the zone player 11(n).

In one particular embodiment, the audio information source interface 30 divides the audio information associated with an audio work into a series of frames, with each frame comprising digital audio information for a predetermined period of time. As used herein, an audio track may comprise any unit of audio information that is to be played without interruption. On the other hand, an audio program may comprise a series of one or more audio tracks that are to be played in succession. It will be appreciated that the tracks comprising the audio program may also be played without interruption, or alternatively playback between tracks may be interrupted by a selected time interval. FIG. 4 schematically depicts an illustrative framing strategy used in connection with one embodiment of the invention for a digital audio stream comprising an audio work. More specifically, FIG. 4 depicts a framed digital audio stream 50 comprising a sequence of frames 51(1) through 51(F) (generally identified by reference numeral 51(f)). Each frame 51(f), in turn, comprises a series of audio samples 52(f)(1) through 52(f)(S) (generally identified by reference numeral 52(f)(s)) of the audio track. Preferably all of the frames will have the same number "S" of audio samples, although it will be appreciated from the following that that is primarily for convenience. On the other hand, it will be appreciated that, the number of audio samples may differ from "S"; this may particularly be the case if the frame 51(f) contains the last audio samples for the digital audio stream for a particular audio work. In that case, the last frame 51(F) will preferably contain samples 52(F)(1) through 52(F)(x), where "x" is less than "S." Generally, it is desirable that the number of samples be consistent among all frames 51(f), and in that case padding, which will not be played, can be added to the last frame 51(F).

Associated with each frame 51(f) is a header 55(f) that includes a number of fields for storing other information that is useful in controlling playback of the audio samples in the respective frame 51(f). In particular, the header 55(f) associated with a frame 51(f) includes a frame sequence number field 56, an encoding type field 57, a sampling rate information field 58, a time stamp field 60, an end of track flag 61, and a length flag field 62. The header 55(f) may also include fields (not shown)

for storing other information that is useful in controlling playback. Generally, the frame sequence number field 56 receives a sequence number "f" that identifies the relative position of the frame 51(f) in the sequence of frames 51(1)..51(f)...51(F) containing the digital audio stream 50. The encoding type field 57 receives a value that identifies the type of encoding and/or compression that has been used in generating the digital audio stream. Conventional encoding or compression schemes include, for example, the well-known MP3 and WAV encoding and/or compression schemes, although it will be appreciated that other schemes may be provided for as well. The sampling rate information field 58 receives sampling rate information that indicates the sampling rate for the audio samples 52(f)(s). As will be apparent to those skilled in the art, the sampling rate determines the rate at which the zone player 11(n) is to play the audio samples 52(f)(s) in the frame, and, as will be described below, determines the period of the digital to analog converter clock 34.

The condition of the end of work flag 61 indicates whether the frame 51(f) contains the last digital audio samples for the audio track associated with the framed digital audio work 50. If the frame 51(f) does not contain the audio samples that are associated with the end of the digital audio stream 50 for a respective audio work, the end of work flag will be clear. On the other hand, if the frame 51(f) does contain the audio samples that are associated with the end of the digital audio stream 50 for a respective audio work, the end of work flag 61 will be set. In addition, since the number of valid audio samples 52(F)(s) in the frame 51(F), that is, the samples that are not padding, may be less than "S," the default number of audio samples in a frame 51(f), the length flag field 62 will contain a value that identifies the number of audio samples in 52(F)(s) in the last frame 51(F) of the audio work 50. If, as noted above, the frames have a consistent number "S" of samples, the samples 52(F)(x+1) through 52(F)(S) will contain padding, which will not be played.

The time stamp field 60 stores a time stamp that identifies the time at which the zone player 11(n) is to play the respective frame. More specifically, for each frame of a framed digital audio stream 50 that is buffered in the audio information buffer 21, the audio information source interface 30, using timing information from the digital to analog converter clock 34, will determine a time at which the zone player 11(n) is to play the respective frame, and stores a time stamp identifying the playback time in the time stamp field 60. The time stamp associated with each frame will later be used by the playback scheduler 32 to determine when the portion of the digital audio stream stored in the frame is to be coupled to the digital to analog converter 33 to initiate play back. It will be appreciated that the time stamps that are associated with frames in sequential frames 51(1), 51(2),...,51(F), will be such that they will be played back in order, and without an interruption

between the sequential frames comprising the digital audio stream 50. It will further be appreciated that, after a time stamp has been determined for the first frame, stored in frame 51(1), of a digital audio stream 50, the audio information source interface 30 can determine time stamps for the subsequent frame 51(2), 51(3),....,51(F) in relation to the number of samples "S" in the respective frames and the sample rate. The time stamps will also preferably be such that frames will be played back after some slight time delay after they have been buffered in the audio information buffer 21; the purpose for the time delay will be made clear below.

Returning to FIG. 3, in addition to dividing the digital audio information into frames, the audio information source interface 30 also aggregates and/or divides the frames 51(f) as necessary into packets, each of which will be of a length that would fit into a message for transmission over the network, and associates each packet with a packet sequence number. For example, if a packet will accommodate multiple frames 51(f), 51(f+1),... 51(f+y-1), it will aggregate them into a packet and associate them with a packet number, for example p(x). If the entire frames 51(f) and 51(f+y-1) was accommodated in packet p(x), where "x" is the sequence number, which will occur if the size of a packet is an exact multiple of the frame size, the next packet, p(x+1) will begin with frame 51(f+y) and will include frames 51(f+y),..., 51(f+2y-1). Subsequent packets p(x+2),.... will be formed in a similar manner. On the other hand, if the packet length will not accommodate an exact multiple of the frame size, the last frame in the packet will be continued at the beginning of the next packet.

If the audio information source interface 30 is aware of track boundaries, which may be the case if the tracks are divided into files, the packets will reflect the track boundaries, that is, the packets will not contain frames from two tracks. Thus, if the last frames associated with a track are insufficient to fill a packet, the packet will contain padding from the last frame associated with the track to the end of the packet, and the next packet will begin with the first frames associated with the next track.

In one embodiment, the audio information source interface 30 stores the packets in the audio information buffer 31 in a ring buffer. As is conventional, a ring buffer includes a series of storage locations in the buffer. Each entry will be sufficient to store one packet. Four pointers are used in connection with the ring buffer, a first pointer pointing to the beginning of the ring buffer, a second pointer pointing to the end of the ring buffer, an third "write" pointer pointing to the entry into which a packet will be written and a fourth "read" pointer pointing to the entry from which packet will be read for use in playback. When a packet is read from the ring buffer for playback, it will be read

from the entry pointed to by the read pointer. After the packet has been read, the read pointer will be advanced. If the read pointer points beyond the end of the ring buffer, as indicated by the end pointer, it will be reset to point to the entry pointed to by the beginning pointer, and the operations can be repeated.

On the other hand, when the audio information source interface 30 stores a packet in the ring buffer, first determine whether the entry pointed to by the write pointer points to the same entry as the entry pointed to by the read pointer. If the write pointer points to the same entry as the entry pointed to by the read pointer, the entry contains at least a portion of a packet that has not yet been read for playback, and the audio information source interface 30 will delay storage of the packet until the entire packet has been read and the read pointer advanced. After the read pointer has been advanced, the audio information source interface 30 can store the packet in the entry pointed to by the write pointer. After the packet has been stored, the audio information source interface 30 will advance the write pointer. If the write pointer points beyond the end of the ring buffer, as indicated by the end pointer, it will be reset to point to the entry pointed to by the beginning pointer, and the operations can be repeated.

As noted above, the zone player 11(n) can operate both as an audio information channel device 23 and a member of the synchrony group 20 of which it is a member. In that case, the audio information buffer 31 can contain one ring buffer. On the other hand, the zone player 11(n) can operate as an audio information channel device 23 for one synchrony group 20(1) (FIG. 2A) and a member of another synchrony group 20(2). In that case, the audio information buffer 31 would maintain two ring buffers, one for the audio and timing information associated with synchrony group 20(1), and the other for the audio and timing information associated with synchrony group 20(2). It will be appreciated that, in the latter case, the zone player 11(n) will only use the audio and timing information that is associated with synchrony group 20(2) for playback.

The playback scheduler 32 schedules playback of the audio information that is buffered in the audio information buffer 31 that is to be played by the zone player 11(n). Accordingly, under control of the playback scheduler 32, the digital audio information that is buffered in the audio information buffer 21 that is to be played by the zone player 11(n) is transferred to the digital to analog converter 33 for playback. As noted above, if the zone player 11(n) is operating as an audio information channel device 23 for a synchrony group 20 for which it is not a member, the playback scheduler 32 will not schedule the digital audio information that is to be played by that synchrony group 20 for playback. The playback scheduler 32 only schedules the digital audio information, if

any, that is buffered in the audio information buffer 31 that is associated with a synchrony group for which the zone player 11(n) is a member, whether as master device 21 or a slave device 22(g).

Essentially, the playback scheduler 32 makes use of the read pointer associated with the circular buffer that contains the audio and playback timing information that is to be played by the zone player 11(n). The playback scheduler 32 retrieves the packet information from the entry of the ring buffer pointed to by the read pointer, and then advances the ring pointer as described above. The playback scheduler 32 determines the boundaries of the frames in the packet and uses the time stamps in the time stamp fields 60 associated with the respective frame 51(f), along with timing information provided by the zone player 11(n)'s digital to analog converter clock 34, to determine when the respective frame is to be transferred to the digital to analog converter 33. Generally, when the time stamp associated with a buffered digital audio information frame corresponds to the current time as indicated by the digital to analog converter clock 34, the playback scheduler 32 will enable the respective frame to be transferred to the digital to analog converter 33.

The digital to analog converter 33, also under control of the digital to analog converter clock 34, converts the buffered digital audio information to analog form, and provides the analog audio information to the audio amplifier 35 for amplification. The amplified analog information, in turn, is provided to the audio reproduction devices 15(n)(r) through the audio reproduction device interface 36. The audio reproduction devices 15(n)(r) transform the analog audio information signal to sound thereby to provide the audio program to a listener. The amount by which the audio amplifier 35 amplifies the analog signal is controlled by the control module 42, in response to volume control information provided by the user through the user interface module 13.

The network communications manager 40 controls network communications over the network 12, and the network interface 41 transmits and receives message packets over the network 12. The network communications manager 40 generates and receives messages to facilitate the transfer of the various types of information described above in connection with FIG. 2, including the channel device control information, slave device control information, audio and playback timing information and the audio information channel device's clock timing information. In connection with the channel device control information and the slave device control information, the network communications manager 40 will generate messages for transfer over the network 12 in response to control information from the control module 42. Similarly, when the network communications manager 40 receives messages containing channel device control information and slave device

control information, the network communications manager will provide the information to the control module 42 for processing.

With regards to the audio information channel device's clock timing information, as noted above, the master device 21 and slave devices 22(g) of the synchrony group 20 obtain the clock timing information from the audio information channel device 23 using the well-known SNTP. If the zone player 11(n) is operating as the audio information channel device 23 for a synchrony group, during the SNTP operation, it will provide its current time, particularly a current time as indicated by its digital to analog converter clock 34. On the other hand, if the zone player 11(n) is operating as the master device 21 or slave device 22(g) of a synchrony group 20, it will receive the clock timing information from the audio information channel device 23. After the respective device 21, 22(g) has obtained the audio information channel device's clock timing information, it will generate a differential time value ΔT representing the difference between the time T indicated by its digital to analog converter clock 34 and the current time information from the audio information channel device 23. The differential time value will be used to update the time stamps for the frames of the digital audio stream 50 (FIG. 4) that are received from the audio information channel device.

With regards to the audio and playback timing information, operations performed by the network communications manager 40 will depend on whether

(i) the audio and playback timing information has been buffered in the audio information buffer 31 for transmission, as audio information channel device 23, over the network 12 to the master device 21 and/or slave devices 22(g) of a synchrony group, or

(ii) the audio and playback timing information has been received from the network 12 to be played by the zone player 11(n) as either the master device 21 for a synchrony group or a slave device in a synchrony group.

It will be appreciated that the network communications manager 40 may be engaged in both (i) and (ii) contemporaneously, since the zone player 11(n) may operate both as the audio information channel device 23(1) for a synchrony group 20(1) (reference FIG. 2A) of which it is not a member, and a member of another synchrony group 20(2) for which another zone player 11(n') is the audio information channel device 23(2). With reference to item (i) above, after a packet that is to be transmitted has been buffered in the respective ring buffer, the network communications manager 40 retrieves the packet, packages it into a message and enables the network interface 41 to transmit the message over the network 12. If the control module 42 receives control information from the user interface module 13 (if the master device 21 is also the audio information channel device 23 for

the synchrony group 20) or from the master device (if the master device 21 is not the audio information channel device 23 for the synchrony group 20) that would require the transmission of a "resynchronize" command as described above, the control module 42 of the audio information channel device 23 enables the network communications manager 40 to insert the command into a message containing the audio and playback timing information. Details of the operations performed in connection with the "resynchronize" command will be described below. As noted above, the "resynchronize" command is used if the user enables a synchrony group to terminate the playback of a track that is currently being played, or cancel playback of a track whose playback has not begun.

On the other hand, with reference to item (ii) above, if network interface 41 receives a message containing a packet containing frames of audio and playback timing information that the zone player 11(n) is to play either as a master device 21 or a slave device for a synchrony group 20, the network interface 41 provides the audio and playback timing information to the network communications manager 40. The network communications manager 40 will determine whether the packet contains a resynchronize command and, if so, notify the control module 42, which will enable operations to be performed as described below. In any case, the network communications manager 40 will normally buffer the various frames comprising the audio and playback timing information in the audio information buffer 31, and in that operation will generally operate as described above in connection with the audio information source interface 30. Before buffering them, however, the network communications manager 40 will update their time stamps using the time differential value described above. It will be appreciated that the network communications manager 40 will perform similar operations whether the messages that contain the packets were multi-cast messages or unicast messages as described above

The updating of the time stamps by the master device 21 and the slave devices 22(g) in the synchrony group 20 will ensure that they all play the audio information synchronously. In particular, after the network communications manager 40 has received a frame 51(f) from the network interface 41, it will also obtain, from the digital to analog converter clock 34, the zone player 11(n)'s current time as indicated by its digital to analog converter clock 34. The network communications manager 40 will determine a time differential value that is the difference between the slave device's current clock time, as indicated by its digital to analog converter 34, and the audio information channel device's time as indicated by the audio information channel device's clock timing information. Accordingly, if the master or slave device's current time has a value T_S and the audio information channel device's current time, as indicated by the clock timing information, has a value T_C, the time

differential value $\Delta T=T_S-T_C$. If the current time of the master or slave device in the synchrony group 20, as indicated by its digital to analog converter clock 34, is ahead of the audio information channel device's clock time as indicated by the clock timing information received during the SNTP operation, the time differential value will have a positive value. On the other hand, if the master or slave device's current time is behind the audio information channel device's clock time, the time differential value ΔT will have a negative value. If the zone player 11(n) obtains clock timing information from the audio information channel device 23 periodically while it is a member of the synchrony group 20, the network communications manager 40 can generate an updated value for the time differential value ΔT when it receives the clock timing information from the audio information channel device 23, and will subsequently use the updated time differential value.

The network communications manager 40 uses the time differential value ΔT that it generates from the audio information channel device timing information and zone player 11(n)'s current time to update the time stamps that will be associated with the digital audio information frames that the zone player 11(n) receives from the audio information channel device. For each digital audio information frame that is received from the audio information channel device, instead of storing the time stamp that is associated with the frame as received in the message in the audio information buffer 21, the network communications manager 40 will store the updated time stamp with the digital audio information frame. The updated time stamp is generated in a manner so that, when the zone player 11(n), as a member of the synchrony group plays back the digital audio information frame, it will do so in synchrony with other devices in the synchrony group.

More specifically, after the zone player 11(n)'s network interface 41 receives a message containing a packet that, in turn, contains one or more frames 51(f), it will provide the packet to the network communications manager 40. For each frame 51(f) in the packet that the network communications manager 40 receives from the network interface 41, the network communications manager 40 will add the time differential value ΔT to the frame's time stamp, to generate the updated time stamp for the frame 51(f), and store the frame 51(f), along with the header 55(f) with the updated time stamp in the audio information buffer 31. Thus, for example, if a frame's time stamp has a time value T_F, the network communications manager 40 will generate an updated time stamp T^U_F having a time value $T^U_F=T_F+\Delta T$. Since time value T^U_F according to the slave device's digital to analog converter clock 34 is simultaneous to the time value T_F according to the audio information channel device's digital to analog converter clock 34, the zone player 11(n) device will play the digital audio information frame at the time determined by the audio information channel device 23.

Since all of the members of the synchrony group 20 will perform the same operations, generating the updated time stamps T^U_F for the various frames 51(f) in relation to their respective differential time values, all of the zone players 11(n) in the synchrony group 20 will play them synchronously. The network communications manager 40 will generate updated time stamps T^U_F for all of the time stamps 60 in the packet, and then store the packet in the audio information buffer 31.

It will be appreciated that, before storing a packet in the audio information buffer 21, the network communications manager 40 can compare the updated time stamps T^U_F associated with the frames in the packet to the slave device's current time as indicated by its digital to analog converter clock 34. If the network communications manager 40 determines the time indicated by the updated time stamps of frames 51(f) in the packet are earlier than the zone player's current time, it can discard the packet instead of storing it in the audio information buffer 21, since the zone player 11(n) will not play them. That is, if the updated time stamp has a time value T^U_F that identifies a time that is earlier than the zone player's current time T_S as indicated by the zone player's digital to analog converter clock 34, the network communications manager 40 can discard the packet.

If the zone player 11(n) is operating as the master device 21 of a synchrony group 20, when the user, through the user interface module 13, notifies the zone player 11(n) that another zone player 11(n') is to join the synchrony group 20 as a slave device 22(g), the control module 42 of the zone player 11(n) enables the network communications manager 40 to engage in an exchange of messages, described above in connection with FIG. 2, to enable the other zone player 11(n') to join the synchrony group 20 as a slave device. As noted above, during the message exchange, the messages generated by the network communications manager 40 of the zone player 11(n) will provide the network communications manager of the zone player 11(n') that is to join the synchrony group 20 with information such as the multi-cast address being used by the audio information channel device 23 that is providing the audio program to the synchrony group 20, as well as a unicast network address for the audio information channel device 23. After receiving that information, the network communications manager and network interface of the zone player 11(n') that is to join the synchrony group 20 can begin receiving the multi-cast messages containing the audio program for the synchrony group, engage in SNTP transactions with the audio information channel device 23 to obtain the latter's current time, and also enable the audio information channel device 23 to send the zone player 11(n') frames 51(f) that it had previously broadcast using the unicast message transmission methodology as described above.

On the other hand, if the network communications manager 40 and network interface 41 of the zone player 11(n) receive a message over the network 12 indicating that it is to become a slave device 22(g) of a synchrony group for which another zone player 11(n') is the master device, the network communications manager 40 for zone player 11(n) will provide a notification to the control module 42 of zone player 11(n). Thereafter, the control module 42 of zone player 11(n) can enable the network communications manager 40 of zone player 11(n) to perform the operations described above to enable it to join the synchrony group 20.

As noted above, the user, using user interface module 13, can enable the synchrony group to terminate playback of a track of an audio program that is currently being played. After playback of a track that is currently being played has been terminated, playback will continue in a conventional manner with the next track that has been buffered in the audio information buffer 31. It will be appreciated that that could be the next track that is on the original play list, or a previous track. In addition, the user can enable the synchrony group 20 to cancel playback of a track that it has not yet begun to play, but for which buffering of packets has begun in the synchrony group 20. Both of these operations make use of the "resynchronize" command that the master device 21 of the synchrony group 20 can enable the audio information channel device 23 to include in the multi-cast message stream that it transmits to the synchrony group 20. Generally, in response to receipt of the resynchronize command, the members of the synchrony group 20 flush the ring buffer containing the packets that they are to play in the future. In addition, if the members of the synchrony group provide separate buffers for their respective digital to analog converters 33, the members will also flush those buffers as well. After the audio information channel device transmits a packet containing the resynchronize command:

(i) in the case of the use of the resynchronize command to terminate playing of a track that is currently being played, the audio information channel device 23 will begin multi-casting packets for the next track, to begin play immediately, and will continue through the play list in the manner described above; and

(ii) in the case of the use of the resynchronize command to cancel play of a track for which buffering has begun, but which is to be played in the future, the audio information channel device 23 will begin multi-casting packets for the track after the track that has been cancelled, to be played beginning at the time the cancelled track was to begin play, and will also continue through the play list in the manner described above.

It will be appreciated that,

(a) in the first case (item (i) directly above), the resynchronize command can enable the read pointer to be set to point to the entry in the circular buffer into which the first packet for the next track will be written, which will correspond to the entry to which the write pointer points, but

(b) in the second case (item (ii) directly above), the resynchronize command can enable the write pointer for the circular buffer to be set to point to the entry that contains the first packet for the track whose play is being cancelled.

It will further be appreciated that, if a track is cancelled for which buffering has not begun, the resynchronize command will generally not be necessary, since the audio information channel device 23 for the synchrony group 20 need only delete that track from the play list.

Operations performed in connection with use of the resynchronize command to cancel playback of a track that is currently being played will be described in connection with Packet Sequence A below, and operations performed in connection with the use of the resynchronize command to cancel playback of a track that is has not yet begun to play, but for which buffering of packets has begun, will be described in connection with Packet Sequence B below.

Packet Sequence A

(A1.0) [packet 57]

(A1.1 [continuation of frame 99]

(A1.2) [frame 100, time = 0:00:01, type = mp3 audio]

(A1.3) [frame 101, time = 0:00:02, type = mp3 audio]

(A1.4) [frame 102, time = 0:00:03, type = mp3 audio]

(A2.0) [packet 58]

(A2.1) [continuation of frame 102]

(A2.2) [frame 103, time = 0:00:04, type = mp3 audio]

(A2.3) [frame 104, time = 0:00:05, type = mp3 audio]

(A2.4) [frame 105, time = 0:00:06, type = mp3 audio]

(A3.0) [packet 59]

(A3.1) [continuation of frame 105]

(A3.2) [frame 106, time = 0:00:07, type = mp3 audio]

(A3.3) [frame 107, time = 0:00:08, type = mp3 audio]

(A3.4) [frame 108, time = 0:00:09, type = mp3 audio]

(A4.0) [packet 60]

(A4.1) [continuation of frame 108]

(A4.2) [frame 109, time = 0:00:10, type = mp3 audio]

(A4.3) [Resynchronize command]

(A4.4) [Padding, if necessary]

(A5.0) [packet 61]

(A5.1) [frame 1, time = 0:00:07, type = mp3 audio]

(A5.2) [frame 2, time = 0:00:08, type = mp3 audio]

(A5.3) [frame 3, time = 0:00:09, type = mp3 audio]

(A5.4) [frame 4, time = 0.00.10, type = mp3 audio]

(A6.0) [packet 62]

(A6.1) [continuation of frame 4]

(A6.2) [frame 5, time = 0:00:11, type = mp3 audio]

(A6.3) [frame 6, time = 0:00:12, type = mp3 audio]

(A6.4) [frame 7, time = 0:00:13, type = mp3 audio]

Packet Sequence A comprises a sequence of six packets, identified by packet 57 through packet 62, that the audio information channel device 23 multi-casts in respective messages to the members of a synchrony group 20. It will be appreciated that the series of messages that the audio information channel device 23 may multi-cast to the synchrony group 20 may include a messages prior to the packet 57, and may also include messages after packet 62. Each packet comprises a packet header, which is symbolized by lines (A1.0), (A2.0),...(A6.0) in Packet Sequence A, and will generally also include information associated with at least a portion of a frame. In the packets represented in Packet Sequence A, each packet includes information associated with a plurality of frames. Depending on the lengths of the packets, each packet may contain information associated with a portion of a frame, an entire frame, or multiple frames. In the illustration represented by Packet Sequence A, it is assumed that each packet may contain information associated with multiple frames. In addition, it is assumed that a packet does not necessarily contain information associated with an integral number of frames; in that case, a packet may contain information associated with

a portion of a frame, and the next packet will contain the information associated with the rest of a frame.

The frames and associated header playback timing information contained in the various packets are symbolized by lines (A1.1), (A1.2),...,(A1.4), (A2.1),....(A6.4) of Packet Sequence A. Thus, for example, line (A1.2) of packet 57 represents the one-hundredth frame, that is, frame 51(100) (reference FIG. 4), of the track whose audio information is being transmitted in the sequence of packets that includes packet 57. The frame 51(100) is to be played at an illustrative time, according to the audio information channel device's digital to analog converter clock, of "time = 0:00:01," and the frame is encoded and/or compressed using the well-known MP3 encoding and compression methodology. In that case, the legend"time = 0:00:01" represents the time stamp that would be included in field 60 (FIG. 4) of the header associated with the frame 50(100) as multi-cast by the audio information channel device for the synchrony group. It will be appreciated that the playback time and encoding/compression methodology will be referred in the header 55(100) that is associated with the frame 51(100). It will also be appreciated that the header may also contain additional information as described above.

Similarly, line (A1.3) of packet 57 represents the one-hundred and first frame, that is, frame 51(101), of the track whose audio information is being transmitted in the sequence of packets that includes packet 57. The frame 51(101) is to be played at an illustrative time, according to the audio information channel device's digital to analog converter clock, of "0:00:02," and the frame is also encoded and/or compressed using the MP3 encoding and compression methodology. Line (A1.4) of packet 57 represents similar information, although it will be appreciated that, depending on the length of packet 57, the line may not represent the information for an entire frame 51(102) and/or its associated header. If the length of packet 57 is not sufficient to accommodate the information for the entire frame 51(102) and/or associated header, the information will continue in packet 58, as represented by line (A2.1) in Packet Sequence A. Similarly, if the length of packet 56 was not sufficient to contain the information for an entire frame 51(99) preceding frame 51(100), packet 57 (lines (A1.0) through 1.4) may contain any information from frame 51(99) that packet 56 was unable to accommodate.

As noted above, when the master device 21 or a slave device 22(g) in the synchrony group 20 receives the packet 57, its respective network communications manager 40 will update the time stamps associated with the various frames 51(f) as described above before buffering the respective frames in the respective audio information buffer 31.

Packets 58 and 59 contain information that is organized along the lines described above in connection with packet 57.

Packet 60 also contains, as represented by lines (A4.1) and (A4.2), information that is organized along the lines of the information represented by lines (Ax.1) and (Ax.2) ("x" equals an integer) described above in connection with packets 57 through 59. On the other hand, packet 60 contains a resynchronize command, as represented by line (A4.3). Packet 60 also may contain padding, as represented by line 4.4, following the resynchronize command. As noted above, the master device 21 of a synchrony group 20 will enable the audio information channel device 23 that is providing audio information to the synchrony group 20 to multi-cast a message containing the resynchronize command when it receives notification from the user interface module 13 that the user wishes to cancel playback of a track that is currently being played. In the example depicted in Packet Sequence A, as will be described below, the audio information channel device 23 receives notification from the master device 21 that the user wishes to cancel playback of a track at a time corresponding to "time = 0:00:07" according to its digital to analog converter clock 34, and, in line (A4.3) of packet 60 it will provide the resynchronize command, followed by padding, if necessary.

As will be apparent from examining lines (A3.1) through (A3.4) of packet 59 and lines (A4.1) and (A4.2) of packet 60, although the audio information channel device 23 has received the notification from the synchrony group's master device 21 to multi-cast the resynchronize command at a time corresponding to "time = 0:00:07" according to the clock time indicated by its digital to analog converter clock 34, it (that is, the audio information channel device 23) has already multi-cast messages containing frames that are to be played at that time and subsequently. That is, the audio information channel device 23 has, multi-cast in packet 59, frames 51(106) through 51(108) that contain time stamps "time = 0:00:07," "time = 0:00:08" and "time = 0:00:09," respectively, and, in packet 60, in addition to the continuation of frame 51(108), frame 51(109) that contains time stamp "time = 0:00:10." (It will be appreciated that the times indicated by the illustrative time stamps are for illustration purposes only, and that in an actual embodiment the time stamps may have different values and differentials.)

As noted above, the audio information channel device 23 multi-casts a message containing a packet that, in turn, contains the resynchronize command when it receives the notification from the master device 21 to do so. In the example depicted in Packet Sequence A, the packet will be multi-cast when the audio information channel device's digital to analog converter clock time corresponds to "0:00:07." Subsequently, two things happen. In one, aspect, when the master device 21 and slave

devices 22(g) receive the packet that contains the resynchronize command, they will stop playing the audio program that they are playing.

In addition, the audio information channel device 23 will begin transmitting frames containing audio information for the next track, including therewith time stamps immediately following the digital to analog converter clock time at which the packet including the resynchronize command was transmitted. Accordingly, and with further reference to Packet Sequence A, the audio information channel device 23 will multi-cast a message containing packet 61. As indicated above, packet 61 contains, as represented in lines (A5.1) through (A5.3), frames 51(1) through 51(3), which are the first three frames of the next track of the audio program that is to be played. It is also compressed and encoded using the MP3 encoding and compression scheme, and it is accompanied by time stamps "time = 0:00:07," "time = 0:00:08" and "time = 0:00:10." As noted above, the time stamp "time = 0:00:07" corresponds to the clock time at which the audio information channel device 23 multi-casts the resynchronize command, and, when the master device 21 and slave devices 22(g) receive these frames, they would be expected to begin playing them very shortly, if not immediately after the audio information channel device 23 multi-casts the message containing the packet that, in turn, contains the resynchronize command. Packet 61 also includes at least a portion of the next frame, that is, frame 51(4), for that track. In addition, Packet Sequence A depicted above further includes a subsequent packet, namely, packet 62, that contains any necessary continuation of frame 51(4), as well as three subsequent frames. If any additional packets are required for the track, as well as for subsequent tracks, they can be multi-cast in a similar manner.

As further noted above, the resynchronize command can also be used to cancel playing of one or more tracks for which playback has begun. This will be illustrated in connection with Packet Sequence B:

Packet Sequence B

(B1.0) [packet 157]

(B1.1) [continuation of frame 99]

(B1.2) [frame 100, time = 0:00:01, type = mp3 audio]

(B1.3) [frame 101, time = 0:00:02, type = mp3 audio]

(B1.4) [frame 102, time = 0:00:03, type = mp3 audio]

(B2.0) [packet 158]

(B2.1) [continuation of frame 102]

(B2.2) [frame 103, time = 0:00:04, type = mp3 audio]

(B2.3) [frame 104, time = 0:00:05, type = mp3 audio]

(B2.4) [frame 105, time = 0:00:06, type = mp3 audio]

(B3.0) [packet 159]

(B3.1) [continuation of frame 105]

(B3.2) [frame 106, time = 0:00:07, type = mp3 audio]

(B3.3) [track boundary notification]

(B3.4) [Padding, if necessary]

(B4.0) [packet 160]

(B4.1) [frame 1, time = 0:00:08, type = mp3 audio]

(B4.2) [frame 2, time = 0:00:09, type = mp3 audio]

(B4.3) [frame 3, time = 0:00:10, type = mp3 audio]

(B5.0) [packet 161]

(B5.1) [continuation of frame 3]

(B5.2) [frame 4, time = 0:00:11, type = mp3 audio]

(B5.3) [Resynchronize, after packet 159]

(B5.4) [Padding, if necessary]

(B6.0) [packet 162]

(B6.1) [frame 1, time = 0:00:08, type = mp3 audio]

(B6.2) [frame 2, time = 0:00:09, type = mp3 audio]

(B6.3) [frame 3, time = 0:00:10, type = mp3 audio]

(B6.4) [frame 4, time = 0:00:11, type = mp3 audio]

(B7.0) [packet 163]

(B7.1) [continuation of frame 4]

(B7.2) [frame 5, time = 0:00:12, type = mp3 audio]

(B7.3) [frame 6, time = 0:00:13, type = mp3 audio]

(B7.4) [frame 7, time = 0:00:14, type = mp3 audio]

Packet Sequence B comprises a series of seven packets, identified by packet 157 through 163 , that the audio information channel device 23 multi-casts to the members of a synchrony group 20. As with Packet Sequence A, it will be appreciated that the series of packets that the audio information channel device 23 may multi-cast to the synchrony group 20 may include packets prior to the packet 157, and may also include packets after packet 162. Each packet comprises a packet header, which is symbolized by lines (B1.0), (B2.0),...(B7.0) in Packet Sequence B. As in Packet Sequence A, each packet will also generally include information associated with at least a portion of a frame 51(f)along with its associated frame 55(f). As in the packets represented in Packet Sequence A, each packet includes information associated with a plurality of frames. Depending on the lengths of the packets, each packet may contain information associated with a portion of a frame, an entire frame, or multiple frames. Further, as with Packet Sequence A, it is assumed that each packet may contain information associated with multiple frames. In addition, it is assumed that a packet does not necessarily contain information associated with an integral number of frames; in that case, a packet may contain information associated with a portion of a frame, and the next packet will contain the information associated with the rest of a frame.

The structures of the packets represented by Packet Sequence B are similar to those described above in connection with Packet Sequence A, and will not be repeated here. Generally, Packet Sequence B illustratively contains a sequence of packets that represent at least portions of three tracks that may have been selected from, for example, a play list. In particular, packets 157 through 159 represent frames from a portion of one track, packets 160 and 161 represent frames from a second track and packets 162 and 163 represent frames from a third track. The play list indicated that the first, second and third tracks were to be played in that order. With particular reference to Packet Sequence B, it should be noted that line (B3.3) indicates that packet 159 includes an indication that that packet contains the last frame for the track, and line (B3.4) provides for padding to the end of the packet. The first frame of the next track begins in packet 160.

In connection with the use of the resynchronize command to cancel playback of a track, at least a portion of which the audio information channel device 23 has multi-cast to the members of the synchrony group, packet 161, in line (B5.3) represents a resynchronize command that indicates that resynchronization is to occur after packet 159, that is, immediately after the packet that contains the last frame of the first of the three tracks represented by the packets in Packet Sequence B. It should be noted that the resynchronize command is in the packet 161, while the resynchronization is to occur at packet 160, that is, the synchrony group is to not play the track starting with packet

160, but instead is to begin playing the track frames for which begin with the next packet, that is, packet 162. As with Packet Sequence A, in Packet Sequence B the audio information channel device 23, in packet 162 and 163, multi-casts frames whose time stamps indicate that they are to be played when the frames that were multi-cast in packets 160 and 161 were to be played. By use of the resynchronize command and specifying a packet in this manner, the audio information channel device can cancel playback of a track for which playback has not yet begun.

It will be appreciated that the resynchronize command is generally not necessary for cancelling play back of a track that the audio information channel device 23 has not started multi-casting to the synchrony group 20, since the audio information channel device 23 itself can re-order the play list to accommodate the cancellation.

The invention provides a number of advantages. In particular, the invention provides a network audio system in which a number of devices share information can reproduce audio information synchronously, notwithstanding the fact that packets, which may contain digital audio information, transmitted over the network to the various zone players connected thereto may have differing delays and the zone players operate with independent clocks. Moreover, although the invention has been described in connection with audio information, it will be appreciated that the invention will find utility in connection with any type of isochronous information for which synchrony among devices is desired. The system is such that synchrony groups are created and destroyed dynamically, and in such a manner as to avoid requiring a dedicated device as the master device.

It will be appreciated that a number of changes and modifications may be made to the network audio system 10 as described above. For example, although the invention has been described as providing that the audio information channel device 23 provides digital audio information to the members synchrony group 20 that has been encoded using particular types of encoding and compression methodologies, it will be appreciated that the audio information channel device 23 can provide digital audio information to various members of the synchrony group 20 that have been encoded and compressed using different types of encoding and compression methodologies, and, moreover, for which different sampling rates have been used. For example, the audio information channel device 23 may provide digital audio information to the master device 21 and slave devices 22(1) through 22(g_1) using the MP3 methodology at a specified sampling rate, the digital audio information for the same program to slave devices 22(g_1+1) through 22(g_2) using the WAV methodology at one specified sampling rate, and to slave devices 22(g_2+1) through 22(G)

using the WAV methodology at another specified sampling rate. In that case, the audio information channel device 23 can specify the particular encoding and compression methodology that has been used in the encoding type field 57 associated with each frame and the sampling rate in the sampling rate field 58. Moreover, since the encoding and compression type and sampling rate are specified for each frame, the encoding and compression type and sampling rate can be changed from frame to frame. The audio information channel device 23 may use different multi-cast addresses for the different encoding and compression types and sampling rates, but it will be appreciated that that would not be required.

It will be appreciated that two advantages of providing that the encoding and compression methodology and the sampling rate is provided on a frame-by-frame basis, instead of on, for example, a track-by-track basis, is that that would facilitate a slave device joining the synchrony group 20 at a frame mid-track, without requiring, for example, the master device 21 or the audio information channel device 23 to notify it of the encoding and compression methodology or the sampling rate.

Another modification is that, instead of the network communications manager 40 of a member of a synchrony group 20 generating the updated time stamp T^u_F for a digital audio information frame by adding the time differential value ΔT to the time stamp T_F associated with a frame, the network communications manager 40 may instead generate the updated time stamp T^U_F by subtracting the differential time value ΔT from the member's current time T_S as indicated by the member's digital to analog converter clock 34 at the time at which the digital audio information is received. It will be appreciated, however, that there may be variable time delays in processing of messages by the slave device's network communications manager 40, and so it may be preferable to generate the time differential value ΔT using the time stamp T_F provided by the audio information channel device 23.

In addition, instead of the network communications manager 40 of a member of a synchrony group generating an updated time stamp to reflect the difference between the times indicated by the member's digital to analog converter clock and the audio information channel device's digital to analog converter clock, the network communications manager 40 can generate the time differential value ΔT and provide it to the member's playback scheduler 32. In that case, the member's network communications manager 40 can store each digital audio information frame along with the time stamp T_F as received from the master device in the audio information buffer 21. The playback scheduler 32 can utilize the time differential value ΔT, and the time stamps T_F associated with the

digital audio information frames, to determine when the respective digital audio information frames are to be played. In determining when a digital audio information frame is to be played, the playback scheduler can add the time differential value to the time stamp T_F associated with the digital audio frame, and enable the digital audio frame to be coupled to the digital to analog converter 33 when the time indicated by the sum corresponds to the current time as indicated by the slave device's digital to analog converter clock 34. Alternatively, when the member's digital to analog converter clock 34 updates its current time T_S, the playback scheduler can generate an updated current time T'_S by subtracting the differential time value ΔT from the current time T_S, and using the updated current time T'_S to determine when to play a digital audio information frame.

As described above, the members of a synchrony group 20 periodically obtain the audio information channel device's current time value and uses the current time value that it receives from the audio information channel device to periodically update the time differential value ΔT that it uses in updating the time stamps associated with the various frames. It will be appreciated that, if the digital to analog converter clock(s) associated with the member(s) of a synchrony group 20 are ensured to have the same rate as the digital to analog converter clock, a member need only obtain the current time value from the audio information channel device once, at the beginning of playback.

As another alternative, if the zone players are provided with digital to analog converter clock 34 whose time and rate can be set by an element such as the network communications manager 40, when a zone player 11(n) is operating as a member of a synchrony group 20, its network communications manager 40 can use the various types of timing information that it receives from the audio information channel device 23, including the current time information and the playback timing information indicated by the time stamps that are associated with the various frames 51(f) comprising the audio and playback timing information that it receives, to adjust the synchrony group member's digital to analog converter clock's time value and/or the clock rate that it uses for playback. If the clock's time value is to be adjusted, when the synchrony group member's network communications manager 40 initially receives the current time information from the audio information channel device 23 for the synchrony group 20, the network communications manager 40 can set the synchrony group member's digital to analog converter clock 34 to the current time value as indicated by the audio information channel device's current time information. The network communications manager 40 can set the clock 34 to the current time value indicated by the audio information channel device's current time information once, or periodically as it receives the current time information.

Alternatively or in addition, the synchrony group member's network communications manager 40 can use one or both of the current time information and/or the playback timing information in the time stamps associated with the respective frames 51(f) to adjust the clock rate of the clock 34 that it uses for playback. For example, when the synchrony group member's network communications manager 40 receives a frame 51(f_X) having a time stamp having a time value T_{f_X}, it can generate the updated time value $T^U{}_{f_X} = T_{f_X} + \Delta T$ as described above, and store the frame with the time stamp with the updated time value in the audio information buffer 30. In addition, since both the number of samples in a frame and the sampling rate, which determines the rate at which the frame is to be played, are known to the network communications manager 40, it can use that information, along with the updated time value $T^U{}_{F_X}$ that is to be used for frame 51(f_X) to generate an expected updated time value $T^E{}_{f_{X+1}}$ that is expected for the updated time stamp of the next frame 51(f_{X+1}). After the synchrony group member's network communications manager 40 receives the next frame 51(f_{X+1}), it can generate the updated time value $T^U{}_{f_{X+1}}$ and compare that value to the expected updated time value $T^E{}_{f_{X+1}}$. If the two time values do not correspond, or if the difference between them is above a selected threshold level, the clock that is used by the audio information channel device 23 to generate the time stamps is advancing at a different rate than the synchrony group member's digital to analog converter clock 34, and so the network communications manager 40 can adjust the rate of the digital to analog converter clock 34 to approach that of the clock used by the audio information channel device 23 so that the differential time value ΔT is constant. On the other hand, if the two time values do correspond, then the time differential value ΔT is constant, or the difference is below a threshold level, and the network communications manager 40 need not change the clock rate of the digital to analog converter clock 34. It will be appreciated that, if the clock rate is to be adjusted, the rate adjustment can be fixed, or it can vary based on, for example, the difference between the updated time value $T^U{}_{f_{X+1}}$ and the expected updated time value $T^E{}_{f_{X+1}}$.

It will also be appreciated that, if no rate adjustment is performed for one frame 51(f_{X+1}), the synchrony group member's network communications manager 40 can generate an expected updated

time value $T^{E}_{f_{X+2}}$ that is expected for the updated time stamp of the next frame 51(f_{X+2}) using the updated time value $T^{U}_{F_X}$ determined for frame 51(f_X), along with the number of samples in a frame and the sampling rate, and compare the expected updated time value $T^{E}_{f_{X+2}}$ to the updated time value $T^{U}_{f_{X+2}}$ that it generates when it receives frame 51(f_{X+2}). At that point, if the network communications manager 41 determines that two time values do not correspond, or if the difference between them is above a selected threshold level, it can adjust the rate of the digital to analog converter clock 34. Similar operations can be performed if no rate adjustment is performed for several successive frames 51(f_{X+1}), 51(f_{X+2}),.... This will accommodate the possibility that the rate differential between the clock 34 and the clock used by the audio information channel device 23 in generating the time stamps have rates that differ by an amount sufficiently small that it cannot be detected using time stamps of two or more successive frames.

Instead or in addition to adjusting the clock rate as described above, the synchrony group member's network communications manager 40 can perform similar operations in connection with adjusting the clock rate in connection with the current time information that it receives from the audio information channel device 23.

Furthermore, although the network audio system 10 has been described such that the master device 21 of a synchrony group 20 can, in response to control information provided thereto by a user through the user interface module 13, provide a notification to a zone player 11(n) that it is to become a member of its synchrony group 20 as a slave device 22(g), it will be appreciated that the user interface module 13 can provide the notification directly to the zone player 11(n) that is to become a member of the synchrony group 20. In that case, the zone player 11(n) can notify the master device 21 that it is to become a slave device 22(g) in the synchrony group 20, after which the master device 21 can provide information regarding the synchrony group 20, including the multi-cast and unicast addresses of the audio information channel device and other information as described above.

Similarly, although the network audio system 10 has been described such that the master device 21 of a synchrony group 20 can, in response to control information provided thereto by a user through the user interface module 13, provide a command to a slave device 22(g) to enable the slave device 22(g) to adjust its volume, it will be appreciated that the user interface module 13 can provide

control information directly to the slave device 22(g) to enable the slave device 22(g) to adjust its volume.

In addition, although the network audio system 10 has been described such that each frames 51(f) is associated with a frame sequence number (reference field 56, FIG. 4), it will be appreciated that, if the packets described above in connection with Packet Sequence A and Packet Sequence B are provided with packet sequence numbers, the frame sequence numbers need not be provided, since the packet sequence numbers can suffice for defining the frame sequencing.

Furthermore, although the network audio system 10 has been described such that the zone players 11(n) are provided with an audio amplifier 35 for amplifying the analog signal provided by the respective digital to analog converters 33, it will be appreciated that a zone player may be provided that does not itself include an audio amplifier. In that case, the analog signal may be coupled to an external amplifier for amplification as necessary before being provided to the audio reproduction device(s) 15(n)(r). It will be appreciated that a single zone player 11(n) may be provided with multiple audio amplifiers and audio reproduction device interfaces, and, if necessary, multiple digital to analog converters 33, to provide audio programs for corresponding numbers of synchrony groups.

Similarly, although the zone players 11(n) have been described such that they may be connected to one or more audio information sources, it will be appreciated that an audio information source may form part of and be integrated into a zone player 11(n). For example, a zone player may include a compact disk player, cassette tape player, broadcast radio receiver, or the like, that has been integrated into it. In addition, as noted above, an individual zone player 11(n) may be connected to multiple audio information sources and may contemporaneously operate as the audio information channel device 23 for multiple synchrony groups .

In addition, although FIG. 1 shows the network audio system 10 as including one user interface module 13, it will be appreciated that the system 10 may include a plurality of user interface modules. Each user interface module be useful for controlling all of the zone players as described above, or alternatively one or more of the user interface modules may be useful for controlling selected subsets of the zone players.

Moreover, it will be appreciated that, although the invention has been described in connection with audio information, it will be appreciated that the invention will find utility in connection with any type of information for which synchrony among devices connected to a network is desired.

As noted above, while a zone player 11(n) is operating as audio information channel device 23 for a synchrony group 20, when the zone player 11(n)'s audio information source interface 30 or network communications manager 40 stores digital audio information frames based on audio information from an audio information source 14(n)(s) in the audio information buffer 31, it will provide time stamps for the respective frames to schedule them for playback after some time delay after they have been buffered in the audio information buffer 31. The delay is provided so that, for other zone players 11(n'), 11(n"),... that are operating as members of a synchrony group, there will be sufficient time for the audio and playback timing information to be transferred over the network 12 to those other zone players 11(n'), 11(n"),... so that it can be processed and played by them at the appropriate time as described above. The time period that is selected for the time delay may be fixed or variable, and in either case may be based on a number of factors. If the time period selected for the time delay is fixed, it may be based on, for example, factors such as an estimate of the maximum latency in the network 12, the estimated maximum loading of the various components comprising the zone players 11(n), and other estimates as will be appreciated by those skilled in the art.

The time delay may be the same for audio information from all types of audio information sources, and may be constant over the entire period that the synchrony group 20 is playing an audio work. Alternatively, different time delays may be utilized based on various criteria. For example, if the audio information is to be played independently of information associated with other types of media, the time delay may be selected to be relatively long, on the order of a significant fraction of a second, or longer. On the other hand, if the audio information is to be played contemporaneously with, for example, video information, which may be supplied by, for example, a video disk, video tape cassette, over cable, satellite, or broadcast television, which may not be buffered or which may be displayed independently of the network audio system 10, it may be undesirable to provide for such a lengthy delay, since the time delay of the audio playback, in relation to the video display, may be noticeable. In that case, the zone player 11(n) may provide for a much shorter time delay. In one embodiment, the time delay provided for audio information to be played concurrently with video information is selected to be generally on the order of fifty milliseconds, which would barely, if at all, be perceptible to someone viewing the video. Other desirable time delays for information from other types of sources will be apparent to those skilled in the art.

As yet a further possibility, the zone player 11(n), when operating as an audio information channel device 23 for a synchrony group 20, can dynamically determine the time delay based on a number of conditions in the network audio system 10, including, for example, the message transfer

latency in network 12, the loading of microprocessors or other components that are used in the various zone players 11(n'), 11(n"),... that may comprise a synchrony group 20, as well as other factors. For example, if the audio information channel device 23 determines that the latency in the network 12 has increased beyond a selected threshold, the audio information channel device 23 can adjust the delay to increase the likelihood that the members of the synchrony group 20 will be able to receive the packets and process the frames so that they will be able to play them at the appropriate times. Similarly, if the audio information channel device 23 is notified that a member of the synchrony group 20 to which it provides audio information requires additional time to receive and process the frames that it transmits, the audio information channel device 23 can adjust the delay accordingly. It will be appreciated that, to reduce or minimize possible discontinuities in the audio playback by the members of the synchrony group, the audio information channel device 23 can, instead of adjusting the time delay during a particular audio track, adjust the time delay between tracks, during silent periods of a track or otherwise as will be appreciated by those skilled in the art. In addition, the audio information channel device 23 can use conventional audio compression methodologies to facilitate a speeding up and/or slowing down of playback of an audio track while it is in the process of providing additional time delay. Generally, the members of the synchrony group 20 can provide notifications to the audio information channel device 23 if they determine that they will need an additional time delay, and the audio information channel device 23 can adjust the time delay in accordance with the notifications from the members of the synchrony group 20.

It will be appreciated that a system in accordance with the invention can be constructed in whole or in part from special purpose hardware or a general purpose computer system, or any combination thereof, any portion of which may be controlled by a suitable program. Any program may in whole or in part comprise part of or be stored on the system in a conventional manner, or it may in whole or in part be provided in to the system over a network or other mechanism for transferring information in a conventional manner. In addition, it will be appreciated that the system may be operated and/or otherwise controlled by means of information provided by an operator using operator input elements (not shown) which may be connected directly to the system or which may transfer the information to the system over a network or other mechanism for transferring information in a conventional manner.

The foregoing description has been limited to a specific embodiment of this invention. It will be apparent, however, that various variations and modifications may be made to the invention, with the attainment of some or all of the advantages of the invention. It is the object of the appended

claims to cover these and such other variations and modifications as come within the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent is:

CLAIMS

1. A system comprising plurality of devices, one of the devices operating as a task source device and at least one other device operating as a member of a synchrony group,

A. the task source device being configured to distribute a series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to a clock maintained by the task source device, at which the devices comprising the synchrony group are to execute the respective task;

B each member device being configured to:

(i) periodically obtain from the task source device an indication of a current time value indicated by the task source device's clock, and

(ii) determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value indicated by the task source device's clock, and a current time value indicated by its respective clock, a time, relative to its respective clock, at which it is to execute the task.

2. A system as defined in claim 1 in which the synchrony group comprises a plurality of member devices.

3. A system as defined in claim 2 in which each device comprising a member of the synchrony group is further configured to execute each task that it receives from the task source device at the determined time, thereby to facilitate execution by them of respective tasks in the series in respective timing relationships relative to the time indicated by the task source device's clock.

4. A system as defined in claim 3 in which the member devices are configured to execute respective tasks in synchrony.

5. A system as defined in claim 2 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the master device being configured to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

6. A system as defined in claim 5 further including a user interface module configured to control the master device's performance of said at least one type of synchrony group management operation, the master device being further configured to provide status information relating to the status of the synchrony group to the user interface module.

7. A system as defined in claim 6 in which the status information includes identifications of the devices comprising the synchrony group.

8. A system as defined in claim 6 in which the status information includes an identification of the task currently being executed.

9. A system as defined in claim 5, the system comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is configured to enable the at least one additional device to join the synchrony group as a slave device.

10. A system as defined in claim 9 in which the task source device is configured to distribute tasks to the member devices using a selected multi-cast transmission methodology, the member devices being configured to buffer the tasks until they are to be executed, and further in which, when the at least one additional device joins the synchrony group as a slave device, the task source device is enabled to transmit at least one previously distributed task to the slave device using a selected unicast transmission methodology.

11. A system as defined in claim 5 in which, in at least one type of synchrony group management operation, the master device is configured to enable the task source device to join the synchrony group as a slave device, the task source device continuing to operate as the task source device for the synchrony group.

12. A system as defined in claim 5 in which, in at least one type of synchrony group management operation, the master device is configured to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group.

13. A system as defined in claim 5 in which, in at least one type of synchrony group management operation, the master device is configured to control the series of tasks to be distributed by the task source device.

14. A system as defined in claim 5 in which, in at least one type of synchrony group management operation, the master device is further configured to control execution by the member devices of the tasks that have been distributed by the task source device.

15. A system as defined in claim 14 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which in at least one type of synchrony group management operation, the master device is configured to enable the member devices to terminate execution of a task sequence that is currently being executed.

16. A system as defined in claim 15 in which, in the synchrony group management operation enabling the member devices to terminate execution of a task sequence that is currently being executed, the master device enables the task source device to distribute a command to enable the

member devices to terminate execution of the task sequence, the member devices being configured to, after receiving the command, terminate execution of the task sequence.

17. A system as defined in claim 14 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which at least one type of synchrony group management operation, the master device is configured to enable the member devices to cancel execution of a task sequence that has been previously distributed, but for which execution has not begun.

18. A system as defined in claim 17 in which, in the synchrony group management operation enabling the member devices to cancel execution of a task sequence that has been previously distributed but for which execution has not begun, the master device enables the task source device to distribute a command to enable the member devices to cancel execution of the task sequence, the member devices being configured to, after receiving the command, cancel execution of the task sequence.

19. A system as defined in claim 5 in which, in at least one type of synchrony group management operation, the member device operating as the master device is configured to enable the master device to migrate from one member device to another member device in the synchrony group.

20. A system as defined in claim 5 in which, in at least one type of synchrony group management operation, the master device is configured to enable the task source device to migrate from one device to another device in the system.

21. A system as defined in claim 20 in which

A. the device operating as the task source device is configured to, after being enabled to migrate the task source device to said other device, provide migration information to the other device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices,

B. the other device being configured to, after receiving the migration information,

   i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

   ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

22. A system as defined in claim 21 in which the information respecting the tasks that are to be distributed is a source of streaming information, the other device being configured to, after receiving the migration information, assemble the streaming information into tasks and associate each task with a said time stamp.

23. A system as defined in claim 21 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the other device being configured to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

24.A system as defined in claim 23 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being configured to assemble the information from a position in the file associated with the identified offset.

25. A system as defined in claim 23 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the other device being configured to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

26. A system as defined in claim 1 in which the task source device is further configured to distribute the tasks using a selected multi-cast message transmission methodology.

27. A system as defined in claim 1 in which the task source device is configured to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

28. A system as defined in claim 27 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

29. A system as defined in claim 28 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

30. A system as defined in claim 27 in which task source device is configured to obtain information associated with the tasks from at least two types of information sources, the task source device being further configured to select, for each task the delay interval between the time indicated by the time

stamp and the current time based on the information source type that is associated with the respective task.

31. A system as defined in claim 1 in which at least one member device is further configured to adjust its clock rate in relation to a clock rate value maintained by the task source device's clock.

32. A system as defined in claim 31 in which the at least one member device is configured to adjust its clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

33. A system as defined in claim 1 in which at least one other device operates as a task source device configured to distribute tasks to a second synchrony group, the device operating as the task source device for the first synchrony group also operating as a member device of a second synchrony group.

34. A system as defined in claim 1 in which at least one member device comprises:

A. a task receiving module configured to receive the series of tasks,

B. a current time retrieval module configured to obtain, from the task source device, the current time value as indicated by the task source's clock;

C. an execution time determination module configured to determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the member device's respective clock at which the task is to be executed; and

D. a task execution module configured to execute each respective task at the time determined by the execution time determination module.

35. A system as defined in claim 34 further including a control module for controlling execution of commands received by said interface module.

36. A system as defined in claim 35 in which the at least one member device further comprises a buffer configured to buffer tasks that the task receiving module receives from the task source device until they are to be executed, the task execution module being configured to execute the buffered tasks at the times determined by the execution time determination module.

37. A system as defined in claim 36 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task

sequence currently being executed, being configured to not execute subsequent tasks in the task sequence that have been buffered.

38. A system as defined in claim 37 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a subsequent task sequence at a time determined by the execution time determination module.

39. A system as defined in claim 36 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, enable the task execution module to not execute tasks from that task sequence that have been buffered.

40. A system as defined in claim 39 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

41. A system as defined in claim 34 in which the member device includes:

A. a migration information receiving module configured to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control module configure to, after the migration information has been received.,

   i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

   ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

42. A system as defined in claim 41 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into tasks and associate each task with a said time stamp.

43. A system as defined in claim 41 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

44.A system as defined in claim 43 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

45. A system as defined in claim 43 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

46. A system as defined in claim 34 in which the member device further includes a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

47. A system as defined in claim 46 in which the clock rate adjustment module is configured to adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

48. A system as defined in claim 1 in which the task source device comprises:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. an execution control command generation module configured to, in response to a predetermined event, enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

49. A system as defined in claim 48 in which the task transmission module is configured to utilize a selected multi-cast transmission methodology.

50. A system as defined in claim 48 in which the predetermined event comprises input indicia provided by an operator.

51. A system as defined in claim 50 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

52. A system as defined in claim 51 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

53. A system as defined in claim 51 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

54. A system as defined in claim 53 in which the task transmission module is configured to insert a command to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

55. A system as defined in claim 48 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert

into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

56. A system as defined in claim 55 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

57. A system as defined in claim 55 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

58. A system as defined in claim 57 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

59. A system as defined in claim 55 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

60 A system as defined in claim 1 in which the task source device comprises:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. a task source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

61. A system as defined in claim 60 in which the task source device is configured to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

62. A system as defined in claim 61 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

63. A system as defined in claim 62 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

64. A system as defined in claim 62 in which task source device is configured to obtain information associated with the tasks from at least two types of information sources, the task source device being further configured to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

65. A device for executing a series of tasks provided by a task source at times specified by the task source in relation to a clock maintained by the task source, the device comprising

A. an interface module configured to receive the series of tasks, each task being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the task source, at which the device is to execute the respective task;

B. a current time retrieval module configured to obtain, from the task source, a current time value as indicated by the task source's clock;

C. an execution time determination module configured to determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the task is to be executed; and

D. a task execution module configured to execute each respective task at the time determined by the execution time determination module.

66. A device as defined in claim 65 further including a control module for controlling execution of commands received by said interface module.

67. A device as defined in claim 65 further comprising a buffer configured to buffer tasks that the interface module has received until they are to be executed, the task execution module being configured to execute the buffered tasks at the times determined by the execution time determination module.

68. A device as defined in claim 67 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being configured to not execute subsequent tasks in the task sequence that have been buffered.

69. A device as defined in claim 68 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a subsequent task sequence at a time determined by the execution time determination module.

70. A device as defined in claim 69 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to receive task execution control commands for controlling task execution, the control module being configured to, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, enable the task execution module to not execute tasks from that task sequence that have been buffered.

71. A device as defined in claim 70 in which the control module is configured to enable the task execution module to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

72. A device as defined in claim 66, the control module being configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks for execution by the task execution module.

73. A device as defined in claim 72 in which the control module is configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed task using a selected unicast transmission methodology.

74. A device as defined in claim 65 in which the control module is configured to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving tasks and the task execution module from executing previously received tasks that have not yet been executed.

75. A device as defined in claim 65 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable selected operations to be performed in response to the control information.

76. A device as defined in claim 75 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

77. A device as defined in claim 75 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

78. A device as defined in claim 75 in which, in response to control information to enable the task source to begin operating, the control module performs selected operations to enable the task source to begin operating.

79. A device as defined in claim 78, the device also operating as the task source, the device including a task generator module configured to, under control of the control module, obtain information from which the tasks are to be generated and generate the tasks.

80. A device as defined in claim 79 in which the interface module is further configured to transmit the tasks to at least one other device.

81. A device as defined in claim 79 in which the device is not the task source, the control module being configured to enable the interface module to transmit a command to enable the task source to operate.

82. A device as defined in claim 81 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks currently being executed to be terminated , the control module is configured to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of tasks associated with the task sequence to enable termination of execution of the task sequence.

83. A device as defined in claim 81 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks at least a portion of which have been received, but which are not being executed, the control module is configured to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of commands to disable execution of the task sequence.

84. A device as defined in claim 75 in which the control module is configured to enable the user interface module interface module to transmit status information to the user interface module.

85. A device as defined in claim 84 in which the status information includes the execution status of at least one task.

86. A device as defined in claim 65 further including:

A. a migration information receiving module configured to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control module configured to, after the migration information has been received.,

   i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

87. A device as defined in claim 86 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into tasks and associate each task with a said time stamp.

88. A device as defined in claim 86 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

89. A device as defined in claim 88 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

90. A device as defined in claim 89 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

91. A device as defined in claim 65 further including a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

92. A task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the task source device comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. an execution control command generation module configured to, in response to a predetermined event, enable the task transmission module to insert into the series of tasks

transmitted by the task transmission module a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

93. A task source device as defined in claim 92 in which the task transmission module is configured to utilize a selected multi-cast transmission methodology.

94. A task source device as defined in claim 92 in which the predetermined event comprises input indicia provided by an operator.

95. A task source device as defined in claim 94 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

96. A task source device as defined in claim 95 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

97. A task source device as defined in claim 95 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

98. A task source device as defined in claim 97 in which the task transmission module is configured to insert a command to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

99. A task source device as defined in claim 92 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

100. A task source device as defined in claim 99 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

101. A task source device as defined in claim 99 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

102. A task source device as defined in claim 101 in which, in response to said predetermined event, the execution control command generation module is configured to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

103. A task source device as defined in claim 99 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

104. A task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the task source device comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time, the task execution time determination module being configured to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by a clock maintained by the task source device; and

C. a task transmission module configured to transmit the series of tasks to said at least one other device.

105. A system as defined in claim 104 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

106. A system as defined in claim 105 in which the task source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

107. A system as defined in claim 104 in which task source device is configured to obtain information associated with the tasks from at least two types of information sources, the task source device being further configured to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

108. A task source device for distributing a series of tasks for execution by at least one other device, the task source device comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. a task source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

109. A method of operating a system comprising plurality of devices, one of the devices operating as a task source device and at least one other device operating as a member of a synchrony group,

A. the task source device being enabled to distribute a series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to a clock maintained by the task source device, at which the devices comprising the synchrony group are to execute the respective task;

B each member device being enabled to:

(i) periodically obtain from the task source device an indication of a current time value indicated by the task source device's clock, and

(ii) determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value indicated by the task source device's clock, and a current time value indicated by its respective clock, a time, relative to its respective clock, at which it is to execute the task.

110. A method as defined in claim 109 in which the synchrony group comprises a plurality of member devices.

111. A method as defined in claim 110 in which each device comprising a member of the synchrony group is further enabled to execute each task that it receives from the task source device at the determined time, thereby to facilitate execution by them of respective tasks in the series in respective timing relationships relative to the time indicated by the task source device's clock.

112. A method as defined in claim 111 in which the member devices are enabled to execute respective tasks in synchrony.

113. A method as defined in claim 110 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the master device being enabled to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

114. A method as defined in claim 113 further including a user interface module enabled to control the master device's performance of said at least one type of synchrony group management operation, the master device being further enabled to provide status information relating to the status of the synchrony group to the user interface module.

115. A method as defined in claim 114 in which the status information includes identifications of the devices comprising the synchrony group.

116. A method as defined in claim 114 in which the status information includes an identification of the task currently being executed.

117. A method as defined in claim 113, the method comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is enabled to enable the at least one additional device to join the synchrony group as a slave device.

118. A method as defined in claim 117 in which the task source device is enabled to distribute tasks to the member devices using a selected multi-cast transmission methodology, the member devices being enabled to buffer the tasks until they are to be executed, and further in which, when the at least one additional device joins the synchrony group as a slave device, the task source device is enabled to transmit at least one previously distributed task to the slave device using a selected unicast transmission methodology.

119. A method as defined in claim 113 in which, in at least one type of synchrony group management operation, the master device is enabled to enable the task source device to join the synchrony group as a slave device, the task source device continuing to operate as the task source device for the synchrony group.

120. A method as defined in claim 113 in which, in at least one type of synchrony group management operation, the master device is enabled to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group.

121. A method as defined in claim 113 in which, in at least one type of synchrony group management operation, the master device is enabled to control the series of tasks to be distributed by the task source device.

122. A method as defined in claim 113 in which, in at least one type of synchrony group management operation, the master device is further enabled to control execution by the member devices of the tasks that have been distributed by the task source device.

123. A method as defined in claim 122 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which in at least one type of synchrony group management operation, the master device is enabled to enable the member devices to terminate execution of a task sequence that is currently being executed.

124. A method as defined in claim 123 in which, in the synchrony group management operation enabling the member devices to terminate execution of a task sequence that is currently being executed, the master device enables the task source device to distribute a command to enable the member devices to terminate execution of the task sequence, the member devices being enabled to, after receiving the command, terminating execution of the task sequence.

125. A method as defined in claim 122 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, and further in which at least one type of synchrony group management operation, the master device is enabled to enable the member devices to cancel execution of a task sequence that has been previously distributed, but for which execution has not begun.

126. A method as defined in claim 125 in which, in the synchrony group management operation enabling the member devices to cancel execution of a task sequence that has been previously distributed but for which execution has not begun, the master device enables the task source device to distribute a command to enable the member devices to cancel execution of the task sequence, the member devices being enabled to, after receiving the command, cancel execution of the task sequence.

127. A method as defined in claim 113 in which, in at least one type of synchrony group management operation, the member device operating as the master device is enabled to enable the master device to migrate from one member device to another member device in the synchrony group.

128. A method as defined in claim 113 in which, in at least one type of synchrony group management operation, the master device is enabled to perform the step of enabling the task source device to migrate from one device to another device in the system.

129. A method as defined in claim 128 in which

A. the device operating as the task source device is enable to perform the step of, after being enabled to migrate the task source device to said other device, providing migration

information to the other device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices,

B. the other device is enabled to, after receiving the migration information, perform the steps of

i. distributing the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notifying the members of the synchrony group that it is to thereafter operate as the task source device.

130. A method as defined in claim 129 in which the information respecting the tasks that are to be distributed is a source of streaming information, the other device being enabled to, after receiving the migration information, perform the steps of assembling the streaming information into tasks and associating each task with a said time stamp.

131. A method as defined in claim 129 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the other device being enabled to perform the steps of obtaining information from the identified file, assembling the information into tasks and associating each task with a said time stamp.

132.A method as defined in claim 131 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being enabled to perform the step of assembling the information from a position in the file associated with the identified offset.

133. A method as defined in claim 131 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the other device being enabled to perform the step of obtaining information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

134. A method as defined in claim 109 in which the task source device is further enabled to distribute the tasks using a selected multi-cast message transmission methodology.

135. A method as defined in claim 109 in which the task source device is enabled to perform the step of providing, provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

136. A method as defined in claim 135 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

137. A method as defined in claim 136 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

138. A method as defined in claim 135 in which task source device is enabled to perform the steps of obtaining information associated with the tasks from at least two types of information sources, and selecting, for each task, the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

139. A method as defined in claim 109 in which at least one member device is further enabled to perform the step of adjusting its clock rate in relation to a clock rate value maintained by the task source device's clock.

140. A method as defined in claim 139 in which the at least one member device is enabled to perform the step of adjusting its clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

141. A method as defined in claim 109 in which at least one other device operates as a task source device enabled to distribute tasks to a second synchrony group, the device operating as the task source device for the first synchrony group also operating as a member device of a second synchrony group.

142. A method as defined in claim 109 including, within a member device,

A. a task receiving step of receiving the series of tasks,

B. a current time retrieval step of obtaining, from the task source device, the current time value as indicated by the task source's clock;

C. an execution time determination step of determining, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the member device's respective clock at which the task is to be executed; and

D. a task execution step of executing each respective task at the time determined during the execution time determination step.

143. A method as defined in claim 142 further including a control step for controlling execution of commands received during the task receiving step

144. A method as defined in claim 143 in which the at least one member device further comprises a buffer configured to buffer tasks received from the task source device during the task receiving step until they are to be executed, the task execution step including the step of executing the buffered tasks at the times determined during the execution time determination step.

145. A method as defined in claim 144 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the task receiving step being further enabled to receive task execution control commands for controlling task execution, the control step including the step of, in response to receipt of at least one task execution control command for controlling task execution, controlling the task execution step to terminate execution of a task sequence currently being executed, and further to not execute subsequent tasks in the task sequence that have been buffered.

146. A method as defined in claim 145 in which the control step includes the step of enabling the task execution step to resume execution of at least one task associated with a subsequent task sequence at a time determined during the execution time determination step.

147. A method as defined in claim 144 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the task receiving step including the step of receiving task execution control commands for controlling task execution, the control step including the step of, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, providing that tasks from that task sequence that have been buffered not be executed.

148. A method as defined in claim 147 in which the control step includes the step of enabling execution to resume of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

149. A method as defined in claim 142 in which the member device performs:

A. migration information receiving step of receiving migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control step of, after the migration information has been received.,

i. distributing the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notifying the members of the synchrony group that it is to thereafter operate as the task source device.

150. A method as defined in claim 149 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into tasks and associating each task with a said time stamp.

151. A method as defined in claim 149 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into tasks and associating each task with a said time stamp.

152. A method as defined in claim 151 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

153. A method as defined in claim 151 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into tasks and associating each task with as said time stamp.

154. A method as defined in claim 142 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

155. A method as defined in claim 154 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

156. A method as defined in claim 109 including, within a task source device,

A. a task acquisition step of obtaining respective ones of the tasks;

B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission step of transmitting the series of tasks to said at least one other device; and

D. an execution control command generation step of, in response to a predetermined event and during the task transmission step, the insertion into the series of tasks transmitted by the task transmission module of a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

157. A method as defined in claim 156 in which the task transmission step includes the step of utilizing a selected multi-cast transmission methodology.

158. A method as defined in claim 156 in which the predetermined event includes the step of receiving input indicia provided by an operator.

159. A method as defined in claim 158 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

160. A method as defined in claim 159 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

161. A method as defined in claim 159 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the task transmission step the insertion, into the series of tasks, of a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and

(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will

reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and

(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

162. A method as defined in claim 161 in which the task transmission step includes the step of inserting a command into the task sequence to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

163. A method as defined in claim 159 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

164. A method as defined in claim 163 in which the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

165. A method as defined in claim 163 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the inserting into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

166. A method as defined in claim 165 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

167. A method as defined in claim 163 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the task transmission step, the insertion, into the series of tasks, of a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and

(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and

(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

168. A method as defined in claim 109 in which the task source device is enabled to perform

A. a task acquisition step of obtaining respective ones of the tasks;

B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission step of transmitting the series of tasks to said at least one other device; and

D. a task source device migration control step of, in response to a predetermined event, providing migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

169. A method as defined in claim 109 in which the task source device is enabled to perform the step of providing, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by the clock maintained by the task source device.

170. A method as defined in claim 169 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

171. A method as defined in claim 170 in which the task source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp

172. A method as defined in claim 169 in which task source device is enabled to perform the step of obtaining information associated with the tasks from at least two types of information sources, and selecting for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

173. A method of operating a device for executing a series of tasks provided by a task source at times specified by the task source in relation to a clock maintained by the task source, the method including

A. a task receiving step of receiving the series of tasks, each task being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the task source, at which the device is to execute the respective task;

B. a current time retrieval module of obtaining, from the task source, a current time value as indicated by the task source's clock;

C. an execution time determination step of determining, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the task is to be executed; and

D. a task execution module step of executing each respective task at the time determined during the execution time determination step.

174. A method as defined in claim 173 further including a control step for controlling execution of commands received by said interface module.

175. A method as defined in claim 174 further comprising a buffer configured to buffer tasks that have been received until they are to be executed, the task execution step including the step of executing the buffered tasks at the times determined during the execution time determination step.

176. A method as defined in claim 175 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further enabled to receive task execution control commands for controlling task execution, the control module being enabled to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being enabled to not execute subsequent tasks in the task sequence that have been buffered.

177. A method as defined in claim 176 in which the control step includes the step of enabling task execution to resume execution with at least one task associated with a subsequent task sequence at a time determined during the execution time determination step.

178. A method as defined in claim 175 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the task receiving step including

the step of receiving task execution control commands for controlling task execution, the control step, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, including the step of providing that task execution not including execution of tasks from that task sequence that have been buffered.

179. A method as defined in claim 178 in which the control step includes the step of enabling task execution to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

180. A method as defined in claim 173, the control step including the step of, in response to receipt of a command to become a member of a synchrony group, receiving tasks during the task receiving step for execution during the task execution step.

181. A method as defined in claim 180 in which the control step includes the step of, in response to receipt of a command to become a member of a synchrony group, enable the task receiving step to include the step of receiving tasks currently being transmitted using a selected multi-cast transmission methodology, and further to include the step of retrieving at least one previously distributed task using a selected unicast transmission methodology.

182. A method as defined in claim 173 in which the control step includes the steps of, in receipt of a command to disengage from a synchrony group, disabling the receipt of tasks and the execution of previously-received tasks that have not yet been executed.

183. A method as defined in claim 173 further comprising a user interface module control information receiving step of receiving control information from a user interface module, the control step including the step of enabling selected operations to be performed in response to the control information.

184 A method as defined in claim 183 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control step includes the step of transmitting a command to the other device to enable the other device to become a member of the synchrony group.

185. A method as defined in claim 183 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

186. A method as defined in claim 185 in which, in response to control information to enable the task source to begin operating, the control step includes the step of performing selected operations to enable the task source to begin operating.

187. A method as defined in claim 186, the device also operating as the task source, the method including a task generation steps of, under control of the control step, obtaining information from which the tasks are to be generated and generating the tasks.

188. A method as defined in claim 187 further including the step of transmitting the tasks to at least one other device.

189. A method as defined in claim 187 in which the device is not the task source, the control step including the step of enabling the transmission of a command to enable the task source to operate.

190. A method as defined in claim 189 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks currently being executed to be terminated , the control step includes the step of transmitting a command to enable the task source to insert a resynchronize command in the series of tasks associated with the task sequence to enable termination of execution of the task sequence.

191. A method as defined in claim 189 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks at least a portion of which have been received, but which are not being executed, the control step includes the step of transmitting a command to enable the task source to insert a resynchronize command in the series of commands to disable execution of the task sequence.

192. A method as defined in claim 174 in which the control step includes the step of transmitting status information to the user interface module.

193. A method as defined in claim 192 in which the status information includes the execution status of at least one task.

194. A method as defined in claim 173 in which the member device performs:

A. migration information receiving step of receiving migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control step of, after the migration information has been received.,

   i. distributing the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives

from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notifying the members of the synchrony group that it is to thereafter operate as the task source device.

195. A method as defined in claim 194 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into tasks and associating each task with a said time stamp.

196. A method as defined in claim 194 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into tasks and associating each task with a said time stamp.

197. A method as defined in claim 196 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

198. A method as defined in claim 196 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into tasks and associating each task with as said time stamp.

199. A method as defined in claim 173 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

200. A method as defined in claim 199 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

201. A method of operating a device for distributing a series of tasks for execution by at least one other device at respective execution times, the method comprising:

A. a task acquisition step of obtaining respective ones of the tasks;

B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission step of transmitting the series of tasks to said at least one other device; and

D. an execution control command generation step of, in response to a predetermined event and during the task transmission step, the insertion into the series of tasks transmitted by the task transmission module of a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

202. A method as defined in claim 201 in which the task transmission step includes the step of utilizing a selected multi-cast transmission methodology.

203. A method as defined in claim 201 in which the predetermined event includes the step of receiving input indicia provided by an operator.

204. A method as defined in claim 203 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

205. A method as defined in claim 204 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

206. A method as defined in claim 203 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the task transmission step the insertion, into the series of tasks, of a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and

(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and

(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

207. A method as defined in claim 206 in which the task transmission step includes the step of inserting a command into the task sequence to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

208. A method as defined in claim 201 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

209. A method as defined in claim 208 in which the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

210. A method as defined in claim 208 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the task transmission step, the inserting into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

211. A method as defined in claim 210 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the task transmission step, the insertion into the series of tasks of a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

212. A method as defined in claim 208 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the task transmission step, the insertion, into the series of tasks, of a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and

(ii) enabling

(a) during the task execution time determination step, that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and

(b) during the task transmission step, the transmission of the tasks of the subsequent task sequences to the at least one other device.

213. A method of operating a device for distributing a series of tasks for execution by at least one other device at respective execution times, the method comprising:

A. a task acquisition step of obtaining respective ones of the tasks;

B. a task execution time determination step of determining a time at which each respective task is to be executed, and to associating the respective task with a time stamp indicating its execution time, the task execution time determination step including the step of providing, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by a clock maintained by the task source device; and

C. a task transmission step of transmitting the series of tasks to said at least one other device.

214. A method as defined in claim 213 in which the task execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the device can be executed by at least one other device at the time indicated by the time stamp.

215. A method as defined in claim 214 in which the task execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the device can be distributed to other devices over a network for execution by the other devices at the time indicated by the time stamp.

216. A method as defined in claim 213 in which task acquisition step includes the step of obtaining information associated with the tasks from at least two types of information sources, the task execution time determination step including the step of selecting, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

217. A method of operating a device for distributing a series of tasks for execution by at least one other device, the method comprising:

A. a task acquisition module configured to obtain respective ones of the tasks;

B. a task execution time determination module configured to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to transmit the series of tasks to said at least one other device; and

D. a task source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

218. A computer program product for use in connection with a computer to provide a device for executing a series of tasks provided by a task source at times specified by the task source in relation to a clock maintained by the task source, the computer program product comprising a computer-readable medium having encoded thereon:

A. an interface module configured to enable the computer to receive the series of tasks, each task being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the task source, at which the device is to execute the respective task;

B. a current time retrieval module configured to enable the computer to obtain, from the task source, a current time value as indicated by the task source's clock;

C. an execution time determination module configured to enable the computer to determine, from the time stamp associated with each respective task and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the task is to be executed; and

D. a task execution module configured to enable the computer to execute each respective task at the time determined by the execution time determination module.

219. A computer program product as defined in claim 218 further including a control module for enabling said computer to control execution of commands received by the interface module.

220. A computer program product as defined in claim 219 further comprising a buffer module configured to enable the computer to buffer tasks received by the interface module until they are to

be executed, the task execution module being configured to enable the computer to execute the buffered tasks at the times determined by the execution time determination module.

221. A computer program product as defined in claim 220 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to enable the computer to receive task execution control commands for controlling task execution, the control module being configured to enable the computer to, in response to receipt of at least one task execution control command for controlling task execution, enable the task execution module to terminate execution of a task sequence currently being executed, being configured to enable the computer to not execute subsequent tasks in the task sequence that have been buffered.

222. A computer program product as defined in claim 220 in which the control module is configured to enable the computer to enable the task execution module to resume execution of at least one task associated with a subsequent task sequence at a time determined by the execution time determination module.

223. A computer program product as defined in claim 219 in which the series of tasks includes a series of task sequences with each task sequence including a subset of the series of tasks, the interface module being further configured to enable the computer to receive task execution control commands for controlling task execution, the control module being configured to enable the computer to, in response to receipt of at least one task execution control command to cancel execution of a task sequence for which at least one task has been buffered but for which execution has not begun, enable the task execution module to not execute tasks from that task sequence that have been buffered.

224. A computer program product as defined in claim 223 in which the control module is configured to enable the computer to enable the task execution module to resume execution of at least one task associated with a task sequence subsequent to the task sequence for which at least one task has been buffered but for which execution has not begun.

225. A computer program product as defined in claim 219, the control module being configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks for execution by the task execution module.

226. A computer program product as defined in claim 225 in which the control module is configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive tasks currently being transmitted using a selected

multi-cast transmission methodology, and further to retrieve at least one previously distributed task using a selected unicast transmission methodology.

227. A computer program product as defined in claim 219 in which the control module is configured to enable the computer to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving tasks and the task execution module from executing previously received tasks that have not yet been executed.

228. A computer program product as defined in claim 219 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable the computer to enable selected operations to be performed in response to the control information.

229. A computer program product as defined in claim 228 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

230. A computer program product as defined in claim 228 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

231. A computer program product as defined in claim 228 in which, in response to control information to enable the task source to begin operating, the control module performs selected operations to enable the task source to begin operating.

232. A computer program product as defined in claim 231, the device also operating as the task source, the device including a task generator module configured to enable the computer to, under control of the control module, obtain information from which the tasks are to be generated and generate the tasks.

233. A computer program product as defined in claim 232 in which the interface module is further configured to enable the computer to transmit the tasks to at least one other device.

234. A computer program product as defined in claim 232 in which the device is not the task source, the control module being configured to enable the computer to enable the interface module to transmit a command to enable the task source to operate.

235. A computer program product as defined in claim 234 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence

of tasks currently being executed to be terminated , the control module is configured to enable the computer to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of tasks associated with the task sequence to enable termination of execution of the task sequence.

236. A computer program product as defined in claim 234 in which tasks are divided into a series of task sequences, and, in response to receipt of control information enabling execution of a sequence of tasks at least a portion of which have been received, but which are not being executed, the control module is configured to enable the computer to enable the interface module to transmit a command to enable the task source to insert a resynchronize command in the series of commands to disable execution of the task sequence.

237. A computer program product as defined in claim 228 in which the control module is configured to enable the computer to enable the user interface module interface module to transmit status information to the user interface module.

238. A computer program product as defined in claim 237 in which the status information includes the execution status of at least one task.

239. A computer program product as defined in claim 218 further including:

A. a migration information receiving module configured to enable the computer to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control module configured to enable the computer to, after the migration information has been received.,

   i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

   ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

240. A computer program product as defined in claim 239 in which the information respecting the tasks that are to be distributed is a source of streaming information, the migration control module

being configured to enable the computer to, after the migration information has been received, assemble the streaming information into tasks and associate each task with a said time stamp.

241. A computer program product as defined in claim 239 in which the information respecting the tasks that are to be distributed is in a file identified in the migration information, the migration control module being configured to enable the computer to obtain information from the identified file, assemble the information into tasks and associate each task with a said time stamp.

242. A computer program product as defined in claim 241 in which the information respecting the tasks that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to enable the computer to assemble the information from a position in the file associated with the identified offset.

243. A computer program product as defined in claim 241 in which the information respecting the tasks that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to enable the computer to obtain information from successive files in the series assemble the information into tasks and associate each task with as said time stamp.

244. A computer program product as defined in claim 218 further including a clock rate adjustment module configured to enable the computer to adjust the member device's clock rate in relation to a clock rate value maintained by the task source device's clock.

245. A computer program product as defined in claim 244 in which the clock rate adjustment module is configured to enable the computer to adjust the clock rate in relation to time stamps associated with respective ones of the tasks received from the task source device.

246. A computer program product for use in connection with a computer to provide a task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a task acquisition module configured to enable the computer to obtain respective ones of the tasks;

B. a task execution time determination module configured to enable the computer to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to enable the computer to transmit the series of tasks to said at least one other device; and

D. an execution control command generation module configured to enable the computer to , in response to a predetermined event, enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to modify the execution sequence of the tasks transmitted thereto.

247. A computer program product as defined in claim 246 which the task transmission module is configured to enable the computer to utilize a selected multi-cast transmission methodology.

248. A computer program product as defined in claim 246 in which the predetermined event comprises input indicia provided by an operator.

249. A computer program product as defined in claim 246 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of at least one task in relation to the time the predetermined event occurs.

250. A computer program product as defined in claim 249 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to terminate execution of a task that it is currently executing and/or to not execute at least one task that is to be executed subsequent to the predetermined event.

251. A computer program product as defined in claim 249 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to enable the computer to , in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to terminate execution of the currently executing task and/or to not execute at least one subsequent task, if any, in the task sequence including the currently executing task; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence currently being executed will reflect the termination and/or non-execution of tasks from the task sequence of the task that is currently being executed, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

252. A computer program product as defined in claim 251 in which the task transmission module is configured to enable the computer to insert a command to enable the at least one other device to not execute all tasks in the task sequence subsequent to the terminated and/or non-executed task.

253. A computer program product as defined in claim 246 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to control execution of a task in relation to the task's position in the series of tasks.

254. A computer program product as defined in claim 253 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a task in relation to the task's position in the series of tasks.

255. A computer program product as defined in claim 254 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task in relation to the task's position in the series of tasks.

256. A computer program product as defined in claim 255 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the task transmission module to insert into the series of tasks transmitted by the task transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted task, in relation to the task's position in the series of tasks, for which execution has not begun.

257. A computer program product as defined in claim 253 in which the series of tasks includes a series of task sequences with each task sequence including a sub-set of the series of tasks, the execution control command generation module being configured to enable the computer to , in response to said predetermined event,

(i) enable the task transmission module to insert into the series of tasks transmitted by the task transmission module, a command enabling the at least one other device to cancel execution of a task sequence for which execution has not begun; and

(ii) enable

(a) the task execution time determination module to provide that time stamps associated with tasks of task sequences subsequent to the task sequence whose execution was cancelled will reflect the cancellation, and

(b) the task transmission module to transmit the tasks of the subsequent task sequences to the at least one other device.

258. A computer program product for use in connection with a computer to provide a task source device for distributing a series of tasks for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a task acquisition module configured to enable the computer to obtain respective ones of the tasks;

B. a task execution time determination module configured to enable the computer to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time, the task execution time determination module being configured to enable the computer to provide, associated with at least one task, a time stamp indicating a task execution time later than the time currently indicated by a clock maintained by the task source device; and

C. a task transmission module configured to enable the computer to transmit the series of tasks to said at least one other device.

259. A computer program product as defined in claim 258 in which the task execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one task distributed by the task source device can be executed by the member devices at the time indicated by the time stamp.

260. A computer program product as defined in claim 259 in which the task execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least

one task distributed by the task source device can be distributed to the member devices for execution at the time indicated by the time stamp.

261. A computer program product as defined in claim 258 in which task acquisition module is configured to enable the computer to obtain information associated with the tasks from at least two types of information sources, the task execution time determination module being configured to enable the computer to select, for each task the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective task.

262. A computer program product for use in connection with a computer to provide a task source device for distributing a series of tasks for execution by at least one other device, the computer program product comprising a computer readable medium having encoded thereon:

A. a task acquisition module configured to enable the computer to obtain respective ones of the tasks;

B. a task execution time determination module configured to enable the computer to determine a time at which each respective task is to be executed, and to associate the respective task with a time stamp indicating its execution time;

C. a task transmission module configured to enable the computer to transmit the series of tasks to said at least one other device; and

D. a task source device migration control module configured to enable the computer to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group.

263. A system comprising a plurality of devices,

A one device being enabled to operate as a task source device, the task source device being enabled to transmit a series of tasks to the other devices, each task being associated with execution time information;

B. at least one device being enabled to operate as a task execution device, the task execution device being enabled to receive the series of tasks from the network and executing each respective task at a time in relation to the timing information associated with the respective task; and

C. one device being enabled to operate as a control device, the control device being enabled to control operations of the task source device and the task execution device.

264. A system as defined in claim 263 in which the device that is enabled to operate as the control device is also enabled to operate as a task execution device.

265. A system as defined in claim 263 in which the device that is enabled to operate as the control device is also enabled to operate as the task source device.

266. A system as defined in claim 263 in which the device that is enabled to operate as the task source device is also enabled to operate as a task execution device.

267. A system for facilitating processing of data by device operating as a member of a synchrony group, synchronously with a clock maintained by a data source device that provides the data to the synchrony group,

A. the data source device being configured to divide the data into a series of frames for distribution to the synchrony group, each frame being associated with a time stamp indicating a time, relative to a clock maintained by the data source device, at which the devices comprising the synchrony group are to process the frame;

B each member device in the synchrony group being configured to:

(i) periodically obtain from the data source device an indication of a current time value indicated by the data source device's clock;

(ii) receive the series of frames from the data source device;

(iii) determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value indicated by the data source device's clock, a current time value indicated by the member device's respective clock, a time, relative to the member device's respective clock, at which the member device is to process the frame; and

(iv) process the respective frame at the determined time.

268. A system as defined in claim 267 in which at least one frame comprises audio data, each member device, while processing each frame, producing sound represented by the respective frame.

269. A system as defined in claim 267 comprising a plurality of member devices, the member devices processing each frame synchronously in relation to the clock maintained by the data source device so that they all produce sound represented by the respective frame synchronously.

270. A system as defined in claim 269 in which the data source device is configured to provide time stamps for at least two successive frames so that the member devices will play them with a selected time interval therebetween.

271. A system as defined in claim 270 in which the time interval is zero.

272. A system as defined in claim 269 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the master device being configured to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

273. A system as defined in claim 272 in which the master device is further configured to provide status information relating to the status of the synchrony group to the user interface module.

274. A system as defined in claim 273 in which the status information includes identifications of the devices comprising the synchrony group.

275. A system as defined in claim 273 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, each audio track being associated with an identifier, the status information including the identification of the audio track currently being played.

276. A system as defined in claim 272, the system comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is configured to enable the at least one additional device to join the synchrony group as a slave device.

277. A system as defined in claim 276 in which the data source device is configured to distribute frames to the member devices using a selected multi-cast transmission methodology, the member devices being configured to buffer the frames until they are to be played, and further in which, when the at least one additional device joins the synchrony group as a slave device, the data source device is enabled to transmit at least one previously distributed frame to the slave device using a selected unicast transmission methodology.

278. A system as defined in claim 272 in which, in at least one type of synchrony group management operation, the master device is configured to enable the data source device to join the synchrony group as a slave device, the data source device continuing to operate as the data source device for the synchrony group.

279. A system as defined in claim 272 in which, in at least one type of synchrony group management operation, the master device is configured to enable a slave device to disengage from the synchrony

group, the disengaged slave device thereafter not being a member device in the synchrony group and not playing frames distributed by the data source device.

280. A system as defined in claim 272 in which, in at least one type of synchrony group management operation, the master device is configured to control the series of frames to be distributed by the data source device.

281. A system as defined in claim 280 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, the master device being configured to control the frames to be distributed by the data source device on a track-by-track basis.

282. A system as defined in claim 281 in which, in at least one type of synchrony group management operation, the master device is further configured to control playback by the member devices of the frames associated with the respective audio tracks that have been distributed by the data source device in response to control information from the user interface module.

283. A system as defined in claim 282 in which, in response to control information from the user interface module to facilitate control of playback by the member devices, the master device is configured to enable the data source device to distribute a playback control command to the member devices.

284. A system as defined in claim 283 in which a playback control command enables the member devices to terminate playback of a track that is currently being played back.

285. A system as defined in claim 284 in which the playback control command enables the member devices to terminate playback of a track with a frame subsequent to a frame currently being played.

286. A system as defined in claim 283 in which the playback control command enables the member devices to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

287. A system as defined in claim 272 in which, in at least one type of synchrony group management operation, the member device operating as the master device is configured to enable the master device to migrate from itself to another member device in the synchrony group.

288. A system as defined in claim 272 in which, in at least one type of synchrony group management operation, the master device is configured to enable the data source device to migrate from one device to another device in the system.

289. A system as defined in claim 288 in which

A. the device operating as the data source device is configured to, after being enabled to migrate the data source device to said other device, provide migration information to the other device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices,

B. the other device being configured to, after receiving the migration information,

i. distribute the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and

ii. notify the members of the synchrony group that it is to thereafter operate as the data source device.

290. A system as defined in claim 289 in which the information respecting the frames that are to be distributed is a source of streaming information, the other device being configured to, after receiving the migration information, assemble the streaming information into frames and associate each frame with a said time stamp.

291. A system as defined in claim 289 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the other device being configured to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

292.A system as defined in claim 291 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being configured to assemble the information from a position in the file associated with the identified offset.

293. A system as defined in claim 291 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the other device being configured to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

294. A system as defined in claim 267 in which the data source device is further configured to distribute the frames using a selected multi-cast message transmission methodology.

295. A system as defined in claim 267 in which the data source device is configured to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

296. A system as defined in claim 295 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

297. A system as defined in claim 296 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

298. A system as defined in claim 295 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

299. A system as defined in claim 267 in which at least one member device is further configured to adjust its clock rate in relation to a clock rate value maintained by the data source device's clock.

300. A system as defined in claim 299 in which the at least one member device is configured to adjust its clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

301. A system as defined in claim 267 in which at least one other device operates as a data source device configured to distribute frames to a second synchrony group, the device operating as the data source device for the first synchrony group also operating as a member device of a second synchrony group.

302. A system as defined in claim 267 in which at least one member device comprises:

A. an interface module configured to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;

B. a current time retrieval module configured to obtain, from the data source, a current time value as indicated by the data source's clock;

C. an processing time determination module configured to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and

D. a frame processing module configured to process each respective frame at the time determined by the processing time determination module.

303. A system as defined in claim 302 in which the at least one frame comprises audio data, each member device, while processing each frame, producing a signal representing sound represented by the respective frame.

304. A system as defined in claim 302 further including a control module for controlling execution of commands received by said interface module.

305. A device as defined in claim 304 further comprising a buffer configured to buffer frames that the interface module has received until they are to be processed, the frame processing module being configured to process the buffered frames at the times determined by the processing time determination module.

306. A system as defined in claim 305 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to receive playback control commands for controlling processing of tracks, the control module being configured to execute at least one playback control command controlling track processing.

307. A system as defined in claim 306 in which at least one type of playback control command enables the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

308. A system as defined in claim 307 in which the playback control command enables the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

309. A system as defined in claim 306 in which the playback control command enables the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

310. A system as defined in claim 306 in which the control module is configured to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

311. A system as defined in claim 302 in which the member device includes:

A. a migration information receiving module configured to receive migration information from the task source device, the migration information including a source for information respecting the tasks to be distributed, timing information relative to the clock maintained by the task source device and identifications of the member devices of the synchrony group, and

B. a migration control module configure to, after the migration information has been received.,

i. distribute the series of tasks to the synchrony group, each task being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the task source device, at which the devices comprising the synchrony group are to execute the respective task, and

ii. notify the members of the synchrony group that it is to thereafter operate as the task source device.

312. A system as defined in claim 311 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into frames and associate each frame with a said time stamp.

313. A system as defined in claim 311 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

314. A system as defined in claim 313 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

315. A system as defined in claim 313 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

316. A system as defined in claim 302 in which the member device further includes a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

317. A system as defined in claim 316 in which the clock rate adjustment module is configured to adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

318. A system as defined in claim 267 in which the data source device comprises:

A. a frame acquisition module configured to obtain respective ones of the frames;

B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to transmit the series of frames to said at least one other device; and

D. an execution control command generation module configured to, in response to a predetermined event, enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

319. A system as defined in claim 318 in which at least one frame comprises audio data, each member device, while processing each frame, producing generating a signal representing sound represented by the respective frame.

320. A system as defined in claim 318 in which the frame transmission module is configured to utilize a selected multi-cast transmission methodology.

321. A system as defined in claim 318 in which the predetermined event comprises input indicia provided by an operator.

322. A system as defined in claim 321 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

323. A system as defined in claim 322 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

324. A data source device as defined in claim 323 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and

(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and

(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

325. A system as defined in claim 324 in which the frame transmission module is configured to insert a command to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

326. A system as defined in claim 267 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

327. A system as defined in claim 326 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

328. A system as defined in claim 326 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

329. A system as defined in claim 328 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

330. A system as defined in claim 327 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and

(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and

(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

331. A system as defined in claim 267 in which the data source device comprises:

A. a frame acquisition module configured to obtain respective ones of the frames;

B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to transmit the series of frames to said at least one other device; and

D. a data source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

332. A system as defined in claim 331 in which the data source device is configured to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

333. A system as defined in claim 332 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

334. A system as defined in claim 333 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

335. A system as defined in claim 333 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

336. A device for processing a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the device comprising

A. an interface module configured to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;

B. a current time retrieval module configured to obtain, from the data source, a current time value as indicated by the data source's clock;

C. an processing time determination module configured to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and

D. a frame processing module configured to process each respective frame at the time determined by the processing time determination module.

337. A device as defined in claim 336 in which the frame comprises audio data, each member device, while processing each frame, producing a signal representing sound represented by the respective frame.

338. A device as defined in claim 336 further including a control module for controlling execution of commands received by said interface module.

333. A system as defined in claim 332 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

334. A system as defined in claim 333 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

335. A system as defined in claim 333 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

336. A device for processing a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the device comprising

A. an interface module configured to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;

B. a current time retrieval module configured to obtain, from the data source, a current time value as indicated by the data source's clock;

C. an processing time determination module configured to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and

D. a frame processing module configured to process each respective frame at the time determined by the processing time determination module.

337. A device as defined in claim 336 in which the frame comprises audio data, each member device, while processing each frame, producing a signal representing sound represented by the respective frame.

338. A device as defined in claim 336 further including a control module for controlling execution of commands received by said interface module.

339. A device as defined in claim 336 further comprising a buffer configured to buffer frames that the interface module has received until they are to be processed, the frame processing module being configured to process the buffered frames at the times determined by the processing time determination module.

340. A device as defined in claim 339 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to receive playback control commands for controlling processing of tracks, the control module being configured to execute at least one playback control command controlling track processing.

341. A device as defined in claim 340 in which at least one type of playback control command enables the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

342. A device as defined in claim 341 in which the playback control command enables the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

343. A device as defined in claim 340 in which the playback control command enables the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

344. A device as defined in claim 340 in which the control module is configured to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

345. A device as defined in claim 338, the control module being configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames for processing by the frame processing module.

346. A device as defined in claim 345 in which the control module is configured to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed frame using a selected unicast transmission methodology.

347. A device as defined in claim 346 in which the control module is configured to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving frames and the frame processing module from processing previously received frames that have not yet been processed.

348. A device as defined in claim 336 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable selected operations to be performed in response to the control information.

349. A device as defined in claim 348 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

350. A device as defined in claim 349 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

351. A device as defined in claim 348 in which, in response to control information to enable the data source to begin operating, the control module performs selected operations to enable the data source to begin operating.

352. A device as defined in claim 351, the device also operating as the data source, the device including a frame generator module configured to, under control of the control module, obtain information from which the frames are to be generated and generate the frames.

353. A device as defined in claim 342 in which the interface module is further configured to transmit the frames to at least one other device.

354. A device as defined in claim 343 in which the device is not the data source, the control module being configured to enable the interface module to transmit a command to enable the data source to operate.

355. A device as defined in claim 354 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track currently being processed to be terminated , the control module is configured to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of frames associated with the track to enable termination of processing of the track.

356. A device as defined in claim 354 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track at least a portion of which has been received, but for which processing has not begun, the control module is configured to enable the interface module to transmit a command to enable the data

source to insert a resynchronize command in the series of commands to disable processing of the track.

357. A device as defined in claim 344 in which the control module is configured to enable the user interface module interface module to transmit status information to the user interface module.

358. A device as defined in claim 357 in which the status information includes the processing status of at least one frame.

359. A device as defined in claim 336 further including:

A. a migration information receiving module configured to receive migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and

B. a migration control module configured to, after the migration information has been received.,

   i. distribute the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and

   ii. notify the members of the synchrony group that it is to thereafter operate as the data source device.

360. A device as defined in claim 359 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control module being configured to, after the migration information has been received, assembling the streaming information into frames and associate each frame with a said time stamp.

361. A device as defined in claim 359 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control module being configured to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

362. A device as defined in claim 361 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to assemble the information from a position in the file associated with the identified offset.

363. A device as defined in claim 361 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

364. A device as defined in claim 336 further including a clock rate adjustment module configured to adjust the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

365. A data source device for distributing a series of frames for execution by at least one other device at respective execution times, the data source device comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;

B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to transmit the series of frames to said at least one other device; and

D. an execution control command generation module configured to, in response to a predetermined event, enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

366. A data source device as defined in claim 365 in which the frame transmission module is configured to utilize a selected multi-cast transmission methodology.

367. A data source device as defined in claim 365 in which the predetermined event comprises input indicia provided by an operator.

368. A data source device as defined in claim 367 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

369. A data source device as defined in claim 368 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command

to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

370. A data source device as defined in claim 368 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and

(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and

(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

371. A data source device as defined in claim 370 in which the frame transmission module is configured to insert a command to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

372. A data source device as defined in claim 362 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

373. A data source device as defined in claim 372 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

374. A data source device as defined in claim 371 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command

to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

375. A data source device as defined in claim 374 in which, in response to said predetermined event, the execution control command generation module is configured to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

376. A data source device as defined in claim 371 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to, in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and

(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and

(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

377. A data source device for distributing a series of frames for execution by at least one other device at respective execution times, the data source device comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;

B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time, the frame execution time determination module being configured to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by a clock maintained by the data source device; and

C. a frame transmission module configured to transmit the series of frames to said at least one other device.

377. A system as defined in claim 377 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient

to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

379. A system as defined in claim 378 in which the data source device is configured to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

380. A system as defined in claim 377 in which data source device is configured to obtain information associated with the frames from at least two types of information sources, the data source device being further configured to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

381. A data source device for distributing a series of frames for execution by at least one other device, the data source device comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;

B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to transmit the series of frames to said at least one other device; and

D. a data source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

382. A method for operating a system to facilitate processing of data by device operating as a member of a synchrony group, synchronously with a clock maintained by a data source device that provides the data to the synchrony group, the method including the steps of

A. enabling the data source device being to divide the data into a series of frames for distribution to the synchrony group, each frame being associated with a time stamp indicating a time, relative to a clock maintained by the data source device, at which the devices comprising the synchrony group are to process the frame;

B enabling each member device in the synchrony group to:

(i) periodically obtain from the data source device an indication of a current time value indicated by the data source device's clock;

(ii) receive the series of frames from the data source device;

(iii) determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value indicated by the data source device's clock, a current time value indicated by the member device's respective clock, a time, relative to the member device's respective clock, at which the member device is to process the frame; and

(iv) process the respective frame at the determined time.

383. A method as defined in claim 382 in which at least one frame comprises audio data, each member device, while processing each frame, being enabled to generate a signal representing sound represented by the respective frame.

384. A method as defined in claim 382, the system comprising a plurality of member devices, the method including the steps of enabling the member devices to process each frame synchronously in relation to the clock maintained by the data source device so that they all produce sound represented by the respective frame synchronously.

385. A method as defined in claim 384 including the step of enabling the data source device to provide time stamps for at least two successive frames so that the member devices will play them with a selected time interval therebetween.

386. A method as defined in claim 385 in which the time interval is zero.

387. A method as defined in claim 382 in which one of the member devices operates as a master device for the synchrony group, any other member devices comprising respective slave devices, the method including the step of enabling the master device to perform at least one type of synchrony group management operation in connection with the member devices comprising the synchrony group.

388. A method as defined in claim 387, the method including the step of enabling the master device to perform at least one type of synchrony group management operation in response to control information provided thereto by a user interface module.

389. A method as defined in claim 388 further including the step of enabling the master device to provide status information relating to the status of the synchrony group to the user interface module.

390. A method as defined in claim 389 in which the status information includes identifications of the devices comprising the synchrony group.

391. A method as defined in claim 389 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, each audio track being associated with an identifier, the status information including the identification of the audio track currently being played.

392. A method as defined in claim 388 the method comprising at least one additional device, in which, in one type of synchrony group management operation, the master device is configured to enable the at least one additional device to join the synchrony group as a slave device.

393. A method as defined in claim 392 in which the data source device is configured to distribute frames to the member devices using a selected multi-cast transmission methodology, the member devices being configured to buffer the frames until they are to be played, the method including the step of, when the at least one additional device joins the synchrony group as a slave device, the enabling the data source device to transmit at least one previously distributed frame to the slave device using a selected unicast transmission methodology.

394. A method as defined in claim 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to enable the data source device to join the synchrony group as a slave device, the data source device continuing to operate as the data source device for the synchrony group.

395. A method as defined in claim 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to enable a slave device to disengage from the synchrony group, the disengaged slave device thereafter not being a member device in the synchrony group and not playing frames distributed by the data source device.

396. A method as defined in claim 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to control the series of frames to be distributed by the data source device.

397. A method as defined in claim 387 in which each frame is associated with a frame sequence, each frame sequence comprising at least one frame, the frame or frames comprising each frame sequence being associated with an audio track, the method including the step of enabling the master device being configured to control the frames to be distributed by the data source device on a track-by-track basis.

398. A method as defined in claim 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to control playback by the member devices of the frames associated with the respective audio tracks that have

been distributed by the data source device in response to control information from the user interface module.

399. A method as defined in claim 387 in which, in response to control information from the user interface module to facilitate control of playback by the member devices, the method includes the step of enabling the master device to enable the data source device to distribute a playback control command to the member devices.

400. A method as defined in claim 399 in which a playback control command enables the member devices to terminate playback of a track that is currently being played back.

401. A method as defined in claim 399 in which the playback control command enables the member devices to terminate playback of a track with a frame subsequent to a frame currently being played.

402. A method as defined in claim 399 in which the playback control command enables the member devices to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

403. A method as defined in claim 387 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the member device operating as the master device to enable the master device to migrate from itself to another member device in the synchrony group.

404. A method as defined in claim 403 in which, in at least one type of synchrony group management operation, the method includes the step of enabling the master device to enable the data source device to migrate from one device to another device in the system.

405. A method as defined in claim 404 in which

A. the device operating as the data source device is enable to perform the step of, after being enabled to migrate the data source device to said other device, providing migration information to the other device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices,

B. the other device is enabled to, after receiving the migration information, perform the steps of

   i. distributing the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and

ii. notifying the members of the synchrony group that it is to thereafter operate as the data source device.

406. A method as defined in claim 405 in which the information respecting the frames that are to be distributed is a source of streaming information, the other device being enabled to, after receiving the migration information, perform the steps of assembling the streaming information into frames and associating each frame with a said time stamp.

407. A method as defined in claim 405 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the other device being enabled to perform the steps of obtaining information from the identified file, assembling the information into frames and associating each frame with a said time stamp.

408.A method as defined in claim 407 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the other device being enabled to perform the step of assembling the information from a position in the file associated with the identified offset.

409. A method as defined in claim 407 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the other device being enabled to perform the step of obtaining information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

410. A method as defined in claim 382 including the step in which the data source is further configured to distribute the frames using a selected multi-cast message transmission methodology, the device being enabled to receive the frames using the selected multi-cast message transmission methodology.

411. A method as defined in claim 382 in which the data source device is enabled to perform the step of providing, provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

412. A method as defined in claim 411 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

413. A method as defined in claim 411 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so

to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp

414. A method as defined in claim 411 in which data source device is enabled to perform the steps of obtaining information associated with the frames from at least two types of information sources, and selecting, for each frame, the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

415. A method as defined in claim 382 in which at least one member device is further enabled to perform the step of adjusting its clock rate in relation to a clock rate value maintained by the data source device's clock.

416. A method as defined in claim 415 in which the at least one member device is enabled to perform the step of adjusting its clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

417. A method as defined in claim 382 in which at least one other device operates as a data source device configured to distribute frames to a second synchrony group, the method including the steps of enabling the device to operate both as the data source device for the first synchrony group and also operating as a member device of a second synchrony group.

418. A method as defined in claim 382 including, within a member device,

A. a frame receiving step of receiving the series of frames,

B. a current time retrieval step of obtaining, from the data source device, the current time value as indicated by the frame source's clock;

C. an execution time determination step of determining, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the member device's respective clock at which the frame is to be executed; and

D. a frame execution step of executing each respective frame at the time determined during the execution time determination step.

419. A method as defined in claim 418 further including a control step for controlling execution of commands received during the frame receiving step

420. A method as defined in claim 419 in which the at least one member device further comprises a buffer configured to buffer frames received from the data source device during the frame receiving

step until they are to be executed, the frame execution step including the step of executing the buffered frames at the times determined during the execution time determination step.

420. A method as defined in claim 420 in which the series of frames includes a series of frame sequences with each frame sequence including a subset of the series of frames, the frame receiving step being further enabled to receive frame execution control commands for controlling frame execution, the control step including the step of, in response to receipt of at least one frame execution control command for controlling frame execution, controlling the frame execution step to terminate execution of a frame sequence currently being executed, and further to not execute subsequent frames in the frame sequence that have been buffered.

422. A method as defined in claim 421 in which the control step includes the step of enabling the frame execution step to resume execution of at least one frame associated with a subsequent frame sequence at a time determined during the execution time determination step.

423. A method as defined in claim 420 in which the series of frames includes a series of frame sequences with each frame sequence including a subset of the series of frames, the frame receiving step including the step of receiving frame execution control commands for controlling frame execution, the control step including the step of, in response to receipt of at least one frame execution control command to cancel execution of a frame sequence for which at least one frame has been buffered but for which execution has not begun, providing that frames from that frame sequence that have been buffered not be executed.

424. A method as defined in claim 423 in which the control step includes the step of enabling execution to resume of at least one frame associated with a frame sequence subsequent to the frame sequence for which at least one frame has been buffered but for which execution has not begun.

425. A method as defined in claim 418 in which the member device performs:

A. migration information receiving step of receiving migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and

B. a migration control step of, after the migration information has been received.,

   i. distributing the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and

ii. notifying the members of the synchrony group that it is to thereafter operate as the data source device.

426. A method as defined in claim 425 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into frames and associating each frame with a said time stamp.

427. A method as defined in claim 425 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into frames and associating each frame with a said time stamp.

428. A method as defined in claim 427 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

429. A method as defined in claim 427 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into frames and associating each frame with as said time stamp.

430. A method as defined in claim 418 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

431. A method as defined in claim 430 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

432. A method as defined in claim 382 of operating a device for distributing a series of frames for execution by at least one other device at respective execution times, the method comprising:

A. a frame acquisition step of obtaining respective ones of the frames;

B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission step of transmitting the series of frames to said at least one other device; and

D. an execution control command generation step of, in response to a predetermined event and during the frame transmission step, the insertion into the series of frames transmitted by the frame transmission module of a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

433. A method as defined in claim 432 in which the frame transmission step includes the step of utilizing a selected multi-cast transmission methodology.

434. A method as defined in claim 432 in which the predetermined event includes the step of receiving input indicia provided by an operator.

435. A method as defined in claim 434 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

436. A method as defined in claim 435 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

437. A method as defined in claim 434 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the frame transmission step the insertion, into the series of frames, of a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and

(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and

(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

438. A method as defined in claim 437 in which the frame transmission step includes the step of inserting a command into the frame sequence to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

439. A method as defined in claim 435 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

440. A method as defined in claim 439 in which the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

441. A method as defined in claim 439 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the inserting into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

442. A method as defined in claim 441 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

443. A method as defined in claim 439 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the frame transmission step, the insertion, into the series of frames, of a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and

(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and

(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

444. A method as defined in claim 382 in which the data source device is enabled to perform

A. a frame acquisition step of obtaining respective ones of the frames;

B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission step of transmitting the series of frames to said at least one other device; and

D. a data source device migration control step of, in response to a predetermined event, providing migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

445. A method as defined in claim 382 in which the data source device is enabled to perform the step of providing, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by the clock maintained by the data source device.

446. A method as defined in claim 445 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

447. A method as defined in claim 446 in which the data source device is enabled to perform the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp.

448. A method as defined in claim 445 in which data source device is enabled to perform the step of obtaining information associated with the frames from at least two types of information sources, and selecting for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

449. A method of enabling a device to process a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the device comprising

A. an interface step of receiving the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;

B. a current time retrieval step of obtaining, from the data source, a current time value as indicated by the data source's clock;

C. an processing time determination step of determining, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained during the current time retrieval step and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and

D. a frame processing step of processing each respective frame at the time determined during the processing time determination step.

450. A method as defined in claim 449 in which at least one frame comprises audio data, each member device, while processing said at least one frame, generating a signal representing sound represented by the respective frame.

451. A method as defined in claim 449 further including a control step for controlling execution of commands received by said device.

452. A method as defined in claim 451 further comprising a buffer configured to buffer frames that the interface module has received until they are to be processed, the frame processing step including the step of processing the buffered frames at the times determined during the processing time determination step.

453 . A method as defined in claim 451 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to receive playback control commands for controlling processing of tracks, the method including the step of enabling the control module to execute at least one playback control command controlling track processing.

454. A method as defined in claim 453 including the step of, in response to at least one type of playback control command, enabling the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

455. A method as defined in claim 454 including the step of, in response to the playback control command, enabling the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

456. A method as defined in claim 452 including the step of, in response to the playback control command, enabling the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

457. A method as defined in claim 453 including the step of enabling the control module to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

458. A method as defined in claim 449 including the step of enabling the control module to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames for processing by the frame processing module.

459. A method as defined in claim 458 including the step of enabling the control module to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed frame using a selected unicast transmission methodology.

460. A method as defined in claim 449 including the step of enabling the control module to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving frames and the frame processing module from processing previously received frames that have not yet been processed.

461. A method as defined in claim 449, further including the steps of receiving control information from a user interface module, and enabling the control module to enable selected operations to be performed in response to the control information.

462. A method as defined in claim 461 including the step of, in response to control information to enable another device to become a member of the device's synchrony group, enabling the control module to enable the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

463. A method as defined in claim 461 including the step of, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, enabling the control module to enable transmission of a command to the other device to enable the other device to disengage from the synchrony group.

464. A method as defined in claim 461 including the step of, in response to control information to enable the data source to begin operating, enabling the control module to perform selected operations to enable the data source to begin operating.

465. A method as defined in claim 464, the device also operating as the data source, the method including a frame generator step of, under control of the control module, obtaining information from which the frames are to be generated and generating the frames.

466. A method as defined in claim 465 further comprising the step of transmitting the frames to at least one other device.

467. A method as defined in claim 465 in which the device is not the data source, the method including the step of enabling the control module to enable transmission of a command to enable the data source to operate.

468. A method as defined in claim 467 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track currently being processed to be terminated , the method including the step of enabling the control module to enable transmission of a command to enable the data source to insert a resynchronize command in the series of frames associated with the track to enable termination of processing of the track.

469. A method as defined in claim 467 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track at least a portion of which has been received, but for which processing has not begun, the method including the step of enabling the control module to enable transmission of a command to enable the data source to insert a resynchronize command in the series of commands to disable processing of the track.

470. A method as defined in claim 451 further including the step of enabling the control module to enable the user interface module interface module to transmit status information to the user interface module.

471. A method as defined in claim 470 in which the status information includes the processing status of at least one frame.

472. A method as defined in claim 469 in which the member device performs:

A. migration information receiving step of receiving migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and

B. a migration control step of, after the migration information has been received.,

i. distributing the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and

ii. notifying the members of the synchrony group that it is to thereafter operate as the data source device.

473. A method as defined in claim 472 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control step includes the steps of, after the migration information has been received, assembling the streaming information into frames and associating each frame with a said time stamp.

474. A method as defined in claim 472 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control step including the steps of obtaining information from the identified file, assembling the information into frames and associating each frame with a said time stamp.

475. A method as defined in claim 474 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control step including the step of assembling the information from a position in the file associated with the identified offset.

476. A method as defined in claim 474 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control step including the steps of obtaining information from successive files in the series assemble the information into frames and associating each frame with as said time stamp.

477. A method as defined in claim 449 in which the member device is further enabled to perform a clock rate adjustment step including the step of adjusting the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

478. A method as defined in claim 477 in which the clock rate adjustment step includes the step of determining adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

479. A method of operating a device for distributing a series of frames for execution by at least one other device at respective execution times, the method comprising:

A. a frame acquisition step of obtaining respective ones of the frames;

B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission step of transmitting the series of frames to said at least one other device; and

D. an execution control command generation step of, in response to a predetermined event and during the frame transmission step, the insertion into the series of frames transmitted by the frame transmission module of a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

480. A method as defined in claim 479 in which at least one frame comprises audio data.

481. A method as defined in claim 479 in which the frame transmission step includes the step of utilizing a selected multi-cast transmission methodology.

482. A method as defined in claim 479 in which the predetermined event includes the step of receiving input indicia provided by an operator.

483. A method as defined in claim 482 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

484. A method as defined in claim 483 in which, the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

485. A method as defined in claim 482 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling during the frame transmission step the insertion, into the series of frames, of a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and

(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and

(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

486. A method as defined in claim 485 in which the frame transmission step includes the step of inserting a command into the frame sequence to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

487. A method as defined in claim 479 in which the execution control command generation step include the step of enabling, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

488. A method as defined in claim 487 in which the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

489. A method as defined in claim 487 in which the execution control command generation step includes the step of enabling, in response to said predetermined event and during the frame transmission step, the inserting into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

490. A method as defined in claim 489 in which, the execution control command generation step includes the step of, in response to said predetermined event and during the frame transmission step, the insertion into the series of frames of a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

491. A method as defined in claim 488 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation step including the steps of, in response to said predetermined event,

(i) enabling, during the frame transmission step, the insertion, into the series of frames, of a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and

(ii) enabling

(a) during the frame execution time determination step, that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and

(b) during the frame transmission step, the transmission of the frames of the subsequent frame sequences to the at least one other device.

492. A method of operating a device for distributing a series of frames for execution by at least one other device at respective execution times, the method comprising:

A. a frame acquisition step of obtaining respective ones of the frames;

B. a frame execution time determination step of determining a time at which each respective frame is to be executed, and to associating the respective frame with a time stamp indicating its execution time, the frame execution time determination step including the step of providing, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by a clock maintained by the data source device; and

C. a frame transmission step of transmitting the series of frames to said at least one other device.

493. A method as defined in claim 492 in which at least one frame comprises audio data.

494. A method as defined in claim 492 in which the frame execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the device can be executed by at least one other device at the time indicated by the time stamp.

495. A method as defined in claim 494 in which the frame execution time determination step includes the step of selecting the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the device can be distributed to other devices over a network for execution by the other devices at the time indicated by the time stamp.

496. A method as defined in claim 492 in which frame acquisition step includes the step of obtaining information associated with the frames from at least two types of information sources, the frame execution time determination step including the step of selecting, for each frame the delay interval

between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

497. A method of operating a device for distributing a series of frames for execution by at least one other device, the method comprising:

A. a frame acquisition module configured to obtain respective ones of the frames;

B. a frame execution time determination module configured to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to transmit the series of frames to said at least one other device; and

D. a data source device migration control module configured to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

498. A method as defined in claim 497 in which at least one frame comprises audio data.

499. A computer program product for use in connection with a computer to provide a device for processing a series of frames of data provided by a data source at times specified by the data source in relation to a clock maintained by the data source, the computer program product comprising a computer-readable medium having encoded thereon

A. an interface module configured to enable the computer to receive the series of frames, each frame being associated with a time stamp, each time stamp indicating a time value relative to a time indicated a clock maintained by the data source, at which the device is to process the respective frame;

B. a current time retrieval module configured to enable the computer to obtain, from the data source, a current time value as indicated by the data source's clock;

C. an processing time determination module configured to enable the computer to determine, from the time stamp associated with each respective frame and a time differential value representing a difference between the current time value obtained by the current time retrieval module and a current time value indicated by a clock maintained by the device, a time, relative to the device's respective clock, at which the frame is to be processed; and

D. a frame processing module configured to enable the computer to process each respective frame at the time determined by the processing time determination module.

500. A computer program product as defined in claim 499 in which at least one frame comprises audio data, the computer, while processing said frame, generating a signal representing sound represented by the respective frame.

501. A computer program product as defined in claim 499 further including a control module a control module for enabling said computer to control execution of commands received by the interface module.

502. A computer program product as defined in claim 501 further comprising a buffer configured to enable the computer to buffer frames that the interface module has received until they are to be processed, the frame processing module being configured to enable the computer to process the buffered frames at the times determined by the processing time determination module.

503. A computer program product as defined in claim 502 in which the each frame is associated with a track, each track including at least one frame, the interface module being further configured to enable the computer to receive playback control commands for controlling processing of tracks, the control module being configured to enable the computer to execute at least one playback control command controlling track processing.

504. A computer program product as defined in claim 503 in which at least one type of playback control command enables the control module to, in turn, enable the frame processing module to terminate playback of a track that is currently being played back.

505. A computer program product as defined in claim 504 in which the playback control command enables the control module to terminate playback of a track with a frame subsequent to a frame currently being played.

506. A computer program product as defined in claim 503 in which the playback control command enables the control module to cancel playback of a track at least one of whose frames has been previously distributed, but for which playback has not begun.

507. A computer program product as defined in claim 503 in which the control module is configured to enable the computer to enable the frame processing module to resume processing of at least one frame associated with a subsequent track at a time determined by the processing time determination module.

508. A computer program product as defined in claim 501, the control module being configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames for processing by the frame processing module.

509. A computer program product as defined in claim 508 in which the control module is configured to enable the computer to, in response to receipt of a command to become a member of a synchrony group, enable the interface module to receive frames currently being transmitted using a selected multi-cast transmission methodology, and further to retrieve at least one previously distributed frame using a selected unicast transmission methodology.

510. A computer program product as defined in claim 501 in which the control module is configured to enable the computer to, in receipt of a command to disengage from a synchrony group, disable the interface module from receiving frames and the frame processing module from processing previously received frames that have not yet been processed.

511. A computer program product as defined in claim 501 further comprising a user interface module interface module configured to receive control information from a user interface module, the control module being configured to enable the computer to enable selected operations to be performed in response to the control information.

512. A computer program product as defined in claim 511 in which, in response to control information to enable another device to become a member of the device's synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to become a member of the synchrony group.

513. A computer program product as defined in claim 511 in which, in response to control information to enable another device that is a member of the device's synchrony group to disengage from the synchrony group, the control module enables the interface module to transmit a command to the other device to enable the other device to disengage from the synchrony group.

514. A computer program product as defined in claim 511 in which, in response to control information to enable the data source to begin operating, the control module performs selected operations to enable the data source to begin operating.

515. A computer program product as defined in claim 514, the device also operating as the data source, the device including a frame generator module configured to enable the computer to, under control of the control module, obtain information from which the frames are to be generated and generate the frames.

516. A computer program product as defined in claim 515 in which the interface module is further configured to enable the computer to transmit the frames to at least one other device.

517. A computer program product as defined in claim 515 in which the device is not the data source, the control module being configured to enable the computer to enable the interface module to transmit a command to enable the data source to operate.

518. A computer program product as defined in claim 517 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track currently being processed to be terminated , the control module is configured to enable the computer to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of frames associated with the track to enable termination of processing of the track.

519. A computer program product as defined in claim 517 in which each frame is associated with a track, each track including at least one frame, and, in response to receipt of control information enabling processing of a track at least a portion of which has been received, but for which processing has not begun, the control module is configured to enable the computer to enable the interface module to transmit a command to enable the data source to insert a resynchronize command in the series of commands to disable processing of the track.

520. A computer program product as defined in claim 517 in which the control module is configured to enable the computer to enable the user interface module interface module to transmit status information to the user interface module.

521. A computer program product as defined in claim 520 in which the status information includes the processing status of at least one frame.

522. A computer program product as defined in claim 499 further including:

A. a migration information receiving module configured to enable the computer to receive migration information from the data source device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group, and

B. a migration control module configured to enable the computer to, after the migration information has been received.,

   i. distribute the series of frames to the synchrony group, each frame being associated with a time stamp indicating a time, relative to the timing information that it receives

from the device operating as the data source device, at which the devices comprising the synchrony group are to execute the respective frame, and

ii. notify the members of the synchrony group that it is to thereafter operate as the data source device.

523. A computer program product as defined in claim 522 in which the information respecting the frames that are to be distributed is a source of streaming information, the migration control module being configured to enable the computer to, after the migration information has been received, assemble the streaming information into frames and associate each frame with a said time stamp.

524. A computer program product as defined in claim 522 in which the information respecting the frames that are to be distributed is in a file identified in the migration information, the migration control module being configured to enable the computer to obtain information from the identified file, assemble the information into frames and associate each frame with a said time stamp.

525. A computer program product as defined in claim 524 in which the information respecting the frames that are to be distributed begins at an offset, identified in the migration information, into the identified file, the migration control module being configured to enable the computer to assemble the information from a position in the file associated with the identified offset.

526. A computer program product as defined in claim 524 in which the information respecting the frames that are to be distributed is in a series of files identified in the migration information, the migration control module being configured to enable the computer to obtain information from successive files in the series assemble the information into frames and associate each frame with as said time stamp.

527. A computer program product as defined in claim 499 further including a clock rate adjustment module configured to enable the computer to adjust the member device's clock rate in relation to a clock rate value maintained by the data source device's clock.

528. A computer program product as defined in claim 527 in which the clock rate adjustment module is configured to enable the computer to adjust the clock rate in relation to time stamps associated with respective ones of the frames received from the data source device.

529. A computer program product for use in connection with a computer to provide a data source device for distributing a series of frames for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a frame acquisition module configured to enable the computer to obtain respective ones of the frames;

B. a frame execution time determination module configured to enable the computer to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to enable the computer to transmit the series of frames to said at least one other device; and

D. an execution control command generation module configured to enable the computer to , in response to a predetermined event, enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to modify the execution sequence of the frames transmitted thereto.

530. A computer program product as defined in claim 529 in which at least one frame comprises audio data.

531. A computer program product as defined in claim 529 in which the frame transmission module is configured to enable the computer to utilize a selected multi-cast transmission methodology.

532. A computer program product as defined in claim 529 in which the predetermined event comprises input indicia provided by an operator.

533. A computer program product as defined in claim 529 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of at least one frame in relation to the time the predetermined event occurs.

534. A computer program product as defined in claim 533 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to terminate execution of a frame that it is currently executing and/or to not execute at least one frame that is to be executed subsequent to the predetermined event.

535. A computer program product as defined in claim 533 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to enable the computer to , in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to terminate execution of the currently executing frame and/or to not execute at least one subsequent frame, if any, in the frame sequence including the currently executing frame; and

(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence currently being executed will reflect the termination and/or non-execution of frames from the frame sequence of the frame that is currently being executed, and

(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

536. A computer program product as defined in claim 535 in which the frame transmission module is configured to enable the computer to insert a command to enable the at least one other device to not execute all frames in the frame sequence subsequent to the terminated and/or non-executed frame.

537. A computer program product as defined in claim 529 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to control execution of a frame in relation to the frame's position in the series of frames.

538. A computer program product as defined in claim 537 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a frame in relation to the frame's position in the series of frames.

539. A computer program product as defined in claim 537 in which, in response to said predetermined event, the execution control command generation module is configured to enable the computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame in relation to the frame's position in the series of frames.

540. A computer program product as defined in claim 539 in which, in response to said predetermined event, the execution control command generation module is configured to enable the

computer to enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module a command to enable the at least one other device to cancel execution of a previously-transmitted frame, in relation to the frame's position in the series of frames, for which execution has not begun.

541. A computer program product as defined in claim 537 in which the series of frames includes a series of frame sequences with each frame sequence including a sub-set of the series of frames, the execution control command generation module being configured to enable the computer to , in response to said predetermined event,

(i) enable the frame transmission module to insert into the series of frames transmitted by the frame transmission module, a command enabling the at least one other device to cancel execution of a frame sequence for which execution has not begun; and

(ii) enable

(a) the frame execution time determination module to provide that time stamps associated with frames of frame sequences subsequent to the frame sequence whose execution was cancelled will reflect the cancellation, and

(b) the frame transmission module to transmit the frames of the subsequent frame sequences to the at least one other device.

542. A computer program product for use in connection with a computer to provide a data source device for distributing a series of frames for execution by at least one other device at respective execution times, the computer program product comprising a computer readable medium having encoded thereon:

A. a frame acquisition module configured to enable the computer to obtain respective ones of the frames;

B. a frame execution time determination module configured to enable the computer to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time, the frame execution time determination module being configured to enable the computer to provide, associated with at least one frame, a time stamp indicating a frame execution time later than the time currently indicated by a clock maintained by the data source device; and

C. a frame transmission module configured to enable the computer to transmit the series of frames to said at least one other device.

543. A computer program product as defined in claim 542 in which the data is audio data.

544. A computer program product as defined in claim 542 in which the frame execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be executed by the member devices at the time indicated by the time stamp.

545. A computer program product as defined in claim 544 in which the frame execution time determination module is configured to enable the computer to select the delay interval between the time indicated by the time stamp and the current time so to be sufficient to provide that the at least one frame distributed by the data source device can be distributed to the member devices for execution at the time indicated by the time stamp.

546. A computer program product as defined in claim 542 in which frame acquisition module is configured to enable the computer to obtain information associated with the frames from at least two types of information sources, the frame execution time determination module being configured to enable the computer to select, for each frame the delay interval between the time indicated by the time stamp and the current time based on the information source type that is associated with the respective frame.

547. A computer program product for use in connection with a computer to provide a data source device for distributing a series of frames for execution by at least one other device, the computer program product comprising a computer readable medium having encoded thereon:

A. a frame acquisition module configured to enable the computer to obtain respective ones of the frames;

B. a frame execution time determination module configured to enable the computer to determine a time at which each respective frame is to be executed, and to associate the respective frame with a time stamp indicating its execution time;

C. a frame transmission module configured to enable the computer to transmit the series of frames to said at least one other device; and

D. a data source device migration control module configured to enable the computer to, in response to a predetermined event, provide migration information to another device, the migration information including a source for information respecting the frames to be distributed, timing information relative to the clock maintained by the data source device and identifications of the member devices of the synchrony group.

548. A computer program product as defined in claim 547 in which the data is audio data.

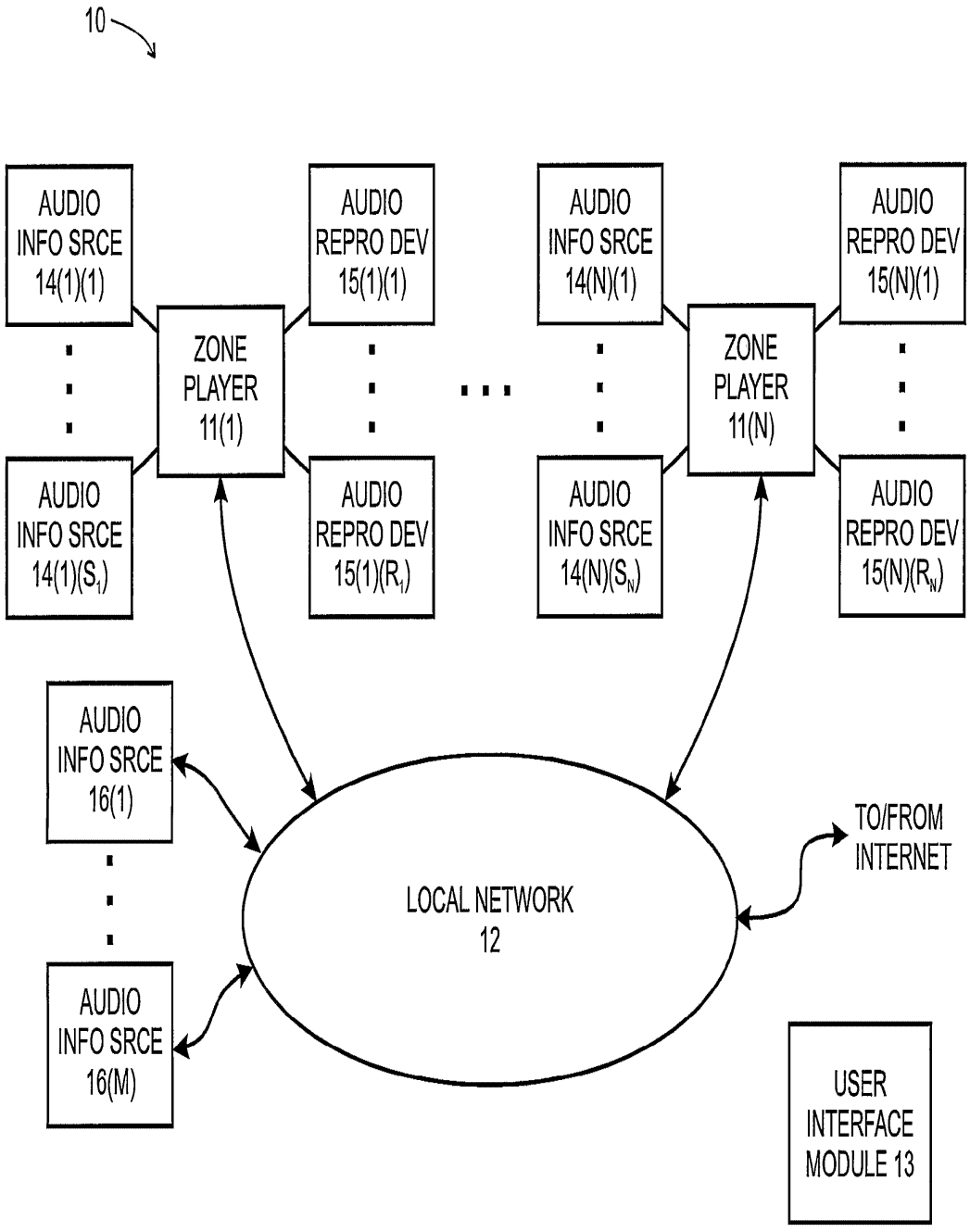

10
AUDIO INFO SRCE 14(1)(1)
AUDIO REPRO DEV 15(1)(1)
AUDIO INFO SRCE 14(N)(1)
AUDIO REPRO DEV 15(N)(1)
ZONE PLAYER 11(1)
ZONE PLAYER 11(N)
AUDIO INFO SRCE 14(1)(S1)
AUDIO REPRO DEV 15(1)(R1)
AUDIO INFO SRCE 14(N)(SN)
AUDIO REPRO DEV 15(N)(RN)
AUDIO INFO SRCE 16(1)
AUDIO INFO SRCE 16(M)
LOCAL NETWORK 12
TO/FROM INTERNET
USER INTERFACE MODULE 13

FIG. 1

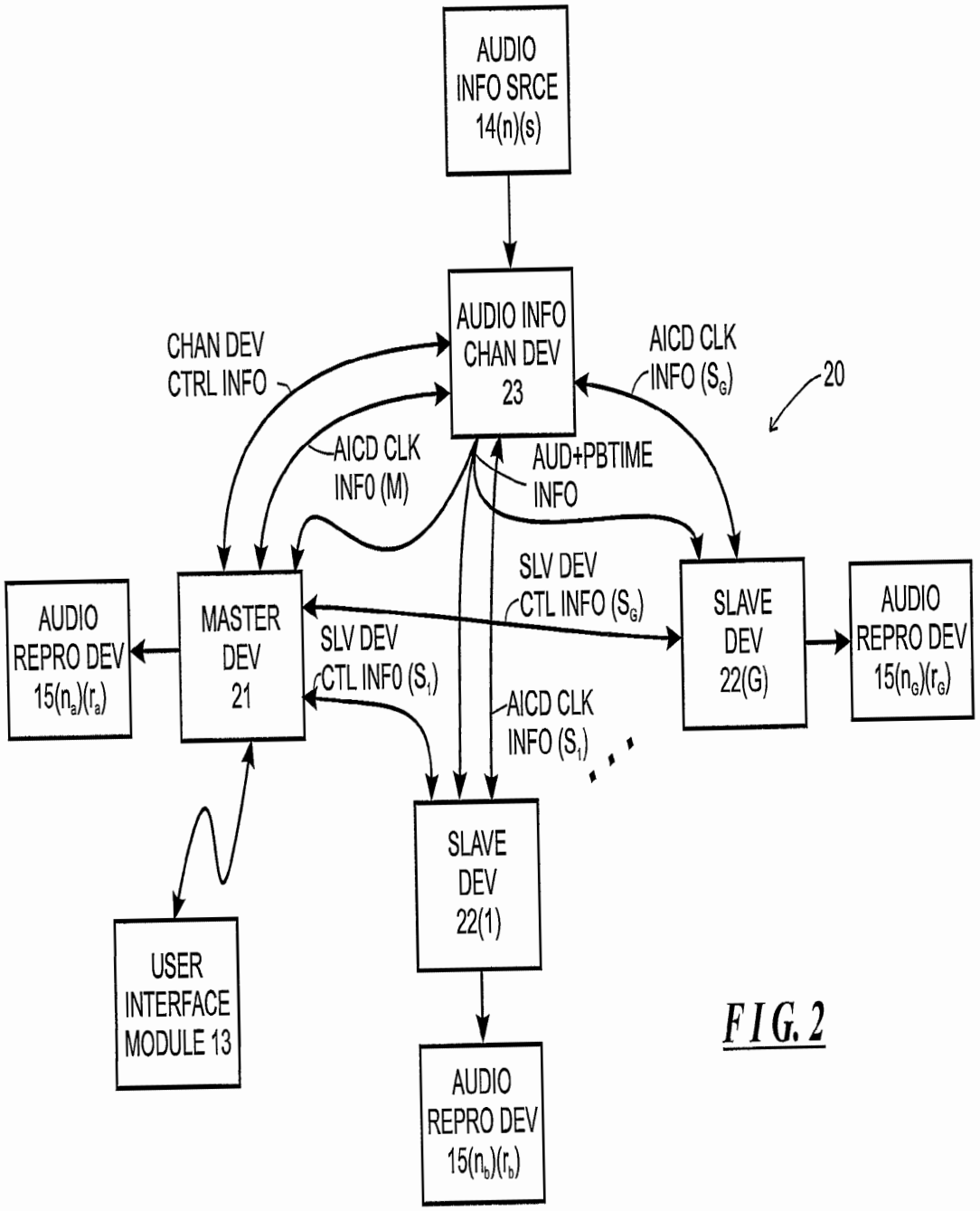

AUDIO INFO SRCE 14(n)(s)
AUDIO INFO CHAN DEV 23
CHAN DEV CTRL INFO
AICD CLK INFO (S_G)
20
AICD CLK INFO (M)
AUD+PBTIME INFO
SLV DEV CTL INFO (S_G)
AUDIO REPRO DEV 15(n_a)(r_a)
MASTER DEV 21
SLV DEV CTL INFO (S_1)
SLAVE DEV 22(G)
AUDIO REPRO DEV 15(n_G)(r_G)
AICD CLK INFO (S_1)
SLAVE DEV 22(1)
USER INTERFACE MODULE 13
AUDIO REPRO DEV 15(n_b)(r_b)

FIG. 2

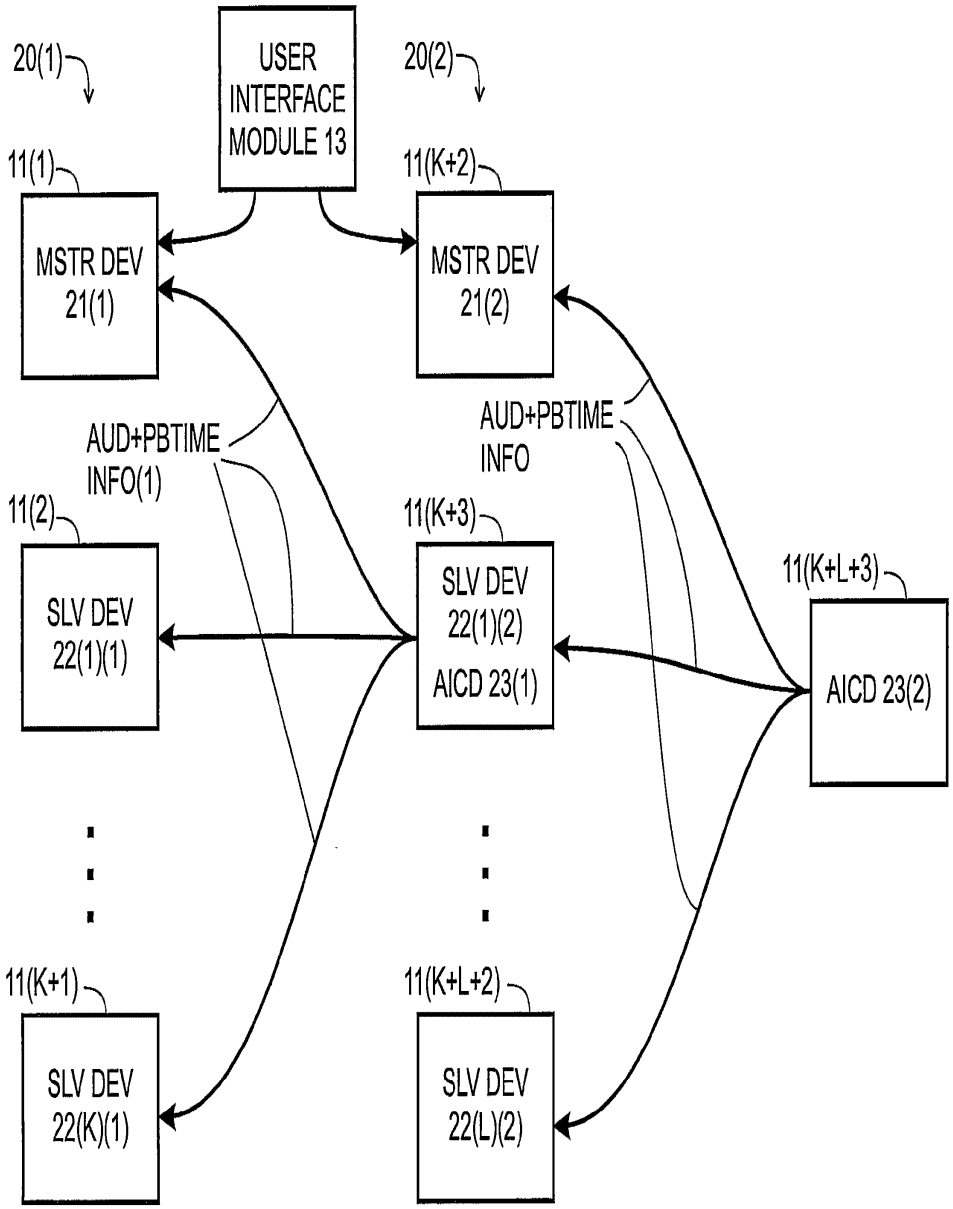

20(1)
USER INTERFACE MODULE 13
20(2)
11(1)
11(K+2)
MSTR DEV 21(1)
MSTR DEV 21(2)
AUD+PBTIME INFO(1)
AUD+PBTIME INFO
11(2)
11(K+3)
11(K+L+3)
SLV DEV 22(1)(1)
SLV DEV 22(1)(2) AICD 23(1)
AICD 23(2)
11(K+1)
11(K+L+2)
SLV DEV 22(K)(1)
SLV DEV 22(L)(2)

FIG. 2A

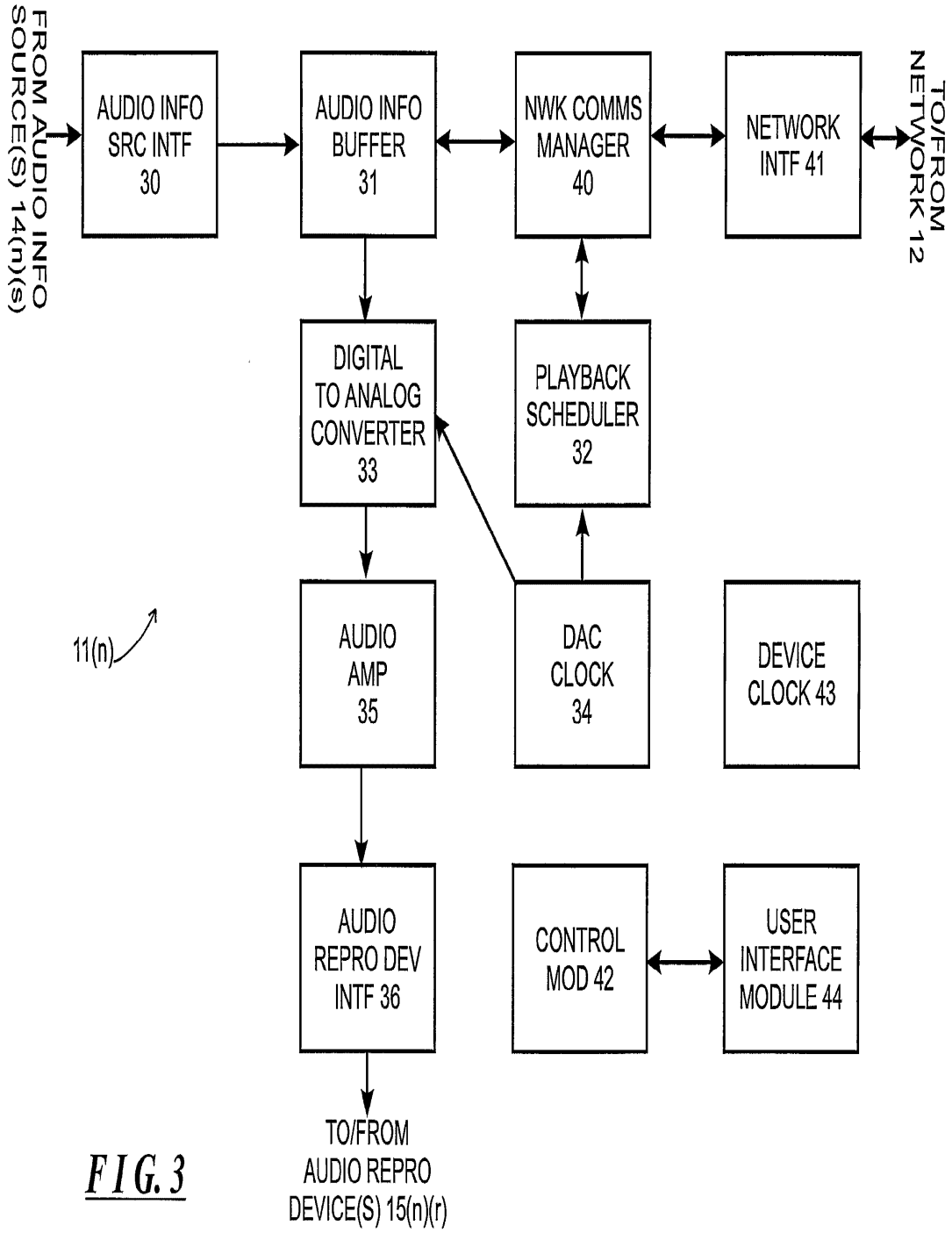

FROM AUDIO INFO SOURCE(S) 14(n)(s)
AUDIO INFO SRC INTF 30
AUDIO INFO BUFFER 31
NWK COMMS MANAGER 40
NETWORK INTF 41
TO/FROM NETWORK 12
DIGITAL TO ANALOG CONVERTER 33
PLAYBACK SCHEDULER 32
11(n)
AUDIO AMP 35
DAC CLOCK 34
DEVICE CLOCK 43
AUDIO REPRO DEV INTF 36
CONTROL MOD 42
USER INTERFACE MODULE 44
TO/FROM AUDIO REPRO DEVICE(S) 15(n)(r)

FIG. 3

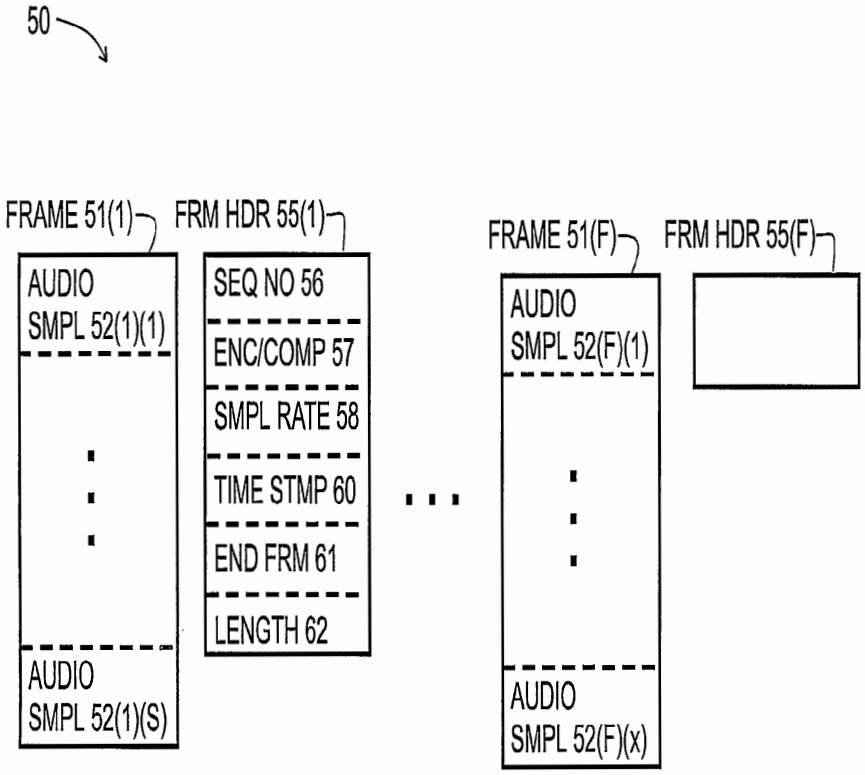

50
FRAME 51(1)
FRM HDR 55(1)
AUDIO SMPL 52(1)(1)
AUDIO SMPL 52(1)(S)
SEQ NO 56
ENC/COMP 57
SMPL RATE 58
TIME STMP 60
END FRM 61
LENGTH 62
FRAME 51(F)
FRM HDR 55(F)
AUDIO SMPL 52(F)(1)
AUDIO SMPL 52(F)(x)

FIG. 4

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 13-0410-PCT	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. **PCT/US2013/046372**	International filing date *(day/month/year)* **18 June 2013 (18.06.2013)**	(Earliest) Priority Date *(day/month/year)* 26 June 2012 (26.06.2012)
Applicant **SONOS, INC.**		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the **drawings**,
   a. the figure of the drawings to be published with the abstract is Figure No. 7
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/046372

A. CLASSIFICATION OF SUBJECT MATTER

G06F 15/16(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F 15/16; G09B 5/00; G06F 17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: media playback, link, queueplaylist, credentialauthorizeauthenticate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007-0048713 A1 (DANIEL PLASTINA et al.) 01 March 2007 See paragraph 8 - paragraph 48; paragraph 73 - paragraph 156;and figures 1-23.	1,4-11,14-20
A		2-3,12-13
A	US 2012-0030366 A1 (COLLART TODD et al.) 02 February 2012 See paragraph 5 - paragraph 35; paragraph 67 - paragraph 107; paragraph 115 - paragraph 163; and figures 1-7,11-19.	1-20
A	US 2006-0143236 A1 (MICHAEL WU) 29 June 2006 See paragraph 14 - paragraph 42; and figures 1-4.	1-20
A	US 2008-0091771 A1 (JEFFREY L. ALLEN et al.) 17 April 2008 See paragraph 28 - paragraph 48; claim 1 and figures 3-6.	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 August 2013 (23.08.2013)	**26 August 2013 (26.08.2013)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	Authorized officer PARK Sang Hyun Telephone No. +82-42-481-8263

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/046372

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007-0048713 A1	01/03/2007	CN101243426 A	13/08/2008
		CN101243426 C0	13/08/2008
		KR 10-2008-0033399 A	16/04/2008
		US 2007-0048712 A1	01/03/2007
		US 2007-0048714 A1	01/03/2007
		US 2007-0083556 A1	12/04/2007
		US 7831605 B2	09/11/2010
		US 8140601 B2	20/03/2012
		WO 2007-021831 A1	22/02/2007
US 2012-0030366 A1	02/02/2012	AU 2008-335095 A1	18/06/2009
		AU 2008-335095 B2	28/03/2013
		CA 2708778 A1	18/06/2009
		EP 2232365 A2	29/09/2010
		EP 2232365 A4	31/07/2013
		JP 2011-520302 A	14/07/2011
		US 2009-150553 A1	11/06/2009
		US 8060631 B2	15/11/2011
		WO 2009-076474 A2	18/06/2009
		WO 2009-076474 A3	13/08/2009
US 2006-0143236 A1	29/06/2006	None	
US 2008-0091771 A1	17/04/2008	CN 101523495 A	02/09/2009
		CN 101997910 A	30/03/2011
		CN 101997910 B	13/03/2013
		CN101523495 B	06/04/2011
		EP 2089881 A1	19/08/2009
		EP 2089881 A4	16/01/2013
		JP 2010-507144A	04/03/2010
		KR 10-2009-0079885 A	22/07/2009
		MX 2009002806 A	31/03/2009
		WO 2008-048761 A1	24/04/2008

Form PCT/ISA/210 (patent family annex) (July 2009)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
GEORGE CHRISTOPHER N.

HANLEY, FLIGHT & ZIMMERMAN, LLC 150 S.
WACKER DRIVE SUITE 2100 CHICAGO IL 60606 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**26 August 2013 (26.08.2013)**
Applicant's or agent's file reference 13-0410-PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/046372	**18 June 2013 (18.06.2013)**	26 June 2012 (26.06.2012)

International Patent Classification (IPC) or both national classification and IPC
G06F 15/16(2006.01)i

Applicant
SONOS, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	23 August 2013 (23.08.2013)	PARK, Sang Hyun Telephone No. +82-42-481-8263

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046372

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046372

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	2-3,12-13	YES
	Claims	1,4-11,14-20	NO
Inventive step (IS)	Claims	2-3,12-13	YES
	Claims	1,4-11,14-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations :

(1) Reference is made to the following documents:

D1: US 2007-0048713 A1 (DANIEL PLASTINA et al.) 01 March 2007
D2: US 2012-0030366 A1 (COLLART TODD et al.) 02 February 2012
D3: US 2006-0143236 A1 (MICHAEL WU) 29 June 2006
D4: US 2008-0091771 A1 (JEFFREY L. ALLEN et al.) 17 April 2008

(2) Novelty & Inventive Steps

Concerning claims 1-10:
Claims 1,4-10
D1 discloses a community media playlist sharing system, wherein system users can upload media playlists which are automatically converted to a standardized format, media playlists can be shared with other users of the community media playlist sharing system, users can link to other playlists and obtain media from playlists automatically from third party points of purchase, users can provide recommendations, ratings and rankings relative to other playlists by system users and receive recommendations from other users and an editorial staff, participate in social networking functions including forums, discussions, weblogs, playlist topic groups and inter-user communications based on affinity for similar playlists, create playlists manually, automatically, or in real time, and wherein system users can obtain points for participation and popularity in the system and obtain profit by meta-affiliate sharing of profit for purchases of music made through playlists submitted by that user as well as through playlist toolbars distributed to third party websites.[paragraph 73 - paragraph 156, and figures 1-23] As all of the features of claims 1,4-10 are disclosed in D1, these claims are anticipated in D1. Therefore, claims 1,4-10 lack novelty under PCT Article 33(2) and are not considered as involving an inventive step under PCT Article 33(3).
Claims 2-3:
The subject matter of claims 2-3 is different from that of D1 in a guest mode. And it is

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Box No. V

not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claims 2-3 are novel and involve an inventive step under PCT Article 33(2) and (3).

Concerning claims 11-20:
Claims 11,14-20:
D1 discloses a community media playlist sharing system, wherein system users can upload media playlists which are automatically converted to a standardized format, media playlists can be shared with other users of the community media playlist sharing system, users can link to other playlists and obtain media from playlists automatically from third party points of purchase, users can provide recommendations, ratings and rankings relative to other playlists by system users and receive recommendations from other users and an editorial staff, participate in social networking functions including forums, discussions, weblogs, playlist topic groups and inter-user communications based on affinity for similar playlists, create playlists manually, automatically, or in real time, and wherein system users can obtain points for participation and popularity in the system and obtain profit by meta-affiliate sharing of profit for purchases of music made through playlists submitted by that user as well as through playlist toolbars distributed to third party websites.[paragraph 73 - paragraph 156, and figures 1-23] As all of the features of claims 11,14-20 are disclosed in D1, these claims are anticipated in D1. Therefore, claims 11,14-20 lack novelty under PCT Article 33(2) and are not considered as involving an inventive step under PCT Article 33(3).
Claims 12-13:
The subject matter of claims 12-13 is different from that of D1 in a guest mode. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claims 12-13 are novel and involve an inventive step under PCT Article 33(2) and (3).

(3) Industrial Applicability

The subject matter of claims 1-20 is believed to be industrially applicable under PCT Article 33(4) because the claimed invention can be used in the computer industry.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 12-0402-PCT	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. **PCT/US2013/046386**	International filing date *(day/month/year)* **18 June 2013 (18.06.2013)**	(Earliest) Priority Date *(day/month/year)* 26 June 2012 (26.06.2012)
Applicant **SONOS, INC.**		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of **3** sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. **1**
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/046386

A. CLASSIFICATION OF SUBJECT MATTER

G06Q 50/10(2012.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06Q 50/10; G06F 15/16; H04N 7/173; G06F 7/00; G06F 17/30; H04L 9/00; H04W 40/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:playlist, authorization, participate, zone:

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7483958 B1 (TAREK Z. ELABBADY et al.) 27 January 2009 See abstract, column 7, lines 61-66, column 11, lines 1-20, claims 1, 6 and figure 4.	1-21
Y	US 2010-0228740 A1 (ALAN CANNISTRARO et al.) 09 September 2010 See abstract, paragraphs [0009], [0036]-[0037], [0047]-[0057], [0089], claim 1 and figure 4.	1-21
A	US 2012-0129446 A1 (STEVE KO et al.) 24 May 2012 See abstract, paragraphs [0036]-[0037], claim 1 and figure 4.	1-21
A	US 2009-0031336 A1 (TIMOTHY R. CHAVEZ et al.) 29 January 2009 See abstract, paragraph [0021], claim 1 and figure 3.	1-21
A	US 2007-0299778 A1 (RYAN A. HAVESON et al.) 27 December 2007 See abstract, claim 1 and figure 3.	1-21

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2013 (27.09.2013)	**30 September 2013 (30.09.2013)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	Authorized officer KIM Sung Gon Telephone No. +82-42-481-8746

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/046386

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7483958 B1	27/01/2009	None	
US 2010-0228740 A1	09/09/2010	None	
US 2012-0129446 A1	24/05/2012	AT 520238 T	15/08/2011
		CN 101346965 A	14/01/2009
		CN 102984041 A	20/03/2013
		EP 1964365 A1	03/09/2008
		EP 1964365 B1	10/08/2011
		EP 2299654 A1	23/03/2011
		HK 1122664 A1	18/11/2011
		JP 2009-521185 A	28/05/2009
		JP 2012-235471 A	29/11/2012
		US 2007-169115 A1	19/07/2007
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		US 2013-080599 A1	28/03/2013
		US 7702279 B2	20/04/2010
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		US 8315555 B2	20/11/2012
		WO 2007-075376 A1	05/07/2007
US 2009-0031336 A1	29/01/2009	None	
US 2007-0299778 A1	27/12/2007	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
JASPER JOSEPH T.

HANLEY, FLIGHT & ZIMMERMAN, LLC 150 S.
WACKER DRIVE, SUITE 2100 CHICAGO IL 60606 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**30 September 2013 (30.09.2013)**
Applicant's or agent's file reference 12-0402-PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/046386	**18 June 2013 (18.06.2013)**	26 June 2012 (26.06.2012)

International Patent Classification (IPC) or both national classification and IPC

G06Q 50/10(2012.01)i

Applicant
SONOS, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	27 September 2013 (27.09.2013)	KIM Sung Gon Telephone No. +82-42-481-8746

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046386

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/046386

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-21	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-21	NO
Industrial applicability (IA)	Claims	1-21	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 7483958 B1 (TAREK Z. ELABBADY et al.) 27 January 2009
D2: US 2010-0228740 A1 (ALAN CANNISTRARO et al.) 09 September 2010

1. Novelty and Inventive Step

1.1 Claims 1-10

1.1.1 Independent claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a method comprising: presenting media content information (e.g., music file, a play list) to the user, determining whether an original media playing license associated with the particular media contents file is available, generating a temporary media playing license from the original media playing license, the temporary media playing license specifying restrictions relating to playback of the particular media content file via the home network device; and sending the temporary media playing license to the home network device (See abstract, column 11, lines 1-20, claim 1, figure 4 in D1). Claim 1 differs from D1 in facilitating addition of content to the playlist by at least one participating user; and playback of content from the playlist in the restricted playback mode. However, D2 discloses a method comprising: receiving from at least one of the plurality of user devices a vote on a media item; and organizing the playlist based on the received votes (See abstract, paragraphs [0047]-[0057], claim 1, figure 4 in D2). Accordingly, claim 1 would have been obvious over D1 and D2. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of : Box No. V

1.1.2 Dependent claims 2-10

The additional feature of claim 2 is identical to the feature of D1 in that media items in the playlist are automatically chosen and added to the playlist by a program on the playlist host device (See claim 6 in D1). Accordingly, claim 2 would have been obvious over D1 and D2. Therefore, claim 2 lacks an inventive step under PCT Article 33(3).

Claim 3 further specifies authenticating the at least one participating user to enable the at least one participating user to add content to the playlist in the restricted playback mode. However, the additional feature of claim 3 is virtually suggested by the feature of D2 considering that the host receives an opt-in command from an authorized user and the opt-in command instructs the host to allow remote access to the playlist (See abstract, paragraphs [0047]-[0057], figure 4 in D2). Accordingly, claim 3 would have been obvious over D1 and D2. Therefore, claim 3 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 4 is identical to the feature of D2 in receiving from at least one of the plurality of user devices a vote on a media item; and organizing the playlist based on the received votes (See abstract, paragraphs [0047]-[0057], claim 1, figure 4 in D2). Accordingly, claim 4 would have been obvious over D1 and D2. Therefore, claim 4 lacks an inventive step under PCT Article 33(3).

Claims 5, 6 further specify that facilitating addition of content comprises accepting user selection of the content from a list of available content via a graphical user interface, and the list of available content includes a library of shared music available via a network. However, the additional features of claims 5, 6 are virtually suggested by the feature of D1 considering presenting media content information (e.g., metadata from the media library) to the user through a display screen, and selecting one or more music files, a play list, or other grouping of music files by the user (See abstract, column 11, lines 1-20, claim 1, figure 4 in D1). And D2 discloses a step of sending a playlist on a host device to a plurality of portable devices for display on a graphical user interface (See paragraph [0009] in D2). Accordingly, claims 5, 6 would have been obvious over D1 and D2. Therefore, claims 5, 6 lack an inventive step under PCT Article 33(3).

Claim 7 further comprises that the restricted playback mode is initiated and ended by a host user according to user authorization. However, the additional feature of claim 7 is merely a

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of : Previous Page

matter of design option when the general knowledge in relevant field of the art is used. Accordingly, claim 7 would have been obvious over D1 and D2. Therefore, claim 7 lacks an inventive step under PCT Article 33(3).

Claim 8 further specifies configuring the restricted playback mode for a fixed time interval. However, the additional feature of claim 8 is virtually suggested by the feature of D2 considering ordering changes can be postponed until the interval since the last touch event has exceeded 2 seconds (See paragraph [0089] in D2). Accordingly, claim 8 would have been obvious over D1 and D2. Therefore, claim 8 lacks an inventive step under PCT Article 33(3).

Claim 9 further specifies that a restricted playback mode includes a specified configuration of zones. However, the additional feature of claim 9 is virtually suggested by the feature of D1 considering that the media content license may be associated with a specific entity or with multiple entities (e.g., groups) (See column 7, lines 61-66 in D1). Accordingly, claim 9 would have been obvious over D1 and D2. Therefore, claim 9 lacks an inventive step under PCT Article 33(3).

Claim 10 further comprises that the subset of playback functions includes limited user interaction with at least one of zone configuration and content playback parameters. However, the additional feature of claim 10 is merely a matter of design option when the general knowledge in relevant field of the art is used. Accordingly, claim 10 would have been obvious over D1 and D2. Therefore, claim 10 lacks an inventive step under PCT Article 33(3).

1.2 Claims 11-20

1.2.1 Independent claim 11

Claim 11 relates to a tangible computer readable storage medium including instructions which, when executed by a processor, are to implement at least a method. But it shares similar technical features with claim 1. Accordingly, the same reasoning applies to claim 11. Therefore, claim 11 lacks an inventive step under PCT Article 33(3).

1.2.2 Dependent claims 12-20

Claims 12-20 share the same technical features with claims 2-10, respectively. Accordingly, the

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of : Previous Page

same reasoning applies to claims 12-20. Therefore, claims 12-20 lack an inventive step under PCT Article 33(3).

1.3 Independent claim 21

Claim 21 relates to a media playback system, but it shares similar technical features with claim 1. Accordingly, the same reasoning applies to claim 21. Therefore, claim 21 lacks an inventive step under PCT Article 33(3).

2. Industrial Applicability

Claims 1-21 are industrially applicable under PCT Article 33(4).

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Nicholas A.J. Millington
Title:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
Appl. No.:	13/864,249
Filing Date:	April 17, 2013
Examiner:	Curtis Kuntz
Art Unit:	2656
Confirmation Number:	9806

SECOND SUPPLEMENTAL PRELIMINARY AMENDMENT

Sir:

Please enter the following amendments prior to examination of the application.

Amendments to the Specification are presented on page 2;

Remarks/Arguments begin on page 3 of this document.

Please amend the application as follows:

Amendments to the Specification:

On page 1 of the specification, please amend the first paragraph after the section heading "Incorporation By Reference" with the new paragraph as follows:

This application claims priority under 35 USC §120 of US Application No. 13/297,000, filed November 15, 2011, entitled "System And Method For Synchronizing Operations Among A Plurality Of Independently Clocked Digital Data Processing Devices", which is a continuation of Patent Application Serial No. 10/816,217, now US Patent 8,234,395, filed on April 1, 2004, entitled "System and Method for Synchronizing Operations ~~Channel Handoff as~~ Among a Plurality of Independently Clocked Digital Data Processing Devices", which is a non-provisional application claiming priority under 35 USC §119 to Provisional Patent Application Serial No. 60/490,768, filed on July 28, 2003, entitled "Method for Synchronizing Audio Playback Between Multiple Networked Devices," now expired, all of which are assigned to the assignee of the present application and are incorporated herein by reference.

REMARKS

Applicants request that the above-presented amendments are entered prior to examination. The Examiner is invited to contact the undersigned if it would be helpful to advance the prosecution of the application.

Respectfully submitted,

Date: October 30, 2013

By: /Robert J. Irvine III/

TechLaw LLP
Telephone: (312) 834-4334

Robert J. Irvine III
Attorney for Applicant
Registration No. 41,865

Electronic Acknowledgement Receipt	
EFS ID:	17272325
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
Filer Authorized By:	
Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	01-NOV-2013
Filing Date:	17-APR-2013
Time Stamp:	19:44:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SNS-71301US11-2ndSuppPreliAmend.pdf	90555 e3b71e2dec91108ae4b8aaf3a79b336d06749435	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Specification	2	2
	Applicant Arguments/Remarks Made in an Amendment	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	90555	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/864,249	Filing Date 04/17/2013	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	11/01/2013	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/NICOLE LOVE-HENSLEY/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/864,249	04/17/2013	Nicholas A. J. Millington	SNS-71301.US.11 (13-0402)

CONFIRMATION NO. 9806

109473
TechLaw LLP
200 S. Wacker Drive
Suite 3100
Chicago, IL 60606

PUBLICATION NOTICE

OC000000063788974

Title:METHOD AND APPARATUS FOR PLAYING AND PROVIDING AUDIO CONTENT IN A SYNCHRONY GROUP

Publication No.US-2013-0238108-A1
Publication Date:09/12/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Nicholas A.J. Millington
Title:	SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES
Appl. No.:	13/864,249
Filing Date:	April 17, 2013
Examiner:	Curtis Kuntz
Art Unit:	2656
Confirmation Number:	9806

SUPPLEMENTAL PRELIMINARY AMENDMENT

Sir:

Please enter the following amendments prior to examination of the application.

Amendments to the Specification are presented on page 2;

Remarks/Arguments begin on page 3 of this document.

Please amend the application as follows:

Amendments to the Specification:

Please amend the title of the application as follows:

~~System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices~~

Method and Apparatus for Playing and Providing Audio Content in a Synchrony Group

REMARKS

Applicants request that the above-presented amendments are entered prior to examination. Applicants have also submitted herewith a supplemental ADS indicating the changes to the title. The Examiner is invited to contact the undersigned if it would be helpful to advance the prosecution of the application.

Respectfully submitted,

Date: August 21, 2013

By: /Robert J. Irvine III/

TechLaw LLP
Telephone: (312) 834-4334

Robert J. Irvine III
Attorney for Applicant
Registration No. 41,865

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SNS-71301-US.11
	Application Number	13/864,249
Title of Invention	System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City		State/Province		Country of Residence	

Mailing Address of Inventor:

Address 1			
Address 2			
City		State/Province	
Postal Code		Country	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number			
Email Address		Add Email	Remove Email

Application Information:

Method and Apparatus for Playing and Providing Audio Content in a Synchrony Group

Title of the Invention	~~System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices~~		
Attorney Docket Number		Small Entity Status Claimed	☐
Application Type			
Subject Matter			
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	
	Application Number	
Title of Invention	System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices	

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	**Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number			

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	
	Application Number	
Title of Invention	System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	
	Application Number	
Title of Invention	System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices	

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◯ Assignee	◯ Legal Representative under 35 U.S.C. 117	◯ Joint Inventor
◯ Person to whom the inventor is obligated to assign.	◯ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Applicant:

Address 1			
Address 2			
City		**State/Province**	
Country[i]		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	
	Application Number	
Title of Invention	System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices	

If the Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature	/Robert J. Irvine III/			Date (YYYY-MM-DD)	2013-08-19
First Name	Robert J.	Last Name	Irvine III	Registration Number	41865

Additional Signature may be generated within this form by selecting the Add button.

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent C o o p eration Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	16644104
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
Filer Authorized By:	
Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	22-AUG-2013
Filing Date:	17-APR-2013
Time Stamp:	10:36:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SNS-71301US11-SuppPrelimAmend-title.pdf	88634 7369b4f8b52f484fb08534d8a923aa9de7d3b14f	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Specification	2	2
	Applicant Arguments/Remarks Made in an Amendment	3	3

Warnings:					
Information:					
2	Application Data Sheet	SNS-71301US11-SupplementalADS.pdf	159593 cfe36c7a9f081526584a14e2c6cc84539abce1df	no	6
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
		Total Files Size (in bytes):	248227		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/864,249	04/17/2013	Nicholas A. J. Millington	SNS-71301.US.11 (13-0402)

CONFIRMATION NO. 9806

109473
TechLaw LLP
200 S. Wacker Drive
Suite 3100
Chicago, IL 60606

POA ACCEPTANCE LETTER

OC000000061850910

Date Mailed: 06/17/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/07/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/zabraha/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 109473

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 109473

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:
Sonos, Inc.
223 E. De La Guerra Street
Santa Barbara, CA 93101

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	/Mark W. Triplett/	Date	September 14, 2012
Name	Mark W. Triplett	Telephone	
Title	Director, Intellectual Property		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	15966282
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
Filer Authorized By:	
Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	07-JUN-2013
Filing Date:	17-APR-2013
Time Stamp:	10:28:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Assignee showing of ownership per 37 CFR 3.73.	SNS-71301US11-373cStatement.pdf	79728 8f3e3c45623233212bdbddabe6e4af2f2bb9003d	no	3

Warnings:	
Information:	

2	Power of Attorney	SONOS-POA.pdf	113691 bc339b23e44ae2271b93e7bdb8050526b8555675	no	1

Warnings:	
Information:	
Total Files Size (in bytes):	193419

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: SONOS, INC.

Application No./Patent No.: 13/864,249 Filed/Issue Date: April 17, 2013

Titled: System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices

SONOS, INC., a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Nicholas A.J. Millington To: Rincon Networks, Inc.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 030384, Frame 0675, or for which a copy thereof is attached.

2. From: Rincon Networks, Inc. To: Sonos, Inc.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 030518, Frame 0778, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Robert J. Irvine III/	June 6, 2013
Signature	Date
Robert J. Irvine III	41865
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/864,249	04/17/2013	2484	1600	SNS-71301.US.11 (13-0402)	20	3

CONFIRMATION NO. 9806

109473
TechLaw LLP
200 S. Wacker Drive
Suite 3100
Chicago, IL 60606

FILING RECEIPT



Date Mailed: 06/04/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
Nicholas A. J. Millington, Santa Barbara, CA;

Applicant(s)
SONOS, INC., Santa Barbara, CA

Assignment For Published Patent Application
SONOS, INC., Santa Barbara, CA

Power of Attorney: None

Domestic Priority data as claimed by applicant
This application is a CON of 13/297,000 11/15/2011
which is a CON of 10/816,217 04/01/2004 PAT 8234395
which claims benefit of 60/490,768 07/28/2003

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 05/21/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/864,249**

Projected Publication Date: 09/12/2013

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES

Preliminary Class

386

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/864,249

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/864,249	04/17/2013	2484	1600	SNS-71301.US.11	20	3

CONFIRMATION NO. 9806

109473
TechLaw LLP
200 S. Wacker Drive
Suite 3100
Chicago, IL 60606

FILING RECEIPT

OC000000061405633

Date Mailed: 05/30/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Nicholas A. J. Millington, Santa Barbara, CA;

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SONOS, INC., Santa Barbara, CA

Assignment For Published Patent Application

SONOS, INC., Santa Barbara, CA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/297,000 11/15/2011
which is a CON of 10/816,217 04/01/2004 PAT 8234395
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If Required, Foreign Filing License Granted: 05/21/2013

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Projected Publication Date: Perfected

Non-Publication Request: No

Early Publication Request: No

Title

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NOT GRANTED

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SelectUSA

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/864,249

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
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INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
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MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
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	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/864,249	04/17/2013	Nicholas A. J. Millington	SNS-71301.US.11

CONFIRMATION NO. 9806

IMPROPER CPOA LETTER

109473
TechLaw LLP
200 S. Wacker Drive
Suite 3100
Chicago, IL 60606



Date Mailed: 05/30/2013

NOTICE REGARDING POWER OF ATTORNEY

This is in response to the power of attorney filed 04/17/2013. The power of attorney in this application is not accepted for the reason(s) listed below:

- The power of attorney from the inventors has not been accepted because the power of attorney must be signed by the applicant for patent. See 37 CFR 1.32(b)(4).

/ebekele/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	System and Method for Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Nicholas A.J. Millington Date (Optional): 2/25/13

Signature: Nicholas A.J. Millington

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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EFS ID:	15769773
Application Number:	13864249
International Application Number:	
Confirmation Number:	9806
Title of Invention:	SYSTEM AND METHOD FOR SYNCHRONIZING OPERATIONS AMONG A PLURALITY OF INDEPENDENTLY CLOCKED DIGITAL DATA PROCESSING DEVICES
First Named Inventor/Applicant Name:	Nicholas A. J. Millington
Customer Number:	109473
Filer:	Robert Johnson Irvine
Filer Authorized By:	
Attorney Docket Number:	SNS-71301.US.11 (13-0402)
Receipt Date:	15-MAY-2013
Filing Date:	
Time Stamp:	10:53:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	SNS-71301US11-DecComm.pdf	65114 e5250633cc60840e57ad0ed1c1a0ee39ea56bfd1	no	1

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2	Oath or Declaration filed	SNS-71301US11-SignedDeclaration.pdf	227818 d3319ecbe9e11da18de11ea1f458ff0f121447b4	no	2
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(Attorney Docket No. SNS-71301.US.11)

In re Application of:	)	
	)	
Nicholas A.J. Millington	)	Examiner: TBD
	)	
Serial No.: 13/864,249	)	
	)	Art Unit: 2484
Filing Date: April 17, 2013	)	
	)	
For: System and Method For Synchronizing Operations Among a Plurality of Independently Clocked Digital Data Processing Devices	)	Confirmation No.: 9806

COMMUNICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant submits the attached executed Declaration and Power of Attorney for the above-referenced U.S. Patent Application.

If the Examiner has any questions, please contact the undersigned at (312) 834-4334.

Respectfully submitted,
TechLaw LLP

Date: May 14, 2013

By: /Robert J. Irvine III/
Robert J. Irvine III
Reg. 41,865

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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	Art Unit	2484
	Examiner Name	TBD
	Attorney Docket Number	SNS-71301.US.11 (13-0402)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13864249
	Filing Date	2013-04-17
	First Named Inventor	Nicholas A. J. Millington
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	32	VOYETRA; Turtle Beach Inc., "AudioTron Setup Guide, Version 3.0", May 2002, 38 pages.	☐

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(54) **A synchronization service for a distributed operating system or the like.**

(57) A synchronization service which can be incorporated into a distributed operating system as a shared service. It allows the realization of different custom-built synchronization strategies for different applications. This approach is based on defining a general set of application-independent synchronization primitives. These are provided by the distributed operating system in the form of a synchronization service. By themselves the individual primities are insuffient to provide synchronization. However, they can be combined in different ways to realize customized synchronization strategies. This leaves the ultimate responsibility for synchronization with the application, but in a much simplified form. Application programs can combine these primitives to construct the most suitable form of synchronization.

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A SYNCHRONIZATION SERVICE FOR A DISTRIBUTED OPERATING SYSTEM OR THE LIKE

This invention relates generally to the field of computers, and more specifically to a synchronization service for use with computers.

Background of the Invention

As computing tasks increase in size and complexity, one approach to speed up the execution of these tasks is to use distributed programs. A distributed program can be defined as a computer program which is partitioned into multiple concurrent components which execute on separate processing sites which do not share a common memory.

In this context, the term "program" is used to imply a global objective (i.e. common goal). Each component (or portion) of the program performs some portion of the overall activity required to attain this common goal. Thus, a distributed program represents a set of (functionally) tightly-coupled components operating in a (physically) loosely-coupled environment.

Asynchronous operation of concurrent cooperating activities results in the time-dependencies and race conditions which can lead to errors. For example, two processes attempting to simultaneously update a shared variable may interfere with each other so that an incorect value is assigned to the variable. The solution to such problems is through synchronization. Synchronization can be defined as the organization of actions and interactions of a system of concurrent asynchronous entities for the purpose of achieving some common objective.

One example of a distributed computer system is the case of a replicated database where each copy of the database is on a separate processing element. When a change is made to one copy then this change must be propagated to all the others if consistency is to be maintained. This involves synchronization. The situation may be complicated further if two or more conflicting changes are initiated simultaneously on different copies. In that case synchronization is required not only to ensure that all copies end up in the same state but also that the resulting state is valid. Other situations where synchronization is necessary include the restoration of the current state to new or recovering copies and the handling of failures.

Distributed synchronization can also be useful in standby schemes where redundant components are configured for greater system availability. In this case the compnoents have to agree as to which will be the active and which the standby components and must also arrange for proper switchover in case of failures.

The cited examples illustrate the diverse ways in which synchronization is used in distributed systems. As can be expected, different applications can have different demands on synchronization: some may require fast response while others may place more emphasis on reliability and fault tolerance. This indicates that the choice of the most suitable synchronization technique and tis implementation can only be made if the particular needs of the application are considered.

Unfortunately, in a large system supporting many different types of distributed application programs, leaving synchronization entirely to the application program could result in excessive duplication of effort, unreliable design, and suboptimal utilization of resources. Even worse, perhaps, is the possibility that the relatively complex issue of synchronization could dominate the design to such an extent that functional concerns are neglected. From that point of view a trusted, system-based, synchronization facility is preferred.

There are several important characteristics of distributed programs which make them significantly more difficult to design and implement compared to conventional non-distributed programs:

(1) Concurrent execution. This means that there is no single sequential control thread such as represented by the execution trace of a non-distributed program. Concurrency introduces timing dependencies among the system components which can lead to deadlocks or instability.

(2) Significant communication delays. The exchange of information between components of a distributed program involves non-negligible and randomly-distributed transmission delays. If these delays are comparable to the rate at which the components change state, the system may become unstable.

(3) Partial failure modes. Failures of distributed components require complex detection and recovery algorithms which are difficult to design and verify. Two types of partial failures exist:

- Communication path failures can result in the duplication, temporal reordering, or total loss of information being exchanged; and
-Processing component failures (hardware and software) lead to temporary loss of functionality.

The recovering action for each type of failure is quite different. Unfortunately, It is often difficult to distinguish them on the basis of the observed symptoms.

From the definition of synchronization it can be seen that the need for synchronization is determined by the shared objective of the cooperating distributed entities. This common objective places interdependencies on the individual entities so that a change in the state of one necessitates appropriate changes (reactions) in others. This can be expressed as a requirement to preserve certain application-dependent state consistency constraints. The problem of maintaining consistency is further complicated by the fact that each entity, in addition to internal interactions, is also exposed to independent interactions with the environment. (The environment consists of other distributed components which do not share the same objective as the synchronized system, but which use it for their own purposes). This means that the stimulus to change state can occur simultaneously in two or more synchronized entities. The synchronization problem can then be viewed as one of ordering concurrent interdepenent activities.

The simplest form of ordering which guarantees consistency is serialization: the execution of activities one at a time. Although synchronization strategies exist which are not based on serialization, they will not be considered here due to their relative complexity.

Two basic, and not necessarily exclusive, classes of strategies exist for achieving serialization in distributed systems;

(1) Centralized strategies.

In this case, the ordering of activities is performed by a unique distinguished entity. Synchronized entities, with externally induced work requests, first approach the distinguished entity for permission. This entity resolves concurrent requests by granting a right to only one of the competing entities. When that entity completes its work, the right is granted to another entity, and so on.

A major feature of this type of scheme is that there is a single point of control. This allows the implementation of relatively complex yet reliable and efficient scheduling algorithms. Examples of centralized strategies can be found in A Decentralized Control Method in a Distributed System by J.P. Cabanel et al, Proceedings 1st Ceonference, Distributed Proc. Systems, Huntsville, Al, 1979 and in A Failure Tolerant Centralized Mutual Exclusion Algorithm by G. N. Buckley et al, Proceedings 4th Conference, Distributed Computer Systems, San Francisco, Ca. 1984.

(2) Distributed strategies.

In this case, there is no central scheduler. Instead, ordering is accomplished through distributed agreement. Key to this scheme is a shared "clock" (logical or physical). This is generally a monotonically increasing numeric variable which is maintained consistently by all the synchronized entities. Work requests are timestamped with the clock value at the time of arrival and then processed in order. However, because two or more requests can be concurrent (i.e., they have the same timestamps), ties are resolved through group negotiation: a new work request is first broadcast to all other entities which respond either with a simple acknowledgement or a work request of their own. Once an entity is aware of all concurrent work requests within the group, it orders them according to some tie-breaking rule and then processes them. Since each entity uses the same ordering algorithm each will perceive the same sequence of events as all the others.

The distinguishing feature of distributed strategies is that operation does not depend on a single critical entity at any time. This makes them very fault-tolerant. However, they are generally less efficient than centralized strategies when the number of entities to be synchronized is large. Examples of distributed strategies can be found in Time, Clocks, and the Ordering of Events in a Distributed System by L. Lamport, Comm. ACM, (21,7), July 1978, in An Algorithm for Maintaining the Consistency of Multiple Copies by D. Herman et al, Proceedings, 1st Conference Distributed Proc. Systems, Huntsville, Al., 1979 and in Synchronization in Distributed Programs by F.B. Schneider, ACM Transactions on Prog. Lang. & Syst, (4,2), April, 1982.

Combinations of these two forms, such as the circulating sequencer proposed in Algorithms for Distributed Data Sharing Systems Which Use Tickets by G. Le Lann, Proc. 3rd Berkeley Workshop on Dist. Data, Aug. 1978, are possible. In that scheme, a centralized controller is used to control the clock used for timestamping. (Although the controller function is circulated among the distributed entities, at any given time it is performed by only one entity.) The ordering of activities is then done in a distributed fashion, based on timestamp values and a tie-breaking rule.

The following patents depict examples of distributed processing in general, and attention is directed to them: U.S. patent 3,411,139 dated November 12, 1968 by J.T. Lynch et al; U.S. patent 3,631,405 dated December 28, 1971 by G.S. Hoff et al; U.S. patent 3,771,137 dated November 6, 1973 by R.P. Barner et al; and U.S. patent 4,115,866 dated September 19, 1978 by J.L.G. Janssens et al.

Summary of the Invention

One objective of the Synchronization Service of the present invention is to provide a set of application-independent capabilities which would allow the construction of specific synchronization strategies belonging to the categories listed above. To do this it must incorporate the essential abstract features of those strategies. These are defined in the form of a general synchronization paradigm described in a following section.

Because of concurrent execution and the possibility of partial failures, it is necessary to closely synchronize the operation of the distributed components of a program. Synchronization can be defined as the ordering of actions and interactions of components in a distributed program so that the state of each component remains consistent with the common goal.

Experience with concurrent systems has shown that the synchronization problem is difficult to solve even for non-distributed situations; the number of possible component interactions is usually very large, increasing the probability of a design error.

A further difficulty is caused by the fact that no single synchronization strategy is adequate for all distributed programs. If multiple distributed programs are to be supported on a system, this means that the synchronization problem may have to be solved in many different ways.

Given the diversity of synchronization strategies and the difficulty of implementing them, is it possible to provide some assistance to designers of distributed programs to increase the reliability of their designs?

The approach to this problem, presented by the present invention, consists of providing a set of primitive synchronization operators at the level of a distributed operating system. Such operators can be used to construct more complex forms of synchronization customized to different applications. This approach has the following advantages:

-It provides a one-time trusted implementation of common mechanisms;

-It does not favour any particular synchronization strategy which would favour some applications but penalize others;

-It provides a systematic framework (programming model) for designing and implementing distributed programs.

The operating system component which implements the synchronization primitives (operators) is called the Synchronization Service.

The essential idea behind the Synchronization Service is that the synchronization problem can be tackled hierarchically. Each level in the hierarchy may have different synchronization mechanisms based on the synchronization facilities of the levels below. The lower levels of this hierarchy can be designed to be application-independent and can therefore be provided as a reliable system service. This, in turn, increases the reliability of programs and reduces development time.

This approach to distributed synchronization attempts to decompose the synchronization problem. At the lowest level of decomposition a general set of application-independent synchronization primitives is defined. These are provided by the distributed operating system in the form of a synchronization service 10. By themselves the primitives are insufficient to provide synchronization. However, they can be combined in different ways to realize customized synchronization strategies. This leaves the ultimate responsibility for synchronization with the application program, but in a much simplified form. The role of the synchronization service 10 is to hide many of the more basic housekeeping functions inherent in distributed synchronization. For instance, all fault-tolerant synchronization schemes require a monitoring function to keep track of the operational status of all relevant distributed components. The present invention consolidates such a function as a system service where it can be shared by many application programs.

Stated in other terms, the present invention is a general service, provided within a distributed operating system, which can be used by application and system programs to implement synchronization between program components that are physically distributed.

Stated in other terms, the present invention is a synchronization service for use with a computer having a distributed operation system, to allow the construction of a customized synchronization scheme, for synchronizing the constituent portions of a distributed program, the service comprising: a general set of application-independent synchronization primitives, whereby the construction of the customized synchronization scheme is achieved by the selective implementation of the application-independent synchronization primitives.

Stated in yet other terms, the present invention is a synchronization service for use with a computer having an operating system distributed over a plurality of processing elements, to allow the construction of a customized synchronization scheme, for synchronizing the constituent components of a distributed program, the service comprising the steps of:

a) joining a program component on a fist processing element to a group of existing program components on at least a second processing element so that each of the existing components is aware of the present and location of the joining components;

b) informing each member of the group of physically distributed program components when one or more components which are members of the group, depart from it;

c) selecting, as a distinguished member, one program component from a group of distributed program components such that, within the group, there is never more than one distinguished member; and

d) providing mutually exclusive rights to the group of distributed program components such that no more than one component can appropriate a given right at any time.

Stated in still other terms the present invention is a synchronization service, for use with a computer having an operating system distributed over a plurality of processing elements, to allow the construction of customized synchronization schemes for synchronizing the constituent components of a distributed program, the service including a synchronization master control comprising: master control means for activating the synchronization service; polling means for polling the processing elements associated with the components of the distributed program so as to monitor the status of the processing elements; control means for joining new members to the group, and for handling departures of members from the group; and a database means containing information representative of the current state of the synchronization service at a given point in time.

Brief Description of the Drawings

The present invention will now be described in more detail with reference to the accompany drawings, wherein like parts in each of the several figures are identified by the same reference character, and wherein:

Figure 1 depicts a simplified block diagram of the synchronization service of the present invention;

Figure 2a is similar to Figure 1 but is for one specific embodiment thereof;

Figure 2b is a variation on the embodiment of Figure 2a;

Figure 2c is similar to Figure 2b;

Figure 3a is a chart depicting the primitives and corresponding replies employed by the invention;

Figure 3b is a symbolic representation of the constituent tasks of synchronization master control of Figure 1;

Figure 3c is a symbolic representation of the constituent tasks of member agent 11 of Figure 1;

Figure 4 is a simplified functional flow diagram for a database;

Figure 5 is a simplified functional flow diagram for a database;

Figures 6 to 8, 9a, 9b, and 10 to 13 inclusive represent action sequences helpful for understanding the operation of the present invention; and

Figure 14 is a simplified representation of the useage dependencies helpful in understanding the operation of the present invention.

Detailed Description

Synchronization service 10 is based on a general distributed program paradigm. This paradigm is represented by the concept of synchronization groups. A synchronization group is a set of distributed program components called "members", and referred to by the reference character 18, which cooperate to achieve a common objective. Note that members 18 are not a part of synchronization service 10, but they use synchronization service 10.

In other words, the distributed operating system 15, to which synchronization service 10 is applied, will support both distributed application programs and distributed system programs. Both the distributed application and system programs consist of several program components (called members 18) which in turn consist of subcomponents called tasks. In synchronization service 10 there is one synchronization group for each distributed application or system program.

A primitive synchronization operator has effect only within the domain of a particular synchronization group. Synchronization groups, therefore, encapsulate units of tightly coupled distributed functionality. Of course, synchronization service 10 allows many synchronization group to coexist on a single distributed operating system 15.

The basic construct of synchronization service 10 is the synchronization group representing a set (i.e., a system) of distributed entities which are tightly coupled to each other in some way. The

state and action dependencies which bind these entities are not specified at this level so that synchronization groups are decoupled from application semantics.

Formally, a synchronization group is a set of components, called members 18, in which each group ideally has the following properties:

(1) Uniqueness: There can be any number of synchronization groups in a larger system but each synchronization group is distinguished from all others by a unique synchronization gruop identifier.

(2) Physical distribution: Each member of a synchronization group exists on a different processing element 12. (This is simply a matter of convenience: extending the concept of synchronization groups to logically distributed entities is possible). Note that there are no restrictions concerning the number of synchronization groups which may have members 18 on a particular processing element 12. This means that two or more synchronization groups can overlap in physical space.

(3) Reliable communication: Communication between any pair of members 18 is non-lossy, non-duplicating, and order-preserving. Furthermore, full connectivity is assumed; i.e., each member 18 can communicate directly with all other members 18. If the physical system does not have these properties then it is assumed that an underlying communication service exists which provides them. The intent here is to isolate communications issues from synchronization issues.

(4) Dynamic behavior: Members 18 can depart or join the synchronization group at any time and independently of each other. (The group exists as long as at least one member 18 exists.) Departures may be either application-driven or due to processing element 12 failure. This property captures the dynamic nature of real-world components.

(5) Mutual exclusion: Each synchronization group maintains a set of shared objects called rights, each of which can be either free or associated with at most one member 18. They are functionally equivalent to semaphores (reference: E.W. Dijkstra, Cooperating Sequential Processes, Technical Report EWD-123, Technological University, Eindhoven, 1965) but for a distributed environment. (However, a member 18 can hold more than one right at a time.) A departing member 18 cannot abscond with a right since any rights it holds are automatically freed. In essence, rights are a general mechanism for distinguishing between group members 18. The assignment of functional significance to rights is up to the application.

(6) Distinguished member: One and only one member 18 of every synchronization group is designated as its distinguished member. The appointment is made at random and is transferred to another member 18 if the current distinguished member 18 departs. This property is intended to serve those synchronization strategies which require a central coordinator although synchronization service 10 makes no assumptions regarding the functional significance of the distinguished member 18. (Note that the distinguished member feature is simply a special case of the mutual exclusion property but has been singled out purely for convenience.) Since the selection and preservation of a distinguished member 18 is by synchronization service 10, application programs need not implement their own election algorithms.

A synchronization group represents a unit of synchronization. The facilities of the synchronization service 10 (described later) are all limited in scope to the respective synchronization group.

The synchronization problem is often formulated as a problem of maintaining data consistency in a dynamic environment. From that point of view, the synchronization service 10 ensures consistency of the folowing information sent to members 18:

(1) current membership list;

(2) the identity of the distinguished member; and

(3) the status of all group rights.

This information is maintained consistently and correctly in the face of continual departures and arrivals of members 18.

The concept of synchronization groups does not encompass application program-level consistency; that is the responsibility of the application program. Instead, a synchronization group maintains a consistent view (on all its members 18) concerning the status of its objects: the list of active members 18, the status of rights, the distinguished member designation. These responsibilities are therefore removed from the view of the application program.

Figure 1 depicts a simplified block diagram of synchronization service 10 of the present invention. A distributed application program, structured as a synchronization group, typically has members 18 (i.e. distributed program components) which are physically distributed across two or more processing elements 12a....12n (referred to collectively as processing elements 12). In the implementation of Figure 1, the structure of synchronization service 10 matches the structure of the synchronization group by providing a local synchronization controller, i.e. member agent 11, for each group member 18. Thus, there is a separate implementation of synchronization service 10 for each application program; note, however, that there is only one synchronization master control 13 regardless of how

many implementations, and only one synchronization agent 14 per processing element 12. Each implementation is functionally independent of the others.

Note that the group of processing elements 12 together with processing element 19 form part of the distributed computing environment (i.e. distributed operating system 15) which synchronization service 10 is designed to synchronize. Not also that each processing element 12 may have a plurality of member agents 11, and that processing element 19 may be combined with one of the processing elements 12.

Member agents 11 provide the main interface to the synchronization service 10. Application program components (i.e. members 18) initiate synchronization activities by invoking the desired synchronization primitives (to be described later). This is communicated to the local member agent 11 which then interacts with other member agents 11 in order to effect the specified synchronization function. The member agent 11 also informs the members 18 of synchronization requests initiated by other members 18 as well as group events such as the failure of active members 18 and the joining of new ones.

Member agents 11 are dynamic entities which follow the dynamics of the application programs they serve. A member agent 11 is created (by the local synchronization agent 14) when an application program component (i.e. member 18) requests to be synchronized with other members 18 in a synchronization group. It is destroyed when the member 18 is unsynchronized.

To ensure coherent behaviour of synchronization service 10, control of the individual implementations of the service 10 is centralized. This is done through a three-level hierarchy with a unique master controller at the top (i.e. synchronization master control 13), an intermediate layer of controllers in the middle (i.e. synchronization agents 14a to 14n, referred to collectively as synchronization agents 14), and a layer of member agents 11 at the bottom. This hierarchy allows a decomposition of the control problem into smaller more comprehensive subproblems. Note from Figure 1 that there is one synchronization agent 14 for each processing element 12, and it controls all the member agents 11 in that processing element 12.

Figure 2a is similar to Figure 1, but depicts a specific embodiment of the synchronization service, referred to by reference character 100 as applied to distributed operating system 115. In Figure 2a there is a synchronization master control 13 on processing element 119, three processing elements 112a, 112b, and 112c, three synchronization agents 14a, 14b, and 14c, along with six members 18a to 18f along with their corresponding member agents 11a to 11f respectively. In the distributed computing example of Figure 2a, processing elements 112a, 112b, 112c and 119 are each an IBM PC-AT. Note that the members 18a to 18f inclusive are not part of synchronization service 100 while everything else shown in Figure 2a is. Members 18a to 18f inclusive use the synchronization service 100. Note also that there is another synchronization master control (not shown) on standby.

Figure 2b is similar to Figure 2a, but is further simplified and depicts only those items that constitute one implementation of synchronization service 100 (i.e. implementation 100a). That is, members 18a and 18e (Figures 2a and 2b) form one synchronized group. Members 18b, 18c, 18d, and 18f (Figure 2a) form at least one other synchronized group.

Figure 2c is a simplified application to exemplify synchronization service 100a of Figure 2b. In Figure 2c the hardware implementating synchronization service 100a is a group of IBM personal computers of the AT series, linked by an IBM LAN (local area network) 226. That is, processing element 112a is an IBM PC-AT computer 212a, processing element 112b is an IBM PC-AT computer 212b, and processing element 119 is an IBM PC-AT computer 219.

In Figure 2c, computer 212a is a telephone operator's workstation as is computer 212b. The application in Figure 2c is to maintain a telephone directory and to allow the user at both computers 212a and 212b to have access to the telephone directory, to access it to determine an individual's telephone number, and to be able to update the telephone directory as changes occur. Computer 219, in this example, handles the tasks of synchronization master control 13 and database 16 (Fig. 2b)

Returning now to the general case of Figure 1, the role of synchronization master control 13 is to provide internal synchronization between the components of the local synchronization service 10. In essence, it performs those functions where a consistent (but not necessarily correct) view of the system 15 is required. More precisely, synchronization master control 13 is responsible for:

(1) Activation of synchronization service 10.

This is done by activating the synchronization agents 14 as the processing elements 12 are restarted.

(2) Monitoring of processing elements 12.

This function involves observing (polling) the status of all processing elements 12 by communicating with local synchronization agents 14. Any changes in these states are detected by synchronization master control 13 and appropriate notifications are dispatched to the synchronization service components affected by the change.

(3) Management of synchronization groups.

synchronization master control 13 is the central arbiter for all synchronization groups in the local synchronization service 10. It is involved in handling transient conditions which occur in group operation:
-group establishment,
-joining of new members 18, and
-departures of joined members 18.
Note that synchronization master control 13 does not participate in the steady-state operation of synchronization groups and, consequently, is not normally a performance bottleneck.

Synchronization master control 13 must be highly fault-tolerant since synchronization service 10 may be used to implement standby schemes by applications. For that reason it is backed up by at least one other instance operating in standby mode. If the currently active synchronization master control 13 fails, the standby will take its place. Because this is the Synchronization Service, the selection of an active synchronization master control 13 from the set of instances must be done through an internal agreement (election). This is the only place in the entire system where the synchronization service 10 cannot be used for such a purpose. However, in this case, the problem occurs in a very specific context and can be solved in a specific way (for example, by using a bully algorithm for a distributed election as described in Elections in a Distributed Computing System by H. Garcia-Molina, IEEE Trans. on Computers, (C-31,1), Jan. 1982).

Once the active synchronization master control 13 has been selected, the standby resorts to a monitoring mode in which it periodically polls the active instance until a failure is detected.

Since a standby is used, following a failure of the synchronization master control 13, its previous state must be reconstructed on the standby, preferably without involving the application program. This can be achieved through the information kept by the synchronization agents 14. As a consequence, except for slightly extended service times due to the recovering process, application programs are unaware of synchronization master control 13 failure.

SYNC MASTER TASK

The Sync Master Task 20 is the root task (i.e. program) of the synchronization service 10 control hierarchy. It provides the central control point for all synchronization groups. It consists of four main subcomponents as depicted in Figure 3b and is located within synchronization master control 13. The four main subcomponents of the Sync Master Task 20 are as follows:

SYNC MASTER CONTROL 21 establishes and maintains the operational state of the Sync Master Task 20. This includes the Sync Master recovery algorithm. Sync Master Control 21 consists of the main procedure of the Sync Master Task 20.

POLLING CONTROL 22 is responsible for detecting failure of processing elements 12. This subcomponent sends periodic messages to all synchronization agents 14. If a reply is not received within a certain time interval (after several retries have been attempted) the corresponding processing element 12 is declared as failed and a notification is sent to all remaining synchronization agents 14. This subcomponent is implemented within the Sync Master Task 20.

SYNC AGENT CONTROL 23 deals with events which occur at the processing element 12 level. This subcomponent is responsible for activating newly-recovered synchronization agents 14 as well as for accepting notifications, from the synchronization agents 14, about the arrivals and departures of group members 18. These are then relayed to the appropriate Group Control 24. This subcomponent is also implemented within the Sync Master Task 20.

GROUP CONTROL 24 handles events which are relevant to one group. This includes the joining and departure of group members 18. The Group Control function is implemented by the Group Master Task 25. There is one such task 25 for each synchronization group. Tasks 25 are created dynamically by the Sync Master Task 20.

The tasks comprising the Sync Master Task 20 maintain a shared detabase 16 (Figure 1) which represents a snapshot of the current state of the synchronization service 10. This database is described later.

SYNCHRONIZATION AGENT

A synchronization agent 14 resides in the control program of each processing element 12 which requires synchronization service 10 and it is the sole representative of the Sync Master Task 20 in that processing element 12. The synchronization agent 14 has the following responsibilities:
-It accepts SYNCHRONIZE directives and creates corresponding member agents 11.
-It monitors the status of all active member agents 11 on its processing element 12 and detects their disappearance (spontaneous or planned).
-It notifies the synchronization master control 13 of all changes (arrivals and departures) of Member Agents 11 on its processing element 12.
The synchronization agent 14 is implemented by the Sync Agent Task which is part of the operating system 15 on the corresponding processing element 12.

The synchronization agents 14 are permanent representatives of synchronization master control 13 within their host processing element 12. They have three main purposes:

(1) Synchronization agents 14 are a focal point for controlling all member agents 11 within a single processing element 12. This reduces the load on synchronization master control 13 which simply sends common control information to synchronization agents 14 for distribution to local member agents 11.

(2) Synchronization agents 14 isolate member agents 11 from the effects of synchronization master control 13 failures. All communication between the synchronization master control 13 and Member Agents 11 is channeled through the synchronization agents 14. If the synchronization master control 13 is temporarily unavailable (due to failure), the synchronization agents 14 will hold member agent 11 messages destined for the synchronization master control 13 until the latter is reinstated. In this way failures of the synchronization master control 13 are masked from member agents 11 and hence the applications.

(3) Synchronization agents 14 participate in the recovery of the synchronization master control 13. When a synchronization master control 13 is being reinstated it can reconstruct its operational state simply by querying all the synchronization agents 14. This is much faster and more reliable than querying the member agents 11 since these are more dynamic and more numerous.

The synchronization master control 13 maintains a database 16 (Figure 1) which represents the current state of the synchronization service 10 within the system 15. The database can be accessed through two keys:
-by group identifier --for access to the data for a particular synchronization group, and
-by processing element identifier --for access to synchronization service components located on a particular processing element 12.

The basic structure used is the linked list of dynamically allocated control blocks, each block corresopnding to some synchronization service component. This represents a trade-off between the requirement to minimize storage costs and the need for fast access to the data.

The next section describes the operation of the internal mechanisms used to achieve the synchronization functions. In the following discussion the communication between member agents 11 is assumed to be reliable; i.e., it is non-lossy, non duplicating, and order preserving. If the communication medium is unreliable an underlying reliable communication service provided within the distributed operating system can be used.

Rights are a set of shared objects within each synchronization group; each right can be free or assicated with at most one member 18. One example of a right is a database lock whereby only one user at a time can write to a database and no one else can read or write at that time. See also the "Update" right referred to later.

Rights are distributed in a centralized fashion since that minimizes overhead and complexity. In principle, this can be done by any member agent 11. For convenience, the control and distribution of rights are performed by the distinguished member (one of the members 18). The distinguished member 18 already has the uniqueness and fault-tolerant properties which are also required by the controller for rights. Thus, the Member 18 selected as the distinguished member has to perform this special function in addition to its standard synchronization functions. The selection of a distinguished member is done, by the synchronization master control 13, at the time the group is established (see below).

When a member 18 requires a right, its member agent 11 directs the request to the distinguished member 18. If the right is available, the distinguished member 18 will grant the right and inform the requesting member agent 11. If the right is already appropriated, then depending on the type of request made, the request is either queued by the distinguished member 18 or it is refused. In the first case, requests are handled on a first-come first-served basis.

Should the current distinguished member 18 fail, a new one is appointed by the synchronization master control 13 (which is also resonsible for detecting the failure). Of course, until a new distinguished member 18 is appointed, rights cannot be distributed or retrieved, but all the other synchronization services are still available. In order to mini-

mize the effect of a distinguished member 18 failure, the state of rights is reconstructed to the point just prior to failure. Each member 18 keeps a list of all rights which it has appropriated as well as a list of all its outstanding rights requests. This information is then exchanged with the new distinguished member 18 which can then assume the same state as the previous distinguished member 18. The entire switchover process is transparent to the application program.

If a member 18 fails, the distinguished member will automatically release any rights held by that member 18 and also purge any queued requests generated by that member 18.

Member agent 11 is the main functional component of synchronization service 10 and is responsible for handling all directives initiated by the user. It performs four classes of functions as depicted in Figure 3c and as represented by the following:

The COMMUNICATIONS HANDLER 33 provides a reliable (order-preserving, non-lossy, non-duplucating) communications service between group members 18; in order to minimize deadlocks the communication mode used is asynchronous message passing. This function is required only if there is no reliable communications service present within the distributed operating system 15.

The GROUP STATE HANDLER 32 maintains a local version of the current state of all the other group members 18.

The DIRECTIVE HANDLER 31 provides the interface between user tasks (components of members 18) and the member agent 11.

The DM HANDLER 30 implements the distinguished member functionality and is active on only one member 18 of the group at a time. This member 18 is selected by the Group Master Task 25 (Figure 3b). The distinguished member 18 is responsible for allocation of rights as well as for broadcasting group status change notifications to all other members 18 of the group. (This information is received from the Group Master Task 25.)

Member agents 11 are created dynamically by the synchronization agent 14 in response to a SYNCHRONIZE directive (Primitive). They are also destroyed by the synchronization agent 14 after they have left the group or following a failure.

Broadcasts and Acknowledgements

When an application program initiates a broadcast (via the GROUP-BROADCAST primitive), its local member agent 11 distributes the information to all other active member agents 11. It then accumulates acknowledgements until all active member agents 11 have replied after which the application program is notified (via the GRP-ACK reply signal).

If an element 12 fails before its acknowledgement is dispatched, the broadcasting member agent 11 will assume an implicit acknowledgement from that member so that failures will not disrupt the application.

Group Establishment and Joining of New Members

A newly joining member 18 first informs the synchronization master control 13 (via its synchronization agent 14) of its intent to join the synchronization group. The synchronization master control 13 then determines if this is the first reported member of the group. If it is, then this Member 18 is designated as the distinguished member 18 and a notification is sent back. This establishes the group.

If the group is already established, synchronization master control 13 registers the new member 18 as being in the joining state and informs the group's distinguished member agent 11. Upon receiving this notification the distinguished member agent 11 broadcasts a join request to all member agents 11 on the list and waits for the corresponding group acknowledgement. The period between the broadcast of the join request and the full acknowledgement of that request by all joined member agents 11 is called the joining interval. During that time some member agents 11 will become aware of the new member agent 11 before others. This opens up the possibility that some messages broadcast within the group may bypass the partially synchronized member agent 11. If messages received by this member agent 11 are passed to the application program, then the application program function of this member 18 would not necessarily perceive the same sequence of group events as other members 18; it could miss some. Therefore, the new member agent 11 must acknowledge any messages received from other member agents 11 (in order to satisfy the acknowledgement requirement) but, once acknowledged, the messages are discarded; i.e. they are not passed on to the application (an exception is messages containing other joining or departure requests which are processed by the member agent 11 but still not relayed to the application). This mode of operation remains in effect until the join

request is finally acknowledged by the entire group. At that point, the new member 18 informs its application that it is fully joined and switches to normal operation. The overall effect, as perceived by the application, is that the joining operation is atomic.

The handling of messages that were discarded during the joining interval is no different to the application program than the handling of messages missed by the member 18 while it was down; that is, once synchronized with the gruop, the application program must proceed to upgrade its functional state to be consistent with the functional states of other members 18. The best method for achieving this depends on the application program.

Departure of Members

The departure of a member 18 from a synchronization group occurs when the member 18 decides to unsynchronize or when the host processing element 12 fails. In the former case, the departing procedure is as follows: the synchronization group (i.e. agent 11) notifies the Sync Master Task 20 of its intention. This event is relayed, via the appropriate Group Master Task 25 (Figure 3b), to the distinguished member 18 of the group. The distinguished member 18 then broadcasts this information to all other group members 18. Note that there is one Group Master Task 25 for every synchronization group defined in service 10.

In the case of a processing element 12 failure, the failure is detected by the Polling Control 22 within Sync Master Task 20 (Figure 3b) and the same sequence as described above is executed.

If the departed member 18 was a distinguished member, Group Master Task 25 will first select a new distinguished member 18 and then proceed in the same manner as above.

The synchronization agents 14 are intermediaries between synchronization master control 13 and the member agents 11. Synchronization agents 14 are created and dispatched when their host processing element 12 is initialized. Upon creation they wait to be contacted by the synchronization master 13, if one exists. Any application level requests for synchronization are queued until an acknowledgement is received from synchronization master control 13.

During normal operation, the synchronization agents 14 serve as a relay point for communication between the synchronization master control 13 and the member agents 11. All communication is buffered until acknowledged by the receiver so that the Member Agents 11 are protected from temporary failures of synchronization master control 13. The synchronization agents 14 also extract and store any information relevant to the reestablishment of the synchronization master control 13.

Most of the operation of the synchronization master control 13 has already been described above. The only aspect remaining is the monitoring function.

The monitoring of the existence of processing elements 12 is done by the Polling Control 22 which polls each individual synchronization agent 14. The failure of a processing element 12 implies that the corresponding synchronization agent 14 is down as well as all member agents 11 that were present on that processing element 12. When that happens the synchronization master control 13 notifies all affected Group Master Tasks 25. These, in turn, inform their distinguished member agents 11 which then broadcast this information to other member agents 11.

Before we go any further, it may be advantageous to introduce the primitives used with synchronization service 10. The primitives can be split into two categories:

(1) Synchronous Primitives are in the form of request-reply pairs; member agents 11 submit requests for some action to be performed on their behalf and synchronization service 10 eventually matches these with appropriate replies.

(2) Asynchronous Notifications are spontaneous signals informing a member agent 11 about changes in the status of its group or conveying a message sent by some other member agent 11.

There are only two types of asynchronous notifications that can be sent to a member agent 11:
-GROUP-CHANGE (group status) is sent when a new member 18 has joined or an active member 18 has departed from the group. The status information includes the complete new membership list and the id of the new distinguished member.
-GROUP-MSG (message) signals the arrival of a message from some other member 18 (broadcast or point-to-point).

The application program must allow forms of communication (i.e. synchronous and asynchronous) although it may choose to handle asynchronous communications in a synchronous manner by ignoring them until the current activity sequence is complete.

The synchronous primitives and corresponding replies are depicted in chart form in Figure 3a, to which attention is directed.

The primitives are:

-SYNCHRONIZE (group-id)

This is directive which is issued by a member 18 (via its member agent 11) when it wishes to become synchronized with the group specified by <group-id>. If no group exists at the time, one is established. The only signal expected in reply to this directive is the SYNCH-DONE signal.

-SYNC-DONE (group-status)

This is a signal from the synchronization service 10 (i.e. member agent 11) in response to a successful synchronization of a member 18 following the invocation of the SYNCHRONIZE directive. The return parameter, <group status>, contains the same information about the status of the group as the GROUP-CHANGE primitive described below. It includes a <dm-flag> parameter which informs the member 18 if it is the bearer of the distinguished member status.

- UNSYNC

This directive is used when a member 18 decides to depart from its group. It ensures orderly deactivation.

-UNSYNC-DONE

This signal is a confirmation that the member 18 has been removed from its synchronization group.

-GROUP-CHANGE (group-status)

This is an asynchronous signal which is generated by the member agent 11 whenever a new member 18 joins the group or when a member 18 departs from the group. If this mmeber 18 is the new distinguished member as a result of the change, a <dm-flag> parameter in the <group-status> data record will be set appropriately. The treatment of this situation is left to the application program. The new status of the group is also returned.

-REQ-RIGHT (right-id, mode)

This directive is issued when a member 18 needs exclusive access to a group right. If the right is available, it is guaranteed to be granted to only one requesting member 18 (there may be multiple simultaneous requests for the same right). If the right is not available, then if the <mode> parameter specifie a "queued" request, it is queued until it can be serviced. Alternatively, if the <mode> parameter specifies "immediate" the request is refused since the right has already been appropriated by another member 18 of the group.

- R-GRANTED (right-id)

This signal informs a member 18 that it has been granted the required right.

-R-REFUSED (right-id)

This signal informs a member 18 which has requested a right, with the "immediate reply" mode specified in the request, that the right is not available. (If a queued request was made then this signal will never be generated.)

-REL-RIGHT (right-id)

This directive is used to release an appropriated right.

-R-RELEASED (right-id)

This signal is the reply to the REL-RIGHT directive.

-QRY-RIGHTS

This is a directive which is used to obtain a snapshot of the distribution of group rights among group members.

-R-STATUS (rights-status)

This is a reply signal to the QRY-RIGHTS directive. The <rights-status> parameter lists, for each group right, the member-id of the member which owns it, it any.

Note that service 10 cannot guarantee the currency of the returned information since changes in the distribution of rights can occur at any time.

-GRP-BRDCST (message)

This directive is used to broadcast a synchronization event (message) to all synchronized members 18. It is the responsibility of the synchronization service 10 (via member agent 11) to ensure that all members 18 receive the message. The <message> parameter can be used to timestamp the synchronization event. The higher level software is responsible for supplying this parameter as well as interpreting its functional significance.

-GROUP-ACK

This is an acknowledgement signal for the GRP-BRDCST directive. It signifies that all members 11 have received the latest broadcast message.

-SND-TO-MEM (message)

This directive is used to send a point-to-point message to another group member 18.

-MSG-ACK

This is an acknowledgement that the latest point-to-point message has been received by the destination member 18.

Before the invention is described further, it may be of value to give some brief examples of the application of the primitives.

The first example is the control of a standby configuration. In this configuration there are two or more distributed program components (i.e. members 18) each on a different processing element 12, each of which is equally capable of providing the necessary function. Only one should be active at any given time while the others are standing by, ready to be activated should the active one fail. Assuming that they are all part of the same synchronization group that the algorithm which each member 18 executes is the same (the synchronization service primitives are highlighted in capitals):

SYNCHRONIZE;
Wait for SYNC-DONE signal;
If not selected as the distinguished member then
Repeat
Listen for SYNC-CHANGE signals;
until selected as the distinguished member;
Execute funciton;

If a member 18 is not selected as the distinguished member following synchronization with the group, then it simply waits until it is designated as the distinguished member.

The next exampled concerns the updating of a replicated database, i.e. the same example mentioned in the Background of the Invention. In this case there are multiple instances of a database, each of which can initiate an update request as a result of external activity. Such requests will be called external to distinguish them from "shadow requests". Shadow request are copies of an external request which a member 18 sends to all other members 18 so that they can make the appropriate changes to their copies of the database. For brevity, the handling of any other requests except update requests is ignored.

The solution shown below uses the mutual exclusion feature of the synchronization group. A right, called the Update right, is defined. The holder of this right is the member 18 whose request will be honored; all other members 18 must withhold their requests and perform the shadow request sent by the holder of the right:

Solution A

Repeat
Wait for next request;
If external request then
begin
REQ-RIGHT (update);
While waiting for R-GRANTED
Handle any incoming shadow requests;
GRP-BRDCST (external request);
Handle external request;
REL-RIGHT (Update);
end
else
Handle shadow request;
until termination;

Note that the application program need not be concerned with spontaneous failures of other members 18 since that is handled by the synchronization service 10.

An important problem which must be handled by this application (i.e. Solution A, above) is the addition of new or recovering instances. These will not necessarily have the same state as the others and therefore must be brought to the same functional level. The situation is complicated by the possibility that updates may be initiated at other instances whil the new instance is being upgraded. One method of dealing with this is for the new instance to appropriate the Update right to ensure that the state remains unchanged while it is being upgraded. The algorithm performed by a restarting instance is then:

SYNCHRONIZE;
Wait for SYNC-DONE signal;
REQ-RIGHT (Update);

While waiting for R-GRANTED
Discard any shadow requests received;
Obtain current copy of database;
REL-RIGHT (Update);

Following this, the normal request-processing algorithm described above (i.e. Solution A) is executed.

The current copy of the database is obtained from any other member 18 through an internal protocol using point-to-point messages (i.e. SND-TO-MEM directives). Instead of a copy of the entire database it may be more convenient to request an update log and then perform the updates missed while the member 18 instance was down.

Figure 4 is a functional flow diagram representing the synchronization service 10 database 16 when accessed through the processing element 12 identifier.

The head and tail pointers (AGT-LST-HD and AGT-LST-TL) respectively, point to a linked list of synchronization agent control blocks (tAGT-CB) for those synchronization agents 14 involved.

There is one synchronization agent control block tAGT-CB for each processing element 12 which requires synchronization service 10. It contains a link (AGT-LST-LNK) to other synchronization agent control blocks tAGT-CB. This chain enables quick scanning of affected processing elements 12 when an entire block of processing elements 12 fails. Each synchronization agent control block tAGT-CB also contains a pointer (MMCB-LST-HD) to a chain of member agent control blocks (tMEM-CB) which reside on that processing element 12. Through this chain it is possible to detect quickly all synchronization groups which are affected by the failure of a processing element 12. Whereas all other chains in the synchronization service database 16 remain unchanged once they are established, this chain follows the dynamics of member 18 joinings and departures.

In order to simplify searching and list maintenance, the last Sync Agent control block tAGT-CB in the list is a dummy block.

Each member agent control block tMEM-CB corresponds to one member 18 of one synchronization group. Among other data, this control block contains a pointer (not shown in the diagram) to the corresponding synchronization agent control block tAGT-CB. This link allows quick reconfiguring of the processing element-Member Agent chain when necessary.

Figure 5 is a functional flow diagram representing the synchronization service database 16 when accessed through the unique group identifier.

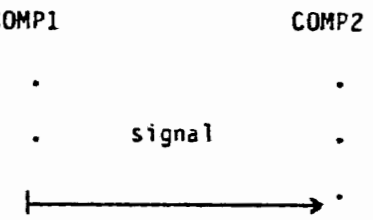
GRP-HDR [gropu id] is a static array of pointers. Each item of the array points to a circular list of member agent control blocks (tMEM-CB of which belong to the same synchronization group.

The member agent control blocks tMEM-CB are linked into a circular list to facilitate selection of a distinguished member. This list grows as members 18 are added to the synchronization group, each successive block identified by the next available positive integer (MEM-ID). This integer corresponds to the member 18 identifier.

ACTION SEQUENCES

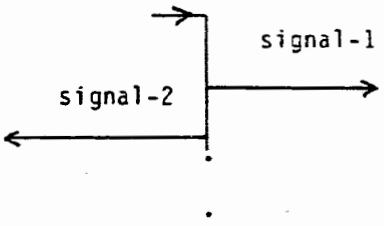
This section describes various action sequences within synchronization service 10. A diagrammatic representation is used to show these sequences. The following conventions are used.

- A full horizontal line indicates a message or rendezvous between two components (i.e. programs or tasks):



where signal is the name of the entry procedure in component COMP2 which accepts the signal. COMP1 is the component which sent the signal.

- a vertical line (1) following the reception of a signal indicates processing within the appropriate component which received the signal. This processing results in one or more signals being dispatched to other components:



- If an asterisk (*) appears next to a signal it implies that the signal may be repeated (to different destinations).

- A signal which is enclosed in braces (e.g.,<signal> indicates that the signal is not mandatory and may be omitted depending on circumstances.