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/N. D./
Examiner, Art Unit 2444
/William C. Vaughn, Jr./
Supervisory Patent Examiner, Art Unit 2444

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	Art Unit
	NINOS DONABED	2444

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/13/2009								
	1	-								
	2	-								
	3	-								
	4	-								
	5	-								
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	7	-								
	8	-								
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	27	-								
	28	-								
	29	-								
	30	-								
	31	-								
	32	-								
	33	-								
	34	-								
	35	✓								
	36	✓								

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CLAIM		DATE								
Final	Original	02/13/2009								
	37	✓								
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	40	✓								
	41	✓								
	42	✓								
	43	✓								
	44	✓								
	45	✓								
	46	✓								
	47	✓								
	48	✓								
	49	✓								
	50	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	Art Unit
	NINOS DONABED	2444

SEARCHED

Class	Subclass	Date	Examiner
709	246	05/07/2008	ND

SEARCH NOTES

Search Notes	Date	Examiner
See EAST Search History	05/07/2008	ND
Conducted double patenting search	05/07/2008	ND
Consulted with SPE William Vaughn	11/13/2008	ND
See updated EAST search	12/13/2009	ND
Consulted with SPE William Vaughn regarding Final	02/12/2009	ND
Consulted with SPE William Vaughn regarding Advisory	03/29/2009	ND
Consulted with SPE William Vaughn regarding Advisory	5/7/2009	ND
Consulted with Primary Paul Kang	02/10/2009	ND
See updated east search	7/30/2009	ND
Consulted with SPe William Vaughn regarding search	7/30/2009	ND

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Leslie Rogan
Attorney Docket Number:	8532P001

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:

R. Drew Major

Application No.: 11/116,783

Filed: April 28, 2005

For: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

Examiner: Donabed, Ninos J.

Art unit: 2444

Confirmation No.: 5535

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Kevin O. Grange/ October 22, 2009
Kevin O. Grange ***Date***

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AND RESPONSE TO OFFICE ACTION

Examiner:

In response to the Office Action mailed on August 20, 2009, Applicant respectfully requests that the Examiner consider the following amendments and the following remarks.

Amendments to the Claims are reflected in the listing of claims that begins on page 2 of this paper.

Remarks begin on page 8 of this paper.

Listing of Claims:

1-19. (Canceled)

20. (Currently amended) A method for presenting rate-adaptive streams, the method comprising:

streaming by a media player operating on an end user station a video from a set of one or more servers, wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers, wherein each of the multiple files yields a different portion of the video on playback, wherein the multiple files across the different copies yield the same portions of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video, and wherein the streaming comprises:

requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes;

automatically requesting by the media player from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including,

~~regularly~~ repeatedly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies, wherein the set of one or more factors relate to the performance of the network; and

making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time; and

presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time.

21. (Previously presented) The method of claim 20, wherein said requesting the plurality of sequential ones of the files includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the files from the received sub-parts.

22. (Canceled)

23. (Previously presented) The method of claim 20, wherein said making the successive determinations to shift comprises:

upshifting to a higher quality one of the different copies when the at least one factor is greater than a first threshold; and

determining if the higher quality playback can be sustained.

24. (Previously presented) The method of claim 23, wherein said making the successive determinations to shift comprises downshifting to a lower quality one of the different copies when the at least one factor is less than a second threshold.

25. (Previously presented) The method of claim 20, further comprising:

receiving user input to enable one of fast-forward, skip randomly, and rewind functionality; and

requesting files of the video at a specified time index that is not the next sequential time in the current playback.

26. (Previously presented) The method of claim 20,

wherein said requesting the plurality of sequential one of the files includes requesting the files from a low quality one of the different copies to enable instant playback of the video, and wherein said automatically requesting includes-upshifting to a higher quality one of the different copies.

27-34. (Canceled)

35. (Previously presented) The method of claim 20, wherein said requesting the plurality of sequential ones of the files includes requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections.

36. (Previously presented) The method of claim 20, wherein said presenting comprises sequentially arranging the requested files from the different copies in the order of ascending playback time for playback with the media player on the end user station.

37. (Previously presented) The method of claim 20, wherein said automatically requesting includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the files from the received sub-parts.

38. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of the available bandwidth of the plurality of TCP connections.

39. (Canceled)

40. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of latency of the requested files, wherein the latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station.

41. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files.

42. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections.

43. (Previously presented) The method of claim 20, wherein at least one of the set of servers is a web server.

44. (Previously presented) The method of claim 43, wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP), and wherein the web server is without specialized server-side intelligence to respond to said requesting.

45. (Previously presented) The method of claim 20, wherein at least one of the set of servers is a cache server of a network infrastructure operator.

46. (Previously presented) The method of claim 20, wherein:

said generating the set of factors comprises:

monitoring time intervals between successive receive times for each of the requested files;

calculating a current performance ratio across a current window of the time intervals; and

calculating a current average of the performance ratio to obtain a current performance factor of the set of factors;

said making further comprises:

comparing the current performance factor with a set of one or more trigger thresholds; and

determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing.

47. (Previously presented) The method of claim 20, wherein said making comprises:

comparing a current performance factor of the set of factors with a set of one or more trigger thresholds, wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin, wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index; and

determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing.

48. (Previously presented) The method of claim 20, wherein:

said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that file, and

said automatically requesting comprises issuing for each of the files a request with the filename of that file.

49. (Previously presented) The method of claim 20, wherein the set of servers includes a content server storing the multiple files of the different copies, and wherein the set of servers includes one or more cache servers caching at least some of the files.

50. (Previously presented) The method of claim 20, wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence.

REMARKS

Applicant respectfully requests reconsideration of this application in view of the following remarks. For the Examiner's convenience and reference, Applicant's remarks are presented in substantially the same order in which the corresponding issues were raised in the Office Action.

Response to Rejections under 35 U.S.C. § 112, first paragraph

Claims 20, 21, 23-26, 35-38, and 40-50 stand rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing to comply with the written description requirement. In particular, the Examiner states that the phrase "requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes" is considered new matter as it is not explicitly or implicitly provided in the original disclosure. Applicant respectfully disagrees because the Applicant's specification provides express support in both the detailed description section and the figures.

By way of example and not limitation, Applicant's specification indicates that "each of the streams is a copy of the content file." Applicant's specification, paragraph 44, Fig. 2b. Applicant's specification also indicates that a stream is "divided into a plurality of streamlets 212." *Id.* at 45. Regarding "streamlets" Applicant's specification describes that a "streamlet refers to any sized portion of the content file 200," that "[e]ach streamlet 212 may comprise a portion of the content contained in stream 210, encapsulated as an independent media object," and that "[t]he content in a streamlet 212 may have a unique time index in relation to the beginning of the content contained in stream 210." *Id.* at paragraph 45. The specification also describes the streamlets may be "files," and "may be identified with a unique filename." *Id.* at paragraphs 49 and 52. Since each streamlet has a unique time index in relation to the beginning of the content contained in the stream, and since each streamlet may be a file, each file has a time index. Applicant's specification describes that the client module requests streamlets, for example, from a web server, or from any of the plurality of web servers. *Id.* at paragraphs 42 and 49. Moreover, the specification provides that files can be requested based on time indexes. Applicant's specification describes an example where the "agent

controller module 402 may *request the streamlets 212 that correspond to time index intervals of 30 seconds*," and an example where "the agent controller module 402 may be configured to *pre-request streamlets 212 corresponding to specified index points* within the content." *Id.* at page 15, paragraph 53. As such, Applicant's specification provides support for "requesting ... a plurality of sequential ones of the files of one of the copies from the set of servers ... based on the time indexes," as recited in claim 20.

Applicant's specification also describes that "the client module 114 is configured to use multiple TCP connections between the client module 114 and the web server 116 or web cache." *Id.* at paragraph 57. As described in the Applicant's specification, the client module 114 also includes "a media player." *Id.* at paragraph 50. As such, Applicant's specification provides that the media player, which is operating on the end user station, performs streaming by "requesting ... a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes," as recited in claim 20. Accordingly, Applicant respectfully requests that the rejection of claims 20, 21, 23-26, 35-38, and 40-50 under 35 U.S.C. § 112, first paragraph, be withdrawn.

Response to Rejections under 35 U.S.C. § 112, second paragraph

The Examiner rejected claims 20, 21, 23-26, 35-38, and 40-50 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as his invention. In particular, the examiner states that "the phrase 'regularly generating a set of one or more factors' is vague and unclear because it is not known how often 'regularly' encompasses," and that the phrase "will be taken to mean generating a set of one or more factors at any time set" (Office Action, page 3). Applicant respectfully submits that claim 20 has been amended to recite "repeatedly generating a set of one or more factors." Applicant respectfully submits that the Applicant's specification provides support for the amendment, for example, at pages 20-22, paragraphs 68-72, Figure 7. In addition to this phrase, claim 20 also recites "making the *successive determinations* to shift the playback quality *based on at least one of the set of factors*." Because more than one determination is made and the determinations are based on the set of factors, the set of one or more

factors are generated more than once. As such, the phrase "repeatedly generating" means that the set of factors are generated more than once, not just "at any time set," as alleged by the Examiner. Applicant respectfully submits that the phrase "repeatedly generating a set of one or more factors" is not vague and unclear. Accordingly, Applicant respectfully requests that the rejection of claims 20, 21, 23-26, 35-38, and 40-50 under 35 U.S.C. §112, second paragraph, be withdrawn.

Response to Rejections under 35 U.S.C. § 103(a)

Claims 20-21, 23-24, 26, 35-38, and 40-44 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Birney "Intelligent Streaming" (hereinafter "Birney"), in view of U.S. Patent Publication No. 2003/0152036 to Quigg-Brown et al. (hereinafter "Quigg-Brown"). Applicant respectfully submits that the combination of cited references fails to teach all the limitations of the claim.

Quigg-Brown Fails to Teach "Requesting by the Media Player" (First Occurrence)

Regarding the first of two occurrences of the "requesting by the media player" limitation, the Examiner states that "Birney does not explicitly teach requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes," *but alleges that Quigg-Brown teaches this limitation*, citing the abstract and paragraph 28-30 (Office Action, page 5). Applicant respectfully disagrees.

Quigg-Brown is directed to "[a] method, system, and apparatus for improving data transfer rate over a network" by dividing a piece of data, i.e., a file, into a number of packets, and if the number of packets exceeds a threshold number, transferring the divided packets "in parallel over a plurality of network connections," ideally TCP/IP connections (Quigg-Brown, Abstract, Figure 8).

First, although Quigg-Brown teaches transferring packets in parallel over a plurality of network connections, Quigg-Brown fails to teach "**requesting ... a plurality of sequential ones of the files** of one of the copies from the set of servers over a plurality of [TCP] connections," as recited in the claim. In particular, Quigg-Brown teaches that "an application or a user at client station 500 *issues a request to server 510 for data, a file*

or an application," not issuing a request for multiple files from the server 510 over a plurality of TCP connections between the client 500 and server 510 (*Id.* at paragraph 31). At best, Quigg-Brown teaches how to transmit a single logical data stream to a target system over multiple TCP connections once the file or application has been requested. Quigg-Brown expressly teaches that "[w]hen an application is sending a single logical data stream over multiple data paths, the receiver has to be able to reconstruct the data stream from the multiple paths," and thus, uses "two-byte identification 708 of the IP header as a counter to allow for the reconstruction of the data" (paragraph 36). Quigg-Brown gives the following example.

> For example, suppose a data stream is being transmitted using five TCP connections (i.e., TCP connections 1 - 5), packet P_1 may be transmitted over TCP connection 1 using 1234 as an IP identification number. P_2, P_3, P_4 and P_5 may be transmitted over TCP connections 2, 3, 4 and 5 with IP identifications 1235, 1236, 1237 and 1238, respectively. The next group of packets (i.e., P_6 - P_{10}) may be transmitted over TCP connections 1 - 5 using IP identifications 1239 - 1244 etc. (paragraph 36).

Quigg-Brown, however, does not teach requesting one of the files over TCP connection 1, another file over TCP connection 2, another file over TCP connection 3, and so on. As such, Quigg-Brown fails to "**requesting ... a plurality of sequential ones of the files** of one of the copies from the set of servers over a plurality of [TCP] connections," as recited in the claim.

Birney Fails to Teach "Requesting by the Media Player" (Second Occurrence)

Moreover, the Examiner indicates that Birney fails to explicitly teach the limitation of "**requesting by the media player** a plurality of sequential ones of the files of one of the copies **from the set of servers over a plurality of [TCP] connections** based on the time indexes" (the first occurrence of "requesting by the media player")(*Id.* at page 5). Yet, in what appears to be a contradictory statement, the Examiner alleges that Birney teaches the limitation of "automatically **requesting by the media player from the set of servers over the plurality of TCP connections** subsequent portions of the video by requesting for each such portion one of the files from one of the copies..." (the second occurrence of "requesting by the media player")(Office Action, page 4). Applicant acknowledges that these are two separate limitations of the claim and include

different language. As noted in bold, however, these limitations have similar language of "requesting by the media player" "from the set of servers over the plurality of TCP connections;" while the one limitation indicates that "a plurality of sequential ones of the files of one of the copies" is requested, while the other indicates that "for each [subsequent portion of the video] one of the files from one of the copies" is requested. Despite the Examiner's allegation that Birney teaches the "automatically requesting" limitation (second occurrence), Applicant respectfully submits that Birney fails to teach at least the highlighted language of both limitations (first and second occurrences).

In particular, Birney teaches that in order to use "intelligent streaming with multiple-bit-rate streams, the *content must be hosted on a Windows Media server*" (paragraph 14). Since the content must be hosted by the Window Media server, the configuration of Birney is a *push-based configuration* in which a specialized server, i.e., a Windows Media Server, automatically detects the changes in bandwidth and selects or switches to the stream "that is the most appropriate for current bandwidth conditions." (Birney, paragraph 7). Since the configuration of Birney is a push-based configuration, the server "selects and delivers the stream with the most appropriate bit rate" (*Id.)*, and *the client does not request the stream with the most appropriate bit rate*. The Examiner already acknowledges that Birney fails to teach the first of these two limitations, namely the "requesting by the media player" limitation (Office Action, page 5). Applicant respectfully submits that Birney fails to teach both limitations because Birney fails to teach "**requesting by the media player**" either "a plurality of sequential ones of the files of one of the copies" or "one of the files from one of the copies," as recited in claim 20. It should also be noted that although Birney briefly suggests that, instead of using a Windows media server, the multiple-bit-rate streams can be played locally or from a web server, Birney expressly states that "*only the highest bit rate streams will play*" when played locally or from a web server (paragraph 14). This means that the single file will play *without intelligent streaming* to adjust "the properties of a stream to maximize the quality of the user experience" (paragraphs 1 and 14). Since only the highest bit rate stream will play when played from a web server, Birney fails to teach "**requesting by the media player**" either "a plurality of sequential ones of the files of one of the copies" or "one of the files from one of the copies," as recited in claim 20.

The combination of Birney and Quigg-Brown Fails to Teach "Requesting by the Media Player" (Both Occurrences)

Not only do the cited references individually fail to teach either occurrence of the "requesting by the media player" limitations, the combination of the cited references fails to teach either of these limitations. When combining the teachings of Quigg-Brown with Birney's teachings of a push-based media server, the combination fails to teach "**requesting by the media player a plurality of sequential ones of the files** of one of the copies **from the set of servers over a plurality of [TCP] connections** based on the time indexes," (first occurrence) because the resulting combination would be a media server that is a capable of pushing data to the client by dividing the data "into a number of packets," making "a determination … as to whether the number of packets exceeds a threshold number," and, if so, transferring the packets "in parallel over a plurality of [TCP/IP] connections" (*Id.* at paragraph 8), bracketed material added. Similarly, the combination fails to teach "**automatically requesting by the media player from the set of servers over the plurality of TCP connections** subsequent portions of the video by requesting for each such portion one of the **files from one of the copies**" (second occurrence).

Birney Fails to Teach "Stored as Multiple Files"

The Examiner alleges that Birney teaches that "each of a plurality of different copies of the video encoded at different bit rates is **stored as multiple files** on the set of servers" (Office Action, pages 3-4). In particular, the Examiner states that "Birney teaches *multiple copies of the same stream being stored on a server at different bit rates* with the same time index used to switch between the streams based on network bandwidth limitations." *Id.* Applicant respectfully submits that the Examiner fails to establish that Birney teaches this limitation because the Examiner seems to ignore the words of the limitation that each of the different copies of the video "**is stored as multiple files**." Birney teaches that the "content must be encoded as a multiple-bit-rate stream," which includes "a number of discrete, user-definable audio and video streams [that] are encoded into a *single Windows Media stream*" (paragraph 6, emphasis added, bracketed material added). Birney expressly teaches that the multiple-bit-rate stream (paragraph 6), which includes the streams encoded at different bit rates, is created and

managed as "*a single file*" (paragraph 11). As such, in contrast to the Examiner's allegation that Birney teaches this limitation, Birney expressly teaches that all of the different bit-rate streams are stored and managed as "*a single file*," not multiple files. Not only does Birney fails to teach that all of the different bit-rate streams are stored as multiple files, Birney also fails to teach that *each* of these different bit-rate streams, which make up the multiple-bit-rate stream, is stored as multiple files. As such, Applicant respectfully submits that Birney fails to teach at least the limitation of "**each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files** on the set of servers."

Quigg-Brown Fails to Teach "Stored as Multiple Files"

Quigg-Brown, which has been used by the Examiner for only the first occurrence of the "Requesting by a Media Player" limitation, fails to cure the deficiency regarding "stored as multiple files," noted above with respect to Birney. Applicant respectfully submits that Quigg-Brown fails to teach that "each of a plurality of different copies of the video encoded at different bit rates **is stored as multiple files** on the set of servers" because Quigg-Brown is silent regarding encoding video at different bit rates and storing each of the different copies as multiple files on the servers. As such, Applicant respectfully submits that Quigg-Brown fails to cure this deficiency of Birney.

Birney Fails to Teach "Time Indexes"

Birney also fails to teach that "each of said files [has] **a time index**," and "requesting ... a plurality of sequential ones of the files of one of the copies ... **based on the time indexes**." As stated above, the Examiner alleges that Birney teaches that the "same time index is used to switch between the stream based on network bandwidth limitations" (Office Action, page 4). Applicant respectfully disagrees with the Examiner's characterization of the reference because *Birney is silent regarding time indexes*. Not only does Birney fail to teach that each of the different bit-rate streams of Birney is stored as multiple files on the set of servers, as described above, Birney also fails to teach that *the single file has any time indexes* or that the *different bit-rate streams within the single file have any time indexes*. In addition, nothing in Birney teaches or suggests that the client requests the video based on time indexes.

Even if, for the sake of argument, time indexes were used "to switch between the streams," as alleged by the Examiner, because Birney only has a single file, these alleged time indexes of Birney do not constitute the claimed "time indexes." Each of the claimed "time indexes" corresponds to one of the multiple files of each of the different copies, where each file yields a portion of the video; whereas the alleged time indexes of Birney could not correspond to one of multiple files because there is only a single file in Birney.

As such, Birney fails to teach that "each of said files [has] **a time index**," and "requesting ... a plurality of sequential ones of the files of one of the copies ... **based on the time indexes**," as recited in claim 20.

Quigg-Brown Fails to Teach "Time Indexes"

Quigg-Brown, which has been used by the Examiner for only the first occurrence of the "Requesting by a Media Player" limitation, fails to cure the deficiencies regarding "time indexes" noted above with respect to Birney. Quigg-Brown fails to teach that "each of said files [has] **a time index**," and "requesting ... a plurality of sequential ones of the files of one of the copies ... **based on the time indexes**" because Quigg-Brown is silent regarding the files having time indexes. As such, Applicant respectfully submits that Quigg-Brown fails to cure these deficiencies of Birney.

Birney Fails to Teach "Making the Successive Determinations" by the Media Player

The Examiner also alleges that Birney teaches the limitation of "making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time," stating that "Birney teaches shifting the playback quality to the highest quality dependent on network conditions." (Office Action, page 5). Applicant respectfully submits that the Examiner fails to establish that Birney teaches this limitation because the Examiner seems to ignore that "making the successive determinations to shift the playback quality" is performed "**by the media player**." In particular, the claim recites "automatically requesting **by the media player** ... dependent upon **successive determinations by the media player** to shift the playback quality to a higher or lower quality one of the different copies, said

automatically requesting including, … **making the successive determinations to shift the playback quality**."

In most strategies presented in Birney, the "*server automatically detects*" the current available bandwidth and determines which stream to use (paragraph 7). In one strategy, however, Birney indicates that the media server *and* the client automatically determine the current available bandwidth (*Id.*). The media server, in this strategy, however, still is the one that "selects and delivers the stream with the most appropriate bit rate" (*Id.*), and the client does not request the most appropriate bit rate based on the current available bandwidth. As such, none of the strategies presented in Birney teaches or suggests that the client alone determines which stream is the most appropriate for current bandwidth conditions, and which stream to request. Birney goes on further to stress the importance that "the content *must be hosted on a Windows Media Server* and played in Windows Media Player," in order to use intelligent streaming with multiple-bit-rate streams (paragraph 14, emphasis added). When played locally or from a web server (instead of a Windows media server), intelligent streaming cannot be accomplished (*Id.*). Thus, Birney describes the server, not the client, as having the intelligence for performing "intelligent streaming" to determine whether to switch "to a stream with a lower bit rate" or "to a stream with a higher bit rate," even though the client may be used to determine the current available bandwidth between server and client. Accordingly, Birney fails to teach "**automatically requesting by the media player** … subsequent portions of the video by requesting for each such portion one of the files from one of the copies **dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies**," and "**making the successive determinations [by the media player] to shift the playback quality** based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time," as recited in claim 20.

Quigg-Brown Fails to Teach "Making the Successive Determinations" by the Media Player

Quigg-Brown, which has been used by the Examiner for only the first occurrence of the "Requesting by a Media Player" limitation, fails to cure the deficiencies regarding

"making the successive determinations" by the media player noted above with respect to Birney. Quigg-Brown also fails to teach "automatically requesting **by the media player** ... dependent upon **successive determinations by the media player** to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including, ... **making the successive determinations to shift the playback quality**" because Quigg-Brown is silent regarding making determinations to shift the playback quality.

For the foregoing reasons, Applicant respectfully submits that the combination of cited references fails to teach all the limitations of claim 20. Accordingly, Applicant requests that the rejection of claims 20-21, 23-26, 35-38, and 40-50 under 35 U.S.C. §103(a) be withdrawn.

CONCLUSION

It is respectfully submitted that in view of the amendments and remarks set forth herein, the rejections have been overcome, putting the claims in condition for allowance. If the Examiner believes a telephone interview would expedite the prosecution of this application, the Examiner is invited to contact Dan DeVos at (408) 720-8300.

If there are any additional charges, please charge them to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: October 22, 2009

/Kevin O. Grange/

Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Electronic Acknowledgement Receipt

EFS ID:	6315401
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	22-OCT-2009
Filing Date:	28-APR-2005
Time Stamp:	19:11:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	4945
Deposit Account	022666
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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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) Filed (SB/08)	8532P001_IDS_and_1449.pdf	57540 1f5044579fbc7ebe9230b37871052eddf6f075d5	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2		8532P001_Resp_to_OA.pdf	97993 42ade2efa21a0f8fbfd103cea22a8c3fa34fe5ac	yes	18

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	18

Warnings:					
Information:					
3	Fee Worksheet (PTO-875)	fee-info.pdf	30164 3d029f84b801f7f92bc79193f939ace8fac1934b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	185697		

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National Stage of an International Application under 35 U.S.C. 371

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PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/116,783	04/28/2005	

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☒		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			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 $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	10/22/2009	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 21	Minus	** 34	= 0	X $26 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 1	Minus	***5	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/CORALIA BETANCOURT/

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.**

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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known

Application Number	11/116,783
Filing Date	April 28, 2005
First Named Inventor	Major, R. Drew
Group Art Unit	2444
Examiner Name	Donabed, Ninos

Sheet 1 of 1

Attorney Docket No: 8532P001

US PATENT DOCUMENTS

Examiner Initial *	Cite No [1]	USP Document Number	Publication or Issue Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-20030005455A1	01/02/2003	Bowers	
		US-20040054551A1	03/18/2004	Ausubel, et al.	
		US-20040143672A1	07/22/2004	Padmanabham, et al.	
		US-20040170392	09/02/2004	Lu, et al.	
		US-20080162713	07/03/2008	Bowra, et al.	
		US-6486803B1	11/26/2002	Luby, et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No [1]	Foreign Patent Document — Country Code/Number/Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [2]

OTHER DOCUMENTS -- NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No [1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]

EXAMINER **DATE CONSIDERED**

Based on PTO/SB/08A(09-06) - Substitute Disclosure Statement Form (PTO-1449) as modified by BSTZ 03/26/07

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional) [2] Applicant is to place a check mark here if English language Translation is attached

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2444
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed for applications filed after June 30, 2003). It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on the date shown below.

October 22, 2009.
(Date of Deposit)
Kevin O. Grange
(Typed or printed name of person mailing correspondence)

/Kevin O. Grange/ 10-22-09
(Signature of person mailing correspondence) (Date)

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

_____ 37 C.F.R. §1.97(b).

__X__ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

__X__ A statement pursuant to 37 C.F.R. §1.97(e) or

____ **The Director is Authorized to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. § 1.17(p).**

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If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: Oct. 22, 2009 /Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2444
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

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I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on the date shown below.

November 6, 2009.
(Date of Deposit)
Kevin O. Grange
(Typed or printed name of person mailing correspondence)

/Kevin O. Grange/ 11-6-09
(Signature of person mailing correspondence) (Date)

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Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: Nov. 6, 2009

/Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Substitute for Form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	11/116,783
				Filing Date	April 28, 2005
				First Named Inventor:	R. Drew Major
				Art Unit	2444
				Examiner Name	Donabed, Ninos J
Sheet	**1**	**of**	**1**	Attorney Docket Number	8532P001

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		PCT Notification of Transmittal of the International Search Report and Written Opinion of the International Searching Authority, for PCT/US05/15091, October 29, 2007, 8 pages.	
		PCT Notification of Transmittal of International Preliminary Report on Patentability, for PCT/US05/15091, October 29, 2007, 6 pages.	
		Office Action for 11/673,483, July 9, 2009, 14 pages.	
		Office Action for 11/673,483, February 3, 2009, 9 pages.	
		ALBANESE, Andres, et al. "Priority Encoding Transmission", TR-94-039, August 1994, 36 pages, International Computer Science Institute, Berkeley, California.	
		PURI, Rohit, et al. "Multiple Description Source Coding Using Forward Error Correction Codes", October 1999, 5 pages, Department of Electrical Engineering and Computer Science, University of California, Berkeley, California.	
		GOYAL, Vivek K., "Multiple Description Coding: Compression Meets the Network", September 2001, pages 74-93, IEEE Signal Processing Magazine.	

Examiner Signature		Date Considered	

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Electronic Acknowledgement Receipt

EFS ID:	6411245
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	06-NOV-2009
Filing Date:	28-APR-2005
Time Stamp:	18:50:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	4765
Deposit Account	022666
Authorized User	

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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) Filed (SB/08)	8532P001_IDS_and_1449.pdf	66683 947c2d4d39d8a5a0d31508d0c392f844465e4bba	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2	NPL Documents	NPL_8532P001_PCT_ISR.pdf	322319 dc6553e8e36f851f1c7350952f06e1faa11e3c58	no	8
Warnings:					
Information:					
3	NPL Documents	NPL_8532001PCT_Report_on_Patentability.pdf	240374 8ccefb1294879f347060214276792O9b7ad19441	no	6
Warnings:					
Information:					
4	NPL Documents	NPL_Multiple_Description_Coding_Compression_Meets_the_Network.pdf	1352328 45f963c2b903a3e4c3016cc9303957fc09a82f97	no	20
Warnings:					
Information:					
5	NPL Documents	NPL_Multiple_Description_Source_Coding_using_Forward_error_correction_codes.pdf	132985 bba2f7dde2930a43125e61bca616d4b9a90fccad	no	5
Warnings:					
Information:					
6	NPL Documents	NPL_OA_P002_020309.pdf	280230 8e48353ec5541a3ba0c2c8d4666128a60849bef2	no	9
Warnings:					
Information:					
7	NPL Documents	NPL_OA_P002_070909.pdf	446647 5a852d4d30fc3a518eb8ba1dea31bc9774e6c0de	no	14
Warnings:					
Information:					

8	NPL Documents	NPL_Priority_Encoding.pdf	332434 9c242701f9e5e378fe58fcdfdda7336655d33154	no	36
Warnings:					
Information:					
9	Fee Worksheet (PTO-875)	fee-info.pdf	30165 1e97f3c1958e95b2d3ae08517976a6541135efa6	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	3204165	

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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
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.

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Leslie Rogan
Attorney Docket Number:	8532P001

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Dianne Nethery
Attorney Docket Number:	8532P001

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Complete if Known	
Application Number	11/116,783
Filing Date	April 28, 2005
First Named Inventor:	R. Drew Major
Art Unit	2444
Confirmation No.	5535
Examiner Name	Donabed, Ninos J.
Attorney Docket Number	8532P001

Sheet	1	of	1

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (If known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		WICKER, Stephen B., "ERROR CONTROL SYSTEMS for Digital Communication and Storage", Prentice-Hall, Inc., New Jersey, USA, 1995 (Book: see NPL's Parts 1-6)	

Examiner Signature		Date Considered	

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

This collection of information is required by 37 CFR 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 2 hours 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, 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, Virginia 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Based on Form PTO/SB/08A (08-03) as modified by BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP on 09/10/03.

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2444
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed for applications filed after June 30, 2003). It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on the date shown below.

November 9, 2009.
(Date of Deposit)

Kevin O. Grange
(Typed or printed name of person mailing correspondence)

/Kevin O. Grange/ 11-9-09
(Signature of person mailing correspondence) (Date)

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

_____ 37 C.F.R. §1.97(b).

__X__ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

____ A statement pursuant to 37 C.F.R. §1.97(e) or

__X__ **The Director is Authorized to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. § 1.17(p).**

_____ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

(1) A statement pursuant to 37 C.F.R. §1.97(e); and

(2) **Authorization to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. §1.17(p) for submission of the Information Disclosure Statement.**

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: Nov. 9, 2009

/Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Electronic Acknowledgement Receipt

EFS ID:	6421582
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Dianne Neathery
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	09-NOV-2009
Filing Date:	28-APR-2005
Time Stamp:	21:04:00
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) Filed (SB/08)	8532P001_IDS_1449Form_11_09_2009.pdf	94789 4687731cfc92ef3f9ed13aa0fccca435fc101e7e	no	3

Warnings:	
Information:	

This is not an USPTO supplied IDS fillable form					
2	NPL Documents	NPL_Error_Control_Systems_Part_1.PDF	3050132 29a0dfc4c3d0d983e47a1449aef07dab7ae8d97b	no	85
Warnings:					
Information:					
3	NPL Documents	NPL_Error_Control_Systems_Part_2.PDF	3071026 cc29e9f23696cc500d99fc7a0aac1686a29a85fc	no	81
Warnings:					
Information:					
4	NPL Documents	NPL_Error_Control_Systems_Part_3.PDF	4055424 50c94b03ec528c1707f6c349e183cacd0439c583	no	89
Warnings:					
Information:					
5	NPL Documents	NPL_Error_Control_Systems_Part_4.PDF	6864502 23d7ab478249f743dab21322c793e5ef1184d1af	no	95
Warnings:					
Information:					
6	NPL Documents	NPL_Error_Control_Systems_Part_5.PDF	14409798 0ab86162be3baf253480d1734421573cf267e115	no	91
Warnings:					
Information:					
7	NPL Documents	NPL_Error_Control_Systems_Part_6.pdf	8577814 97eb7bd84dd620ce68af0852bb2d81d0319aa360	no	68
Warnings:					
Information:					
8	Fee Worksheet (PTO-875)	fee-info.pdf	30227 658d8d84f6065114ff7d55b9ca2ba7b2a144eec6	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	40153712	

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.

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Dianne Neathery
Attorney Docket Number:	8532P001

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	6421787
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Dianne Neathery
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	09-NOV-2009
Filing Date:	28-APR-2005
Time Stamp:	21:32:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	6173
Deposit Account	022666
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)					
File Listing:					
Document Number	**Document Description**	**File Name**	**File Size(Bytes)/ Message Digest**	**Multi Part /.zip**	**Pages (if appl.)**
1	Fee Worksheet (PTO-875)	8532P001_Fee_Transmittal_11_09_2009.pdf	30249 85934244981860387 08fd0a4316abca51b2e9adf	no	2
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	30228 29671959797c6c8bd989d8e2157c66757853f3de	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	60477		

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

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Dianne Neathery
Attorney Docket Number:	8532P001

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
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Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	Art Unit
	NINOS DONABED	2444

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/04/2010								
	1	-								
	2	-								
	3	-								
	4	-								
	5	-								
	6	-								
	7	-								
	8	-								
	9	-								
	10	-								
	11	-								
	12	-								
	13	-								
	14	-								
	15	-								
	16	-								
	17	-								
	18	-								
	19	-								
	20	✓								
	21	✓								
	22	-								
	23	✓								
	24	✓								
	25	✓								
	26	✓								
	27	-								
	28	-								
	29	-								
	30	-								
	31	-								
	32	-								
	33	-								
	34	-								
	35	✓								
	36	✓								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	Art Unit
	NINOS DONABED	2444

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/04/2010								
	37	✓								
	38	✓								
	39	-								
	40	✓								
	41	✓								
	42	✓								
	43	✓								
	44	✓								
	45	✓								
	46	✓								
	47	✓								
	48	✓								
	49	✓								
	50	✓								

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	8532P001	5535

8791 7590 02/22/2010

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
SUNNYVALE, CA 94085-4040

EXAMINER	
DONABED, NINOS J	
ART UNIT	PAPER NUMBER
2444	
MAIL DATE	DELIVERY MODE
02/22/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/116,783	MAJOR ET AL.	
	Examiner	Art Unit	
	NINOS DONABED	2444	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 October 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *20,21,23-26,35-38 and 40-50* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20-21, 23-26. 35-38. 40-50* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *10/22/2009, 11/6/2009,11/9/2009*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Response to Amendment

This communication is in response to Applicant's amendment dated 10/22/2009. Claims 20,21, 23-26,35-38 and 40-50 are pending.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 20-21, 23-26, 35-38, 40-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Birney "Intelligent Streaming" in view of Kalra (United Stated Patent 6490627) further in view of Quigg-Brown (United States Patent Application 2003/0152036.)

Regarding claim 20,

Birney teaches a method for presenting rate-adaptive streams, the method comprising:

streaming by a media player operating on an end user station a video from a set of one or more servers, wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers, wherein each of the multiple files yields a different portion of the video on playback, wherein the multiple files across the different copies yield the same portions of the video on

playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video, and wherein the streaming comprises: **(See pages 1-2 (multi-bit rate encoding), Birney teaches multiple copies of the same stream being stored on a server at different bit rates with the same time index used to switch between the stream based on network bandwidth limitations)**

repeatedly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies, wherein the set of one or more factors relate to the performance of the network; and **(See pages 2-3 including multiple-bit-rate encoding and intelligent bandwidth control sections, Birney teaches determining bandwidth capabilities)**

making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files portions of the highest quality one of the copies determined sustainable at that time; and presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time.**(See pages 1-2, Birney teaches shifting playback quality to the highest quality dependent on network bandwidth.)**

Birney further teaches a client and a server working together to automatically determine the available bandwidth and based on this working together adjusting to a higher or lower quality stream **(See pages 2-4, Birney)**

While the implication of Birney is that both the server and the client work together to determine a quality of stream, Birney does not explicitly state that this is done by the media player acting alone.

Kalra teaches requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers; **(See figure 16A1 and column 15 line 56 - column 16 line 60, Kalra teaches requesting by a client media player one of the adaptive streams/copies based on the client capabilities)**

automatically requesting by the media player from the set of servers subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including, **(See figure 16A1 and column 15 line 56 - column 16 line 60, Kalra teaches automatically requesting by the media player higher or lower quality data based on a quality factor)**

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have known to combine the teachings of Kalra with Birney because both deal with streaming different quality of streaming content to a client device from a server. The advantage of incorporating requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers; automatically requesting by the media player from the set of servers subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the

playback quality to a higher or lower quality one of the different copies, said automatically requesting of Kalra into Birney is that sata streams accessed by client from server are tailored to match profile of each client, such that best stream combinations are provided to maximize resolution of 3D, audio and video components thus making the system more robust and efficient. **(See column 1, Kalra)**

Birney and Kalra do not explicitly teach one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections.

Quigg-Brown teaches teach one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections **(See abstract and paragraphs [0028] – [0030])**

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have known to combine the teachings of Quigg Brown with Birney because both deal with streaming of files. The advantage of incorporating one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections of Quigg Brown into Birney is that it improves the data transfer rate by transferring the packets in parallel through the network. **(See paragraphs [0002] – [0005], Quigg brown.)**

Regarding claim 21,

Birney, Kalra, and Quigg Brown teach the method of claim 20,wherein said requesting the plurality of sequential ones of the files includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the portions files from the received sub-parts. **(See page 2 paragraphs 3-5, Birney)**

Regarding claim 23,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said determining making the successive determinations to shift comprises: upshifting to a higher quality one of the different copies when the at least one performance factor is greater than a first threshold; and determining if the higher quality playback can be sustained. **(See page 2 paragraphs 4-5, Birney)**

Regarding claim 24,

Birney, Kalra, and Quigg Brown teach the method of claim 23, wherein said determining making the successive determinations to shift comprises downshifting to a lower quality one of the different copies when the at least one performance factor is less than a second threshold. **(See page 2 paragraphs 3-5, Birney)**

Regarding claim 25,

Birney, Kalra, and Quigg Brown teach the method of claim 20, further comprising: receiving user input to enable one of fast-forward, skip randomly, and rewind functionality; and requesting files of the video at a specified time index that is not the next sequential time in the current playback. **(See page 3, Birney)**

Regarding claim 26,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said requesting the plurality of sequential one of the files includes requesting the files from a low quality one of the different copies to enable instant playback of the video, and wherein said automatically requesting includes upshifting to a higher quality one of the different copies. **(See page 2 paragraphs 1-4, Birney)**

Regarding claim 35,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said requesting the plurality of sequential ones of the files includes requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections. **(See paragraphs [0002] – [0005], Quigg Brown)** See motivation for claim 20.

Regarding claim 36,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said presenting comprises sequentially arranging the received requested portions files from

the different copies in the order of ascending playback time for playback on with the media player on the end user station. **(See page 3 paragraphs 1-3, Birney)**

Regarding claim 37,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said automatically requesting includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the files from the received sub-parts. **(See page 2 paragraphs 3-5, Birney)**

Regarding claim 38,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of is indicative of the available bandwidth of the plurality of TCP connections. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 40,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of factors is indicative of latency of the requested files, wherein the latency is a time measure between when a one of the requests is issued and a time that response data of the begins to arrive at the end user station. **(See page 2 paragraphs 1-5, Birney)**

Regarding claim 41,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files. **(See page 1 paragraphs 1-3, Birney)**

Regarding claim 42,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 43,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein at least one of the set of servers is a web server. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 44,

Birney, Kalra, and Quigg Brown teach the method of claim 43, wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP), and wherein the web server is without specialized server-side intelligence to respond to said requesting. **(See page 2, Birney)**

Regarding claim 45,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein at least one of the set of servers is a cache server of a network infrastructure operator. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 46,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein: said generating the set of factors comprises: monitoring time intervals between successive receive times for each of the requested files (**See pages 1-2, Birney)**; calculating a current performance ratio across a current window of the time intervals; and calculating a current average of the performance ratio to obtain a current performance factor of the set of factors; said making further comprises: comparing the current performance factor with a set of one or more trigger thresholds(**See pages 1-2, Birney)**; and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing (**See pages 2, Birney**)

Regarding claim 47,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said making comprises: comparing a current performance factor of the set of factors with a set of one or more trigger thresholds, wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin, wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video

received by the media player for playback at a current playback time index; and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing. **(See page 1 and 2 paragraphs 2-5, Birney)**

Regarding claim 48,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein: said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that file, and said automatically requesting comprises issuing for each of the files a request with the filename of that file. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 49,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the set of servers includes a content server storing the multiple files of the different copies, and wherein the set of servers includes one or more cache servers caching at least some of the files. **(See page 2 paragraphs 1-3, Birney)**

Regarding claim 50,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence. **(See page 2 paragraphs 2-5, Birney)**

Response to Arguments

Applicant's arguments filed 10/22/2009 have been fully considered but they are not persuasive.

- Applicant's Argument: The Applicant argues that the prior art of record does not teach “the copies of the video is stored as multiple files”.

Examiner’s Response: Examiner respectfully disagrees and points to pages 2-3 of Birney. The passage clearly teaches that discrete streams with different quality bit rates are stored on the server. A discrete stream corresponds directly to multiple files with different bit rate encoding. For at least the above mentioned reasons, the prior art of record does indeed cover the claim limitations.

- Applicant's Argument: The Applicant argues that the prior art of record does not teach “time indexes”.

Examiner’s Response: Examiner respectfully disagrees and points to page 2 of Birney. The passage clearly teaches that multiple steams are encoded and a media player/server adjust the stream based on bandwidth and other conditions which may impact a user’s viewing of a video. The way multi bit encoding works is; say for example a medium stream is being sent to a client from a server and at a time if 25 minutes 35 seconds, the bandwidth suddenly drops; the client/server then will determine that a low quality stream should now be used and **seamlessly** switch the video to low quality after

the determination is made at, for example, 25 minutes 40 seconds. The low quality stream will pick up at the **time** that the medium stream stops. Therefore a **time index** is being used in order to **seamlessly** switch stream qualities. For at least the above mentioned reasons, the prior art of record does indeed cover the claim limitations.

- Applicant's Argument: The Applicant argues that the prior art of record does not teach "making the successive determinations [by the media player] to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time".

Examiner's Response: Examiner respectfully disagrees and points to pages 2-3 of Birney and figure 16A1 and column 15 line 40 – column 16 line 49, Kalra. The passages clearly teach that a media player along with a server make the successive determination based on a client profile to shift the quality of stream sent to the client from the server. For at least the above mentioned reasons, the prior art of record does indeed cover the claim limitations.

Conclusion

Applicant's submission of an information disclosure statement under 37 CFR 1.97(c) with the fee set forth in 37 CFR 1.17(p) on 11/6/2009 prompted the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS**

MADE FINAL. See MPEP § 609.04(b). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any response to this Office Action should be **faxed** to (571) 272-8300 or **mailed** to:

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Hand-delivered responses should be brought to
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Any inquiry concerning this communication or earlier communications from the examiner should be directed to NINOS DONABED whose telephone number is (571)270-3526. The examiner can normally be reached on Monday-Friday, 7:30 AM-5:00 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William Vaughn can be reached on (571) 272-3922. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/N. D./
Examiner, Art Unit 2444
/William C. Vaughn, Jr./
Supervisory Patent Examiner, Art Unit 2444

Substitute for Form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	11/116,783
				Filing Date	April 28, 2005
				First Named Inventor:	R. Drew Major
				Art Unit	2444
				Examiner Name	Donabed, Ninos J
Sheet	**1**	**of**	**1**	Attorney Docket Number	8532P001

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		PCT Notification of Transmittal of the International Search Report and Written Opinion of the International Searching Authority, for PCT/US05/15091, October 29, 2007, 8 pages.	
		PCT Notification of Transmittal of International Preliminary Report on Patentability, for PCT/US05/15091, October 29, 2007, 6 pages.	
		Office Action for 11/673,483, July 9, 2009, 14 pages.	
		Office Action for 11/673,483, February 3, 2009, 9 pages.	
		ALBANESE, Andres, et al. "Priority Encoding Transmission", TR-94-039, August 1994, 36 pages, International Computer Science Institute, Berkeley, California.	
		PURI, Rohit, et al. "Multiple Description Source Coding Using Forward Error Correction Codes", October 1999, 5 pages, Department of Electrical Engineering and Computer Science, University of California, Berkeley, California.	
		GOYAL, Vivek K., "Multiple Description Coding: Compression Meets the Network", September 2001, pages 74-93, IEEE Signal Processing Magazine.	

Examiner Signature	/Ninos Donabed/	Date Considered	02/04/2010

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

This collection of information is required by 37 CFR 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 2 hours 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SENT FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.**

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Based on Form PTO/SB/08A (08-03) as modified by BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP on 09/10/03

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.D

Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Complete if Known	
Application Number	11/116,783
Filing Date	April 28, 2005
First Named Inventor:	R. Drew Major
Art Unit	2444
Confirmation No.	5535
Examiner Name	Donabed, Ninos J.
Attorney Docket Number	8532P001

Sheet	**1**	**of**	**1**

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (If known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		WICKER, Stephen B., "ERROR CONTROL SYSTEMS for Digital Communication and Storage", Prentice-Hall, Inc., New Jersey, USA, 1995 (Book: see NPL's Parts 1-6)	

Examiner Signature	/Ninos Donabed/	Date Considered	02/04/2010

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

This collection of information is required by 37 CFR 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 2 hours 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, 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, Virginia 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.D

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	Art Unit
	NINOS DONABED	2444

SEARCHED

Class	Subclass	Date	Examiner
709	246	05/07/2008	ND

SEARCH NOTES

Search Notes	Date	Examiner
See EAST Search History	05/07/2008	ND
Conducted double patenting search	05/07/2008	ND
Consulted with SPE William Vaughn	11/13/2008	ND
See updated EAST search	12/13/2009	ND
Consulted with SPE William Vaughn regarding Final	02/12/2009	ND
Consulted with SPE William Vaughn regarding Advisory	03/29/2009	ND
Consulted with SPE William Vaughn regarding Advisory	5/7/2009	ND
Consulted with Primary Paul Kang	02/10/2009	ND
See updated east search	7/30/2009	ND
Consulted with SPe William Vaughn regarding search	7/30/2009	ND
Consulted SPE William Vaughn regarding Final	2/4/2010	nd

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known

Application Number	11/116,783
Filing Date	April 28, 2005
First Named Inventor	Major, R. Drew
Group Art Unit	2444
Examiner Name	Donabed, Ninos

Attorney Docket No: 8532P001

US PATENT DOCUMENTS

Examiner Initial *	Cite No [1]	USP Document Number	Publication or Issue Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-20030005455A1	01/02/2003	Bowers	
		US-20040054551A1	03/18/2004	Ausubel, et al.	
		US-20040143672A1	07/22/2004	Padmanabham, et al.	
		US-20040170392	09/02/2004	Lu, et al.	
		US-20080162713	07/03/2008	Bowra, et al.	
		US-6486803B1	11/26/2002	Luby, et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No [1]	Foreign Patent Document — Country Code/Number/Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [2]

OTHER DOCUMENTS -- NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No [1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]

EXAMINER /Ninos Donabed/ **DATE CONSIDERED** 02/04/2010

Based on PTO/SB/08A(09-06) - Substitute Disclosure Statement Form (PTO-1449) as modified by BSTZ 03/26/07

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional) [2] Applicant is to place a check mark here if English language Translation is attached

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.D

REMARKS

Applicant respectfully requests reconsideration of this application in view of the following remarks.

- The Office Action, in the "Response to Arguments" section, does not address the Applicant's or arguments made regarding "**Requesting by the Media Player**." In particular, the Applicant made various arguments, including the arguments presented in the following sections "Quigg-Brown Fails to Teach 'Requesting by the Media Player' (First Occurrence)," "Birney Fails to Teach 'Requesting by the Media Player' (Second Occurrence)," and the "Combination of Birney and Quigg-Brown Fails to Teach 'Requesting by the Media Player" (Both Occurrences)."
- The Office Action, in the "Response to Arguments" section argues that page 2-3 of Birney teaches that discrete streams with different quality bit rates are stored on the server, and that a discrete stream corresponds directly to multiple files with different bit rate encoding. It appears, however, that the Office Action ignores the wording of the claims that each of the different copies of the video is "stored as multiple files," as well as the arguments presented in Applicant's previous response on this matter, labeled **"Birney Fails to Teach 'Stored as Multiple Files'."** The cited section of Birney expressly states that "a number of discrete, user-definable audio and video streams are encoded into a single Windows Media stream," which is managed as "a single file" (paragraph 11). The Office Action also fails to address the argument that "**Quigg-Brown Fails to Teach 'Stored as Multiple Files'."** Thus, the Office Action has failed to establish a prima facie rejection on this matter.
- The Office Action, in the "Response to Arguments" section concludes that the word **"seamlessly"** in Birney means that time indexes are used, providing a self-generated example of how the Examiner believes intelligent streaming works without any supporting evidence. Since Birney is silent regarding "time indexes," it appears that the Office Action relies on personal knowledge to support that finding of what is known in the art. To rely on personal knowledge, the Office Action would need to take Official Notice under MPEP 2144.03(C) so that the Applicant can challenge the Official Notice. If the Office Action intended the response on this matter to be considered as taking Official Notice, the Applicant respectfully challenges the Official Notice, requesting that the Examiner provide documentary evidence, as well as point to some concrete evidence in the record in support of these finding. Also, if the Examiner is relying on personal knowledge to support the finding of what is known in the art, Applicant respectfully submits that the Examiner provide an affidavit or declaration setting forth specific factual statements and explanation to support the finding. *MPEP* 2144.03(C). Thus, the Office Action has failed to show that Birney teaches the claimed "time indexes."
- Even if, for the sake of argument, the Office Action were to present a reference for the challenge of the Official Notice noted above, this reference would not only have to teach "time indexes," but also that each of the "time indexes" corresponds to one of the ***multiple*** files of each of the different copies, where each file yields a portion of the video, as claimed, since Birney is deficient on this issue. In particular, the Office Action, in the "Response to Arguments" section does not address the alternative argument presented in the section **"Birney Fails to Teach 'Time Indexes,'"** which

indicates that even if time indexes were to be used in Birney, these alleged time indexes of Birney could not correspond to one of multiple files of a copy because *there is only a single file in Birney*. In contrast, claim 20 recites "each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video."

- The Office Action, in the "Response to Arguments" section seems to miss the point of Applicant's arguments regarding **"Making the Successive Determinations."** In particular, the Office Action seems to ignore that even if the client helps determine the bandwidth between the client and server in Birney, the server is the one performing the "intelligent streaming" to push the lower or higher bit rate stream to the client. Birney does not teach that the claim language of the media player requesting files from the servers "dependent upon successive determinations by the media player."

In addition to the arguments presented above in the bullet points, Applicant respectfully incorporates by reference the arguments presented in the remarks of the Applicant's previous response, filed Oct. 22, 2009, which provide a detailed analysis that supports the briefly stated arguments above.

From the bullet point items described above, there is clearly a basis for appeal since the Office Action is incomplete and insufficient. Applicant respectfully requests that the Examiner reconsider the sufficiency of the Office Action and reopen prosecution to issue a new or supplemental Office Action that cures the deficiencies or issue a notice of allowance. Clearly the bullet point items also show (as well as the incorporated arguments) that the claims are clearly patentable over the cited references and that a notice of allowance should be issued.

CONCLUSION

It is respectfully submitted that in view of the amendments and remarks set forth herein, the rejections have been overcome, putting the claims in condition for allowance. If the Examiner believes a telephone interview would expedite the prosecution of this application, the Examiner is invited to contact Kevin Grange at (408) 720-8300.

If there are any additional charges, please charge them to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: February 25, 2010

/Kevin O. Grange/

Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Electronic Acknowledgement Receipt

EFS ID:	7089175
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	25-FEB-2010
Filing Date:	28-APR-2005
Time Stamp:	15:59:41
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		8532P001_Resp_to_FOA.pdf	40749 e57390e05ad29dbedce30a86510762c50e82b831	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment After Final	1	1
	Applicant Arguments/Remarks Made in an Amendment	2	4
Warnings:			
Information:			
	Total Files Size (in bytes):	40749	

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:

R. Drew Major

Application No.: 11/116,783

Filed: April 28, 2005

For: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

Examiner: Donabed, Ninos J.

Art unit: 2444

Confirmation No.: 5535

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Kevin O. Grange/ Feb. 25, 2010
Kevin O. Grange ***Date***

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO FINAL OFFICE ACTION
under 37 C.F.R. § 1.116 – Expedited Procedure

Examiner:

In response to the Final Office Action mailed on February 22, 2010, Applicant respectfully requests that the Examiner consider the following following remarks.

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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	8532P001	5535

8791 7590 03/23/2010

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
SUNNYVALE, CA 94085-4040

EXAMINER	
DONABED, NINOS J	
ART UNIT	PAPER NUMBER
2444	
MAIL DATE	DELIVERY MODE
03/23/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Advisory Action Before the Filing of an Appeal Brief	Application No. 11/116,783	Applicant(s) MAJOR ET AL.	
	Examiner NINOS DONABED	Art Unit 2444	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 25 February 2010 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires _____months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.

   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ They raise the issue of new matter (see NOTE below);
   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: _____. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☒ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☒ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: *None*.
   Claim(s) objected to: *None*.
   Claim(s) rejected: *20,21,23-26,35-38 and 40-50*.
   Claim(s) withdrawn from consideration: *None*.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
12. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
13. ☒ Other: See Continuation Sheet.

/William C. Vaughn, Jr./
Supervisory Patent Examiner, Art Unit 2444

/N. D./
Examiner, Art Unit 2444

Continuation of 13. Other: Applicant argues that the prior art of record "fails to teach "stored as multiple files".

Examiner respectfully disagrees and points to page 2 of Birney which teaches discrete streams of encoded data which constitute different bit rates. The claim calls for "video encoded at different bit rates is stored as multiple files" which is clearly covered by the discrete streams of encoded data.

Applicant argues that the prior art of record "fails to teach making successive determinations".

Examiner respectfully disagrees and points to 2-3 of Birney which shows that both the media player and the server are utilized to make the successive determinations. Since the claim is open-ended, the server and media player working in collaboration to make the successive determination is indeed covered by the prior art. Further see, figure 16A1 and column 15 line 40 - column 16 line 49, Kalra. The passages clearly teaches that a media player along with a server make the successive determination based on a client profile to shift the quality of stream sent to the client from the server.

Applicant argues that the prior art of record "fails requesting by the media player".

Examiner respectfully disagrees and points to pages 2-4 of Birney. This section teaches a client system running windows media player which requests a stream from the server and if the bandwidth can not support the quality video it works with the server and requests a different grade of video. This clearly covers the requesting by the media player limitation in the claims. .

Aylo Exhibit 1018
Page 643 of 2308

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:

R. Drew Major

Application No.: 11/116,783

Filed: April 28, 2005

For: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

Examiner: Donabed, Ninos J.

Art unit: 2444

Confirmation No.: 5535

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Kevin O. Grange/ Feb. 25, 2010
Kevin O. Grange ***Date***

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

OK TO ENTER: /N.D./

RESPONSE TO FINAL OFFICE ACTION
under 37 C.F.R. § 1.116 – Expedited Procedure

Examiner:

In response to the Final Office Action mailed on February 22, 2010, Applicant respectfully requests that the Examiner consider the following following remarks.

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

_____ 37 C.F.R. §1.97(b).

_____ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

____ A statement pursuant to 37 C.F.R. §1.97(e) or

____ **The Director is Authorized to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. § 1.17(p).**

__X__ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

(1) A statement pursuant to 37 C.F.R. §1.97(e); and

(2) **Authorization to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. §1.17(p) for submission of the Information Disclosure Statement.**

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: April 22, 2010

/Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known

Application Number	11/116,783
Filing Date	April 28, 2005
First Named Inventor	Major, R. Drue
Group Art Unit	2444
Examiner Name	Donabed, Ninos J.

Sheet 1 of 1

Attorney Docket No: 8532P001

US PATENT DOCUMENTS

Examiner Initial *	Cite No [1]	USP Document Number	Publication or Issue Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-20030204519A1	10/30/2003	Sirivara, et al.	
		US-7408984B2	08/05/2008	Lu, et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No [1]	Foreign Patent Document — Country Code/Number/Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [2]

OTHER DOCUMENTS -- NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No [1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]

EXAMINER **DATE CONSIDERED**

Based on PTO/SB/08A(09-06) - Substitute Disclosure Statement Form (PTO-1449) as modified by BSTZ 03/26/07

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional) 2 Applicant is to place a check mark here if English language Translation is attached

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2444
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed for applications filed after June 30, 2003). It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on the date shown below.

April 22, 2010.
(Date of Deposit)
Kevin O. Grange
(Typed or printed name of person mailing correspondence)

/Kevin O. Grange/ 4-22-2010
(Signature of person mailing correspondence) (Date)

Electronic Acknowledgement Receipt

EFS ID:	7472615
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange
Filer Authorized By:	
Attorney Docket Number:	8532P001
Receipt Date:	22-APR-2010
Filing Date:	28-APR-2005
Time Stamp:	23:18:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	6061
Deposit Account	022666
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		8532P001_After-final_response.pdf	139490 4399b69bbad1679ac272a3e7eced4437aabdee22	yes	7

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment After Final	1	1
Applicant Arguments/Remarks Made in an Amendment	2	7

Warnings:

Information:

2	Information Disclosure Statement (IDS) Filed (SB/08)	8532P001_IDS_1449.pdf	156993 920984411eaca96030e62f2666563164f009bcd8	no	3

Warnings:

Information:

This is not an USPTO supplied IDS fillable form

3	Transmittal Letter	8532P001_Statement_Under_37_CFR_197e.pdf	62784 ba4fb24270b70b4fce53c54b2bca81ea2dacc175	no	2

Warnings:

Information:

4	Fee Worksheet (PTO-875)	fee-info.pdf	30129 20c0077c8eb6fe6ced262f72bb1ecd627b737677	no	2

Warnings:

Information:

Total Files Size (in bytes):	389396

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.

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2144
Filed: April 28, 2005	
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

STATEMENT UNDER 37 C.F.R. §1.97(e)

Sir:

I hereby certify (as indicated by an "X" to the left of the appropriate paragraph):

____ That each item of information contained in the accompanying 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.

CERTIFICATE OF ELECTRONIC FILING

I hereby certify that this correspondence is being submitted electronically via EFS on the date shown below.

/Kevin O. Grange/ April 22, 2010
Kevin O. Grange (Date)

__X__ That no item of information contained in the accompanying Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned attorney after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in §1.56(c) more than three months prior to the filing the Information Disclosure Statement.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: April 22, 2010

/Kevin O. Grange/
Kevin O. Grange
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(408) 720-8300

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange
Attorney Docket Number:	8532P001

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:

R. Drew Major

Application No.: 11/116,783

Filed: April 28, 2005

For: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

Examiner: Donabed, Ninos J.

Art unit: 2444

Confirmation No.: 5535

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Kevin O. Grange/ April 22, 2010
Kevin O. Grange ***Date***

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO FINAL OFFICE ACTION
under 37 C.F.R. § 1.116 – Expedited Procedure

Examiner:

In response to the Final Office Action mailed on February 22, 2010 and the Advisory Action mailed March 23, 2010, Applicant respectfully requests that the Examiner consider the following remarks.

REMARKS

Applicant respectfully requests reconsideration of this application in view of the following remarks.

Arguments that Remain Unaddressed

- As a preliminary matter, the Advisory Action, in the Continuation section, only addresses three arguments presented in the Applicant's previous response, filed Feb. 24, 2010, failing to address the third and fourth bullet points regarding Birney's usage of "seamlessly," and failing to teach the claimed "time indexes." Applicant requests these be addressed because they will be raised if an appeal is necessary.

"Stored as Multiple Files"

- The Advisory Action, in the Continuation section, argues that page 2 of Birney teaches discrete streams of encoded data that constitute different bit rates, and alleges that the discrete streams "clearly cover" the claims language "video encoded at different bit rates is stored as multiple files." This does not properly address the wording of the claims that "**each of the different copies of the video** is stored as multiple files." Unlike the claimed invention, Birney expressly teaches that the discrete streams are in a single file, not that each discrete stream is stored as a separate file or that portions of each stream are stored in separate files. In particular, the cited section of Birney expressly states that "a number of discrete, user-definable audio and video streams are encoded into a single Windows Media stream," which is managed by the Windows Media server as "*a single file*" (paragraph 11).
- The Advisory Action uses the phrase "covered by," but the standards to use are novelty and nonobviousness. Regarding "multiple files," there is novelty as evidenced by the Examiner pointing at discrete streams, rather than the Examiner finding the claimed separate files in Birney. The Examiner fails to make a prima facie rejection of obviousness in both the Final Office Action and in the Advisory Action. Birney describes the use of a single file holding all of the streams, while Applicant claims multiple copies and that each copy is broken into multiple separate files (with details about portions of the video, alignment of potions of the different copies, of the media player requesting from different ones of the copies different ones of the files based on successive determination to create a stream and playback the video). Birney's Windows Media server selecting from different bit rate streams in a single file is different from the claimed media player's successive determinations/requesting of different files from a server, much less the files having the claimed characteristics. The entity making the decisions/requests is different, how the video is stored on the server is different, and how the video is requested is different. These differences are not obvious in view of Birney, evidenced in part by the claimed approach's benefits over Birney's approach (and Kalra does not make these claimed differences obvious, as described in more detail below). Unlike Birney or the alleged combination, which requires Windows Media Servers be used, the claimed separate files do not require a "specialized media server or server-side intelligence" to retrieve the separate files, or special media software to be stored in the servers that serve the video or that cache the video in the Internet (Applicant's Specification, page 14, paragraph 49); rather, the claimed manner allows for standard servers to be used. These standard servers are less expensive than specialized media

servers and are typically already part of the network. In addition, since the claimed manner can use standard web and cache servers of ISPs, the claimed manner can provide "a highly scalable solution" (*Id.*). One of ordinary skill in the art at the time reading Birney and the other available art would not have found the claimed invention obvious, but rather have implemented as Birney describes.

"Requesting by the Media Player" or "Successive Determinations by the Media Player"

- In the Final Office Action, it appears that the Examiner concedes that Birney fails to teach the two claim limitations of "requesting by the media player", since the Examiner's analysis in the Final Office Action only cites to Kalra for these two limitations. Yet, in the Advisory Action, the Examiner alleges again that pages 2-4 of Birney teaches a client running windows media player which requests a stream from the Windows Media server and alleges that "if the bandwidth can not support the quality video it works with the [Windows Media] server and requests a different grade of video" (Advisory Action, bracketed material added). Applicant respectfully disagrees with both positions taken in the Final Office Action and the Advisory Action. Regarding Birney, the media player does not work with the Windows Media server for intelligent streaming, the Windows Media server performs intelligent streaming on its own. This is an unsupported position exemplified by the Final Office Action pointing at two pages rather than a specific citation. There is no quote to support this—it is simply the Examiner reading things into the reference that are not present. In fact, Birney expressly teaches the opposite. Birney teaches that in order to use "intelligent streaming with multiple-bit-rate streams, the *content must be hosted on a Windows Media server*" (paragraph 14), and thus, is a push-based configuration in which a specialized server selects or switches to the stream "that is the most appropriate for current bandwidth conditions," (Birney, paragraph 7) not the media player working with the Windows Media server to request a different grade of video as alleged by the Examiner. In fact, Birney expressly teaches that after the Windows Media server and client determine the current available bandwidth, "the [Windows Media] server selects and delivers the stream with the most appropriate bit rate" (Birney page 2, Intelligent Bandwidth Control, item 1, bracketed material added). Although Birney describes both the media player and the Windows Media server being utilized to determine the bandwidth between the client and the Windows Media server, that is not the same thing as [the media player] requesting different parts of the video based on successively determining which bit rate to use (in Birney, this is done by the Window Media server alone). Therefore, regardless of whether the client helps the Windows Media server determine the current available bandwidth, the claim limitations are not met.
- Regarding Kalra, the Final Office Action alleges that Kalra teaches "requesting by a client media player one of the adaptive streams/copies based on the client capabilities," and that such teaching reads on the limitation of "requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers" (Final Office Action page 4). Applicant respectfully disagrees. Kalra also teaches a push-based configuration in which a client computer determines a user profile (CPU constraint and user's video quality preference) (steps 602A and 602B). Kalra, col. 15, line 56 to col. 16, line 60). After a connection is established between the adaptive stream server and the client computer (step 604), the client computer

sends the user profile to the adaptive stream server (step 606) and the adaptive stream server transmits the adaptive streams in accordance with the user profile thereafter (step 608). Contrary to the Examiner's allegation that Kalra teaches the "requesting" limitation, Kalra expressly teaches that after the client computer sends the user profile to the adaptive stream server, a user makes a selection of the particular sequence that he desires to see/her" (step 608) and that "[o]nce the adaptive stream server receives a profile from the user … it uses this information … **to make a determination of which streams to transmit"** to the client computer (col. 16, lines 32-36 and 50-55, emphasis added), rather than the client computer making multiple requests for the different files of the particular sequence based on successive determinations. This shows that the client computer makes an initial selection of the particular data to be streamed, and the adaptive stream server has the intelligence to determine which streams to transmit to the client computer using the user profile, which was previously determined prior to establishing a connection and making the initial selection. Thus, Kalra's adaptive streaming is also a push-based configuration in which a specialized server selects the appropriate streams to transmit to the client computer. Accordingly, Kalra fails to cure Birney's deficiencies regarding "requesting" and "successively determinations," as noted herein and in Applicant's previous responses, failing to make a prima facie rejection of obviousness.

- In addition, the Final Office Action alleges that Kalra teaches "automatically requesting by the media player higher or lower quality data based on a quality factor," and that such teaching reads on the "automatically requesting" limitation (Final Office Action page 4). Applicant respectfully disagrees. Regardless of whether the adaptive stream structure is modified to introduce a quality factor that, for a given DCT coefficient, uses the most significant bits for lower quality transmission and all bits for higher quality transmission, the client only makes an initial request for the particular sequence based on the user's selection at the client computer, and the adaptive stream server makes the determination of which streams to transmit to the client computer using the previously-determined user's profile. In addition, as noted above, the adaptive stream server is a specialized server that selects the appropriate streams to transmit to the client computer. Thus, Kalra fails to cure Birney's deficiencies regarding "automatically requesting," as noted herein and in Applicant's previous responses, failing to make a prima facie rejection of obviousness.
- The Advisory Action uses the term "covered by" instead of the standards of novelty and nonobviousness. There is novelty as evidenced by the Examiner implying that Birney does not teach these limitations by referring to Kalra in the Final Office Action (page 4) for these two "requesting by the media player" limitations. In addition, the Office Action fails to establish a prima facie case of obviousness. Applicant previously argued that Birney fails to teach these limitations, and, in response, the Final Office Action took the position that Kalra teaches these limitations. However, in the Advisory Action, the Examiner seems to return to the position that Birney teaches the "requesting by the media player" limitations, instead of Kalra doing so, as previously argued in the Final Office Action. Although switching positions is not necessarily improper, the one sentence explanation in the advisory action, failing to address Applicant's previous arguments regarding Birney, and pointing at two pages rather than a specific citation all show that the Examiner has failed to make a proper prima facie rejection of obviousness. As argued above,

not only has the Examiner failed to establish a prima facie rejection using Birney, the Examiner has failed to establish a prima facie rejection using Birney and Kalra as described herein.

"Making Successive Determinations"

- The Advisory Action argues that pages 2-3 of Birney show that both the media player and the Windows Media server are utilized to make the successive determinations, and alleges that, "since the claim is open-ended, the server and media player working in collaboration to make the successive determinations is indeed covered by the prior art."
- There is no basis for the position that the claim is open ended. This is just an attempt to make art apply to a claim which is allowable. The claim says "by the media player" in multiple places. For instance, the claim language requires that the media player requests files from the set of servers "dependent upon successive determinations by the media player." Also, as indicated above, the claim language requires the media player "requesting" the files from the different bit rate copies and making the "successive determinations" about which bit rate copy to use; these limitations are not obvious in view of Birney as previously described.
- In the alleged combination, Birney is used to chop up a video into segments, and then the segments are encoded at different bit rates as in Kalra. While this is a big stretch and Applicant does not agree, this still does not yield the claimed successive determinations and requesting by the media player. Specifically, the claimed successive determinations are which bit rate to use, not what the current available bandwidth is. In the combination where the client and the server decide the bandwidth together, the server on its own picks the bit rate and pushes the video. In other words, the client is not involved in the bit rate determination; and since the server is making the bit rate determinations, there is no need for the client to request subsequent parts of the video based on these successive determinations. The "factors" in the claim can include available bandwidth (see e.g., claim 38), and the claim is unspecific about how the factors are generated; but the claim is specific that the media player determines the bit rate copy and makes the requests to the set of servers. Thus, the bandwidth determinations cannot be equated to the bit rate copy determinations and requests by the media player to the set of servers.
- The claim language requires successive determinations, and requesting subsequent parts of the video based on the successive determinations, and thus there are multiple requests made the media player. Thus, some art that shows an initial request by the player cannot be used to find the claim obvious. Again, the Final Office Action fails to establish a prima facie case of obviousness. In the Final Office Action, after the admission that Birney fails to teach this limitation, the Office Action indicates that Kalra teaches the "requesting" limitations without specifically addressing how Kalra teaches *making successive determinations by the media player*. Then, in what appears to be a contradictory position in the Advisory Action, the Examiner cites Kalra, expressly stating that Kalra "clearly teaches that **a media player along with a server make the successive determinations** based on a client profile to shift the quality of stream sent to the client from the server" (Advisory Action page 2, emphasis added). Yet, this suggested combination would still result in the media player along with the server making the successive determinations, not the media player making the successive determinations. As such, Kalra fails to cure the

deficiencies of Birney regarding making successive determinations by the media player, and the Office Action fails to establish a prima facie obviousness rejection.

Possible Claim Amendments

- Applicant believes that the claim language is clear on its face, but if the following amendments would result in a notice of allowance, the Applicant is willing to make an amendment to claim 20 to recite "wherein each of the multiple files of a given one of said different copies yields a different portion of the video on playback," and/or "automatically requesting by the media player from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player alone to shift the playback quality to a higher or lower quality one of the different copies;" otherwise, Applicant is willing to appeal the claims as they currently stand. Applicant believes that such amendments are unnecessary since these are already implicitly present in the claims, and that such amendments would not require a new search.

In addition to the arguments presented above in the bullet points, Applicant respectfully incorporates by reference the arguments presented in the remarks of the Applicant's previous response, filed Oct. 22, 2009, which provide a detailed analysis that supports the briefly stated arguments above, as well as the remarks of the Applicant's previous response, filed February 24, 2010.

From the bullet point items described above, there is clearly a basis for appeal since the Final Office Action is incomplete and insufficient. Applicant respectfully requests that the Examiner reconsider the sufficiency of the Final Office Action and reopen prosecution to issue a new or supplemental Office Action that cures the deficiencies or issue a notice of allowance. Clearly, the bullet point items also show (as well as the incorporated arguments) that the claims are clearly patentable over the cited references and that a notice of allowance should be issued.

CONCLUSION

It is respectfully submitted that in view of the amendments and remarks set forth herein, the rejections have been overcome, putting the claims in condition for allowance. If the Examiner believes a telephone interview would expedite the prosecution of this application, the Examiner is invited to contact Kevin Grange at (408) 720-8300.

If there are any additional charges, please charge them to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR, & ZAFMAN LLP

Date: April 22, 2010

/Kevin O. Grange/

Kevin O. Grange
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1279 Oakmead Parkway
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	8532P001	5535

8791 7590 05/17/2010

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
SUNNYVALE, CA 94085-4040

EXAMINER	
DONABED, NINOS J	
ART UNIT	PAPER NUMBER
2444	
MAIL DATE	DELIVERY MODE
05/17/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 11/116,783	**Applicant(s)** MAJOR ET AL.	
	Examiner NINOS DONABED	**Art Unit** 2444	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 22 April 2010 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires _____months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.

   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ They raise the issue of new matter (see NOTE below);
   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: _____. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☒ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☒ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: *none*.
   Claim(s) objected to: *none*.
   Claim(s) rejected: *20-21, 23-26, 35-38, 40-50*.
   Claim(s) withdrawn from consideration: *none*.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
12. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
13. ☒ Other: See Continuation Sheet.

/William C. Vaughn, Jr./
Supervisory Patent Examiner, Art Unit 2444

/N. D./
Examiner, Art Unit 2444

Aylo Exhibit 1018
Page 662 of 2308

Continuation of 13. Other: Applicant argues that the prior art of record does not explicitly teaches "stored as multiple files".

Examiner respectfully disagrees and again points to page 2 of Birney which teaches discrete streams of encoded data which constitute different bit rates. The claim calls for "video encoded at different bit rates is stored as multiple files" which is clearly covered by the discrete streams of encoded data. Again all of the streams are separate files, i.e. each stream is its own discrete file. These streams are individual files with different bit rates/

Applicant argues that the prior art of record "fails to teach making successive determinations".

Examiner again respectfully disagrees and points to 2-3 of Birney which shows that both the media player and the server are utilized to make the successive determinations. Since the claim is open-ended, the server and media player working in collaboration to make the successive determination is indeed covered by the prior art. Further see, figure 16A1 and column 15 line 40 - column 16 line 49, Kalra. The passages clearly teaches that a media player along with a server make the successive determination based on a client profile to shift the quality of stream sent to the client from the server. Again the server along with the client (media player) work together to determine which stream to send to the client. Both client and server help in making the successive determinations for the different streams.

Applicant again argues that the prior art of record fails to teach " requesting by the media player".
Examiner respectfully disagrees and points to pages 2-4 of Birney. This section teaches a client system running windows media player which requests a stream from the server and if the bandwidth can not support the quality video it works with the server and requests a different grade of video. This clearly covers the requesting by the media player limitation in the claims. Again the client running the media player software requests different versions of the content based on quality considerations such as bandwidth.

Aylo Exhibit 1018
Page 663 of 2308

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:

R. Drew Major

Application No.: 11/116,783

Filed: April 28, 2005

For: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

Examiner: Donabed, Ninos J.

Art unit: 2444

Confirmation No.: 5535

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Kevin O. Grange/ April 22, 2010
Kevin O. Grange ***Date***

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

OK TO ENTER: /N.D./

RESPONSE TO FINAL OFFICE ACTION
under 37 C.F.R. § 1.116 – Expedited Procedure

Examiner:

In response to the Final Office Action mailed on February 22, 2010 and the Advisory Action mailed March 23, 2010, Applicant respectfully requests that the Examiner consider the following remarks.

Electronic Acknowledgement Receipt

EFS ID:	7677582
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	24-MAY-2010
Filing Date:	28-APR-2005
Time Stamp:	19:16:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$270
RAM confirmation Number	8896
Deposit Account	022666
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Notice of Appeal Filed	8532P001_Notice_of_Appeal.pdf	246744 67904a55a65a540a1d1c5ae455c08fe4e7563193	no	2
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	30147 36a7e45bef31bac31a28b67bef743880d058f83e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	276891		

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/31 (07-09)
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 displays a valid OMB control number.

NOTICE OF APPEAL FROM THE EXAMINER TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Docket Number (Optional): 8532P001

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on May 24, 2010

Signature: /Leslie Rogan/

Typed or printed name: Leslie Rogan

In re Application of: R. Drew Major

Application Number	Filed
11/116,783	April 28, 2005

For: Apparatus, System, and Method for Adaprive-rate Shifting of Streaming Content

Art Unit	Examiner
2444	Donabed, Ninos J

Applicant hereby **appeals** to the Board of Patent Appeals and Interferences from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 540

☑ Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ 270

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 02-2666 .

☐ A petition for an extension of time under 37 CFR 1.136(a) (PTO/SB/22) is enclosed.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

☑ attorney or agent of record. Registration number 60793.

☐ attorney or agent acting under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34. _____

/Kevin O. Grange/
Signature

Kevin O. Grange
Typed or printed name

408-720-8300
Telephone number

May 24, 2010
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 41.31. 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, 1.14 and 41.6. 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.

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.

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Leslie Rogan
Attorney Docket Number:	8532P001

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Notice of appeal	2401	1	270	270
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**270**

Attorney's Docket No.: 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: R. Drew Major Application No.: 11/116,783 Filed: April 28, 2005 For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	Examiner: Donabed, Ninos J Art Unit: 2444 Confirmation No.: 5535

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PETITION FOR EXTENSION OF TIME PURSUANT TO 37 C.F.R. § 1.136 (a)

Sir:

Applicant respectfully petitions pursuant to 37 CFR 1.136(a) for a three month extension of time to file the Appeal Brief. The extended period is set to expire on October 25, 2010. Authorization is given to charge the Applicant's Deposit Account No. 02-2666 in the amount of $555.00, to cover the fee for a three month extension of time.

Please charge any shortages and credit any overages to our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN

Dated: Oct. 25, 2010

/Kevin O. Grange/
Kevin O. Grange
60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on the date shown below.

October 25, 2010
(Date of Deposit)

Leslie Rogan
(Typed or printed name of person mailing correspondence)

/Leslie Rogan/ 10-25-2010
(Signature of person mailing correspondence) (Date)

Attorney's Docket No.: 8532P001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
R. Drew Major *et al.*	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Group Art Unit: 2444
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM, AND METOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

The Appellant submits the following Appeal Brief pursuant to 37 C.F.R. § 41.37(c) for consideration by the Board of Patent Appeals and Interferences. The Appellant authorizes the amount of $270.00 to cover the cost of filing the opening brief as required by 37 C.F.R. § 1.17(f) to be charged to Deposit Account No. 02-2666. If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2666.

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I. REAL PARTY IN INTEREST

R. Drew Major and Mark B. Hurst, the parties named in the caption, transferred their rights to the subject Application through an assignment recorded on July 28, 2006 (Reel/Frame 018020/0750) in the patent application to Move Networks, Inc. of American Fork, Utah. Thus, as the owner at the time the brief is being filed, Move Networks, Inc. is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences that will directly affect, be directly affected by or have a bearing on the Board's decision in this Appeal.

III. STATUS OF CLAIMS

Claims 20-21, 23-25, 35-38, and 40-50 are currently pending and rejected in the Application. Claims 1-19, 22, 27-34, and 39 are canceled. The Appellant respectfully appeals the rejections of claims 20-21, 23-25, 35-38, and 40-50.

IV. STATUS OF AMENDMENTS

No amendments were submitted after the Final Office Action, mailed February 22, 2010 ("Final Office Action").

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

Appellant respectfully submits that the following includes the claim language and citations that show where support for the claim language is found. Appellant respectfully submits that the citations should not be used to read limitations from the specification into the claims.

Claim 20 recites a method for presenting rate-adaptive streams (*See* Application, e.g., pgs. 6-7 ¶¶19-21, pgs. 20-23 ¶¶66-73, and Figs. 6 & 7), the method comprising: streaming by a media player operating on an end user station a video from a set of one or more servers (*See* e.g., pg. 11 ¶42, pg. 14, ¶50), wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers (*See* e.g., pgs. 11-12 ¶¶44-45,

and Figs. 2A-2C), wherein each of the multiple files yields a different portion of the video on playback (*See* e.g., pg. 11 ¶42 and 12 ¶45), wherein the multiple files across the different copies yield the same portions of the video on playback (*See* e.g., pgs. 11-12 ¶¶44-45), each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video (*See* e.g., pgs. 11-12 ¶¶44-45, and Figs. 2A-2C), and wherein the streaming comprises: requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes (*See* e.g., pgs. 15-17 ¶¶54-55, 57, and 60, and Figs. 4 and 6); automatically requesting by the media player from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies (*See* e.g., pgs. 20-22 ¶¶66, 68-72, and Figs. 6 and 7), said automatically requesting including, repeatedly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies (*See* e.g., pgs. 21-22 ¶¶69-72, Fig. 7), wherein the set of one or more factors relate to the performance of the network (*See* e.g., pgs. 21-22 ¶¶69-72); and making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time (*See* e.g., pgs. 21-22 ¶¶69-72, Fig. 7); and presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time (*See* e.g., pg. 15 ¶52, page 20, ¶52, Fig. 6).

Claim 23, which depends from claim 20, recites wherein said making the successive determinations to shift comprises: upshifting to a higher quality one of the different copies when the at least one factor is greater than a first threshold (*See* e.g., pgs. 5-6 ¶20, pgs. 21-22 ¶71, Fig. 7); and determining if the higher quality playback can be sustained (*See* e.g., pg. 5 ¶20, pgs. 21-22 ¶71, Fig. 7).

Claim 35, which depends from claim 20, recites wherein said requesting the plurality of sequential ones of the files includes requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections (*See* e.g., pgs. 17-18 ¶60).

Claim 40, which depends from claim 20, recites wherein the at least one of the set of factors is indicative of latency of the requested files, wherein the latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station (*See* e.g., pg. 3 ¶10, pg. 16, ¶56).

Claim 41, which depends from claim 20, recites wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files (*See* e.g., pg. 14 ¶51, pg. 16, ¶56, pg. 21, ¶68).

Claim 42, which depends from claim 20, recites wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections (*See* e.g., pgs. 2-3 ¶8, pg. 16, ¶56, pgs. 17-18, ¶59-60).

Claim 44, which depends from claim 20, recites wherein at least one of the set of servers is a web server (*See* e.g., pg. ¶11 42, pgs. 13-14 ¶49), wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP) (*See* e.g., pgs. 13-14 ¶49, pg. 16 ¶55), and wherein the web server is without specialized server-side intelligence to respond to said requesting (*See* e.g., pgs. 13-14 ¶49).

Claim 45, which depends from claim 20, recites wherein at least one of the set of servers is a cache server of a network infrastructure operator (*See* e.g., pgs. 13-14 ¶49).

Claim 46, which depends from claim 20, recites wherein: said generating the set of factors comprises: monitoring time intervals between successive receive times for each of the requested files (*See* e.g., pg. 14 ¶51, pgs. 20-21 ¶68, Fig. 7); calculating a current performance ratio across a current window of the time intervals (*See* e.g., pg. 21 ¶69, Fig. 7); and calculating a current average of the performance ratio to obtain a current performance factor of the set of factors (*See* e.g., pg. 21 ¶70, Fig. 7); and said making further comprises: comparing the current performance factor with a set of one or more trigger thresholds (*See* e.g., pg. 21 ¶71, Fig. 7); and

determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing (*See* e.g., pg. 21 ¶71, Fig. 7).

Claim 47, which depends from claim 20, recites wherein said making comprises: comparing a current performance factor of the set of factors with a set of one or more trigger thresholds (*See* e.g., pg. 21 ¶71, Fig. 7), wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin (*See* e.g., pg. 21 ¶71, Fig. 7), wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index (*See* e.g., pg. 21 ¶71, Fig. 7); and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing (*See* e.g., pg. 21 ¶71, Fig. 7).

Claim 48, which depends from claim 20, recites wherein: said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that file (*See* pg. 15 ¶52), and said automatically requesting comprises issuing for each of the files a request with the filename of that file (*See* pg. 15 ¶52, pg. 16 ¶55, Fig. 7).

Claim 49, which depends from claim 20, recites wherein the set of servers includes a content server storing the multiple files of the different copies (*See* e.g., pg. 10-11 ¶¶41-42), and wherein the set of servers includes one or more cache servers caching at least some of the files (*See* e.g., pgs. 13-14 ¶49).

Claim 50, which depends from claim 20, recites wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence (*See* e.g., pgs. 13-14 ¶49).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The issues involved in this Appeal are as follows:

A. Whether claims 20-21, 25, 26, 36, 38, and 43 are obvious under 35 U.S.C. § 103(a) based on Birney, "Intelligent Streaming" ("Birney") in view of Kalra (U.S. 6,490,627) ("Kalra") and Quigg-Brown (U.S. Patent Publ. No. 2003/0152036) ("Quigg-Brown").

B. Whether claims 23-24 are obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

C. Whether claim 35 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

D. Whether claims 40-42 are obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

E. Whether claim 44 obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

F. Whether claims 45, 49, and 50 are obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

G. Whether claim 46 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

H. Whether claim 47 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

I. Whether claim 48 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

All of the claims do not stand or fall together. The basis for the separate patentability of the claims is set forth below.

VII. ARGUMENT

A. Rejection of Claim 20-21, 25, 26, 36, 38, and 43 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claims 20-21, 25, 26, 36, 38, and 43 stand rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. The Appellant respectfully requests that these rejections be reversed for at least the following reasons.

1. Independent Claim 20

By way of overview, discussed below are various arguments regarding specific claim language of the independent claim 20, including, for example, the portions of the video being stored in multiple files (*see* section VII.A.1.a of this Brief), alignment of the portions stored in the files of the different copies based on time index (*see* section VII.A.1.b of this Brief), the media player requesting from different ones of the copies different ones of the files (*see* section VII.A.1.c) based on successive determination to create a stream and playback the video (*see* sections VII.A.1. d of this Brief). Birney's Windows Media server uses a single file rather than multiple files, and thus the claimed manner of storing the video on the server is different (*see* section VII.A.1.a of this Brief). Since Birney does not have separate files, it is not surprising that Birney does not describe the claimed alignment of these files based on time indexes (*see* sections VII.A.1.b of this Brief). Furthermore, Birney's Windows Media server selects from different bit rate streams in the single file rather than: 1) the claimed client requesting the files (*see* sections VII.A.1.c of this Brief); and 2) the claimed client making the determinations to shift quality, and thus the entity making the decisions is different (*see* sections VII.A.1.d of this Brief). These differences are not obvious in view of Birney, evidenced in part by the claimed approach's benefits over Birney's approach. Furthermore, Kalra and Quigg-Brown do not make these claimed differences obvious, as described in more detail below (*see* section VII.A.1.a and VII.A.1.c of this Brief).

a. Independent claim 20 is not obvious because the cited references do not teach or suggest "wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers" and "the multiple files across the different copies yield the same portion of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video"

Independent claim 20 recites, among other limitations, "wherein each of a plurality of different copies of the video encoded at different bit rates ***is stored as multiple files*** on the set of servers, wherein each of the multiple files yields a different portion of the video on playback, wherein the multiple files across the different copies yield the same portions of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video" [emphasis added].

1) The cited references do not teach "wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers" and "the multiple files across the different copies yield the same portion of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video"

The Examiner states that Birney teaches these aspects in pages 1-2 of Birney, stating that "Birney teaches multiple copies of the same stream being stored on a server at different bit rates with the same time index used to switch between the stream based on the network bandwidth limitations." *See* Final Office Action, page 3. The Examiner also states that "all of the streams are separate files, i.e., each stream is its own discrete file," and these streams "are individual files with different bit rates." *See* Second Advisory Action, mailed May 17, 2010 ("Second Advisory Action"), page 2. Appellant respectfully submits that the Examiner fails to establish that Birney teaches this limitation because the Examiner seems to ignore the words of the limitation that each of the different copies of the video "**is stored as multiple files**."

Birney teaches that the "content must be encoded as a multiple-bit-rate stream," which includes "a number of discrete, user-definable audio and video streams [that] are encoded into a *single Windows Media stream.*" *See* paragraph 6, emphasis added, bracketed material added. Birney expressly teaches that the multiple-bit-rate stream (*see* paragraph 6), which includes the streams encoded at different bit rates, is created and managed as "*a single file*" (*see* paragraph 11). As such, in contrast to the Examiner's allegation that Birney teaches this limitation, Birney expressly teaches that *all of the different bit-rate streams* are stored and managed as "*a single file*," not multiple files. Not only does Birney fails to teach that all of the different bit-rate streams are stored as multiple files, Birney also fails to teach that *each* of these different bit-rate streams, which make up the multiple-bit-rate stream, is stored as multiple files. This teaching is in direct contradiction to the Examiner's statements that "each stream is its own discrete file." *See* Second Advisory Action, page 2.

Moreover, regarding "multiple files," there is novelty as evidenced by the Examiner pointing at discrete streams, rather than the Examiner finding the claimed separate files in Birney.

For the foregoing reasons, Appellant respectfully submits that Birney fails to teach at least the limitations of "wherein each of a plurality of **different copies of the video encoded at different bit rates is stored as multiple files** on the set of servers" and "the multiple files across the different copies yield the same portion of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video." The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations.

2) The cited references fail to render independent claim 20 obvious "wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers" and "the multiple files across the different copies yield the same portion of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video"

The Examiner states in the Advisory Action, mailed March 23, 2010 ("First Advisory Action"), that page 2 of Birney teaches discrete streams of encoded data that constitute different bit rates, and alleges that the discrete streams "clearly cover" the claims language "video encoded at different bit rates is stored as multiple files." *See* First Advisory Action, continuation section. This does not properly address the wording of the claims that "**each of the different copies of the video** is stored as multiple files." As described above, unlike the claimed invention, Birney expressly teaches that the discrete streams are in a single file, not that each discrete stream is stored as a separate file or that portions of each stream are stored in separate files. In particular, the cited section of Birney expressly states that "a number of discrete, user-definable audio and video streams are encoded into a single Windows Media stream," which is managed by the Windows Media server as "*a single file.*" *See* Birney, paragraph 11. Moreover, the Examiner uses the phrase "covered by," but the standards to use are novelty (as addressed above) and nonobviousness.

The Examiner fails to make a prima facie rejection of obviousness in both the Final Office Action and in the First Advisory Action. Birney describes the use of a single file holding all of the streams, while Appellant claims multiple copies and that each copy is broken into multiple separate files. Unlike Birney or the alleged combination, whose single file approach requires Windows Media Servers be used, the claimed separate files do not require a "specialized media server or server-side intelligence" to retrieve the separate files, or special media software to be stored in the servers that serve the video or that cache the video in the Internet (*see* Appellant's Specification, page 14, paragraph 49); rather, the claimed manner allows for standard servers to be used. These standard servers are less expensive than specialized media servers and are typically already part of the network. In addition, since the claimed manner can

use standard web and cache servers of ISPs, the claimed manner can provide "a highly scalable solution" (*see id.*). One of ordinary skill in the art at the time reading Birney, Kalra and Quigg-Brown would not have found the claimed invention obvious, but rather have implemented as Birney describes.

b. Independent claim 20 is not obvious because the cited references do not teach or suggest alignment of the portions and requesting of the portions based on "Time Indexes."

Independent claim 20 recites, among other limitations, "**each of said files having a time index** such that the files whose playback is the same portion of the video for each of the different copies have the same **time index** in relation to the beginning of the video," and "requesting … the files … **based on the time indexes**" [emphasis added].

The Examiner states that that Birney teaches that the "same time index is used to switch between the stream based on network bandwidth limitations." *See* Final Office Action, page 4. Appellant respectfully disagrees with the Examiner's characterization of the reference because *Birney is silent regarding time indexes*. Not only does Birney fail to teach that each of the different bit-rate streams of Birney is stored as multiple files on the set of servers, as described above in section VII.A.1.a of this Brief, Birney also fails to teach that *the single file has any time indexes* or that the *different bit-rate streams within the single file have any time indexes*. In addition, nothing in Birney teaches or suggests that the client requests the video based on time indexes.

Even if, for the sake of argument, time indexes were used "to switch between the streams," as alleged by the Examiner, because Birney only has a single file, these alleged time indexes of Birney do not constitute the claimed "time indexes." Each of the claimed "time indexes" corresponds to one of the multiple files in each of the different copies, "such that the files whose playback is the same portion of the video for each of the different copies have the same **time index** in relation to the beginning of the video"; whereas the alleged time indexes of Birney could not correspond to one of multiple files because there is only a single file in Birney.

In the Final Office Action, the Examiner, relying on a sentence from Birney which states "intelligent streaming dynamically and seamlessly adjust the bit rate of the streaming content as the available bandwidth changes," argues the following:

> The passage [of page 2 in Birney] clearly teaches that multiple streams are encoded and a media player/server adjust the stream based on bandwidth and other conditions which may impact a user's viewing of a video. The way multi bit encoding works is; say for example a medium stream is being sent to a client from a server and at a time if 25 minutes 35 seconds, the bandwidth suddenly drops; the client/server then will determine that a low quality stream should now be used and **seamlessly** switch the video to low quality after the determination is mat at, for example, 25 minutes 40 seconds. The low quality stream will pick up at the **time** that the medium stream stops. Therefore a **time index** is being used in order to **seamlessly** switch stream qualities. (bolding in original)

In sum, the Examiner concludes that the word **"seamlessly"** in Birney means that time indexes are used, providing a self-generated example of how the Examiner believes intelligent streaming works without any supporting evidence. Since Birney is silent regarding "time indexes," it appeared that the Office Action was relying on personal knowledge to support that finding of what is known in the art, effectively taking Official Notice under MPEP 2144.03(C). The Appellant respectfully challenged the Official Notice, but no further documentary evidence has been proffered[1]. Thus, the Examiner has failed to show that Birney teaches the claimed "time indexes."

Moreover, even if, for the sake of argument, the Examiner were to present a reference for the challenge of the Official Notice noted above, this reference would not only have to teach "time indexes," but also that each of the "time indexes" corresponds to **one of the *multiple* files** in each of the different copies "such that the files whose playback is the same portion of the video for each of the different copies have the same **time index** in relation to the beginning of the video", as claimed, since Birney is deficient on this issue (as argued in Appellant's response filed Feb. 24, 2010). In particular, the Examiner, in the "Response to Arguments" section did not address an alternative argument presented in the section **"Birney Fails to Teach 'Time Indexes,'"** of Appellant's response filed Oct. 22, 2009, which indicates that even if time indexes were to be used in Birney, these alleged time indexes of Birney could not correspond to one of multiple files of a copy because *there is only a single file in Birney*.[2] In contrast, claim 20 recites "each of said files having a time index such that the files whose playback is the same portion of

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[1] Appellant respectfully notes that the Examiner has failed to address the above arguments made regarding "time indexes" in the First Advisory Action, mailed March 23, 2010, and the Second Advisory Action, mailed May 17, 2010.

[2] Appellant respectfully notes that the Examiner has failed to address the above arguments made regarding "seamlessly" in the First Advisory Action, mailed March 23, 2010, and the Second Advisory Action, mailed May 17, 2010.

the video for each of the different copies have the same time index in relation to the beginning of the video."

For the foregoing reasons, Appellant respectfully submits that Birney fails to teach not only that "each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video," and "requesting … a plurality of sequential ones of the files of one of the copies … **based on the time indexes**," as recited in independent claim 20. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations.

c. Independent claim 20 is not obvious because the cited references do not teach or suggest "Requesting by the Media Player a plurality of sequential ones of the files**" or "**automatically **requesting by the media player** … subsequent portions of the video **by requesting for each such portion one of the files from one of the copies** dependent upon **Successive Determinations by the Media Player"**

Independent claim 20 recites, among other limitations, "**requesting by the media player** a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes; automatically **requesting by the media player** from the set of servers over the plurality of TCP connections subsequent portions of the video **by requesting for each such portion one of the files from one of the copies** dependent upon successive determinations **by the media player** to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including …making the successive determinations to shift the playback quality."

1) The cited references do not teach "Requesting by the Media Player a plurality of sequential ones of the files**" or "**automatically **requesting by the media player** … subsequent portions of the video **by requesting for each such portion one of the files from one of the copies** dependent upon Successive Determinations **by the Media Player"**

The Examiner states that "[w]hile the implication of Birney is that both the server and the client work together to determine a quality of stream, Birney does not explicitly state that this is done by the media player acting alone." *See* Final Office Action, page 4. The Examiner, however, argues that Kalra teaches requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers, stating that "Kalra teaches requesting by a client media player one of the adaptive streams/copies based on the client capabilities." *See* Final Office Action, page 4, citing figure 16A1 and col. 14, line 56 to col. 16, line 60. Appellant respectfully disagrees, and this does not address "**requesting by the media player** … subsequent portions of the video **by requesting for each such portion one of the files from one of the copies," much less "**dependent upon **successive determinations by the media player** to shift the playback quality."

In the Final Office Action, it appears that the Examiner concedes that Birney fails to teach these claim limitations, since the Examiner's analysis in the Final Office Action only cites to Kalra for these limitations. Yet, in the First Advisory Action, the Examiner alleges again that pages 2-4 of Birney teaches a client running windows media player which requests a stream from the Windows Media server and alleges that "if the bandwidth can not support the quality video it works with the [Windows Media] server and requests a different grade of video." *See* First Advisory Action, bracketed material added. Appellant respectfully disagrees with both positions taken in the Final Office Action and the First Advisory Action.

Regarding Birney, the Windows Media server performs intelligent streaming (switching between different quality levels) on its own. The Examiner's unsupported position is exemplified by the Examiner pointing at two pages rather than a specific citation in the Final Office Action. There is no quote in Birney to support the Examiner's position —it is simply the Examiner reading things into the reference that are not present. In fact, Birney expressly teaches the opposite. Birney discusses the use of a regular web server and a Windows Media server.

When a regular web server is used "only the highest bit rate streams will play," meaning there will be no shifts to different bit streams and thus, no "intelligent streaming" (*See* paragraph 14); rather, shifts in bit rate (and thus, "intelligent streaming") requires the use of the specialized Windows Media server ("intelligent streaming with multiple-bit-rate streams, the *content must be hosted on a Windows Media server.*" *See* paragraph 14). These teachings show that the Windows Media server makes the determinations to switch to the stream that is most appropriate for current bandwidth conditions, and, in response, pushes the appropriate data from the selected stream to the client. Regardless of whether the Windows Media server or regular web server is used, Birney's client does not have any intelligence to make the determinations to switch to a higher or lower quality stream or to request files from the selected stream.

In other words, Birney's approach for "intelligent streaming" requires a push-based configuration in which a specialized server selects or switches to the stream "that is the most appropriate for current bandwidth conditions," (*see* paragraph 7) not a pull-based configuration in which the media player selects and requests files from the selected one of the different copies, as claimed. In support of this position, Birney expressly teaches that after the Windows Media server and client determine the current available bandwidth, "the [Windows Media] *server selects and delivers the stream with the most appropriate bit rate*." *See* Birney page 2, Intelligent Bandwidth Control, item 1, emphasis and bracketed material added. Although Birney describes both the media player and the Windows Media server being utilized to determine the bandwidth between the client and the Windows Media server, that is not the same thing as the media player requesting different parts of the video based on successively determining which bit rate to use (in Birney, this is done by the Window Media server alone). Therefore, regardless of whether the client helps the Windows Media server determine the current available bandwidth, the claim limitations are not met.

Regarding Kalra, the Final Office Action alleges that Kalra teaches "requesting by a client media player one of the adaptive streams/copies based on the client capabilities," and that such teaching reads on the limitation of "requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers." *See* Final Office Action, page 4. In addition, the Final Office Action alleges that Kalra teaches "automatically requesting by the media player higher or lower quality data based on a quality factor," and that such teaching reads

on the "automatically requesting" limitation. *See* Final Office Action page 4. Appellant respectfully disagrees. Kalra, like Birney, also teaches a push-based configuration in which a client computer determines a user profile (CPU constraint and user's video quality preference) (steps 602A and 602B). *See* Kalra, col. 15, line 56 to col. 16, line 60. After a connection is established between the adaptive stream server and the client computer (step 604), the client computer sends the user profile to the adaptive stream server (step 606) and the adaptive stream server transmits the adaptive streams *in accordance with the user profile* thereafter (step 608). *See Id.* at col. 16, lines 30-36, emphasis added. Contrary to the Examiner's allegation that Kalra teaches the "requesting" limitation, Kalra expressly teaches that after the client computer sends the user profile to the adaptive stream server, a user makes a selection of the particular sequence that he desires to see/her" (step 608) and that "[o]nce the adaptive stream server receives a profile from the user … it uses this information … **to make a determination of which streams to transmit"** to the client computer (*see* col. 16, lines 32-36 and 50-55, emphasis added), rather than the client computer making multiple requests for the different files of the particular sequence based on successive determinations. This shows that the client computer makes an initial selection of the particular data to be streamed, and the adaptive stream server has the intelligence to determine which streams to transmit to the client computer using the user profile, which was previously determined prior to establishing a connection and making the initial selection. Thus, Kalra's adaptive streaming is also a push-based configuration in which a specialized server selects the appropriate streams to transmit to the client computer. Also, regardless of whether the adaptive stream structure is modified in Karla to introduce a quality factor that, for a given DCT coefficient, uses the most significant bits for lower quality transmission and all bits for higher quality transmission, the client only makes an initial request for the particular sequence based on the user's selection at the client computer, and the adaptive stream server makes the determination of which streams to transmit to the client computer using the previously-determined user's profile. Accordingly, Kalra fails to cure Birney's deficiencies regarding "**requesting by the media player** a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes; automatically **requesting by the media player** from the set of servers over the plurality of TCP connections subsequent portions of the video **by**

requesting for each such portion one of the files from one of the copies dependent upon **successive determinations by the media player** to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including …**making the successive determinations to shift the playback quality**."

For the foregoing reasons, Appellant respectfully submits that Birney and Kalra, either alone or in combination, are deficient relative to this claim language. The Examiner does not indicate and the Appellant does not discern any part of Quigg-Brown that cures the aforementioned deficiencies of Birney and Kalra regarding these limitations.

2) The cited references fail to render independent claim 20 obvious regarding "requesting …files over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes," and "automatically requesting … subsequent portions of the video by requesting for each such portion one of the files from one of the copies"

The Examiner states that "Birney and Kalra do not explicitly teach [requesting] one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections." *See* Final Office Action, page 5. The Examiner argues that Quigg-Brown teaches these limitations. *See* Final Office Action, page 5, citing Quigg-Brown Abstract, and paragraphs 28-30. Appellant respectfully disagrees.

Quigg-Brown is directed to "[a] method, system, and apparatus for improving data transfer rate over a network" by dividing a piece of data, i.e., a file, into a number of packets, and if the number of packets exceeds a threshold number, transferring the divided packets "in parallel over a plurality of network connections," ideally TCP/IP connections. *See* Quigg-Brown, Abstract, Figure 8.

Although Quigg-Brown teaches transferring packets in parallel over a plurality of network connections, Quigg-Brown fails to teach "**requesting … a plurality of sequential ones of the files** of one of the copies from the set of servers over a plurality of [TCP] connections," and "automatically requesting … from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting **for each such portion one of the files** from one of the copies," as recited in the claim. More specifically, Quigg-Brown teaches that "an

application or a user at client station 500 *issues a request to server 510 for data, a file or an application,*" and the server 510 sends multiple packets of the file or application in parallel back to the client station 500 *in response to the single request*, not that the client station 500 issues requests for multiple files from the server 510 over a plurality of TCP connections between the client 500 and server 510. *See* paragraph 31. At best, Quigg-Brown teaches how to transmit a single logical data stream to a target system over multiple TCP connections once the file or application has been requested. Quigg-Brown expressly teaches that "[w]hen an application is sending a single logical data stream over multiple data paths, the receiver has to be able to reconstruct the data stream from the multiple paths," and thus, uses "two-byte identification 708 of the IP header as a counter to allow for the reconstruction of the data." *See* paragraph 36. Quigg-Brown gives the following example.

> For example, suppose a data stream is being transmitted using five TCP connections (i.e., TCP connections 1 - 5), packet P_1 may be transmitted over TCP connection 1 using 1234 as an IP identification number. P_2, P_3, P_4 and P_5 may be transmitted over TCP connections 2, 3, 4 and 5 with IP identifications 1235, 1236, 1237 and 1238, respectively. The next group of packets (i.e., P_6 - P_{10}) may be transmitted over TCP connections 1 - 5 using IP identifications 1239 - 1244 etc.

See paragraph 36.

Quigg-Brown, however, does not teach requesting one of the files over TCP connection 1, another file over TCP connection 2, another file over TCP connection 3, and so on. In addition, Quigg-Brown does not teach requesting multiple files over TCP connection 1, multiple files over TCP connection 2, and so on. As such, Quigg-Brown fails to "**requesting ... a plurality of sequential ones of the files** of one of the copies from the set of servers over a plurality of [TCP] connections," and "automatically requesting ... from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting **for each such portion one of the files** from one of the copies," as recited in the independent claim 20.

Moreover, not only do the cited references individually fail to teach either occurrence of the "requesting by the media player" limitations, the combination of the cited references fails to teach either of these limitations. When combining the teachings of Quigg-Brown with Birney's teachings or Kalra's teachings of a push-based media server, the combination fails to teach the claimed invention because the resulting combination would be a media server that divides the data "into a number of packets," makes "a determination … as to whether the number of packets exceeds a threshold number," and, if so, pushes the packets to the client "in parallel over a plurality of [TCP/IP] connections." *See Id.* at paragraph 8, bracketed material added. Thus, what is requested is different (e.g., Quigg-Brown's single file *cf.* claimed "multiple files"), the number of requests is different (e.g., Quigg-Brown computer sending a single request cf. the claimed multiple requests for multiple files), and, most importantly, what the multiple TCP connections are used for is different (e.g., Quigg-Brown computer transmission a single request for a single file (presumably over a single TCP connection) and receipt of multiple packets over multiple TCP connections *cf.* the claimed multiple requests are transmitted over the multiple TCP connections). As such, the combination fails to teach "**requesting by the media player a plurality of sequential ones of the files** of one of the copies **from the set of servers over a plurality of [TCP] connections** based on the time indexes," (first occurrence) and "**automatically requesting by the media player from the set of servers over the plurality of TCP connections** subsequent portions of the video by requesting for each such portion one of the **files from one of the copies**" (second occurrence).

For the foregoing reasons, Appellant respectfully submits that the combination of cited references fails to teach "**requesting … sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes**," and "**automatically requesting … from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies**," as recited in independent claim 20.

d. Independent claim 20 is not obvious because the cited references do not teach or suggest "Making Successive Determinations."

Independent claim 20 recites, among other limitations, "automatically requesting by the media player …, said automatically requesting including, …**making the successive determinations to shift the playback quality** based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time."

The Examiner alleges that Birney teaches the limitation of "making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time," stating that "Birney teaches shifting the playback quality to the highest quality dependent on network conditions." *See* Final Office Action, page 3. Appellant respectfully submits that the Examiner fails to establish that Birney teaches this limitation because the Examiner seems to ignore that "making the successive determinations to shift the playback quality" is performed "**by the media player**." In particular, the claim recites "automatically requesting **by the media player** … dependent upon **successive determinations by the media player** to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including, … **making the successive determinations to shift the playback quality**."

In most strategies presented in Birney, the "*server automatically detects"* the current available bandwidth AND determines which stream to use. *See* Birney, paragraph 7. In one strategy, however, Birney indicates that the media server *and* the client automatically determine the current available bandwidth. *See id.* However, the media server, in this strategy, is the one that "selects and delivers the stream with the most appropriate bit rate" (*see id.*), and the client does not request the most appropriate bit rate based on the current available bandwidth. As such, none of the strategies presented in Birney teaches or suggests that the client alone determines which stream is the most appropriate for current bandwidth conditions, and which stream to request. Birney goes on further to stress the importance that "the content *must be hosted on a Windows Media Server* and played in Windows Media Player," in order to use intelligent streaming with multiple-bit-rate streams. *See* paragraph 14, emphasis added. When played

locally or from a web server (instead of a Windows media server), intelligent streaming cannot be accomplished. *See id.* Thus, Birney describes the server, not the client, as having the intelligence for performing "intelligent streaming" to determine whether to switch "to a stream with a lower bit rate" or "to a stream with a higher bit rate," even though the client may be used to determine the current available bandwidth between server and client. More specifically, the Examiner seems to be ignoring the fact that even if the client helps determine the bandwidth, the server is the one performing the "intelligent streaming" to push the lower or higher bit rate stream to the client.

The Examiner in the Second Advisory Action states[3]:

> Examiner again respectfully disagrees and points to 2-3 of Birney, which shows that both the media player and the server are utilized to make the successive determinations. **Since the claim is open-ended, the server and media player working in collaboration to make the successive determination is indeed covered by the prior art.** (emphasis added).

Appellant respectfully disagrees because there is no basis for the position that the claim is open ended. This is just an improper attempt to make art apply to a claim which is allowable. The claim says "**by the media player**" in multiple places. For instance, the claim language requires that the media player requests files from the set of servers "dependent upon successive determinations **by the media player**." Also, as indicated above, the claim language requires the media player "requesting" the files from the different bit rate copies and making the "successive determinations" about which bit rate copy to use; these limitations are not obvious in view of Birney as previously described in section VII.A.1.a and VII.A.1.c of this Brief.

Accordingly, Birney fails to teach "automatically requesting by the media player … subsequent portions of the video by requesting for each such portion one of the files from one of the copies **dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies**," and "**making the successive determinations [by the media player] to shift the playback quality** based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time," as recited in claim 20.

Regarding Kalra, the Examiner in the Second Advisory Action also states[4]:

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[3] The Examiner in the First Advisory Action recites the same quote.

> Further, see, figure 16A1 and column 15 line 40- column 16 line 49, Kalra. The passages clearly teaches that a media player along with a server make the successive determination based on a client profile to shift the quality of stream sent to the client from the server. Again the server along with the client (media player) work together to determine which stream to send to the client. **Both client and server help in making the successive determinations for the different streams.** (emphasis added).

In the alleged combination, Birney is used to chop up a video into segments, and then the segments are encoded at different bit rates as in Kalra. While this is a big stretch and Appellant does not agree, this still does not yield the claimed successive determinations and requesting by the media player. Specifically, the claimed successive determinations are determinations as to which bit rate to use, not what the current available bandwidth is. In the combination where the client and the server decide the bandwidth together, the server on its own picks the bit rate and pushes the video. In other words, the client is not involved in the bit rate determination; and since the server is making the bit rate determinations, there is no need for the client to request subsequent parts of the video based on these successive determinations. The claim is specific that the media player determines the bit rate copy and makes the requests to the set of servers. Thus, the bandwidth determinations cannot be equated to the bit rate copy determinations and requests by the media player to the set of servers.

e. Conclusion

In view of the foregoing, the Examiner fails to establish a prima facie case of obviousness, and the combination of cited references does not teach or suggest all the limitations of independent claim 20.

2. Dependent Claims 21, 25, 26, 36, 38, and 43

Claims 21, 25, 26, 36, 38, and 43 depend from the independent claim 20 and thus incorporate the respective limitations thereof. For at least the above reasons regarding the independent claim, the cited references fail to teach or suggest all the limitations of these dependent claims. Accordingly, the Appellant respectfully requests reversal of these rejections.

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[4] The Examiner in the First Advisory Action recites the same quote except for the last sentence.

B. Rejection of Claims 23-24 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claims 23-24 stand rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claims 23-24 depend from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations as described below. Dependent claim 23 recites "upshifting to a higher quality one of the different copies when the at least one factor is greater than a first threshold," and "**determining if the higher quality playback can be sustained**" [emphasis added].

Appellant respectfully submits that the language of claim 20 for making successive determinations and requesting files from one of the different copies dependent upon those successive determinations to shift the playback quality to a higher or lower quality one of the different copies has been discussed above with respect to section VII.A. Claim 23 introduces, in the context of upshifting to a higher quality one of the different copies, an additional, different check on whether to upshift to a higher quality as indicted by the use of different language for this additional, different check than that used in claim 20. Thus, when it is determined to upshift to a higher quality stream (see language in claim 20), the media player performs the additional, different check (see language of claim 23) to determine if the higher quality playback can be sustained before upshifting to the higher quality stream. It is beneficial to perform this additional check when upshifting to avoid immediate downshifting when the higher quality stream cannot be sustained. This can be used, for example, as a prediction or an early detection to normal shifting to reduce the number of upshifts that are made that require a subsequent downshift.

The Examiner states that page 2, paragraphs 4-5 of Birney teach this limitation. *See* Final Office Action, page 6. Appellant respectfully disagrees. Paragraphs 4-5 of Birney describe "intelligent bandwidth control" in which the Windows Media server detects a decrease in bandwidth and switches to a stream with a lower bit rate, and, when the bandwidth improves, the Windows Media server switches to a stream with a higher bit rate. *See* Birney, page 2, paragraphs 4-5. Birney teaches switching to a stream with a lower bit rate when bandwidth

decreases, and switching to a stream with a higher bit rate when the bandwidth improves. In fact, Birney provides additional details on the former, including that the client and Windows Media server can "intelligently degrade image quality in order to avoid buffering" (called streaming thinning). *See* bullet point #3. In addition, Birney describes that, in the context of when the bandwidth can no longer support streaming video, the Windows Media server maintains "a continuous audio stream" after the Windows Media server stops sending video frames." *See* bullet point #4 of page 2. Birney does not, however, teach any additional details on switching to a higher bit rate stream, but just that if the bandwidth improves the Windows Media server switches to a stream with a higher bit rate. More simply put, since Birney does not provide additional details on how it switches to a higher bit rate, Appellant is left to assume that if the bandwidth increases beyond an upper threshold, the Windows Media server shifts to a higher bit rate without contemplating an additional check to confirm the higher bit rate could be sustained. Whereas, claim 23 specifically recites the limitation of "making the successive determinations to shift the playback quality,"[5] as well as an additional, separate operation of "**determining if the higher quality playback can be sustained**." Thus, Birney fails to teach at least this limitation of claim 23.

Moreover, since Birney fails to teach or suggest this additional, different check, it is assumed that Birney would toggle up and down unnecessarily when the measure of the current bandwidth conditions is close to an upper threshold. In contrast, the claimed invention would be an improved system over Birney because the claimed invention performs the additional, different check when upshifting to a higher quality stream.

For the foregoing reasons, Birney fails to teach at least "**determining if the higher quality playback can be sustained**," as recited in claim 23. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations.

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[5] Appellant's specification describes and illustrates an embodiment in which one operation 710 is performed to determine whether to upshift to a higher quality, and if "yes," another operation 720 is performed to determine if the upshift can be sustained. *See* Application, Fig. 7, and pages 21-22, ¶71. Appellant's specification indicates that the determination of whether use of the higher quality stream is sustainable at operation 716 may be made by comparing an estimate of the higher quality stream's performance factor with the trigger threshold. *See id.*

In view of the foregoing, the combination of cited references does not teach or suggest all the limitations of dependent claim 23. Claim 24 depends from the dependent claim 23 and thus incorporates the respective limitations thereof. For at least the above reasons regarding the dependent claims 23-24, the cited references fail to teach or suggest all the limitations of these dependent claims. Accordingly, the Appellant respectfully requests reversal of these rejections.

C. Rejection of Claim 35 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claim 35 stands rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claim 35 depends from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations as described below. Dependent claim 35 recites "wherein said requesting the plurality of sequential ones of the files includes **requesting ... the files over different ones of the plurality of TCP connections**." [emphasis added].

Applicant respectfully submits that independent claim 20 recites two different requesting steps, and it is only the first of those requesting steps that is addressed by claim 35. Specifically, the first requesting step in claim 20 is "requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections." Dependent claim 35 narrows this first requesting step of claim 20 by requiring multiple requests for the different files and that these multiple requests be sent over different ones of the multiple TCP connections. Quigg-Brown, however, does not send out multiple requests over different TCP connections. Rather, Quigg-Brown sends a single request (presumably over a single TCP connection) for a single file and the request may be fulfilled by sending multiple parts of the single file (i.e., divided packets) over different TCP connections in parallel. Thus, Quigg-Brown fails to teach at least this limitation of claim 35.

Moreover, The Examiner states that paragraphs 2-5 of Quigg-Brown teach this limitation. *See* Final Office Action, page 7. Appellant respectfully disagrees. As described above in section VII.A.1.c of this Brief, Quigg-Brown does not teach issuing multiple requests for multiple files

from the server 510 over multiple TCP connections between the client 500 and server 510; rather Quigg-Brown teaches that "an application or a user at client station 500 *issues a request to server 510 for data, a file or an application,*" and the server 510 sends multiple packets of the file or application in parallel back to the client station 500 *in response to the single request. See* paragraphs 31 and 36. Also, per the example given in paragraph 36, Quigg-Brown does not teach that one file is requested over TCP connection 1, another file over TCP connection 2, another file over TCP connection 3, and so on, or that multiple requests are sent over TCP connection 1, TCP connection 2, and so on. Thus, as previously described, what is requested is different (e.g., Quigg-Brown's single file *cf.* claimed "multiple files"), the number of requests is different (e.g., Quigg-Brown computer sending a single request *cf.* the claimed multiple requests for multiple files), and, most importantly, what the multiple TCP connections are used for is different (e.g., Quigg-Brown computer sending a single request for a single file (presumably over a single TCP connection) and receipt of multiple packets over multiple TCP connections *cf.* the claimed multiple requests are transmitted over the multiple TCP connections). As such, Quigg-Brown fails to "**requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections**," as recited in the dependent claim 35. The Examiner does not indicate and the Appellant does not discern any part of Birney or Kalra that cures the aforementioned deficiencies of Quigg-Brown regarding this limitation. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 35 and the cited references fail to teach at least these limitations of claim 35. Accordingly, the Appellant respectfully requests reversal of these rejections.

D. Rejection of Claims 40, 41, and 42 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claims 40, 41, and 42 stand rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claims 40, 41, and 42 depend from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20. The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the

limitations of the claims as described below. Claims 40, 41, and 42 do not stand or fall together. The basis for the separate patentability of claims 40, 41, and 42 is set forth below.

By way of overview, discussed below are various arguments regarding additional factors other than bandwidth fluctuations. For example, claims 40, 41, and 42 specifically claim "latency," "time intervals between successive receive times," and "delays or losses in one or more of the plurality of TCP connections." These measures are separate, different factors than the "available bandwidth of the plurality of TCP connections," recited in claim 38. Birney only addresses monitoring bandwidth fluctuations, and thus, fails to teach or suggest these other factors.

1. Dependent Claim 40

Dependent claim 40 recites "wherein the at least one of the set of factors **is indicative of latency of the requested files**, wherein the latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station" [emphasis added].

The Examiner states that page 2, paragraphs 1-5 of Birney teach this limitation. *See* Final Office Action, page 8. The cited passages, however, describe monitoring "bandwidth fluctuations" between the Windows Media server and the client, and, in response, adopting the best strategy as noted in bullet points 1-4 of page 2 of Birney. Appellant respectfully submits that the current available bandwidth, described in Birney, does not constitute the claimed "latency of the requested files," because "latency" is claimed as a different factor than "available bandwidth" (*see* claim 38).[6] More specifically, claim 40 recites that "**latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station**." This measure accounts for a different factor than bandwidth fluctuations, and thus improves performance when this different factor impacts the playback experience but there are not bandwidth fluctuations and/or when a jump to a higher/lower playback quality is made because there are both bandwidth fluctuations and

[6] Appellant respectfully notes that, by the doctrine of claim differentiation, the scope of claim 40 should be assumed to differ from the scope of claim 38, which recites "wherein the at least one of the set of factors is indicative of the **available bandwidth** of the plurality of TCP connections" [emphasis added]. The Examiner has already used the teachings of page 2 in an effort to satisfy the limitations of claim 38 regarding "available bandwidth" and has failed to show how Birney teaches that "**latency**" can be used as a different factor than "available bandwidth." *See* Final Office Action, page 8.

fluctuations in the latency. Nothing in Birney teaches or suggests that the Windows Media server, or the client, has the capability to determine time between when a request is issued and a time that response data begins to arrive at the client. As such, Birney fails to teach at least these limitations of claim 40. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding this limitation. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 40 and the cited references fail to teach or make obvious at least these limitations of claim 40. Accordingly, the Appellant respectfully requests reversal of these rejections.

2. Dependent Claim 41

Dependent claim 41 recites "wherein the at least one of the set of factors is **indicative of time intervals between successive receive times** for each response to the requested files" [emphasis added].

The Examiner again relies on page 2, paragraphs 2-5 of Birney to teach this limitation. *See* Final Office Action, page 9. Again, the cited passages, however, describe monitoring "bandwidth fluctuations" between the Windows Media server and the client, and, in response, adopting the best strategy as noted in bullet points 1-4 of page 2 of Birney. Appellant respectfully submits that the current available bandwidth, described in Birney, does not constitute the claimed "time intervals between successive receive times for each response to the requested files," because "time intervals between successive receive times for each response" is claimed as a different factor than "available bandwidth" (*see* claim 38).[7] This measure accounts for a different factor than bandwidth fluctuations, and thus improves performance when this different factor impacts the playback experience but there are not bandwidth fluctuations and/or when a jump to a higher/lower playback quality is made because there are both bandwidth fluctuations and fluctuations in the time intervals between the successive receive times. Nothing in Birney teaches or suggests that the Windows Media server, or the client, has the capability to determine the time intervals between successive receive times for each response to requested files. As such, Birney fails to teach at least this limitation of claim 41. The Examiner does not

[7] Appellant respectfully notes that, by the doctrine of claim differentiation, the scope of claim 40 should be assumed to differ from the scope of claim 38, which recites "wherein the at least one of the set of factors is indicative of the **available bandwidth** of the plurality of TCP connections" [emphasis added]. The Examiner has already used the teachings of page 2 to satisfy the limitations of claim 38 regarding "available bandwidth" and has failed to show how Birney teaches that "**time intervals between successive receive times**" can be used as a different factor than "available bandwidth." *See* Final Office Action, page 8.

indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding this limitation. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 41 and the cited references fail to teach or make obvious at least these limitations of claim 41. Accordingly, the Appellant respectfully requests reversal of these rejections.

3. Dependent Claim 42

Dependent claim 42 recites "wherein the at least one of the set of factors is indicative of **delays or losses in one or more of the plurality of TCP connections**" [emphasis added].

The Examiner again relies on page 2, paragraphs 2-5 of Birney to teach this limitation. *See* Final Office Action, page 9. Again, the cited passages, however, describe monitoring "bandwidth fluctuations" between the Windows Media server and the client, and, in response, adopting the best strategy as noted in bullet points 1-4 of page 2. Appellant respectfully submits that the current available bandwidth, described in Birney, does not constitute the claimed "delays or losses in one or more of the plurality of TCP connections," because "delays and losses" are claimed as a different factor than "available bandwidth" (*see* claim 38).[8] This measure accounts for a different factor than bandwidth fluctuations, and thus improves performance when this different factor impacts the playback experience but there are not bandwidth fluctuations and/or when a jump to a higher/lower playback quality is made because there are both bandwidth fluctuations and delays or losses in one or more of the plurality of TCP connections. Nothing in Birney teaches or suggests that the Windows Media server, or the client, has the capability to determine delays or losses in TCP connections. As such, Birney fails to teach at least these limitations of claim 42. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding this limitation. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 42 and the cited references fail to teach or make obvious at least these limitations of claim 42. Accordingly, the Appellant respectfully requests reversal of these rejections.

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[8] Appellant respectfully notes that, by the doctrine of claim differentiation, the scope of claim 40 should be assumed to differ from the scope of claim 38, which recites "wherein the at least one of the set of factors is indicative of the **available bandwidth** of the plurality of TCP connections" [emphasis added]. The Examiner has already used the teachings of page 2 to satisfy the limitations of claim 38 regarding "available bandwidth" and has failed to show how Birney teaches that "**delays and losses**" in TCP connections can be used as a different factor than "available bandwidth." *See* Final Office Action, page 8.

E. Rejection of Claim 44 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claim 44 stands rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claim 44 depends from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations as described below. Dependent claim 44 recites "wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP), and wherein the web server is **without specialized server-side intelligence** to respond to said requesting" [emphasis added].

The Examiner states that page 2 of Birney teaches a web server without specialized server-side intelligence. *See* Final Office Action, page 9. Appellant respectfully disagrees because Birney expressly teaches the opposite. More specifically, Birney expressly teaches that if you use a regular web server "only the highest bit rate streams will play" (*see* paragraph 14), meaning there will be no shifts between streams for "intelligent streaming."

In contrast, Birney teaches that in order to use "intelligent streaming with multiple-bit-rate streams, the *content must be hosted on a Windows Media server.*" *See* paragraph 14. The Windows Media server is *a specialized server* because the Window Media server works with the *specialized single file created by the Windows Media server* that can only be served by the Windows Media server. *See* paragraph 14. In particular, Birney teaches that "the [Windows Media] server selects and delivers the stream with the most appropriate bit rate" (*see* Birney page 2, Intelligent Bandwidth Control, item 1, bracketed material added) to select or switch to the stream "that is the most appropriate for current bandwidth conditions" (*see* paragraph 7).

Moreover, because the claimed invention uses a web server that is without specialized server-side intelligence, the request for files can be standard HTTP requests. The Examiner states that page 2 of Birney teaches that the non-existent files are requested from the web server using HTTP. *See* Final Office Action, page 9. Appellant respectfully disagrees. There is novelty as evidenced by the Examiner implying that Birney teaches this limitation when the page, as well as the entire reference, fails to explicitly or implicitly teach that the claimed client requesting the

files from the Windows Media Server, much less using HTTP to make the requests for the files. Appellant also respectfully submits that one of ordinary skill in the art would not have reason to use HTTP type file requests when using the Windows Media server, because the Windows Media server is a specialized server with specialized server-side intelligence that pushes data to a client, as opposed to a pull-based configuration in which the media player request the files from the server using HTTP.

For the foregoing reasons, Birney fails to teach at least these limitations of claim 44. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 44 and the cited references fail to teach or make obvious at least these limitations of claim 44. Accordingly, the Appellant respectfully requests reversal of these rejections.

F. Rejection of Claims 45, 49, and 50 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claims 45, 49, and 50 stand rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claims 45, 49, and 50 depends from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations. Dependent claim 45 recites "wherein at least one of the set of servers is **a cache server** of a network infrastructure operator" [emphasis added]. Dependent claim 49 recites "wherein the set of servers includes a content server storing the multiple files of the different copies, and wherein the set of servers includes **one or more cache servers caching at least some of the files**" [emphasis added]. Dependent claim 50 recites "wherein the multiple files are independently cacheable by **a cache server without specialized server-side intelligence**" [emphasis added]. Claim 20 clearly requires one or more content servers to store all of the multiple files of the different copies. Claim 23, however, specifically recites "a content server" and "one or more cache servers," where the latter can cache some of the multiple files of the different copies, such as, for example, the recently requested ones of the

multiple files. To put it another way, the content server stores all the files of the different copies and serves up these files when they are individually requested, and the cache servers can cache the more recently requested ones of the files.

The Examiner states that page 2 of Birney teaches these limitations. *See* Final Office Action, pages 9-10, and 11. Appellant respectfully disagrees because Birney is silent as to using cache servers. Regarding the "cache server," there is novelty as evidenced by the Examiner pointing at passages that describe the Windows Media server, rather than the Examiner finding the claimed "cache server" in Birney. Although Birney is silent regarding the use of "cache servers," if cache servers were used, they would have to be used in connection with the Windows Media server; otherwise, like when using regular web servers, "only the highest bit rate streams would play" when using cache servers, since the cache servers do not have the specialized server-side intelligence for "intelligent streaming." Accordingly, Birney fails to teach at least these limitations of claims 45, 49, and 50. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations. As such, the Examiner has failed to establish a prima facie case of obviousness for claims 45, 49, and 50 and the cited references fail to teach at least these limitations of claims 45, 49, and 50. Accordingly, the Appellant respectfully requests reversal of these rejections.

G. Rejection of Claim 46 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claim 46 stands rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claim 46 depends from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations. Dependent claim 46 recites:

> The method of claim 20, wherein:
> said generating the set of factors comprises:
> **monitoring time intervals between successive receive times** for each of the requested files;

calculating a current performance ratio across a current window of the time intervals; and

calculating a current average of the performance ratio to obtain a current performance factor of the set of factors;

said making further comprises:

comparing the current performance factor with a set of one or more trigger thresholds; and

determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing. [emphasis added].

The Examiner states that pages 1-2 of Birney teach all the limitations of claim 46. *See* Final Office Action, page 10. The cited passages, however, describe monitoring "bandwidth fluctuations" between the Windows Media server and the client, and, in response, adopting the best strategy as noted in bullet points 1-4 of page 2. Appellant respectfully submits that nothing in Birney teaches that the Windows Media server, or the client, has the capability to monitor "**time intervals between successive receive times for each response to the requested files**," much less the capability to calculate "**a current performance ratio** across a current window of the time intervals," and to calculate "**a current average of the performance ratio** to obtain a current performance factor of the set of factors," as recited in claim 46. As such, Birney fails to teach at least these limitations of claim 46. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 46 and the cited references fail to teach or make obvious at least these limitations of claim 46. Accordingly, the Appellant respectfully requests reversal of these rejections.

H. Rejection of Claim 47 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claim 47 stands rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claim 47 depends from claim 20, the Appellant respectfully requests reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations. Dependent claim 47 recites "comparing a current performance factor of the set of factors with a set of one or more trigger thresholds, **wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin**, wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index" [emphasis added].

The Examiner states that pages 1-2, paragraphs 2-5 of Birney teach all the limitations of claim 47. *See* Final Office Action, pages 10-11. Appellant respectfully disagrees because Birney is silent as to trigger thresholds, how the triggered thresholds are determined, as well as determining the trigger factors by "a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin," as recited in claim 47. In particular, Birney generically states that the Windows Media server uses intelligent streaming to adjust the bit rate of the content stream to counteract changes in the available bandwidth, but does not specifically teach how the available bandwidth is used to determine whether to adjust the bit rate or not. Birney does not discuss thresholds and how they are determined, much less determined by using the specifically claimed "read ahead margin," and "safety margin." As such, Birney fails to teach at least these limitations of claim 47. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding this limitation. As such, the Examiner has failed to establish a prima facie case of obviousness for claim 47 and the cited references fail to teach or make obvious at least these limitations of claim 47. Accordingly, the Appellant respectfully requests reversal of these rejections.

I. Rejection of Claim 48 under 35 U.S.C. § 103(a) Based on Birney, Kalra, and Quigg-Brown

Claim 48 stands rejected under 35 U.S.C. § 103(a) as being obvious over Birney, Kalra, and Quigg-Brown. Because claim 48 depends from claim 20, the Appellant respectfully requests

reversal of these rejections for at least the reasons set forth in section VII.A of this Brief with respect to independent claim 20.

The Appellant also respectfully requests reversal of these rejections because the cited references do not teach or suggest all the limitations. Dependent claim 48 recites "said requesting comprises issuing for each of the plurality of sequential ones of the files **a request with the filename of that file**, and said automatically requesting comprises issuing for each of the files **a request with the filename of that file**" [emphasis added].

The Examiner states that page 2, paragraphs 2-5 of Birney teach all the limitations of claim 48. *See* Final Office Action, page 11. Appellant respectfully disagrees because Birney is silent as to *issuing a request for each of the files with the filename of that file*. Not only does Birney fail to teach "requesting by the media player," as set forth in section VII.A.1.c of this Brief, the cited passages do not explicitly or implicitly teach that the media player requests the files by issuing requests with the filenames of those files. As such, Birney fails to teach at least these limitations claim 48. The Examiner does not indicate and the Appellant does not discern any part of Kalra or Quigg-Brown that cures the aforementioned deficiencies of Birney regarding these limitations. As such, the cited references fail to teach or make obvious at least these limitations of claim 48. Accordingly, the Appellant respectfully requests reversal of these rejections.

In view of the foregoing, the Appellant respectfully requests that the Board overturn the above rejections.

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Dated: October 25, 2010

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CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being submitted to the United States Patent and Trademark Office electronically via EFS Web on the date shown below.

/Kevin O. Grange/ Oct. 25, 2010
Name Date

VIII. CLAIMS APPENDIX

1-19. (Canceled)

20. (Previously presented) A method for presenting rate-adaptive streams, the method comprising:

streaming by a media player operating on an end user station a video from a set of one or more servers, wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers, wherein each of the multiple files yields a different portion of the video on playback, wherein the multiple files across the different copies yield the same portions of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video, and wherein the streaming comprises:

requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes;

automatically requesting by the media player from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including,

regularly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies, wherein the set of one or more factors relate to the performance of the network; and

making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time; and

presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time.

21. (Previously presented) The method of claim 20, wherein said requesting the plurality of sequential ones of the files includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the files from the received sub-parts.

22. (Canceled)

23. (Previously presented) The method of claim 20, wherein said making the successive determinations to shift comprises:

upshifting to a higher quality one of the different copies when the at least one factor is greater than a first threshold; and

determining if the higher quality playback can be sustained.

24. (Previously presented) The method of claim 23, wherein said making the successive determinations to shift comprises downshifting to a lower quality one of the different copies when the at least one factor is less than a second threshold.

25. (Previously presented) The method of claim 20, further comprising:

receiving user input to enable one of fast-forward, skip randomly, and rewind functionality; and

requesting files of the video at a specified time index that is not the next sequential time in the current playback.

26. (Previously presented) The method of claim 20,

wherein said requesting the plurality of sequential one of the files includes requesting the files from a low quality one of the different copies to enable instant playback of the video, and wherein said automatically requesting includes upshifting to a higher quality one of the different copies.

27-34. (Canceled)

35. (Previously presented) The method of claim 20, wherein said requesting the plurality of sequential ones of the files includes requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections.

36. (Previously presented) The method of claim 20, wherein said presenting comprises sequentially arranging the requested files from the different copies in the order of ascending playback time for playback with the media player on the end user station.

37. (Previously presented) The method of claim 20, wherein said automatically requesting includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the files from the received sub-parts.

38. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of the available bandwidth of the plurality of TCP connections.

39. (Canceled)

40. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of latency of the requested files, wherein the latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station.

41. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files.

42. (Previously presented) The method of claim 20, wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections.

43. (Previously presented) The method of claim 20, wherein at least one of the set of servers is a web server.

44. (Previously presented) The method of claim 43, wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP), and wherein the web server is without specialized server-side intelligence to respond to said requesting.

45. (Previously presented) The method of claim 20, wherein at least one of the set of servers is a cache server of a network infrastructure operator.

46. (Previously presented) The method of claim 20, wherein:

said generating the set of factors comprises:

monitoring time intervals between successive receive times for each of the requested files;

calculating a current performance ratio across a current window of the time intervals; and

calculating a current average of the performance ratio to obtain a current performance factor of the set of factors;

said making further comprises:

comparing the current performance factor with a set of one or more trigger thresholds; and

determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing.

47. (Previously presented) The method of claim 20, wherein said making comprises:

comparing a current performance factor of the set of factors with a set of one or more trigger thresholds, wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin, wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index; and

determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing.

48. (Previously presented) The method of claim 20, wherein:

said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that file, and

said automatically requesting comprises issuing for each of the files a request with the filename of that file.

49. (Previously presented) The method of claim 20, wherein the set of servers includes a content server storing the multiple files of the different copies, and wherein the set of servers includes one or more cache servers caching at least some of the files.

50. (Previously presented) The method of claim 20, wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence.

IX. EVIDENCE APPENDIX

No related evidence exists.

X. RELATED PROCEEDINGS APPENDIX

No related proceedings exist.

Electronic Acknowledgement Receipt

EFS ID:	8695176
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange
Filer Authorized By:	
Attorney Docket Number:	8532P001
Receipt Date:	25-OCT-2010
Filing Date:	28-APR-2005
Time Stamp:	23:33:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$825
RAM confirmation Number	10139
Deposit Account	022666
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	8532P001_3_mo_EOT.pdf	11635 8ba4d016f3d02e4917919108c458f02e126ca8a4	no	1
Warnings:					
Information:					
2	Appeal Brief Filed	8532P001_Appeal_Brief.pdf	330931 508bc5b2f4294ae8b0641233912c5d0a0cfe3b17	no	46
Warnings:					
Information:					
3	Fee Worksheet (PTO-875)	fee-info.pdf	32026 db5ec128e998abd57119168b39549648b0368d08	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	374592		

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<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.

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange
Attorney Docket Number:	8532P001

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Filing a brief in support of an appeal	2402	1	270	270
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	2253	1	555	555
Miscellaneous:				
			Total in USD ($)	**825**

Substitute for Form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	11/116,783
				Filing Date	April 28, 2005
				First Named Inventor:	Major, R. Drew
				Art Unit	2444
				Examiner Name	Donnabed, Ninos J.
Sheet	1	**of**	1	Attorney Docket Number	8532P001

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (If known)		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-	6,389,473	05/14/2002	Carmel et al.	
		US-	7,818,444	10/19/2010	Brueck, et al.	
		US-				
		US-				

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		Notice of Allowance for 11/673,483, August 5, 2010, 7 pages.	

Examiner Signature		Date Considered	

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

This collection of information is required by 37 CFR 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 2 hours 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SENT FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Based on Form PTO/SB/08A (08-03) as modified by BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP on 09/10/03.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2444
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed for applications filed after June 30, 2003). It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on the date shown below.

October 26, 2010.
(Date of Deposit)

Leslie Rogan
(Typed or printed name of person mailing correspondence)

/Leslie Rogan/ October 26, 2010
(Signature of person mailing correspondence) (Date)

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

_____ 37 C.F.R. §1.97(b).

_____ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

____ A statement pursuant to 37 C.F.R. §1.97(e) or

____ **The Director is Authorized to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. § 1.17(p).**

__X__ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

(1) A statement pursuant to 37 C.F.R. §1.97(e); and

(2) **Authorization to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. §1.17(p) for submission of the Information Disclosure Statement.**

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: October 26, 2010

/Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
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(408) 720-8300

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Kevin Grange/Leslie Rogan
Attorney Docket Number:	8532P001

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	8708631
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	26-OCT-2010
Filing Date:	28-APR-2005
Time Stamp:	21:21:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	6406
Deposit Account	022666
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	8532P001_1-97e_Statement.pdf	13254 5667775ff406d906b23fbce7af4b62541f088b76	no	2
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Filed (SB/08)	8532P001_IDS_w_statement.pdf	123396 9afea17ca1425948fe71f1cd9ca97e39f9595a0f	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	NPL Documents	P002_NOA_8-5-10.pdf	331992 38fc5e6c552ba2acc12fbf993069365b247b4e34	no	7
Warnings:					
Information:					
4	Fee Worksheet (PTO-875)	fee-info.pdf	30163 29fcf8b51ed4c06df8aab99e70666e135af14995	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	498805		

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<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.

Attorney's Docket No. 8532P001 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J
Application No.: 11/116,783	Art Unit: 2444
Filed: April 28, 2005	
For: APPARATUS, SYSTEM AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

STATEMENT UNDER 37 C.F.R. §1.97(e)

Sir:

I hereby certify (as indicated by an "X" to the left of the appropriate paragraph):

____ That each item of information contained in the accompanying 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.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on October 26, 2010.
(Date of Deposit)

Leslie Rogan
(Typed or printed name of person mailing correspondence)

/Leslie Rogan/
(Signature of person mailing correspondence)

__X__ That no item of information contained in the accompanying Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned attorney after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in §1.56(c) more than three months prior to the filing the Information Disclosure Statement.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: Oct. 26, 2010 /Kevin O. Grange/

Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	
R. Drew Major	Examiner: Donabed, Ninos J.
Application No.: 11/116,783	Art Unit: 2454
Filed: April 28, 2005	Confirmation No.: 5535
For: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Sir:

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: Oct. 26, 2010

/Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

Substitute for Form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	11/116,783
				Filing Date	April 28, 2005
				First Named Inventor:	Major, R. Drew
				Art Unit	2444
				Examiner Name	Donnabed, Ninos J.
Sheet	1	**of**	1	Attorney Docket Number	8532P001

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (If known)		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-				
		US-				
		US-				
		US-				

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		Final Office Action for 11/673,483, February 4, 2010, 21 pages.	
		Advisory Action for 11/673,483, April 9, 2010, 3 pages.	
		Advisory Action for 11/673,483, May 26, 2010, 3 pages.	

Examiner Signature		Date Considered	

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

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Electronic Acknowledgement Receipt

EFS ID:	8708664
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	26-OCT-2010
Filing Date:	28-APR-2005
Time Stamp:	21:20:02
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) Filed (SB/08)	8532P001_IDS_2.pdf	68253 da834fdeb24610feb1920511ca65c6f947930f38	no	2

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2	NPL Documents	P002_AA_4-9-10.pdf	184412 64e89912c4f8fdb7fd5cc14b30ca5e0be24b8a98	no	3
Warnings:					
Information:					
3	NPL Documents	P002_AA_5-26-10.pdf	135063 9ed14e988d5bc57a6b5e68856fac2acda6469eb0	no	3
Warnings:					
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4	NPL Documents	P002_FOA_2-4-10.pdf	695467 c1dbffee6e3e296354417bdee09e584705d7b313	no	21
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		Total Files Size (in bytes):	1083195		

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<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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	8532P001	5535

8791 7590 11/02/2010

EXAMINER

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
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ART UNIT	PAPER NUMBER

DATE MAILED: 11/02/2010

Please find below and/or attached an Office communication concerning this application or proceeding.

Notification of Non-Compliant Appeal Brief (37 CFR 41.37)	Application No.	Applicant(s)	
	11/116783	R. Drew Major, et. al.	
	Examiner	Art Unit	
	Donabed, Ninos J.	2444	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

The Appeal Brief filed on *Oct. 25, 2010* is defective for failure to comply with one or more provisions of 37 CFR 41.37.

To avoid dismissal of the appeal, applicant must file an amended brief or other appropriate correction (see MPEP 1205.03) within **ONE MONTH or THIRTY DAYS** from the mailing date of this Notification, whichever is longer. **EXTENSIONS OF THIS TIME PERIOD MAY BE GRANTED UNDER 37 CFR 1.136.**

1. ☐ The brief does not contain the items required under 37 CFR 41.37(c), or the items are not under the proper heading or in the proper order.

2. ☐ The brief does not contain a statement of the status of all claims, (e.g., rejected, allowed, withdrawn, objected to, canceled), or does not identify the appealed claims (37 CFR 41.37(c)(1)(iii)).

3. ☐ At least one amendment has been filed subsequent to the final rejection, and the brief does not contain a statement of the status of each such amendment (37 CFR 41.37(c)(1)(iv)).

4. x (a) The brief does not contain a concise explanation of the subject matter defined in each of the independent claims involved in the appeal, referring to the specification by page and line number and to the drawings, if any, by reference characters; and/or (b) the brief fails to: (1) identify, for each independent claim involved in the appeal and for each dependent claim argued separately, every means plus function and step plus function under 35 U.S.C. 112, sixth paragraph, and/or (2) set forth the structure, material, or acts described in the specification as corresponding to each claimed function with reference to the specification by page and line number, and to the drawings, if any, by reference characters (37 CFR 41.37(c)(1)(v)).

5. ☐ The brief does not contain a concise statement of each ground of rejection presented for review (37 CFR 41.37(c)(1)(vi))

6. ☐ The brief does not present an argument under a separate heading for each ground of rejection on appeal (37 CFR 41.37(c)(1)(vii)).

7. ☐ The brief does not contain a correct copy of the appealed claims as an appendix thereto (37 CFR 41.37(c)(1)(viii)).

8. ☐ The brief does not contain copies of the evidence submitted under 37 CFR 1.130, 1.131, or 1.132 or of any other evidence entered by the examiner **and relied upon by appellant in the appeal**, along with a statement setting forth where in the record that evidence was entered by the examiner, as an appendix thereto (37 CFR 41.37(c)(1)(ix)).

9. ☐ The brief does not contain copies of the decisions rendered by a court or the Board in the proceeding identified in the Related Appeals and Interferences section of the brief as an appendix thereto (37 CFR 41.37(c)(1)(x)).

10. x Other (including any explanation in support of the above items):

1) The mapping to the specification in the "summary of claimed subject matter" is incorrect. Several citations are not correctly mapping the issues being discussed in the brief. For example, for claim 20, the paragraph states, "See Application, e. g., pgs. 6-7, ¶¶ 19-21", yet those paragraphs appear between pages 5 and 6. Also, in claim 20, there is an entry concerning "different copies...is stores as multiple files on the set of servers" and the citation refers to paragraphs 44 and 45; yet, the discussion about what has been mentioned in that section of the brief is on paragraphs 42 and 43. Please provide a correct mapping to the specification matching the claim notations being cited in the brief. An entire brief is not required for this section.

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Aylo Exhibit 1018
Page 737 of 2308

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

R. Drew Major *et al.*

Application No.: 11/116,783

Filed: April 28, 2005

For: APPARATUS, SYSTEM, AND METOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

Examiner: Donabed, Ninos J

Group Art Unit: 2444

Confirmation No.: 5535

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Leslie Rogan/ Nov. 10, 2010

Leslie Rogan ***Date***

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NOTIFICATION OF NON-COMPLIANT APPEAL BRIEF UNDER 37 C.F.R. § 41.37(c)(1)(v)

In response to the Notification of Non-Compliant Appeal Brief mailed on November 2, 2010, Applicant respectfully requests that the Office enter the following amendments.

AMENDMENTS

Amendments to the Summary of the Claimed Subject Matter section:

Please replace the Summary of Claimed Subject Matter section with the following amended Summary of Claimed Subject Matter section:

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

Appellant respectfully submits that the following includes the claim language and citations that show where support for the claim language is found. Appellant respectfully submits that the citations should not be used to read limitations from the specification into the claims.

Claim 20 recites a method for presenting rate-adaptive streams (*See* Application, e.g., pgs. 5-6 [[6-7]] ¶¶19-21, pgs. 20-22 [[20-23]] ¶¶66-73, and Figs. 6 & 7), the method comprising: streaming by a media player operating on an end user station a video from a set of one or more servers (*See* e.g., pg. 11 ¶42, pg. 14, ¶50), wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers (*See* e.g., pgs. 11-12 ¶¶43-45 [[44-45]], and Figs. 2A-2C), wherein each of the multiple files yields a different portion of the video on playback (*See* e.g., pg. 11 ¶42 and pg. 12 ¶45), wherein the multiple files across the different copies yield the same portions of the video on playback (*See* e.g., pgs. 11-12 ¶¶43-45 [[44-45]]), each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video (*See* e.g., pgs. 11-12 ¶¶43-45 [[44-45]], and Figs. 2A-2C), and wherein the streaming comprises: requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes (*See* e.g., pgs. 15-16 [[15-17]] ¶¶54-55, pgs. 16-17 ¶57, and pgs 17-18 ¶60, and Figs. 4 and 6); automatically requesting by the media player from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies (*See* e.g., pgs. 20-22 ¶¶66, 68-72, and Figs. 6 and 7), said

automatically requesting including, repeatedly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies (*See* e.g., pgs. 21-22 ¶¶69-72, Fig. 7), wherein the set of one or more factors relate to the performance of the network (*See* e.g., pgs. 21-22 ¶¶69-72); and making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time (*See* e.g., pgs. 21-22 ¶¶69-72, Fig. 7); and presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time (*See* e.g., pg. 14 [[15]] ¶52, page 20, ¶67 [[52]], Fig. 6).

Claim 23, which depends from claim 20, recites wherein said making the successive determinations to shift comprises: upshifting to a higher quality one of the different copies when the at least one factor is greater than a first threshold (*See* e.g., pgs. 5-6 ¶20, pgs. 21-22 ¶71, Fig. 7); and determining if the higher quality playback can be sustained (*See* e.g., pg. 5-6 ¶20, pgs. 21-22 ¶71, Fig. 7).

Claim 35, which depends from claim 20, recites wherein said requesting the plurality of sequential ones of the files includes requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections (*See* e.g., pgs. 17-18 ¶60).

Claim 40, which depends from claim 20, recites wherein the at least one of the set of factors is indicative of latency of the requested files, wherein the latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station (*See* e.g., pg. 3 ¶10, pg. 16, ¶56).

Claim 41, which depends from claim 20, recites wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files (*See* e.g., pg. 14 ¶51, pg. 16, ¶56, pg. 20-21, ¶68).

Claim 42, which depends from claim 20, recites wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections (*See* e.g., pgs. 2-3 ¶8, pg. 16, ¶56, pgs. 17-18, ¶59-60).

Claim 44, which depends from claim 20, recites wherein at least one of the set of servers is a web server (*See* e.g., pg. [[¶]]11 ¶42, pgs. 13-14 ¶49), wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP) (*See* e.g., pgs. 13-14 ¶49, pg. 16 ¶55), and wherein the web server is without specialized server-side intelligence to respond to said requesting (*See* e.g., pgs. 13-14 ¶49).

Claim 45, which depends from claim 20, recites wherein at least one of the set of servers is a cache server of a network infrastructure operator (*See* e.g., pgs. 13-14 ¶49).

Claim 46, which depends from claim 20, recites wherein: said generating the set of factors comprises: monitoring time intervals between successive receive times for each of the requested files (*See* e.g., pg. 14 ¶51, pgs. 20-21 ¶68, Fig. 7); calculating a current performance ratio across a current window of the time intervals (*See* e.g., pg. 21 ¶69, Fig. 7); and calculating a current average of the performance ratio to obtain a current performance factor of the set of factors (*See* e.g., pg. 21 ¶70, Fig. 7); and said making further comprises: comparing the current performance factor with a set of one or more trigger thresholds (*See* e.g., pg. 21-22 ¶71, Fig. 7); and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing (*See* e.g., pg. 21-22 ¶71, Fig. 7).

Claim 47, which depends from claim 20, recites wherein said making comprises: comparing a current performance factor of the set of factors with a set of one or more trigger thresholds (*See* e.g., pg. 21-22 ¶71, Fig. 7), wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin (*See* e.g., pg. 21-22 ¶71, Fig. 7), wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index (*See* e.g., pg. 21-22 ¶71, Fig. 7); and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing (*See* e.g., pg. 21-22 ¶71, Fig. 7).

Claim 48, which depends from claim 20, recites wherein: said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that

file (*See* pg. 14-15 ¶52), and said automatically requesting comprises issuing for each of the files a request with the filename of that file (*See* pg. 14-15 ¶52, pg. 16 ¶55, Fig. 7).

Claim 49, which depends from claim 20, recites wherein the set of servers includes a content server storing the multiple files of the different copies (*See* e.g., pg. 10-11 ¶¶41-42), and wherein the set of servers includes one or more cache servers caching at least some of the files (*See* e.g., pgs. 13-14 ¶49).

Claim 50, which depends from claim 20, recites wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence (*See* e.g., pgs. 13-14 ¶49).

CONCLUSION

Based on Section 1205.03 of the MPEP, an entire new brief has not been submitted. The above amended section provides a summary of the claimed subject matter as required by 37 CFR 41.37(c)(1)(v). It is respectfully submitted that in view of the amendments set forth herein, the brief is compliant under 37 C.F.R. § 41.37(c)(1)(v).

If there are any additional charges, please charge them to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: November 10, 2010

/Kevin O. Grange/

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Sunnyvale, CA 94086-4040
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Electronic Acknowledgement Receipt

EFS ID:	8807720
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Kevin Grange/Leslie Rogan
Filer Authorized By:	Kevin Grange
Attorney Docket Number:	8532P001
Receipt Date:	10-NOV-2010
Filing Date:	28-APR-2005
Time Stamp:	13:57:12
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	Appeal Brief Filed	8532P001_Resp_to_Notice_of_Non-Compliant_Appeal_Brief.pdf	44863 c21a340d6ef386b1f08727a550395804cebd0557	no	6

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National Stage of an International Application under 35 U.S.C. 371
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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.

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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: ECHOSTAR ADVANCED TECHNOLOGIES L.L.C.

Application No./Patent No.: 11/116,783 Filed/Issue Date: April 28, 2005

Titled: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

ECHOSTAR ADVANCED TECHNOLOGIES L.L.C., a limited liability company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

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B. [X] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: R. Drew Major, Mark B. Hurst To: Move Networks, Inc.

The document was recorded in the United States Patent and Trademark Office at
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2. From: Move Networks, Inc. To: EchoStar Advanced Technologies L.L.C.

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The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature	1/12/11 Date
Max Gratton (Reg. No. 56,541) Printed or Typed Name	Corporate Counsel Title

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.**

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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: 70560

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: 70560

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

EchoStar Advanced Technologies L.L.C.
100 Inverness Terrace East
Englewood, CO 80112

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SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	1/28/11
Name	Brandon Ehrhart	Telephone	720 514-5297
Title	Vice President, Associate General Counsel and Assistant Secretary		

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.**

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Electronic Acknowledgement Receipt

EFS ID:	9244429
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	08791
Filer:	Brett Carlson/Sharron Castillo
Filer Authorized By:	Brett Carlson
Attorney Docket Number:	8532P001
Receipt Date:	17-JAN-2011
Filing Date:	28-APR-2005
Time Stamp:	16:05:30
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	20110117_POA.pdf	269859 5d9edaf1f3fde7448c8e084f21589a82a94ad775	no	1

Warnings:	
Information:	

2	Assignee showing of ownership per 37 CFR 3.73(b).	20110117_Stmt373b_11116783.pdf	269737 f0773633d223a80037209bdb65c657c59dac75fb	no	1

Warnings:	
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Total Files Size (in bytes):	539596

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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.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/116,783	04/28/2005	R. Drew Major	8532P001

CONFIRMATION NO. 5535

70560
INGRASSIA FISHER & LORENZ, P.C. (EchoStar)
7010 E. COCHISE ROAD
SCOTTSDALE, AZ 85253

POA ACCEPTANCE LETTER

OC000000045630350

Date Mailed: 01/26/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/17/2011.

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.

/mnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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11/116,783	04/28/2005	R. Drew Major	8532P001

CONFIRMATION NO. 5535

POWER OF ATTORNEY NOTICE

8791
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Date Mailed: 01/26/2011

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/17/2011.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/mnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	**Art Unit**
	NINOS DONABED	2444

SEARCHED			
Class	**Subclass**	**Date**	**Examiner**
709	246	05/07/2008	ND

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
See EAST Search History	05/07/2008	ND
Conducted double patenting search	05/07/2008	ND
Consulted with SPE William Vaughn	11/13/2008	ND
See updated EAST search	12/13/2009	ND
Consulted with SPE William Vaughn regarding Final	02/12/2009	ND
Consulted with SPE William Vaughn regarding Advisory	03/29/2009	ND
Consulted with SPE William Vaughn regarding Advisory	5/7/2009	ND
Consulted with Primary Paul Kang	02/10/2009	ND
See updated east search	7/30/2009	ND
Consulted with SPe William Vaughn regarding search	7/30/2009	ND
Consulted SPE William Vaughn regarding Final	2/4/2010	nd
Consulted SPE William Vaughn regarding Appeal	1/27/2011	nd

INTERFERENCE SEARCH			
Class	**Subclass**	**Date**	**Examiner**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	066.0141 (P2004-04-01.1)	5535

70560 7590 02/16/2011

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EXAMINER	
DONABED, NINOS J	
ART UNIT	PAPER NUMBER
2444	

NOTIFICATION DATE	DELIVERY MODE
02/16/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 11/116,783
Filing Date: April 28, 2005
Appellant(s): MAJOR ET AL.

Move Networks
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 10/25/2010 appealing from the Office action mailed 2/22/2010.

(1) Real Party in Interest

The examiner has no comment on the statement, or lack of statement, identifying by name the real party in interest in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The following is a list of claims that are rejected and pending in the application:

Claims 20-21, 23-26, 35-38, 40-50 are under appeal. Claims 20-21, 23-26, 35-38, 40-50 are pending in the application.

(4) Status of Amendments After Final

The examiner has no comment on the appellant's statement of the status of amendments after final rejection contained in the brief.

(5) Summary of Claimed Subject Matter

The examiner has no comment on the summary of claimed subject matter contained in the brief.

(6) Grounds of Rejection to be Reviewed on Appeal

The examiner has no comment on the appellant's statement of the grounds of rejection to be reviewed on appeal. Every ground of rejection set forth in the Office action from which the appeal is taken (as modified by any advisory actions) is being maintained by the examiner except for the grounds of rejection (if any) listed under the

subheading "WITHDRAWN REJECTIONS." New grounds of rejection (if any) are provided under the subheading "NEW GROUNDS OF REJECTION."

(7) Claims Appendix

The examiner has no comment on the copy of the appealed claims contained in the Appendix to the appellant's brief.

(8) Evidence Relied Upon

6490627	Quigg-Brown	2-2002
6490627	Kalra	6-1999

Birney, "Intelligent Streaming" Microsoft Corporation

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 20-21, 23-26, 35-38, 40-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Birney "Intelligent Streaming" in view of Kalra (United Stated Patent 6490627) further in view of Quigg-Brown (United States Patent Application 2003/0152036.)

Regarding claim 20,

Birney teaches a method for presenting rate-adaptive streams, the method comprising:

streaming by a media player operating on an end user station a video from a set of one or more servers, wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers, wherein each of the multiple files yields a different portion of the video on playback, wherein the multiple files across the different copies yield the same portions of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video, and wherein the streaming comprises: **(See pages 1-2 (multi-bit rate encoding), Birney teaches multiple copies of the same stream being stored on a server at different bit rates with the same time index used to switch between the stream based on network bandwidth limitations)**

repeatedly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies, wherein the set of one or more factors relate to the performance of the network; and **(See pages 2-3 including multiple-bit-rate encoding and intelligent bandwidth control sections, Birney teaches determining bandwidth capabilities)**

making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files portions of the highest quality one of the copies determined sustainable at that time; and

presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time.**(See pages 1-2, Birney teaches shifting playback quality to the highest quality dependent on network bandwidth.)**

Birney further teaches a client and a server working together to automatically determine the available bandwidth and based on this working together adjusting to a higher or lower quality stream **(See pages 2-4, Birney)**

While the implication of Birney is that both the server and the client work together to determine a quality of stream, Birney does not explicitly state that this is done by the media player acting alone.

Kalra teaches requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers; **(See figure 16A1 and column 15 line 56 - column 16 line 60, Kalra teaches requesting by a client media player one of the adaptive streams/copies based on the client capabilities)**

automatically requesting by the media player from the set of servers subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including, **(See figure 16A1 and column 15 line 56 - column 16 line 60, Kalra teaches automatically requesting by the media player higher or lower quality data based on a quality factor)**

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have known to combine the teachings of Kalra with Birney

because both deal with streaming different quality of streaming content to a client device from a server. The advantage of incorporating requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers; automatically requesting by the media player from the set of servers subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting of Kalra into Birney is that sata streams accessed by client from server are tailored to match profile of each client, such that best stream combinations are provided to maximize resolution of 3D, audio and video components thus making the system more robust and efficient. **(See column 1, Kalra)**

Birney and Kalra do not explicitly teach one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections.

Quigg-Brown teaches teach one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections **(See abstract and paragraphs [0028] – [0030])**

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have known to combine the teachings of Quigg Brown with Birney because both deal with streaming of files. The advantage of incorporating one of

the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes and requesting by the media player from the set of servers over the plurality of TCP connections of Quigg Brown into Birney is that it improves the data transfer rate by transferring the packets in parallel through the network. **(See paragraphs [0002] – [0005], Quigg brown.)**

Regarding claim 21,

Birney, Kalra, and Quigg Brown teach the method of claim 20,wherein said requesting the plurality of sequential ones of the files includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the portions files from the received sub-parts. **(See page 2 paragraphs 3-5, Birney)**

Regarding claim 23,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said determining making the successive determinations to shift comprises: upshifting to a higher quality one of the different copies when the at least one performance factor is greater than a first threshold; and determining if the higher quality playback can be sustained. **(See page 2 paragraphs 4-5, Birney)**

Regarding claim 24,

Birney, Kalra, and Quigg Brown teach the method of claim 23, wherein said determining making the successive determinations to shift comprises downshifting to a lower quality one of the different copies when the at least one performance factor is less than a second threshold. **(See page 2 paragraphs 3-5, Birney)**

Regarding claim 25,

Birney, Kalra, and Quigg Brown teach the method of claim 20, further comprising: receiving user input to enable one of fast-forward, skip randomly, and rewind functionality; and requesting files of the video at a specified time index that is not the next sequential time in the current playback. **(See page 3, Birney)**

Regarding claim 26,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said requesting the plurality of sequential one of the files includes requesting the files from a low quality one of the different copies to enable instant playback of the video, and wherein said automatically requesting includes upshifting to a higher quality one of the different copies. **(See page 2 paragraphs 1-4, Birney)**

Regarding claim 35,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said requesting the plurality of sequential ones of the files includes requesting the plurality of

sequential ones of the files over different ones of the plurality of TCP connections. **(See paragraphs [0002] – [0005], Quigg Brown)** See motivation for claim 20.

Regarding claim 36,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said presenting comprises sequentially arranging the received requested portions files from the different copies in the order of ascending playback time for playback on with the media player on the end user station. **(See page 3 paragraphs 1-3, Birney)**

Regarding claim 37,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said automatically requesting includes requesting sub-parts of the files over different ones of the plurality of TCP connections, and wherein said presenting includes reassembling the files from the received sub-parts. **(See page 2 paragraphs 3-5, Birney)**

Regarding claim 38,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of is indicative of the available bandwidth of the plurality of TCP connections. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 40,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of factors is indicative of latency of the requested files, wherein the latency is a time measure between when a one of the requests is issued and a time that response data of the begins to arrive at the end user station. **(See page 2 paragraphs 1-5, Birney)**

Regarding claim 41,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files. **(See page 1 paragraphs 1-3, Birney)**

Regarding claim 42,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 43,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein at least one of the set of servers is a web server. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 44,

Birney, Kalra, and Quigg Brown teach the method of claim 43, wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP), and wherein the web server is without specialized server-side intelligence to respond to said requesting. **(See page 2, Birney)**

Regarding claim 45,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein at least one of the set of servers is a cache server of a network infrastructure operator. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 46,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein: said generating the set of factors comprises: monitoring time intervals between successive receive times for each of the requested files (**See pages 1-2, Birney)**; calculating a current performance ratio across a current window of the time intervals; and calculating a current average of the performance ratio to obtain a current performance factor of the set of factors; said making further comprises: comparing the current performance factor with a set of one or more trigger thresholds(**See pages 1-2, Birney)**; and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing (**See pages 2, Birney**)

Regarding claim 47,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein said making comprises: comparing a current performance factor of the set of factors with a set of one or more trigger thresholds, wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin, wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index; and determining whether to upshift or downshift to a higher or lower quality one of the different copies based on said comparing. **(See page 1 and 2 paragraphs 2-5, Birney)**

Regarding claim 48,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein: said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that file, and said automatically requesting comprises issuing for each of the files a request with the filename of that file. **(See page 2 paragraphs 2-5, Birney)**

Regarding claim 49,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the set of servers includes a content server storing the multiple files of the different copies, and wherein the set of servers includes one or more cache servers caching at least some of the files. **(See page 2 paragraphs 1-3, Birney)**

Regarding claim 50,

Birney, Kalra, and Quigg Brown teach the method of claim 20, wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence. **(See page 2 paragraphs 2-5, Birney)**

(10) Response to Argument

The examiner summarizes the various points raised by the applicant and addresses replies individually.

As per appellant, “the cited references do not teach or suggest "wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers" and "the multiple files across the different copies yield the same portion of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video" (Argument A, See brief pages 10 1-7 and 12 lines 1-7)

In response to A), Examiner points to page 2 of "Intelligent Streaming” which states “In multiple-bit-rate encoding, **a number of discrete, user-definable audio and video streams are encode**d into a single Windows Media stream. **The streams are encoded from the same content, but each is encoded at a different bit rate**. When

Windows Media Player connects to a Windows Media server to receive a multiple-bit-rate Windows Media file or broadcast stream, the server only sends the set of audio and video streams that is the most appropriate for current bandwidth conditions". Clearly the reference teaches a plurality of different discrete copies of the video, each file/streams are encoded from the same content but at a different rate.

Furthermore, figure 7A-7B and column 6 lines 10-65, Kalra teaches the multiple files across the different copies yield the same portion of the video on playback.

Regarding the "each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video," Examiner points to page 5 of "Intelligent Streaming". This section teaches "**after 10 minutes**, network congestion increases, and bandwidth suddenly falls to 32 Kbps. The client's frame rate begins to decrease, and some packets are lost, but the server reacts immediately by switching to a 19-Kbps stream. The user notices some degradation in image quality, but audio is continuous and disruption of the presentation is minimized. Then, **20 minutes later**, bandwidth worsens again, decreasing to 14 Kbps". This section teaches seamlessly switching between the bit rate files at a specific time (10 and 20 minutes) based on network congestion. Clearly the files are stored based on time, time indexing is used with regards to the files, in order to seamlessly switch between the different files.

As per appellant, “the cited references do not teach or suggest alignment of the portions and requesting of the portions based on "Time Indexes." (Argument A, See brief page 13 lines 5-7)

In response to B), Examiner points to page 5 of “Intelligent Streaming”. This section teaches ”**after 10 minutes**, network congestion increases, and bandwidth suddenly falls to 32 Kbps. The client's frame rate begins to decrease, and some packets are lost, but the server reacts immediately by switching to a 19-Kbps stream. The user notices some degradation in image quality, but audio is continuous and disruption of the presentation is minimized. Then, **20 minutes later**, bandwidth worsens again, decreasing to 14 Kbps". This section teaches seamlessly switching between the bit rate files at a specific time (10 and 20 minutes) based on network congestion. Clearly the files are stored based on time, time indexing is used with regards to the files, in order to seamlessly switch between the different files.

As per appellant, “the cited references do not teach or suggest "Requesting by the Media Player a plurality of sequential ones of the files" or "automatically requesting by the media player ... subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon Successive Determinations by the Media Player" (Argument C, See brief page 15 lines 10-15)

In response to C), Examiner points to page 2 of “Intelligent Streaming”. This section teaches “The server and **client** [media player] automatically determine the current available bandwidth, and then the server selects and delivers the stream with the most appropriate bit rate.” The client/media player automatically makes successive determinations and requests the appropriate “Stream”/sequential portions of the video based on available bandwidth and other criteria. Clearly, the media player works directly with server to make determinations of which stream would be optimal and requesting the portions of the stream for any particular time.

As per appellant, “the cited references fail to render independent claim 20 obvious regarding "requesting ...files over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes," and "automatically requesting ... subsequent portions of the video by requesting for each such portion one of the files from one of the copies" (Argument D, See brief page 19 lines 9-12)

In response to D), Examiner points to page 2 of “Intelligent Streaming”. This section teaches “The server and **client** [media player] automatically determine the current available bandwidth, and then the server selects and delivers the stream with the most appropriate bit rate.” The client/media player automatically makes successive determinations and requests the appropriate “Stream”/sequential portions of the video based on available bandwidth and other criteria. Clearly, the media player works directly

with server to make determinations of which stream would be optimal and requesting the portions of the stream for any particular time.

Furthermore examiner points to paragraphs [0028] – [0032] of Quigg-Brown, which teaches splitting a data stream over a number of TCP connections based on a client requesting a stream of data. Each part of the data stream is a particular time of the video to be played. Clearly this teaches a plurality of TCP connections being used to transport a data stream after a request is made.

As per appellant, “the cited references do not teach or suggest "determining if the higher quality playback can be sustained." (Argument E, See brief page 26 lines 22-24)

In response to E), Examiner points to page 2 of “Intelligent Streaming”. This section teaches “The server and **client** [media player] automatically determine the current available bandwidth, and then the server selects and delivers the stream with the most appropriate bit rate.” The client/media player along with the server work together to determine if a higher playback is available and if the bandwidth can sustain the stream. If it cannot, the stream is switched to a lower quality.

As per appellant, “Quigg- Brown fails to "requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections” (Argument F, See brief page 28 lines 14-16)

In response to F), Examiner points to paragraphs [0028] – [0032] of Quigg-Brown, which teaches splitting a data stream over a number of TCP connections based on a client requesting a stream of data. Each part of the data stream is a particular time of the video to be played. Clearly this teaches a plurality of TCP connections being used to transport a data stream after a request is made.

As per appellant, “The prior art does not teach "latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station." (Argument G, See brief page 29 lines 19-23)

In response to G), Examiner points to page 2 of “Intelligent Streaming”. This section teaches “The server and **client** [media player] automatically determine the current available **bandwidth**, and then the server selects and delivers the stream with the most appropriate bit rate.” Bandwidth is a measurement of the amount of data (bits) that can be transmitted over time (per second). The request is the client/server requesting a stream and the time it takes to receive the stream and subsequent segments is bandwidth of the channel. The client./server request a stream and the rate is indirectly related to the latency, i.e. the greater the bandwidth, the lower the latency and vice versa.

As per appellant, “The prior art does not teach, claim 41, "wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files" (Argument H, See brief page 30 lines 9-12)

In response to H), Examiner points to page 2 of “Intelligent Streaming”. This section teaches “The server and **client** [media player] automatically determine the current available **bandwidth**, and then the server selects and delivers the stream with the most appropriate bit rate.” Bandwidth is a measurement of the amount of data (bits) that can be transmitted over time (per second). The request is the client/server requesting a stream and the time it takes to receive the stream and subsequent segments is bandwidth of the channel. The client./server request a stream and the rate is indirectly related to the latency, i.e. the greater the bandwidth, the lower the latency and vice versa. Again this clearly teaches that the bandwidth is a measurement of the time interval between requests.

As per appellant, “The prior art does not teach, claim 42 recites "wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections”. (Argument I, See brief page 31 lines 6-8)

In response to I), Examiner points to page 2 of “Intelligent Streaming”. This section teaches “The server and **client** [media player] automatically determine the current available **bandwidth**, and then the server selects and delivers the stream with

the most appropriate bit rate." Bandwidth is a measurement of the amount of data (bits) that can be transmitted over time (per second). The request is the client/server requesting a stream and the time it takes to receive the stream and subsequent segments is bandwidth of the channel. Again the bandwidth is a measure of the delay in the system and thus is one of the factors (bandwidth which also measures delay). Therefore, delay is intrinsically related to the bandwidth and clearly is taught by "Intelligent Streaming".

As per appellant, "The prior art does not teach, wherein the web server is without specialized server-side intelligence to respond to said requesting". (Argument J, See brief page 32 lines 5-9)

In response to J), Examiner points to Applicant's specification, paragraphs [0049] – [0050]. This is the only mention of specialized server intelligence in the specification. Examiner points to page 2 of "Intelligent Streaming" which teach a server which stores the media streams. No specialized server intelligence being used above and beyond the general operations of the streaming server. Again since no definition of the specialized intelligence is given by Applicant, and Examiner's interpretation which includes artificial intelligence is not found in the server of "Intelligent Streaming", the claim is clearly taught by the prior art.

As per appellant, “The prior art does not teach, claim 45 recites "wherein at least one of the set of servers is a cache server of a network infrastructure operator" [emphasis added]. Dependent claim 49 recites "wherein the set of servers includes a content server storing the multiple files of the different copies, and wherein the set of servers includes one or more cache servers caching at least some of the files". Dependent claim 50 recites "wherein the multiple files are independently cacheable by a cache server without specialized server-side intelligence". (Argument K, See brief page 33 lines 19-28)

In response to K), Examiner points to paragraphs [0050] Applicant’s specification which states “Use of cache servers is well known to those skilled in the art, and will not be discussed further herein.” To begin, the Applicant is admitting that the cache severs are well known in the art, which makes the cache servers at the very least Applicant admitted prior art or at the very least obvious for those skilled in the art. Secondly, Examiner points to page 2 -3 of "Intelligent Streaming" which teach a server that stores/caches the multiple streams and send’s them based on a request from a client. At the very least, Applicant has admitted that the cache server and functions are well known in the art and also the section pointed to by Examiner further teach the cache server and its functions.

As per appellant, “The prior art does not teach, that the Windows Media server, or the client, has the capability to monitor "time intervals between successive receive

times for each response to the requested files," much less the capability to calculate "a current performance ratio across a current window of the time intervals," and to calculate "a current average of the performance ratio to obtain a current performance factor of the set of factors," as recited in claim 46". (Argument L, See brief page 35 lines 11-17)

In response to L), Examiner points to page 6 of “Intelligent Streaming” which teaches “**monitoring the performance** of your CPU and memory resources is a simple way to monitor the quality of your encoding. The more streams, the more frames per second, the larger the image size, and the higher the quality that you specify, the more tasks per second the CPU must perform. Windows Media Encoder automatically adjusts its task load to the given bandwidth and to the limits of the CPU. For example, if you enter a high frame rate (30 frames per second) and a low bit rate (28.8 Kbps), and then use CBR encoding, Windows Media Encoder maintains a constant bit rate and attempts to achieve the requested frame rate by lowering image quality.” This section clearly teaches monitoring the requested files at intervals and adjusting the stream based on the capabilities of the stream and media player. Furthermore this section shows monitoring the performance based on the average frames per second quality being streamed. And based on the performance factors (computer capabilities and bandwidth), the streams are automatically adjusted to higher or lower qualities based on these factors throughout the streaming time/interval.

As per appellant, “Birney is silent as to trigger thresholds, how the triggered thresholds are determined, as well as determining the trigger factors by "a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin," as recited in claim 47". (Argument M, See brief page 36 lines 13-17)

In response to M), Examiner points to page 5 of “Intelligent Streaming” which teaches “When a client attempts to connect to the server to receive a broadcast or file, the server determines the current bandwidth of the connection. For example, suppose a user connects with a 56-Kbps analog modem, but does so at a time when network traffic is particularly high. When the user connects, the server might determine the actual available bandwidth to be 40 Kbps. At that bandwidth, a 53-Kbps stream is too high, so the server streams a 31-Kbps video stream and the audio stream.

After 10 minutes, network congestion increases, and bandwidth suddenly falls to 32 Kbps. The client's frame rate begins to decrease, and some packets are lost, but the server reacts immediately by switching to a 19-Kbps stream. The user notices some degradation in image quality, but audio is continuous and disruption of the presentation is minimized. Then, 20 minutes later, bandwidth worsens again, decreasing to 14 Kbps. This is even too low for the lowest video stream, so the Windows Media server stops streaming all video to the client. The user notices the loss of video but is still able to listen to an uninterrupted audio stream, which only requires 8 Kbps of bandwidth. A few minutes later, bandwidth improves a great deal, and the server again is able to send the 31-Kbps video stream.”

This section clearly teaches a trigger threshold being set which when reached forces the stream quality being sent to the client to be changed, either to a higher quality or lower quality. When packets begin to be lost/(the safety margin relates to the effects the degradation would have on the user) because of the decrease in bandwidth, the stream is automatically switched. Therefore, this section clearly teaches how the triggered thresholds are determined, as well as determining the trigger factors by "a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin.

As per appellant, “Appellant respectfully disagrees because Birney is silent as to issuing a request for each of the files with the filename of that file.". (Argument N, See brief page 37 lines 8-11)

In response to N), Examiner points to page 6 of “Intelligent Streaming” which teaches “Intelligent streaming uses a series of strategies to modify the bit rate of the stream so it plays continuously on the client regardless of the current bandwidth. As bandwidth fluctuates between server and client, the server detects the changes and adopts the best strategy. The strategies are as follows: 1. The server and client automatically determine the current available bandwidth.” The media player and server request the different files stored at different bit rates based on the capabilities. The media player and server request the file with a certain bit rate then upshift or downshift to a different file based on bandwidth and other factors.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/N. D./

Examiner, Art Unit 2444

/William C. Vaughn, Jr./

Supervisory Patent Examiner, Art Unit 2444

Conferees:

/William C. Vaughn, Jr./

Supervisory Patent Examiner, Art Unit 2444

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	**Art Unit**
	NINOS DONABED	2444

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/04/2010	02/01/2011							
	1	-	-							
	2	-	-							
	3	-	-							
	4	-	-							
	5	-	-							
	6	-	-							
	7	-	-							
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	15	-	-							
	16	-	-							
	17	-	-							
	18	-	-							
	19	-	-							
	20	✓	A							
	21	✓	A							
	22	-								
	23	✓	A							
	24	✓	A							
	25	✓	A							
	26	✓	A							
	27	-	-							
	28	-	-							
	29	-	-							
	30	-	-							
	31	-	-							
	32	-	-							
	33	-	-							
	34	-	-							
	35	✓	A							
	36	✓	A							

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11116783	MAJOR ET AL.
	Examiner	Art Unit
	NINOS DONABED	2444

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/04/2010	02/01/2011							
	37	✓	A							
	38	✓	A							
	39	-	-							
	40	✓	A							
	41	✓	A							
	42	✓	A							
	43	✓	A							
	44	✓	A							
	45	✓	A							
	46	✓	A							
	47	✓	A							
	48	✓	A							
	49	✓	A							
	50	✓	A							

Substitute for Form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	11/116,783
				Filing Date	April 28, 2005
				First Named Inventor:	Major, R. Drew
				Art Unit	2444
				Examiner Name	Donnabed, Ninos J.
Sheet	1	**of**	1	Attorney Docket Number	8532P001

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (If known)		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-	6,389,473	05/14/2002	Carmel et al.	
		US-	7,818,444	10/19/2010	Brueck, et al.	
		US-				
		US-				

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

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		Notice of Allowance for 11/673,483, August 5, 2010, 7 pages.	

Examiner Signature	/Ninos Donabed/	Date Considered	03/09/2011

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	066.0141 (P2004-04-01.1)	5535

70560 7590 03/17/2011

INGRASSIA FISHER & LORENZ, P.C. (EchoStar)
7010 E. COCHISE ROAD
SCOTTSDALE, AZ 85253

EXAMINER	
DONABED, NINOS J	
ART UNIT	PAPER NUMBER
2444	

NOTIFICATION DATE	DELIVERY MODE
03/17/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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IPDEPT@Dishnetwork.com

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Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
11116783	4/28/2005	MAJOR ET AL.	066.0141 (P2004-04-01.1)

INGRASSIA FISHER & LORENZ, P.C. (EchoStar)
7010 E. COCHISE ROAD
SCOTTSDALE, AZ 85253

EXAMINER	
NINOS DONABED	
ART UNIT	**PAPER**
2444	20110311

DATE MAILED:

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Commissioner for Patents

This communication is acknowledge recicipt and consideration of IDS' dated 10/26/2010, 10/26/2010, and 4/22/2010.

/William C. Vaughn, Jr./
Supervisory Patent Examiner, Art Unit 2444

/N. D./
Examiner, Art Unit 2444

PTO-90C (Rev.04-03)

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

_____ 37 C.F.R. §1.97(b).

_____ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

____ A statement pursuant to 37 C.F.R. §1.97(e) or

____ **The Director is Authorized to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. § 1.17(p).**

__X__ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

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(2) **Authorization to charge our Deposit Acct. No. 02-2666 in the amount of $180.00 for the fee under 37 C.F.R. §1.17(p) for submission of the Information Disclosure Statement.**

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: April 22, 2010 /Kevin O. Grange/
Kevin O. Grange
Reg. No. 60,793

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
(408) 720-8300

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.D

Substitute for form 1449A/PTO	*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*	**Application Number**	11/116,783
	Filing Date	April 28, 2005
	First Named Inventor	Major, R. Drue
	Group Art Unit	2444
	Examiner Name	Donabed, Ninos J.
Sheet 1 of 1	Attorney Docket No: 8532P001	

US PATENT DOCUMENTS					
Examiner Initial *	**Cite No [1]**	**USP Document Number**	**Publication or Issue Date MM-DD-YYYY**	**Name of Patentee or Applicant of cited Document**	**Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear**
		US-20030204519A1	10/30/2003	Sirivara, et al.	
		US-7408984B2	08/05/2008	Lu, et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	**Cite No [1]**	**Foreign Patent Document** Country Code/Number/Kind Code (if known)	**Publication Date MM-DD-YYYY**	**Name of Patentee or Applicant of cited Document**	**Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear**	**T [2]**

OTHER DOCUMENTS -- NON PATENT LITERATURE DOCUMENTS			
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EXAMINER	/Ninos Donabed/	**DATE CONSIDERED**	03/09/2011

Based on PTO/SB/08A(09-06) - Substitute Disclosure Statement Form (PTO-1449) as modified by BSTZ 03/26/07

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Substitute for Form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	11/116,783
				Filing Date	April 28, 2005
				First Named Inventor:	Major, R. Drew
				Art Unit	2444
				Examiner Name	Donnabed, Ninos J.
Sheet	1	**of**	1	Attorney Docket Number	8532P001

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (If known)		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-				
		US-				
		US-				
		US-				

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published	T[2]
		Final Office Action for 11/673,483, February 4, 2010, 21 pages.	
		Advisory Action for 11/673,483, April 9, 2010, 3 pages.	
		Advisory Action for 11/673,483, May 26, 2010, 3 pages.	

Examiner Signature	/Ninos Donabed/	Date Considered	03/09/2011

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English Translation is attached.

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.D

Electronic Acknowledgement Receipt

EFS ID:	9898661
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	70560
Filer:	Brett Carlson/Sharron Castillo
Filer Authorized By:	Brett Carlson
Attorney Docket Number:	066.0141 (P2004-04-01.1)
Receipt Date:	18-APR-2011
Filing Date:	28-APR-2005
Time Stamp:	18:04:26
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	Reply Brief Filed	20110418_ReplyBrief_P2004-04-01-1.pdf	199367 72a47b1892b39e8599bfe7246897b22cf31122d1	no	19

Warnings:	
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Total Files Size (in bytes):	199367

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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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Serial. No.:	11/116,783	Confirmation No. 5535
Filed:	April 28, 2005	Customer No.: 70560
T.C./A.U.:	2444	
Examiner:	Ninos J. Donabed	
Title:	APPARATUS, SYSTEM, AND METOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT	
Docket No:	066.0141 (P2004-04-01.1)	

APPEAL BRIEF PURSUANT TO 37 C.F.R. § 41.41

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Alexandria, VA 22313-1450

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Commissioner:

We hereby submit our Reply Brief in response to the Examiner's Answer mailed on February 16, 2011. Our response on Monday, April 18, 2011 is timely under 35 U.S.C. § 21 and MPEP § 710.05.

This Brief will supplement the information provided in the original Appeal Brief filed on October 25, 2010 appealing the Office Action mailed on February 22, 2010.

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I. INTRODUCTION 1

II. STATUS OF CLAIMS 2

III. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL 3

IV. ARGUMENTS 5

I. INTRODUCTION

This is a Reply Brief filed under 37 C.F.R. § 41.41 in response to the Examiner's Answer Brief filed on February 16, 2011. This Reply supplements, but does not replace the earlier Appeal Brief filed on October 25, 2010, and we do not waive any of the arguments presented in the earlier brief. Even though the Appeal Brief was fully responsive to the rejections that are of record, we are filing this Reply simply to address several statements made in the Examiner's Answer, and to clarify the issues that are before the Board.

Each of the items required by 37 C.F.R. § 41.41 is set forth below.

II. STATUS OF CLAIMS

As noted by the Examiner, claims 20-21, 23-26, 35-38 and 40-50 are pending. Each of these claims is presently under Appeal.

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III. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection to be reviewed in this appeal the same as those presented in our prior Brief. To reiterate, the issues involved in this Appeal are as follows:

A. Whether claims 20-21, 25, 26, 36, 38, and 43 are obvious under 35 U.S.C. § 103(a) based on Birney, "Intelligent Streaming" ("Birney") in view of Kalra (U.S. 6,490,627) ("Kalra") and Quigg-Brown (U.S. Patent Publ. No. 2003/0152036) ("Quigg-Brown").

B. Whether claims 23-24 are obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

C. Whether claim 35 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

D. Whether claims 40-42 are obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

E. Whether claim 44 obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

F. Whether claims 45, 49, and 50 are obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

G. Whether claim 46 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

H. Whether claim 47 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

I. Whether claim 48 is obvious under 35 U.S.C. § 103(a) based on Birney in view of Kalra and Quigg-Brown.

As noted previously, all of the claims do not stand or fall together, and bases for the separate patentability of the claims was set forth in the Appeal Brief.

5

Aylo Exhibit 1018
Page 794 of 2308

IV. ARGUMENTS

The following is simply intended to bring several issues to the Board's attention and to address the Examiner's statements in the Answer Brief. For full analyses of the rejections, please refer to the original Appeal Brief that was filed on October 25, 2010.

As a preliminary matter, we note that many of the rejections simply fail to consider the full extent of our actual claim language. MPEP § 2143.03 requires that "***all words*** in a claim must be considered in judging the patentability of that claim against the prior art" (emphasis added). Many of the rejections currently of record attempt to cite generalized concepts from the references without applying these concepts to the particular details that are actually recited in our claims. As a result, many of the concepts that are extracted from the cited references are simply not relevant to the actual methods recited in our claims, as described in greater detail in our Appeal Brief, and as supplemented below.

We therefore request that the Board independently review the references of record, especially the primary Birney "Intelligent Streaming" document. Upon review, it will be clear that the cited art falls well short of teaching or suggesting the full extent of our claim language.

The following discussion uses the same outline structure as the "Response to Argument" section at pages 13-24 of the Examiner's Answer Brief for simplicity and convenience of reference.

A) The cited references do not teach or suggest that "<u>each of a plurality of different copies of the video...is stored as multiple files</u>".

Claim 20 requires each of the following features to be present: (1) a plurality of different copies of the video; (2) each of the different copies is stored as a plurality of files; (3) each of the multiple files in each of the different copies has a time index; and (4) files across the different copies share the same time index in relation to the beginning of the video. None of these features are found in a conventional streaming media application, such as the application described in the Birney publication.

The Birney "Intelligent Streaming" publication is not concerned with <u>file based retrieval</u> of media content at all. To the contrary, **Birney describes a system in which "audio and video streams are *<u>encoded into a single Windows Media stream</u>*"** (Birney p. 2, cited in Answer Brief at p. 13, emphasis added). Indeed, the Answer Brief incorrectly blurs the distinction between file based media retrieval and streaming media at the top of page 14, where it notes "each file/streams are encoded from the same content but at a different rate". The Examiner seems to be improperly treating files and streams as the same thing, without providing any basis doing so.

There is absolutely no mention in Birney of storing <u>a plurality of files for each of the different copies</u>. At best, Birney discloses combining several different video streams into one Windows media stream. This does not, however, teach or suggest storing a plurality of commonly-indexed files for each of the different copies of the video, as recited in claim 20.

The Kalra reference cited in the Answer Brief similarly relates to streaming media, rather than file-based video. The Answer Brief cites Kalra's FIGS. 7A-B and col. 6, lines 10-65 as describing the "multiple file" aspects of our claims, but in fact this language simply describes an "adaptive stream" in which supplemental streams are used to enhance the content of a "base stream".

Simply stated, neither Birney nor Kalra describes a method in which each of the different copies of the video is stored as a plurality of files, as required by claim 20. Even a combination of these references, then, would still fall short of teaching or suggesting the full extent of our claim 20.

B) The cited references do not teach or suggest "*each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video*" as recited in claim 20.

Since the art does not teach the multiple file aspects of our claims, it certainly does not teach the further detail regarding time indices that is recited in claim 20. In particular, claim 20 recites that each of the plurality files has "*a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video*". That is, the various files that make up the different copies of the video share common time indices in relation to the beginning of the video. As noted above, this allows the media player to interchange files between different copies of the video.

The Office Action cites the following portion of Birney against the "same time index" features of our claims. The following section is the entire extent of Birney's consideration of "time", so it is reproduced here in full:

> **After 10 minutes, network congestion increases, and bandwidth suddenly falls to 32 Kbps. The client's frame rate begins to decrease, and some packets are lost, but the server reacts immediately by switching to a 19-Kbps stream. The user notices some degradation in image quality, but audio is continuous and disruption of the presentation is minimized. Then, 20 minutes later, bandwidth worsens again, decreasing to 14 Kbps. This is even too low for the lowest video stream, so the Windows Media server stops streaming all video to the client. The user notices the loss of video but is still able to listen to an uninterrupted audio stream, which only requires 8 Kbps of bandwidth. A few minutes later, bandwidth improves a great deal, and the server again is able to send the 31-Kbps video stream.**

Note that this portion of Birney does not relate at all to a "time index" that is shared between files from different copies of the video, nor does the language relate to any sort of time index "in relation to the beginning of the video", as recited in our claims. The reference simply uses the phrases "after 10 minutes" and "20 minutes later" to present an example of streaming video. It does not present a "time index" in any meaningful sense of the phrase, and certainly does not teach "*each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video*", as recited in our claim 20. Birney therefore does not teach the full extent of our claim language for which it is cited.

C) The cited references do not teach or suggest "requesting <u>by the media player</u> a plurality of sequential ones of the files of one of the copies", as recited in claim 20.

Claim 20 clearly recites that that media player requests a plurality of sequential files. In response, the Answer Brief quotes a portion of the Birney

reference that actually supports our position by expressly stating that *the Birney server, not the client, selects and delivers the stream to the client*. The Examiner's quotation (from page 16 of the Answer Brief) appears below:

> **In response to C),** Examiner points to page 2 of "Intelligent Streaming". This section teaches "The server and **client** [media player] automatically determine the current available bandwidth, and then the server selects and delivers the stream with the most appropriate bit rate." The client/media player automatically makes successive determinations and requests the appropriate "Stream"/sequential portions of the video based on available bandwidth and other criteria. Clearly, the media player works directly with server to make determinations of which stream would be optimal and requesting the portions of the stream for any particular time.

Even to the extent that Birney's media player may be involved in determining available bandwidth, this does not meet the language of our claim. The Examiner's statements that the "media player works directly with the server" do not consider the full extent of our claim language, which clearly requires that the media player request a plurality of sequential files.

Claim 20 provides substantial additional detail about this "requesting by the media player" that even further distinguishes the Birney reference. Several of these features are described in increasing detail below.

D) The cited references do not teach or suggest claim 20's recitation of "automatically requesting subsequent portions of the video by requesting for each portion one of the files from one of the copies".

The Answer Brief applies exactly the same analysis and the same language from Birney that was addressed above with respect to Section C) above. Because Birney fails to describe requesting files from the client in any manner, Birney

certainly fails to disclose this additional detail with regard to the media player request. Once again, the Birney reference fails to teach or suggest the full extent of our claim language for which it is cited.

E) The cited references do not teach or suggest the media player "making the successive determinations to shift the playback quality" as recited in claim 20.

Once again, the Examiner's statement that "the client" is involved in determining the bandwidth of the connection does not address the full extent of claim 20, which requires that the media player "*regularly generat[e] a set of one or more factors indicative of the current ability to sustain the streaming of the video"* and "*making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous playback of the video using the files of the highest quality one of the copies determined sustainable at that time*".

As noted above, Birney expressly states that the *server*, not the client, "selects and delivers" the stream with the most appropriate bit rate. This is in direct opposition to claim 20's requirement that the media player make successive determinations to shift playback quality. At the very least, Birney's limited teaching fails to teach or suggest the full extent of our claim language.

F) Quigg-Brown fails to teach "requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections", as recited in claim 35.

The Answer Brief states that Quigg Brown "*teaches a plurality of TCP connections being used to transport a data stream after a request is made*" (Answer Brief at page 18). This statement is focused entirely on delivering a stream of data from the server to the client over multiple connections rather than requesting files, as recited in our claims.

The rejection therefore fails to consider the actual language of claim 35. Even if the Examiner is correct in his characterization of the Quigg-Brown reference, then, this would still not anticipate claim 35's recitation of *requesting the plurality of sequential ones of the files includes requesting the plurality of sequential ones of the files over different ones of the plurality of TCP connections.*

G) Birney fails to teach "wherein the latency is a time measure between when one of the requests is issued and a time that response data of the request begins to arrive at the end user station" as recited in claim 40.

The Answer Brief does not attempt to find a reference to actual time latency in the cited references. Instead, the Answer Brief simply states without elaboration or citation that Birney's "client/server request a stream and the rate is indirectly related to the latency, i.e., the greater the bandwidth, the lower the latency and vice versa". This statement fails to support a Section 103 rejection for several reasons.

First, this does not meet the language of claim 40, which expressly describes latency as a time measure between when a request is issued and a time that response data begins to arrive at the end user station. Birney does not even remotely contemplate computing latency in this particular manner.

Secondly, it is not sufficient to reject a claim under Section 103 based upon material that "indirectly relates" to claimed features. Assuming *arguendo* that an indirect relationship did exist between latency and bandwidth, this would not be sufficient to sustain a Section 103 rejection of claim 40.

Thirdly, bandwidth and latency are not necessarily related in the manner suggested by the Examiner. A satellite link, for example, may have substantial bandwidth, yet latency can be very high due to the extreme distances through space inherent in satellite communications. Similarly, a low bandwidth connection may exhibit very low latency for relatively short messages if no other traffic is using the connection at the same time.

The Examiner's reliance upon Birney's "bandwidth" calculation therefore fails to teach or suggest the particular latency measurement that is recited in claim 40.

H) Birney fails to teach "wherein the at least one of the set of factors is indicative of time intervals between successive receive times for each response to the requested files" as recited in claim 41.

The Answer Brief simply repeats the prior section's reference to Birney's bandwidth determination feature and then states, inexplicably, that "the client/server request a stream (sic) and the rate is indirectly related to the latency". At best, this statement is utterly unrelated to the language of claim 41.

Even to the extent that the Examiner intended to relate Birney's bandwidth measurement to the language of claim 41, this is not a valid argument for the same reasons presented above. Like the prior section, the rejection of claim 41 that is currently of record is simply not related to the actual language of the claim.

I) Birney fails to teach "wherein the at least one of the set of factors is indicative of delays or losses in one or more of the plurality of TCP connections" as recited in claim 42.

Again, the rejection set forth in the Answer Brief does not consider the actual language of our claims. Birney's bandwidth determination technique does not anticipate or suggest the unique language of claim 42, just as it does not teach the language of claims 40 or 41.

J) Birney fails to teach "wherein the files are requested from the web server using Hyper Text Transfer Protocol (HTTP), and wherein the web server is without specialized server-side intelligence to respond to said requesting", as recited in dependent claim 44.

One example of a system that uses file-based media distribution is described in our Specification at paragraph 0051. In that embodiment, files may be distributed using a conventional HTTP server without the need for specialized server-side software (such as Windows Media Server) to support streaming connections.

The entire focus of the Birney reference is to provide specialized server-side software that can manage the streaming connection to the client. The embodiment of claim 44 does not require specialized software to support streaming video, since the client is able to determine desired files and to request

the files from the server using conventional HTTP. This would not be possible in the Birney system without specialized server-side intelligence.

At the very least, the Birney reference fails to teach that files are requested from the web server using the HTTP protocol. HTTP is not typically compatible with streaming media; since Birney relates to streaming media rather than files, there would be no reason for Birney to incorporate this feature.

K) The art fails to teach "wherein at least one of the set of servers is a cache server of a network infrastructure operator", as recited in dependent claim 45.

Even to the extent that cache servers themselves may have been previously known, such caches were not used to deliver media files in the manner recited in claim 45. Hence, the "admitted prior art" referenced by the Examiner does not extend to the full breadth of claim 45. Again, the rejection of record does not anticipate the full extent of our claim language.

L) Birney fails to teach a media player that performs the particular method of claim 46.

Claim 46 recites five method steps that are executed by the media player to generate the set of factors referenced in claim 20. This method includes a number of features relating to monitoring time intervals between successive receive times for each of the requested files, and then calculating performance metrics based upon these time intervals.

In response, the Answer Brief cites Birney's description of a CPU monitor that executes on the video server. This monitor fails to describe any sort of processing by the media player, so it certainly does not meet the various features recited in claim 46. Further, the "CPU monitor" on the server is not relevant to

time intervals between successive receive times for files requested by a media player.

The cited portions of Birney completely fail to teach or suggest the claimed features of claim 35 for which they are cited.

M) Birney fails to teach "comparing a current performance factor of the set of factors with a set of one or more trigger thresholds, wherein the set of one or more trigger thresholds is determined by a combination of two of the set of factors relating to a current read ahead margin and a minimum safety margin, wherein the current read ahead margin is an amount of contiguously available, sequentially arranged requested files of video received by the media player for playback at a current playback time index", as recited in claim 47.

Claim 47 provides additional detail about the media player's "making" process. The Answer Brief alleges that the Birney reference teaches "trigger thresholds", but it does not address the additional features found in this claim. Even to the extent that Birney may imply some sort of trigger threshold (a conclusion that we dispute), Birney certainly does not teach or suggest the remaining features of this claim, including the manner in which the trigger thresholds are formed. The rejection of record therefore fails to teach the full extent of claim 47.

N) Birney fails to teach "said requesting comprises issuing for each of the plurality of sequential ones of the files a request with the filename of that file, and said automatically requesting comprises issuing for each of the files a request with the filename of that file", as recited in claim 48.

As we noted at the outset, the Birney reference relates to conventional streaming video rather than any sort of file-based scheme for delivering media content. Birney therefore fails to describe many of the different aspects of our

claims, including the storing multiple files for each of the different copies of the video, using the same time index for files in different copies of the video, and sequentially requesting files by the media player. Birney operates in a fundamentally different manner in which the specialized server selects and delivers a video stream to a client. The Birney client has no opportunity to request particular files, since the Birney system is organized in a fundamentally different manner.

Claim 48 adds additional detail by reciting that the media player requests sequential files by issuing a requests that include the filenames of the files. This is entirely antithetical to the operation of the Birney system, which uses a single media stream and that uses the server to adapt the stream on behalf of the client. The Birney client would have no ability or need to obtain the filename of a requested file, since Birney does not allow the media player to request individual files at all. Once again, the cited art fails to disclose the actual language of our claims.

O) Conclusion

In general, the various rejections of record do not consider the full extent of our actual claim language. When the references are truly compared to the language of our claims, it is apparent that our claims contain many features that patentably distinguish over the art of record.

For all the reasons stated herein and in the original Appeal Brief, then, Birney and the other references of record fail to describe every element and limitation of our claimed inventions. We therefore repeat our request that the

Board reverse all of the rejections contained in the Final Office Action mailed on February 22, 2010.

In the unlikely event that the Patent Office determines that an extension and/or other relief is required for entry of this Reply Brief or to otherwise prevent abandonment of this matter, the Patent Owner hereby petitions for any required relief, including any extension of time, and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to Deposit Account No. 50-2091.

Respectfully submitted,

Ingrassia, Fisher & Lorenz PC

Dated: Monday, April 18, 2011

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	066.0141 (P2004-04-01.1)	5535

70560 7590 05/10/2011

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EXAMINER	
DONABED, NINOS J	

ART UNIT	PAPER NUMBER
2444	

NOTIFICATION DATE	DELIVERY MODE
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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
11116783	4/28/2005	MAJOR ET AL.	066.0141 (P2004-04-01.1)

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EXAMINER
NINOS DONABED

ART UNIT	PAPER
2444	20110427

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Commissioner for Patents

The reply Brief filed on April 18, 2011 has been considered and placed in the file. No further action by the examiner is deemed necessary, and the case has been forwarded to the Board of Appeal and Interferences.

/William C. Vaughn, Jr./
Supervisory Patent Examiner, Art Unit 2444

/N. D./
Examiner, Art Unit 2444

PTO-90C (Rev.04-03)

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Appeal No: 2011-008734
Application: 11/116,783
Appellant: R. Drew Major et al.

Board of Patent Appeals and Interferences
Docketing Notice

Application 11/116,783 was received from the Technology Center at the Board on May 09, 2011 and has been assigned Appeal No: 2011-008734.

In all future communications regarding this appeal, please include both the application number and the appeal number.

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By order of the Board of Patent Appeals and Interferences.

Electronic Acknowledgement Receipt

EFS ID:	15606406
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	70560
Filer:	Brett Carlson/Sharron Castillo
Filer Authorized By:	Brett Carlson
Attorney Docket Number:	066.0141 (P2004-04-01.1)
Receipt Date:	24-APR-2013
Filing Date:	28-APR-2005
Time Stamp:	19:38:41
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	Power of Attorney	20130424_POA_P2004-04-01-1.pdf	155604 a5936465c4525e7424990e74e32e66f01483b5fb	no	2

Warnings:	
Information:	

2	Assignee showing of ownership per 37 CFR 3.73.	20130424_Stmt373b_P2004-04-01-1.pdf	434944 e1c5339611d80585a82e2f36632f3892ca223836	no	2

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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.

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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/80 (07-12)
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SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	/John T. Kennedy/	Date	12-12-2012
Name	John T. Kennedy	Telephone	303.723.1725
Title	Legal Secondee and Acting Chief IP Counsel		

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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.
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PTO/SB/96 (02-09)
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: DISH DIGITAL L.L.C.

Application No./Patent No.: 11/116,783 Filed/Issue Date: April 28, 2005

Titled: APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVE-RATE SHIFTING OF STREAMING CONTENT

DISH DIGITAL L.L.C. , a limited liability company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;

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3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: R. Drew Major, Mark B. Hurst To: Move Networks, Inc.

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☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(b)(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.

/BRETT A. CARLSON, REG. NO. 39928/	April 24, 2013
Signature	Date
Brett A. Carlson	Attorney of Record
Printed or Typed Name	Title

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.**

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/116,783	04/28/2005	R. Drew Major	066.0141 (P2004-04-01.1)

CONFIRMATION NO. 5535

110240
Ingrassia Fisher & Lorenz, P.C. (DISH Digital)
7010 East Cochise Road
Scottsdale, AZ 85253

POA ACCEPTANCE LETTER

OC000000060781136

Date Mailed: 05/01/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/24/2013.

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.

/erimando/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/116,783	04/28/2005	R. Drew Major	066.0141 (P2004-04-01.1)

CONFIRMATION NO. 5535

POWER OF ATTORNEY NOTICE

70560
INGRASSIA FISHER & LORENZ, P.C. (EchoStar)
7010 E. COCHISE ROAD
SCOTTSDALE, AZ 85253

OC000000060781074

Date Mailed: 05/01/2013

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/24/2013.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/erimando/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/116,783	04/28/2005	R. Drew Major	066.0141 (P2004-04-01.1)	5535

110240 7590 07/23/2014

Ingrassia Fisher & Lorenz, P.C. (DISH Digital)
7010 East Cochise Road
Scottsdale, AZ 85253

EXAMINER	
PAPPAS, PETER	
ART UNIT	**PAPER NUMBER**
2444	

NOTIFICATION DATE	DELIVERY MODE
07/23/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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ipdept@echostar.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte R. DREW MAJOR and MARK B. HURST

Appeal 2011-008734
Application 11/116,783
Technology Center 3600

Before ANTON W. FETTING, BIBHU R. MOHANTY, and MCHAEL C. ASTORINO, *Administrative Patent Judges*.

MOHANTY, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

The Appellants seek our review under 35 U.S.C. § 134 of the final rejection of claims 20–21, 23–25, 35–38, and 40–50 which are all the claims pending in the application. We have jurisdiction under 35 U.S.C. § 6(b).

SUMMARY OF THE DECISION

We REVERSE.

Aylo Exhibit 1018
Page 821 of 2308

THE INVENTION

The Appellants' claimed invention is directed to a system for adaptive rate-content streaming (Spec. ¶ 12). Claim 20, reproduced below with the numbering in brackets added, is representative of the subject matter on appeal.

> 20. A method for presenting rate-adaptive streams, the method comprising:
>
> [1] streaming by a media player operating on an end user station a video from a set of one or more servers, [2] wherein each of a plurality of different copies of the video encoded at different bit rates is stored as multiple files on the set of servers, [3] wherein each of the multiple files yields a different portion of the video on playback, wherein the multiple files across the different copies yield the same portions of the video on playback, each of said files having a time index such that the files whose playback is the same portion of the video for each of the different copies have the same time index in relation to the beginning of the video, and wherein the streaming comprises:
>
> [4] requesting by the media player a plurality of sequential ones of the files of one of the copies from the set of servers over a plurality of Transmission Control Protocol (TCP) connections based on the time indexes;
>
> [5] automatically requesting by the media player from the set of servers over the plurality of TCP connections subsequent portions of the video by requesting for each such portion one of the files from one of the copies dependent upon successive determinations by the media player to shift the playback quality to a higher or lower quality one of the different copies, said automatically requesting including,
>
> [6] regularly generating a set of one or more factors indicative of the current ability to sustain the streaming of the video using the files from different ones of the copies, wherein the set of one or more factors relate to the performance of the network; and
>
> [7] making the successive determinations to shift the playback quality based on at least one of the set of factors to achieve continuous

playback of the video using the files of the highest quality one of the copies determined sustainable at that time; and

[8] presenting the video by playing back with the media player on the end user station the requested files in order of ascending playback time.

THE REJECTIONS

The following rejections are before us for review:

Claims 20, 21, 23–26, 35–38, and 40–50 are rejected under 35 U.S.C. § 103(a) as unpatentable over Birney ("Intelligent Streaming" Microsoft Corporation, May 2003) (hereafter Birney), Kalra (US 6,490,627 B1, iss. Dec. 3, 2002) and Quigg-Brown (US 2003/0152036 A1, pub. Aug. 14, 2003).

FINDINGS OF FACT

We have determined that the findings of fact in the Analysis section below are supported at least by a preponderance of the evidence[1].

ANALYSIS

The Appellants argue that the rejection of claim 20 is improper because the prior art fails to disclose claim limitation [2] (Br. 10–11, Reply Br. 6).

In contrast, the Examiner has determined that the cited claim limitation is found in Birney (Ans. 4, 13–14).

---

[1] *See Ethicon, Inc. v. Quigg*, 849 F.2d 1422, 1427 (Fed. Cir. 1988) (explaining the general evidentiary standard for proceedings before the Patent Office).

We agree with the Appellants. Here, the cited claim limitation [2] requires:

> [2] wherein *each of a plurality of different copies* of the video encoded at different bit rates *is stored as multiple files* on the set of servers. (Claim 1, emphasis added).

Here, cited claim limitation [2] requires that the plurality of different copies of the video are *stored as multiple files*. In contrast, the cited portions of the Birney reference fail to show this. While Birney at page 2 in the "Multiple-Bit-Rate Encoding section" does disclose that there are "a number of discrete, user-definable audio and video streams" it is also disclosed in the same sentence that these streams are "encoded into a *single* Windows Media stream" (emphasis added). As these streams are encoded into a *single* stream, they are not *stored as multiple files* as the claim limitation requires.

The Examiner has also made a reference to cited claim limitation [2] being found in Kalra at Figures 7A–7B and column 6, lines 10–65 (Ans. 14). While Kalra at Figure 7A does show multiple streams it is not disclosed that they are *stored* as multiple files. Further, Kalra at column 6, lines 36–65, shows that Figure 7B, rather than Figure 7A, discloses the data format *when stored*. Kalra in Figure 7B shows a *single stored* stream with slices of the individual files. Thus, Kalra fails to disclose that the different copies of the video are *stored as multiple files*.

For these above reasons, the rejection of claim 20 and its dependent claim is not sustained.

CONCLUSIONS OF LAW

We conclude that Appellants have shown that the Examiner erred in rejecting the claims as listed in the Rejection section above.

DECISION

The Examiner's rejection of claims 20, 21, 23–26, 35–38, and 40–50 is reversed.

REVERSED

mp

Electronic Acknowledgement Receipt

EFS ID:	19715584
Application Number:	11116783
International Application Number:	
Confirmation Number:	5535
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Customer Number:	110240
Filer:	Brett Carlson/Sharron Castillo
Filer Authorized By:	Brett Carlson
Attorney Docket Number:	066.0141 (P2004-04-01.1)
Receipt Date:	29-JUL-2014
Filing Date:	28-APR-2005
Time Stamp:	16:24:03
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	2862
Deposit Account	502091
Authorized User	CARLSON, BRETT A.

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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)	20140729_IDS_P2004-04-01-1.pdf	622752 15a3447dce563853d27675f9a5759aade5daeb00	no	25
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3	Foreign Reference	EP1202487A2.pdf	1169542 e3961c13249effa85f97034caddedff4dbedc77d	no	21
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6	Foreign Reference	GB2367219A.pdf	1022882 4b911a530138606f2eb7560e4982065ed5cfef6d	no	24
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16	Foreign Reference	WO2006010113.pdf	5663204 6e292580427daf9fc8f17d85c0318e226cf0bd6a	no	118
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Information:					
46	Fee Worksheet (SB06)	fee-info.pdf	30346 ec1884efdd73cc1eaba8ebe08e575075ded8e9a	no	2
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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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PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-054930
(43)Date of publication of application : 19.02.2004

(51)Int.Cl. G06F 13/42
G06F 13/38
H04N 7/173

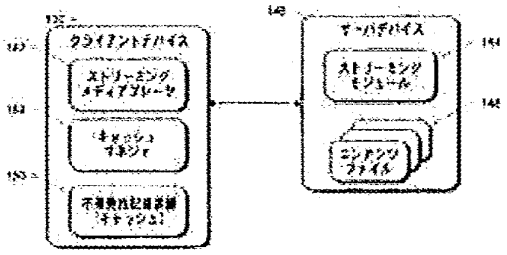
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(54) COMPUTER READABLE MEDIUM, SYSTEM, AND METHOD FOR CLIENT-SIDE CACHING OF STREAMING MEDIA CONTENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a technique for client-side caching of a streaming media content.
SOLUTION: Various functions with respect to streaming media content are made available to users. Such functions includes one or more functions for streaming the media content at a rate independent of the encoded bit rate of the content to allow streaming of the content to continue even when a user has selected various shuttle control options (e.g., pause, stop, fast forward, seek, rewind, etc.), a function for allowing the streaming content to be recorded for playback at a later time, and a function for allowing the streaming content to be played back while shifting time.



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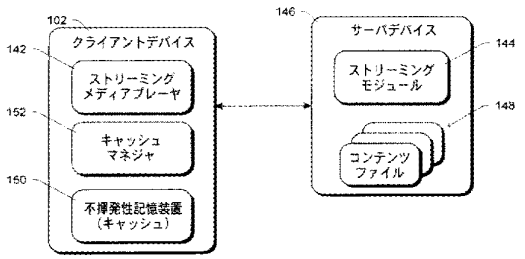
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最終頁に続く

(54)【発明の名称】ストリーミングメディアコンテンツのクライアント側でのキャッシングのためのコンピュータ可読媒体、システムおよび方法

(57)【要約】
【課題】ストリーミングメディアコンテンツのクライアント側でのキャッシングの技術を提供する。
【解決手段】ストリーミングメディアコンテンツに関する各種の機能をユーザが利用できるようにする。そのような機能には、メディアコンテンツをそのコンテンツの符号化ビットレートに依存しないレートでストリーミングすることにより、ユーザが各種のシャトルコントロールオプション（例えば一時停止、停止、早送り、シーク、巻き戻しなど）を選択した際でも、コンテンツのストリーミングを継続することを可能にする、また後の時間に再生するためにストリーミングコンテンツを記録することを可能にする、また時間をずらしてストリーミングコンテンツを再生することを可能にする、のいずれか１つまたは複数が含まれる。
【選択図】　図２



【特許請求の範囲】
【請求項１】
クライアントデバイスの１つまたは複数のプロセッサによって実行されるときに、前記１つまたは複数のプロセッサにより、
サーバデバイスから、ストリーミングメディアコンテンツを該ストリーミングメディアコンテンツの符号化ビットレートに依存しないレートで受信させる
複数の命令が格納されていることを特徴とする１つまたは複数のコンピュータ可読媒体。
【請求項２】
前記複数の命令は、さらに前記１つまたは複数のプロセッサに、
前記受信したストリーミングメディアコンテンツを不揮発性の記憶装置に保存させる
ことを特徴とする請求項１に記載の１つまたは複数のコンピュータ可読媒体。
【請求項３】
前記サーバデバイスはプロキシサーバを含むことを特徴とする請求項１に記載の１つまたは複数のコンピュータ可読媒体。
【請求項４】
前記複数の命令はさらに前記１つまたは複数のプロセッサに、
前記ストリーミングメディアコンテンツについて要求されたレートを指示する速度要求を前記サーバデバイスに送信させ、
前記ストリーミングメディアコンテンツの前記レートの指示を前記サーバデバイスから受信させる
ことを特徴とする請求項１に記載の１つまたは複数のコンピュータ可読媒体。
【請求項５】
前記要求されたレートは値ｘで表され、前記速度要求は、
プラグマ：速度＝ｘ
を含むストリーミング速度メッセージヘッダであることを特徴とする請求項４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項６】
前記要求されたレートは値ｘで表され、前記速度要求は、
速度＝ｘ
を含むストリーミング速度メッセージヘッダであることを特徴とする請求項４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項７】
サーバデバイスで実施される方法であって、
ストリーミングメディアコンテンツに対する要求をクライアントデバイスから受信することと、
前記メディアコンテンツを前記コンテンツの符号化ビットレートに依存しないレートで前記クライアントデバイスにストリーミングすることと
を含むことを特徴とする方法。
【請求項８】
前記ストリーミングメディアコンテンツに対する要求をユーザから受信することと、
前記ユーザの要求に応答して、前記サーバデバイスに前記ストリーミングメディアコンテンツを要求することと
をさらに含むことを特徴とする請求項７に記載の方法。
【請求項９】
前記受信したストリーミングメディアコンテンツをキャッシュすること
をさらに含むことを特徴とする請求項７に記載の方法。
【請求項１０】
前記サーバデバイスは、プロキシサーバを含むことを特徴とする請求項７に記載の方法。
【請求項１１】
前記ストリーミングメディアコンテンツに要求されたレートを指示する速度要求を前記サ

ーバデバイスに送信することと、
前記ストリーミングメディアコンテンツの前記レートの指示を前記サーバデバイスから受信することと
をさらに含むことを特徴とする請求項７に記載の方法。
【請求項１２】
前記要求されたレートは値ｘで表され、前記速度要求は、
プラグマ：速度＝ｘ
を含むストリーミング速度メッセージヘッダであることを特徴とする請求項１１に記載の方法。
【請求項１３】
前記要求されたレートは値ｘで表され、前記速度要求は、速度＝ｘ
を含むストリーミング速度メッセージヘッダであることを特徴とする請求項１１に記載の方法。
【請求項１４】
クライアントデバイスの１つまたは複数のプロセッサによって実行されると、前記１つまたは複数のプロセッサに、
ストリーミングメディアコンテンツの再生を少なくとも一時的に停止する要求を受信させ、
前記クライアントデバイスにおける前記ストリーミングメディアコンテンツの再生を停止させ、
前記ストリーミングメディアコンテンツの再生を停止させる要求に関わらず、前記ストリーミングメディアコンテンツの受信を継続させる
複数の命令が格納されていることを特徴とする１つまたは複数のコンピュータ可読媒体。
【請求項１５】
前記要求は停止コマンドを含むことを特徴とする請求項１４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項１６】
前記要求は一時停止コマンドを含むことを特徴とする請求項１４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項１７】
前記複数の命令はさらに、前記１つまたは複数のプロセッサに前記受信したストリーミングメディアコンテンツをキャッシュさせることを特徴とする請求項１４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項１８】
サーバからストリーミングメディアコンテンツを受信することと、
ユーザからシャトルコントロールオプションを受信することと、
前記サーバに前記シャトルコントロールオプションを指示せずに、前記シャトルコントロールオプションに従って前記ストリーミングメディアコンテンツの再生を変更することとを含むことを特徴とする方法。
【請求項１９】
前記シャトルコントロールオプションは停止コマンドを含むことを特徴とする請求項１８に記載の方法。
【請求項２０】
前記シャトルコントロールオプションは一時停止コマンドを含むことを特徴とする請求項１８に記載の方法。
【請求項２１】
前記シャトルコントロールオプションは巻き戻しコマンドを含むことを特徴とする請求項１８に記載の方法。
【請求項２２】
前記シャトルコントロールオプションは早送りコマンドを含むことを特徴とする請求項１

８に記載の方法。
【請求項２３】
前記サーバから受信すると前記ストリーミングメディアコンテンツをキャッシュすることをさらに含むことを特徴とする請求項１８に記載の方法。
【請求項２４】
クライアントデバイスの１つまたは複数のプロセッサによって実行されると、前記１つまたは複数のプロセッサに、
サーバデバイスからストリーミングメディアコンテンツを受信させ、
前記受信したストリーミングメディアコンテンツを前記クライアントデバイスの不揮発性記憶装置に保存させる
複数の命令が格納されていることを特徴とする１つまたは複数のコンピュータ可読媒体。
【請求項２５】
前記サーバデバイスはプロキシサーバを含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項２６】
前記不揮発性記憶装置はハードディスクドライブを含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項２７】
前記不揮発性記憶装置は、光ディスクおよび光ディスクドライブを含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項２８】
前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる前記命令は、コンテンツをキャッシュすることが許される旨の指示を前記サーバデバイスから受信した場合にのみ、前記１つまたは複数のプロセッサに、その受信したストリーミングメディアコンテンツを保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項２９】
前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる前記命令は、ストリーミングメディアコンテンツのキャッシングが前記サーバデバイスによってサポートされることを示すサポートヘッダを含むメッセージを前記サーバデバイスから受信した場合にのみ、前記１つまたは複数のプロセッサに、その受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項３０】
前記サポートヘッダは、ストリーミングメディアコンテンツのクライアントでのキャッシングが前記サーバデバイスによってサポートされることを示す機能名を含み、前記機能名は、
ｃｏｍ．ｍｉｃｒｏｓｏｆｔ．ｗｍ．ｆａｓｔｃａｃｈｅ
を含むことを特徴とする請求項２９に記載の１つまたは複数のコンピュータ可読媒体。
【請求項３１】
前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる前記命令は、キャッシュ制御指示に関連のストリーミングメディアコンテンツをキャッシュすることが前記クライアントデバイスに許されることを示すキャッシュ制御指示を含むメッセージを前記サーバデバイスから受信した場合にのみ、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。
【請求項３２】
前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを

前記不揮発性記憶装置に保存させる前記命令は、前記ストリーミングメディアコンテンツのキャッシュが許されることが、前記ストリーミングメディアコンテンツの識別子によって示されている場合にのみ、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３３】

前記識別子はＵＲＬ（Ｕｎｉｆｏｒｍ　ＲｅｓｏｕｒｃｅＬｏｃａｔｏｒ）を含むことを特徴とする請求項３２に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３４】

前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる前記命令は、ユーザがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしていない場合にのみ、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３５】

前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる前記命令は、前記クライアントデバイスのメディアプレーヤがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしていない場合にのみ、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３６】

前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる前記命令は、前記ストリーミングメディアコンテンツのタイプがキャッシュ可能タイプである場合にのみ、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存させる命令を含むことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３７】

前記複数の命令はさらに前記１つまたは複数のプロセッサに、
前記ストリーミングメディアコンテンツに対する事後の要求を受信させ、
前記事後の要求に応答して、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置から取得させる
ことを特徴とする請求項２４に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３８】

前記複数の命令はさらに前記１つまたは複数のプロセッサに、
前記ストリーミングメディアコンテンツの有効期限が切れているかどうかを調べさせ、
前記ストリーミングメディアコンテンツの有効期限が切れていない場合にのみ、前記事後の要求に応答して、前記不揮発性記憶装置から前記ストリーミングメディアコンテンツを取得させる
ことを特徴とする請求項３７に記載の１つまたは複数のコンピュータ可読媒体。

【請求項３９】

前記複数の命令はさらに前記１つまたは複数のプロセッサに、
前記ストリーミングメディアコンテンツの有効期限が切れているかどうかを調べさせ、
前記ストリーミングメディアコンテンツの有効期限が切れている場合は、前記ストリーミングメディアコンテンツを再確認させる
ことを特徴とする請求項３７に記載の１つまたは複数のコンピュータ可読媒体。

【請求項４０】

前記複数の命令はさらに前記１つまたは複数のプロセッサに、

前記不揮発性記憶装置からの前記ストリーミングメディアコンテンツの再生に係わるロギング情報を含むメッセージを生成させ、前記メッセージは、データ構造のメッセージ本体部分に前記ロギングが含まれることを示すロギング情報ヘッダを含むことを特徴とする請求項３７に記載の１つまたは複数のコンピュータ可読媒体。

【請求項４１】

前記ロギング情報ヘッダは、

Ｃｏｎｔｅｎｔ－Ｔｙｐｅ：ａｐｐｌｉｃａｔｉｏｎ／ｘ－ｗｍｓ－ｓｅｎｄｅｖｅｎｔ

を含むことを特徴とする請求項４０に記載の１つまたは複数のコンピュータ可読媒体。

【請求項４２】

不揮発性記憶装置と、

システム上で再生するためにストリーミングメディアコンテンツをサーバデバイスから受信するように構成され、さらに、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成されたストリーミングメディアプレーヤコンポーネントとを備えることを特徴とするシステム。

【請求項４３】

前記ストリーミングメディアプレーヤコンポーネントはさらに、ストリーミングメディアコンテンツのキャッシングが前記サーバデバイスによってサポートされることを示すサポートヘッダを含むメッセージを前記サーバデバイスから受信した場合にのみ、前記受信したストリーミングメディアコンテンツを前記不揮発性記憶装置に保存するように構成されることを特徴とする請求項４２に記載のシステム。

【請求項４４】

前記サポートヘッダは、ストリーミングメディアコンテンツのクライアントでのキャッシングが前記サーバデバイスによってサポートされることを示す機能名を含み、前記機能名は、

ｃｏｍ．ｍｉｃｒｏｓｏｆｔ．ｗｍ．ｆａｓｔｃａｃｈｅ

を含むことを特徴とする請求項４３に記載のシステム。

【請求項４５】

前記ストリーミングメディアプレーヤコンポーネントはさらに、前記コンテンツのキャッシングが許されることを示す指示を前記サーバデバイスから受信した場合にのみ、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成されることを特徴とする請求項４２に記載のシステム。

【請求項４６】

前記ストリーミングメディアプレーヤコンポーネントはさらに、キャッシュ制御指示に関連のストリーミングメディアコンテンツをキャッシュすることが前記システムに許されることを示すキャッシュ制御指示を含むメッセージを前記サーバデバイスから受信した場合にのみ、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成されることを特徴とする請求項４２に記載のシステム。

【請求項４７】

前記ストリーミングメディアプレーヤコンポーネントはさらに、前記ストリーミングメディアコンテンツのキャッシングが許されることが、前記ストリーミングメディアコンテンツの識別子によって示されている場合にのみ、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成されることを特徴とする請求項４２に記載のシステム。

【請求項４８】

前記識別子はＵＲＬ（Ｕｎｉｆｏｒｍ　Ｒｅｓｏｕｒｃｅ　Ｌｏｃａｔｏｒ）を含むことを特徴とする請求項４７に記載のシステム。

【請求項４９】

前記ストリーミングメディアプレーヤコンポーネントはさらに、ユーザがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしていない場合にのみ、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成

されることを特徴とする請求項４２に記載のシステム。
【請求項５０】
前記ストリーミングメディアプレーヤコンポーネントはさらに、前記ストリーミングメディアプレーヤがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしていない場合にのみ、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成されることを特徴とする請求項４２に記載のシステム。
【請求項５１】
前記ストリーミングメディアプレーヤコンポーネントはさらに、前記ストリーミングメディアコンテンツのタイプがキャッシュ可能タイプである場合にのみ、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶するように構成されることを特徴とする請求項４２に記載のシステム。
【請求項５２】
前記ストリーミングメディアプレーヤコンポーネントはさらに、
前記ストリーミングメディアコンテンツに対する事後の要求を受信し、
前記事後の要求に応答して、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置から取得する
ように構成されることを特徴とする請求項４２に記載のシステム。
【請求項５３】
前記ストリーミングメディアプレーヤコンポーネントはさらに、
前記ストリーミングメディアコンテンツの有効期限が切れているかどうかを調べ、
前記ストリーミングメディアコンテンツの有効期限が切れていない場合にのみ、前記事後の要求に応答して、前記ストリーミングメディアコンテンツを前記不揮発性記憶装置から取得する
ように構成されることを特徴とする請求項５２に記載のシステム。
【請求項５４】
前記ストリーミングメディアプレーヤコンポーネントはさらに、
前記ストリーミングメディアコンテンツの有効期限が切れているかどうかを調べ、
前記ストリーミングメディアコンテンツの有効期限が切れている場合は、前記ストリーミングメディアコンテンツを再確認する
ように構成されることを特徴とする請求項５２に記載のシステム。
【請求項５５】
前記ストリーミングメディアプレーヤコンポーネントはさらに、
前記不揮発性記憶装置からの前記ストリーミングメディアコンテンツの再生に係わるロギング情報を含むメッセージを生成し、前記メッセージは、データ構造のメッセージ本体部分に前記ロギング情報が含まれることを示すロギング情報ヘッダを含む
ように構成されることを特徴とする請求項５２に記載のシステム。
【請求項５６】
前記ロギング情報ヘッダは、
Ｃｏｎｔｅｎｔ－Ｔｙｐｅ：ａｐｐｌｉｃａｔｉｏｎ／ｘ－ｗｍｓ－ｓｅｎｄｅｖｅｎｔ
を含むことを特徴とする請求項５５に記載のシステム。
【請求項５７】
クライアントデバイスの１つまたは複数のプロセッサによって実行されると、前記１つまたは複数のプロセッサに、
サーバデバイスからストリーミングメディアコンテンツを受信させ、
後の時間に再生するために、前記受信したストリーミングメディアコンテンツを前記クライアントデバイスでキャッシュさせる
複数の命令が格納されていることを特徴とする１つまたは複数のコンピュータ可読媒体。
【請求項５８】
前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツをキャッシュさせる前記命令は、コンテンツのキャッシングが許される旨の指示を前記サー

バデバイスから受信した場合にのみ、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツを保存させる命令を含むことを特徴とする請求項５７に記載の１つまたは複数のコンピュータ可読媒体。
【請求項５９】
前記後の時間は、前記ストリーミングメディアコンテンツすべてを前記サーバデバイスから受信した後の時間を含むことを特徴とする請求項５７に記載の１つまたは複数のコンピュータ可読媒体。
【請求項６０】
クライアントデバイスの１つまたは複数のプロセッサによって実行されると、前記１つまたは複数のプロセッサに、
サーバデバイスからストリーミングメディアコンテンツを受信させ、
前記ストリーミングメディアコンテンツの再生の時間をずらすことを可能にさせる
複数の命令が格納されていることを特徴とする１つまたは複数のコンピュータ可読媒体。
【請求項６１】
前記複数の命令はさらに、前記１つまたは複数のプロセッサに、前記受信したストリーミングメディアコンテンツをキャッシュさせることを特徴とする請求項６０に記載の１つまたは複数のコンピュータ可読媒体。
【請求項６２】
不揮発性記憶装置と、
ストリーミングメディアコンテンツの符号化ビットレートに依存しないレートで前記ストリーミングメディアコンテンツをサーバデバイスから受信し、
前記ストリーミングメディアコンテンツを前記不揮発性記憶装置に記憶し、
前記ストリーミングメディアコンテンツの後の時間の再生を可能にし、
前記ストリーミングメディアコンテンツの時間をずらした再生を可能にし、
受け取ったシャトルコントロールオプションを前記サーバデバイスに指示することなく、
前記シャトルコントロールオプションに従って、前記ストリーミングメディアコンテンツの再生を変更し、
ストリーミングメディアコンテンツの再生を少なくとも一時的に停止する要求を受信し、
前記システムにおける前記ストリーミングメディアコンテンツの再生を停止し、
前記ストリーミングメディアコンテンツの再生を停止させる要求に関わらず、前記ストリーミングメディアコンテンツの受信を継続する
ように構成されたストリーミングメディア再生コンポーネントと
を備えることを特徴とするシステム。
【請求項６３】
データ構造が格納されたコンピュータ可読媒体であって、
データ構造タイプを識別するデータを含む第１の部分と、
１つまたは複数のヘッダを識別するデータを含む第２の部分であって、前記１つまたは複数のヘッダは、ストリーミングメディアコンテンツのクライアントでのキャッシングが、前記ストリーミングメディアコンテンツのソースによってサポートされるかどうかを示すサポートヘッダを含む第２の部分と、
前記データ構造中の前記第２の部分の終わりを識別するデータを含む第３の部分と
を備えることを特徴とするコンピュータ可読媒体。
【請求項６４】
前記サポートヘッダは、ストリーミングメディアコンテンツのクライアントでのキャッシングが前記ソースによってサポートされることを示す機能名を含み、前記機能名は、
ｃｏｍ．ｍｉｃｒｏｓｏｆｔ．ｗｍ．ｆａｓｔｃａｃｈｅ
を含むことを特徴とする請求項６３に記載のコンピュータ可読媒体。
【請求項６５】
データ構造が格納されたコンピュータ可読媒体であって、
データ構造タイプを識別するデータを含む第１の部分と、

キャッシュ制御指示に関連のストリーミングメディアコンテンツをクライアントデバイスがキャッシュできるかどうかを示すキャッシュ制御指示を識別するデータを含む第２の部分と、
前記データ構造中の前記第２の部分の終わりを識別するデータを含む第３の部分と
を備えることを特徴とするコンピュータ可読媒体。
【請求項６６】
前記キャッシュ制御指示はさらに、プロキシデバイスが前記ストリーミングメディアコンテンツをキャッシュできるかどうかを示すことを特徴とする請求項６５に記載のコンピュータ可読媒体。
【請求項６７】
前記キャッシュ制御指示はさらに、ストリーミングメディアコンテンツのキャッシングをサポートしないキャッシングデバイスが前記ストリーミングメディアコンテンツをキャッシュできるかどうかを示すことを特徴とする請求項６５に記載のコンピュータ可読媒体。
【請求項６８】
前記クライアントデバイスがストリーミングメディアコンテンツをキャッシュできることを示すのに、キャッシュ制御指示を使用しないことを特徴とする請求項６５に記載のコンピュータ可読媒体。
【請求項６９】
前記クライアントデバイスのストリーミングメディアプレーヤが前記ストリーミングメディアコンテンツをキャッシュできることを示すキャッシュ制御指示は、
ｎｏ－ｃａｃｈｅ，　ｕｓｅｒ－ｐｕｂｌｉｃ
を含むことを特徴とする請求項６５に記載のコンピュータ可読媒体。
【請求項７０】
前記クライアントデバイスのストリーミングメディアプレーヤが前記ストリーミングメディアコンテンツをキャッシュできないことを示すキャッシュ制御指示は、
ｎｏ－ｕｓｅｒ－ｃａｃｈｅ
を含むことを特徴とする請求項６５に記載のコンピュータ可読媒体。
【請求項７１】
データ構造が格納されたコンピュータ可読媒体であって、
データ構造タイプを識別するデータを含む第１の部分と、
１つまたは複数のヘッダを識別するデータを含む第２の部分であって、前記１つまたは複数のヘッダは、ストリーミングメディアコンテンツをストリーミングする速度を示すストリーミング速度ヘッダを含み、前記ストリーミングメディアコンテンツをストリーミングする速度は、前記ストリーミングメディアコンテンツの符号化ビットレートに依存しない第２の部分と、
前記データ構造中の前記第２の部分の終わりを識別するデータを含む第３の部分と
を備えることを特徴とするコンピュータ可読媒体。
【請求項７２】
前記ストリーミングメディアコンテンツをストリーミングする速度は値ｘによって表され、前記ストリーミング速度ヘッダは、
プラグマ：速度＝ｘ
を含むことを特徴とする請求項７１に記載のコンピュータ可読媒体。
【請求項７３】
前記ストリーミングメディアコンテンツをストリーミングする速度は値ｘによって表され、前記ストリーミング速度ヘッダは、
速度＝ｘ
を含むことを特徴とする請求項７１に記載のコンピュータ可読媒体。
【請求項７４】
前記ストリーミングメディアコンテンツをストリーミングする速度は、前記ストリーミングメディアコンテンツを受信するクライアントデバイスによって要求された速度であるこ

とを特徴とする請求項７１に記載のコンピュータ可読媒体。
【請求項７５】
データ構造が格納されたコンピュータ可読媒体であって，
データ構造タイプを識別するデータを含む第１の部分と，
１つまたは複数のヘッダを識別するデータを含む第２の部分であって、前記１つまたは複数のヘッダは、前記データ構造のメッセージ本体部分に、クライアントデバイスキャッシュからのストリーミングメディアコンテンツの再生に係わるロギング情報が含まれることを示すロギング情報ヘッダを含む第２の部分と，
前記データ構造中の前記第２の部分の終わりを識別するデータを含む第３の部分と
を備えることを特徴とするコンピュータ可読媒体。
【請求項７６】
前記ロギング情報ヘッダは、
Ｃｏｎｔｅｎｔ－Ｔｙｐｅ：ａｐｐｌｉｃａｔｉｏｎ／ｘ－ｗｍｓ－ｓｅｎｄｅｖｅｎｔ
を含むことを特徴とする請求項７５に記載のコンピュータ可読媒体。
【請求項７７】
前記複数の命令が、さらに前記１つまたは複数のプロセッサに、
前記ストリーミングメディアコンテンツに対する要求をユーザから受信させ、前記ユーザの要求に応答して前記サーバデバイスに対して前記ストリーミングメディアコンテンツを要求させる
ことを特徴とする請求項１に記載の１つまたは複数のコンピュータ可読媒体。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、ストリーミングメディアに関し、詳細には、ストリーミングメディアコンテンツのクライアント側でのキャッシングに関する。
【０００２】
【従来の技術】
オーディオ、ビデオ、および／またはテキストメディアコンテンツのストリーミングなどのコンテンツストリーミングが次第に普及しつつある。一般に、用語「ストリーミング」とは、メディアを表すデータがネットワークを通じてクライアントコンピュータに提供され、クライアントコンピュータは、「ファイル」全体が配信されるのを待つのではなく、それをネットワークサーバから受信しながらストリーミングコンテンツをレンダリングすることを意味する。
【０００３】
ストリーミングメディアコンテンツの利用性が高まることにより、以前にはインターネットまたは他のコンピュータネットワークを介しては入手できなかった様々な情報コンテンツの入手が可能になっている。ライブコンテンツは，そのようなコンテンツの顕著な一例である。ストリーミングメディアコンテンツを使用すると、注目すべきイベントのオーディオ、ビデオ、またはオーディオ／ビジュアルの対象を、その進行と同時にインターネットを通じて放送することができる。同様に、テレビ局またはラジオ局は、インターネットを通じて各自のライブコンテンツを伝送することができる。
【０００４】
現在、ストリーミングメディアコンテンツは、「ジャストインタイム（ちょうど間に合う）配信」の概念を使用してストリーミングされている。コンテンツは、クライアントで再生するためにそのコンテンツの符号化ビットレートでクライアントに配信される。ストリームメディアコンテンツには、（例えば、再送する必要のある損失データやその他のネットワークの不整合を考慮に入れて）いくらかのバッファリングを行う。しかし、現在のクライアントシステムは通例、クライアントで行うバッファリング量を最小に抑え、それによりクライアントにおけるメモリ要件を低減し、またバッファリングによる始動待ち時間も短縮することを試みている。

【０００５】
【発明が解決しようとする課題】
しかし、現在のストリーミングメディアコンテンツおよびバッファリングシステムは、他タイプのコンテンツ再生システムに備わる機能を持たないことにより損をしている。例えばＶＣＲ（ビデオカセットレコーダ）で録画したテレビ番組はユーザによって巻き戻すことができ、すでに見た部分を容易に繰り返し見ることができ、あるいはユーザの必要に応じて後の時間に見ることができる。これに対し、現在のストリーミングメディアコンテンツシナリオでは、そのような動作をユーザによって行うことができない。ストリームメディアコンテンツを巻き戻すには、コンテンツのストリーミングを停止し、新しい位置で再開する（そしてしたがってその新しい位置から開始するストリームを再度バッファリングする）必要があり、通例ユーザは、ストリーミングメディアコンテンツを後の時間に見ることができない。すなわち、コンテンツは受信と同時にユーザに対して再生され、ユーザがコンテンツを後の時間に見たい場合はその後の時間にコンテンツをストリーミングしなければならない。
【０００６】
【課題を解決するための手段】
本発明による下記のストリーミングメディアコンテンツのクライアント側でのキャッシングは、上記の課題およびその他の課題を解決することができる。
【０００７】
以下、本発明によるストリーミングメディアコンテンツのクライアント側でのキャッシングについて説明する。
【０００８】
本発明の一実施形態によれば、ストリーミングメディアコンテンツを、コンテンツの符号化ビットレートに依存しないレートでストリーミングすることができる。
【０００９】
本発明の他の実施形態によれば、ユーザが様々なシャトルコントロールオプション（例えば一時停止、停止、早送り、シーク、巻き戻しなど）を選択した場合でも、ストリーミングメディアコンテンツのストリーミングを継続することができる。
【００１０】
本発明のさらに他の実施形態によれば、後の時間に再生するためにストリーミングメディアコンテンツを記録することができる。
【００１１】
本発明のさらに別の実施形態によれば、ストリーミングメディアコンテンツを時間をずらして再生する（ｔｉｍｅ－ｓｈｉｆｔ）ことができる。
【００１２】
追加的な実施形態によれば、サーバデバイスから受信したストリーミングメディアコンテンツをクライアントデバイスにキャッシュ（キャッシュメモリに格納）することができる。そしてクライアントデバイスのストリーミングメディアコンテンツに対する事後の要求は、サーバデバイスからそのストリーミングメディアコンテンツを再度ストリーミングするのではなく、キャッシュされたストリーミングメディアコンテンツを使用して満たすことができる。
【００１３】
本明細書の記述を通じて、同様の構成要素および／または特徴を参照する際は同じ参照符号を使用することとする。
【００１４】
【発明の実施の形態】
図面を参照して、本発明によるストリーミングメディアコンテンツのクライアント側でのキャッシングの実施の形態を以下に詳述する。ストリーミングメディアコンテンツをキャッシュすることにより、従来は利用できなかった様々な機能をユーザが利用できるようにすることができる。そのような機能の例には、コンテンツの符号化ビットレートに依存し

ないレートでメディアコンテンツをストリーミングすることにより、ユーザが各種のシャトル（ｓｈｕｔｔｌｅ）コントロールオプション（例えば一時停止、停止、早送り、シーク、巻き戻しなど）を選択した際でもコンテンツのストリーミングを継続することが可能になる、後の時間に再生するためにストリーミングコンテンツを記録することが可能になる、ストリーミングコンテンツを時間をずらして再生することが可能になることが含まれる。ストリーミングメディアコンテンツのクライアント側でのキャッシングの様々な実施形態は、これらの機能のうち異なる機能、あるいはこれらの機能の異なる機能の組合せを含むことができる。

【００１５】

図１に、ストリーミングメディアコンテンツのクライアント側でのキャッシングを用いることができる例示的なネットワーク環境１００を示す。環境１００では、複数の（ｘ個の）クライアントコンピューティングデバイス１０２（１）、１０２（２）、．．．、１０２（ｘ）が、ネットワーク１０６を介して複数（ｙ個）のオリジンサーバコンピューティングデバイス１０４（１）、１０４（２）、．．．、１０４（ｙ）に結合されている。ネットワーク１０６は、各種の従来のネットワークプロトコル（公開プロトコルおよび／または独自仕様のプロトコルを含む）のうち任意のプロトコルを用いる、各種の従来のネットワークトポロジおよびタイプ（光ネットワーク、配線および／または無線ネットワークを含む）の任意のネットワークを表すものとする。ネットワーク１０６は、例えば、インターネット、また可能性としては１つまたは複数のローカルエリアネットワーク（ＬＡＮ）および／または広域ネットワーク（ＷＡＮ）の少なくとも一部を含むことができる。

【００１６】

オリジンサーバデバイス１０４から利用可能なストリーミングメディアコンテンツを要求する際に、その要求は、クライアントデバイス１０２からネットワーク１０６を介してサーバデバイス１０４に送られる。オリジンサーバデバイス１０４はその要求を受信し、ネットワーク１０６を介して要求元のクライアントデバイス１０２にその要求されたコンテンツを返送する。１つまたは複数のプロキシサーバ（図示せず）がネットワーク１０６の一部であってよく、クライアントデバイス１０２からの要求およびクライアントデバイス１０２への応答は、実際のサーバデバイス１０４ではなく、そのようなプロキシサーバに送信し、そこから受信してもよい。クライアントデバイス１０２にメディアコンテンツをストリーミングするデバイス（オリジンサーバ、プロキシサーバ、あるいはその他のデバイス）はいずれも、そのストリームメディアコンテンツのソースデバイスと呼ばれる。

【００１７】

コンピューティングデバイス１０２および１０４はそれぞれ、各種の従来のコンピューティングデバイスのいずれであってもよく、これにはデスクトップＰＣ（パーソナルコンピュータ、パソコン）、ノートブック型または携帯型コンピュータ、ワークステーション、メインフレームコンピュータ（大型コンピュータ）、インターネット機器、ゲームコンソール、ハンドヘルド（手持ちサイズ）ＰＣ、携帯電話、携帯情報端末（ＰＤＡ）、これらの組合せなどが含まれる。デバイス１０２および１０４の１つまたは複数は、同じタイプのデバイスでも、あるいは異なるタイプのデバイスであってもよい。

【００１８】

サーバデバイス１０４は、各種のデータをクライアント１０２にストリーミング可能な状態にすることができる。用語「ストリーミング」は、メディア（マスコミ媒体）を表すデータがネットワークを通じてクライアントデバイスに提供され、そのコンテンツが完全に配信される前にコンテンツの再生を開始できることを指し示すのに使用される。データは、公開で利用可能としても、あるいは限定にしてもよい（例えば、特定のユーザだけに制限する、適切な料金を支払った場合のみ利用可能とするなど）。データは、オーディオ、ビデオ、テキスト、アニメーションなど、１つまたは複数の各種タイプのコンテンツのいずれであってもよい。さらに、データは「オンデマンド」式（例えば予め記録されており、サイズが分かっているもの）であっても、あるいは「ブロードキャスト」（例えば、演奏と同時に記録され、記録後すぐにストリーミングが可能な状態とされるコンサートのデ

ジタル表現など、予めサイズが分からないもの）してもよい。

【００１９】

図２に、例示的なクライアントデバイスおよびサーバデバイスを示す。クライアントデバイス１０２は、ソースサーバデバイス１４６のストリーミングモジュール１４４にアクセスするように構成されたストリーミングメディアプレーヤ１４２を含む。ソースサーバデバイス１４６は、例えば、図１のオリジンサーバデバイス１０４か、あるいは別のデバイス（例えばプロキシデバイス）である。ソースサーバデバイス１４６はまた（例えばプレーヤ１４２へのユーザ入力に基づいて）メディアプレーヤ１４２によりその中から選択を行うことができる１つまたは複数のストリーミングメディアコンテンツファイル１４８、および選択されてプレーヤ１４２にストリーミングされたコンテンツファイルを含む。ストリーミングメディアコンテンツは、受信されるとすぐに不揮発性の記憶装置１５０に保存することにより、クライアントデバイスでキャッシュされることができる。図２には示されていないが、１つまたは複数の追加的なデバイス（例えばファイアウォール、ルータ、ゲートウェイ、ブリッジ、複数のプロキシサーバなど）が、クライアントデバイス１０２とサーバデバイス１４６の間に位置してもよい。説明を簡潔にするために図２には単一のクライアント１０２とサーバ１４６しか図示していないが、サーバ１４６には複数のクライアント１０２がアクセスすることができ、また単一のクライアント１０２が複数のサーバ１４６にアクセスできることに留意されたい。

【００２０】

不揮発性の記憶装置１５０は、電源障害が生じた際でもその状態を維持するという点で不揮発性である。したがって、不揮発性記憶装置１５０に保存されたストリーミングメディアコンテンツは、クライアント１０２に電力損失が生じた際（例えばクライアント１０２の電源を切った際）でも消えずに存続する。デバイス１５０としては、磁気ディスクおよびディスクドライブ（例えば従来のハードディスク）、光ディスクおよびディスクドライブ、フラッシュメモリなど、各種の異なる不揮発性ストレージのタイプを使用することができる。

【００２１】

デバイス１０２と１４６間の通信は、各種の異なる従来のプロトコルを使用して行うことができる。一実装では、デバイス１０２と１４６間の通信は、バージョン１．１（ＨＴＴＰ１．１）など、あるバージョンのハイパーテキスト伝送プロトコル（ＨＴＴＰ）を使用して行われる。別の実装では、デバイス１０２と１４６間の通信は、リアルタイムストリーミングプロトコル（ＲＴＳＰ）を使用して行われる。あるいは、セッション開始プロトコル（ＳＩＰ）、シンプルオブジェクトアクセスプロトコル（ＳＯＡＰ）など、他のプロトコルを使用してもよい。

【００２２】

また、ストリーミングメディアコンテンツは、各種の異なるストリーミングメディアフォーマットの任意のものに従って記憶し、ストリーミングすることができる。例示的な一実装では、メディアは、ＡＳＦフォーマット（Ａｄｖａｎｃｅｄ Ｓｙｓｔｅｍｓ Ｆｏｒｍａｔあるいは Ａｄｖａｎｃｅｄ Ｓｔｒｅａｍｉｎｇ Ｆｏｒｍａｔ）に基づいてストリーミングされる。ＡＳＦに関するさらなる情報は、ワシントン州レドモンドのマイクロソフト（登録商標）社から得ることができる。これと同じ技術は、ＭＰＥＧ（Ｍｏｖｉｎｇ Ｐｉｃｔｕｒｅｓ Ｅｘｐｅｒｔｓ Ｇｒｏｕｐ）１、ＭＰＥＧ２、ＭＰＥＧ４、Ｑｕｉｃｋｔｉｍｅ（クイックタイム）など、他のフォーマットにも適用することができる。

【００２３】

図３に、ストリーミング媒体データを通信する際に使用できる例示的なメッセージフォーマットを示す。ＨＴＴＰ１．１メッセージやＲＴＳＰメッセージなどのメッセージのデータ構造１８０は、スタートラインフィールドまたは部分１８２、１つまたは複数のヘッダフィールドまたは部分１８４、空のラインフィールドまたは部分１８６、および任意選択のメッセージ本体フィールドまたは部分１８８を含む。スタートライン部分１８２は、メ

ッセージまたはデータ構造タイプを識別するデータを含み、これはリクエストライン（例えばＨＴＴＰ１．１のＧＥＴ要求や、ＲＴＳＰのＧＥＴ＿ＰＡＲＡＭＥＴＥＲ要求など）であっても、ステータスライン（例えばＨＴＴＰ１．１　２００のＯＫ応答やＲＴＳＰ１．０　２００のＯＫ応答など）であってもよい。メッセージに関する情報を表すデータを含む１つまたは複数のヘッダ１８４も含まれる。空ライン部分１８６は、ヘッダ１８４の終わりを識別するのに使用する。メッセージ本体部分１８８には任意選択で追加的なデータを含めることができる。この説明では、各種の指示をヘッダ１８４に含めるが、それらの指示はあるいはメッセージ本体１８８に位置してもよい。

【００２４】

図２のデバイス１０２と１４６間では、データ構造１８０を備えるデータを使用して、制御情報（例えばメディアコンテンツのストリーミングをセットアップする）や、データ（例えばストリーミングメディアコンテンツ）が適宜通信される。したがって、これらのメッセージは、ストリーミングされるメディアコンテンツに対応するか、または関連付けられる。

【００２５】

図２を参照すると、クライアントデバイス１０２のキャッシュマネジャ１５２は、オリジンサーバ１４６からストリーミングメディアプレーヤ１４２によって受信されたストリーミングメディアコンテンツのキャッシングを管理する。ストリーミングメディアプレーヤ１４２は、コンテンツを受信し、そのコンテンツをキャッシュすべきであると判断した際は、そのコンテンツを記憶するためにキャッシュマネジャ１５２に転送する。ストリーミングメディアプレーヤ１４２はこの判定を独自に行っても、あるいはキャッシュマネジャ１５２から受け取る情報（例えばキャッシュに利用可能な空間があるかどうかなど）に部分的に基づいて判定してもよい。

【００２６】

ストリーミングメディアプレーヤ１４２によるストリーミングメディアコンテンツのキャッシングは、ストリーミングメディアコンテンツのバッファリングとは異なることに留意されたい。キャッシングとバッファリングには様々な違いがあるが、通例その違いには次の１つまたは複数が含まれる：キャッシュされたコンテンツは、揮発性メモリではなく不揮発性の記憶装置に記憶される；キャッシュされたコンテンツは、すでに再生されたコンテンツを含むことができる；キャッシュされたコンテンツは、（例えば「ジャストインタイム」配信のように）直ちに再生されるのではなく、長時間再生されないコンテンツを含むことができる。

【００２７】

図２には異なるストリーミングメディアコンテンツを異なるファイル１４８として示しているが、これに代えて、１つのストリーミングメディアコンテンツを複数のファイルとして記憶してもよい（あるいはブロードキャストコンテンツの場合はファイルがなくともよい）。「１つの」コンテンツを定義する方式は、実装と媒体のタイプによって異なる可能性がある。例えば、音楽を扱うオーディオおよび／またはビデオコンテンツの場合は、１つの歌を１つのコンテンツとすることができる。コンテンツは、固有の境界（例えば異なる歌）に沿って複数部分に区分するか、あるいはその他の任意の方式で（例えばコンテンツを５分ごとに１コンテンツとするなど）区分することができる。

【００２８】

クライアントデバイス１０２の一部である従来のコンポーネントを任意選択で強化して、キャッシュ管理機能を行わせることができる。例示的な一実装では、マイクロソフト（登録商標）社のインターネットエクスプローラブラウザプログラムがキャッシュ管理機能を含み、ストリーミングメディアプレーヤ１４２はこの機能を強化し、使用することができる。

【００２９】

各メディアコンテンツは、ともに単一のファイルとして記憶することができるにも関わらず複数のストリームを含むことができる。そのようなストリームはそれぞれ、特定タイプ

のメディア（例えばオーディオ、ビデオ、テキストなど）を通例は特定の符号化ビットレートで表す。符号化ビットレートは、再生のためにメディアコンテンツを符号化するレート（処理速度）である。符号化ビットレートは、ユーザによって知覚されるコンテンツの再生速度とは無関係であることに留意されたい（例えば、通例は、通常のコンテンツストリームと、ユーザがその通常ストリームの再生速度の２倍と知覚する早送りのコンテンツストリームは、どちらも同じ符号化ビットレートである）。

【００３０】

同一タイプのメディアの複数のバージョン（例えば複数のオーディオバージョン、複数のビデオバージョンなど）をメディアコンテンツに含め、メディアプレーヤ１４２による再生のためにそれらのストリームの異なる組合せを選択できるようにすることができる。これらの異なるバージョンはそれぞれ、通例は異なるビットレートで符号化される（通例はビットレートが高いほどコンテンツの品質が高くなる）。ストリームのどの組合せをストリーミングメディアコンテンツに含めるかは各種の方式で選択することができ、これには、ユーザの嗜好（例えばより高い品質のコンテンツを望むか、あるいはより低い品質のコンテンツを望むか）、利用可能なネットワーク帯域幅、特定コンテンツに望まれるビットレート（例えば、あるビットレートをコンテンツ作成者または配信者が設定し、ストリーミングメディアコンテンツの識別子に含めて、ユーザがその識別子を選択するとストリーミングメディアプレーヤ１４２が（任意選択でユーザの嗜好に基づいて）その求められるビットレートに可能な限り近いストリームを選択するなど）などがある。

【００３１】

コンテンツをキャッシュする際は、キャッシュマネジャ１５２が、ストリーミングメディアコンテンツとしてサーバデバイス１４６から受信した（ストリーミングメディアプレーヤ１４２によって要求された）特定のストリームを不揮発性記憶装置１５０に格納する。同じメディアコンテンツについての異なるストリームの組合せをキャッシュマネジャ１５２によってキャッシュすることができる。あるいは、キャッシュマネジャ１５２は、特定のメディアコンテンツについてのすべてのストリームをサーバデバイス１４６から取得し、そのストリームすべてをキャッシュすることが可能だが、メディアプレーヤ１４２へは要求されたストリームだけを再生することができる。

【００３２】

複数のコンテンツをいっしょに再生リストにまとめることもでき、この再生リストは、それぞれがストリーミングされる特定のコンテンツである，１つまたは複数の項目からなるリストである。これらの異なるコンテンツを（例えばユーザまたはその他の者によって）選択していっしょに再生リストにまとめ、ユーザが単に再生リストを選択するだけでレンダリングのためにそれらのコンテンツすべてを選択できるようにすることができる。例として、ユーザは自分の好きな歌から２０曲を選んで再生リストの一部とし、その後は再生リストの再生を選択することによりそれらの歌を再生させることができる。

【００３３】

クライアント１０２でストリーミングメディアコンテンツをキャッシュすることにより、ストリーミングメディアプレーヤ１４２が各種の機能、およびしたがってユーザ体験の機能強化を提供することが可能になる。これらには、コンテンツの符号化ビットレートに依存しないレートでメディアコンテンツをストリーミングすることにより、ユーザが各種のシャトルコントロールオプション（例えば一時停止、停止、早送り、シーク、巻き戻しなど）を選択した際でもコンテンツのストリーミングを継続することが可能になる、後の時間に再生するためにストリーミングコンテンツを記録することが可能になる，時間をずらしてストリーミングコンテンツを再生することが可能になることが含まれる。

【００３４】

クライアント１０２でストリーミングメディアコンテンツをキャッシュすることにより、符号化ビットレートに依存しないレートでサーバデバイス１４６からクライアントデバイス１０２にメディアコンテンツをストリーミングすることが可能になる。ストリーミングレートが符号化ビットレートと同じになる状況が生じる可能性があるが、ストリーミング

レートは、符号化ビットレートよりも高く、または低くすることができる。ストリーミングメディアプレーヤ１４２によって受信されたストリーミングメディアコンテンツはキャッシュメモリに記憶され、コンテンツを再生する際は、メディアプレーヤ１４２は、そのコンテンツを再生のためにキャッシュメモリから取り出し、それと同時にサーバデバイス１４６からストリーミングされてくるコンテンツの続きの部分をキャッシュメモリに入れ続ける。ストリーミングレートが符号化ビットレートを下回る例示的な状況では、メディアプレーヤ１４２は、キャッシュされたコンテンツの量、符号化ビットレート、およびストリーミングレートに基づいて、ストリーミングされるコンテンツの再生に補足的な遅延を課す。例えば符号化ビットレートが３００ｋｂｐｓでストリーミングレートが１５０ｋｂｐｓである場合、メディアプレーヤ１４２は、十分なコンテンツが記憶され、ユーザが気づくような中断を生じずにコンテンツを始めから終わりまで完全に再生できるようになるまでコンテンツ再生の開始を遅らせる。

【００３５】

一実装では、メディアプレーヤ１４２は、ストリーミングモジュール１４４にストリーミングコンテンツを要求する際に、ストリーミングモジュール１４４に速度の要求も伝達する。この速度要求は、メディアプレーヤ１４２がメディアコンテンツをストリーミングさせたいレート（速度）を指示する。ストリーミングモジュール１４４は要求されたレート（速度）を受け入れ、続いてその要求されたレート（速度）でメディアコンテンツをメディアプレーヤ１４２にストリーミングするか、あるいはそのレート（速度）を変更することができる。例えば、ストリーミングモジュール１４４は、要求されたレートでコンテンツをストリーミングできない場合がある（例えばサーバポリシー（サーバの方針）、サーバのハードウェアおよび／またはソフトウェアの限界、サーバの現在の負荷などの原因による）。ストリーミングモジュール１４４は、どれだけのストリーミングレートになるかについての指示をメディアプレーヤ１４２に送信する（あるいは、ストリーミングモジュール１４４が特に指示しない場合は、ストリーミングレートはメディアプレーヤ１４２が要求するレートでよい）。さらに、ストリーミングモジュール１４４は、（新たな速度要求をストリーミングモジュール１４４に送信することにより）コンテンツのストリーミング中にストリーミングレートの変更を試みることができ、ストリーミングモジュール１４４は、（新たな速度指示をメディアプレーヤ１４２に送信することにより）コンテンツのストリーミング中にストリーミングレートを変更することができる。

【００３６】

メディアプレーヤ１４２は、自身が求めるストリーミングレート、すなわちそれがストリーミングモジュール１４４に要求するレートを各種の異なる要因に基づいて決定することができる。この決定は、コンテンツ単位で行うことができる。一実装では、メディアプレーヤ１４２は、メディアプレーヤ１４２とストリーミングモジュール１４４間の現在利用可能な帯域幅の割り出しを試みる。これは各種の従来の方法で割り出しすることができ、この方法には、デバイス１０２と１４６間でテストメッセージを送信する、デバイス１０２と１４６間の接続の現在および過去の振る舞いを監視する、ストリーミングモジュール１４４から利用可能な帯域幅の指示を受け取るなどがある。現在利用可能な帯域幅を知ると、メディアプレーヤ１４２は、まず現在利用可能な帯域幅よりも小さい特定の量であるストリーミングレートを要求する。この特定の量は、固定された量（例えば常に５０ｋｂｐｓ）でも、動的な量（例えば現在利用可能な帯域幅の１５％、あるいは現在利用可能な帯域幅の５％～２５％の間など）であってもよい。

【００３７】

メディアプレーヤ１４２からストリーミングモジュール１４４に送信されるストリーミング速度要求は、メディアプレーヤ１４２がいろいろな任意の方法のいずれかでデータをストリーミングさせたいレートを示すことができる。一実装では、このレートは、コンテンツの符号化ビットレートに比例する速度係数で表される（例えば、３．２の速度係数は、ストリーミングレートがコンテンツの符号化ビットレートに比べて３．２倍速いことを意味し、０．５の速度係数は、ストリーミングレートがコンテンツの符号化ビットレートの

半分であることを意味する）。別の実装では、速度は、単に所望のストリーミングビットレート（例えば３００ｋｂｐｓ、５００ｋｂｐｓ、２０ｋｂｐｓなど）を指定することによって示される。

【００３８】

速度要求の指示は、各種の異なる方式でメディアプレーヤ１４２からストリーミングモジュール１４４に送信することができる。ＲＴＳＰを使用してデバイス１０２と１４６間の通信を行う一実装では、ストリーミングメディアプレーヤ１４２からストリーミングモジュール１４４に送信されるメッセージに次のＲＴＳＰヘッダを（例えば図３のヘッダ１８４として）付加する。

速度：ｘ

ｘは、コンテンツの符号化ビットレートに比例する要求された速度係数を表す。値ｘは、整数でも実数でもよい（任意選択で小数点以下の桁数を制限することができ、通例は小数点第１位または第２位までに制限するが、他の値を使用することもできる）。このヘッダは様々なメッセージに付加することができ、一実装では、ストリーミングメディアプレーヤ１４２からストリーミングモジュール１４４に送信される、メディアコンテンツのストリーミングを要求するメッセージに含める。

【００３９】

ストリーミングモジュール１４４がその要求に応答する際には、ＲＴＳＰ　ＰＬＡＹ応答メッセージに類似のヘッダ（速度：ｙ）を入れてストリーミングメディアプレーヤ１４２に返送する。ｙは、ストリーミングモジュール１４４が要求されたコンテンツをストリーミングする（コンテンツの符号化ビットレートに比例する）速度を表す（ｙは、値ｘと同じでも同じでなくともよい）。値ｘと同様に、値ｙは、整数または実数とすることができる（小数点以下の桁数は任意選択で制限してもよく、通例は小数点第１位または第２位までに制限するが、他の値も使用することができる）。

【００４０】

ＨＴＴＰを使用してデバイス１０２と１４６間の通信を行う別の一実装では、ストリーミングメディアプレーヤ１４２からストリーミングモジュール１４４に送信されるメッセージに（例えば図３のヘッダ１８４として）次のＨＴＴＰヘッダを付加する。

プラグマ：速度＝ｘ

ｘは、コンテンツの符号化ビットレートに比例する要求された速度係数を表す。プラグマ（ｐｒｏｇｍａ）ヘッダは、実装に固有の指示を含めるためにＨＴＴＰで使用される一般ヘッダフィールドである。上述のＲＴＳＰスピードヘッダと同様に、このヘッダは様々なメッセージに付加することができ、一実装では、ストリーミングメディアプレーヤ１４２からストリーミングモジュール１４４に送信される、メディアコンテンツのストリーミングを要求するメッセージに含められる。

【００４１】

ストリーミングモジュール１４４は、この要求に応答する際には、ＨＴＴＰ　ＧＥＴ応答メッセージに同様のヘッダ（プラグマ：速度＝ｙ）を入れてストリーミングメディアプレーヤ１４２に返送する。ｙは、ストリーミングモジュール１４４が要求のコンテンツをストリーミングする（コンテンツの符号化ビットレートに比例する）速度を表す（ｙは、値ｘと同じでも同じでなくともよい）。値ｘと同様に、値ｙは整数でも実数でもよい（小数点以下の桁数を任意選択で制限することができ、通例は小数点第１位または第２位までに制限するが、他の値を使用してもよい）。

【００４２】

コンテンツのストリーミングレートは、符号化ビットレートを参照して識別することができるが、この識別は単にそれが容易な基準点であるために行うことに留意されたい。ストリーミングレートはなお符号化ビットレートには依存せず、実質的にどのような速度係数でも要求および／または選択することができ、その速度係数を識別する方式は符号化ビットレートを基準とする。

【００４３】

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図４に、サーバからクライアントにメディアコンテンツをストリーミングする例示的プロセス２００を表すフローチャートを示す。プロセス２００は、図２のデバイス１０２および１４６などのクライアントデバイスおよびサーバデバイスによって実施され、またソフトウェア、ファームウェア、ハードウェア、またはそれらの組合せで行うことができる。

【００４４】

初めに、コンテンツの符号化ビットレートに依存しない、メディアコンテンツをストリーミングするときのストリーミングレートをクライアントデバイスとサーバデバイス間でネゴシエートする（動作２０２）。このネゴシエーションは、例えば、上述のようにクライアントによる要求速度の提出と、ストリーミング速度の戻し通知とすることができる。あるいは、このネゴシエーションは他の形を取ることもでき、サーバデバイス（または何らかの他のデバイス）によって開始し、クライアントデバイスがそのストリーミングレートに対して所望の変更を要求する、クライアントデバイスまたはサーバデバイスによって変更可能なデフォルトのレートを使用する、ストリーミングメディアコンテンツの識別子によって示され、クライアントデバイスまたはサーバデバイスによって変更することが可能なレートを使用する、などがある。ストリーミングレートをネゴシエートすると、ネゴシエートされたストリーミングレートでサーバデバイスからクライアントデバイスにメディアコンテンツをストリーミングする（動作２０４）。ストリーミングレートは、任意選択であって、後にコンテンツのストリーミング中に再度ネゴシエートすることができる（これを開始するのはクライアントデバイス、サーバデバイス、あるいは何らかの他のデバイスである）。

【００４５】

図２に戻ると、通例、ストリーミングモジュール１４４は、ストリーミングメディアプレーヤ１４２に対してコンテンツファイル１４８全体をストリーミングメディアコンテンツとして転送することはない。通例は、ファイルヘッダや索引付け情報などの特定の情報は、ストリーミングメディアコンテンツの一部としてストリーミングメディアプレーヤ１４２に対して転送されない。この情報の厳密な性質は、ストリーミングモジュール１４４の設計方式と、メディアコンテンツのストリーミングに使用するフォーマットとに基づいて異なる可能性がある。そのような情報がクライアントデバイス１０２に転送されない場合は、ストリーミングメディアプレーヤ１４２（あるいはキャッシュマネジャ１５２）がその情報を生成し、その情報をキャッシュ１５０に追加する。したがってこの適切な情報はキャッシュ内コンテンツの一部として取得可能になり、キャッシュからストリーミングメディアコンテンツを再生する際にストリーミングメディアプレーヤ１４２によって使用することができる。

【００４６】

ストリーミングメディアプレーヤ１４２は、ストリーミングメディアコンテンツの再生要求を受け取ると、キャッシュマネジャ１５２を介して、要求されたコンテンツがキャッシュ１５０内にあるかどうかを調べる。コンテンツがキャッシュ１５０にある場合（これを「キャッシュヒット」と呼ぶ）、ストリーミングメディアプレーヤ１４２は、サーバデバイス１４６ではなくキャッシュ１５０から要求されたストリーミングメディアコンテンツを取得する。ただし、コンテンツがキャッシュ１５０にない場合（これを「キャッシュミス」と呼ぶ）、ストリーミングメディアプレーヤ１４２は、要求されたストリーミングメディアコンテンツをサーバデバイス１４６から取得する。キャッシュが一杯になり、それ以上のストリーミングメディアコンテンツを入れるだけの記憶空間がなくなった場合には、新たなコンテンツを入れるスペースを作るためにすでにキャッシュされているコンテンツをキャッシュから削除（これをしばしばキャッシュから追い出すという）できることに留意されたい。各種ある従来のキャッシュ置換アルゴリズムを使用して、キャッシュから追い出すコンテンツを決定することができる。

【００４７】

状況によっては、コンテンツファイル１４８に、符号化ビットレートが異なる複数の異なるストリーム（例えば、５６ｋｂｐｓで符号化された低品質のストリームと、３００ｋｂ

ｐｓで符号化された高品質のストリームなど）が含まれる可能性がある。このようなファイルをしばしばマルチプルビットレートファイルと呼ぶ。そのような状況では、通例は１つのストリーム（例えば低品質のストリームまたは高品質のストリーム）だけをクライアントデバイス１０２にストリーミングし、そのストリームをキャッシュ１５０にキャッシュイングする。それと符号化ビットレートが同じである同一コンテンツに対する事後の要求は、キャッシュ１５０から満たすことができる（すなわちキャッシュヒットになる）が、別の符号化ビットレートに対する要求はキャッシュ１５０からは満たすことができない（キャッシュミスとなる）。あるいは、ストリーミングメディアプレーヤ１４２が、ストリーミングモジュール１４４からストリーミングされた符号化ビットレートをすべて備え、それによりそれらのレートすべてをキャッシュ１５０に記憶しておいてもよい。

【００４８】

ストリーミングモジュール１４４は任意選択で、ストリーミングメディアコンテンツの満了時間（有効期限）を含んでもよい。この満了時間は、比例する時間（例えばコンテンツを送信してから５分後）であっても、固定された時間（例えば特定の日時）であってもよい。ストリーミングメディアコンテンツの満了時間は、各種の異なる方式で示すことができる。一実装では、ＨＴＴＰのｍａｘ－ａｇｅキャッシュ制御指示を使用して満了時間を指示する。別の実装では、ＨＴＴＰまたはＲＴＳＰのＥｘｐｉｒｅｓヘッダを使用して満了時間を指示する。

【００４９】

期限が満了すると、ストリーミングメディアプレーヤ１４２は、キャッシュからコンテンツを再生する前にコンテンツを再確認する。この再確認は、通例、ストリーミングメディアプレーヤ１４２でコンテンツ要求（例えばコンテンツの再生を求めるユーザの要求）を受信したときに行っても、あるいは他のときに行ってもよい（例えば、そのコンテンツが要求されているかどうかに関係なく、ストリーミングメディアプレーヤ１４２またはキャッシュマネジャ１５２がキャッシュを監視して、満了時間が経過するとその期限切れを検出するということが可能である）。コンテンツの期限が満了すると、ストリーミングメディアプレーヤ１４２は、そのコンテンツを記述する新しい情報（それによりストリーミングメディアプレーヤ１４２はそのコンテンツに変化があるかどうかを判定することができる）と、新しい満了時間を回復する。

【００５０】

コンテンツが変化していない場合、ストリーミングメディアプレーヤ１４２は、単にそのコンテンツの満了時間を新しい期限日に更新することができ、キャッシュ内のコンテンツには変更を行う必要がない。ただし、コンテンツが変化している場合は、ストリーミングメディアプレーヤ１４２は、そのコンテンツをキャッシュから取得するのではなく、要求されたそのコンテンツをストリーミングモジュール１４４からストリーミングする。あるいは、ストリーミングメディアプレーヤ１４２は、コンテンツの何が変化したのかを判断し、変化した部分だけをストリーミングモジュール１４４からストリーミングし、残りの部分はキャッシュから得ることを試みることもできる。

【００５１】

ストリーミングメディアプレーヤ１４２は、記述オペレーションを使用して、サーバデバイス１４６から取得できる特定のコンテンツを記述した情報を得ることができる。ストリーミングモジュール１４４は、記述要求に応答して、ヘッダ情報（例えば、コンテンツについての書誌学的な（ｂｉｂｌｉｏｇｒａｐｈｉｃ）情報、コンテンツのストリームの特徴、そのコンテンツのインデックスを再生成するのに必要な情報などを含む）、コンテンツに関連のメタデータ、コンテンツの一部として取得可能なストリームのリストなど、識別されるメディアコンテンツを記述する各種の情報を返送する。返送された正確な情報は、ストリーミングモジュール１４４の実装方式と、メディアコンテンツをストリーミングするのに使用する特定のフォーマットとに応じて異なる可能性がある。この情報を使用してコンテンツを再確認することができる。

【００５２】

一実装では、特定のコンテンツストリームのヘッダ情報は、コンテンツが変更された場合にコンテンツ作成者によって変更されるＧＵＩＤ（Ｇｌｏｂａｌｌｙ Ｕｎｉｑｕｅ ＩＤ：グローバル一意識別子）を含む。この値は、「ＭＭＳタイプ」属性として知られる。コンテンツの変更はこのＧＵＩＤ値を調べることによって検出することができ、値が変化していなければコンテンツは変化しておらず、ＧＵＩＤ値が変化していればコンテンツが変化していることになる。

【００５３】

あるいは、別の情報を調べてコンテンツが変化しているかどうかを判定することができる。一実装では、コンテンツ記述情報は、最後に修正された日付の指示を含む（例えば図３のヘッダ１８４とすることができる）。新たに受け取った最後に修正された日付が、以前に受け取った最後に修正された日付と異なる場合、ストリーミングメディアプレーヤ１４２は、コンテンツが変化していると判断する。調べることが可能なこの他の情報は、コンテンツのハッシュ（ｈａｓｈ）である。従来の各種のハッシングアルゴリズムを使用してコンテンツのハッシュ値を生成することができ、一般にはコンテンツを変更するとそのコンテンツのハッシュ値が変化する。ハッシュ値が変化している場合、ストリーミングメディアプレーヤ１４２は、コンテンツが変更されたと判断する。

【００５４】

上述のように、ストリーミングメディアコンテンツは、複数コンテンツからなる再生リストとすることができる。メディアコンテンツの再生リストがキャッシュされている場合、ストリーミングメディアプレーヤ１４２は、再生リストの各メディアコンテンツを必要に応じて再確認する。キャッシュされた時点から変化しているコンテンツは、キャッシュから取得するのではなく、ストリーミングモジュール１４４からストリーミングする。また、再生リストのメディアコンテンツのすべてがクライアントデバイス１０２でキャッシュされてはいない状況が生じる場合がある。そのような状況では、キャッシュされていないコンテンツは、キャッシュから取得するのではなくストリーミングモジュール１４４からストリーミングする。

【００５５】

また、再生リストに関しては、ストリーミングメディアプレーヤ１４２が、再生リスト中の次のコンテンツについての準備が整ったことをストリーミングモジュール１４４に指示する状況が生じる可能性がある。この指示は、「次のエントリのストリーム（ｓｔｒｅａｍ ｎｅｘｔ ｅｎｔｒｙ）」のコマンドをストリーミングモジュール１４４に通信することによって、あるいは、単にそのコンテンツがキャッシュから取得できる場合でも、現在のコンテンツをストリーミングモジュール１４４からストリーミングさせることによって、行うことができる（ストリーミングモジュール１４４は、現在のコンテンツの最後に達すると次のコンテンツのストリーミングを開始する時間であることを知る）。

【００５６】

ストリーミングメディアコンテンツをキャッシングすることにより、ユーザが各種のシャトルコントロールオプション（例えば停止、一時停止、早送り、シーク、巻き戻しなど）を選択した場合でもコンテンツのストリーミングを継続することも可能になる。ストリーミングメディアプレーヤ１４２は、プレーヤ１４２のユーザにシャトルコントロールオプションが利用できるようにし、それによりユーザが必要に応じてストリーミングモジュール１４４の再生を制御できるようにする。ユーザが特定のシャトルコントロールコマンドを入力した際、ストリーミングメディアプレーヤ１４２の振る舞いは、入力されたコマンドに応じて異なる。ただし、多くの場合、ストリーミングメディアプレーヤ１４２は、ストリーミングモジュール１４４からのメディアコンテンツのストリーミングを継続する。

【００５７】

ユーザが停止コマンドを入力した場合、ストリーミングメディアプレーヤ１４２は、ストリーミングメディアコンテンツの再生を中止するが、ストリーミングモジュール１４４からのコンテンツのストリーミングとキャッシュを継続する。同様に、ユーザが一時停止コマンドを入力した場合、ストリーミングメディアプレーヤ１４２は、ストリーミングメデ

ィアコンテンツの再生を一時停止するが、ストリーミングモジュール１４４からのコンテンツのストリーミングとキャッシングを継続する。さらに、ユーザが巻き戻しコマンドを入力した場合は、ストリーミングメディアプレーヤ１４２は、ストリーミングメディアコンテンツの巻き戻しを開始するが、引き続きストリーミングモジュール１４４からコンテンツをストリーミングし、キャッシュする。さらに、ユーザが早送りコマンドを入力した場合は、ストリーミングメディアプレーヤ１４２は、すでにキャッシュされたコンテンツ部分を通じてストリーミングメディアコンテンツの早送りを開始し、必要な範囲までコンテンツをストリーミングし、キャッシュし続ける。

【００５８】

図５に、サーバからクライアントにメディアコンテンツをストリーミングし、同時にシャトルコントロールコマンドを受け取る例示的プロセス２３０を説明するフローチャートを示す。プロセス２３０は、図２のクライアントデバイス１０２のストリーミングメディアプレーヤ１４２など、クライアントデバイスのストリーミングメディアプレーヤによって実施され、ソフトウェア、ファームウェア、ハードウェア、またはそれらの組合せで実行することができる。

【００５９】

初めに、ストリーミングメディアコンテンツの再生に係わるシャトルコントロール要求をストリーミングメディアプレーヤで受け取る（動作２３２）。ストリーミングメディアプレーヤは、要求に従ってストリーミングメディアコンテンツの再生を変える（動作２３４）が、ストリーミングメディアコンテンツの受信を継続する（動作２３６）。ストリーミングメディアプレーヤは、ユーザアクションを詳述する以後のログ提出を除いてはシャトルコントロールコマンドをサーバデバイスに知らせる必要はなく、通例は指示しないことに留意されたい。

【００６０】

また、ユーザがシャトルコントロールコマンドを使用してストリーミングメディアコンテンツの再生をナビゲート（操縦）または制御する能力は、特定のコンテンツ（あるいは特定コンテンツの一部）に対しては制限されることもある。例えば、ユーザは、ストリーミングメディアコンテンツの特定の部分（例えば広告）では早送りできない場合がある。そのような制限の指示は、ストリーミングモジュール１４４からストリーミングメディアプレーヤによって受信され、ストリーミングメディアコンテンツとともにキャッシュされる。したがって、キャッシュからストリーミングメディアコンテンツを再生する際には、そのような制限も実施される。

【００６１】

ストリーミングメディアコンテンツをキャッシュすることにより、さらに、後の時間に再生するためにコンテンツを記録することが可能になる。コンテンツの少なくとも一部は、コンテンツがストリーミングされ、キャッシュされるのと同時にユーザに対して再生することができ、あるいは、コンテンツのどの部分も後の時間まで再生しないことも可能である（例えば、コンテンツのキャッシングが完了してからしばらく経ってから再生するなど）。例えば、ユーザは、複数のストリーミングメディアコンテンツをキャッシュする要求をストリーミングメディアプレーヤ１４２に入力し、後の時間（例えば同じ日の後の時間、翌日、翌週、翌月など）にそれらのコンテンツを再生することができる。そのような要求は、例えば具体的な「コンテンツのキャッシュ」要求であるか、あるいは単に再生要求である。ストリーミングメディアプレーヤ１４２は、そのような要求を受信すると、ストリーミングモジュール１４４と通信して、ストリーミングメディアプレーヤ１４２がユーザのためにそのコンテンツを再生する場合と同じ方式で、要求されたコンテンツをストリーミングさせる。ただし、コンテンツをクライアントデバイス１０２で受信した場合は、ストリーミングメディアプレーヤ１４２は、そのコンテンツを不揮発性記憶装置１５０にキャッシュし、（ユーザから要求されない限りは）そのコンテンツをその時間には再生しない。ユーザが後にそのコンテンツの再生を要求すると、ストリーミングメディアプレーヤ１４２は、そのコンテンツをキャッシュメモリから入手する（ただし、コンテンツの期

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限が切れていないことを前提とする。または、コンテンツの期限が切れている場合はコンテンツが変更されていないことを前提とする）。

【００６２】

ストリーミングメディアコンテンツをキャッシュすることにより、さらに、時間をずらしたストリーミングメディアコンテンツの再生が可能になる。時間をずらした再生では、ユーザは、ストリーミングと同時にストリーミングコンテンツをナビゲートし、制御することができる（例えば一時停止、巻き戻し、早送りなどのコマンドの入力により）。例えば、ユーザはストリーミングメディアコンテンツの再生を特定の位置で一時停止し、数分後にその位置から再生を再開することができ、再生が一時停止されていた間にさらなるコンテンツがクライアントデバイス１０２にストリーミングされていても、再生はなおユーザが再生を一時停止した位置から再開する。別の例として、ユーザは、コンテンツのある部分をもう一度（あるいはさらに複数回）見るために、ストリーミング中にストリーミングメディアコンテンツを巻き戻すことができる。ユーザが例えば３分だけコンテンツを巻き戻した場合、ユーザはその３分間をもう一度見ることができ、その３分間分先行するコンテンツが再度再生されていた間にさらなるコンテンツがクライアントデバイス１０２にストリーミングされていても、再生は、ユーザが巻き戻しコマンドを入力したコンテンツ中の時点から（再生にユーザが気づくような中断を生じずに）継続する。

【００６３】

図６に、後に再生するためにストリーミングメディアコンテンツを記録する例示的プロセス２６０を説明するフローチャートを示す。プロセス２６０は、図２のクライアントデバイス１０２のストリーミングメディアプレーヤ１４２など、クライアントデバイスのストリーミングメディアプレーヤによって実行され、ソフトウェア、ファームウェア、ハードウェア、またはそれらの組合せで行うことができる。

【００６４】

初めに、サーバからストリーミングメディアコンテンツを受信する（動作２６２）。受信したストリーミングメディアコンテンツは、クライアントデバイスのキャッシュにローカルに記憶する（動作２６４）。ストリーミングメディアコンテンツを再生する要求を後の時間に受け取る（動作２６６）が、これはメディアコンテンツのストリーミングが完了した後でも、完了しない時点でもよい。再生要求に応答して、ローカルに保存されたストリーミングメディアコンテンツを再生する（動作２６８）。

【００６５】

また、ストリーミングメディアプレーヤ１４２がストリーミングメディアコンテンツを再生する際には、通例、ストリーミングメディアプレーヤ１４２からストリーミングモジュール１４４に各種のロギング情報が返送される。ストリーミングメディアプレーヤ１４２がストリーミングモジュール１４４ではなくクライアントデバイス１０２のキャッシュからストリーミングメディアコンテンツを取得する状況でも、このロギング情報をストリーミングモジュール１４４に返送しなければならない。ロギング情報は、ストリーミングメディアプレーヤ１４２がコンテンツの再生に費やした時間量、複数回再生されたコンテンツ部分、スキップされたコンテンツ部分、コンテンツの再生が一時停止されたか、もしそうであればコンテンツ中のどの点で一時停止が行われたか、ストリームコンテンツを受信したネットワーク接続に伴う問題など、各種の情報を含むことができる。

【００６６】

ロギング情報は、各種の異なる方式でサーバデバイス１４６に通信することができる。一実装では、通例のヘッダを使用してメッセージを送信して、メッセージ本体（図３の本体１８８）にロギング情報が含まれることを知らせる。

Ｃｏｎｔｅｎｔ－Ｔｙｐｅ：ａｐｐｌｉｃａｔｉｏｎ／ｘ－ｗｍｓ－ｓｅｎｄｅｖｅｎｔ

【００６７】

ただし、この代わりに異なるヘッダを送信してもよい。このメッセージは、例えば、ＲＴＳＰのＳＥＴ＿ＰＡＲＡＭＥＴＥＲメッセージ、またはＨＴＴＰのＰＯＳＴメッセージなどである。

【００６８】
すべてのストリーミングメディアコンテンツがクライアントデバイス１０２でキャッシュ可能であるとは限らないことに留意されたい。ストリーミングメディアコンテンツをクライアントデバイス１０２でキャッシュしない様々な状況がありうる。こうした状況には、例えば、サーバデバイスがキャッシングをサポートしない状況、コンテンツ作成者または配信者が特定のコンテンツをキャッシュすべきでないことを知らせている状況、クライアントデバイス１０２のユーザによってキャッシングが使用禁止にされている状況などがある。さらに、一部の実施形態では、ブロードキャストコンテンツなど特定のコンテンツはキャッシュするべきでないとしている（他の実施形態ではブロードキャストコンテンツをキャッシュすることができる）。ストリーミングメディアプレーヤ１４２は、特定のコンテンツをキャッシュすべきでないと判定した場合、そのコンテンツをキャッシュしない。

【００６９】
一実装では、ストリーミングメディアプレーヤ１４２がストリーミングモジュール１４４からコンテンツをストリーミングするように要求すると、ストリーミングモジュール１４４は、要求されたコンテンツのキャッシングがストリーミングモジュール１４４によってサポートされるかどうかの通知を返送する。この指示はメッセージヘッダ（例えば図３のヘッダ１８４）に含めることができ、「サポート（ｓｕｐｐｏｒｔｅｄ：支援）」ヘッダと称する。サポートヘッダ中の指示の一例を次に示す。
ｃｏｍ．ｍｉｃｒｏｓｏｆｔ．ｗｍ．ｆａｓｔｃａｃｈｅ

【００７０】
ただし、これに代えて他のヘッダを使用することもできる。このサポートヘッダがあるということは、ストリーミングモジュール１４４がクライアントデバイス１０２のキャッシングをサポート（支援）するということを示しており、それでストリーミングモジュール１４４は、例えば、メディアコンテンツを符号化ビットレートに依存しないレートでストリーミングし、キャッシュされたコンテンツについてのロギング情報を受信することなどを可能にする。このサポートヘッダがない場合は、ストリーミングメディアプレーヤ１４２は、メッセージに関連のストリーミングメディアコンテンツをキャッシュしない。

【００７１】
さらに、特定の部分のストリーミングメディアコンテンツのキャッシングを制御するのに、各種のキャッシュ制御指示を使用することができる。キャッシュ制御ヘッダは、キャッシュマネジャ１５２（また、キャッシュメモリを含むプロキシサーバなどの任意の仲介デバイス）が、関連のストリーミングメディアコンテンツのキャッシングをどのように処理するかを記述する情報を含む。キャッシュ制御ヘッダは、そのメッセージを受け取るすべてのキャッシング機構が従うべき指示を指定するのに使用される。ここでは述べないが、追加的なキャッシュ制御指示（例えば従来のＨＴＴＰまたはＲＴＳＰのキャッシュ制御指示）をキャッシュ制御ヘッダに含めてもよい。

【００７２】
使用するプロトコルに応じて、ストリーミングメディアプレーヤだけが関連のコンテンツをキャッシュできることを示すキャッシュ制御指示を含めてもよいし、含めなくともよい。ストリーミング媒体および非ストリーミング媒体（例えばＨＴＴＰ）両方に向けて設計されたプロトコルには、通例、ストリーミングメディアプレーヤ（一般的なＨＴＴＰコンポーネント（例えばウェブブラウザ）やプロキシデバイスではない）が関連のコンテンツをキャッシュできることを示す指示を使用する。ただし、ストリーミング媒体用に特に設計されたプロトコル（例えばＲＴＳＰ）には、ストリーミングメディアプレーヤだけが関連のコンテンツをキャッシュできるという指示は必要ない（したがって通例は使用しない）。

【００７３】
下記の表Ｉに、例示的なキャッシュ制御指示と、ストリーミング媒体用に特に設計されたプロトコル（例えばＲＴＳＰ）とでキャッシングが可能かどうかを示す。表ＩＩは、例示的なキャッシュ制御指示と、ストリーミング媒体向けでないプロトコル（例えばＨＴＴＰ

）でキャッシングが可能かどうかを示す。

【００７４】

【表１】

表１

キャッシュ制御指示	ストリーミングメディアプレーヤによるキャッシング
<none>	可能
"no-user-cache"	不可能
"no-cache"	不可能

【００７５】

【表２】

表１１

キャッシュ制御指示	一般的なHTTPキャッシュ／プロキシデバイスでのキャッシング	ストリーミングメディアプレーヤによるキャッシング
<none>	可能	可能
"no-cache, user-public"	不可能	可能
"no-cache"	不可能	不可能

【００７６】

表ＩＩで、「ｕｓｅｒ－ｐｕｂｌｉｃ」の指示は、ストリーミングメディアプレーヤ１４２によって、関連のコンテンツをキャッシュできるものと理解されたく、また「ｎｏ－ｃａｃｈｅ」の指示を無効にするということに留意されたい。ただし、「ｕｓｅｒ－ｐｕｂｌｉｃ」の指示が含まれない場合は、「ｎｏ－ｃａｃｈｅ」の指示により、関連のコンテンツをキャッシュできないことがストリーミングメディアプレーヤ１４２に示される。さらに、一般的なＨＴＴＰキャッシュまたはプロキシデバイスは、「ｕｓｅｒ－ｐｕｂｌｉｃ」の指示を理解せず、したがって単に「ｎｏ－ｃａｃｈｅ」指示に従い、コンテンツをキャッシュしない。

【００７７】

特定の部位のコンテンツをキャッシュするかどうかを判定する際には、各種の他の要因も絡む可能性がある。一実装では、ＵＲＬ（Ｕｎｉｆｏｒｍ　Ｒｅｓｏｕｒｃｅ　Ｌｏｃａｔｏｒ）などのストリーミングメディアコンテンツ識別子が、コンテンツでのキャッシュが可能である、あるいは可能でないことを示す指示を含むことができる。例えば、値「？ＷＭＣａｃｈｅ＝０」を使用して、コンテンツのキャッシングを行わないことを示し、値「？ＷＭＣａｃｈｅ＝１」を使用してコンテンツのキャッシングを行うことを示すことができる。別の実装では、ストリーミングメディアプレーヤ１４２は、ユーザがストリーミングメディアコンテンツのクライアントでのキャッシングを明確に使用禁止にすることを可能にし、それに応じて、ストリーミングメディアコンテンツがストリーミングメディアプレーヤ１４２によってキャッシュされないこととなる。さらに別の実装では、ストリーミングメディアプレーヤ１４２は、どのストリーミングメディアコンテンツもキャッシュしないことを決定することができる（例えば、ストリーミングメディアプレーヤ１４２は

、コンテンツをキャッシングするのに十分な記憶空間がない、あるいはコンテンツをそのキャッシュから再生した回数が閾値回数を下回るため、以降受信するストリーミングメディアコンテンツをキャッシュしないと決定することなどができる）。さらに別の実装では、特定タイプのストリーミングメディアコンテンツのみをキャッシュすることができる（例えばオンデマンドコンテンツはキャッシュ可能であるが、ブロードキャストコンテンツはキャッシュ可能でないなど）。

【００７８】

また、ストリーミングメディアプレーヤ１４２が、あるストリーミングメディアコンテンツをキャッシュすると決定した場合、そのキャッシングのために任意選択で各種の制約をストリーミングメディアプレーヤに課すことができる。例えば、そのコンテンツをキャッシュする場合にはストリームの間引き（ｔｈｉｎｎｉｎｇ）（例えば、帯域幅を節減するためにサーバデバイスからストリーミングするフレーム数を減らすなど）を要求しないようにストリーミングメディアプレーヤ１４２を設定することができる。

【００７９】

図７に、クライアントデバイスでストリーミングメディアコンテンツをキャッシュする例示的プロセス３００を説明するフローチャートを示す。プロセス３００は、図２のクライアントデバイス１０２のストリーミングメディアプレーヤ１４２などクライアントデバイスのストリーミングメディアプレーヤによって実施され、ソフトウェア、ファームウェア、ハードウェア、またはそれらの組合せで実行することができる。

【００８０】

初めに、サーバデバイスからストリーミングメディアコンテンツを受信する（動作３０２）。プロセス３００は、そのストリーミングメディアコンテンツのキャッシングが可能であるかどうか（動作３０４）に基づいて進行する。キャッシングが可能である場合はコンテンツを不揮発性の記憶装置に保存し（動作３０６）、ストリーミングメディアコンテンツを再生が可能な状態にする（動作３０８）。動作３０８でそのストリーミングメディアコンテンツをキャッシュした場合には、そのコンテンツのストリーミングと同時に、かつ／または後の時間に再生可能な状態にできることに留意されたい。ただしキャッシングが可能でない場合は、単にストリーミングメディアコンテンツを再生可能な状態とし（動作３０８）、すなわちキャッシュしない場合には、そのコンテンツは再度ストリーミングしなければ後の時間に再生することができない。

【００８１】

図８Ａおよび８Ｂは、クライアントデバイスでストリーミングメディアコンテンツをキャッシュするかどうかを判定する例示的プロセス３３０を説明するフローチャートである。プロセス３３０は、図２のクライアントデバイス１０２のストリーミングメディアプレーヤ１４２など、クライアントデバイスのストリーミングメディアプレーヤによって実施され、ソフトウェア、ファームウェア、ハードウェア、またはそれらの組合せで実行することができる。

【００８２】

初めに、ストリーミングメディアプレーヤは、サーバデバイスから取得可能なストリーミングメディアコンテンツにアクセスすることを試み（図８Ａの動作３３６）、サーバデバイスからそのストリーミングメディアコンテンツのヘッダ情報を取得する（動作３３８）。ストリーミングメディアプレーヤは次いで、ユーザがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしているかどうかを調べる（動作３４０）。ユーザがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしている場合は、クライアントでストリーミングメディアコンテンツをキャッシュメモリに入れない（動作３４２）。ただし、ユーザがストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしていない場合は、ストリーミングメディアプレーヤは、ストリーミングメディアコンテンツの識別子にそのコンテンツがキャッシングしないと示されているかどうかを調べる（動作３４４）。キャッシングしないと示されている場合は、ストリーミングメディアコンテンツをクライアントでキャッシュしない

（動作３４２）。

【００８３】

ただし、ストリーミングメディアコンテンツの識別子にそのコンテンツがキャッシングしないと示されていない場合は、ストリーミングメディアプレーヤは、そのストリーミングメディアプレーヤが、ストリーミングメディアコンテンツのクライアントでのキャッシングを使用禁止にしているかどうかを調べる（動作３４６）。使用禁止にしている場合には、ストリーミングメディアコンテンツをクライアントでキャッシュメモリに入れない（動作３４２）。使用禁止でない場合には、ストリーミングメディアプレーヤは、ストリーミングメディアコンテンツ識別子がコンテンツビットレートの変更子を含むかどうかを調べる（動作３４８）。

【００８４】

コンテンツビットレートの変更子が含まれる場合には、ストリーミングメディアプレーヤは、そのコンテンツビットレート変更子の値を超えない最高のビットレートを有するストリームのセットを選択する（図８Ｂの動作３５２）。コンテンツビットレートの変更子が含まれない場合には、ストリーミングメディアプレーヤは、リンク帯域幅とも称するクライアントとサーバ間の帯域幅に基づいてストリームのセットを選択する（図８Ｂの動作３５０）。

【００８５】

ストリームを選択すると、ストリーミングメディアプレーヤは、ストリーミングメディアコンテンツの識別子がそのコンテンツをキャッシュすべきと示しているかどうかに基づいて進行する（動作３５４）。キャッシュすべきと示されていない場合には、ストリーミングメディアプレーヤは、リンク帯域幅が、選択したストリームのビットレートの合計の１．５倍を超えるか、または選択したストリームのビットレートの合計の０．９倍未満であるかどうかを調べる（動作３５６）。あるいは、動作３５６では１．５および０．９以外の値を使用してもよい。リンク帯域幅が、選択したストリームのビットレート合計の１．５倍を超えないか、または選択したストリームのビットレート合計の０．９倍未満でない場合には、クライアントでストリーミングメディアコンテンツをキャッシュしない（図８Ａの動作３４２）。ただし、リンク帯域幅が、選択したストリームのビットレート合計の１．５倍を超えるか、または、選択したストリームのビットレート合計の０．９倍未満である場合には、ストリーミングメディアプレーヤは、選択したプロトコルがストリーミングメディアコンテンツのクライアントでのキャッシングをサポートするかどうかを調べる（動作３５８）。例示的な一実装では、ＴＣＰ（伝送制御プロトコル）によるデータ配信を使用したＨＴＴＰ１．１およびＲＴＳＰで、ストリーミングメディアコンテンツのクライアントでのキャッシングがサポートされる。

【００８６】

プロトコルがストリーミングメディアコンテンツのクライアントでのキャッシングをサポートしない場合には、ストリーミングメディアコンテンツをクライアントでキャッシュしない（図８Ａの動作３４２）。プロトコルがストリーミングメディアコンテンツのクライアントでのキャッシングをサポートする場合、またはストリーミングメディアコンテンツの識別子がコンテンツをキャッシュすべきであると示す（動作３５４）場合には、ストリーミングメディアプレーヤは、サーバがクライアントでのキャッシングを許可するかどうかを調べる（動作３６０）。サーバがクライアントでのキャッシングを許可しない場合には、ストリーミングメディアコンテンツをクライアントでキャッシュしない（図８Ａの動作３４２）。ただしサーバでクライアントでのキャッシングが可能であるとしている場合には、ストリーミングメディアコンテンツを入れるだけの空間がキャッシュメモリにあるかどうかを調べる（動作３６２）。ストリーミングメディアコンテンツをキャッシュするのに必要な空間量は、例えば図８Ａの動作３３８で受信するヘッダ情報で識別することができる。必要な場合にはすでにキャッシュされているコンテンツを任意選択でキャッシュメモリから追い出して十分な空間を作成することもできる。キャッシュメモリに十分な空間がない場合には、ストリーミングメディアコンテンツをクライアントでキャッシュしな

い（図８Ａの動作３４２）。ただしキャッシュするのに十分な空間がある場合には、ストリーミングメディアコンテンツをクライアントでキャッシュする（動作３６４）。

【００８７】

ストリーミングメディアコンテンツがブロードキャストコンテンツである場合など、状況によっては、コンテンツのサイズが分からない場合には，そのためそのコンテンツのすべてに十分な空間がキャッシュにあるかどうかの判定（動作３６２）を行わない場合があることに留意されたい。そのような状況では、単にキャッシュにそれ以上コンテンツを入れるだけのメモリ空間がなくなるまでコンテンツをキャッシュして、空間がなくなった時点でストリーミングメディアコンテンツのキャッシングをやめるようにしてもよい。あるいは、図８Ａの動作３３８で受信するヘッダ情報に入れるなどにより、ストリーミングメディアコンテンツのおよそのサイズをストリーミングメディアプレーヤが取得できるようにしてもよい（例えば、予測されるブロードキャスト継続時間や、ブロードキャストストリーミングメディアコンテンツの符号化ビットレートなどからブロードキャストコンテンツのおよそのサイズを容易に判定することができる）。

【００８８】

図８Ａおよび８Ｂのプロセス３３０は、クライアントデバイスにストリーミングメディアコンテンツをキャッシュするかどうかを判定する例示的なプロセスであり、プロセス３３０には色々な修正を加えてよいことにも留意されたい。例えば、ブロードキャストコンテンツをキャッシュしない実施形態では、コンテンツがブロードキャストコンテンツであるかどうかを調べ、ブロードキャストコンテンツである場合にはコンテンツをキャッシュしない（動作３４２）ように、追加的な動作をプロセス３３０に含めることができる。別の実施形態では，コンテンツ識別子がコンテンツをキャッシュすべきと指示しているかどうかを調べることができ、キャッシュすべきとの場合は、その指示が他のデフォルト設定に優先することができる（例えば、デフォルトではブロードキャストコンテンツをキャッシュしないが，キャッシュが可能というコンテンツ識別子中の指示によってそれを無効にすることができる）。さらに別の実施形態では、ユーザはクライアントでのキャッシングを使用禁止にすることが許されず、したがって動作３４０をプロセス３３０に含める必要がない。さらに別の実施形態では、コンテンツをキャッシュすべきかどうかをコンテンツ識別子で示すことができず、したがって動作３４４をプロセス３３０に含める必要がない。

【００８９】

本明細書には各種のプロセスをフローチャートの形で例示している。これらのプロセスに伴う動作は、フローチャートに示す順序で行っても、あるいは別の順序で行ってもよいことに留意されたい。例えば図８Ａおよび８Ｂでは、動作を図の順序で行っても、あるいは動作３６０または動作３６２を動作３４０より前に行っても，動作３４６を動作３４４の前に行ってもよい。

【００９０】

図９に、本明細書に記載された本発明に係わる技術を実施するのに使用できる例示的な一般的コンピューティング環境４００を示す。コンピュータ環境４００はコンピューティング環境の一例に過ぎず、このコンピュータおよびネットワークアーキテクチャの使用または機能性の範囲について何らの制限を示唆するものではない。またコンピュータ環境４００は、例示的コンピュータ環境４００に示す構成要素の任意の１つまたは組合せに関連する依存関係または必要性を有するものとも解釈すべきでない。

【００９１】

コンピュータ環境４００は，コンピュータ４０２の形態の汎用コンピューティングデバイスを含む。コンピュータ４０２は、例えば図１のクライアント１０２またはサーバ１０４、または図２のクライアント１０２またはサーバ１４６である。コンピュータ４０２の構成要素には、これらに限定しないが、１つまたは複数のプロセッサまたは処理装置４０４、システムメモリ４０６、およびプロセッサ４０４を含む各種のシステムコンポーネントをシステムメモリ４０６に結合するシステムバス４０８が含まれる。

【００９２】

システムバス４０８は、各種のバスアーキテクチャの任意のものを使用したメモリバスまたはメモリコントローラ、周辺バス、アクセラレーテッドグラフィックポート（ＡＧＰ）、およびプロセッサバスまたはローカルバスを含む数タイプのバス構造の任意の１つまたは複数を表す。例として、このようなアーキテクチャには、ＩＳＡ（Ｉｎｄｕｓｔｒｙ Ｓｔａｎｄａｒｄ Ａｒｃｈｉｔｅｃｔｕｒｅ）バス、ＭＣＡ（Ｍｉｃｒｏ Ｃｈａｎｎｅｌ Ａｒｃｈｉｔｅｃｔｕｒｅ）バス、ＥＩＳＡ（Ｅｎｈａｎｃｅｄ ＩＳＡ）バス、ＶＥＳＡ（Ｖｉｄｅｏ Ｅｌｅｃｔｒｏｎｉｃｓ Ｓｔａｎｄａｒｄｓ Ａｓｓｏｃｉａｔｉｏｎ）バス、およびメザニンバスとも称されるＰＣＩ（Ｐｅｒｉｐｈｅｒａｌ Ｃｏｍｐｏｎｅｎｔ Ｉｎｔｅｒｃｏｎｎｅｃｔｓ）バスが含まれる。

【００９３】

コンピュータ４０２は通例各種のコンピュータ可読媒体を含む。そのような媒体は、コンピュータ４０２がアクセスできる任意の利用可能媒体でよく、揮発性および不揮発性の媒体、取り外し可能および取り外し不能媒体が含まれる。

【００９４】

システムメモリ４０６は、ランダムアクセスメモリ（ＲＡＭ）４１０などの揮発性メモリの形態と、および／または読み取り専用メモリ（ＲＯＭ）４１２など不揮発性メモリの形態のコンピュータ可読媒体を含む。起動時などにコンピュータ４０２内の要素間の情報転送を助ける基本ルーチンを含む基本入出力システム（ＢＩＯＳ）４１４は、ＲＯＭ４１２に記憶される。ＲＡＭ４１０は通例、処理装置４０４から即座にアクセス可能な、かつ／または現在処理装置４０４によって操作中のデータおよび／またはプログラムモジュールを含む。

【００９５】

コンピュータ４０２は、この他の取り外し可能／取り外し不能、揮発性／不揮発性のコンピュータ記憶媒体も含むことができる。例として、図９には、取り外し不能、不揮発性の磁気媒体（図示せず）の読み取りおよび書き込みを行うハードディスクドライブ４１６、取り外し可能、不揮発性の磁気ディスク４２０（例えば「フロッピー（登録商標）ディスク」）の読み取りおよび書き込みを行う磁気ディスクドライブ４１８、およびＣＤ－ＲＯＭ、ＤＶＤ－ＲＯＭ、あるいは他の光媒体などの取り外し可能、不揮発性の光ディスク４２４の読み取りおよび書き込みを行う光ディスクドライブ４２２を示す。ハードディスクドライブ４１６、磁気ディスクドライブ４１８、および光ディスクドライブ４２２はそれぞれ、１つまたは複数のデータメディアインタフェース４２５によってシステムバス４０８に接続される。あるいは、ハードディスクドライブ４１６、磁気ディスクドライブ４１８、および光ディスクドライブ４２２は、１つまたは複数のインタフェース（図示せず）によってシステムバス４０８に接続することもできる。

【００９６】

これらのディスクドライブとそれに関連のコンピュータ可読媒体は、コンピュータ可読命令、データ構造、プログラムモジュール、およびコンピュータ４０２のその他のデータの不揮発性の記憶を提供する。この例示としてハードディスク４１６、取り外し可能磁気ディスク４２０、および取り外し可能光ディスク４２４を図示しているが、これ以外に、磁気カセットまたはその他の磁気記憶装置、フラッシュメモリカード、ＣＤ－ＲＯＭ、デジタル多用途ディスク（ＤＶＤ）またはその他の光ストレージ、ランダムアクセスメモリ（ＲＡＭ）、読み取り専用メモリ（ＲＯＭ）、電気的に消去可能なプログラム可能読み取り専用メモリ（ＥＥＰＲＯＭ）など、データを記憶することができ、コンピュータによるアクセスが可能な他のタイプのコンピュータ可読媒体をこの例示的コンピューティングシステムおよび環境の実装に利用できることも理解されたい。

【００９７】

ハードディスク４１６、磁気ディスク４２０、光ディスク４２４、ＲＯＭ４１２、および／またはＲＡＭ４１０には任意数のプログラムモジュールを格納することができ、この例には、オペレーティングシステム４２６、１つまたは複数のアプリケーションプログラム４２８、その他のプログラムモジュール４３０、およびプログラムデータ４３２が含まれ

る。そのようなオペレーティングシステム４２６、１つまたは複数のアプリケーションプログラム４２８、他のプログラムモジュール４３０、およびプログラムデータ４３２（またはこれらの何らかの組合せ）はそれぞれ、分散ファイルシステムをサポートする常駐コンポーネントのすべてまたは一部を実装することができる。

【００９８】

ユーザは、キーボード４３４やポインティングデバイス４３６（例えば「マウス」）などの入力装置を介して、コンピュータ４０２にコマンドと情報を入力することができる。この他の入力装置４３８（具体的には図示せず）には、マイクロフォン、ジョイスティック、ゲームパッド、衛星受信アンテナ、シリアルポート、スキャナなどがある。これらおよびその他の入力装置は、システムバス４０８に結合された入出力インタフェース４４０を介して処理装置４０４に接続されるが、パラレルポート、ゲームポート、あるいはユニバーサルシリアルバス（ＵＳＢ）など、他のインタフェースおよびバス構造によって接続することもできる。

【００９９】

モニタ４４２またはその他のタイプの表示装置もビデオアダプタ４４４などのインタフェースを介してシステムバス４０８に接続することができる。モニタ４４２以外の他の出力周辺装置には、入出力インタフェース４４０を介してコンピュータ４０２に接続できるスピーカ（図示せず）やプリンタ４４６などのコンポーネントが含まれる。

【０１００】

コンピュータ４０２は、遠隔コンピュータ装置４４８など１つまたは複数の遠隔コンピュータへの論理結合を使用するネットワーク環境で動作することができる。例として、遠隔コンピュータ装置４４８は、パーソナルコンピュータ、携帯型コンピュータ、サーバ、ルータ、ネットワークコンピュータ、ピアデバイス、あるいはその他の一般的なネットワークノードなどである。遠隔コンピュータ装置４４８は、ここでコンピュータ４０２との関連で挙げた要素および機能の多くまたはすべてを含むことが可能な携帯型コンピュータとして図示している。

【０１０１】

コンピュータ４０２と遠隔コンピュータ４４８間の論理接続は、ローカルエリアネットワーク（ＬＡＮ）４５０および一般的な広域ネットワーク（ＷＡＮ）４５２として図示している。このようなネットワーク環境は、オフィス、企業内のコンピュータネットワーク、イントラネット、およびインターネットに一般的に見られる。

【０１０２】

ＬＡＮネットワーク環境で実装する場合、コンピュータ４０２は、ネットワークインタフェースまたはアダプタ４５４を介してローカルネットワーク４５０に接続される。ＷＡＮネットワーク環境で実装する場合、コンピュータ４０２は通例、広域ネットワーク４５２を通じて通信を確立するためのモデム４５６またはその他の手段を含む。モデム４５６は、コンピュータ４０２の内部にあっても外部にあってもよく、入出力インタフェース４４０またはその他の適切な機構を介してシステムバス４０８に接続することができる。図のネットワーク接続は例示的なものであり、コンピュータ４０２と４４８の間に通信リンクを確立することのできる他の手段を用いてもよいことを理解されたい。

【０１０３】

コンピューティング環境４００で示すようにネットワークされた環境では、コンピュータ４０２との関連で図に示すプログラムモジュールまたはその一部は、遠隔のメモリ記憶装置に格納することができる。例として、リモートアプリケーションプログラム４５８が遠隔コンピュータ４４８のメモリ装置に常駐している。例示のために、アプリケーションプログラムおよびオペレーティングシステムなどのその他の実行可能なプログラムコンポーネントをここでは別個のブロックとして表しているが、そのようなプログラムおよびコンポーネントは、様々な時にコンピューティングデバイス４０２の別々のストレージコンポーネント（記憶構成要素）に常駐し、コンピュータのデータプロセッサによって実行されることが分かる。

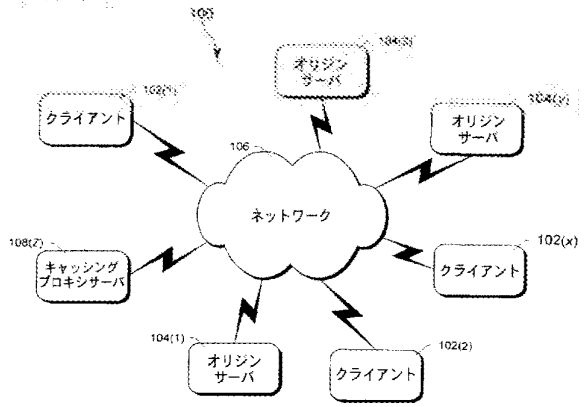
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【０１０４】
ここでは各種のモジュールおよび技術を、１つまたは複数のコンピュータまたは他のデバイスによって実行されるプログラムモジュールなどのコンピュータ実行可能命令の一般的な文脈で説明することができる。一般に、プログラムモジュールには、特定のタスクを実行するか、特定の抽象データ型を実装するルーチン、プログラム、オブジェクト、コンポーネント、データ構造などが含まれる。通例、プログラムモジュールの機能は、各種の実施形態で必要に応じて組み合わせても分散させてもよい。
【０１０５】
こうしたモジュールおよび技術の実装は、何らかの形態のコンピュータ可読媒体に格納しても、そうしたコンピュータ可読媒体を通じて送信してもよい。コンピュータ可読媒体は、コンピュータによるアクセスが可能な任意の利用可能媒体でよい。例として、これに限定しないが、コンピュータ可読媒体は、「コンピュータ記憶媒体」と「通信媒体」を含むことができる。
【０１０６】
「コンピュータ記憶媒体」には、コンピュータ可読命令、データ構造、プログラムモジュール、あるいは他のデータなどの情報を記憶するための任意の方法または技術で実行される、揮発性および不揮発性、取り外し可能および取り外し不能の媒体が含まれる。コンピュータ記憶媒体には、これらに限定しないが、ＲＡＭ、ＲＯＭ、ＥＥＰＲＯＭ、フラッシュメモリまたはその他のメモリ技術、ＣＤ－ＲＯＭ、デジタル多用途ディスク（ＤＶＤ）またはその他の光ストレージ、磁気カセット、磁気テープ、磁気ディスクストレージまたはその他の磁気記憶装置、あるいは所望の情報の記憶に使用することができ、コンピュータによってアクセスできる任意の他の媒体が含まれる。
【０１０７】
「通信媒体」は通例、コンピュータ可読命令、データ構造、プログラムモジュール、またはその他のデータを搬送波やその他の移送機構などの変調データ信号で具現化する。通信媒体には、任意の情報伝達媒体も含まれる。用語「変調データ信号」とは、信号中に情報を符号化するような形でその特性の１つまたは複数を設定または変化させた信号を意味する。例として、通信媒体には、これらに限定しないが、配線ネットワークや直接配線接続などの配線媒体と、音響、ＲＦ（無線周波数）、赤外線、その他の無線媒体などの無線媒体が含まれる。上記の媒体の組合せもコンピュータ可読媒体の範囲に含まれる。
【０１０８】
上記の説明では、構造的特徴および／または方法論的な動作に固有の術語を使用しているが、頭記の特許請求の範囲に定義する本発明はここに記載する特定の特徴または動作に限定されないことを理解されたい。それら特定の特徴および動作は、本発明を実施する例示的形態として開示する。
【図面の簡単な説明】
【図１】ストリーミングメディアコンテンツのクライアント側でのキャッシングを用いることができる例示的なネットワーク環境を示す図である。
【図２】例示的なクライアントデバイスおよびサーバデバイスを示す図である。
【図３】ストリーミングメディアデータを通信する際に使用できる例示的なメッセージフォーマットを示す図である。
【図４】サーバからクライアントにメディアコンテンツをストリーミングする例示的プロセスを示すフローチャートである。
【図５】サーバからクライアントにメディアコンテンツをストリーミングするのと同時に、シャトルコントロールコマンドを受け付ける例示的プロセスを示すフローチャートである。
【図６】後の再生のためにストリーミングメディアコンテンツを記録する例示的プロセスを示すフローチャートである。
【図７】クライアントデバイスにストリーミングメディアコンテンツをキャッシュする例示的プロセスを示すフローチャートである。

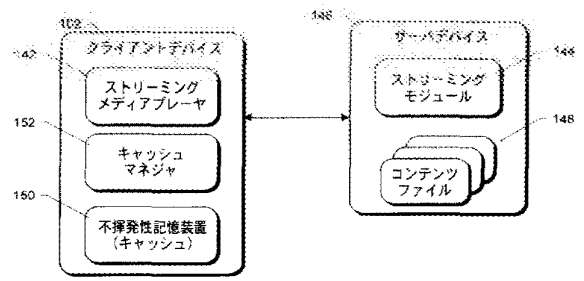
【図８Ａ】ストリーミングメディアコンテンツをクライアントデバイスにキャッシュするかどうかを判定する例示的プロセスを示すフローチャートである。
【図８Ｂ】ストリーミングメディアコンテンツをクライアントデバイスにキャッシュするかどうかを判定する例示的プロセスを示すフローチャートである。
【図９】本発明に係わる技術を実施するのに使用できる例示的な一般的コンピュータ環境を示す図である。
【符号の説明】
１００　ネットワーク環境
１０２（１）、１０２（２）、１０２（ｘ）　クライアントデバイス
１０４（１）、１０４（２）、１０４（ｘ）　オリジンサーバデバイス
１０６　ネットワーク
１０８　キャッシングプロキシサーバ
１４２　ストリーミングメディアプレーヤ
１４４　ストリーミングモジュール
１４６　ソースサーバデバイス
１４８　コンテンツファイル
１５０　不揮発性記憶装置（キャッシュメモリ）
１５２　キャッシュマネジャ
１８０　データ構造
１８２　スタートライン部分
１８４　ヘッダ
１８６　空のライン
１８８　メッセージ本体
４００　コンピュータ環境
４０２　コンピュータ
４０４　処理装置
４０６　システムメモリ
４０８　システムバス
４１０　ＲＡＭ
４１２　ＲＯＭ
４１４　ＢＩＯＳ
４１６　ハードディスクドライブ
４１８　磁気ディスクドライブ
４２０　磁気ディスク
４２２　光ディスクドライブ
４２４　光ディスク
４２５　データメディアインタフェース
４２６　オペレーティングシステム
４２８　アプリケーションプログラム
４３０　プログラムモジュール
４３２　プログラムデータ
４３４　キーボード
４３６　ポインティングデバイス（マウス）
４３８　他の入力装置（他のデバイス）
４４０　入出力インターフェース
４４２　モニタ
４４４　ビデオアダプタ
４４６　プリンタ
４４８　遠隔コンピュータ装置
４５０　ＬＡＮ

４５２　ＷＡＮ（インターネット）
４５６　モデム
４５８　リモートアプリケーションプログラム

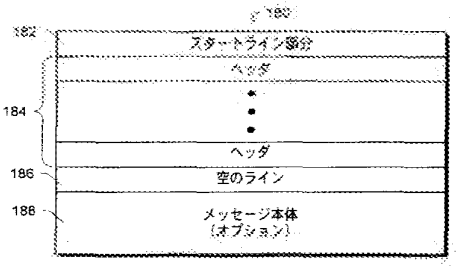
【図１】



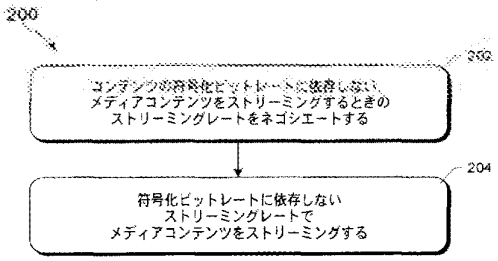
【図２】



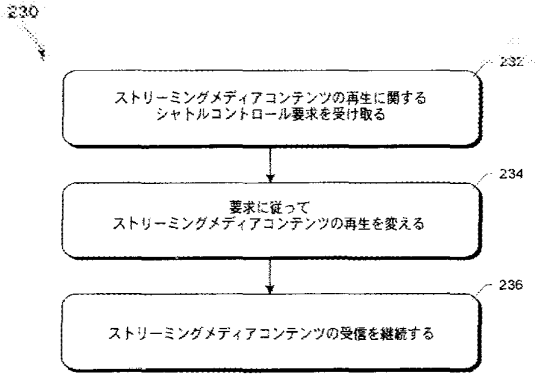
【図３】



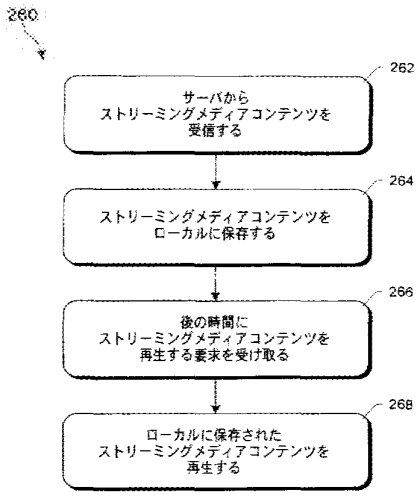
【図４】



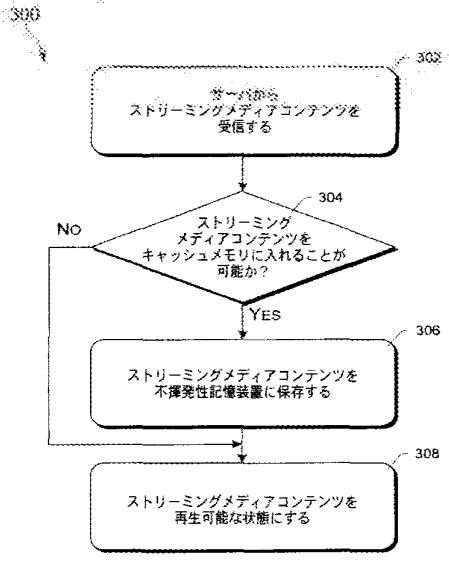
【図５】


230
232
ストリーミングメディアコンテンツの再生に関する
シャトルコントロール要求を受け取る
234
要求に従って
ストリーミングメディアコンテンツの再生を変える
236
ストリーミングメディアコンテンツの受信を継続する

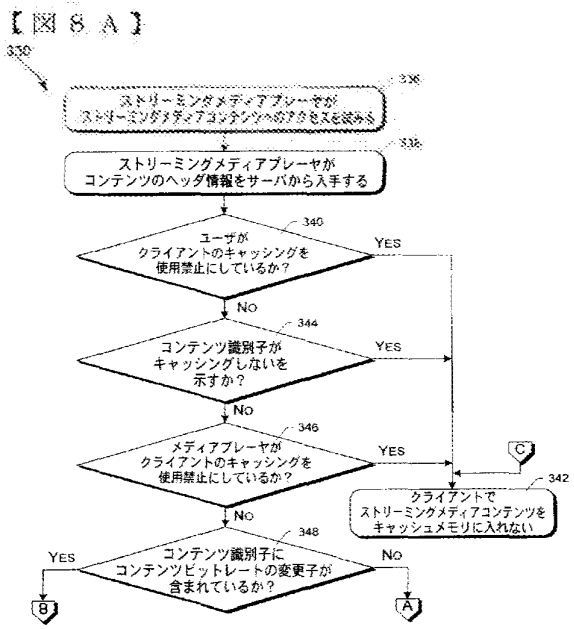
【図６】


260
262
サーバから
ストリーミングメディアコンテンツを
受信する
264
ストリーミングメディアコンテンツを
ローカルに保存する
266
後の時間に
ストリーミングメディアコンテンツを
再生する要求を受け取る
268
ローカルに保存された
ストリーミングメディアコンテンツを
再生する

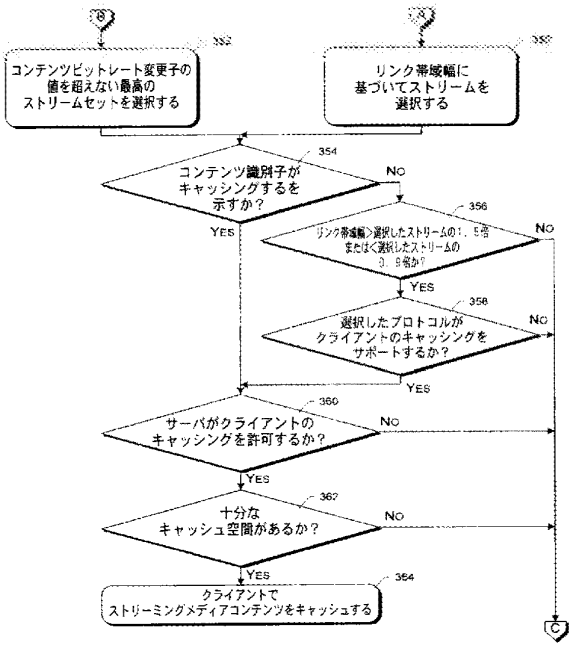
【図７】


300
302
サーバから
ストリーミングメディアコンテンツを
受信する
304
ストリーミング
メディアコンテンツを
キャッシュメモリに入れることが
可能か？
NO
YES
306
ストリーミングメディアコンテンツを
不揮発性記憶装置に保存する
308
ストリーミングメディアコンテンツを
再生可能な状態にする

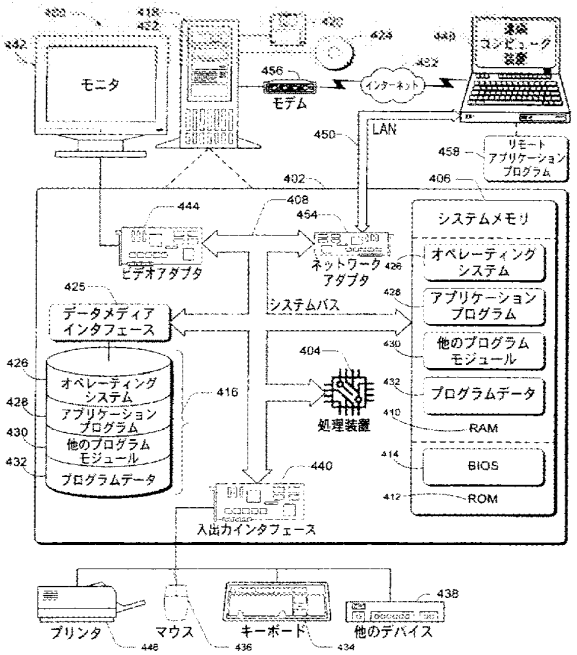
【図８Ａ】


330
336
ストリーミングメディアプレーヤが
ストリーミングメディアコンテンツへのアクセスを試みる
338
ストリーミングメディアプレーヤが
コンテンツのヘッダ情報をサーバから入手する
340
ユーザが
クライアントのキャッシングを
使用禁止にしているか？
YES
NO
344
コンテンツ識別子が
キャッシングしないを
示すか？
YES
NO
346
メディアプレーヤが
クライアントのキャッシングを
使用禁止にしているか？
YES
C
NO
342
クライアントで
ストリーミングメディアコンテンツを
キャッシュメモリに入れない
348
コンテンツ識別子に
コンテンツビットレートの変更子が
含まれているか？
YES
NO
B
A

【図８Ｂ】


B
352
コンテンツビットレート変更子の値を超えない最高のストリームセットを選択する
B
350
リンク帯域幅に基づいてストリームを選択する
354
コンテンツ識別子がキャッシングするを示すか？
NO
YES
356
リンク帯域幅>選択したストリームの1．5倍またはく選択したストリームの3．9倍か？
NO
YES
358
選択したプロトコルがクライアントのキャッシングをサポートするか？
NO
YES
360
サーバがクライアントのキャッシングを許可するか？
NO
YES
362
十分なキャッシュ空間があるか？
NO
YES
364
クライアントでストリーミングメディアコンテンツをキャッシュする
C

【図９】


モニタ
モデム
インターネット
コンピュータ
LAN
リモートアプリケーションプログラム
システムメモリ
オペレーティングシステム
アプリケーションプログラム
他のプログラムモジュール
プログラムデータ
RAM
BIOS
ROM
ビデオアダプタ
ネットワークアダプタ
システムバス
データメディアインタフェース
処理装置
入出力インタフェース
プリンタ
マウス
キーボード
他のデバイス

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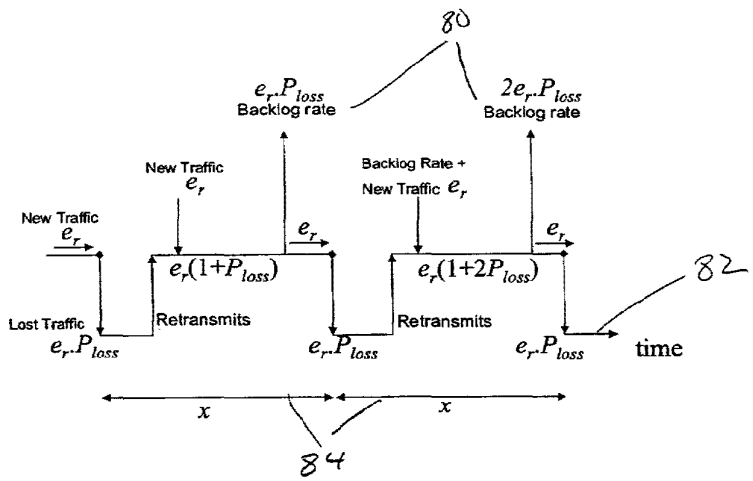
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(54) Title: APPARATUS AND METHOD FOR PREDICTABLE AND DIFFERENTIATED DELIVERY OF MULTIMEDIA STREAMING ON THE INTERNET



(57) Abstract: The inventive method detects network congestion which interferes with streaming of multimedia audio and video packets from and reacts to it and guarantees delivery of packets. The streaming of the multimedia audio and video packets is performed when a server process executing on a sending computing device sends the packets to a player process executing on a receiving computing device via a network, such as the Internet. The detection of the network congestion is performed by communicating configuration information including network parameters from a service manager via the network to the at least one sending computing device and to the at least one receiving computing device. The network congestion (80) is then confirming by transmitting and retracting network probes. At least one buffer management technique is executed to limit degradation in the streaming of the packets. The end of the network congestion is detected by transmitting and retracting said network probes and the rate of streaming of the packets is configured accordingly (82, 84).

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APPARATUS AND METHOD FOR PREDICTABLE AND DIFFERENTIATED DELIVERY OF MULTIMEDIA STREAMING ON THE INTERNET

TECHNICAL FIELD

This invention relates to the field of multimedia audio and video streaming on the Internet, and more particularly, to an apparatus and method for predictable and differentiated delivery of multimedia streaming on the Internet.

BACKGROUND OF THE INVENTION

Multimedia streaming involves broadcast of audio and video information from content providers called streaming servers or senders via the Internet to clients or receivers on user computing devices called streaming players. Real-time delivery of the multimedia streaming on the Internet is inherently uncontrollable and consequently unpredictable. When an Internet delivery path is congested, packets of multimedia streaming are typically dropped, thus causing degraded audio and video playback to be received by the streaming players. Typically, manifested forms of congestion can be classified into two types: instantaneous and sustained (longer-term). Instantaneous congestion is caused by random variations in the arrival patterns of packets of multimedia streaming at different Internet routers and switches, and due to the varying sizes of these packets.

These variations cause varying amounts of delay as the packets of multimedia streaming travel from the streaming server to the streaming receiver. If the delay accumulates beyond a certain point, the packets of multimedia streaming can get lost. This type of congestion typically causes sporadic delays and losses of over hundreds of milliseconds to a few seconds, and is hence referred to as "instantaneous congestion." In contrast, sustained congestion is longer-term and results during periods of excessive demand by the streaming players, e.g., demand for multimedia streaming from popular websites over the network paths on the Internet. During these periods, packet traffic surges can overwhelm the packet buffers in network routers, which are network traffic routing and forwarding computing devices, and packets of multimedia streaming can get

lost in bursts. This is similar to a rush-hour traffic scenario on highways at peak hours. Unlike instantaneous congestion, sustained congestion can last from tens of seconds up to a few minutes.

It is well known that instantaneous congestion is an easy problem to solve. The client or the streaming player can buffer incoming packets of multimedia streaming for a short duration before playback. This reduces the effect of short-term delay between packets of multimedia streaming. Additionally, by requesting that a lost packet be immediately retransmitted, the streaming player can counter the loss of packets of multimedia streaming due to instantaneous congestion. Several existing streaming systems use these techniques, i.e., short-term buffering along with retransmits of lost packets, to isolate the streaming player from the effects of instantaneous congestion. Examples of these systems include the Robust-User Datagram Protocol (UDP) feature in the Real system from Real Networks and the NetShow 3.0 MediaPlayer from Microsoft.

The problem of sustained congestion is harder to solve. This difficulty relates to the fact that the Internet delivery lacks a uniform real-time control. Several standardization and research efforts have proposed ways to introduce such control; however, none have succeeded in creating a global Internet standard. The referred to standardization and research efforts include the following:

1. L. Kleinrock, "On Flow Control in Computer Networks", International Conference on Communications (ICC'78), pages 27.2.1-27.2.5;
2. D.E. Comer, R. S. Yavatkar, "A Rate-based Congestion Avoidance and Control Scheme for Packet Switched Networks", The 10th International Conference on Distributed Computing Systems, pages 390-397, 1990;
3. K.K. Ramakrishnan, R. Jain, "A Binary Feedback Scheme for Congestion Avoidance in Computer Networks", ACM Transactions on Computer Systems, Vol. 8, No. 2, May 1990, Pages 158-181; and
4. D. Mitra, "Asympotically Optimal Design of Congestion Control for High Speed Data Networks", IEEE Transactions on Communications, Vol. 40, No. 2, February 1992.

For example, the RSVP effort, described in Braden, R., Zhang, L., Berson, S., Herzog, S., and Jamin, S., "Resource Reservation Protocol (RSVP) - Version 1

Functional Specification", RFC 2205, Proposed Standard, September 1997, seeks to add "quality of service" control within each network router and switch within the Internet. Another effort that seeks to create fast paths on the Internet is the "differentiated service" effort within the Internet Engineering Task Force (IETF) described in the following publications:

1) Nichols, K., Jacobson, V. and Zhang, L., "A Two-bit Differentiated Services Architecture for the Internet", Internet Draft, December 1997;
2) Ferguson, P., "Simple Differential Services: IP TOS and Precedence, Delay Indication, and Drop Preference", Internet Draft, November 1997; and
3) Clark, D. and Wroclawski, J., "An Approach to Service Allocation in the Internet", Internet Draft, July 1997.

The problem with these approaches is that they require structural changes throughout the Internet. This requirement assumes an explicit cooperation between various managers of the equipment comprising the Internet, which is an impractical assumption. Consequently, these efforts have stalled or are expected to have limited success. An alternative approach is to offer "adaptive applications". This approach proposes that application content be adapted based on the level of congestion. Methods based on this approach degrade the "experience" of an application in a controlled manner, but do not attempt to guarantee predictability or isolation from congestion effects. This approach is discussed in I. Busse, B. Deffner, H. Schulzrinne, "Dynamic QoS Control of Multimedia Applications based on RTP", May 30, 1995 and Real Networks, "White Paper on SureStream Technology", Available at http://www.real.com/devzone/library/whitepapers/surestrm.html.

What is needed is a "delivery framework" that will isolate streaming players from the effect of sustained congestion by providing a "predictable" delivery. Furthermore, there is also a need for a "differentiated streaming" framework that will provide for multiple levels of delivery isolation to the streaming players, without requiring structural changes in the Internet, as in K. Nichols et al., P. Ferguson and D. Clark, discussed above.

SUMMARY OF THE INVENTION

The object of the present invention is to achieve a particular level of delivery isolation on particular streaming players. This level of delivery isolation may be based on factors like an importance "value" associated with particular streaming players, or the price the user of the streaming players are charged, etc. As an example, the streaming server may place specific streaming players in the high "value" category based on the demographic information on their owners, while other streaming players may be placed in the low "value" category.

Another object of the present invention is to ensure that the high value users of streaming players always receive consistent, predictable delivery of streaming content, even if there is an excessive user demand. If there is a situation of sustained congestion, wherein not all users can be satisfied, the content provider might want to ensure that the high value users are promised predictable delivery.

Accordingly, the present invention provides a method and an apparatus for predictable and differentiated streaming on the Internet. The system consists of software and random-access memory-based buffers installed at the streaming server and at the streaming players along with a service manager at a separate location. The method prescribes the manner in which the system is used to achieve predictable and differentiated delivery of streaming multimedia packets.

The invention is based on streaming multimedia packets between the software on the streaming server and the software on the streaming. The buffer sizes in the computing devices of the streaming player and of the streaming server are initialized based on the configuration information provided by the service manager software at the start of the execution of the inventive method. This configuration information includes:

a) the expected duration of sustained congestion periods,

b) the worst-case packet loss rate during the sustained congestion period,

c) the encoded bit-rate of streaming source information, and etc.

During the delivery of the streaming multimedia packets, the software on the streaming server relays the streaming packets to the software on the streaming player, which stores the packets in a playout buffer before playing them out. The playout buffer takes care of

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delay variation that may arise due to instantaneous congestion on the network path. In case of short-term losses caused by instantaneous congestion, the software on streaming player immediately requests the server-end software to retransmit the lost information.

Predictable Delivery Method

To deal with sustained congestion ("congestion") the invention incorporates the following method. The software on the streaming player uses estimation techniques based on probes to detect and confirm the onset of sustained congestion. Once the congestion status is verified, the streaming player software informs the streaming server software about this event. The streaming server software then modifies the manner in which it streams packets to the streaming player software. In particular, the streaming server software ensures that the transmission rate of packets never exceeds the encoded bit-rate of the streaming source. Furthermore, it gives preemptive priority to the retransmitted packets over new packets. This creates a backlog of new packets at one of the streaming server buffers.

Meanwhile, the streaming player software continuously monitors the status of received packets and detects the end of congestion through estimation techniques based on probes. Once the end of congestion is confirmed, the streaming player software informs the streaming server software about this event. The streaming server software then begins to stream its backlog of new packets to the streaming player software. The transmission rate of this stream is increased based on the estimation information from the streaming player software along with feedback obtained from other streaming players in the network. This rate is carefully selected to ensure that the network is not flooded back into congestion. The buffer sizing at the streaming player and at the streaming server is based on the configuration information and ensures that the user experiences an uninterrupted playback during sustained congestion. This assumes that the configuration information is the "worst-case" scenario. If the actual service parameters turn out to be worse than the configuration information, the streaming player software contacts the service manager after the service. The configuration information at the service manager is now updated in a persistent manner with the actual worst-case parameters.

In one preferred embodiment, this update happens as follows. At the next service invocation, the buffers are sized based on the updated configuration information. The method thus automatically learns the worst-case behavior from the actual behavior of the network each time. Eventually, the method can guarantee a predictable delivery based on a non-interrupted playout in most cases. Various other embodiments are also possible, wherein the buffer size is fixed, but the encoding bit-rate of the stream is modified to choose the largest encoding bit-rate that leads to an uninterrupted playback.

Differentiated Streaming Method

The method for differentiated streaming involves identical operations as the predictable streaming method, except for the mechanism for streaming the backlog of packets from the streaming server software. For differentiated streaming, the streaming server software transmits the stream based on the "value" associated with the particular user, in addition to the information used for predictable streaming.

Accounting Delivery Service

Additionally, the methodology of the mentioned invention is utilized to offer the inventive method as an "accountable delivery service" to a large number of content providers, i.e., streaming servers, and users, i.e., streaming players. Such a service may deliver performance contract-based services to users of the streaming players on the Internet.

The service manager plays a central role in this service, by keeping and exchanging the state of several streaming players, delivery paths, and content providers/streaming servers in its database. The method of the present invention tracks the "actual" delivered viewing/listening experience of users of streaming servers by computing the delivery statistics including but not restricted to metrics that quantify "pauses or interruptions", "content throughput", and "content loss". In addition to the features of predictability and differentiation, the delivery service can also answer the question of "service feasibility". That is, at the beginning of a session, the service manager can estimate, based on the historical and instantaneous information, whether a

particular user can receive an "expected quality experience." While the present invention does not describe the details of this service, it should be obvious to those skilled in the art to build such a service around the framework of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the invention will be apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which the reference characters refer to like parts throughout and in which:

Figure 1 is a schematic diagram of the devices and programs comprising the invention.

Figure 2 is a schematic diagram of the components of the devices utilized by the invention.

Figure 3 is a schematic diagram of the operation of the invention during normal streaming.

Figure 4 is a schematic diagram of the operation of the invention during congestion.

Figure 5 is a schematic diagram of the recovery scheduling operation of the invention after congestion.

Figure 6 is a diagram of the modeling the backlog operation of the invention during congestion.

Figure 7 is a state transition diagram for streaming player module (normal streaming).

Figure 8 is a state transition diagram for streaming server module (normal streaming).

Figure 9 is diagram of a congestion processing protocol at the streaming player module (during and after congestion).

Figure 10 is a diagram of an congestion processing protocol at the streaming server module (during and after congestion).

DETAILED DESCRIPTION OF THE INVENTION

Architecture

The invention, shown in Figure 1, comprises at least one computing device 10 for executing a service manager process 12, at least one computing device 14 for executing streaming server process 16, and at least one computing device 18 for executing streaming player process 20. The service manager process 12 is shown as residing on the computing device 12 only for the clarity of presentation. It may be obvious to those skilled in the art that the service manager process 12 may reside on any computing devices 14 and 18. Furthermore, server processes 16 may be present on the computing devices 18 alongside player processes 20, and vice versa the player processes 20 may be present on the computing devices 14 alongside server processes 16. Each computing device 10, 14 and 18 are connected to a network 22 and establish data paths amongst each other. In the preferred embodiment, the network is the Internet.

The streaming server process 16 transmits a single multimedia stream to each streaming player process 20 and the streaming player process 20 receives that single multimedia stream. The streaming server process consists of three buffers:

a) Output buffer 24, used to transmit new packets from the server process 16 to the player process 20;

b) Backup buffer 26 , for maintaining temporary copies of the packets transmitted to the player process 20; and

c) Retransmit buffer 28, for maintaining retransmit requests received from the player process 20. The streaming player process 20 may comprise a player buffer 29.

Before a streaming session begins, the Service Manager process 12 downloads configuration information via the network 22 to both the computing device 14 for the use of the streaming server process 16 and to the computing device 18 for the use of the streaming player process 20. At the end of each streaming session, the configuration information on the computing device 10 is updated for the future use of the Service Manager process 12 via the network 22 by both the streaming server process 16 on the computing device 14 and the streaming player process 20 on the computing device 18.

The computing devices 10, 14, and 18 may take the configuration of any computer ranging from mainframes and personal computers (PCs) to digital telephones and hand held devices, e.g., palm pilots™. In one illustrative embodiment of this invention shown in Figure 2, such computing devices may comprise a bus 30, which is connected directly to each of the following:

1. a central processing unit (CPU) 32;
2. a memory 34;
3. a system clock 36;
4. a peripheral interface 38;
5. a video interface 40;
6. an input/output (I/O) interface 42;
7. a communications interface 44; and
8. a multimedia interface 46.

The common bus 30 is further connected

1. by the video interface 40 to a display 50;
2. by the I/O interface 42 to a storage device 52, which may illustratively take the form of memory gates, disks, diskettes, compact disks (CD), digital video disks (DVD), etc.;
3. by the multimedia interface 46 to any multimedia component 56;
4. by peripheral interface 38 to the peripherals 58, such as the keyboard, the mouse, navigational buttons, e.g., on a digital phone, a touch screen, and/or writing screen on full size and hand held devices, e.g., a palm pilot ™;
5. by the communications interface 44, e.g., a plurality of modems, to a network connection 60, e.g., an Internet Service Provider (ISP) and to other services, which is in turn connected to the network 22, whereby a data path is provided between the network 22 and the computing devices 10, 14, and 18 (Figure 1) and, in particular, the common bus 30 of these computing devices; and
6. furthermore, by the communications interface 44 to the wired and/or the wireless telephone system 54.

Normal Conditions

Turning now to Figure 3, the normal streaming operation is shown when there are either zero, i.e., no losses, or sporadic streaming losses, i.e., loss occurring due to instantaneous burst of streaming packets. The overall streaming sequence works as follows. Packets streamed from the streaming server process 16 are queued up in the streaming server output buffer 24 for transmission. The server process 16 is responsible for transmitting streaming packets 70 to the computing device 18 executing the player process 20. Periodically, this process 16 checks the output buffer 24 and the retransmit buffer 28 to determine if there are streaming packets 70 awaiting transmission or any requests form the player process. Any remaining streaming packets in the output buffer 24 are then transmitted. If retransmission requests are found, any streaming packets 70 requested for retransmission and found in the backup buffer 26 are transmitted. When streaming packets 70 are transmitted, a temporary backup copy of the transmitted streaming packets 70 is kept in the backup buffer.

The streaming player process 20 receives the streaming packets 70 and stores them at the tail-end of the player buffer 29. Periodically after a user-defined interval, the player process 20 examines the received streaming packets 70 to see if any streaming packets 70 are missing. If packets are missing, the player process 20 sends a request 72 to the server process 16 to retransmit the missing packets. After assuring that all the streaming packets 70 are received, the received streaming packets 70 are forwarded from the head-end of the player buffer to the streaming player process 20.

Congested Conditions

The invention detects congestion early on, and then may take steps so that the impact of congestion on the stream is minimized. A correctly configured framework can keep a stream completely transparent of sustained congestion, thus providing an effect equivalent to a "reservation." Two principles are at the basis of this framework, detection/reaction to congestion and congestion recovery.

1. Detecting and reacting to congestion

The invention detects congestion through probes launched by the player process 20. The probes are discussed in detail later. Once congestion is confirmed, the server process 16 reacts by using a technique called "constant bit-rate emulation." This name derives from the fact that the server process 16 tries to maintain a constant upper bound on the rate at which the streaming packets 70 are streamed to the player process 20. Typically, the upper bound is set equal to the encoding bit rate of the stream. In effect, the server process 16 emulates a constant bit-rate by substituting new server packets with packets that have been requested 72 for retransmission. Please recall that in congestion, the server has a large number of retransmit requests 72 issued from the player process 20. Figure 4 shows the flow of streaming packets 70 during this congestion situation. Two important reasons motivate the constant bit-rate emulation method:

a) The method demonstrates a "network-friendly" yet efficient behavior. The method is network-friendly, since it conserves bandwidth during congestion by lowering the upper bound of its streaming transmission rate. Additionally, the method is efficient for the following reasons. First, the upper bound on the transmission rate is set equal to the maximum encoding bit-rate of the source stream; this is not a restrictive setting. Unlike other schemes that voluntarily reduce the source rate during congestion, the present invention only reduces the transmission rate by the amount of incurred loss. This decision has an important implication in practice. Most practical congestion-processing algorithms will incur errors and delays in estimating and reacting to the start of congestion or end of congestion. Consequently, there will be temporary periods in which these algorithms "think" that the network is congested, when in practice, the network has cleared out of congestion. In situations like this, estimation errors do not degrade the streaming throughput. In fact, the invention delivers a throughput better or equal to the throughput of any other scheme, if there is no loss of streaming packets 70.

b) Assuming most connections sharing the network with streaming are using the Transmission Control Protocol (TCP), the constant bit-rate of the invention in congestion allows the TCP traffic on the same path to accurately sense the available bandwidth (most Internet or Web traffic uses TCP). An alternative design with

adapting bit-rate would confuse most other TCP connections and cause each to keep oscillating their TCP windows. If all TCP connections maintain a steady window-size, the performance of the network is much smoother in congestion. This behavior can drain out the congestion faster and reduce the estimation errors.

2. Detecting End-of-Congestion and Recovery from congestion

The invention detects the end of congestion through probes launched by the player process 20. Once the player process 20 confirms that congestion is over, the server process 16 enters a phase called "recovery scheduling". Figure 4 shows a recovery scheduling after congestion. To understand this phase, recall that in the previous state of congestion, the server transmits packets at a constant rate. By substituting new packets with older lost packets, the server is in effect creating a backlog of new packets in its output buffer. The idea in recovery scheduling is to exhaust the substantial backlog that may build up at the server output queue. Clearly, this backlog must not be cleared by flooding the network. Such action may cause significant losses in the intermediate switch buffers. In addition, if thousands of streams of packets 70 flood the backlog at the same time, this may cause certain network points to get congested again. Recovery scheduling is a procedure that configures the rate of streaming the backlog based on the network parameters. Additionally, recovery scheduling can also take into account the "premium" placed on the particular player process 20. The latter consideration allows the server process 16 to stream backlog of streaming packets at different priorities. "Higher value" users can receive backlog sooner than "lower value" users. This is the basic principle behind differentiated streaming.

Buffer Design

As described previously, the configuration information is downloaded to the computing devices 14 and 16 at the beginning of each streaming session. This configuration information includes the following parameters:

(1) Worst-case duration of congestion, $c*x$, where x is a sampling or retransmission interval, and c is a number of sampling intervals in a congestion period.

(2) Worst-case of loss of streaming packets 70 during congestion defined by P_{loss}

(3) Encoding bit-rate of the stream of streaming packets 70 defined by e_r

(4) Averaged and minimum service rate, SR_{avg} and SR_{min}. This is the rate at which streaming packets 70 are actually transferred from the server process 16 to the player process 20. SR_{min} is the minimum rate across the path via the Internet 22 from the server process 16 to the player process 20.

(5) Path bottleneck link bandwidth B_{min} and the hop link capacities, where B_{min} is the minimum physical bandwidth across all the hops, i.e., the routing devices between the server process 16 and the player process 20.

The parameters indicated in the list above may be obtained through historical measurements of the relevant values and through measurements made on streaming packets 70 at the computing device 14 of the server process 16. The parameters are in turn used to design the sizes of the buffers 24, 26, 28 and 29 of server process 16 and the player process 20. One preferred embodiment of achieving this is described immediately below. That embodiment ignores the upper bounds limits on the buffer sizes related to the available random-access memory 34 (Figure 2) in the computing devices 14 and 18.

Player Buffer-size (b_c)

The buffer on the computing device 18 used by the streaming player process 20 plays out the streaming packets 70 at the maximum rate of e_r bits per second. During sustained congestion, the packet loss is approximately P_{loss}, and the maximum transmission rate from the server, as explained above is e_r. It follows that the rate of the player buffer 29 fill rate equals to $e_r * (1 - P_{loss})$ bits per second. Thus, the net drain on the player buffer 29 proceeds at the rate of $e_r * P_{loss}$ bits per second. To prevent the player buffer 29 from draining out completely within the congestion period $c * x$, the buffer-size of the player buffer 29 should satisfy the constraint defined as:

$$\frac{b_c}{e_r * P_{loss}} \geq c * x \quad \text{or} \quad b_c \geq c * x * e_r * P_{loss} \qquad \text{(Equation 1)}$$

Streaming Server Output Buffer-size (b_o)

Recall that the streaming server output buffer holds the backlog of new packets created during the congestion period. Consequently, the size of this buffer is dictated by the worst-case amount of backlog during the congestion period. To calculate the worst-case backlog of the streaming packets 70, a simple model may be built up. Figure 6 shows the approximate amount of backlog as a function of time 82 during sustained congestion. As indicated, the backlog rate 80 after two retransmission intervals 84 is $2 * e_r * P_{loss}$. By extension, after c retransmission intervals 84, the backlog rate 80 will be $cx * e_r * P_{loss}$. This establishes the constraint on the size of the output buffer 14 (Figure 1) in the memory 34 (Figure 2) of the computing device 14 (Figure 1) executing streaming server process 16 (Figure 1).

$$b_o \geq c * x * e_r * P_{loss} \qquad \text{(Equation 2)}$$

Server Backup Buffer-size (b_{backup})

The backup buffer 26 (Figure 1) holds temporary copies of the server packets that have been transmitted to the player process 20 (Figure 1). The copies must be held until the server is sure that the packets have been successfully received in the player buffer 29 (Figure 1). To estimate the size of this backup buffer 26 (Figure 1) again, an operational model is built. First, the transmission rate in packets per seconds is defined as R_p. At the start of the first retransmit 84, the approximate rate of loss of the streaming packets 70 (Figure 3) is $P_{loss} * R_p$. Assuming the loss affects new as well as retransmitted streaming packets 70 (Figure 3) equally, the approximate rate of loss for older unsuccessful streaming packets 70 (Figure 3) at the second retransmit 84 is $P_{loss}^2 * R_p$. Supposing now that the number of retransmits that will reduce the loss rate for older

packets to a negligibly small number, e.g., 0.1 packets for every retransmission interval is defined by m. This implies that:

$$P_{loss}^{m} * R_p \leq \frac{0.1}{x}, \quad \text{or that} \quad m \geq \frac{\log\left(0.1/R_p * x\right)}{\log P_{loss}}$$

Alternatively, if s is the packet size, the above equation may be expressed as:

$$m \geq \frac{\log\left(0.1 * s/e_r * x\right)}{\log P_{loss}}$$

The minimum required buffer size may be defined as equal to $m * x$. Consequently, the size constraint of the backup buffer 26 (Figure 1) is

$$b_{backup} \geq m * x \quad \geq x * \frac{\log\left(0.1 * s/e_r * x\right)}{\log P_{loss}} \qquad \text{(Equation 3)}$$

The detailed operational method underlying the invention is captured through a protocol called "Streaming Congestion Protocol" (SCP). In the section below the SCP sequences during different phases of streaming are described. Figures 6 and 7 show the detailed operational sequence at the streaming server process 16 (Figure 3) and the streaming player process 20 (Figure 3) during normal streaming of the streaming packets 70 (Figure 3). The operational sequences are described with the help of state diagrams. A state diagram shows various states and transitions between states. Each state captures a specific operational state, and the transitions between states capture the events that cause the operational states to change. Figure 7 shows the state diagram of events at the streaming server process 16 (Figure 1). Figure 8 shows the corresponding state diagram at the streaming player process 20.

Processing during and after congestion

Please refer to Figure 9, by default, the streaming player process 20 is in a normal state 100. The player process 20 may keep a track of the packet loss of a received stream at a periodic interval that may be user determined. If the amount of loss exceeds a

threshold, e.g., Threshold1, across a time-window of some number of seconds which may also be user determined, e.g., TW1, the player process 20 moves into the Likely Congestion state 102. At this point, the streaming player process 16 (Figure 1) launches congestion probes to determine whether the congestion symptoms are verified. These probes form a part of a test called confirm congestion test. If the test indicates that congestion is confirmed, the process moves to a Congestion Confirmed state 104. Immediately, the streaming player process 20 contacts its server counterpart and informs it about the new state change along with some other relevant information.

Note that the transition from a Likely Congested state 102 to Congestion Confirmed State 104 can happen in two other ways. First, the player process 20 may actually receive a Remote Congestion Confirmed report in state 106 from its server process 16 (Figure 1) indicating that some other player process 20 on a related network path is in the Congestion Confirmed state. If this happens, the player immediately moves to the Congestion Confirmed State 104 itself. If the player process 20 has already started conducting congestion probes before this notification, the player process 20 may halt them at the instant it receives the notification. Alternatively, the player process 20 may receive a Local Congestion Confirmed report in state 102 reporting that some other local player process 20 on the same streaming player module has verified congestion. If the Remote or local Congestion Confirmed reports have verified congestion within a past time-window not exceeding the time defined as Tcc, the player process 20 moves to a confirmed congestion state 104.

Once the streaming player process 20 (Figure 1) enters the congestion confirmed state 104, it periodically monitors the loss of the received stream of streaming packets 70 (Figure 3). If the packet loss is less than a second user defined threshold, e.g., Threshold2, across a second user defined time-window, e.g., TW2 seconds, the player process 20 enters the likely end-of-congestion (EOC) state 106. At this point, the player process 20 launches an EOC probe test that either confirms or invalidates the EOC decision. If the EOC probe test confirms congestion, the streaming player process 20 enters the EOC state 108 and sends an EOC report 110 to its server process 16 (Figure 1) counterpart. With this transition, the process re-enters the normal state 100. Note that

during transitions from the EOC state 110 back to the Normal State 100, the streaming player process 20 also needs to continually process the arriving packets in step 120 (Figure 7), check and request for retransmission of missing packets in step 122 (Figure 7), and forward packets to the streaming player for playback in step 124 (Figure 7). These activities are indicated in Figure 7 and are not shown in Figure 9 for purposes of clarity.

Figure 10 shows the SCP state-diagram of the server process 16. After initialization, the server process 16 enters the normal state 130. If the server process 16 receives a report from its streaming player process 20 (Figure 1) indicating congestion, the server moves to the Confirmed Congestion or Confirmed Congestion State 132. At this point, the server process 16 shares the Confirmed Congestion status information with other server processes 16 running on the same computing device 14 (Figure 1) in the Propagate Confirmed Congestion state 134, and potentially also from other computing device 14 (Figure 1) through interaction with the service manager 12 (Figure 1) via the network 22 (Figure 1). The idea behind this is to have selected server processes report the congestion to their player process so that these player processes can avoid doing the Confirmed Congestion probing test. This cuts down on the congestion reaction time and significantly cuts down the probing traffic. In general, each server process that receives the Confirmed Congestion status in the Receive the Confirmed Congestion status state 140 from other server processes 16, first determines whether the Confirmed Congestion status is relevant to its target player process 20 (Figure 1). If this is the case, the server processes notify their player process 20 (Figure 1). Notification is done through a special signaling scheme involving reliable transport protocol (RTP) messages, as discussed in Schulzrinne, Casner, Frederick, Jacobson, "RTP: A Transport Protocol for Real-time Applications", RFC 1889, Internet Engineering Task Force.

The streaming server process 16 will then make transitions from the Confirmed Congestion State 132. Starting with the Confirmed Congestion state 132, the server process 16 transmits streaming packets 70 (Figure 3) at a constant bit-rate. The server process 16 moves to the Recovery Scheduling State 136 as soon as it receives an End-of-congestion or EOC report from the player process 20 (Figure 1) targeted for the reception of

its content. Thereafter the server process 16 changes its mode of transmission, using recovery scheduling to drain its backlogged output buffer 24 (Figure 1) in an intelligent way. As soon as the backlog is over, the server process 16 moves back to the normal state 130.

While in the Normal State 130 the server process 16 may receive and filter information from other server processes 16 by entering the Receive Confirmed Congestion State 140. It may also notify the player processes 20 (Figure 1) about the confirmed congestion status through the in-band RTP signaling, by entering the Confirmed Congestion Notification state 138 from where the process 16 will return to the Normal state 130.

The server process 16 also needs to continually process the departing packets in step 150 (Figure 8), check and process the requests for retransmission of missing packets in step 152 (Figure 8), and backup packets to the backup buffer 26 (Figure 1) for playback. These activities are indicated in Figure 8 and are not shown in Figure 10 for purposes of clarity.

Recovery scheduling algorithm

Supposing that the server process 16 (Figure 1) streams of streaming packets 70 (Figure 3) are classified into K number of priority classes. Class 1 being the highest priority and class "K" being the lowest priority. Each priority class "j" is associated with a weighting function α^j, where $0 < \alpha^K < \alpha^{K-1} < .. \alpha^j < .. < \alpha^1 = 1$. Considering the server process 16 (Figure 1) with priority equaling to "j", the rule for transmission rate e_t of this process is:

$$e_t = \min(\alpha^j \times SR_{min}, \alpha^j \times \frac{B - \lambda_{other}}{\sum_{i=1}^{i=K} \alpha^i n^i})$$

(Equation 4)

In equation 4, all the terms are measured at the service bottleneck hop between the computing device 14 executing the server process 16 and the computing device 18 executing the player process 16. B is the bottleneck link capacity at the bottleneck hop.

λ_{other} is the aggregate packet rate carried at the hop from traffic not utilizing the inventive method. This rate can be estimated by obtaining the aggregate packet rate of the streaming packets 70 (Figure 3) of the inventive method λ_{SME} from the service manager, and using the fact that $\lambda_{other} = B \times \rho - \lambda_{SME}$, where $\rho = 1 - \frac{SR_{\min}}{B}$ is the utilization of the bottleneck hop. The parameter n^i is defined as the number of priority "i" streams carried at the bottleneck hop. The hop is a section of a network between two network-computing devices such as routers. This parameter may be obtained from the service manager 12 (Figure 1). The logic behind this equation is as follows. The first term indicates that the new transmission rate should be set equal to the minimum service rate along the path, in order to recover from the backlog. The second term takes into account the result of increasing the transmission rate on the utilization at the bottleneck hop. In other words, since the maximum utilization can be 100%, each computing device 14 executing server process 16 must carefully weigh the effects of increasing the transmission rate. The best rate is the maximum rate that does not congest the bottleneck bandwidth during recovery. Hence the min operator. Finally, the priorities within the equation 4 provide for differentiated streaming.

Congestion Estimators

Earlier on, we described the congestion estimation tests as part of the SCP algorithm. In principle, congestion can be estimated in a variety of ways, and the invention is not restricted to any one particular method of congestion estimation. A particular embodiment of the invention for estimating congestion based on a mix of passive and active probes will now be described. This method comprises a set of rules configured around the results of the probes. A specific congestion test e.g., an end of congestion test or a confirmed congestion test mentioned in earlier sections, combines these rules in a particular way.

The following are some of a variety of methods that may be used to compute the bottleneck bandwidth on a path between the streaming player 20 (Figure 1) and the

streaming server 16 (Figure 1). These methods are shown here for exemplary purposes only and not to indicate that only these methods must be used with the present invention.

Capacity Probe

This method is described in detail in Van Jacobson, "pathchar - A tool to infer characteristics of Internet paths", MSRI, April 21, 1997; and R. L. Carter and M.E. Crovella, "Measuring Bottleneck Link Speed in Packet-switched Networks", TR-96-006, Boston University Computer Science Department, March 15, 1996. This method is initiated by the player process 20 (Figure 1) at various stages of a streaming session. The steps of this exemplary method are as follows:

1. Do a traceroute and get hop identities marked by IP addresses.
2.

a) For every hop from one onwards, send a series of ICMP timestamp requests (type 13) from the player to the hop. Packet sizes of queries are changed in steps of 1024, 512, 256, 128, and 64, where each queries are sent out with a spacing of 3 seconds between them.

b) For every hop i between the player and the server, the player must record the ICMP timestamp response (type 14) and compute the time difference between the hop i transmit time t_i and the player receive instant t_1.

c) Denote the time difference by $\tau_{i1} = t_i - t_1$.

d) Take four measurements for timestamp differences by varying packet size through five values. Discard the minimum and the maximum, and take average of the remaining two. Let s' and s'' denote the packet sizes of two selected queries to hop i. Let $\tau_{i1'}$ and $\tau_{i1''}$ denote the measurements for the respective packet sizes.

e) Calculate $X_{i1} = \frac{\tau_{i1'} - \tau_{i1''}}{s' - s''}$

$$B_{i,i-1} = \frac{1}{X_{i1} - \left(\sum_{k=1}^{i-2} \frac{1}{B_{i-k,i-k-1}} \right)}$$

It can be proved that link capacity can be computed recursively.

The path bottleneck bandwidth $B_{min} = \min_i B_{i,i-1}$. (Equation 5)

Service Rate Probe

The "Service Rate probe" computes the approximate service rate of transferring packets between the server and the player, as discussed in Van Jacobson, "pathchar - A tool to infer characteristics of Internet paths", MSRI, April 21, 1997; and R. L. Carter and M.E. Crovella, "Measuring Bottleneck Link Speed in Packet-switched Networks", TR-96-006, Boston University Computer Science Department, March 15, 1996. The minimum service rate is the least service rate on the path, while the average service rate is the "expected" service rate on the path. . The steps of this exemplary method are as follows:

1. Obtain the hop list through traceroute. Suppose there are n-1 hops between the player and the server.
2. Periodically, the player initiates a cycle. In each cycle, the player sends n-1 queries, each spaced by ¼ second. The player forms timestamp differences between query responses from consecutive hops. The results are sent back to the server.
3. The server uses results from several cycles along with the link capacities to calculate the service rate.
   a) First, the server calculates $\tau_{m,m-1}^{min} = min(\tau_{m,1} - \tau_{m-1,1})$ where the min operator works over all collected cycle results. We approximate $\tau_{m,m-1}^{min}$ to be the base-line delay between node m and node m-1.
   b) Denote the maximum queuing delay between node m and node m-1 by $q_{m,m-1}^{max}$, where node is a computing device, e.g., a computer or a router connected to the network.

c) Then, $q_{m,m-1}^{max} = max\left(\tau_{m,m-1} - \tau_{m,m-1}^{min}\right)$

d) Denote the average queuing delay between node m and node m-1 by $q_{m,m-1}^{avg}$.

e) Then, $q_{m,m-1}^{avg} = avg\left(\tau_{m,m-1} - \tau_{m,m-1}^{min}\right)$

Finally, the minimum service rate is:

$$SR_{m,m-1}^{min} = \frac{s}{\frac{s}{B_{m,m-1}} + q_{m,m-1}^{max}},$$

and the average service rate is:

$$SR_{m,m-1}^{avg} = \frac{s}{\frac{s}{B_{m,m-1}} + q_{m,m-1}^{avg}} \qquad \text{(Equation 6)}$$

Congestion Detection Rule (CC Test)

A robust but responsive congestion detection mechanism is an essential part of the inventive method. It is important to respond quickly to congestion; this can reduce the congestion period and hence make it easier for the recovery scheduling to do its job in a shorter period of time. Ultimately this can allow the method to work with a reduced buffer size and hence a reduced connect lag. It is equally important to robustly distinguish a sustained congestion condition. False detection can lead to reduced throughput and performance. Recall that the inventive method treats sustained congestion by reducing the throughput of the newer packets, so that the throughput of older retransmitted packets is maximized.

The present invention uses the following congestion detection rule:

1. Packet losses exceeding a threshold for a consecutive time-window of duration T_s. T_s is set to 10 seconds by default.
2. If condition 1 is triggered, three short service rate probes are sent, spaced 2 seconds apart, from the player to the SR_{min} hop. Responses are averaged to form

SR_{avg}.

The player process 20 (Figure 1) computes the expected utilization $\rho = 1 - \frac{SR_{avg}}{B}$. If condition 1 is satisfied and the utilization from condition 2 is more than a specified utilization threshold, e.g., 95%, the player process 20 (Figure 1) declares sustained congestion (Confirmed Congestion), and asks the server to enter the constant bit-rate emulation mode. An alternative method may consists of a simple rule where if packet losses exceed a threshold for N_1 consecutive sampling time-windows, the player process 20 (Figure 1) declares sustained congestion and asks the server to enter the constant bit-rate emulation mode. By default, N_1 is set to 1, and time-window is set equal to 1 second.

End of Congestion Rule (EOC Test)

The end of congestion rule is analogous to the congestion detection rule:

1. No packet losses for a consecutive time-window of duration T_e. T_e is set equal to 10 seconds by default.
2. If condition 1 is triggered, three short service rate probes are sent, spaced 2 seconds apart, from the player to the SR_{min} hop. Responses are averaged to form SR_{avg}.

   The player computes the expected utilization $\rho = 1 - \frac{SR_{avg}}{B}$.

If condition 1 is satisfied and the utilization from condition 2 is less than a specified threshold, e.g., 90%, the player declares sustained congestion to be over, and asks the server to transition to the state of recovery scheduling. An alternative method may consists of a simple rule where if in a state of sustained congestion, no packet losses are manifest for N_2 consecutive sampling time-windows, the player declares sustained congestion to be over, and asks the server to transition to the state of recovery scheduling. By default, N_2 may be set equal to five, and the sampling time-window is set equal to 1 second.

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Thus, an apparatus and method for predictable and differentiated delivery of multimedia streaming on the Internet is provided. One skilled in the art will appreciate that the present invention can be carried out in other ways and practiced by other than the described embodiments, yet not departing from the spirit and essential characteristics depicted herein. The present embodiments therefore should be considered in all respects as illustrative, and the present invention is limited only by the claims that follow.

CLAIMS

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent is:

1. A method of streaming of multimedia audio and video packets from at least one sending computing device to an at least one receiving computing device via a network, said method comprising the steps of:

a) at a start of said streaming communicating configuration information from a service manager via the network to both an at least one sending computing device for use by an at least one server process and an at least one receiving computing device for use by an at least one player process, said at least one sending computing device comprising an at least one retransmit buffer, an at least one output buffer, an at least one backup buffer and said at least one server process, said at least one receiving computing device, comprising an at least one player buffer and an at least one player process;

b) queuing same packets in the at least one output buffer and to the at least one backup buffer;

c) determining if there are packets in the at least one output buffer and transmitting the packets from the at least one output buffer to the at least one receiving computing device via the network;

d) receiving the packets on the at least one receiving device and storing them in the at least one player buffer;

e) determining if there are omissions in the packets stored in the at least one player buffer and forwarding retransmission requests to the at least one sending computing device and storing them in the at least one retransmit buffer; and

f) determining if there are said retransmit requests in the at least one retransmit buffer and transmitting the packets from the at least one backup buffer to the at least one receiving computing device via the network.

2. The method of claim 1 wherein, the network is Internet.

3. The method of claim 2 wherein, a size of the at least one player buffer is $\geq c*x*e_r*P_{loss}$, where c is a number of sampling intervals in a congestion period, x is a sampling or retransmission interval, $c*x$ is a worst-case duration of congestion, e_r is an encoding bit-rate of a stream of the packets and P_{loss} is a worst case of loss of the packets.

4. The method of claim 3 wherein, a size of the at least one output buffer is $\geq c*x*e_r*P_{loss}$.

5. The method of claim 4 wherein, a size of the at least one backup buffer is $\geq m*x \geq x*\frac{\log\left(0.1*s/e_r*x\right)}{\log P_{loss}}$, where m is a number of retransmits that will reduce the loss rate for older packets to a negligibly small number, and $m*x$ is a minimum required size of the at least one player buffer.

6. A method of detecting and reacting to a network congestion which interferes with streaming of multimedia audio and video packets from at least one sending computing device to an at least one receiving computing device via a network, said method comprising the steps of:

a) communicating configuration information including network parameters from a service manager via the network to the at least one sending computing device and to the at least one receiving computing device, the at least one sending computing device comprising at least one server process, the at least one receiving computing device comprising at least one player process;

b) confirming the network congestion by transmitting and retracting network probes;

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c) executing at least one congestion control technique to limit degradation in the streaming of the packets;

d) detecting an end of the network congestion by transmitting and retracting said network probes;

e) configuring a rate of streaming of the packets according to said network parameters

7. The method of claim 6, wherein said at least one congestion control technique is the constant bit-rate emulation.

8. The method of claim 7, wherein said at least one congestion control technique only reduces a transmission rate of the packets by the amount of incurred loss of the packets.

9. The method of claim 7, further comprising the steps of:

detecting an end of congestion;

computing available bandwidth in the network; and

transmitting packets according to said bandwidth.

10. The method of claim 9, wherein some of the at least one player process are differentiated and protected from effects of said network congestion to a greater than others by receiving a stream backlog sooner.

11. The method of claim 10, wherein some of the at least one player process are differentiated and protected from effects of said network congestion to a greater than others by receiving a stream backlog sooner according to a rule for transmission rate of the packets

$$e_t = \min(\alpha^j \times SR_{min}, \alpha^j \times \frac{B - \lambda_{other}}{\sum_{i=1}^{i=K} \alpha^i n^i})$$

, where e_t indicates said transmission rate of packets, α^j is a weighting function, for class $\{1 \ldots K\}$.

12. The method of claim 11, wherein said detecting of said end of the network congestion is performed according to the expected utilization $\rho = 1 - \frac{SR_{avg}}{B}$, where SR_{avg} is the average rate at which the packets are transferred from the at least one server process to the at least one player process and B is a bottleneck link capacity at a bottleneck hop.

13. The method of claim 12, wherein said network probes compute an approximate service rate of transferring the packets from said at least one server process to said at least one player process according to the following equation:

$SR^{min}_{m,m-1} = \frac{s}{\frac{s}{B_{m,m-1}} + q^{max}_{m,m-1}}$, and $SR^{avg}_{m,m-1} = \frac{s}{\frac{s}{B_{m,m-1}} + q^{avg}_{m,m-1}}$, where SR_{avg} and SR_{min} are averaged and minimum service rate, $q^{max}_{m,m-1}$ is the maximum queuing delay between a node m and a node m-1.

14. A method of guaranteed delivery of streaming multimedia audio and video packets from at least one sending computing device to an at least one receiving computing device via a network, said method comprising the steps of:

a) continuously processing arriving packets;

b) keeping track of loss of the packets at the at least one receiving computing device, said at least one receiving computing device comprising one or more player processes;

c) determining if said loss exceeds a first threshold during a first interval;

d) verifying congestion symptoms;

e) communicating said verified congestion symptoms to the at least one sending computing device, said at least one sending computing device comprising one or more server processes;

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f) monitoring said loss and determining if said loss exceeds a second threshold during a second interval to determine an end of congestion; and

g) verifying congestion symptoms.

15. The method of claim 14, wherein said step of keeping track is performed at user define intervals.

16. The method of claim 15, wherein said first threshold, said second threshold, said first interval, and said second interval are user defined.

17. The method of claim 16, wherein said congestion symptoms are verified by receiving a remote congestion confirmed report.

18. The method of claim 17, wherein said congestion symptoms are verified by performing a congestion probe.

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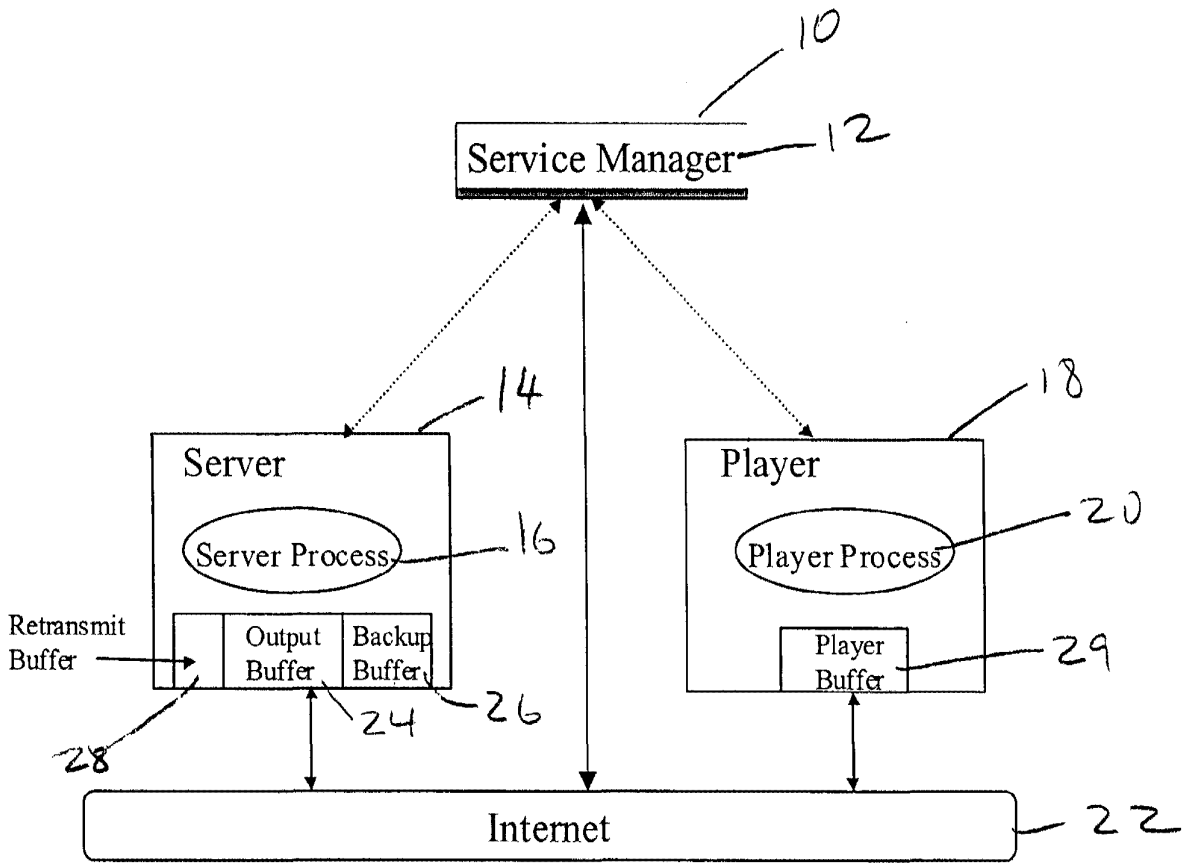

10
Service Manager
12
14
Server
Server Process
16
Retransmit Buffer
Output Buffer
Backup Buffer
24
26
28
18
Player
Player Process
20
Player Buffer
29
Internet
22

Figure 1

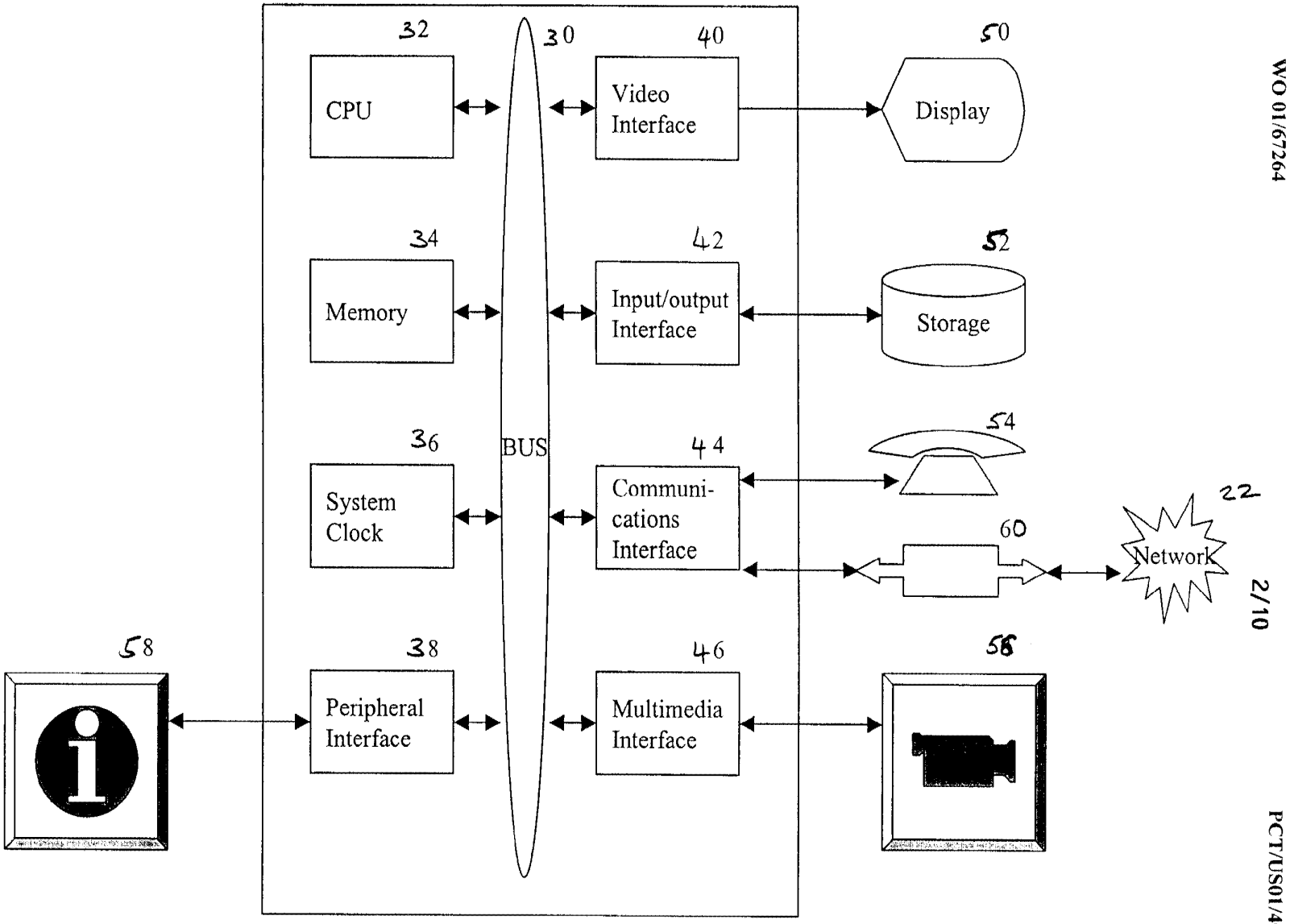

32
30
40
50
CPU
Video Interface
Display
34
42
52
Memory
Input/output Interface
Storage
54
36
BUS
44
System Clock
Communi-cations Interface
22
60
Network
58
38
46
56
Peripheral Interface
Multimedia Interface

Figure 2

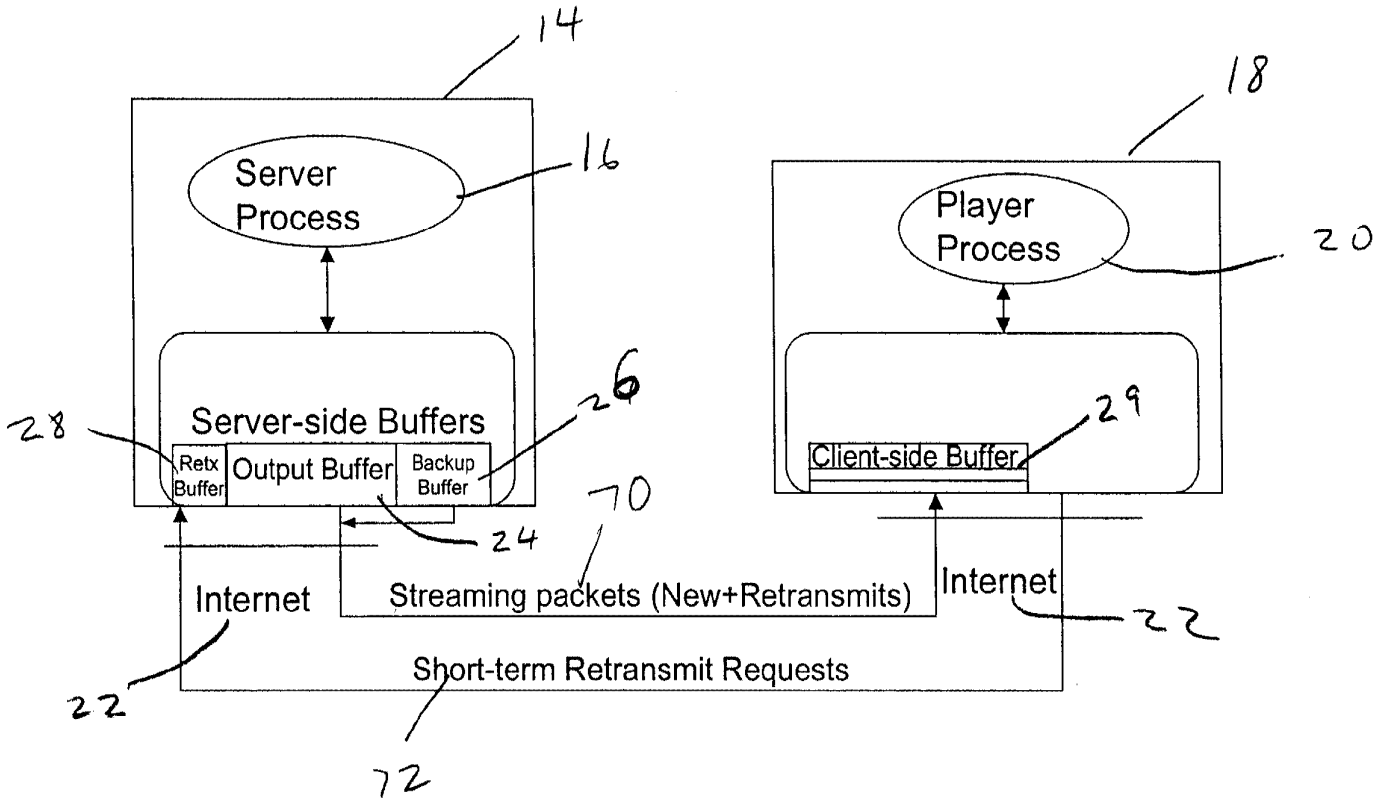

14
Server Process
16
18
Player Process
20
Server-side Buffers
26
28
Retx Buffer
Output Buffer
Backup Buffer
24
Client-side Buffer
29
70
Internet
Streaming packets (New+Retransmits)
Internet
22
22
Short-term Retransmit Requests
72

Figure 3

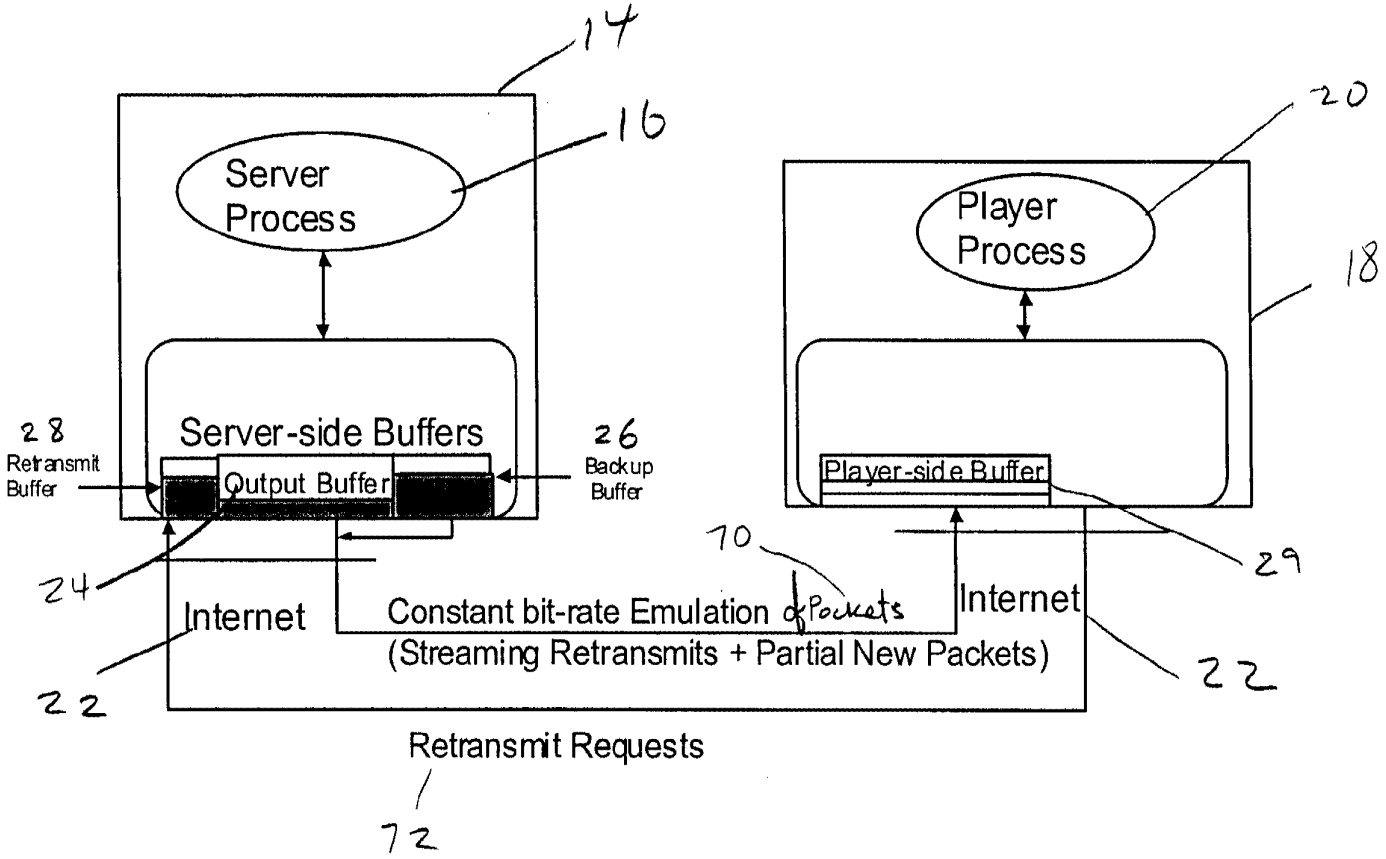

14
16
Server Process
20
Player Process
18
28
Retransmit Buffer
Server-side Buffers
Output Buffer
26
Backup Buffer
Player-side Buffer
29
24
70
Internet
Constant bit-rate Emulation of Packets
(Streaming Retransmits + Partial New Packets)
Internet
22
22
Retransmit Requests
72

Figure 4

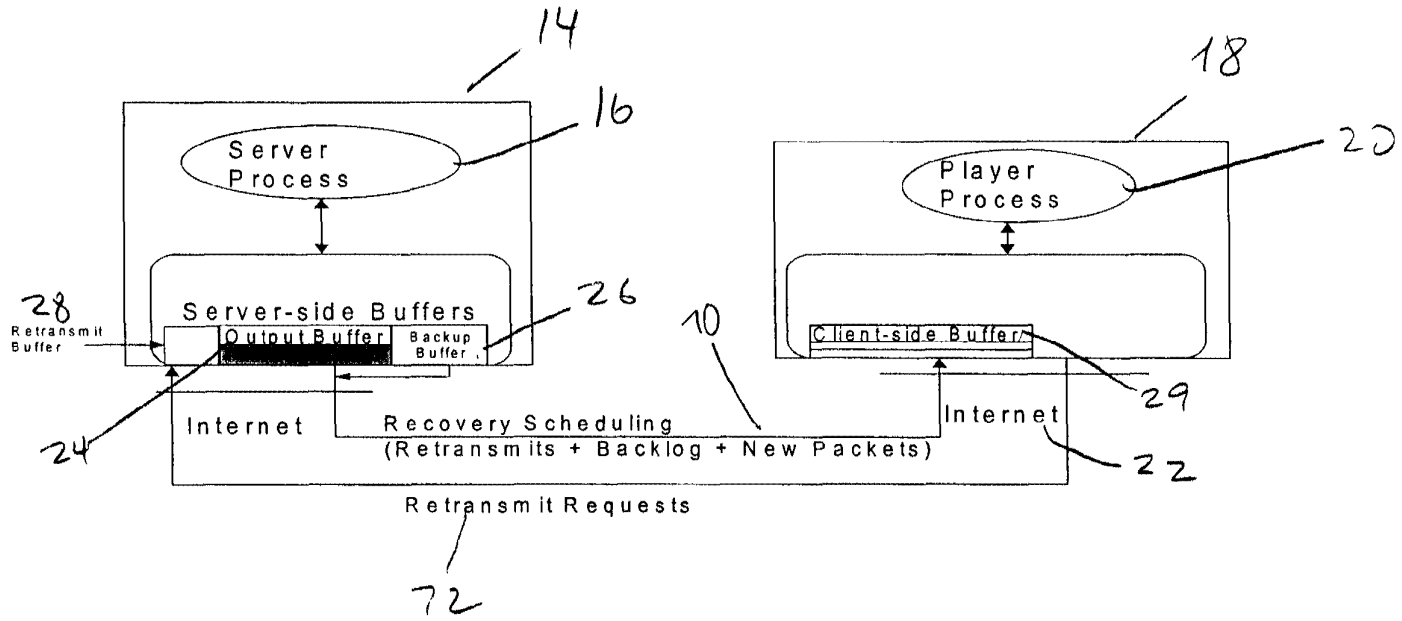

14
16
Server Process
18
20
Player Process
28
Retransmit Buffer
Server-side Buffers
Output Buffer
Backup Buffer
26
10
Client-side Buffer
29
24
Internet
Recovery Scheduling
(Retransmits + Backlog + New Packets)
Internet
22
Retransmit Requests
72

Figure 5

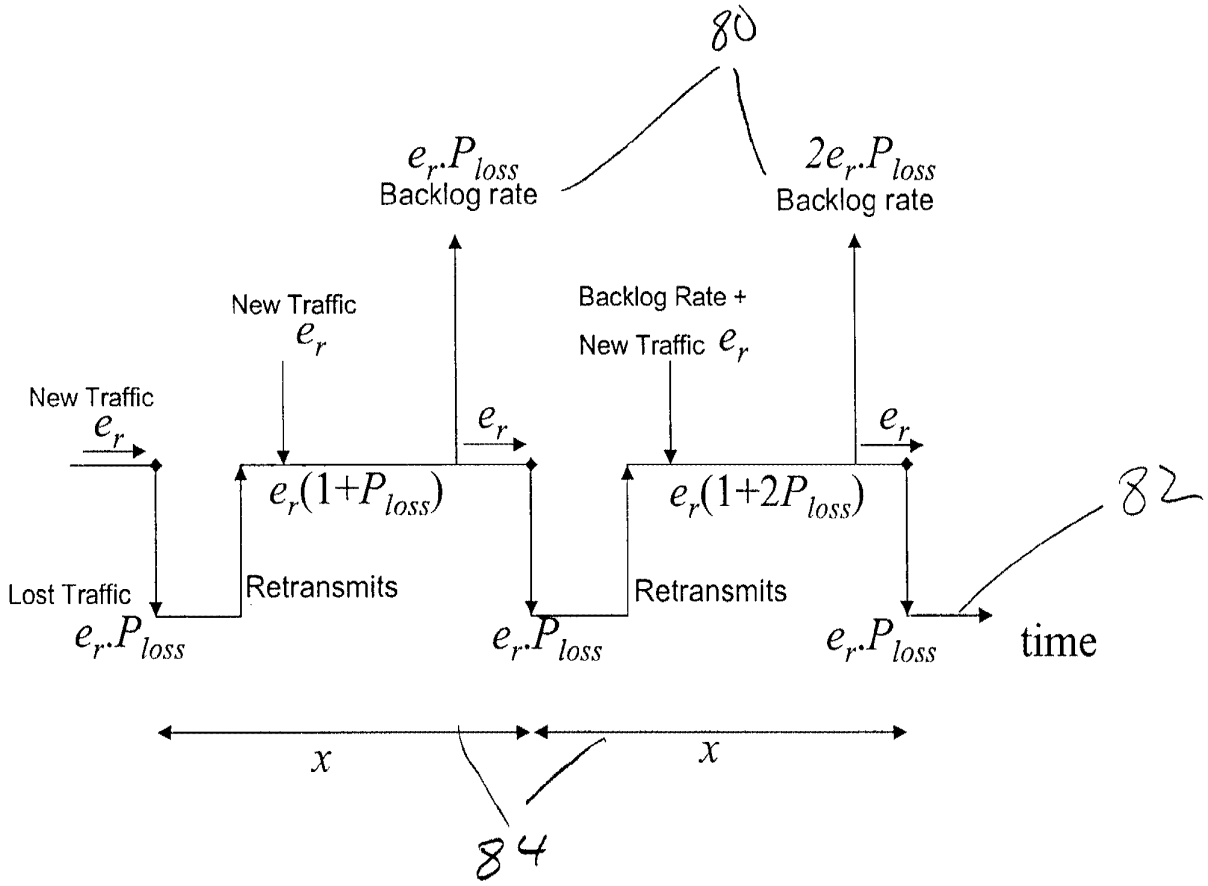

80
$e_r.P_{loss}$
Backlog rate
$2e_r.P_{loss}$
Backlog rate
New Traffic
e_r
Backlog Rate +
New Traffic e_r
New Traffic
e_r
e_r
e_r
$e_r(1+P_{loss})$
$e_r(1+2P_{loss})$
82
Lost Traffic
$e_r.P_{loss}$
Retransmits
$e_r.P_{loss}$
Retransmits
$e_r.P_{loss}$
time
x
x
84

Figure 6

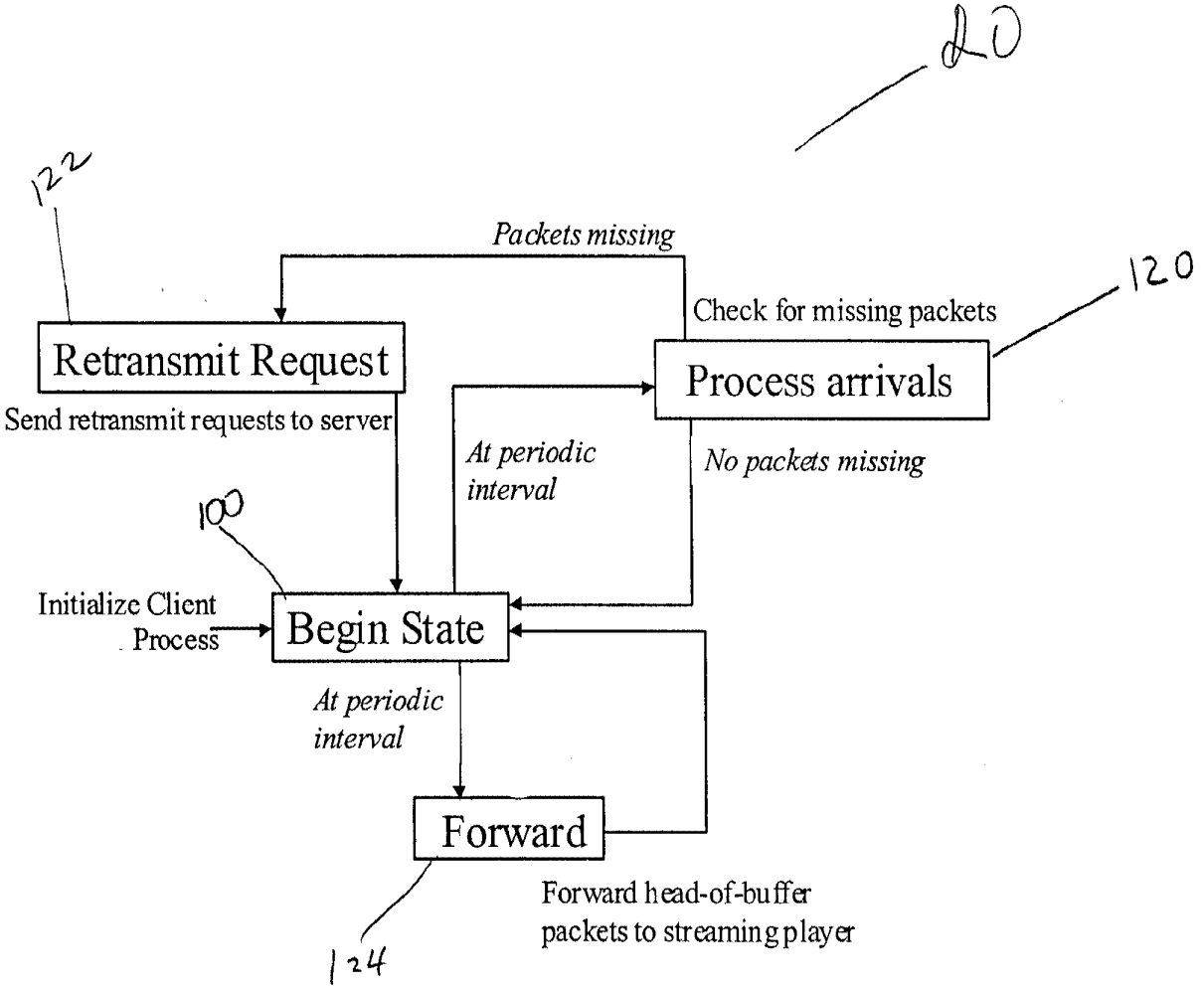

Packets missing
Check for missing packets
Retransmit Request
Process arrivals
Send retransmit requests to server
At periodic interval
No packets missing
Initialize Client Process
Begin State
At periodic interval
Forward
Forward head-of-buffer packets to streaming player

Figure 7

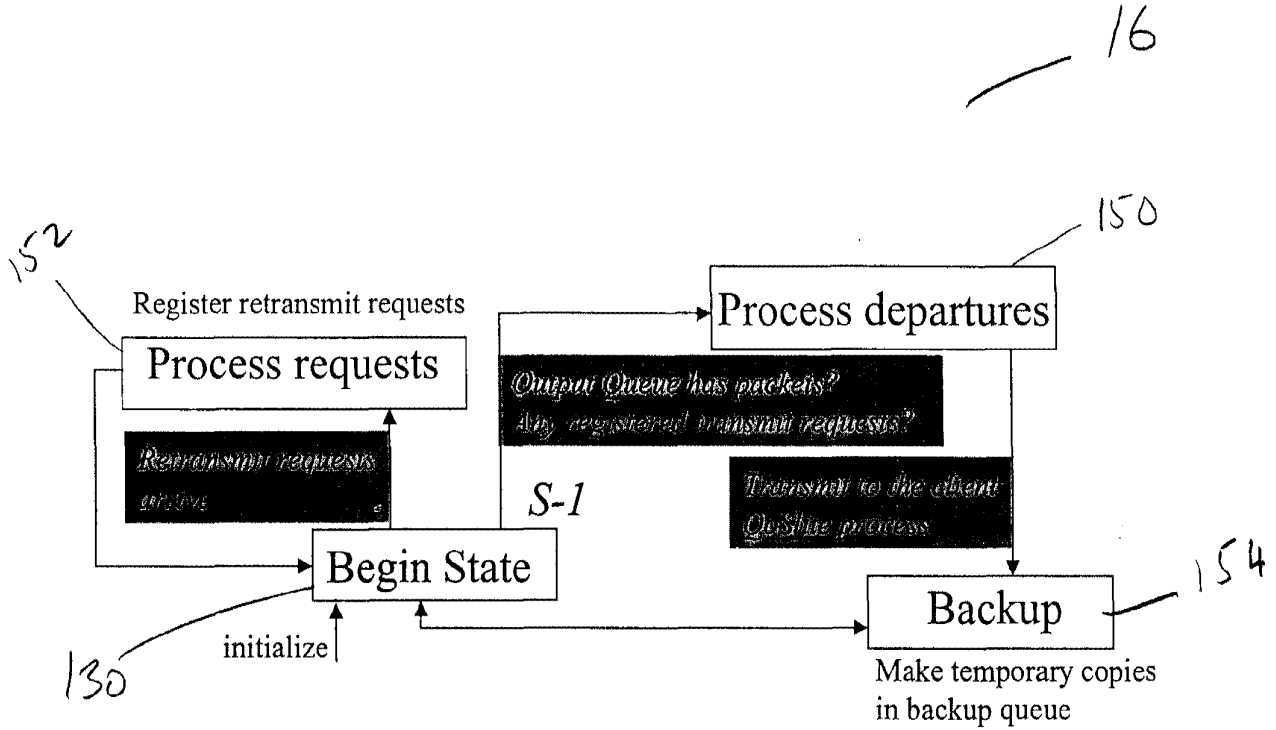

16
152
150
Register retransmit requests
Process requests
Process departures
Output Queue has packets?
Any registered retransmit requests?
Retransmit requests arrive
Transmit to the client QoSlice process
S-1
Begin State
154
Backup
130
initialize
Make temporary copies in backup queue

Figure 8

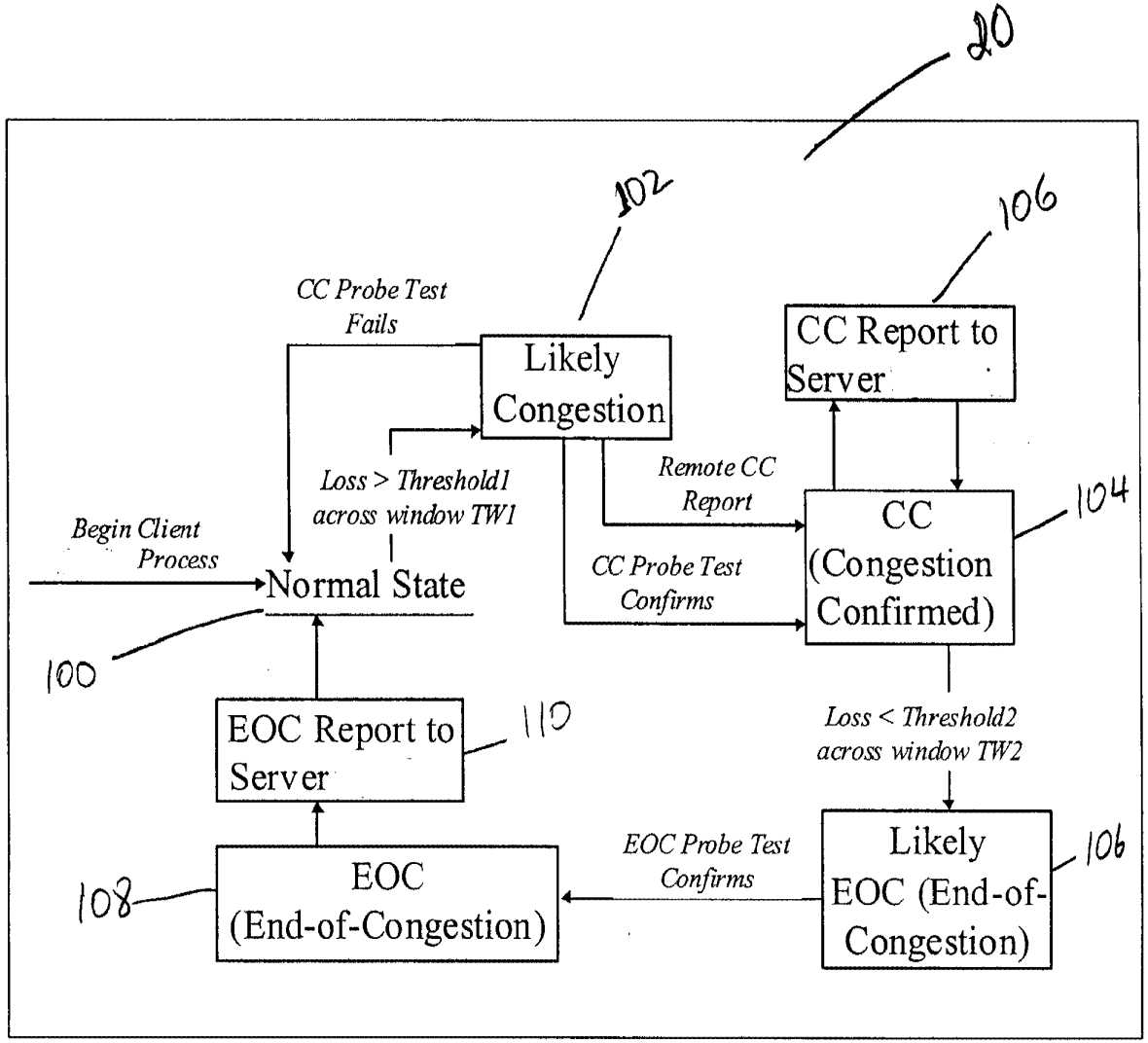

20
102
106
CC Probe Test Fails
Likely Congestion
CC Report to Server
Loss > Threshold1 across window TW1
Remote CC Report
Begin Client Process
Normal State
CC (Congestion Confirmed)
104
CC Probe Test Confirms
100
EOC Report to Server
110
Loss < Threshold2 across window TW2
EOC Probe Test Confirms
Likely EOC (End-of-Congestion)
106
108
EOC (End-of-Congestion)

Figure 9

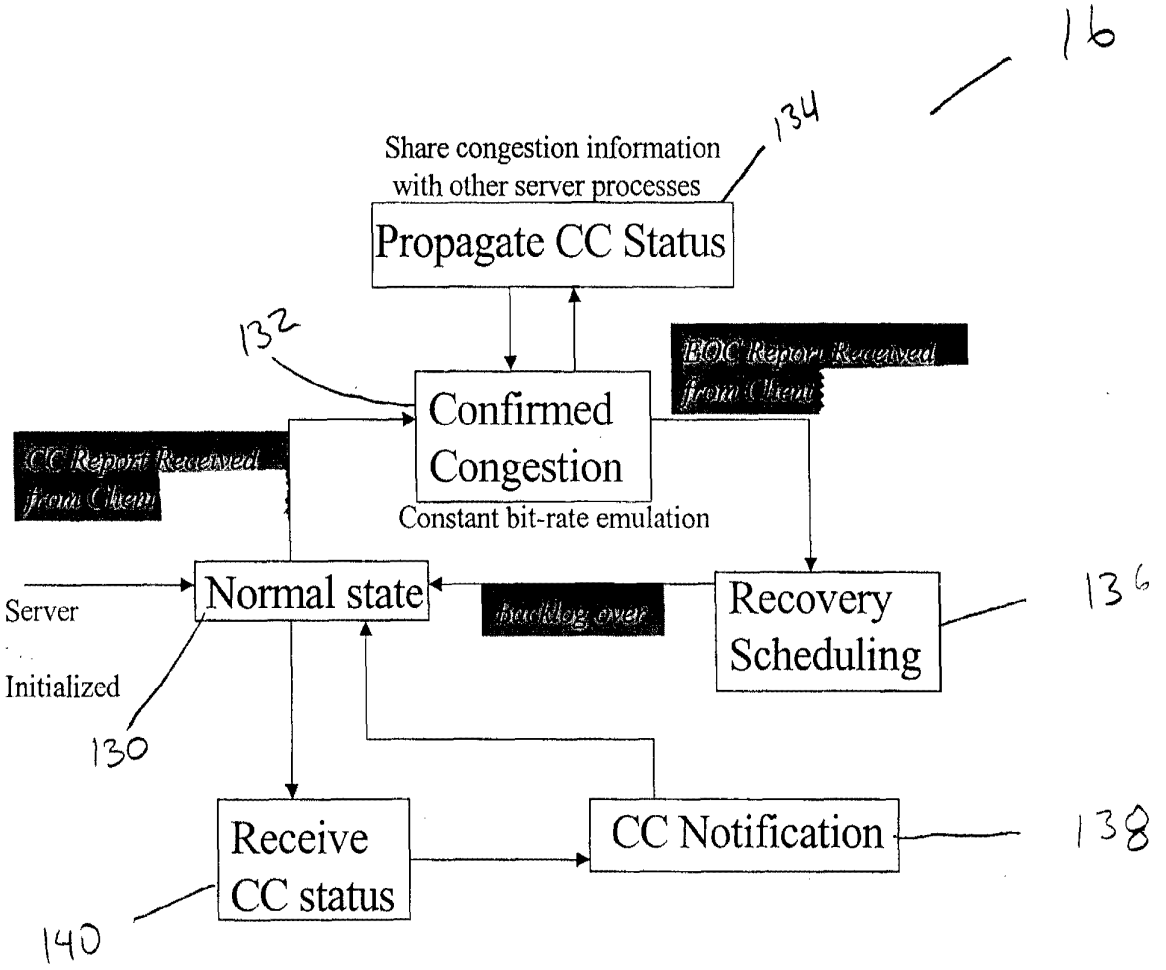

16
Share congestion information
with other server processes
134
Propagate CC Status
132
Confirmed
Congestion
Constant bit-rate emulation
BOC Report Received
from Client
CC Report Received
from Client
Server
Initialized
Normal state
backlog over
Recovery
Scheduling
136
130
Receive
CC status
140
CC Notification
138

Figure 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/40264

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G06F 15/16
US CL :709/231, 232, 235

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. : 709/231, 232, 235

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P	US 6,031,818 A (LO et al) 29 February 2000, col. 2, line 54-col. 5, line 28.	1, 2
X,P	US 6,018,515 A (SORBER) 25 January 2000, col. 4, line 18-col. 10, line 65.	6-10, 14-18
A, P	US 6,014,706 A (CANNON et al) 11 January 2000, see all.	1-18
A	US 5,339,392 A (RISBERG et al) 16 August 1994, see all.	1-18

☐ 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
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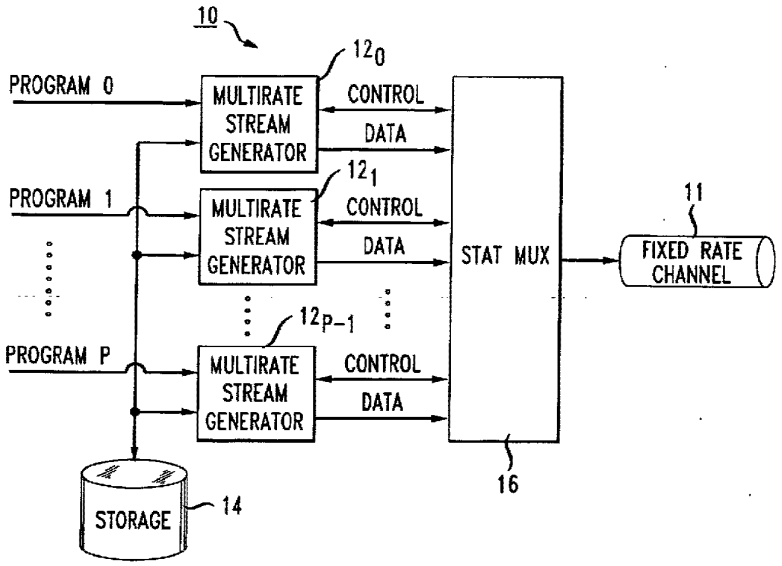
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(54) Title: VIDEO ON DEMAND SERVER SYSTEM AND METHOD



(57) Abstract: A Video-on-Demand Server architecture (100, 200, 300) transmits a plurality of pre-coded programs having different bit rates across a fixed bandwidth channel (11). For each program, a generator (120-12P-1, 110, 210) generates a plurality of different bit rate representations for each program. Each generator also provides control information at each of a plurality of successive time windows T for each bit rate representation. The control information provides a bit rate and a quality measure during each time window T. The control information enables a statistical multiplexer (16, 160, 260) to select a bit rate representation for each program during each time window T to maximize the quality of the selected representations while not exceeding the total available channel capacity.

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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.

VIDEO ON DEMAND SERVER SYSTEM AND METHOD

TECHNICAL FIELD

This invention relates to a technique for efficiently providing video on demand while maintaining bandwidth constraints of a fixed channel.

BACKGROUND ART

Present day Video-on-Demand (VoD) systems typically transmit Constant Bit Rate (CBR) video. Transmitting CBR video does not achieve the same efficiency as transmitting variable bit rate (VBR) video for equivalent long-term average bit rates. Transmitting multiple pre-recorded VBR-encoded video programs over a constant bandwidth channel has problems since the sum of the instantaneous bitrates required by each program can sometimes exceed the total available bitrate. On the other hand, broadcast applications employing real-time encoders use statistical multiplexing to exploit the instantaneous bitrate variations between multiple programs being carried on the same carrier or transponder. The encoders operate in real time to enable the system to constrain the total combined bit rate for all programs so as not to exceed the channel capacity over a given time window. Each video program has an associated complexity measure. A central controller dynamically adjusts the bit rate allocated to each video program based upon the relative complexities.

There now exist devices known as "video transraters" that operate to reduce the bit rate of video streams within a common compression standard, such as MPEG 2 for example. Present day transraters often experience difficulties when converting between constant and variable bit rates. Such transraters also can experience difficulties when trying to alter the bit rate for bit streams that have many scene changes, or a large number of I-Pictures.

Scalable video encoding, which permits dividing a video signal into a base layer and one or more enhancement layers, can also address bit rate issues. Several methods of scalable video encoding exist, including spatial, SNR, temporal, data partitioning, fine grain scalability (FGS), frequency scalability. The MPEG-2 and MPEG-4 video compression standards include several scalability methods. Using scalable encoding requires both the transmitter and receiver have the same ability to implement different coding algorithms, thus introducing additional complexity.

Thus, there exists a need for a technique for managing variable bit rate video on demand that obviates the disadvantages of the prior art.

BRIEF SUMMARY OF THE INVENTION

Briefly, in accordance with present principles, there is provided a method for transmitting a plurality of pre-coded programs having different bit rates across a fixed bandwidth channel. For each program, at least two, and preferably, a plurality of different bit rate representations are generated. Control information is provided at each of a plurality of successive time windows for each bit rate representation. The control information provides a bit rate and a quality measure during each time window. The control information enables selection during each time window of a bit rate representation for each program to maximize the quality of the selected representations while not exceeding the total available channel capacity in that time window.

BRIEF SUMMARY OF THE DRAWING

FIGURE 1 depicts a block schematic of first preferred embodiment of a Video-on-Demand server architecture in accordance with the present principles;

FIGURE 2 depicts a block schematic of second preferred embodiment of a Video-on-Demand server architecture in accordance with the present principles; and

FIGURE 3 depicts a block schematic of third preferred embodiment of a Video-on-Demand server architecture in accordance with the present principles.

DETAILED DESCRIPTION

Before proceeding to describe the technique of the present principles, the following terminology will prove helpful:

T is the time interval over which the system optimization is being contemplated

C is the total channel capacity available in time frame T

P is the total number of programs

$p \in (0, P\text{-}1)$, is the index of a particular program

$N[p]$ is the total number of representations of program p

$n[p] \in (0, N[p]-1)$ is the index of a particular representation of program p

$r[p, x]$ is the bit rate of representation x of program p during T

$q[p, x]$ is the quality of representation x of program p during T

FIGURE 1 depicts a first preferred embodiment of a Video-on-Demand server architecture 10 in accordance with the present principles for transmitting pre-encoded CBR and/or VBR audio/video programs over a fixed bandwidth channel 11 having a total channel capacity, C. The server architecture 10 includes a plurality of multirate stream generators 12_0, $12_1 \ldots 12_{P-1}$, where P is an integer greater than zero corresponding to the number of separate input streams. The stream rate generators 12_0-12_{P-1} each pre-code a corresponding one of the programs Program 0, Program 1...Program $P-1$ at a plurality of different bit rates. Stated another way, each multirate stream generator pre-codes the corresponding program to yield at least two or more different bit rate representations. A representation can include a particular stored encoded bit stream, or a combination of various portions of different encoded bit streams. A storage device 14, typically in the form of a single disc drive, a Redundant Array of Inexpensive Discs (RAID), or a plurality of RAIDs, serves to store the pre-coded representations generated by the multirate stream generators 12_0-12_{P-1}.

Each of the multirate stream generators 12_0-12_{P-1} generates control information for each time window T of for the corresponding one of Programs 0 to $P-1$, respectively. The control information for each time window T for each representation of each program includes an indication of the bit rate of that representation and a quality measure, such as the peak signal-to-noise ratio (PSNR) of the representation. A central statistical multiplexer ("stat mux") 16 receives the control information for each representation. At each successive time window T, the stat mux 16 selects a representation for each program to maximize the quality of the transmitted programs while maintaining the total bit rate at or below the total capacity C of the channel 11.

The lowest bit rate representation for each program should not exceed a prescribed value such that the sum of the lowest bit rates for all programs will not exceed the channel capacity for each interval T. In this way, at least one representation of each program can undergo transmission over the channel 11. Requiring the lowest bit rate representation for each program to have a peak bit rate of C/P or less can achieve this constraint. Other methods exist that meet the constraint $\sum_{p=0}^{P-1} r[p,0] \le C$ for all time windows T of all programs. Typically, advance knowledge does not exist as to when playback of particular programs will commence. Therefore,

enforcing capacity restraints becomes easiest by requiring that the bit rate limit of the lowest bit rate representation be the same for all time windows T of a particular program.

The process for the maximization of the overall combined quality can occur in several different ways. In all cases, the constraint $\sum_{p=0}^{P-1} r[p,n[p]] \leq C$ must remain met for all time windows T of all programs. A minimax approach can satisfy the constraint by choosing *n[p]* for each $p \in (0, P\text{-}1)$ to maximize the quality of the minimum quality program (i.e., minimizing the maximum distortion.)

The minimax approach can be implemented by sorting the control information for each representation of each program so that the quality and bit rate index increases monotonically increasing with the index. The change in bit rate for each step (referred to as the "delta (Δ)"bit rate) is then stored. The stat mux 16 begins with the lowest index for each program representation and computes the total capacity S. The stat mux 16 the selects the program representation at the lowest quality and checks if adding its delta bit rate to S exceeds C. If the addition of the representation does not exceed C, the index for that representation is incremented, and process is repeated. Once C is exceeded, the representation with the next to lowest quality is checked to see if adding its delta bit rate to S exceeds C. The process is repeated until no increment in any representation can be made without exceeding the channel capacity C. Alternatively, the total quality of all programs could be optimized by maximizing the sum of the individual program qualities which involves solving the following constrained optimization problem:

$$\max_{n[.]} \sum_{p=0}^{P-1} q[p,n[p]]; \text{ subject to } \sum_{p=0}^{P-1} r[p,n[p]] \leq C$$

It is also possible to optimize the product of the individual program qualities in the following manner:

$$\max_{n[.]} \prod_{p=0}^{P-1} q[p,n[p]]; \text{ subject to } \sum_{p=0}^{P-1} r[p,n[p]] \leq C$$

A weighted average can also be used, in order to provide different classes of service for different viewers.

The multirate stream generators 12_0-12_{P-1} can use several different methods, or a combination of methods to form multiple representations of each program. In all cases, a random access point, such as an intra-coded (I) frame should occur at the beginning of each time window T, for each representation, so that for each time window T a different representation can be

chosen without causing drift. Each representation can use either CBR or VBR coding as long as the capacity of the lowest bit rate representation meets the total channel capacity constraint.

In a first method, a multirate video encoder encodes each program at several different bit rates into several independent bit streams. Each different bit rate bit stream serves as a different representation. FIGURE 2 depicts an architecture 100 for carrying out this method. As seen in FIG. 2, a multirate video encoder 110 serves to encode a corresponding program to yield a plurality of different rate representations. A separate one of transport packetizers 112_0, $112_2 \ldots 112_{P-1}$ each packetizes a corresponding representation. The multirate encoding performed by the multirate encoder 110, and the packetization performed by the packetizers 112_0-112_{P-1} occurs once, not necessarily in real time, prior to storage in a storage device 140 similar in construction to the storage device 14 of FIG. 1.

Selection of the representations stored in storage device 140 for output in real time occurs in response to a signal received from a selector block 150. The selector block 150 identifies the stored representation for output in response to a request from the stat mux 160 for a particular representation. Upon receipt of the signal from the selector block 150, the storage device 140 supplies the selected packetized representations to the stat mux 160 for output.

In a second method, portions of the several different bit streams are combined to yield additional representations of a program. The presence of random access points at the same location in all bit streams of a program (as would naturally occur at scene changes) or the use of fixed group-of-pictures structures, permits the combination of compressed data from different bit rate streams at random access boundaries to form new representations. No need exists to store each representation independently, as long as the ability exists to generate each representation from the data that is stored. Consider the following example where T is one second, the data is coded at 30 fps, and I frames are inserted every 15 frames, yielding three different bit rate bit streams, designated as Bit stream 0, Bit stream 1, and Bit Stream 2, respectively. Each bit stream constitutes a separate representation. An additional representation can be formed which uses Bitstream 0 for the first 15 frames and Bitstream 1 for the second 15 frames, and so on.

Assuming alignment of the random access points with the transport packets, the server architecture 100 of FIG. 2 works well when the transport packetization occurs in advance. FIGURE 3 depicts a VoD server architecture 200 better suited when the random access points do not necessarily align with the transport packets. Referring to FIG. 3, VoD server architecture 200 includes multirate video encoder 210 for generating a plurality of different bit rate

representations for storage in a storage device 240 similar to the storage devices 14 and 140. The representations stored in the storage device 140 exist as un-packetized bit streams.

Selection of the representations stored in storage device 240 for output in real time occurs in response to a signal received from a selector block 250. The selector block 250, similar in nature to the selector block 150 of FIG. 2, identifies the stored representation for output in response to a request from a static mixer/multiplexer 260 for a particular representation. Upon receipt of the signal from the selector block 250, the storage device 240 supplies the selected packetized representations to the static mixer/multiplexer. A packetizer 212 packetizes the output stream of the static mixer/multiplexer 260 for output on the channel (not shown).

Representations also can be formed by switching between stored bit streams for non-reference pictures, such as for video codecs (not shown) that include pictures that are not used as reference pictures for predicting other pictures, such as MPEG-2 B frames or JVT non-stored pictures. Each non-reference picture can be selected from a different stored bitstream without affecting the quality of subsequently coded pictures, as the non-stored pictures are not used for prediction. Complete elimination of a non-reference picture in a representation can also occur. Each non-reference picture could be switched individually, or groups of non-reference pictures could be switched together, allowing for many possible total bit rate representations. The multirate stream signal generators 12_0-12_{P-1} of FIG. 1 can choose to limit the number of possible representations to send to the stat mux 16 of FIG. 1 to choose those with significant differences in quality and bit rate. It is not necessary for each representation to be independently stored in storage, but a table listing the location and length of each coded frame can be stored to simplify generation of the representation when needed. It is also possible to store multiple bit rate bit streams only for the non-stored pictures and only store a single version of the reference (I and P) pictures, which can significantly reduce storage requirements.

With the VoD server architectures 100 and 200 of FIGS. 2 and 3, respectively, the stat mux 160 and the static mixer/multiplexer 260 generate a bit stream corresponding to the selected representation. If individual pictures are not transport packet aligned, the architecture 200 of FIG. accomplishes transport packetization after the generation of the bit stream for a particular representation. Otherwise, the VoD server architecture 100 of FIG. 2 FIG. 2 will work well.

In accordance with another aspect of the present principles, scalable video coding can occur by the use of a scalable video encoder (not shown) to form a base layer and one or more enhancement layers. Any type of scalability that which employs the base layer for motion compensated reference picture prediction in order to avoid drift can be used, such as frequency

scalability, FGS, SNR scalability or temporal scalability. The lowest bit rate representation corresponds to the base layer. The peak bit rate of the base layer must be such that when the bit rates of all programs' base layers are summed, the channel capacity C is not exceeded for each time window T. Other higher bit rate representations will correspond to the base layer plus some portion of the enhancement layer. This approach requires that the video decoder support the type of scalability used. The VoD server architecture 100 of FIG. 2 is used upon inclusion of an entire enhancement layer in a particular representation. The VoD server architecture 200 of FIG. 3 is used if portions of an enhancement layer are used in a representation.

For systems which use encryption for contents right management, the VoD server architecture 100 of FIG. 2 does not require any decryption or encryption in real time, as encryption is added to the transport packetization process done in non-real time and entire encrypted transport packets are stored and transmitted. The VoD server architecture 200 of FIG. 3 requires that encryption be performed along with transport packetization in real-time.

VoD programs generally include both audio and video. As audio bit rates are generally significantly lower than video bit rates and are also generally at a fixed bit rate, there is less advantage to be gained by selecting from different pre-encoded audio bit streams by the stat mux 16 and 160 of FIGS 1 and 2, and the static mixer/multiplexer 260 of FIG. 3. A user likely will find the switching of audio quality during the viewing of a single program disturbing. The total channel capacity C can be considered to be totally consumed by the video channel; assuming that a single bit rate audio stream is also sent for each program. Alternatively, the above-described methods can also be applied to audio, where multiple representations of audio programs with different bit rates and qualities can be generated.

A video player (not shown) that works with the VoD server architectures of the present principles will contain a video decoder (not shown) and some storage for buffering. For the particular program being received, the data can arrive at a non-uniform data rate, but with the requirement that the data corresponding to time unit T will arrive any time within the T time window. The video player must have the capability of buffering and delaying for T. An upper limit on the maximum bit rate that can be transmitted for a given representation of a program for a time window T can be pre-determined to limit the decoder complexity and decoder buffer size. The decoding buffer is generally a requirement of a video decoder, e.g. MPEG-2 levels sets buffer size particular requirements, and the combination of T and the bitrate may be chosen to meet it.

Fast forward and fast reverse tracks for each program can also be stored at the VoD server. They can be stored at a single bit rate, or at several different bit rates, and allowed to adapt as is done for the normal play program.

Determination of the time window T length is based on several factors. T should be as large as possible to get the most statistical multiplexing gain, but small enough to constrain the delay at the video player for start-up and switching between normal play and trick play streams. T should be small enough to meet decoder requirements.

The foregoing describes a system and method for efficiently providing video on demand while maintaining bandwidth constraints of a fixed channel.

CLAIMS

1. A method for transmitting a plurality of pre-coded programs having different bit rates across a fixed bandwidth channel, comprising the steps of:

generating at least two different bit rate representations of each program;

providing control information at each of a plurality of successive time windows T for each representation of each program, the control information for each successive window indicating a bit rate and quality measure for a representation of a corresponding program; and

during each time window T, selecting a representation for each program such to maximize the quality of the selected representations while not exceeding a total available capacity for the channel.

2. The method according to claim 1 wherein the step of generating at least two different bit rates representation further comprises the step of generating for each program a lowest bit rate representation having a peak bit rate not greater than C/P where C is the total channel capacity in time T and P is the total number of programs.

3. The method according to claim 1 wherein the step of providing the control information further comprises the step of establishing the peak signal-to-noise ratio (PSNR) as the quality measure embodied in the control information.

4. The method according to claim 1 wherein the selecting step further comprises the step of selecting a representation for each program which meets the constraint $\sum_{p=0}^{P-1} r[p, n[p]] \leq C$ for all time windows wherein:

C is the total channel capacity available in time frame T;

P is the total number of programs;

$p \in (0, P\text{-}1)$, is the index of a particular program;

$N[p]$ is the total number of representations of program p;

$n[p] \in (0, N[p] - 1)$ is the index of a particular representation of program p; and

$r[p, x]$ is the bit rate of representation x of program p during T

5. The method according to claim 4 further comprising the step of choosing each program's representation n[p] $\in$ (0, N[P]-1) to maximize the quality of the program p that had the minimum quality.

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

(a) sorting the quality information for with the bit rate and quality measure monotonically increasing with an index value;

(b) storing each bit rate increment (delta) and quality value for each index value;

(c) beginning with a lowest index value, computing total capacity S for program representations selected thus far for such index value;

(d) selecting a program representation at a lowest quality measure;

(e) checking whether the bit rate increment of the selected program at the lowest quality, when added to the representations selected thus far, exceeds total channel capacity, and if not

(f) incrementing the index value; and

(g) repeating steps (c)-(f).

7. The method according to claim 1 wherein the selecting step further comprises the step of selecting the representation for each program such to maximize a sum of individual program qualities by solving $\max_{n[.]} \sum_{p=0}^{P-1} q[p, n[p]]$; subject to $\sum_{p=0}^{P-1} r[p, n[p]] \leq C$

wherein ,

C is the total channel capacity available in time frame T;

P is the total number of programs;

$p \in (0, P\text{-}1)$, is the index of a particular program;

$N[p]$ is the total number of representations of program p;

$n[p] \in (0, N[p] - 1)$ is the index of a particular representation of program p;

$r[p, x]$ is the bit rate of representation x of program p during T; and

$q[p, x]$ is the quality of representation x of program p during T.

8. The method according to claim 1 wherein the selecting step further comprises the step of selecting the representation for each program such to maximize a product of individual program qualities by solving

$$\max_{n[.]} \prod_{p=0}^{P-1} q[p,n[p]]; \text{ subject to } \sum_{p=0}^{P-1} r[p,n[p]] \leq C$$

where,

C is the total channel capacity available in time frame T;

P is the total number of programs;

$p \in (0, P\text{-}1)$, is the index of a particular program;

$N[p]$ is the total number of representations of program p;

$n[p] \in (0, N[p]-1)$ is the index of a particular representation of program p;

$r[p, x]$ is the bit rate of representation x of program p during T; and

$q[p, x]$ is the quality of representation x of program p during T.

9. The method according to claim 8 further comprising the step of applying a weighted average to provide different classes of service for different viewers.

10. A system for transmitting a plurality of pre-coded programs having different bit rates across a fixed bandwidth channel, comprising the steps of:

means for generating at least two different bit rate representations of each program;

means providing control information at each of a plurality of successive time windows T for each representation of each program, the control information for each successive window indicating a bit rate and quality measure for a representation of a corresponding program; and

means for selecting during each time window T a representation for each program such to maximize the quality of the selected representations while not exceeding a total available capacity for the channel.

11. The system according to claim 10 wherein the generating means and control information providing means collectively comprise:

a plurality of multirate stream generators, each associated with a corresponding one of the plurality of pre-coded programs.

12. The system according to claim 10 wherein the generating means and control information providing means collectively comprise:

a multirate video encoder for encoding at least two bit rate representations of each pre-coded program.

13. The system according to claim 10 wherein the generating means and control information providing means collectively comprise:

a multirate video encoder for encoding at least two bit rate representations of each pre-coded program; and

a plurality of transport packetizers, each serving to packetize the bit rate presentations for each pre-coded program.

14. The system according to claim 10 wherein the selecting means includes a static multiplexer.

15. The system according to claim 12 wherein the selecting means comprises:

a static multiplexer; and

a transport packetizer for packetizing the selecting representation.

16. The system according to claim 10 wherein the selecting means generates for each program a lowest bit rate representation having a peak bit rate not greater than C/P where C is the total channel capacity in time T and P is the total number of programs.

17. The system according to claim 10 wherein control information providing means establishes quality measure in accordance with a peak signal-to-noise ratio (PSNR).

18. The system according to claim 10 wherein the selecting means selects a representation for each program which meets the constraint $\sum_{p=0}^{P-1} r[p, n[p]] \leq C$ for all time windows where:

C is the total channel capacity available in time frame T;

P is the total number of programs;

$p \in (0, P\text{-}1)$, is the index of a particular program;

$N[p]$ is the total number of representations of program p;

$n[p] \in (0, N[p]-1)$ is the index of a particular representation of program p; and

$r[p, x]$ is the bit rate of representation x of program p during T.

19. The system according to claim 18 wherein the selecting means chooses each program's representation n[p] $\in$ (0, N[P]-1) to maximize the quality of the program p that had the minimum quality.

20. The system according to claim 10 wherein the selecting means selects the representation for each program such to maximize a sum of individual program qualities by solving:

$$\max_{n[.]} \sum_{p=0}^{P-1} q[p,n[p]]; \quad \text{subject to} \quad \sum_{p=0}^{P-1} r[p,n[p]] \le C$$

where,

C is the total channel capacity available in time frame T;

P is the total number of programs;

$p \in (0, P\text{-}1)$, is the index of a particular program;

$N[p]$ is the total number of representations of program p;

$n[p] \in (0, N[p]-1)$ is the index of a particular representation of program p;

$r[p, x]$ is the bit rate of representation x of program p during T; and

$q[p, x]$ is the quality of representation x of program p during T.

21. The system according to claim 10 wherein the selecting means selects the representation for each program such to maximize a product of individual program qualities by solving:

$$\max_{n[.]} \prod_{p=0}^{P-1} q[p,n[p]]; \quad \text{subject to} \quad \sum_{p=0}^{P-1} r[p,n[p]] \le C$$

where,

C is the total channel capacity available in time frame T;

P is the total number of programs;

$p \in (0, P\text{-}1)$, is the index of a particular program;

$N[p]$ is the total number of representations of program p;

$n[p] \in (0, N[p]-1)$ is the index of a particular representation of program p;

$r[p, x]$ is the bit rate of representation x of program p during T; and

$q[p, x]$ is the quality of representation x of program p during T.

22. The system according to claim 10 wherein a weighted average is applied to provide different classes of service for different viewers.

ABSTRACT OF THE DISCLOSURE

A Video-on-Demand Server architecture (100, 200, 300) transmits a plurality of pre-coded programs having different bit rates across a fixed bandwidth channel (11). For each program, a generator (12_0-12_{P-1}, 110, 210) generates a plurality of different bit rate representations for each program. Each generator also provides control information at each of a plurality of successive time windows T for each bit rate representation. The control information provides a bit rate and a quality measure during each time window T. The control information enables a statistical multiplexer (16, 160, 260) to select a bit rate representation for each program during each time window T to maximize the quality of the selected representations while not exceeding the total available channel capacity.

FIG. 1

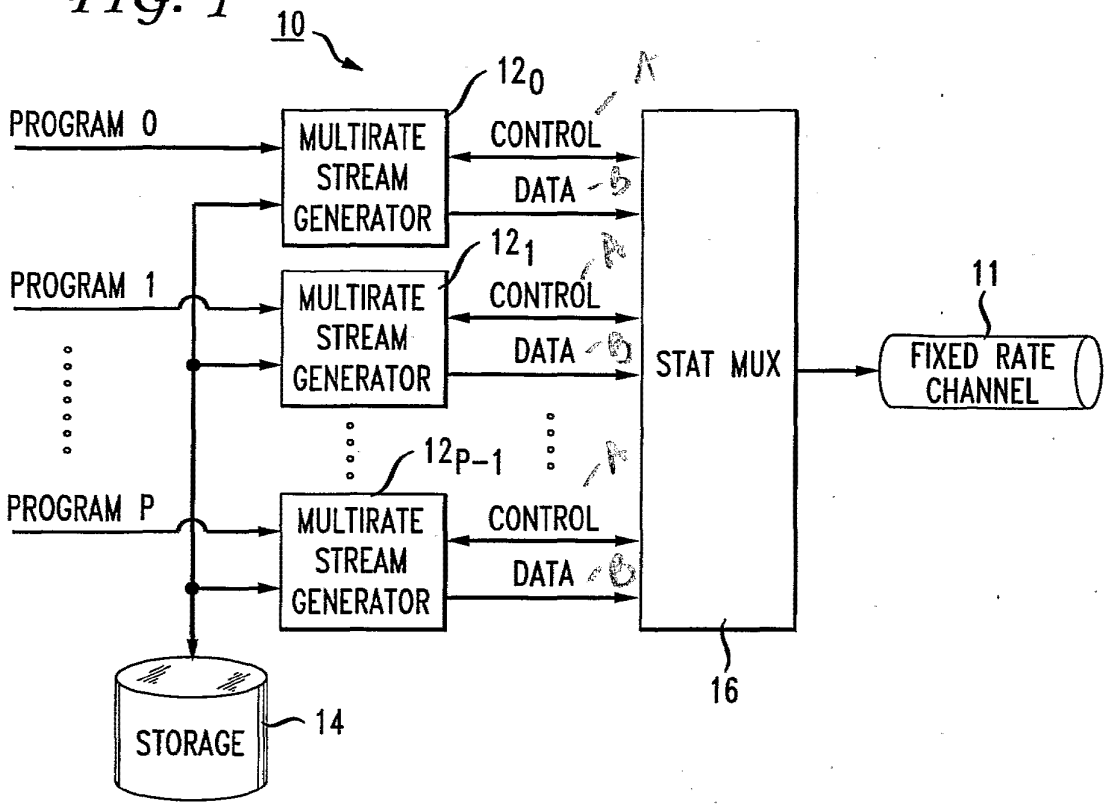

10
PROGRAM 0
PROGRAM 1
PROGRAM P
MULTIRATE STREAM GENERATOR
MULTIRATE STREAM GENERATOR
MULTIRATE STREAM GENERATOR
12_0
12_1
12_{P-1}
CONTROL
DATA
CONTROL
DATA
CONTROL
DATA
STAT MUX
11
FIXED RATE CHANNEL
16
STORAGE
14

FIG. 2

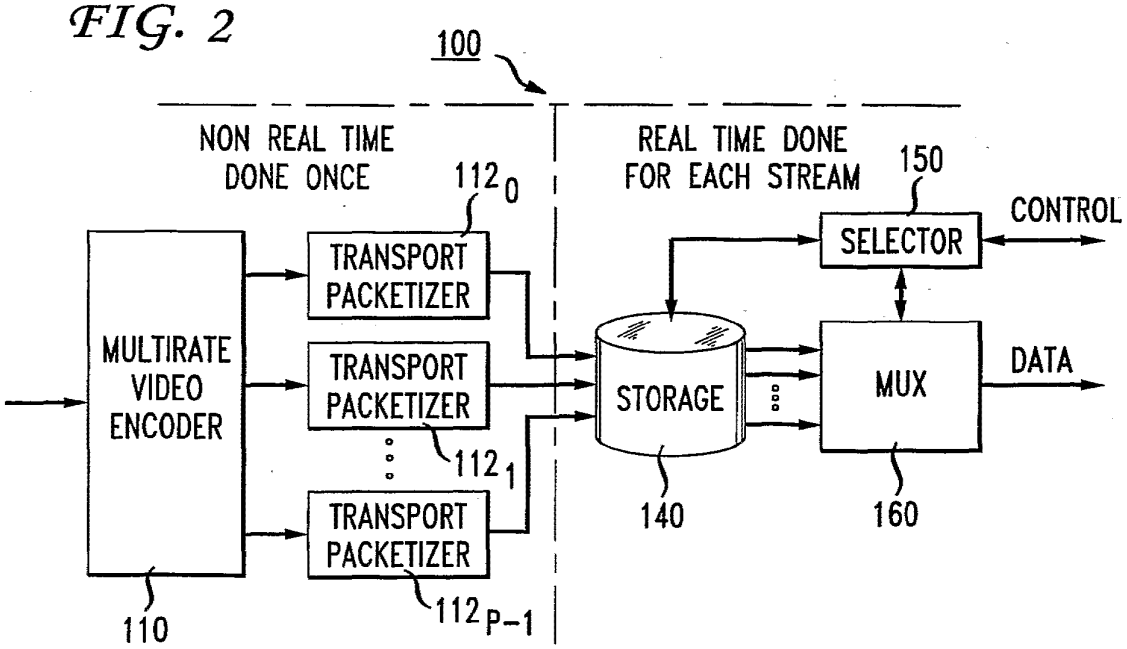
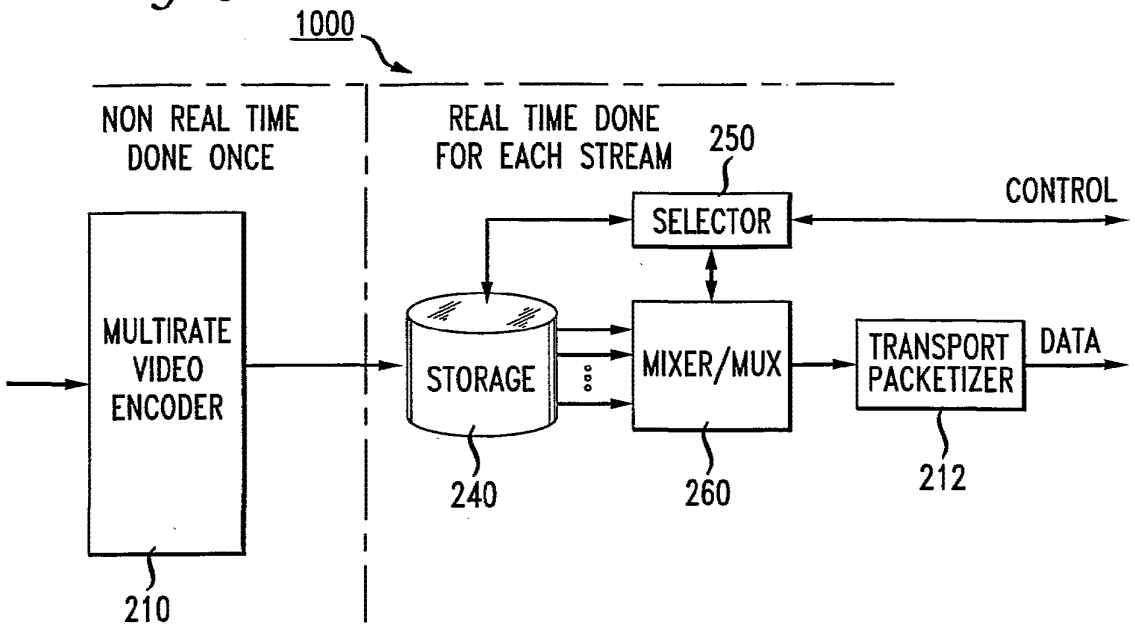

100
NON REAL TIME DONE ONCE
REAL TIME DONE FOR EACH STREAM
MULTIRATE VIDEO ENCODER
110
TRANSPORT PACKETIZER
TRANSPORT PACKETIZER
TRANSPORT PACKETIZER
112_0
112_1
112_{P-1}
STORAGE
140
150
SELECTOR
CONTROL
MUX
160
DATA

FIG. 3


1000
NON REAL TIME
DONE ONCE
REAL TIME DONE
FOR EACH STREAM
250
SELECTOR
CONTROL
MULTIRATE
VIDEO
ENCODER
STORAGE
MIXER/MUX
TRANSPORT
PACKETIZER
DATA
210
240
260
212

PCT
New International Application
Inventory of Unscannable or Missing Items

Serial Number

Check This Column if Item Is Present	Item	Check This Column if Item Is Missing on Filing
	Return Receipt Postcard	
	Check (amount $_____)	
	PCT EASY Diskette	
	DNA Diskette	
	Exhibit	
	Express Mail Label or Envelope	
	Applicant Supplied Priority Document	
	Other (specify)	XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX
XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX	Cover Letter	
XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXX	Other (specify)	

Winword[TM] \ Automation\Unscanned inventory.wpd sheet

Electronic Patent Application Fee Transmittal

Application Number:	11116783
Filing Date:	28-Apr-2005
Title of Invention:	Apparatus, system, and method for adaptive-rate shifting of streaming content
First Named Inventor/Applicant Name:	R. Drew Major
Filer:	Brett Carlson
Attorney Docket Number:	066.0141 (P2004-04-01.1)

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Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

(19) Europäisches Patentamt
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(11) EP 1 395 014 A1

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(54) A method of transmitting data streams with data segments of variable length

(57) A method of transmitting data streams between a sending host and a receiving host using a transport protocol comprising the steps of making available data streams at the sending host in the form of mono-rate or multi-rate content streams having the same content but different encoding rates, establishing a connection between the sending host and the receiving host, transmitting data streams with a selected encoded rate to the receiving host, and separating the data streams into data segments of variable length at the sending host as required during transmission.

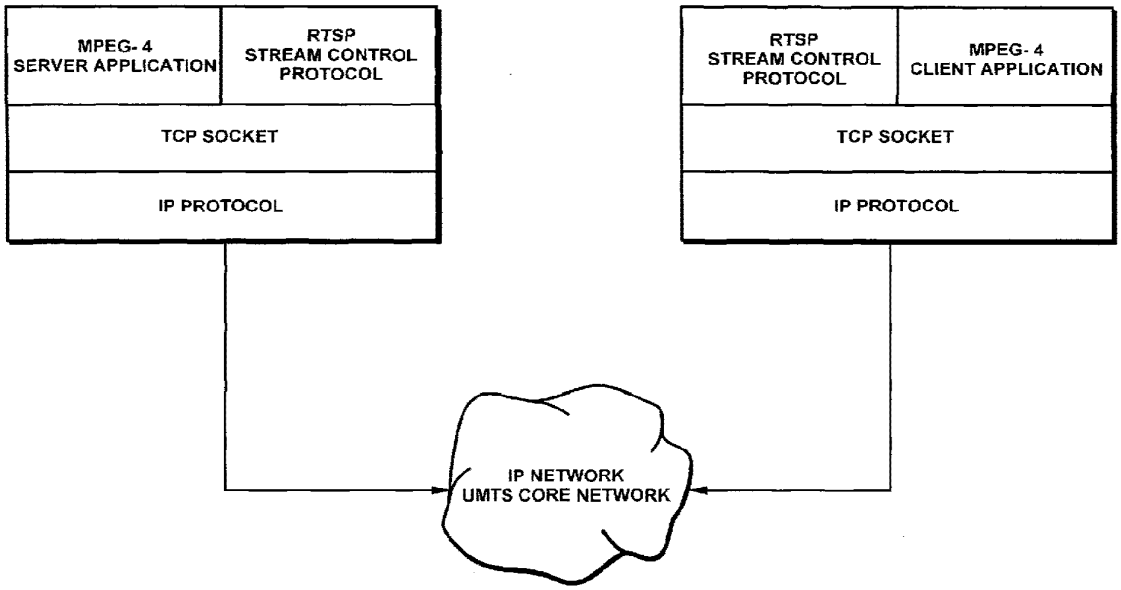


Fig. 1

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Description

[0001] The present invention relates to a method of transmitting data streams between a sending host and a receiving host using a transport protocol such as TCP.

[0002] In network communications between a sending host and a receiving host, the transmission of data packets is mostly done on a best-effort basis. In the communication link, the available bandwidth and the current link conditions vary and hence, the end hosts must be provided with mechanisms to probe and adjust themselves to the current link conditions.

[0003] With the development of 3rd generation networks, so-called streaming applications are gaining importance. Streaming applications are understood as a continuous stream of data, e.g. video or audio data which is typically sensitive to time delays. In order that the user will be able to receive multimedia data streams on a portable receiver, for example a mobile phone, several requirements on the transport mechanism will be imposed in order that the delivered data meets with the resulting time constraints. These constraints are difficult to meet in a best-effort environment, which is subject to bandwidth variations and delays.

[0004] To cope with the problem of bandwidth adaption, it is common praxis to make several data streams with different encoding rates but same content available at the sending host. According to the available bandwidth, it is then switched between the data streams in order to adjust the rate to the available bandwidth. In other words, multi-rate content streams at the sending host are transmitted and switching operations between streams are performed depending on the available bandwidth. The current stream is forwarded to the receiving host in one piece and consequently, for every switching operation, the ongoing connection must be torn down and a new one must be set up. As a result, this operation is inefficient and decreases the data throughput.

[0005] Alternatively, it is possible to transmit only one stream of data to the receiving host and to discard data packets based on priority and time constraints. However, this leads to a loss of data and is therefore not an optimal solution.

[0006] The object subject to the present invention is to minimize the latency of the switching operation and to ensure fast recovery from an incorrect switching decision.

[0007] This object is solved according to the present invention with a method as set forth in claim 1. Preferred embodiments of the method are subject to various dependent claims.

[0008] The method of the present invention supposes the existence of multi-rate content data streams at the sending host. With the method of the present invention, it is possible to quickly switch between data streams that are variably segmented at the application layer as required during transmission. Instead of using data streams of fixed segment length, the data segments given to the socket are made smaller before, during and after the switching. For each content several video streams encoded with different rates are stored at the video server. Under normal sending conditions, i.e. the transmission has reached some equilibrium where the bandwidth is enough and the losses are not dominating, the video content is passed to the sending TCP socket in segments of the same size (irregardless of the stream encoding rate, the segment size is a function of the link, not of the encoding rate). Only when the server is notified (or knows by other means) that a stream switch might be needed, then it reduces the size of these segments.

[0009] Further, with the method of the present invention, it is neither necessary to modify the originally encoded data at the sending host or to modify the transport protocol nor to introduce additional control messages, making the method easy to implement.

[0010] Preferably, the switching is performed between data streams of different rate and the variable segmentation of the data streams is performed around the switching instant. Hence, a quick stream switching from the old to the new data stream can be performed. Further, preferably, the segmentation during, before or after the switching instance is made finer, such that the switching operation is more resilient to an incorrect decision and enables a quicker, further switching operation.

[0011] Advantageously, the step of switching between streams involves a feedback message (e.g. an RTSP command) i.e. communication between hosts when a switching operation is needed and when to make the necessary preparations therefor, for example, to start with finer segmentation.

[0012] It is furthermore of advantage if the feedback message includes at least one of the parameters, which comprise the length of data segment, an identifier of the data to be sent or a stream control command which makes the operation smoother and less susceptible to data losses.

[0013] Preferably, the length of the data segments is gradually increased after a switching instant to reduce interface communication, i.e. between application and TCP socket.

[0014] The present invention will be more fully understood from the following detailed description with reference to the accompanying drawings which show:

Figure 1: the basic architecture of a sending host and a receiving host connected by a communications network in which the method subject to the present invention can be performed,

Figure 2: a block diagram of a server architecture as the sending host in which the method of the present invention is performed, and

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Figure 3: a block diagram of a client architecture.

[0015] Figure 1 illustrates the basic architecture of a communications network for connecting a video server as a sending host to a video client acting as a receiving host. The communications network is, for example, a UMTS core network, an external network, such as the internet or an internal intranet over which the server and the client communicate by means of a transport protocol. As transport protocol TCP is selected as an example, but it is clear to a skilled person that any other transport protocol for transmitting data can be employed.

[0016] In a more general way, it will now be explained how TCP handles the exchange of data between the server and the client.

[0017] First of all, the video server needs to transfer its data to the protocol and tell it to send same to the client. To progressively read and send data, the protocol uses a kind of buffer with added functionalities, a so-called TCP socket. Generally, sockets are unequivocally identified by the IP addresses of the correspondents, the protocols and ports which are used. Once a connection between two sockets is established, the communication can be controlled by use of interface calls, which, for example may comprise "create a socket", "bind a socket to a transport address", "accept" or "close a connection", "send", "receive" or "write" data between the sender and the receiver.

[0018] Wide-spread socket implementations are UNIX BSD 4.2 and Windows Winsock 2.0, where equivalent interface calls are implemented.

[0019] Each interface call has parameters, e.g. for the "send" call, parameters of relevance are the socket descriptor, the identifier of the data to be sent and the length of the data stream. Once a data stream is passed in one call, no single bit of this data stream can be modified. The only way to abort transfer of this data stream is to break down the connection.

[0020] Nevertheless, in order to close the connection, the application must explicitly issue a "close" call. Interface calls can be queued as, for example, in FTP. When asked for a file, the FTP server usually issues two interface calls for this transmission, namely a "send" call indicating the socket, the identifier of the data stream and the length thereof and a "close" call identifying the socket. The two interface calls are put into the queue and when the "send" call is completed, the connection is irreversibly broken down because the "close" call was next in the queue.

[0021] Alternatively, for example, in case of TELNET, the connection is established and the socket is set to wait for incoming data, i.e. commands typed on the keyboard.

[0022] Of course, the application can be configured such that the server only issues a send call and waits for the client to close. However, this is uncommon.

[0023] Additionally, it is assumed that the TCP protocol provides a means for asynchronously signaling certain information about events in the socket. Often in the specification, the information will be an error message. In other cases, there will be information relating to the completion of processing a SEND or RECEIVE or another interface call.

[0024] Referring again to Figure 1, the video server provides, e.g. an MPEG 4 compressed data stream, i. e. a given video content, which is made available to the TCP socket in the form of mono-rate or multi-rate streams. Multi-rate streams are defined for the purpose of this and the following description, as one or several data streams with the same video content at different encoding rates. The MPEG data streams are forwarded to the TCP socket. Subsequently, by means of an IP protocol, data is transmitted to the video client. A stream control protocol, e.g. RTSP, should be used to perform such operating as PLAY, PAUSE or STOP the transmission.

[0025] With reference to Figure 2, which shows the basic architecture of a video server 200, at the MPEG server application 210, video content is made available in a buffer 211 at different coding rates. A switch 212, which receives stream control RTSP commands from RTSP block 220, such as "Play", "Pause", "Tear down" or "Change rate", selects one of the data streams which is forwarded to the TCP socket 230 in form of an MPEG file.

[0026] It is clear to a skilled person that other stream control protocols than RTSP could be used at the server and the client. The stream control protocol typically instructs to perform play, forwarding, rewinding, pause or stop functions. Additionally, if multi-rate content is available, switch to a higher or lower encoding rate can be instructed.

[0027] Once a server has received a request for a file containing a chosen content encoded at a desired rate, the server application forwards each of the segments, in which the file was previously segmented, one after another to the TCP socket by means of consecutive interface calls, e.g. consecutive SEND calls. Unlike in current FTP applications, the connection is not torn down after each data transmission process is completed. The data connection remains open, so that there is no need to build up a new connection every time a segment is transmitted. Following this, the TCP socket forms with these segments packet data units (PDUs) for transmission to the client, as it finds most appropriate

[0028] Upon establishing a connection, the TCP socket selects a segment size for the data streams which the server finds most appropriate for the link under consideration of the channel bandwidth and starts transmitting.

[0029] Initially, the size of the segments is made small before, during and after a switching operation in order to avoid a large waiting time before a further switch operation can be performed in case the previous switch decision was incorrect. Subsequently, the size of the data segments can be increased gradually throughout the connection time.

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[0030] Eventually, when there is a change in the available link bandwidth, the video client shall indicate a possible switch operation by means of, for example, an RTSP message and the server will start doing finer segmentation. Hence, the server switches between data streams of different encoding rates. This is done based on initial information and subsequently controlled by feedback from the client. Alternatively, this could be determined by the server, which would, however, impose processing requirements on the server. Also a combination of control mechanisms at the server and the client is possible. How the server or the client exactly makes the decision to perform a switching operation or indicates a possible anticipated switch is out of the scope of the present invention.

[0031] The basic architecture of a TCP streaming client 300 is illustrated in Figure 3. The client 330 typically consists of a TCP socket 310, an application layer buffer 320 and a buffer manager 330 for the application layer buffer.

[0032] The client 300 processes the data segments of variable length as they come. In response thereto, it sends ACKs and performs flow control in order to prevent an overflow of the TCP socket 310 while extracting the maximum bit rate possible from the link. To do this, the TCP socket indicates to the server, with each ACK, how much data it can receive until the socket is full using a window field in the header of the TCP protocol. If needed, the TCP client signals a zero-window telling the server to enter a "Persist" mode wherein no data is sent until the client allows to do so while the connection is maintained. The Persist mode and the signaling of a window field are standard functionalities of the TCP protocol. When the TCP circuit has capacity for more data, it signals this to the server. Streaming control commands are signalled to the server by means of RTSP commands.

[0033] The application layer buffer 320, also called "play-out buffer" receives data from the socket and transmits same to the MPEG client application 340. The manager 330 for the application layer buffer 320 receives a frame request from the MPEG client application and issues a socket request upon considering the state of the application layer buffer. The buffer manager 320 therefore insures that the bit rate with which the TCP socket 310 can deliver the new data to the application layer buffer 320 matches the bit rate at which the application layer buffer is emptied to the MPEG client application 340. The exact control mechanism of the buffer manager is out of the scope of the present invention.

[0034] Finally, from the MPEG client application, the data is transferred to a display 350 for visualization for the user.

Claims

1. A method of transmitting data streams between a sending host and a receiving host using a transport protocol comprising the steps of:

   making available data streams at the sending host in form of mono-rate or multi-rate content streams having same content but different encoding rates,

   establishing a connection between the sending host and the receiving host for the duration of transmission,

   transmitting data streams of the same content with a selected encoding rate to the receiving host, and

   separating the data streams in data segments of variable length at the sending host as required during the established connection.

2. The method according to claim 1, further comprising the steps of switching between data streams of different rate and performing the variable segmentation of the data streams around the switching instant.

3. The method according to claim 1 or 2, wherein the data streams are finer segmented during, before or after the switching instant.

4. The method according to claim 2, wherein the step of switching between streams involves a feedback message.

5. The method according to claim 4, wherein the feedback message includes signalling at least one of the parameters which comprise data segment length, an identifier of the data to be sent or a stream control command.

6. The method according to one of claims 1-5, wherein the receiving host communicates to the sending host when a stream switching is needed.

7. The method according to one of claims 1-6, wherein the sending host determines the timing of the switching instant dependent on the available bandwidth of the communication link.

8. The method according to one of claims 1-7, wherein the length of the data segments is gradually increased after a switching instant.

9. The method according to one of claims 1-8, wherein the received data streams at the receiving host are temporarily stored in an internal buffer.

10. The method according to one of claims 1-9, wherein the receiving host issues stream control commands

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to the sending host depending on the state of the internal buffer.

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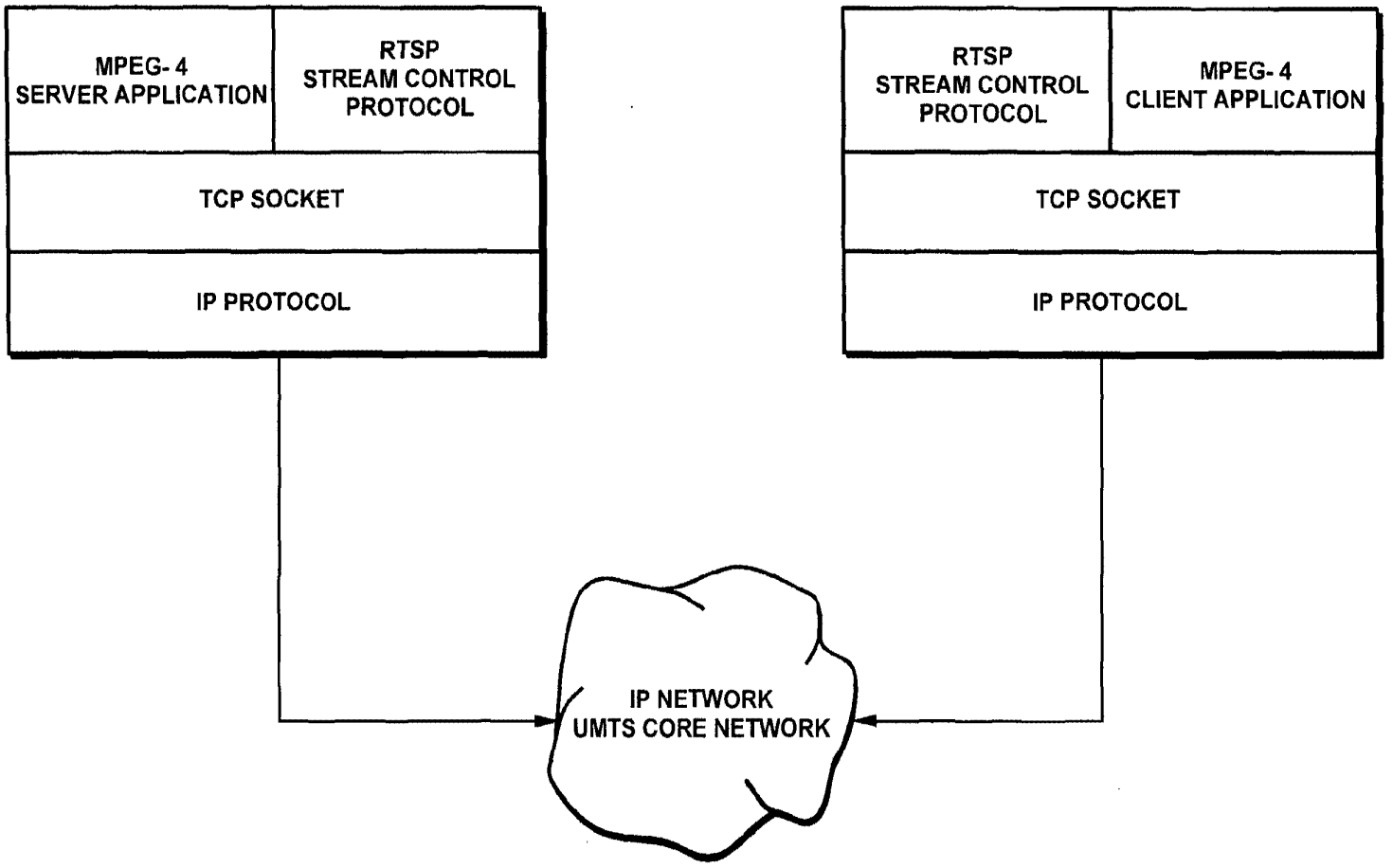

MPEG-4
SERVER APPLICATION
RTSP
STREAM CONTROL
PROTOCOL
TCP SOCKET
IP PROTOCOL
RTSP
STREAM CONTROL
PROTOCOL
MPEG-4
CLIENT APPLICATION
TCP SOCKET
IP PROTOCOL
IP NETWORK
UMTS CORE NETWORK

Fig. 1

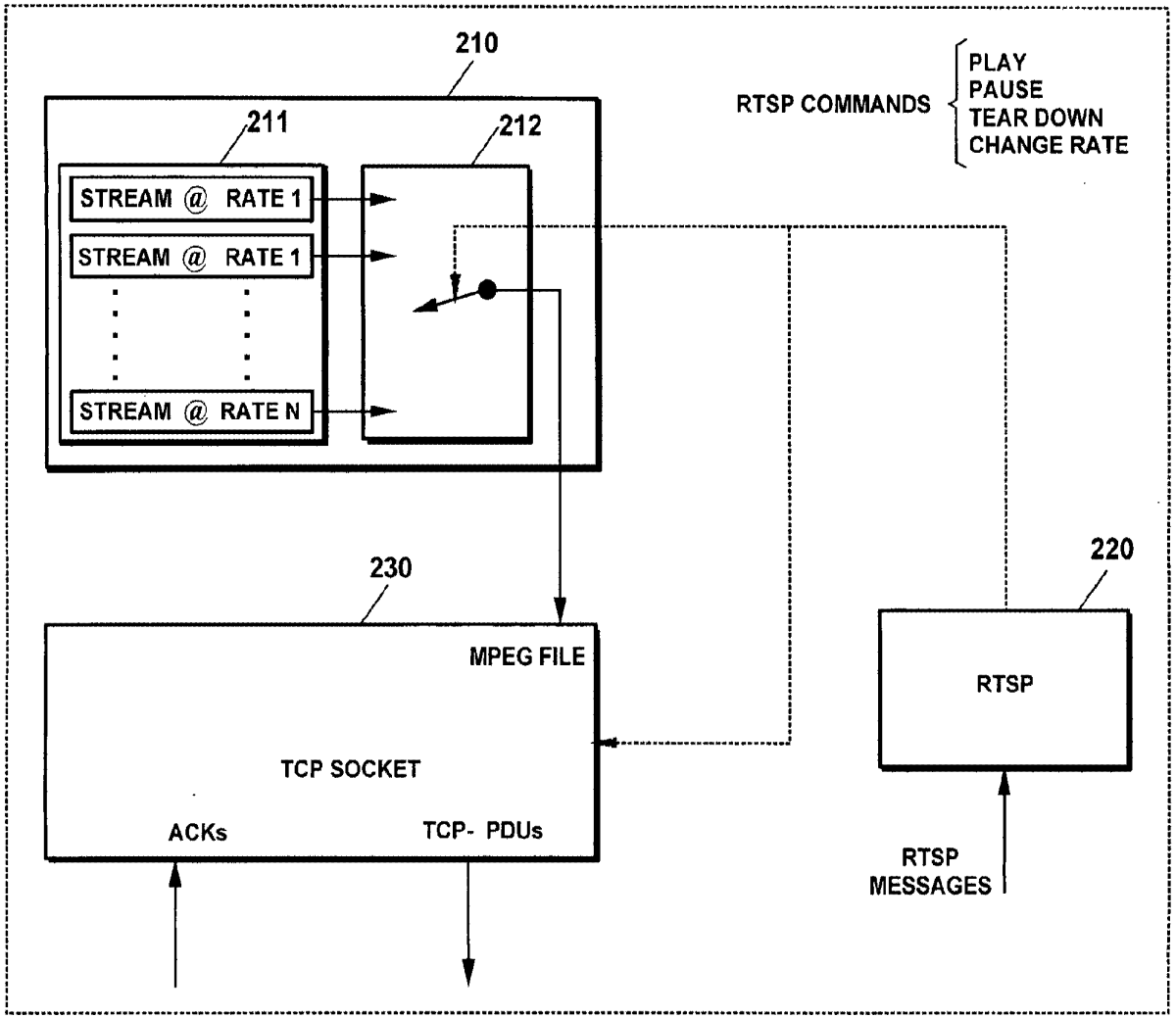


Fig. 2

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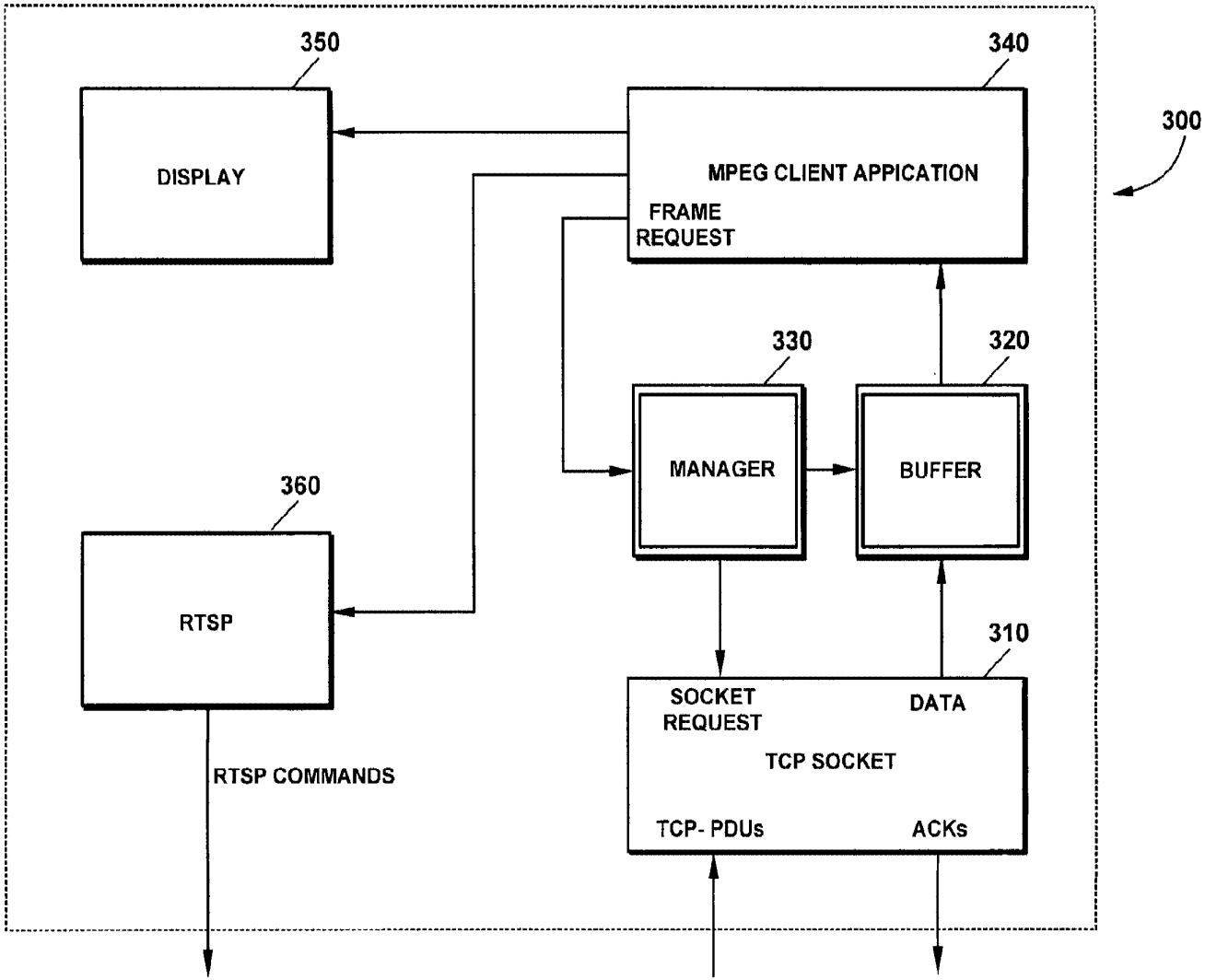

350
340
300
DISPLAY
MPEG CLIENT APPICATION
FRAME
REQUEST
330
320
MANAGER
BUFFER
360
RTSP
310
SOCKET
REQUEST
DATA
TCP SOCKET
RTSP COMMANDS
TCP- PDUs
ACKs

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 01 9052

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	CONKLIN G J ET AL: "VIDEO CODING FOR STREAMING MEDIA DELIVERY ON THE INTERNET" IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE INC. NEW YORK, US, vol. 11, no. 3, March 2001 (2001-03), pages 269-281, XP001093477 ISSN: 1051-8215 * page 271, left-hand column, line 35 - line 44; figures 1,2 * * page 270, left-hand column, line 11 - line 20 * ---	1-10	H04L29/06 H04L29/08
Y	EP 0 786 885 A (NOKIA TELECOMMUNICATIONS OY) 30 July 1997 (1997-07-30) * abstract * * page 2, column 2, line 14 - line 34 * ---	1-10	
X	WO 02 054284 A (LEISTAD GEIRR I ;DANKWORTH HARALD (NO); FAST SEARCH & TRANSFER ASA) 11 July 2002 (2002-07-11) * page 2, line 31 - page 3, line 7 * * page 4, line 6 - page 5, line 6; figure 1 * * page 9, line 18 - page 10, line 15 * * page 11, line 3 - line 28; figure 3 * --- -/--	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	7 January 2003	Michael, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
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D : document cited in the application
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Page 940 of 2308

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 01 9052

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	HUI J Y ET AL: "CLIENT-SERVER SYNCHRONIZATION AND BUFFERING FOR VARIABLE RATE MULTIMEDIA RETRIEVALS" IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE INC. NEW YORK, US, vol. 14, no. 1, 1996, pages 226-237, XP000548824 ISSN: 0733-8716 * page 228, left-hand column, line 15 - line 33 * * page 228, right-hand column, line 14 - line 32 * ---	10	
A	JONGWON KIM ET AL: "TCP-friendly Internet video streaming employing variable frame rate encoding and interpolation" IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, vol. 10, no. 7, October 2000 (2000-10), pages 1164-1177, XP002226167 ISSN: 1051-8215 * page 1164, right-hand column, line 25 - line 40; figure 1 * ---	7	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	WO 02 052859 A (DURRANT SIMON ;LAKE JULIAN (GB); MULROY PAT (GB); PA CONSULTING SE) 4 July 2002 (2002-07-04) * page 3, line 12 - line 30 * -----	7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	7 January 2003	Michael, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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Page 941 of 2308

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 01 9052

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07-01-2003

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		WO 02054284 A1	11-07-2002
WO 02052859 A	04-07-2002	WO 02052859 A1	04-07-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Page 942 of 2308

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2011-004225
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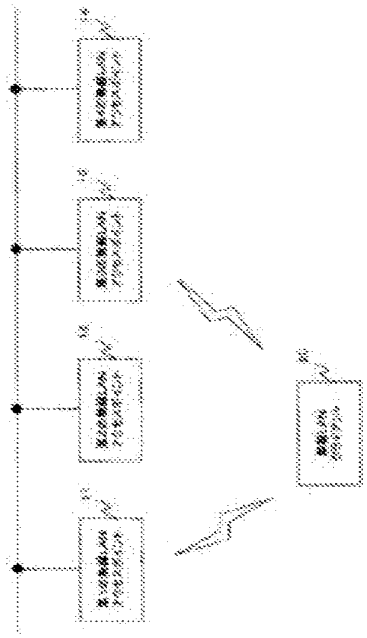
(51)Int.Cl. *H04W 48/20 (2009.01)*
H04W 84/12 (2009.01)
H04W 48/16 (2009.01)

(21)Application number : 2009-146288
(22)Date of filing : 19.06.2009

(71)Applicant : NEC INFRONTIA CORP
(72)Inventor : HODOSHIMA TAKESHI

(54) SYSTEM, METHOD AND PROGRAM OF HIGH-SPEED ROAMING OF WIRELESS LAN

(57)Abstract:
PROBLEM TO BE SOLVED: To attain high-speed roaming in a wireless LAN network.
SOLUTION: In a LAN system including: a plurality of wireless LAN access points; and a wireless LAN client to be connected to the wireless LAN access points, the wireless LAN access points are the ones existing on the same local area network, used channels and BSSIDS of the wireless LAN access points set to the same ESSID are recognized as wireless LAN access point information, held as data, and the wireless LAN client utilizes the wireless LAN access point information when the above connection is performed.



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(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2011-4225
(P2011-4225A)
(43)公開日　平成23年1月6日(2011.1.6)

(51)Int.Cl.		F I			テーマコード（参考）
H04W 48/20	(2009.01)	H04Q	7/00	416	5K067
H04W 84/12	(2009.01)	H04Q	7/00	630	
H04W 48/16	(2009.01)	H04Q	7/00	404	

審査請求 未請求　請求項の数 15　OL　（全 11 頁）

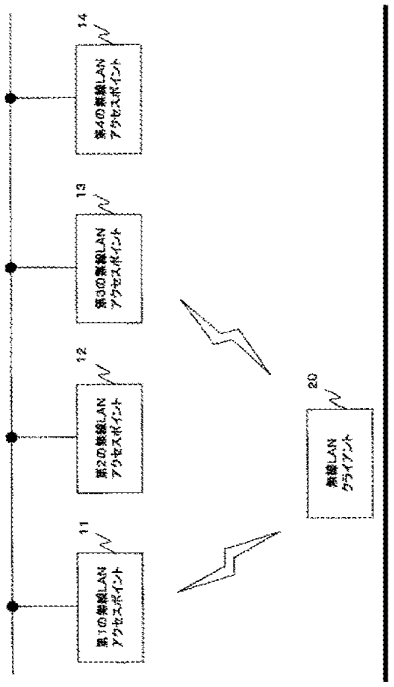
(21)出願番号　特願2009-146288 (P2009-146288)
(22)出願日　平成21年6月19日 (2009.6.19)

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弁理士　関口　正夫
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弁理士　仲野　孝雅
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Ｆターム(参考)　5K067 AA15 EE02 EE10 HH22 HH23 JJ72

(54)【発明の名称】無線ＬＡＮの高速ローミングシステム、高速ローミング方法及び高速ローミングプログラム

(57)【要約】
【課題】無線ＬＡＮネットワークにおいて高速ローミングを実現する。
【解決手段】複数の無線ＬＡＮアクセスポイントと、当該無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントと、を有する無線ＬＡＮシステムにおいて、前記無線ＬＡＮアクセスポイントは同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として認識しデータとして保持し、前記無線ＬＡＮクライアントは前記接続を行う際に前記無線ＬＡＮアクセスポイント情報を利用する。
【選択図】図１



【特許請求の範囲】
【請求項1】
複数の無線ＬＡＮアクセスポイントと、当該無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントと、を有する無線ＬＡＮシステムにおける接続方法において、
前記無線ＬＡＮアクセスポイントは同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として認識しデータとして保持し、前記無線ＬＡＮクライアントは前記接続を行う際に前記無線ＬＡＮアクセスポイント情報を利用することを特徴とする接続方法。
【請求項2】
前記無線ＬＡＮアクセスポイントは、前記無線ＬＡＮクライアントと接続された際に、自らが保持している前記無線ＬＡＮアクセスポイント情報を無線ＬＡＮクライアントに受け渡すことを特徴とする請求項１に記載の接続方法。
【請求項3】
前記無線ＬＡＮクライアントは最初に前記無線ＬＡＮアクセスポイントに接続を試みる際は前記ローカルエリアネットワーク上に存在する前記無線ＬＡＮアクセスポイントの全チャンネルをスキャンし、当該スキャンをした中から最良の条件の無線ＬＡＮアクセスポイントを選択し接続し、前記無線ＬＡＮクライアントが前記無線ＬＡＮアクセスポイントと圏外から再接続を試みる際、或いは、ローミングする際には、前記受け取った無線ＬＡＮアクセスポイント情報を基に、最低限のチャンネルをスキャンし、当該スキャンをしたチャンネルの中から最良の無線ＬＡＮアクセスポイントを選択し接続することを特徴とする請求項１又は２に記載の接続方法。
【請求項4】
前記最低限のチャンネルのスキャンは、前記無線ＬＡＮクライアントが、前記無線ＬＡＮアクセスポイント情報の中から自分の接続可能なＥＳＳＩＤを持つ無線ＬＡＮアクセスポイントのチャンネルを抽出し、当該抽出したチャンネルのみを前記最低限のチャンネルと判断することにより行われることを特徴とする請求項１乃至３の何れか１項に記載の接続方法。
【請求項5】
複数の無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントが行う接続方法であって、
前記無線ＬＡＮアクセスポイントに最初に接続を試みる際は前記ローカルエリアネットワーク上に存在する前記無線ＬＡＮアクセスポイントの全チャンネルをスキャンし、当該スキャンをした中から最良の条件の無線ＬＡＮアクセスポイントを選択し接続し、接続された際に前記無線ＬＡＮアクセスポイントから、当該無線ＬＡＮアクセスポイントと同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として受け取り、前記無線ＬＡＮクライアントが前記無線ＬＡＮアクセスポイントと圏外から再接続を試みる際、或いは、ローミングする際には、前記受け取った無線ＬＡＮアクセスポイント情報を基に、最低限のチャンネルをスキャンし、その中から最良の無線ＬＡＮアクセスポイントを選択し接続することを特徴とする接続方法。
【請求項6】
複数の無線ＬＡＮアクセスポイントと、当該無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントと、を有する無線ＬＡＮ接続システムにおいて、
前記無線ＬＡＮアクセスポイントは同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として認識しデータとして保持し、前記無線ＬＡＮクライアントは前記接続を

行う際に前記無線ＬＡＮアクセスポイント情報を利用することを特徴とする接続システム。

【請求項7】

前記無線ＬＡＮアクセスポイントは、前記無線ＬＡＮクライアントと接続された際に、自らが保持している前記無線ＬＡＮアクセスポイント情報を無線ＬＡＮクライアントに受け渡すことを特徴とする請求項６に記載の接続システム。

【請求項8】

前記無線ＬＡＮクライアントは最初に前記無線ＬＡＮアクセスポイントに接続を試みる際は前記ローカルエリアネットワーク上に存在する前記無線ＬＡＮアクセスポイントの全チャンネルをスキャンし、当該スキャンをした中から最良の条件の無線ＬＡＮアクセスポイントを選択し接続し、前記無線ＬＡＮクライアントが前記無線ＬＡＮアクセスポイントと圏外から再接続を試みる際、或いは、ローミングする際には、前記受け取った無線ＬＡＮアクセスポイント情報を基に、最低限のチャンネルをスキャンし、当該スキャンをしたチャンネルの中から最良の無線ＬＡＮアクセスポイントを選択し接続することを特徴とする請求項６又は７に記載の接続システム。

【請求項9】

前記最低限のチャンネルのスキャンは、前記無線ＬＡＮクライアントが、前記無線ＬＡＮアクセスポイント情報の中から自分の接続可能なＥＳＳＩＤを持つ無線ＬＡＮアクセスポイントのチャンネルを抽出し、当該抽出したチャンネルのみを前記最低限のチャンネルと判断することにより行われることを特徴とする請求項６乃至８の何れか１項に記載の接続システム。

【請求項10】

複数の無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントにおいて、

前記無線ＬＡＮアクセスポイントに最初に接続を試みる際は前記ローカルエリアネットワーク上に存在する前記無線ＬＡＮアクセスポイントの全チャンネルをスキャンし、当該スキャンをした中から最良の条件の無線ＬＡＮアクセスポイントを選択し接続し、接続された際に前記無線ＬＡＮアクセスポイントから、当該無線ＬＡＮアクセスポイントと同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として受け取り、前記無線ＬＡＮクライアントが前記無線ＬＡＮアクセスポイントと圏外から再接続を試みる際、或いは、ローミングする際には、前記受け取った無線ＬＡＮアクセスポイント情報を基に、最低限のチャンネルをスキャンし、その中から最良の無線ＬＡＮアクセスポイントを選択し接続することを特徴とする無線ＬＡＮクライアント。

【請求項11】

複数の無線ＬＡＮアクセスポイントと、当該無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントと、を有するシステムに搭載される無線ＬＡＮ接続プログラムにおいて、

前記無線ＬＡＮアクセスポイントは同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として認識しデータとして保持し、前記無線ＬＡＮクライアントは前記接続を行う際に前記無線ＬＡＮアクセスポイント情報を利用するシステムとしてコンピュータを機能させることを特徴とする接続プログラム。

【請求項12】

前記無線ＬＡＮアクセスポイントは、前記無線ＬＡＮクライアントと接続された際に、自らが保持している前記無線ＬＡＮアクセスポイント情報を無線ＬＡＮクライアントに受け渡すことを特徴とする請求項１１に記載の接続プログラム。

【請求項13】

前記無線ＬＡＮクライアントは最初に前記無線ＬＡＮアクセスポイントに接続を試みる

際は前記ローカルエリアネットワーク上に存在する前記無線ＬＡＮアクセスポイントの全チャンネルをスキャンし、当該スキャンをした中から最良の条件の無線ＬＡＮアクセスポイントを選択し接続し、前記無線ＬＡＮクライアントが前記無線ＬＡＮアクセスポイントと圏外から再接続を試みる際、或いは、ローミングする際には、前記受け取った無線ＬＡＮアクセスポイント情報を基に、最低限のチャンネルをスキャンし、当該スキャンをしたチャンネルの中から最良の無線ＬＡＮアクセスポイントを選択し接続することを特徴とする請求項１１又は１２に記載の接続プログラム。

【請求項14】

前記最低限のチャンネルのスキャンは、前記無線ＬＡＮクライアントが、前記無線ＬＡＮアクセスポイント情報の中から自分の接続可能なＥＳＳＩＤを持つ無線ＬＡＮアクセスポイントのチャンネルを抽出し、当該抽出したチャンネルのみを前記最低限のチャンネルと判断することにより行われることを特徴とする請求項１１乃至１３の何れか１項に記載の接続プログラム。

【請求項15】

複数の無線ＬＡＮアクセスポイントと接続される無線ＬＡＮクライアントに搭載される接続プログラムにおいて、

前記無線ＬＡＮアクセスポイントに最初に接続を試みる際は前記ローカルエリアネットワーク上に存在する前記無線ＬＡＮアクセスポイントの全チャンネルをスキャンし、当該スキャンをした中から最良の条件の無線ＬＡＮアクセスポイントを選択し接続し、接続された際に前記無線ＬＡＮアクセスポイントから、当該無線ＬＡＮアクセスポイントと同一のローカルエリアネットワーク上に存在する無線ＬＡＮアクセスポイントであって同一のＥＳＳＩＤに設定されている無線ＬＡＮアクセスポイントの使用チャンネル及びＢＳＳＩＤを同一ネットワークの無線ＬＡＮアクセスポイント情報として受け取り、前記無線ＬＡＮクライアントが前記無線ＬＡＮアクセスポイントと圏外から再接続を試みる際、或いは、ローミングする際には、前記受け取った無線ＬＡＮアクセスポイント情報を基に、最低限のチャンネルをスキャンし、その中から最良の無線ＬＡＮアクセスポイントを選択し接続する無線ＬＡＮクライアントとしてコンピュータを機能させることを特徴とする接続プログラム。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、無線ＬＡＮに関し、より詳細には無線ＬＡＮのローミング又は再接続に関する。

【背景技術】

【0002】

近年無線ＬＡＮの機器の低価格化等の影響もあり、無線ＬＡＮが一般に広く普及している。また、無線ＬＡＮを構築する際に１つのローカルエリアネットワーク内に多数の無線ＬＡＮアクセスポイントを敷設するといったことも一般的に行われている。

【0003】

このような環境下において無線ＬＡＮクライアントは、１つのローカルエリアネットワーク内の全ての無線ＬＡＮアクセスポイントを対象として、接続可能な無線ＬＡＮアクセスポイントを検索する。

【0004】

そして、無線ＬＡＮクライアントは、検索の結果に基づいて最良と判断した無線ＬＡＮアクセスポイントに対して接続動作をする（例えば特許文献１参照）。

【図面の簡単な説明】

【0016】

【図1】本発明の実施形態における無線ＬＡＮネットワークの基本的構成の例を表す図である。

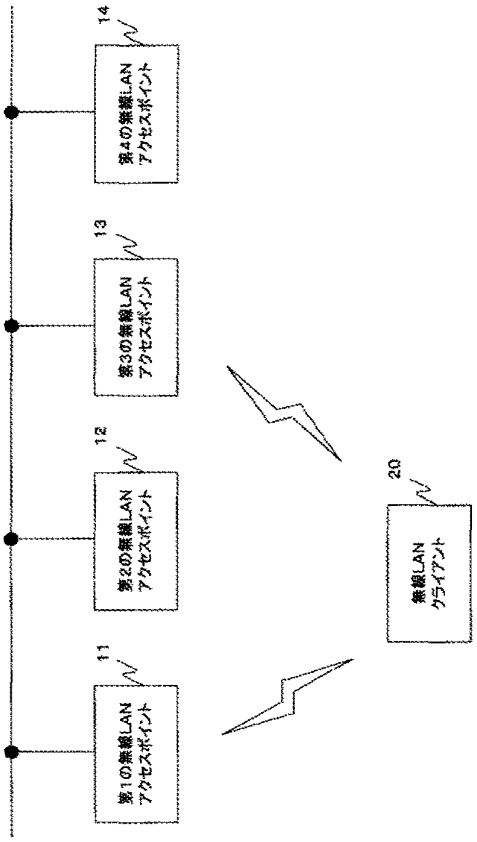
【図2】本発明の実施形態における各機器の設定の例を表す図である。

【図3】本発明の実施形態における無線ＬＡＮアクセスポイント情報の例を表す図である

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。
【図4】本発明の実施形態における無線ＬＡＮクライアントの無線ＬＡＮアクセスポイント接続動作を表すフローチャートである。
【符号の説明】
【0045】
１１　第１の無線ＬＡＮアクセスポイント
１２　第２の無線ＬＡＮアクセスポイント
１３　第３の無線ＬＡＮアクセスポイント
１４　第４の無線ＬＡＮアクセスポイント
２０　無線ＬＡＮクライアント

【図1】


第1の無線LAN
アクセスポイント
11
第2の無線LAN
アクセスポイント
12
第3の無線LAN
アクセスポイント
13
第4の無線LAN
アクセスポイント
14
無線LAN
クライアント
20

【図2】

各機器の設定			
SYSTEM NAME	BSSID	ESSID	CH
AP11	11111−11111	Office1	1
AP12	22222−22222	Office1	4
AP13	33333−33333	Office1	7
AP14	44444−44444	Office2	14
CL20	−	Office1	−

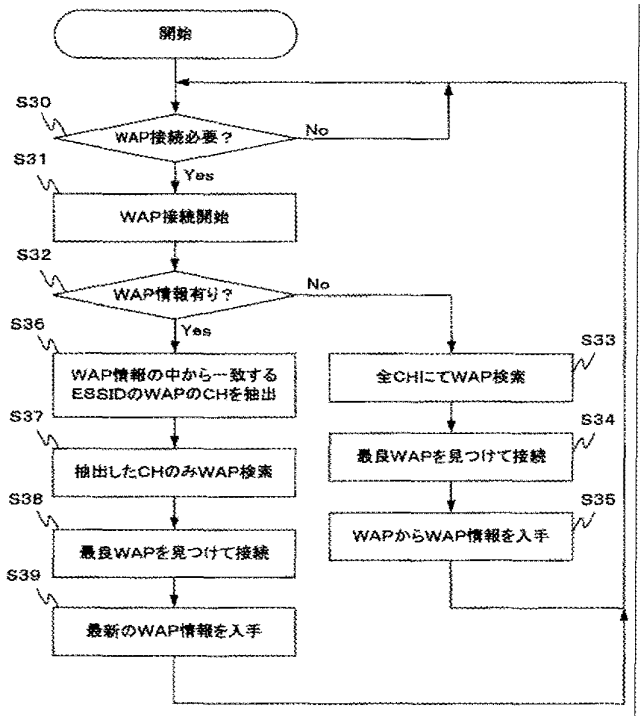
【図3】

無線LANアクセスポイント情報			
SYSTEM NAME	BSSID	ESSID	CH
AP11	11111−11111	Office1	1
AP12	22222−22222	Office1	4
AP13	33333−33333	Office1	7
AP14	44444−44444	Office2	14

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【図4】


開始
S30
WAP接続必要？
No
Yes
S31
WAP接続開始
S32
WAP情報有り？
No
Yes
S36
WAP情報の中から一致する
ESSIDのWAPのCHを抽出
S37
抽出したCHのみWAP検索
S38
最良WAPを見つけて接続
S39
最新のWAP情報を入手
S33
全CHにてWAP検索
S34
最良WAPを見つけて接続
S35
WAPからWAP情報を入手

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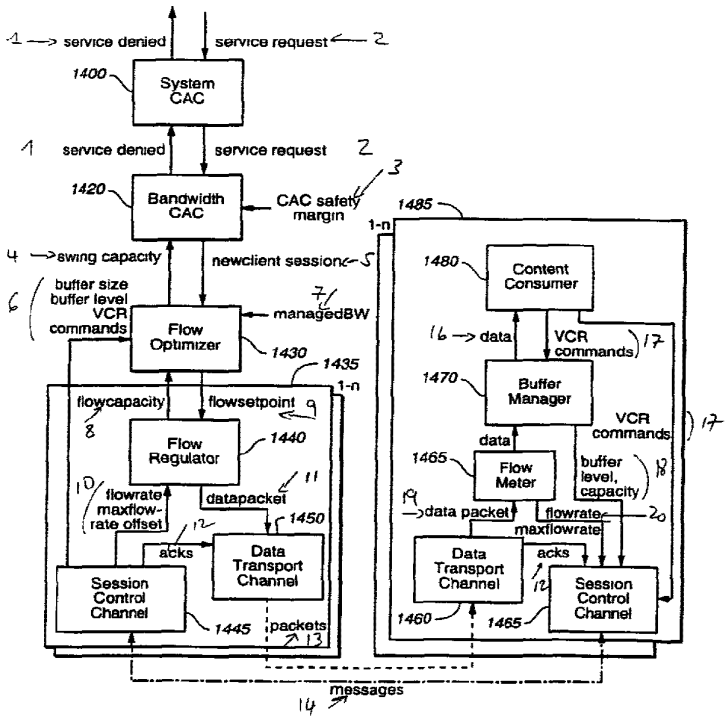
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(54) Title: METHOD FOR CONNECTION ACCEPTANCE CONTROL AND RAPID DETERMINATION OF OPTIMAL MULTI-MEDIA CONTENT DELIVERY OVER NETWORKS



(57) Abstract: A method of bandwidth allocation for delivery of stored digital content from at least one server device to at least one client device by way of a network is disclosed. The method begins by prescribing a control variable which represents a target flow rate from the server device to each client device. Next, time-varying constraints on the flow rate of the content are determined. A cost function of the control variable for each client is determined. The cost function corresponds to a maximized value of the control variable. Finally, bandwidth is prescribed to each client based upon the value of the control variable maximized by the cost function. In this respect, the method achieves optimal allocation of bandwidth between the server and the respective clients.

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METHOD FOR CONNECTION ACCEPTANCE CONTROL AND RAPID DETERMINATION OF OPTIMAL MULTI-MEDIA CONTENT DELIVERY OVER NETWORKS

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to the field of delivery of multimedia content over a variety of networks. More specifically, it pertains to multimedia servers which service many clients simultaneously for the delivery of multimedia content which is used and played back at each client. It addresses methods for determining optimal delivery rates to each client and methods for determining whether new clients may be accepted without diminishing the quality of service to existing clients.

Status of the Prior Art

[0002] In the history of multimedia program delivery, some in the industry have long advocated the use of large client-side buffers and faster-than-real-time content delivery over a network as offering the best of all worlds: a jitter-free viewing experience and a cost-effective utilization of the network resources at hand. Few systems, however, go very far in addressing how to schedule clients or a method for accepting new clients. Real-time systems, often known as streaming systems, can schedule new clients in a very simple manner -- if sufficient bandwidth remains for the added real-time stream, then the client may be accepted. However, such systems do not maximize the number of simultaneous clients. On the other hand, faster than real-time delivery, sometimes known as store-and-forward systems, opens up the possibility for more flexible scheduling procedures to control and optimize the number of simultaneous clients while ensuring a high level of quality of service.

[0003] The methods for such call acceptance and flow modulation that have been proposed in the prior art have been largely ad-hoc and also incomplete. These have been ad-hoc in the sense that there has been no guiding rationale for their selection from among many possible and potentially superior alternatives. The methods have also been incomplete insofar as they did not address the question of whether any given incoming request for service should be accepted or denied. Video-on-demand systems, or more generally, any system in which a multimedia server is designed to serve multiple clients over a network to deliver bounded content, can benefit from the use of such flow modulation techniques and call acceptance procedures.

Optimal Content Flow Modulation

[0004] One time-honored way of designing methods of the class required here is to re-cast the problem to be solved as an optimization problem, in which one seeks to maximize a designated value function moment-by-moment, subject to a set of real-world operational constraints which will typically vary over time. Accordingly, given a set of clients and associated sessions, an optimal delivery procedure continuously establishes content flow rates from the content server to each of its clients so as to maximize aggregate value according to the governing value function.

[0005] This approach holds several advantages: 1) optimization problems are well understood, and are tractable by a large and diverse collection of computational methods; 2) if it exists, a global solution that is obtained is arguably optimal by construction, and thus superior or equal to all other.

[0006] The present invention teaches the method of optimizing two particular value functions:

1) total data delivered (maximize throughput).

2) total delivery charges (maximize charges).

[0007] The first value function does not distinguish one customer from another and will deliver as much data as possible from server to clients irrespective of the characteristics of the latter. The second value function favors the service of high paying customers. It can easily be seen that the first function is a special case of the second one whereby all clients are charged equally.

[0008] As will be seen in this disclosure, optimizing for these functions and identifying the necessary constraints requires a new and unique perspective that is specifically designed for the multimedia environment. Moreover, the disclosed methods are specifically designed to account for and accommodate real-world scenarios of today's networks. Consequently many variations of the method are presented to accommodate various scenarios.

SUMMARY OF THE INVENTION

Call/Connection Acceptance Control (CAC)

[0009] A CAC procedure is responsible for deciding whether a candidate for service can be accommodated without jeopardizing sessions already in progress at the present time or at some time in the future; failing that it must decide whether a service request should be queued for a time or rejected.

Flow Modulation

[0010] Flow modulation methods are those portions of the system which manage the communication and data flow between the server and the clients. Collectively, these methods provide the multimedia data to the client and provide the server with the information about the state of the transmission, playback, user status and network status. These parameters are further used by the present invention in the CAC procedures. In fact, as will be shown, the proposed CAC procedures are tightly integrated with the flow modulation methods.

Adaptation to Variations in Network Capacity

[0011] Operational constraints may change over time. For instance, one might elect to vary the total bandwidth available for multimedia content delivery according to the time of day. Alternatively, exogenous data flows on the network may cause unexpected disturbances by usurping available bandwidth and impeding the delivery of data along established session channels. The content delivery strategy of the present invention includes the ability to adapt to scheduled as well as unexpected disturbances so as to minimize unwanted disruptions of services.

Burst Transmissions Provide the Opportunity to Adapt

[0012] The present invention, due to it's faster-than-realtime transmissions (also know as burst transmissions), which are realized by use of high-bandwidth networks and large client cache or intermediate storage, provides an opportunity to adapt to changing network conditions. In contrast real-time (streaming) systems are essentially designed for worst-case scenarios: each client must be assumed to constantly use the complete real-time playback bandwidth. Such a system is unable to adapt to any derivation from this scenario. For example, take the simple case where the total server bandwidth is 100% utilized by all clients playing back the streaming video. Should any network condition change, such as a temporary

decrease in available bandwidth over the network, then one or more clients' playback is interrupted, and the system can not recover from such a condition until the bandwidth is regained. Even worse if a single client presses pause either that unused bandwidth must remain reserved and no more clients can be accepted, or that paused client is pushed out in order to service the new client. In essence little or no CAC procedure may be implemented.

[0013] In contrast the present invention burst transmits portions of a program and immediately 'gets ahead of itself', thus allowing headroom for a myriad of methods to intelligently handle new clients, client interactivity and possible network fluctuations.

[0014] Methods are taught for optimally determining the flow rate to each client. Methods are also taught for accepting or rejecting new clients; these call-acceptance methods are tightly coupled with said flow rate modulation methods. A series of constraint expressions are presented which govern the methods for determining the flow rates and acceptance of new clients. Linear programming techniques are used to optimally solve these expressions. Various embodiments are presented including scenarios for multiple-rate tariffs, and time-of-day bandwidth variations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These as well as other features of the present invention will become more apparent upon reference to the drawings wherein:

Figure 1 depicts the flow of control and/or data between the different stations of a content delivery session;

Figure 2 illustrates the Entity Data Model;

Figure 3 geometrically illustrates the linear programming problem statement;

Figure 4a geometrically illustrates an expansion of the flow optimization problem statement;

Figure 4b geometrically illustrates the method for rapid determination of flow rates to maximize flow;

Figure 5 illustrates a method for implementing flow modulation to maximize flow;

Figure 6 illustrates a method for implementing flow modulation for maximized charges;

Figure 7 illustrates typical content flow;

Figure 8 illustrates typical server swing capacity;

Figure 9 illustrates a method for call-acceptance and control (CAC);

Figure 10 illustrates planned constraints on maximum flow;

Figure 11 illustrates a method for call-acceptance and control (CAC) with scheduled flow changes;

Figure 12 illustrates stratification of services;

Figure 13 illustrates a method for call-acceptance and control (CAC) for maximal charge;

Figure 14 is a system block diagram for a system implementing the present optimization of client bandwidth;

Figure 15 is a flowchart showing an algebraic method for calculating the optimization of client bandwidth;

Figure 16 is a flowchart showing an algebraic method for calculating the optimization of client costs; and

Figure 17 illustrates optimized viewing of a live event.

DETAILED DESCRIPTION OF THE INVENTION

Data & Control Flows (Figure 1)

[0016] Figure 1 depicts the flow of control and/or data between the different stations of a content delivery session. As shown a client attempts a connection 100 and manifests itself to the Content Selection subsystem by means of a low bandwidth control channel (not shown). Next the client is authenticated and a selection is made 110, typically with the aid of browser software. If the client is not authenticated, it is dismissed from the system 120. If the client has been authenticated and a program selected for viewing then the rate of service is set at this point 130, perhaps according to the selection that was made, or some contractual stipulation. The client is now placed on the service queue of the CAC subsystem 140. A client that is made to wait too long will eventually balk 150. Assuming this does not occur, the CAC subsystem 140 will eventually allocate a channel to the client and open a session 160. Control now devolves upon the Content Flow Modulator (not shown) which starts the flow of content from server to client 170. Subsequent capacity changes, whether predictable or not, may force an abrupt termination of a session in progress 180. Otherwise the session runs to completion 190.

Entity Data Model (Figure 2, listing, table)

[0017] The entities entering into our discussion are depicted in Figure 2. Client 200 maintains certain data associated with this entity; as shown but not labeled, which includes without limitation, status, id and costOfService. The other entities also each include unlabeled but depicted data. The diagram further depicts the relationship between each entity. As shown, client 200 is assigned a session 240. Client 200 employs a channel 210. Client 200 selects contentSelection 230. Session 240 delivers content through channel 210. Server 220 modulates channel 210. Server 200 contains contentSelection 210. Server 220 accepts, defers or denies client 200 and contentSelection 230 is associated with session 240.

[0018] Furthermore Figure 2 depicts the various one-to-many relationships. Each client 200 employs one channel 210. Client 200 may or may not receive one of channel 210, as depicted by the 0/1 notation. Similarly, client 200 may or may not receive a session 240. However, whenever client 200 does receive a session 240, it will always receive a channel 210 since channel 210 and session 240 are allocated as a pair. One or more (N) of client 200 may select one of contentSelection 230. And server 220 contains one or more (N) of contentSelection 230. Each one of contentSelection 230 is associated with 0-N of session 240. Each session 240 delivers content through one of channel 210. And server 220 modulates one or more (N) of channel 210.

[0019] A more detailed list of each entity of Fgure 2, and each one's associated description, data elements and function calls is listed below. This listing closely resembles that of object-oriented programming. As such, 'methods' represent the ability to obtain or modify data, while 'attributes' represent data which is directly associated with that particular entity. The listing also includes information relating to one embodiment wherein software programming specifics are disclosed, such as

a variable type (double, int and so forth) and more. The present invention is not limited to such an embodiment and other implementations are possible without deviating from the scope and intent of the present invention. The listing, however detailed, is merely illustrative of the data and functions which are used in the equations and methods described herein.

[0020] Consequently, data and functions from this listing, associated with the various entities, will be used in forthcoming equations, flowcharts and methods. The reader is directed to this listing as reference when reading such equations and examining such drawings.

--- start of entity data model detailed listing ---

Model: Untitled 1 (public)

Contains:

client, session, channel, server, contentSelection.

Component: client (public Class/Interface)

Comment:

A client entity stands for a client presently requesting or receiving service.

Methods:

public static **lookup (id: in int) : client**

public **GetId () : const int&**

public **SetId (val : in int&)**

public **GetCostOfService () : const double&**

public **SetCostOfService (val : in double&)**

Attributes:

private **status: client < int >**

Specifies whether or not a client has been allocated a channel and session.

private **id: int**

Integer-valued identifier that is unique to the client (primary key). Can be obtained from a monotonically increasing counter.

private **costOfService: double**

Dollar charge per Mbyte. This value is the same for all customers under flow optimization. Under cost/charge optimization may be an integer value reflective of the rank; the higher the rank the higher the charge.

Has:

public **selected: contentSelection**

public **assigned a: session**

public **employs: channel**

Component: session (public Class/Interface)

Comment:

A session entity holds various state information about the service being received by an associated customer.

public **GetCurrentPosition () : const double&**

public **SetCurrentPosition (val : in double&)**

public **GetPayloadToGo () : const double&**

public **SetPayloadToGo (val : in double&)**

public **GetStatus () : const int&**

public **SetStatus (val : in int&)**

public **GetMinimumFlowRate () : const double&**

public **SetMinimumFlowRate (val : in double&)**

public **GetFlowRateRange () : const double&**

public **SetFlowRateRange (val : in double&)**

public **GetMaxFlowRate () : const double&**

public **SetMaxFlowRate (val : in double&)**

Attributes:

private **playTimeToGo: double**

Indicates the minutes remaining in the viewing experience. Initialized to contentSelectiont.playTime (see below).

private **currentPosition: double**

Pointer into media content from which content is being delivered.

private **payloadToGo: double**

The amount of media content (in Mbytes) as yet undelivered by the server. Does not include any content presently stored in the client-side buffer.

private **status: int**

Indicates whether sesion is active or paused.

private **minimumFlowRate: double**

This is the minimum flow from server to client required to ensure uninterrupted service over the remaining playTime. Has a value of zero if playloadToGo is zero. Given by (payloadToGo * 8)/(playTimeToGo *60)

private **flowRateRange: double**

Specifies the effective range over which the channel content flow serving a session is constained without consideration for interactions with other flows. Equals maxFlowRate - minimumFlowRate

private **maxFlowRate: double**

Effective maximum bound on flow as expressed in formula (8) which must be re-evaluated periodically.

Has:

public **delivers content through: channel**

Component: channel (public Class/Interface)

Comment:

A channel represents the network resources from server to client associated with an ongoing session, encompassing the client-side buffer if any, and its level.

public **GetBufferLevel () : const double&**

public **SetBufferLevel (val : in double&)**

public **GetFlowRate () : const double&**

public **SetFlowRate (val : in double&)**

public **GetMaxFlowRate () : const double&**

public **SetMaxFlowRate (val : in double&)**

Attributes:

private **bufferSize: double**

Capacity of the client-side buffer (or equivalent)

private **bufferLevel: double**

Current buffer level in MBytes of stored content.

private **flowRate: double**

Flow rate through channel specified by the relevant optimizing flow modulator.

private **maxFlowRate: double**

This value represents the maximum possible flow rate from the server to an individual client over its "channel". This value reflects restrictions on flow that pertain to an individual client. It may be determined by factors such as the bandwidth of client's link to the network, or a limit imposed administratively to ensure balanced network utilization.

Component: server (public Class/Interface)

Comment:

Entity representing the media server and its CAC and flow modulation activities.

public **GetFlowRate () : const double&**

public **SetFlowRate (val : in double&)**

public **GetMaxMinFlowRate[] () : const double&**

public **SetMaxMinFlowRate[] (val : in double&)**

Attributes:

private **maxFlowRate: double**

Maximum possible content flow that is allocated to the server by the network.

private **flowRate: double**

Aggregate content flow rate, summed over all sessions and their associated channels.

private **cac_flowSafetyMargin: double**

Tunable safety margin used by the CAC algorithm to protect sessions-in-progress from being affected by changes in available network bandwidth.

private **maxMinFlowRate[]: double**

Applies when N rate tariffs exist. This array holds the maximum floor level for each category of service. The value for the costliest category N is stored in maxMinFlowRate[N-1], and for the least costliest in maxMinFlowRate[0]. It is the relative magnitude of these ascending values that matters, not their absolute value. Thus the actual maximum floor flow rate for category k is given by server.maxFlowRate * (server.maxMinFlowRate[k-1] /server.maxMinFlowRate[N-1]). Similarly, the maximum floor flow rate for category N is server.maxFlowRate.

Has:

public **contains: contentSelection**

public **modulates: channel**

Component: contentSelection (public Class/Interface)

Comment:

Entity represents a video/sound clip or other bounded unit of content. A continuous data feed does not qualify.

Attributes:

private **averagePlayRate: double**

The average rate at which media content is consumed by the client, as computed by dividing the (payload * 8) by the (playTime * 60)

private **playTime: double**

Duration of play of the media content in minutes.

private **payLoad: double**

total size of the content in Mbytes.

Has:

public **is associated with: session**

--- end of entity data model detailed listing ---

The following table summarizes the highlights of the previous detailed description of each entity in Figure 2.

TABLE 1

Entity	**Description**
client 200	Each client is denoted by an associated unique integer index $_{Id}$. The set of active clients is denoted by $\mathbf{S}_{ActiveClients}$. The set of deferred clients is denoted by $\mathbf{S}_{QdClients}$. Incoming clients are expected to select the content they wish to view prior to being queued for dispatch by the CAC sub-system, which requires knowledge of the client's bandwidth requirements, duration of play, and cost of service, all of which may vary according to the selection.

server 220	Servers sit astride a network and can deliver media content through the network to their clients up to a designated maximum flow rate. The server is responsible for accepting or rejecting clients, launching sessions and associated channels for the former, and modulating content flows over all channels in an optimal manner.
channel 210	A channel represents the data path between the server and the client. The channel buffer is typically located near or within the clients viewing station. The flow of content through the channel is set by the flow modulator sub-system.
contentSelection 230	A server will typically act as a repository for media content, which it can deliver to clients upon demand. For our purposes, media content is characterized by its payload and the play duration, which together imply the ***averagePlayRate*** = (payload*8)/(playTime *60). The averagePlayRate is none other than the streaming rate imposed by real-time just-in-time streaming algorithms.
session 240	Every session represents an instance of media content delivery to an associated client over a designated channel. The ***playTimeToGo*** indicates the time remaining before the content is fully played out to the client. The ***payloadToGo*** is the amount of content data as yet undelivered to the channel. A session terminates when this value reaches zero, at which time ***playTimeToGo*** may still be large, according to the capacity, the level of the channel buffer, and the media play rate.

Constraints On Content Flow

[0021] Before referring to more Figures, it is imperative to establish some formulas and problem statements which are used in the methods which follow.

[0022] The flow of content between entities is subject to the following constraints at all times. Buffer levels are always expressed in Mbytes and data rates in Mbits/sec.

(1)$\Sigma_{\text{i } \epsilon \text{ SactiveClients}}$ (client.lookup(i).channel.flowRate) < = server.maxFlowRate
The sum of all channel flows cannot exceed the imposed maximum throughput capacity of the server.

(2)client.lookup(i).channel.flowRate < = client.lookup(i).channel.maxFlowRate for all $\mathbf{i} \in \Sigma_{\text{activeClients}}$

The data path from server to client is subject to its own constriction.

(3)client.lookup(i).channel.flowRate < =(client.lookup(i).channel.bufferSize - client.lookup(i).channel.bufferLevel)* 8/60 + client.lookup(i).session.mediaContent.averagePlayRate, for all $\mathbf{i} \in \Sigma_{\text{activeClients,}}$

The channel buffer is never allowed to overflow.

(4)client.lookup(i).channel.flowRate < = client.lookup(i).session.payloadToGo * 8/60

for all $\mathbf{i} \in \Sigma_{activeClients,}$

Content that does not exist cannot be delivered. (Constraint 1 will ordinarily prevail except at the very end of a session.)

[0023] The constraints listed above are straightforward applications of common sense in relation to the flow of data through constricted channels, out of finite data sources, and into and out of bounded buffers. By contrast, the following constraint, which imposes a minimum channel flow rate instead of a maximum, is less obvious. The minimum value, termed the ***minFlowRate*** is set to the flow rate which, if sustained over the balance of the play time to go (***playTimeToGo***), ensures that all required content will be available when needed -- and no sooner -- until all content is played out. This floor value can be calculated for $\mathbf{i} \in \Sigma_{activeClients}$ by the formula:

(5)client.lookup(i).session minFlowRate =(client.lookup(i).session.payloadToGo * 8)/ (client.lookup(i).session.playTimeToGo * 60)

Accordingly, the flow rate on the right-hand-side is termed the just-in-time (JIT) flow rate (f^{JIT}).

Thus:

(6)client.lookup(i).channel.flowRate >= client.lookup(i).session.minFlowRate
for all $\mathbf{i} \in \Sigma_{activeClients}$

[0024] The variable constraint bounds (i.e. the values to the right of the inequality symbol) of equations 1 – 4 and 6 are re-evaluated on a periodic basis (e.g. once per second) prior to the execution of the CAC procedure and optimizer. In

particular, the ***minFlowRate*** value starts out at the beginning of a session equal to the streaming rate. By construction the ***minFlowRate*** rate never exceeds this initial value so long as constraint 6 is honored. In fact, constraint 5 implies that the ***minflowRate*** value must be a diminishing function of time that may hold its value for a time but never rises. As seen from equation 6, the actual data rate of the channel, ***flowRate***, is always greater than or equal to the ***minFlowRate***. By design, and virtue of the fact the present invention uses faster-than-realtime transmissions, the system quickly gets ahead of itself and ensures that after initial conditions, the ***minFlowRate*** is always equal to or less than the real-time rate and that it continues to decrease. As we shall see, the CAC procedure exploits this monotonic characteristic of the minimum flow rate over time.

[0025] Constraints 2, 3 and 4 are of like kind, each specifying an upper bound on individual channel flows. Whereas the bound for constraint 2 is typically a constant, the bounds on 3 and 4 will vary over time. Nevertheless, only one of the three bounds is effective at any given time, namely the one with the smallest bound value, given by:

(7) client.lookup(i).session.maxFlowRate = minimum of

1) client.lookup(i).channel.maxFlowRate,

2) (client.lookup(i).channel.bufferSize - client.lookup(i).channel.bufferLevel)*

8/60 + client.lookup(i).session.mediaContent.averagePlayRate,

3) client.lookup(i).session.payloadToGo * 8/60

Consequently, formulas 2, 3, and 4 can be consolidated into a single constraint, the bound for which is computed at every scan to be the smallest bound of associated constraints 2, 3 and 4.

(8) client.lookup(i).channel.flowRate < = client.lookup(i).session.maxFlowRate,

whereby for all $i \in \Sigma_{activeClients}$, maxflowRate is given by equation (7).

At any one time, individual channel flows are constrained over a range, as follows:

(9) client.lookup(i).session.flowRateRange =
client.lookup(i).session.maxFlowRate - client.lookup(i).session.minimumFlowRate

Value Functions

[0026] The value functions introduced previously can be expressed mathematically as linear functions of channel flows, as follows:

Optimizing Throughput (Maximal Flow)

(10) value $= \Sigma_{i \in SactiveClients}$ client.lookup(i).channel.flowRate)

Optimizing Charges (Maximal Charges)

(11) value $= \Sigma_{i \in SactiveClients}$ (client.lookup(i).channel.flowRate * client.lookup(i).costOfService)

Optimization Problem Statement (Figure 3)

[0027] The optimization problem, which in one embodiment is strictly throughput and in another case is charge, can be stated simply as follows:

Find values for

client.lookup(i).channel.flowRate for all $i \in \Sigma_{activeClients}$

constrained by inequalities 1 through 5, such that the value obtained by evaluating expression 10 or 11 assumes a maximum.

[0028] Both of these problem formulations are examples of Linear Programming for which a number of well-known and generally effective computational solutions exist. In linear programming one seeks to optimize a linear cost function of variable **x**

(12) $c*x = c_1*x_1 + \ldots + c_n*x_n$

subject to a set of linear inequality constraints

(13) $A*x <= b$

where $x^T = (x_1,\ldots,x_n)$, $c = (c_1,\ldots,c_n)$ are the state variable & cost vectors, A is an n-by-m matrix, $b^T = (b_i,\ldots b_m)$ is the constraint vector, and the operator '*' stands for matrix or scalar multiplication.

[0029] Figure 3 is introduced as illustrative of the problem statement and the general methods of the prior art, and is not incorporated as an element of the invention.

[0030] The linear programming problem as well as its solution can best be understood with the aid of geometry. Figure 3, depicting a 2-dimensional Cartesian problem space, inequality constraints (13) define a convex hull H 310 over which a search for an optimum value of $\mathbf{x} = (x_1,x_2)$ is permitted to range. The cost vector **c** 350 defines an infinite family of equal cost lines (hyper-planes) which lie orthogonal to **c**. Three examples of such lines are shown in L_1 360, L_2 365, and L_3 370., each of progressively higher value. The supreme value of the cost function is obtained by sliding along **c** 350 till one can go no further, in this instance toward vertex V_4 340 of hull H 310. Many well-known methods (e.g. the Simplex Method) work roughly in this fashion, exploiting the fact that at least one optimum point must be at a vertex. In particular, the Simplex method algorithm begins by finding a vertex (e.g. V_2 320), and then moves along a sequence of vertices (e.g. V_3 330, V_4 340) improving itself each time until no further improvement is possible & the summit is reached.

[0031] Let us suppose instead that V_3 330 were placed along L_3 370 along with V_4 340. According to prior art methods, V_3 330 and V_4 340 are the two possible solutions, but the equally valuable points in between them are not. As we shall soon see, the problem of throughput optimization (6) falls in this category.

[0032] While vertex V_1 300 does not factor into this description, it is depicted in Figure 3 for completeness.

Flow Modulation

Methods for Maximal Flow

The following sections detail two embodiments to optimize total data flow.

Overview (Figure 4-a)

[0033] Figure 4-a depicts a scenario involving two flows. The convex hull is in this instance bounded by line segments L1, L2, L3, L4 and L5. L6 is a boundary used in a different embodiment, however the present embodiment uses L5 and not L6. Flow f_2 can range over the interval separating line segments L1 from L3, namely f_2^{MIN} and f_2^{MAX}; the range is depicted as f_2^{RANGE}. Flow f_1 can range over the interval between lines L2 and L4, namely f_1^{MIN} and f_1^{MAX}, and depicted as f_1^{RANGE}. The sum of flows f_1 and f_2 is constrained to lie inside of line segment L5 which, by construction, is always orthogonal to the cost vector $\mathbf{C_f}$. Cost vector $\mathbf{C_c}$ is also illustrated but used in a distinct embodiment. In the present embodiment only $\mathbf{C_f}$ is used. In the illustrated example of the present embodiment, the constraint on total flow is set to 5, and is therefore low enough to cause L5 to intersect L3 and L4. This would not have been true had the value chosen had been 10 instead of 5. With L5 safely out of contention, the convex hull would instead be a simple rectangle bounded by L1 through L4, thereby permitting both flows to assume their respective maxima without interference. In practice operational constraints exist intrinsically or are imposed from the outside so as to ensure cost effective sharing of potentially costly network resources.

[0034] Supposing Figure 4 to be correct, the well-known methods would select vertex $V_{3\text{-}5}$, which lies at the intersection of L3 and L5, or $V_{4\text{-}5}$, which lies at the intersection of L4 and L5. These solutions, though optimal, are undesirable for the present invention as they fail to spread available bandwidth over all channels as fairly as would a centrally located interior point of L5. For this reason, two alternative optimization methods are taught, which are adapted to the particular needs of this problem and ensure a fairer allocation of constrained bandwidth among all channels.

Iterative Procedure (Figure 5)

[0035] In order to optimize use of all available bandwidth, the following general method is used, with the details illustrated in Figure 5. This method is a solution for the problem illustrated in Figure 4-a, which geometrically illustrates the optimization problem in the limited case of two flows, f1 and f2. The following description expands the problem to an arbitrary number of clients (and therefore flows) and presents a method for solving this optimization problem.

[0036] Referring to Figure 5, in step 500, values are calculated for the ***session maxFlowRate*** and ***session.minFlowRate*** for each client as per the minimum and maximum constraint bound expressions in equations 6 and 8, respectively. This step correlates to the determination of $f_1$min, $f_1$max, $f_2$min and $f_2$max from Figure 4-a.

[0037] The difference between these two yields the ***session.flowRateRange*** of each client. Thus:

session.flowRateRange = session maxFlowRate- session.minimumFlowRate

[0038] In step 505, the active clients are sorted in an ascending fashion based upon their **session.*flowRateRange***. As will be shown this critical step facilitates allocation of the remaining server bandwidth as evenly as possible among all active channels, thus maximizing the number of channels that benefit by use of the total server bandwidth. An arbitrary assignment of remaining bandwidth is likely to saturate the server before all channels have been assigned extra bandwidth, thereby favoring certain channels on an ad-hoc basis. This step correlates to keeping the solution in bounds of the space delinated by line segments L1-L5 of Figure 4-a.

[0039] In step 510, each client's channel flow rate is set to the ***session mimimumFlowRate***.

[0040] By doing so, it is ensured that the minimum flow constraint is met for each session and that the minimum flow rate is a non-increasing function of time, which is critical to the proper functioning of the CAC procedure. This portion of the process also ensures that the solution, starting from the vertex in Figure 4-a as defined by the intersection of L1 and L2, moves generally in the direction of vector c_f . All clients are also marked as unprocessed.

[0041] In the next step, 520, ***server.flowRate*** is set to the sum of each active client's **session.flowRate.**

[0042] Next, the following is iterated over all clients in sorted sequence (during any given iteration the selected client is given by its ***id***) by performing steps 530 through 570. In step 530 evaluating the following expressions test for possible server saturation:

delta = (server.maxFlowRate - server.flowRate) / (qty of un-processed clients)
range = client.lookup(***id***).session.maxFlowRate -
client.lookup(***id***).session.flowRate

[0043] If ***range*** is greater then ***delta***, this implies that the server can be saturated in this iteration by allocating ***delta*** to all unprocessed clients (step 540).

[0044] On the other hand, the 'no' path for step 530 implies that the server is not saturated and that the present client (given by ***id***) will saturate first. Accordingly, in 550 the ***delta*** variable is set as follows:

delta = range

[0045] To again correlate this process back to the geometry of Figure 4-a, server saturation is indicated when the solution which is being sought in the direction of vector c_f goes beyond line segment L5.

[0046] Next, the flow rate is incremented for all unprocessed clients by ***delta***, causing client ***id*** to saturate.

[0047] In step 560 the server flow rate is adjusted accordingly:

server.flowRate = server.flowRate + delta * (qty of unprocessed clients)

In step 570 the client given by ***id***, now saturated, is marked as processed.

Algebraic Procedure (Figures 4-b and 15) By Interpolation

[0048] Referring to Figure 4-b, the iterative method described in the previous section begins its search for a maximum from vertex V_{min} along the direction shown by line C_1. In contrast, the present method follows the diagonal line segment L_{diag} of the rectangle bounded by lines L1 through L4, starting at vertex V_{min} and ending at point $V_{3\text{-}4}$.

[0049] Provided it exists, the intersection between L_{diag} and L5, indicated by V_f, is optimal on the same basis as any other point lying along the intersection of L5 with the rectangle bounded by L1 through L4, as previously discussed.

[0050] Whenever L5 does not intersect this rectangle, the optimal solution is given by vertex V3-4 at which f1 and f2 both assume their respective maxima.

[0051] In the first instance, the coordinates for point V_f can be obtained by elementary vector geometry and algebraic manipulation, as follows:

First, we define a number of abbreviations,

f_k^{min} represents client.lookup(k).session.minimum flow rate

f_k^{range} represents client.lookup(k).session.flow rate range

f_{svf}^{max} represents server.maxflowrate

We seek scale factor x such that the vector sum of $(f_1^{min} \ldots f_n^{min}) + x\ (f_1^{range} \ldots f_n^{range})$ intersects an equi-cost hyperplace for capacity c. The point of intersection is obtained by solving equation:

$$(f_1^{min} + \ldots + f_n^{min}) + x(f_1^{range} + \ldots + f_n^{range}) = c$$

Solving for x, we obtain:

$$x = [f_{svr}^{max} - (f_1^{min} + \ldots + f_n^{min})]/(f_1^{range} + \ldots + f_n^{range})$$

where $f_{svr}^{max} - (f_1^{min} + \ldots + f_n^{min})$ represents the unused bandwidth beyond the minimum allocation for each session. For any given session, the optimal flow rate is given by:

$$f_i = f_i^{min} + x\, f_i^{range}, \text{ if } x < 1,$$

or

$$f_i = f_i^{min} + f_i^{range}, \text{ if } x > 1$$

[0052] This solution by interpolation is interesting by virtue of the great efficiency of the calculation, and the fact that no session saturates ($x >= 1$) unless all sessions saturate. In contrast, the previous method entails considerably more computational effort, and tends to saturate sessions with the lowest reserve capacity.

[0053] A block diagram for this algorithm is depicted in Figure 15. Block 1500 establishes the maxim and minima for each flow. For each flow the minimum is subtracted from the maximum to obtain the range. Available Bandwidth is calculated in block 1520, as the difference between the aggregate flow capacity and the sum of flow minima. Factor x is calculated next in block 1540, and tested against 1 in block 1650. Flow rates for each session are computed in block 1560 if x is less than 1, or 1570 in the contrary case.

A Method for Maximal Charge

[0054] The following sections detail one embodiment to optimize the total monetary charges within the system. The second method is algebraic in nature, and thus very efficient.

Overview (Figure 4-a)

[0055] Referring back to Figure 4-a, cost vector C_c lies orthogonal to line L6, which intersects the convex hull at the vertex formed by the intersection of lines L4 and L5, namely $V_{4\text{-}5}$. This cost vector, and the optimal point that it implies, favors flow f1 over flow f2 . In this example, as the cost of service for f1 equals 2, thus exceeding the cost of service of 1 set for f2 . As the number of flows grow to exceed the number of distinct categories of service (and associated costs of service) the unique optimal solution, depicted in Figure 4 for the case where every flow has a distinct cost of service, no longer applies. Once again a plurality of flows within a service category vie for bandwidth which a method should endeavor to distribute evenly. This method is derived from the previous one, and optimizes one cost category after another, starting with the most costly and ending with the least costly, or when all available capacity is allocated.

An Iterative Search Procedure (Figure 6)

[0056] Let the service categories be denoted by k= 1...N, where k also denotes the cost of service.

[0057] Let $C_1..C_N$ be the partition of $S_{activeClients}$ that places all clients with cost of service k in set C_k. Partition sets C_k can be ordered to form sequence SeqC = $C_N...C_1$.

[0058] Figure 6 depicts the method for implementing the method to maximize the cost of service (service charge).

[0059] This method is nearly identical to the iterative procedure used to maximize flow. The principle difference stems from the partitioning of clients according to their category (cost) of service: clients charged most are allocated bandwidth preferentially. This is accomplished by adding another level of iteration around the method of Figure 5. The inner iteration (steps 650 through 680) functions exactly as before, with the difference that its actions are limited to the clients belonging to the given service category ***k*** (i.e. $C_{k)}$. This difference also holds true of step 640 which sorts category ***k*** clients according to their flow ranges prior to entry in the bandwidth-allocating inner loop. The outer loop proceeds down a sorted sequence of service categories SeqC (generated in step 630), starting with the category generating the greatest revenue to the service provider. Given a fairly static set of service categories, this sort need be performed only when the categories undergo change. Steps 670, 675 and 680 are identical to their counterparts in the method of Figure 5 (i.e. 570, 575 and 580).

[0060] The net effect of this method is preferential allocation of bandwidth according to category of service, and equitable treatment of clients within the same category of service.

An Iterative Algebraic Procedure (Figure 16)

[0061] The algebraic method used to maximize bandwidth (Figures 4b and 15) can be viewed as a special case of cost optimization in which all costs are equal. By construction, all sessions belonging to a given category, starting with the most expensive category, and ending with the least, and updating available bandwidth after each step in sequence, we obtain an iterative algebraic method that scales much better than the preceding method.

[0062] A block diagram for this algorithm is depicted in Figure 16. Block 1600 establishes the maxima and minima for each flow. For each flow, the minimum is subtracted from the maximum to obtain the range. In block 1610, every session flow is assigned the minimum allowed value, which value will apply by default should the iterative procedure run out of bandwidth before all categories can be considered. Block 1620 computes the initial value for available bandwidth, as the difference between the aggregate flow capacity and the sum of flow minima.

[0063] Flow values are obtained for each cost category in order of decreasing cost within blocks 1640 through 1675. Factor x is calculated next in block 1540, and tested against 1 in block 1650. Flow rates for each sessions of the category under consideration are computed in block 1660 if x is less than 1, or 1670 in the contrary case. In the former case there is no more bandwidth to allocated to the sessions in the category under consideration.

Call Acceptance Control (CAC)

CAC for Maximal Flow Overview (Figures 7-8)

[0064] The CAC procedure applicable to this flow optimization relies on the essential step of accepting a new client if and only if the added load induced thereby does not compromise service to existing clients or the new one. This critical step could not be accomplished without the close integration with previously- described flow-modulation methods of Figures 5, 6, 15 and 16.

[0065] According to the previous discussion, the minimum flow rate is the minimum sustained flow rate that guarantees that the associated viewer will not be subject to interruptions in service due to a shortfall of content from the media server. It follows that whenever data is being delivered at a rate in excess of the minimum flow rate, a downward adjustment toward the minimum level could be accommodated as needed to surrender bandwidth to any newcomer.

[0066] Figure 7 depicts content flow over a channel for the course of a typical session, and also how data is delivered under real-time streaming D. The amount of content delivered is the same in either case, but the manner of delivery differs considerably. A session is launched at time 0 as the network is lightly loaded, and the optimizer sets an accordingly high flow rate. Another client emerges at the end of interval 700, causing a downward adjustment to the flow rate over interval B, as available bandwidth is shared between two sessions. During both of these intervals the minimum flow rate 720 drops quickly, as data accumulates in the client's media buffers. At the end of interval B, a massive influx of clients necessitates that flow be dropped to the minimum flow rate, which now lies substantially below the streaming rate D and is held until all data is delivered at the end of interval C. Note that the minimum flow rate, shown as element 720, diminishes monotonically over time.

[0067] The ***server swing capacity*** is defined as the difference between the maximum capacity of the server and the total minimum flow rates for all active clients. Therefore:

(14) swingCapacity =

server.maxFlowRate - $\Sigma_{\text{i } \epsilon \text{ SactiveClients}}$ (client.lookup(i).session.minFlowRate)

[0068] Given the monotonic decreasing nature of session minimum flow rates, server swing capacity can readily be seen to be a *monotonic increasing* function of time over the intervals separating client admissions, at which point it undergoes a drop as a new load is taken on. This all-important characteristic implies the following:

Any client admitted for service based on the present value of swing capacity is guaranteed to have sufficient bandwidth at its disposal over the entire future course of the session.

[0069] Figure 8 depicts the server swing capacity 800 over the course of the sessions illustrated in Figure 7. Swing capacity rises quickly over intervals A & B as data is delivered at high flow rates over the network. It holds steady over interval C when all channels flow at their minimum rate then jumps at the end of C before resuming its monotonic rise once again.

Procedure (Figure 9)

[0070] In this procedure, which executes on a periodic basis, queued clients awaiting bandwidth are scanned in FIFO order. For each one, the required bandwidth is computed as per the client's prior content selection. If the available swing capacity (reduced by a safety margin) exceeds the amount required, then the client is activated and swing capacity is adjusted accordingly. Otherwise, two possible cases are considered: 1) under the *FirstFit* embodiment, the procedure

continues scanning clients to the end of the queue, activating clients whose requirements can be met; 2) under the *FIFO* embodiment, the procedure ends with the first candidate client whose requirements cannot be met.

[0071] In step 900, available server swing capacity is evaluated according to the formula

swingCapacity =

server.maxFlowRate - $\Sigma_{\text{i} \in \text{SactiveClients}}$ (client.get(i).session.minimumFlowRate)

The bandwidth requirement for client ***id*** in Step 920 is obtained as follows:

required_bandwidth = client.lookup(***id***).contentSelection.averagePlayRate

The predicate evaluated in Step 940 is given by the expression:

(required_bandwidth < = swingCapacity - server.cac_flowSafetyMargin)

[0072] In step 950, client activation entails allocation of a session and a channel, and insertion in the set of active clients eligible for bandwidth allocation by the optimal flow modulator.

[0073] In step 960 the swing capacity is diminished by the amount reserved for the activated client:

swingCapacity = swingCapacity - required_bandwidth;

Responding to Variations in Network Capacity (Maximal Flow)

[0074] In the CAC procedure for maximal flow, a safety margin was introduced, namely *server.cac_flowSafetyMargin*, to provide the means for ensuring that the server's swing capacity will never fall below a minimal threshold value.

[0075] According to this procedure, the following inequality always holds true:
(15) swingCapacity > = server.cac_flowSafetyMargin

[0076] In the previous discussion, a server's swing capacity provided the basis for determining whether or not a prospective client should be allocated bandwidth.

[0077] By holding *server.cac_flowSafetyMargin* in reserve, the CAC algorithm forces delivery of content at faster than real-time rates among accepted clients, even under the heaviest load. The net effect is to apply upward pressure on client side buffer levels, thus promoting continuous accumulation of content and a jitter-free viewing experience once a session is under way.

[0078] In another embodiment, server swing capacity can also be interpreted as specifying the *maximum* amount by which the *server.maxFlowRate* constraint can be dropped without affecting service, should such an adjustment prove necessary due, for instance, to an influx of exogenous network traffic that diminishes the amount available for multi-media services. Parameter *server.cac_flowSafetyMargin* can thus be set so as to *guarantee a minimum capacity to tighten the constraint on maximum server flow* in response to unexpected load changes that affect the server's ability to service its existing clients as well as new ones.

Anticipating Scheduled Variations in Network Capacity (Maximal Flow)

Overview (Figure 10)

[0079] Figure 10 depicts how the constraint on maximum flow might be allowed to vary according to the time of day, day of the week, and so forth, in expectation of time-varying traffic flow levels extrapolated from past experience, traffic flow models, etc. Maximum flow rate 1000 can be seen to vary based upon the time of

day. In practice, defining the right-hand-side of inequality constraint 1 as a time-dependent expression can impose such time-varying capacities. According to the previous description, the optimizer, which executes on a periodic basis, will automatically seek new flow levels for every active session as the constraint varies. There is, however, no guarantee that an acceptable operating point will be found for all sessions (i.e. one that respects the minimal and maximum constraints on session channel flow). One such example is the case where the server is loaded to the limit and total capacity is curtailed in excess of the aforementioned safety margin. Should such a situation arise the only recourse may well be the termination of a number of established sessions (i.e. load shedding).

[0080] The goal is to eliminate service disruptions of this sort by allowing the CAC procedure to look ahead into the future, and accept new clients only if these can be accommodated without any compromise in service in the midst of *previously anticipated changes* in available network capacity. The following CAC procedure generalizes the previous one: before accepting a client, the test on swing capacity is repeated over a sequence of time segments that cover the proposed viewing period.

Definitions -

Let:

(16) t_end(i) = client.lookup(i).session.playTimeToGo + t_now

Let server.maxFlowRate(t) be server flow capacity as a function of time, as exemplified in Figure 10.

[0081] Let $Seq_T(t\_now)$ = advancing sequence of future times, lead by t_now, when server.maxFlowRate(t) undergoes a step change. For instance, at 9:15 in Figure 10 this sequence reads as follows: 9:15, 9:30, 11:30, 13:30, 6:30, 7:30.

[0082] The server swing capacity at a future time t is computed according to the capacity and worst-case client flows at time t.

(17) swingCapacity(t) = server.maxFlowRate(t) -

$$\Sigma_{t\_end(i) > t} \text{(client.lookup(i).session.minFlowRate)}$$

[0083] It is noteworthy that the worst-case client flows at time t are expressed in terms of the present minimum flow rates, which cannot increase over time, but might hold steady. Finally, a predicate is defined that tests whether a prospective customer will cause swing capacity to be exceeded at some time t, as follows:

```
(18)  boolean client_fits(i ,t) {

        if(client.lookup(i).contentSelection.averagePlayRate < =

            swingCapacity(t) - server.cac_flowSafetyMargin)

          return true;

      else return false;
        }
```

Procedure (Figure 11)

[0084] This procedure is an adaptation of the first, which has been extended to consider swing capacity at times in the future when capacity undergoes scheduled changes. Before accepting a client, its minimal bandwidth requirement (which by construction of the flow modulator will never increase over time) is checked against *projected swing capacity* at points in time when total available capacity undergoes scheduled step changes, provided these times fall within the proposed content viewing period. A candidate is activated only if all tests succeed.

[0085] Step 1100 builds a sequence of time values (SeqT) at which step capacity changes are scheduled to occur. The first element of this sequence is t_now, representing the present.

[0086] Beyond step 1100 the queue of waiting clients is scanned in FIFO order, yielding a candidate designated by ***id*** at each iteration.

[0087] The bandwidth requirement for client ***id*** in Step 1120 is obtained as follows:

required_bandwidth = client.lookup(***id***).contentSelection.averagePlayRate

[0088] The worst-case end time for content flow to ***id*** is obtained according to the content selected, as follows:

t_end = t_now + client.lookup(***id***).selected.playTime

[0089] Steps 1130 through 1150 are executed within an iteration for each time point t in SeqT falling between t_now and t_end. This iteration is ended in step 1130 if t exceeds the time window of interest, or in step 1150 if the supply of scheduled capacity changes is exhausted.

[0090] For each time value, step 1140 compares required bandwidth to projected swing capacity.

Projected swing capacity at time t is:

$$\text{swingCapacity}(t) = \text{server.maxFlowRate}(t) - \sum_{t\_end(i) > t} (\text{client.lookup}(i).\text{session.minimumFlowRate})$$

[0091] Note that only active clients whose t_end times occur after t are considered in the sum of minimum flow rates.

[0092] The predicate expression used in step 1140 at time t is thus:

(required_bandwidth < = swingCapacity(t) - server.cac_flowSafetyMargin)

Step 1160 performs the same actions as step 660 in the previous CAC flowchart

[0093] The first CAC process is a special case of the present one, in which the set of step change times to server.maxFlowRate is empty (i.e. server.maxFlowRate is constant), and $Seq_T(t\_now) == t\_now$.

[0094] In preparing Seq_T(t_now), one need only consider future times that will pass before the longest possible content is played out if started at t_now. In order to sidestep problems associated with rollover (at midnight, year 2000, etc.), time is best expressed as a monotonically increasing value (e.g. seconds since Jan 1 1990).

CAC for Maximal Charges

Overview (Figure 13)

[0095] Previously, a method for flow modulation was presented that maximizes charges to clients with active sessions. The CAC embodiment presented previously was not sufficient as it does not consider the cost of service as a basis for connection acceptance. As a result, it may turn away higher paying customers while granting service to lower paying ones, thereby defeating the purpose for this particular embodiment. Therefore, another embodiment is defined which offers the following features:

1. Awaiting clients are serviced in order of their respective service categories, higher paying clients first.

2. Once accepted, a client is guaranteed to receive acceptable service irrespective of its service category.

3. Under heavy load conditions higher paying customers are more likely to be accepted than lower paying ones.

4. Lower paying customers will no be starved for service when higher paying ones enjoy a surplus.

5. Available bandwidth is not thrown away needlessly while clients are being denied service.

[0096] The first objective is easily met by dividing the client queue into as many bands as there are service categories, resulting in a banded queue. Bands are ordered within the queue according to their service categories, with the costliest category in front. As prospective clients arrive and make their selection they are placed in their respective queue band according to their service category (which may be set contractually, according to content selection, etc.).

[0097] Our second objective is met by employing a procedure patterned after those presented previously & offering the same guarantee. Toward our third and fourth objectives we propose dividing total available bandwidth in as many strata as there are service categories. As depicted in Figure 12, two service categories are shown, Premium and Basic, each entailing an associated cost of service. A prospective client is accepted only if there is sufficient swing capacity available within its given service category. The swing capacity for a given category is given by the smaller of 1) the difference between its maximum floor flow rate (corresponding to the top of the stratum for the service category) and the sum of the minimum rates of all active sessions in its category or below, and 2) available swing capacity overall. Finally, our fifth objective is met by allowing the flow optimizer to function freely subject to its operational constraints. The imposed ceilings on call acceptance by category relate to *minimum flow rates*, which merely impose a floor on *actual flow rates*. For example, basic clients might well consume all available bandwidth 300 in the absence of any premium customers, yet could be throttled back toward their floor flow rates (which together cannot exceed 200 in this example) at any time should any premium customer suddenly demand service. In contrast, premium customers could consume the entire 300

bandwidth. As lower paying customers appear these would be admitted to the degree that their quota on minimum flow is not exceeded (i.e. 200) and the availability of swing capacity on the system.

Procedure (Figure 13)

[0098] The present procedure requires a number of ancillary definitions, which follow:

Let the service categories be denoted by k= 1...N, where k also denotes the cost of service.

Let server.maxMinFlowRate[k-1] be the top of the stratum for service category k. Note that server.maxMinFlowRate [N-1] = server.maxFlowRate.

Let S_K be the set of active client indices with a service category *equal to or less than* k. Note that S1 is contained in S2, S2 is contained in S3, and so forth, and that $S_N = S_{activeClients}$.

Let swingCapacity(k) denote available swing capacity for service category k. By construction:

(19) swingCapacity(k) = minimum of:
(server. maxMinFlowRate [k-1] - $\Sigma_{i \in Sk}$(client.lookup(i).session.minFlowRate)),
(server.maxFlowRate - $\Sigma_{i \in SactiveClients}$ (client.lookup(i).session.minFlowRate)))

[0099] Referring to Figure 13, this method is used for CAC when multiple rate tariffs are in effect, and there is a desire to maximize economic returns to the service provider while offering acceptable service to all.

[00100] All waiting clients are scanned in FIFO sequence. The actions taken in Steps 1320 and 1360 are identical to those described in connection with earlier CAC flowcharts.

[00101] Step 1340 evaluates a predicate expression that tests whether the required bandwidth can be accommodated without exceeding the lesser of 1) swing capacity available to the client's category of service, and 2) total available swing across all categories of service. The latter factor could be determinative if all available bandwidth were allocated to high paying customers, leaving lower paying ones such as the proposed client unable to draw from their unfilled quota.

Let us suppose that candidate client ***id*** belongs to rate category ***k***.

We define the swing capacity available in rate category ***k*** as:

swingCapacity(***k***) = least of:

(server.maxMinFlowRate[k-1] - $\Sigma_{\text{i in Sk}}$ (client.lookup(i).session.minimumFlowRate))

and

(server.maxFlowRate - $\Sigma_{\text{i } \epsilon \text{ SactiveClients}}$ (client.lookup(i).session.minimumFlowRate))

The predicate expression invoked by step 1340 can now be written as follows:

(required_bandwidth < = swingCapacity(***k***) - server.cac_flowSafetyMargin)

[00102] This algorithm processes queued clients in band sequence, and within every band in FIFO order. If the predicate evaluates to true, the client is activated. Otherwise two possible cases are considered: 1) under the *FirstFit* embodiment, the procedure continues scanning clients to the end of the banded queue, activating clients whose requirements can be met; 2) under the *FIFO* embodiment, the procedure ends with the first candidate client whose requirements cannot be met. Many other variations on these two embodiments might also be considered.

Anticipating Scheduled Variations in Network Capacity (Maximal Charge)

Overview

[00103] The procedure applicable to optimization of delivery charges is obtained by blending elements of the CAC method depicted in Figure 13 into the method depicted in Figure 11, which applies without change. To understand how this might work it may be useful to visualize a version of Figure 10 stratified along its length in the manner of Figure 8. As the maximum flow level undergoes a step change, so too do the widths of its constituent strata in equal proportion.

Procedure

[00104] As previously mentioned, the CAC method (Figure 11) applies to this circumstance also, provided we alter the definition of two routines, (17) and (18), upon which that procedure relies, yielding (20) and (21), and adopt the banded queue organization outlined in the previous section.

[00105] The server swing capacity at a future time t is computed according to the capacity and worst-case client flows at time t.

(20) swingCapacity(k, t) = minimum of (

(server.maxFlowRate(t) * (server.maxMinFlowRate[k-1] /server.maxMinFlowRate[N-1])

$\Sigma_{\text{i e Sk \& (t\_end(i) > t)}}$ (client.lookup(i).session.minFlowRate)),

(server.maxFlowRate - $\Sigma_{\text{i e SactiveClients \& (t\_end(i) > t)}}$ (client.lookup(i).session.minFlowRate)))

Finally, we define a predicate that tests whether a prospective customer will cause swing capacity to be exceeded at some time t, as follows:

```
(21) boolean client_fits(i ,t) {
        k = client.lookup(i).costOfService;
        if(client.lookup(i).contentSelection.averagePlayRate <=
                        swingCapacity(k,t) - server.cac_flowSafetyMargin)
                return true;
        else return false;
    }
```

System Description

[00106] Referring to Figure 14, a block diagram illustrating a preferred embodiment for a system implementing the methods presented herein is shown.

[00107] Block 1485 depicts plurality of network-based client computers that receive data from a server over the course of a session. Every client sessions has an associated session block 1435 within the server by means which a flow rate of content from client to server is effected and regulated to a given flow rate set-point. The flow optimizer 1430 manages bandwidth utilization across all sessions that have been admitted by the system call admission control (CAC) and the bandwidth call admission control blocks, labeled 1400 and 1420 respectively. Specifically, the flow optimizer 1430 modulates the flow rate set-point of every active session so as to optimize aggregate flow or, more generally, cost.

Call Admission Control

[00108] Whenever a client contacts a server requesting service, the server must determine whether or not to admit the client. This admission function is performed in two separate phases. The system call admission control block 1400 considers whether or not sufficient internal resources exist to support the request.

Toward this end, the system CAC 1400 estimates the needs of the prospective client with respect to a set of limited system resources such as I/O bandwidth, cache memory, open files, threads, etc. A request is denied if any required resource cannot be obtained. In the contrary case, the request is passed on to the Bandwidth CAC, which tests if the client fits and admits or rejects the client accordingly. The swing capacity is computed by the flow optimizer 1430 on a periodic basis according to equations (14) and (17) as appropriate. The managed bandwidth must reflect the true capacity of the attached network and the adapters leading thereto. This parameter should not be set arbitrarily high to prevent rejection of client requests. Doing so will cause the system to admit calls that cannot be properly handled, thereby diminishing the quality of the viewing experience.

[00109] Having admitted a client, block 1430 creates a client session block 1435, which then begins to converse with its client-resident counterpart, 1480) during their launch phase. Thereafter, the flow optimizer 1430 assumes control, and modulates flow over the session until either all content is delivered, or a failure to deliver is detected, or one of a number of VCR-like stream control events intervene (e.g. pause, rewind, fast-forward).

Server and Client Session Control Blocks

[00110] Data Transport Channel 1450 is responsible for transporting data packets originating from the flow regulator 1440 within the server to the former's peer entity 1460 within the client. The mode of communication between the peer entities may be connection-oriented (e.g. TCP, which delivers a byte stream in order, without duplication or loss) or datagram-oriented (e.g. UDP). Best-efforts datagram service is typically enhanced with acknowledgements to facilitate rapid recovery from occasional packet loss, out-of-sequence delivery, and duplication.

[00111] Peered session control channels 1445 and 1465 permit configuration and status data, together with miscellaneous commands, to be sent from client to server and vice-versa. A reliable connection-oriented transport service is typically employed for this purpose (e.g. TCP). Data and commands alike are multiplexed over this channel in the service of other entities within the clients or server. Thus, a datagram-oriented data transport channel 1460 within a client 1485 might employ the session control channel to ferry selective acknowledgements to its peer in the server. Similarly, the flow meter 1465 within the client 1485 forwards the measured flow rate to the associated flow regulator 1440 within the server.

[00112] The flow regulator 1440 obtains content data from a cache or disk, at the current offset into the content file, which it forwards as packets to the data transfer channel 1450. The size and/or pacing of the packets are determined by the flow regulator 1440 in order to achieve the flow rate set-point imposed by the flow optimizer 1430. The flow regulator 1440 is also responsible for determining the channel flow capacity to the client, which is the least of a configured value obtained from the client and a measured value. Toward this end, during the launch phase, the flow regulator 1440 might send content data packets to the client flow meter 1475 in a series of packet trains at progressively higher peak flow rates ending with the configured maximum flow rate, if any. The highest measured flow rate reported by the client flow meter 1475 is accepted as the flow rate capacity, which is posted for use by the flow optimizer 1430. Subsequently, the flow regulator 1440 will compare the flow rate set-point with the flow rates reported by the flow meter 1465, and down grade capacity as needed should the measured flow rate fall consistently fall below the requested flow rate. Whenever such a downgrading occurs, the flow regulator 1440 will test for subsequent

relaxation of a transient constriction by means of the aforementioned series of packet trains in which the peak packet flow rate exceeds the delivered flow rate.

[00113] The buffer manager 1470 accepts data from the flow meter 1465, which data is retained until it is consumed or passed over the content consumer 1480. The buffer will typically be implemented as a ring buffer in memory or on disk. The write cursor will lag the read cursor by a no less than a specifiable time interval so as to permit rewinds of acceptable scope without requiring selective data re-retrieval from the server.

Flow Optimizer 1430

[00114] The flow optimizer 1430 assumes control over a session once it has been launched, and its channel capacity has been determined. Subsequently, it modulates the flow rate set-point of every session such as to optimize aggregate flow or charges across all active sessions, subject to a variety of min/max constraints on sessions flows, and a maximum constraint on aggregate session flow, as previously discussed.

[00115] The flow optimizer 1430 continues to modulate session flow until all content has been delivered, or one of a number of session anomalies intervene, as follows:

[00116] A downgraded session flow capacity drops below the minimum session flow rate. The session is dropped by the optimizer 1430 as a solution involving this channel does not exist. The user is forced to apply for re-admission, with the option of accepting slower than real-time delivery at the present encoding rate, or accepting a degraded viewing experience at a reduced encoding rate better adapted to the presently available bandwidth.

[00117] A pause VCR command is received from the client. Flow to the client can continue until the client-side buffer is topped off, after which time flow drops to zero. The session is permanently dropped should the pause persists too long. Until that time, the CAC safety margin is temporarily increased by the jit (Just-In-Time) flow rate of the paused session. In this way the session can be resumed without the need for re-admission and the jit bandwidth is made available to currently sessions so long as the pause persists.

[00118] A VCR Jump-Forward command is received from the client. This action is problematic as it causes the just-in-time flow rate (calculated at the new forward offset) to increase, in violation of the assumptions of the CAC algorithm. It must be noted that this violation will occur even if the content that is sought has already been delivered to the client-side buffer. One workable policy is to force the client to apply for re-admission at the forward offset and with a suitably modified buffer level.

[00119] A VCR Jump-Backward (Rewind) command is received. This action may entail the need for re-transmission of content, as previously discussed. The just-in-time flow rate will decrease as per the new position and adjusted buffer contents.

Tunable Minimum Constraint

[00120] A parameterized family of minimum flow constraints can be defined as follows:

(22)

wherein: $f_k(t)$ = Target content flow rate for session k;

$f_k^{JIT}(t)$ = Just-in-time flow rate for session k;

(RHS of Equation (5))

β = Burst tuning factor (positive or zero); and

$f_k^{min}(t)$ = Minimum (reserved) flow rate for session k.

[00121] This family converges on $f_k(t) >= f_k^{JIT}(t)$ when β approaches 0. A β value of .1, for example, ensures a minimum flow rate that exceeds the JIT flow rate by 10%. Thus, non-zero values of β force early delivery of content to a player's media buffer, with beneficial effects on the viewing experience.

Alternative Call Admission Control

[00122] The traditional CAC algorithm compares the flow rate requirement of a prospective client with the unused bandwidth (obtained by subtracting the aggregate flow target from the server flow capacity) and grants service if unused bandwidth is not exceeded. This procedure may break down as the optimizer causes all available bandwidth to be used if it can, thereby reducing unused bandwidth to zero in the best case, even when a new client could be accommodated with a healthy margin to spare.

[00123] Nevertheless, a simple variation on this idea can be used. Available bandwidths can be defined as the difference between server flow capacity and the sum of minimum flow rates for each session computed according to (22) as follows:

(23) $f_{available} = f_{Svr}^{max} - (f_1^{min} + \ldots + f_n^{min})$

wherein: $f_{available}$ = Available bandwidth

f_{Svr}^{max} = Server aggregate flow capacity; and

f_n^{min} = Minimum (reserved) flow rate for session n.

[00124] Service is granted if the computed minimum flow rate of the prospective client is less than available bandwidth even when unused bandwidth is zero.

Toward a Tunable QOS

[00125] In the preceding discussion it is assumed that all clients share the same value of β. One might also consider a scheme whereby a client receives a β value according to the class/cost of service that client has signed up for: the greater the cost (and expected quality of service, or QOS) the greater the value of β.

[00126] Instead of maximizing charges by the methods described above, a variation on the algorithm to maximize flow is considered whereby the reserve flow computation for every session takes into account the individual β value of the associated client. In this fashion a single algorithm can serve either end. The optimizer first ensures that every session receives its required minimum bandwidth (which would now typically depend on β and elapsed session time) before allocating any excess bandwidth more or less evenly to all by interpolation. (According to Figure 15.)

[00127] The scheme is simpler computationally than the iterative interpolation method shown in Figure 16; it is also arguably more fair and stable with respect tot he allocation of available bandwidth.

Deadline-Driven Content Distribution

[00128] In delivering viewable or audible content to a player, the optimization algorithm imposes a minimum flow rate that ensures that all content is delivered by the implied deadline, which is the last moment of a play session. Notwithstanding, the optimizer attempts to deliver content earlier according to bandwidth availability within the server taken as a whole. A similar, though far simpler scenario arises relative to the distribution of content from an optimized server to a target device, whenever the delivery must be accomplished by a designated time, or equivalently, within a given elapsed time, and when overlapped non-blocking consumption of the content at a fixed rate is not required.

[00129] One example concerns the application where a session bundle comprises a session associated with the featured program together with sessions for every advertisement scheduled to interrupt the feature program at a designated time. Each session is endowed with a separate media buffer, which, in the case of ads, would typically be large enough to accommodate the ad in full, thereby permitting a seamless transition to the ad at the appointed time.

[00130] In adapting the optimizer to the needs of content distribution we must revisit the formulation of the flow constraints, as follows:

1. Media buffers are not of a concern, let alone buffer overflow, and it can be assumed that all content received is saved away in a file on disk, or in memory awaiting further use.

2. For these same reasons, the value of β may be zero, at which the minimum flow rate equals the just-in-time rate obtained by dividing the content as yet undelivered by the time till deadline:

(24) $f_k^{JIT}(t_k) = L_k^{TOGO} / (T_k - t_k)$

wherein: L_k^{TOGO} = Content to go for session k, i.e., as yet undelivered by the server at time t, (client.lookup (k).session.payloadToGo).

Given the arbitrary format of the file to be distributed, T no longer signifies the "duration of play" at the average play rate (averagePlayRate); rather, T represents the elapsed time to the deadline measured at the moment the delivery session was launched, and t represents the elapsed time since session launch.

Session Bundles

[00131] A session bundle is a set of sessions that flow along a shared channel, and are thus subject to an aggregate flow constraint equal to the capacity of the shared channel. One important application of session bundles is connected with ad insertion.

[00132] It is not enough to treat each of the constituent sessions as independent with respect to the flow optimizer, for this practice might well result in session flow targets that do not exceed channel capacity when considered singly, yet exceed this same shared capacity when summed together.

[00133] A solution to this problem involves two distinct steps:

1. The sessions bundle is treated as a virtual session by the server optimizer, subject to the minimum flow constraint obtained by summation of the individual session minima, and a maximum constraint that is the least of (a) the sum of the least of constraints (3) and (4) for each session, and (b) the shared

channel capacity client.lookup(k).channel.maxFlowRate (f_k^{cap}). The flow optimizer then generates an aggregate flow target for all channels virtual sessions by interpolation, using:

(25) $Cost(t) = f_1(t)+..+f_n(t)$

[00134] The cost vector in this instance is the n-dimensional unit vector, where n is the number of active clients.

(26) $c=(1, 1,....,1)$

[00135] Now it is possible to have an achievable aggregate flow target for the session bundle k that we must apportion optimally among the constituent sessions. Fortunately for us, our interpolation procedure of Figure 15 can be applied again to the sessions in our bundle, but where the aggregate flow target generated above replaces the aggregate flow constraint f_{svr}^{max}

Specifically:

For every flow f_{ki}, within session bundle k, the optimal flow rate is obtained by interpolation between minimum and maximum session flows:

(27) $f_{ki}^{opt} = f_{ki}^{min} + \alpha * (f_{ki}^{max} - f_{ki}^{min})$

(28) $\alpha = [(f_K^{bundle} - f_{k1}^{min} + ...f_{kn}^{min})]/[(f_{k1}^{max} - f_{k2}^{min}) + + (F_{kn}^{max} - f_{kn}^{min})]$

and the value of f_k^{bundle} is obtained from a higher level optimization in which session bundle k is treated as a virtual session for which:

(29) $f_k^{min} = f_{k1}^{min} + ... + f_{kn}^{min}$

(30) $f_k^{max} = \min(f_{k1}^{max} + .. + f_{kn}^{max}, f_k^{cap})$

It must be noted that session bundles are typically dynamic in nature, outliving many if not all of their constituent sessions. Before a session is added to the bundle two CAC decisions must be reached:

(1) establish bandwidth availability within the bundle; and

(2) bandwidth availability within the server.

Relationship to Adaptive Rate Control

[00136] The flow optimization methods should be viewed as constituting the lowest and perhaps only the first of many supervisory control layers to sit astride all streaming sessions, which comprise their own hierarchical stack of control functions; rate adaptive control sitting above a flow rate regulator which relies on a transport entity.

[00137] Channel capacity is known to vary widely over time. A capacity drop to below the minimum reserve flow rate is problematic as it causes the latter to rise in violation of its monotonicity assumption. In a server with available bandwidth to spare such a rise can be accommodated by the flow optimizer (by bumping the session's minimum flow reservation to the higher value) provided the flow deficit can be made up in the near term by draining pre-delivered content from the media buffer. Should either of these resources approach depletion, stream degradation to a lesser bit-rate or frame rate may be the only viable option short of a pause. Whether up or down, any rate change is a change to *fe*, which must be preceded by change to session's reserve flow rate allocation by the optimizer.

[00138] As can be seen, the optimizer and rate adapter must be integrated with care. One possible approach would be to modify a rate adapter such that it renegotiates its proposed *fe* value with the flow optimizer prior to effecting the rate change it deems appropriate based on information provided by the flow regulator. Rate increases might well be subject to deferral under heavy load conditions, awaiting bandwidth availability. The opposite is true of rate flow decreases: these would be forestalled as long as possible by the optimizer on a system that is not fully loaded, as previously discussed.

Live Events

[00139] Referring to Figure 17, the method of the present application can be extended to the optimization of "live", time-shifted "near-live" events, and cascaded delivery, wherein one server delivers content to another while the latter accepts clients for the same content. The extension assumes the following characteristics of the server and the live performance:

1. The performance is of a fixed duration T known in advance, encoded at an average rate *fe*, with a projected content payload of *fe*T*;

2. The origin server at the point of injection delays the stream by a small dwell time T^{DWELL} on the order of seconds (e.g. 10). Notwithstanding, the delayed content is available for early delivery to mirrored servers and players with the aim of providing these with a modicum of isolation from network jitter affecting the timely delivery of the live video frames.

3. Throughout the live event, captured content is stored in a file, thereby permitting late joiners to view the "live event" starting from any point between the present and the event start time;

4. At the conclusion of the live event, the encoded content, now fully captured to a file, is available for viewing over the balance of the admission window (e.g., 60 minutes in Figure 17).

[00140] The optimisation of live events and video on demand (VOD) differ principally in one respect, namely in the formulation of the server content underflow constraint.

For VOD, this constraint is

(31)

$L_k^{TOGO}(t)$ is initialised to the content size (*fe*T*) at that start of play, and decremented as content is delivered to the client. Δt is the time interval between successive periodic optimizations (e.g. 1 second). In practice this constraint rides

well above other operative maximum flow constraints (e.g. buffer overflow, channel capacity) until the very last calculation of the session flow target by the optimiser.

[00141] For a live stream, this constraint must additionally reflect the fact that content is streaming into the server (where it builds up), even as the server streams it out toward clients, and that the latter activity cannot possibly overtake the former.

[00142] Referring to Figure 17, (which illustrates how optimised live streams behave) line L1 depicts the build-up of freshly captured content to the server. Line L2, which is delayed (time-shifted) relative to L1 by the dwell time T^{DWELL}, represents the live performance as cast and viewable by clients. One such client is admitted at time A and joins the live session at the live moment B. The dashed curved line linking points B and C shows a plausible build-up of content in the client's media buffer in advance of play, as the viewer continues its advance along line L2. Past point C the top of the media buffer tracks the live capture stream and thenceforth advances along line L1. In this instance, the time shift between the live performance as cast (L2) and the live performance as captured (L1) imposes a maximum on the amount of content that could ever accumulate in a client media buffer, irrespective of its actual capacity.

[00143] Another client, admitted at time $t=10$, is interested in viewing the live stream from the beginning without missing anything. As before, the dashed line joining 10 and D depicts a plausible build-up of content in the client's media buffer in advance of play, as the viewer continues its advance along line L3, which is time-shifted by $(10+T^{DWELL})$ minutes relative to L1. The greater time shift (now between L1 and L3) permits more extensive pre-buffering of "near live" content.

[00144] The present constraints do not impose suitable flow limits at and beyond points C and D when the client delivery streams finally links up with the live capture stream, in the live moment. Consequently the optimiser may propose flow targets that cannot be realized.

[00145] Accordingly, the following modification for use in connection with live or cascaded streams is made:

(32) $f_k(t) <= [(L_k^{TOGO}(t) - Live^{TOGO}(t)] / \Delta t$

for a live event delivered at flow rate *fe*, we have

(33) $Live^{TOGO}(t) = \max(fe*(T - T^{DWELL} - t), 0)$

[00146] $Live^{TOGO}(t)$ is the span between projected content size *fe* **T* (level line L0 in Figure 17) and the content capture level line L1, whereas $L_k^{TOGO}(t)$ is the gap between L0 (i.e., *fe* * *T*) and the dashed curved line representing the content level delivered to the media buffer. The latter must always exceed the former. As the two approach one another this constraint takes effect, causing $L_k^{TOGO}(t)$ to always exceed $Live^{TOGO}(t)$ as it decreases at rate *fe*.

[00147] Viewers joining late and willing to see the live performance with some delay relative to the live case enjoy higher potential levels of isolation from network disturbances, and thus QOS, by virtue of their greater effective buffer capacity. By the same token, such viewers afford the optimizer greater latitude to optimize the flow of VOD and "live" content across load fluctuations, thereby enhancing server capacity. Viewers that wish to experience the live event in "real-time" nevertheless benefit by a modestly enhanced QOS conferred by a dwell time's worth of content in their buffers.

Summary

[00148] A method and system for call/connection acceptance and flow modulation for network delivery of video/audio programming is thus provided. Although several embodiments have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit of the invention or the scope of the claims.

CLAIMS:

1. A method of bandwidth allocation for delivery of stored digital content from at least one server device to at least one client device by way of a network, the method comprising the steps of:

a) prescribing a control variable which represents a target flow rate from the server device to each client device;

b) determining time-varying constraints on the flow rate of the content;

c) determining a cost function of the control variables for all clients; and

d) prescribing bandwidth to all clients based upon the value of the control variables that maximize the cost function.

2. The method of Claim 1 wherein step (d) comprises performing periodic computations to update the value of the control variable such that the bandwidth can be continuously allocated to each client.

3. The method of Claim 2 wherein a new client is accepted by:

i) determining an admission capacity of the bandwidth;

ii) admitting a prospective client if the clients minimum allowed value of the control variable is less than the admission capacity; and

iii) wherein a client admitted for service is guaranteed to have sufficient content flow over the entire session.

4. The method of Claim 3 wherein:

The admission capacity equals a server swing capacity reduced by a predetermined safety margin which may be zero, the swing capacity equaling the difference between the server flow capacity and the sum of the minimum allowed flow rate for all clients.

5. The method of Claim 4 wherein the minimum allowed value of the control variable is initialized to the average consumption rate.

6. The method of Claim 4 wherein the minimum allowed value of the control variable is initialized to the average consumption rate multiplied by a factor greater than one.

7. The method of Claim 4 wherein the server flow capacity varies in a step-wise function over time according to a predetermined schedule and the method of accepting a new client further comprises:

i) determining a sequence of future step changes of server flow capacity;

ii) determining at each time in the sequence of future step changes the value for a future worst swing case capacity, the worst case swing capacity being obtained from the server flow capacity at the time by subtracting an extrapolated present minimum allowed flow rate for all active clients that are potentially active in the future;

iii) admitting a prospective client if a minimum allowed value of the control variable is less than the capacity obtained from the sequence and the present capacity;

iv) whereby a new client can be admitted without compromising the service to existing clients in the presence of previously scheduled server flow capacity changes and all clients accumulate content in their buffers to the extent of their respective buffer capacity.

8. The method according to Claim 7 wherein the method of accepting a new client further comprises:

i) partitioning the available bandwidth into partitions representing a prescribed service charge;

ii) determining a maximum-minimum capacity for a service charge to be the maximum allowed sum of all minimum allowed flow rates for all clients incurring an equal or lesser service charge, the maximum-minimum capacity equaling the sum of bandwidth allocations for all service charges less than or equal to the service charge;

iii) determinating a service-charge-specific swing capacity for a given service charge as the difference between the maximum-minimum capacity for the service charge and the sum of all minimum allowed flow rates for all clients incurring the service charge or a lesser service charge;

iv) determining the server swing capacity to be the server flow capacity minus a margin and minus the sum of the minimum allowed flow rate for all clients; and

v) determining the service-charge-specific capacity to be the least of the server swing capacity and the charge specific swing capacity.

9. The method of Claim 8 wherein the method of accepting a new client further comprises:

i) determining the sequence of future times of step changes to server flow capacity over a proposed consumption period;

ii) determining for each time in the sequence of future times, the future worst-case value for the service-charge-specific capacity, the worst case value being obtained by using the extrapolated present minimum allowed flow rate of all presently active clients that are potentially active at the time in the future; and

iii) admitting a client incurring a given service charge if the minimum flow rate of the client is less than the capacity obtained from the sequence and the present service-charge-specific capacity.

10. The method of Claim 3 wherein step (b) comprises determining time-varying constraints wherein:

i) an aggregate flow rate for all clients does not exceed a predetermined server flow capacity;

ii) the flow rate from the server to the client does not exceed a maximum allowed flow rate for the client;

iii) the flow rate to the client will never cause a buffer of the client to overflow;

iv) the flow rate to the client stops when the content is exhausted; and

v) the flow rate from the sever will never be less than the client's minimum allowed flow rate which may vary over time and may be zero.

11. The method of Claim 10 wherein the maximum allowed flow rate to the client is given by the minimum of one selected from the following:

i) a client flow rate ceiling;

ii) the flow rate required to fill the client buffer before the next periodic computation; and

iii) the flow rate required to complete the delivery of the content before the next periodic computation.

12. The method of Claim 11 wherein:

i) the minimum allowed client flow rate cannot increase over time, but may decrease such that the initial value of the control rate is no less than the average consumption rate;

ii) the control variable for the client is always greater than or equal to the current minimum allowed client flow rate; and

iii) the client buffer will never underflow until the content is fully consumed at the average consumption rate.

13. The method of Claim 12 wherein the minimum client flow rate is the product of the constant content flow rate from the client to the server that causes the last piece of content to be delivered at the last possible moment as the client buffer is being drained at the average consumption rate, with a factor greater or equal to one.

14. The method of Claim 13 wherein the minimum client flow rate is initialized to the average consumption rate.

15. The method of Claim 13 wherein the minimum client flow rate is initialized to the average consumption rate multiplied by a factor greater than one.

16. The method of Claim 13 further comprising the step of calculating the minimum client flow rate periodically.

17. The method of Claim 1 wherein the cost function represents an aggregate flow rate and is the sum of the flow rates for all clients.

18. The method of Claim 1 wherein the cost function represents a service charge and is the sum of the client flow rates multiplied by the client's cost of service.

19. The method of Claim 18 wherein:

step (a) comprises:

i) determining a maximum allowed flow rate and a minimum allowed flow rate for each client;

ii) determining a flow rate range for each client as the difference between the maximum allowed flow rate and the minimum allowed flow rate; and

iii) initializing a current flow rate for each client as the minimum allowed flow rate and summing the flow rate into the total server flow rate; and

step (d) comprises:

i) computing remaining server bandwidth as the difference between the maximum server flow capacity and the total server flow rate; and

ii) allocating remaining server bandwidth to remaining clients wherein all clients with a given cost of service receive bandwidth equally to the extent of their respective ranges, and no client with a given cost of service being allocated bandwidth unless all clients with a higher cost of service have received their maximum possible allocation of bandwidth.

20. The method of Claim 17 wherein step (a) prescribing the control variable comprises:

i) forming a hyperplane of control variables that aggregate to the maximum allowed aggregate flow rate;

ii) computing a first vector of minimum allowed client flow rates;

iii) computing a second vector of maximum allowed client flow rates;

iv) determining a multi-dimensional shape of which an interior diagonal spans the first and second vectors; and

v) finding a solution of control variables at the point of intersection between the diagonal and the hyperplane.

21. The method of Claim 20 wherein step (v) comprises finding a solution of control variables at the second vector if there is no point of intersection between the diagonal and the hyperplane.

22. The method of Claim 17 wherein step (a) comprises:

i) computing the sum of the minimum allowed flow rates to all active clients;

ii) computing the sum of the flow rate ranges for all active clients;

iii) computing the difference between the maximum allowed aggregate flow rate and the sum of the minimum;

iv) computing a factor as the ratio of the difference over the sum of the ranges;

v) if the factor exceeds 1, the control variable is set to the maximum allowed client flow rate; and

vi) if the factor is less than 1, computing the control variable by multiplying the client range by the factor and then adding the result to the minimum allowed client flow rate.

23. The method of Claim 17 wherein:

step (a) comprises:

i) determining the maximum allowed flow rate and minimum allowed flow rate for each client;

ii) determining the flow rate range for each client as the difference between the maximum flow rate and the minimum flow rate; and

iii) initializing the control variable for each client as said minimum allowed flow rate and summing the flow rate into a total server flow rate; and

step (d) comprises:

i) computing remaining server bandwidth as the difference between the maximum server flow capacity and the total server flow rate; and

ii) allocating remaining server bandwidth to remaining clients to the extent of their respective ranges.

24. The method of Claim 23 wherein the step of allocating remaining server bandwidth further comprises the clients receiving the bandwidth equally to the extent of their respective ranges.

25. The method of Claim 17 wherein the maximized value of the control variable can be determined by:

i) determining a maximimum and minimum flow rate for each client;

ii) determining a range between the maximimum and mininmum flow rates in order to find a flow rate range;

iii) determining available bandwidth by finding the difference between an aggregate flow capacity and a sum of the minimum flow rate;

iv) determining a flow variable by dividing the unused bandwidth by the flow rate range;

v) prescribing the control variable to be the minimum flow rate added to the flow rate range if the flow varible is less than one or prescribing the control variable to be the minimum flow rate added to the flow rate range corrected by the flow variable if the flow favorable is greater than one such that the control variable is easily calculated for each client.

26. The method of Claim 17 wherein at least one session is a session bundle and:

1) the minimum flow constraint is computed as the sum of the minimum flow rate constraints for all bundled sessions;

2) the maximum flow constraint is the least of 1) the sum of the maximum individual flow rate constraints of each session and 2) the flow capacity of the channel shared among the bundled sessions; and

3) the target flow rate is computed for the session is apportioned among the bundled constituent sessions.

27. The method of Claim 26 wherein the bundled session is an advertisement.

28. A system for allocating bandwidth between a server device and at least one client device, the system comprising:

a call acceptance module operative to receive an incoming request for service;

a flow regulator configured to deliver content at a modulated target flow rate, the content being delivered between the server device and a respective client device when a call is accepted by the call acceptance module; and

a flow optimizer configured to modulate the target flow rate of the flow regulator in order to optimize the aggregate flow of content.

29. The system of Claim 28 wherein the flow optimizer is configured to modulate the flow rate of the flow regulator in order to optimize charges for the content.

30. The system of Claim 29 wherein the flow regulator is configured to deliver the modulated flow rate of content in response to the control variable.

31. The system of Claim 28 wherein the flow optimizer is configured to determine a control variable which corresponds to an optimized flow rate.

32. The system of Claim 31 wherein the flow optimizer is configured to generate a cost function of the control variable that corresponds to a maximized value of the control variable.

33. The system of Claim 28 wherein the flow regulator is configured to deliver the modulated flow rate of content in response to the control variable.

34. The system of Claim 28 wherein the flow optimizer is configured to determine a maximized value of the control variable by:

i) determining a maximum and minimum flow rate for each client;

ii) determining a range between the maximum and minimum flow rates in order to find a flow rate range;

iii) determining unused bandwidth by finding the difference between an aggregate flow capacity and a sum of the minimum flow rate;

iv) determining a flow variable by dividing the unused bandwidth by the flow rate range;

v) prescribing the control variable to be the minimum flow rate added to the flow rate range if the flow variable is less than one or prescribing the control variable to be the minimum flow rate added to the flow rate range corrected by the flow variable if the flow favorable is greater than one such that the control variable is easily calculated for each client.

35. The system of Claim 33 wherein the call acceptance module is configured to accept a call based upon the value of the control variable.

36. A method of bandwidth allocation for delivery of stored digital content from at least one server device to at least one client device by way of a network, the method comprising the steps of:

a) prescribing a control variable which represents a target flow rate from the server to each client device based upon the amount of buffer of the client;

b) determining time-varying constraints on the flow rate of the content;

c) determining a cost function of the control variables for all clients in response to the size of the client's buffer; and

d) prescribing bandwidth to all clients based upon the value of the control variables that maximized the cost function.

37. A method for apportioning a given total flow rate (bandwidth) among a plurality of sessions for clients, the method comprising the steps of:

a) computing a sum of minimum flow rate constraints for each session;

b) computing a sum of flow rate ranges for all active clients;

c) computing a difference between the given total flow rate and a sum of the flow rate minima;

d) computing a factor as the ratio of the difference over the sum of the flow rate ranges;

e) if the factor exceeds 1, setting the flow rate to the maximum allowed client flow rate; and

f) if the factor is less than 1, computing the flow rate by multiplying the client range by the factor and then adding the result to the minimum allowed client flow rate.

38. The method of Claim 37 wherein the clients are distinguished by their cost of service and bandwidth is apportioned to clients iteratively, the amount apportioned to each client in a cost category is the amount remaining from prior allocations to clients in higher cost categories.

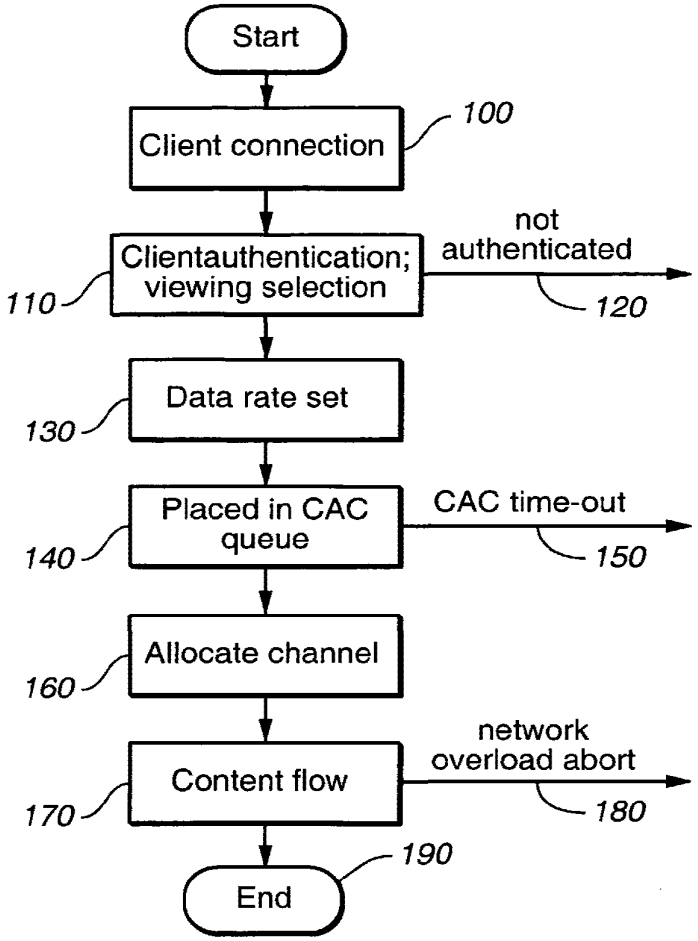

Start
Client connection
100
Clientauthentication; viewing selection
110
not authenticated
120
Data rate set
130
Placed in CAC queue
140
CAC time-out
150
Allocate channel
160
Content flow
170
network overload abort
180
End
190

FIG._1

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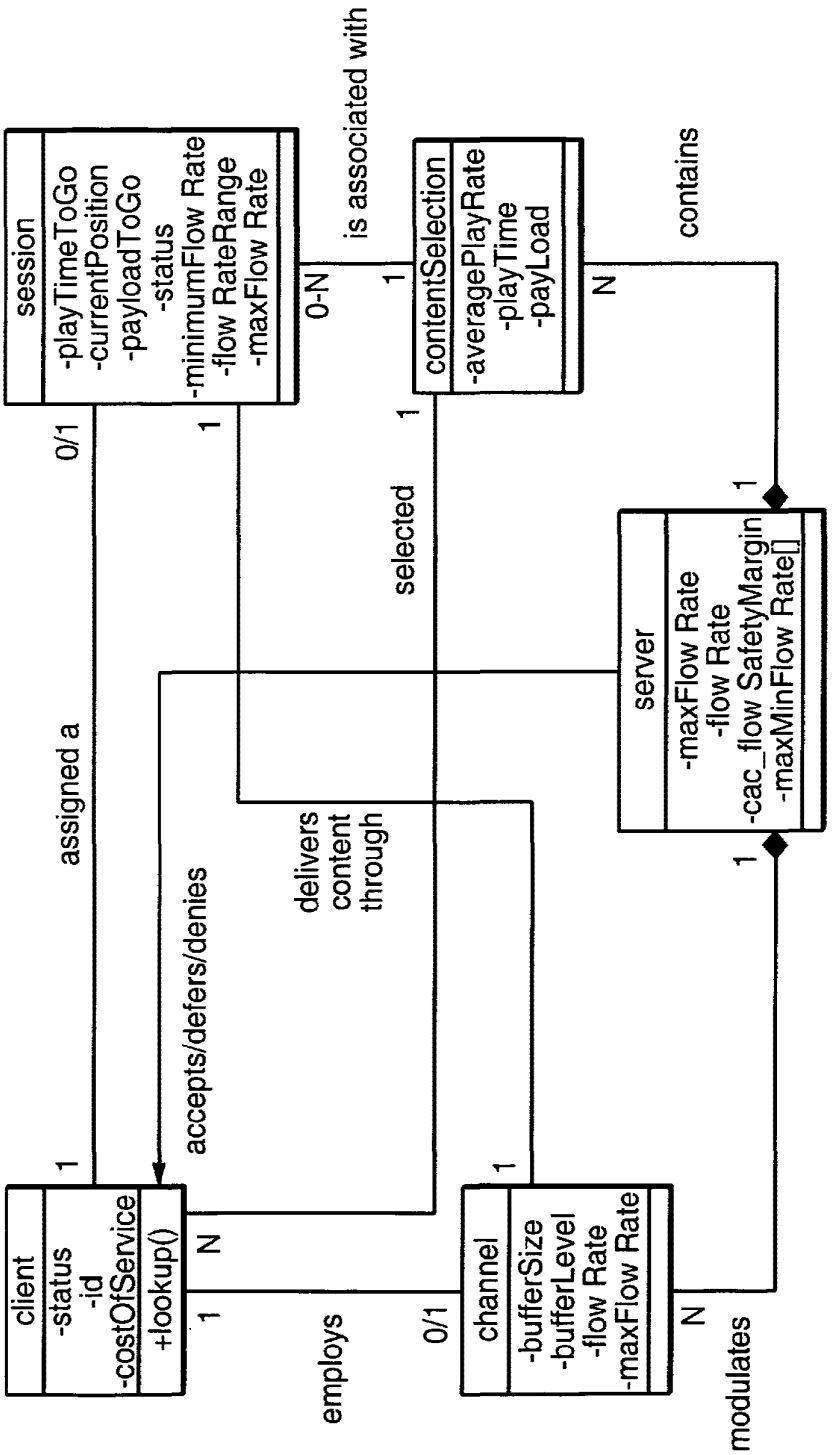


FIG._2

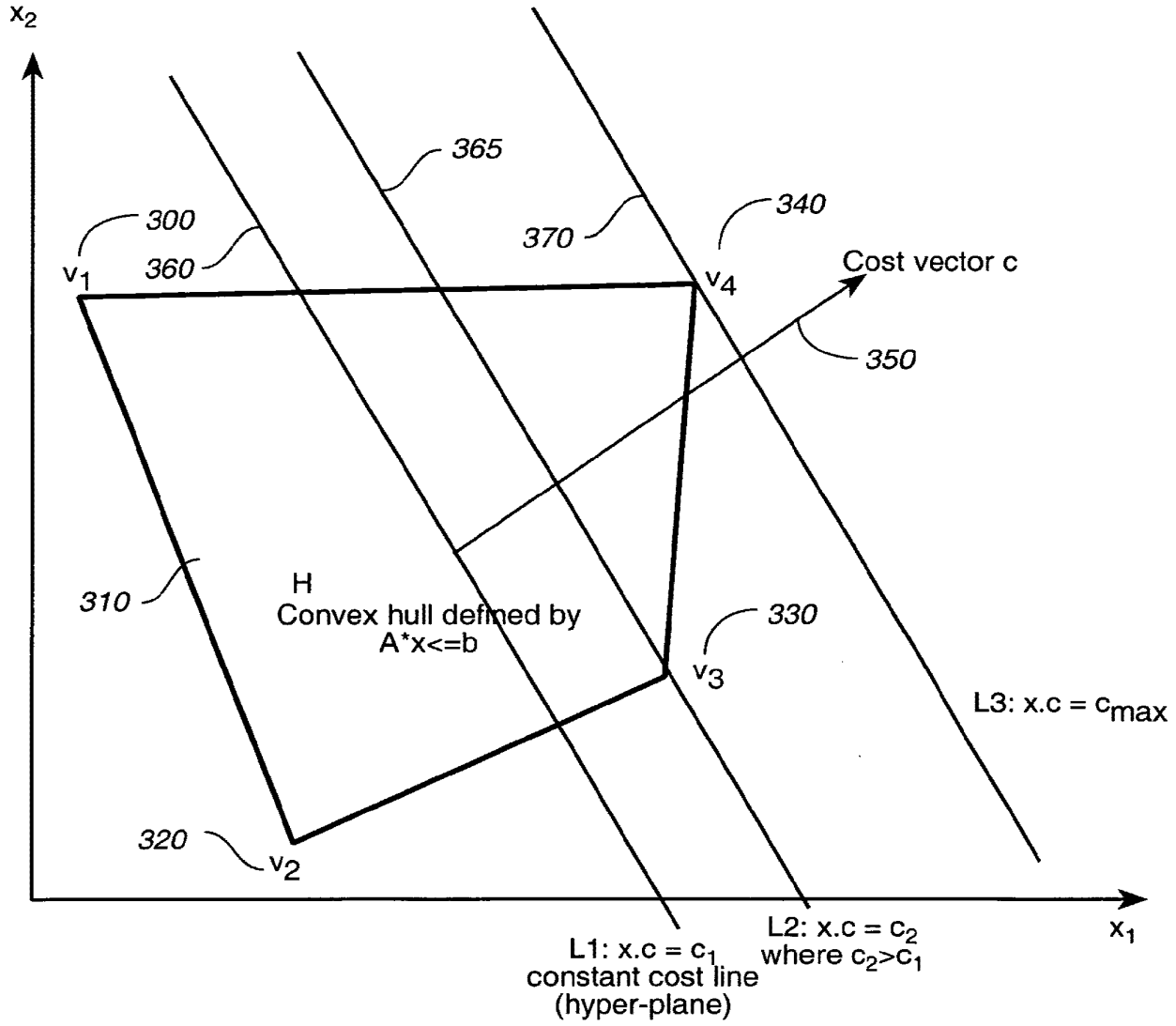

x2
x1
300
v1
360
365
370
340
v4
Cost vector c
350
310
H
Convex hull defined by
A*x<=b
330
v3
L3: x.c = cmax
320
v2
L1: x.c = c1
constant cost line
(hyper-plane)
L2: x.c = c2
where c2>c1

FIG._3

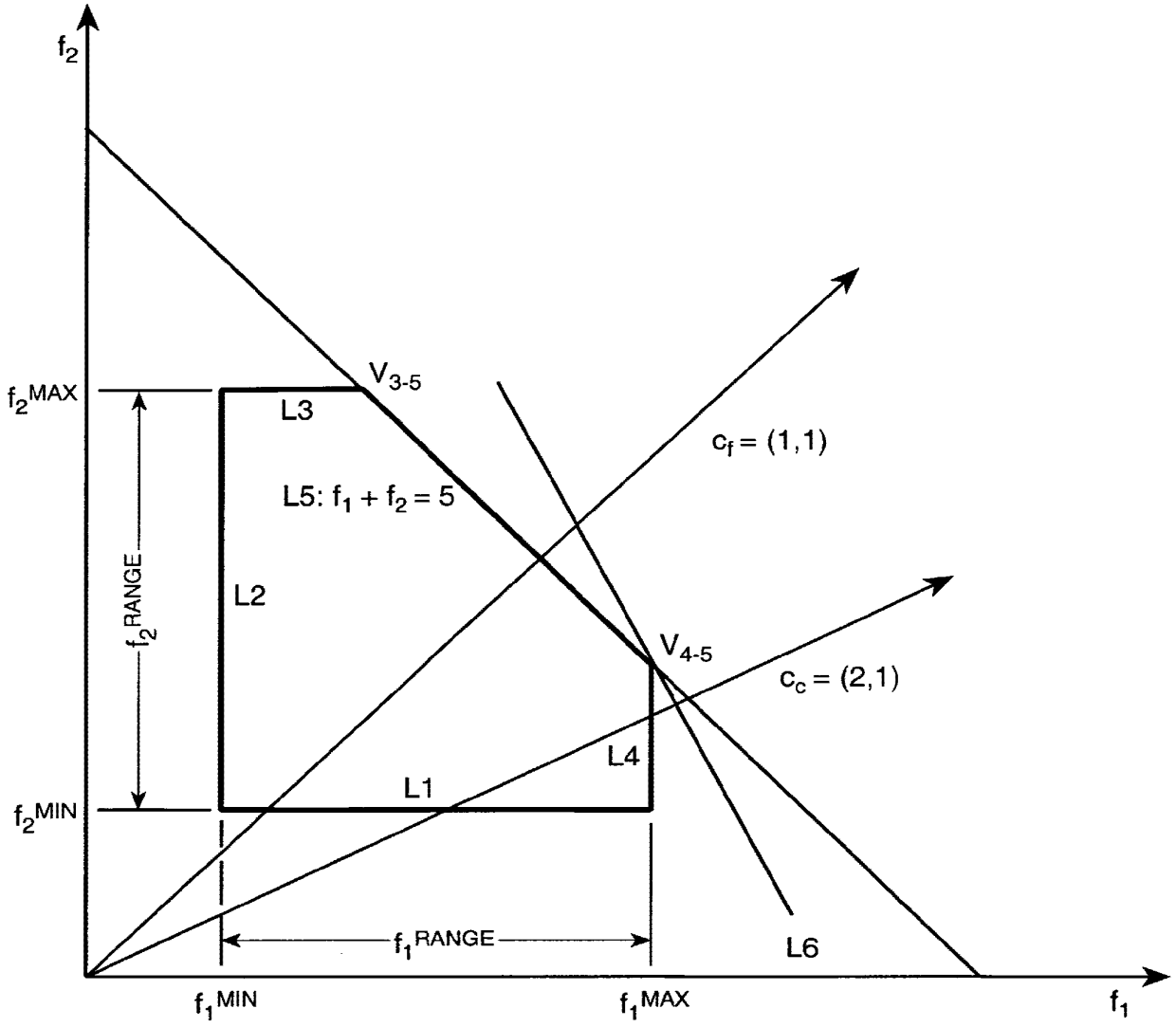

f2
f2MAX
f2MIN
f2RANGE
V3-5
L3
L5: f1 + f2 = 5
L2
V4-5
cf = (1,1)
cc = (2,1)
L4
L1
L6
f1RANGE
f1MIN
f1MAX
f1

FIG._4a

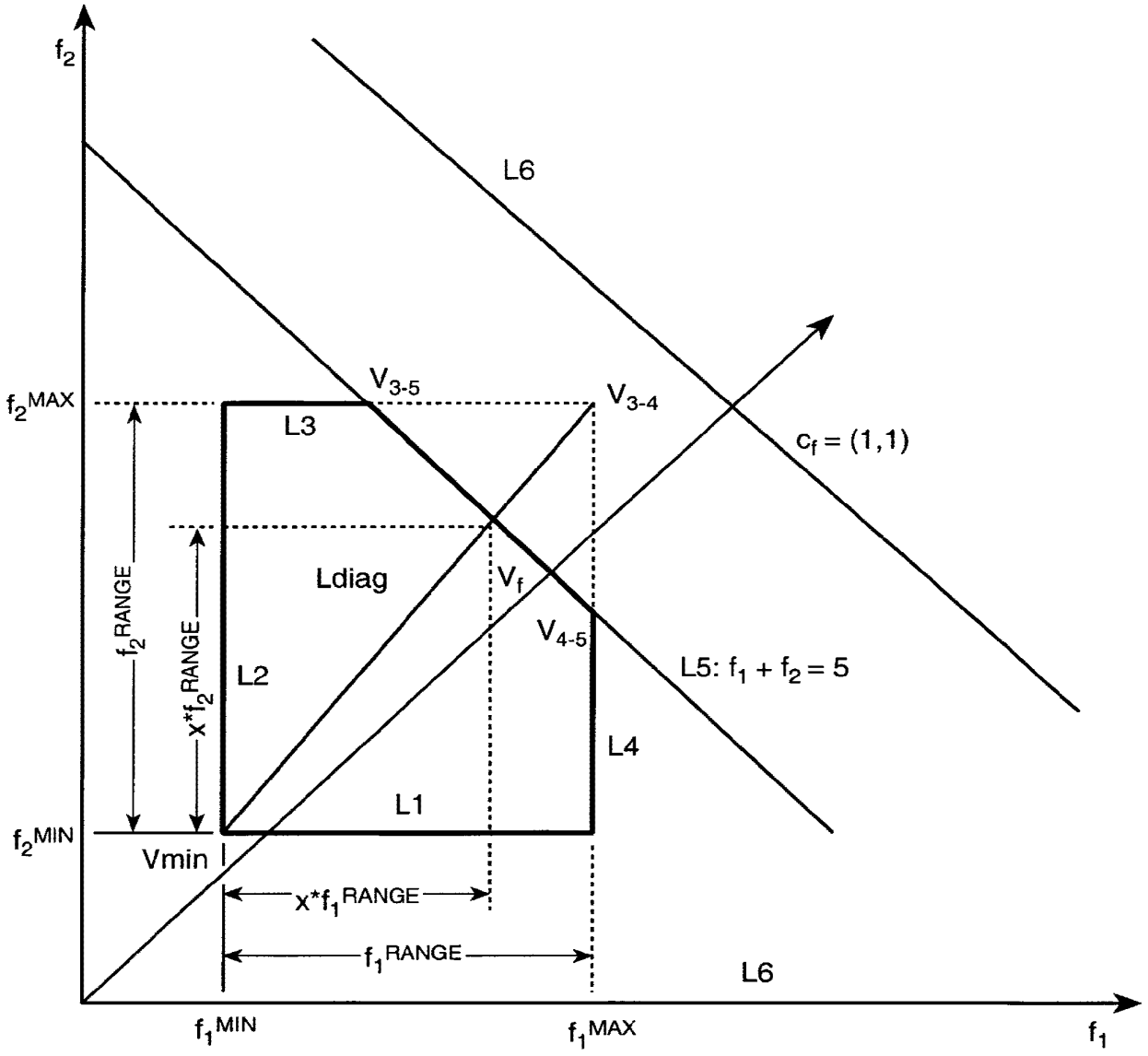

f2
L6
f2MAX
V3-5
V3-4
L3
cf = (1,1)
Ldiag
Vf
V4-5
f2RANGE
x*f2RANGE
L2
L5: f1 + f2 = 5
L4
L1
f2MIN
Vmin
x*f1RANGE
f1RANGE
L6
f1MIN
f1MAX
f1

FIG._4b

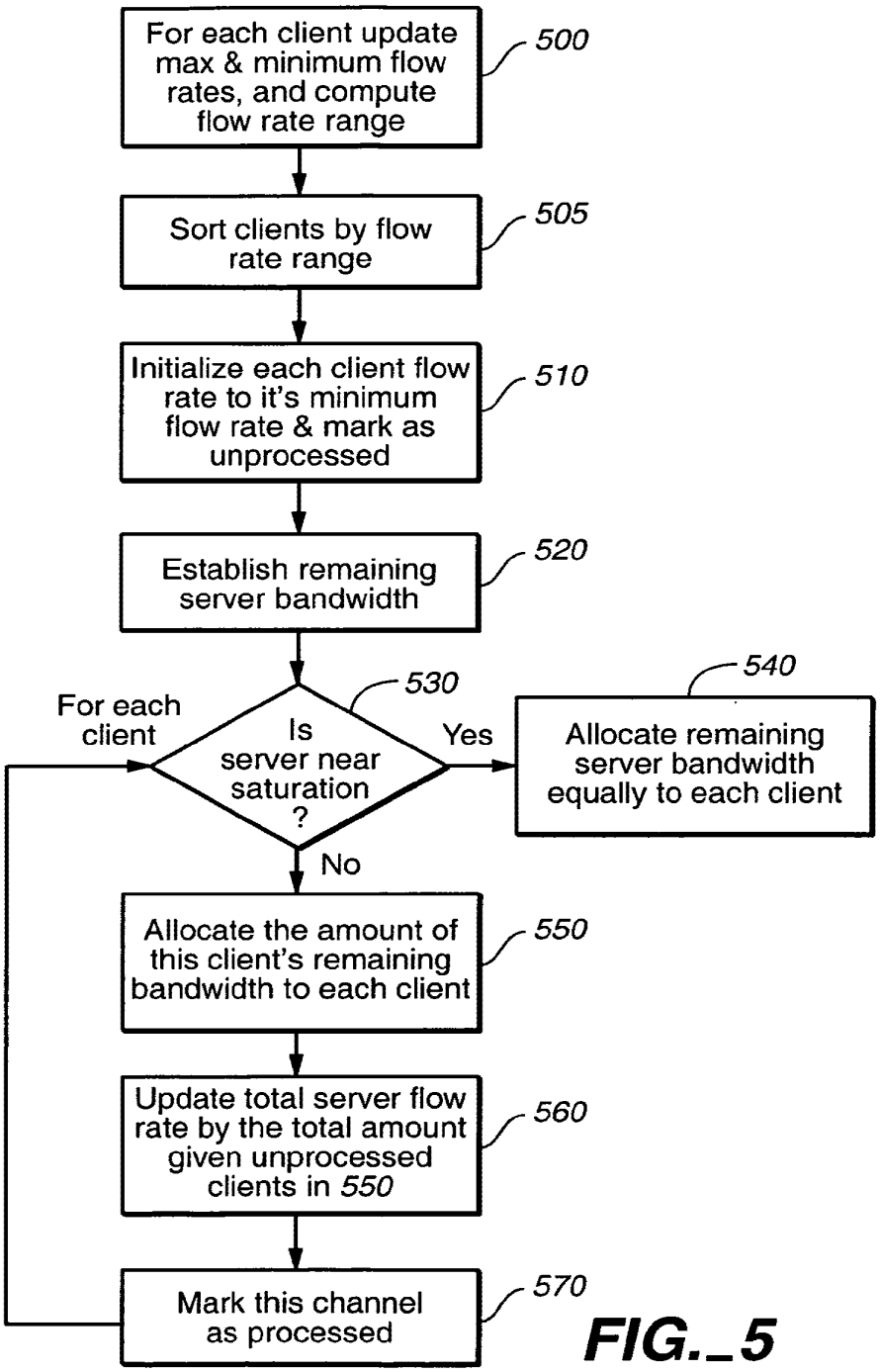

For each client update max & minimum flow rates, and compute flow rate range
500
Sort clients by flow rate range
505
Initialize each client flow rate to it's minimum flow rate & mark as unprocessed
510
Establish remaining server bandwidth
520
For each client
Is server near saturation ?
530
Yes
Allocate remaining server bandwidth equally to each client
540
No
Allocate the amount of this client's remaining bandwidth to each client
550
Update total server flow rate by the total amount given unprocessed clients in 550
560
Mark this channel as processed
570

FIG._5

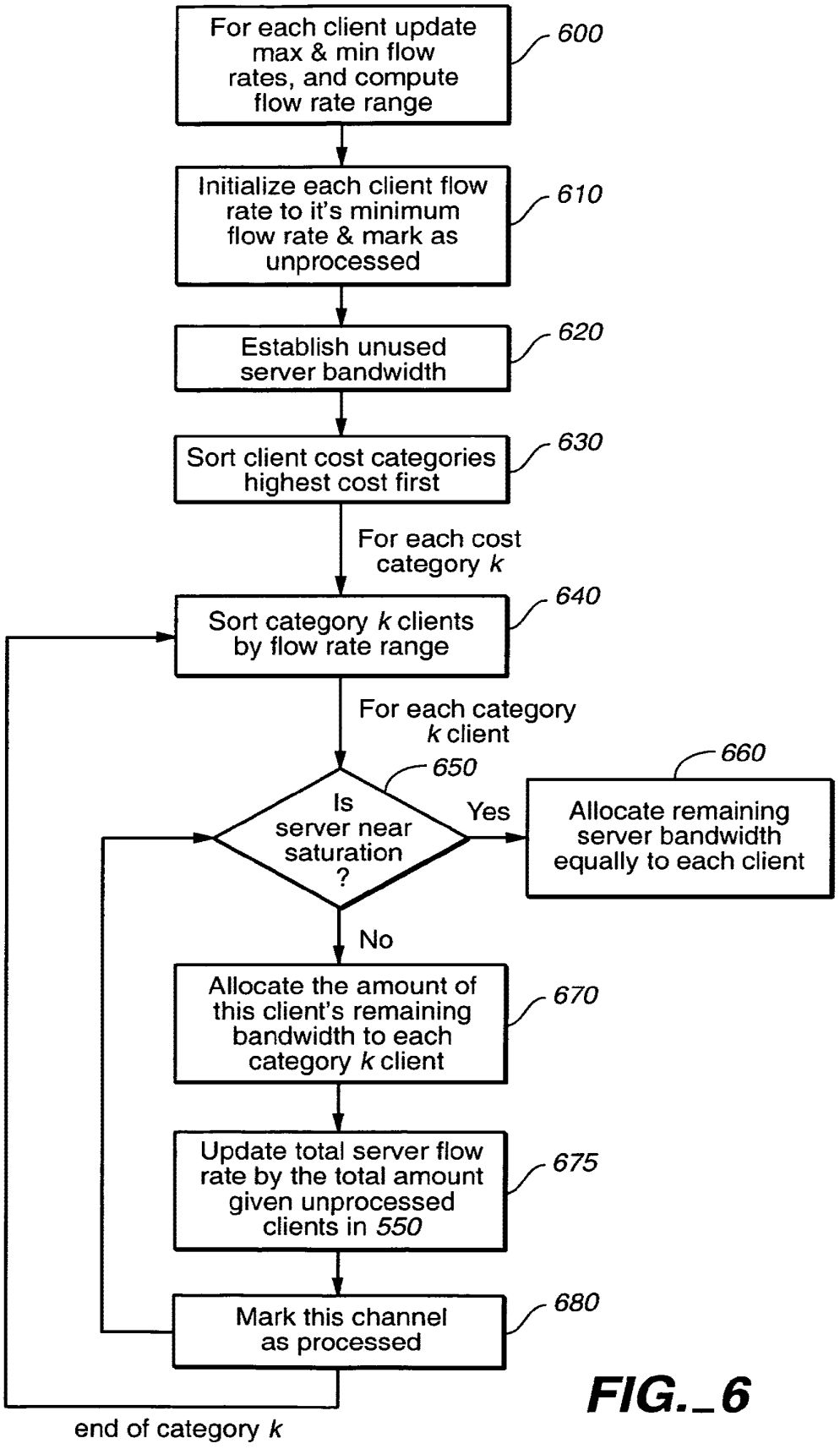

For each client update max & min flow rates, and compute flow rate range
600
Initialize each client flow rate to it's minimum flow rate & mark as unprocessed
610
Establish unused server bandwidth
620
Sort client cost categories highest cost first
630
For each cost category k
Sort category k clients by flow rate range
640
For each category k client
650
Is server near saturation ?
Yes
660
Allocate remaining server bandwidth equally to each client
No
Allocate the amount of this client's remaining bandwidth to each category k client
670
Update total server flow rate by the total amount given unprocessed clients in 550
675
Mark this channel as processed
680
end of category k

FIG._6

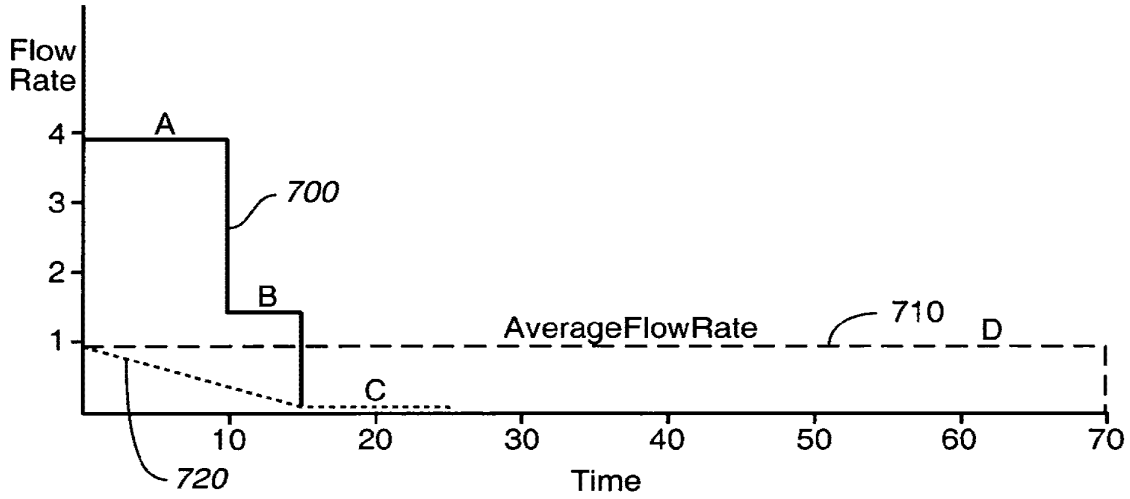

Flow Rate
4
3
2
1
A
700
B
C
AverageFlowRate
710
D
720
10
20
30
40
50
60
70
Time

FIG._7

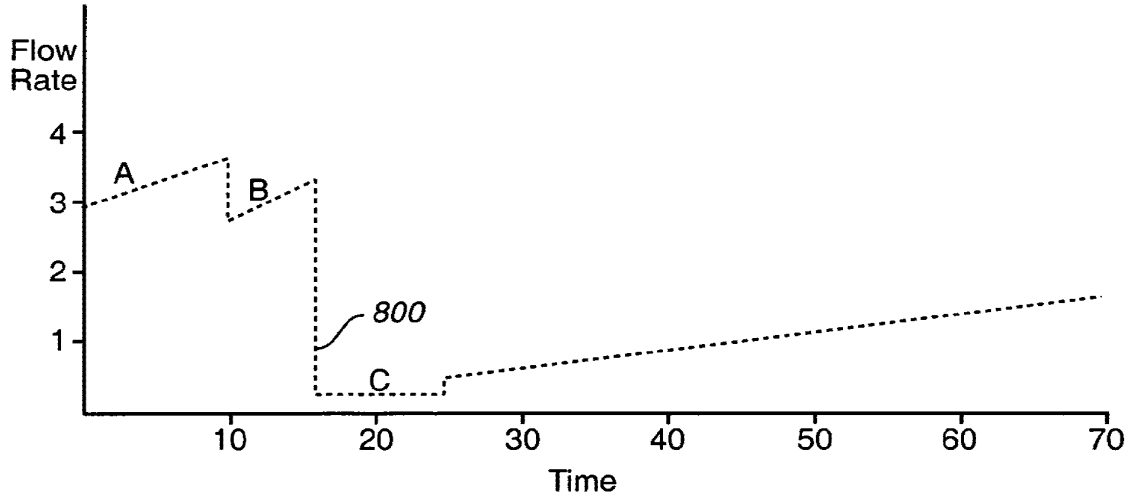

Flow Rate
4
3
2
1
A
B
800
C
10
20
30
40
50
60
70
Time

FIG._8

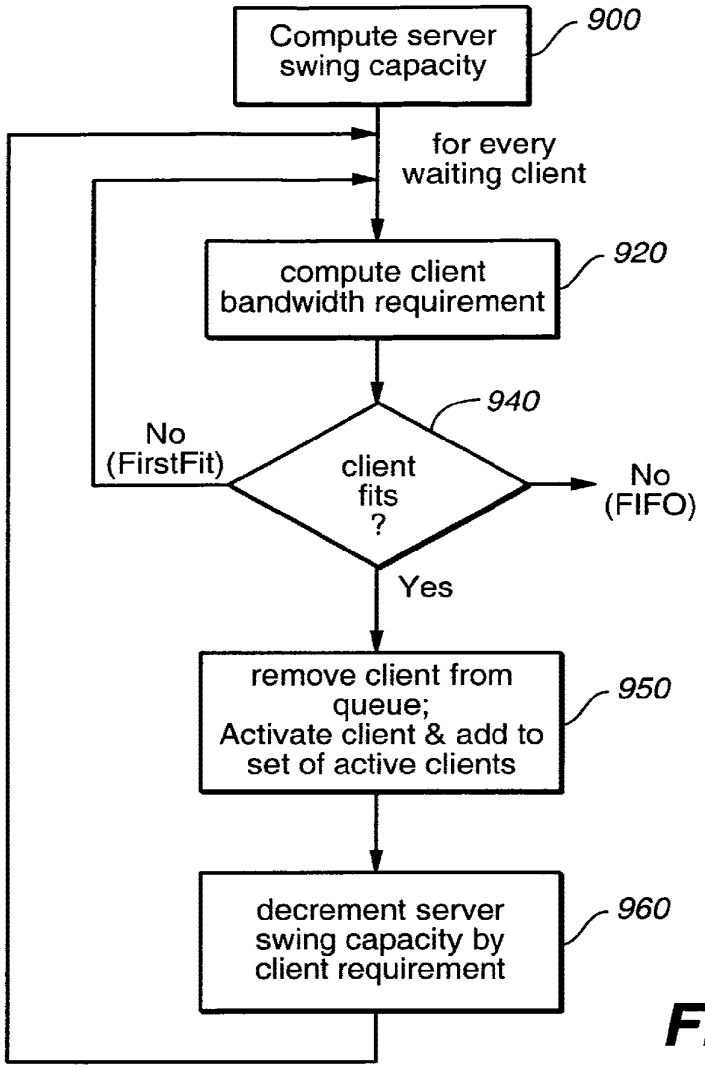

Compute server swing capacity
900
for every waiting client
compute client bandwidth requirement
920
940
client fits ?
No (FirstFit)
No (FIFO)
Yes
remove client from queue; Activate client & add to set of active clients
950
decrement server swing capacity by client requirement
960

FIG._9

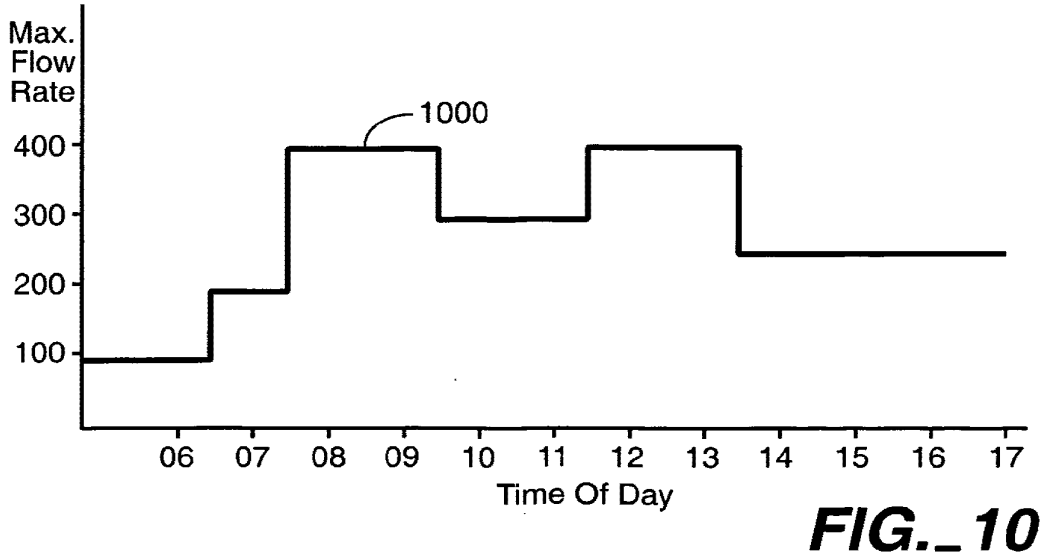

Max. Flow Rate
400
300
200
100
1000
06
07
08
09
10
11
12
13
14
15
16
17
Time Of Day

FIG._10

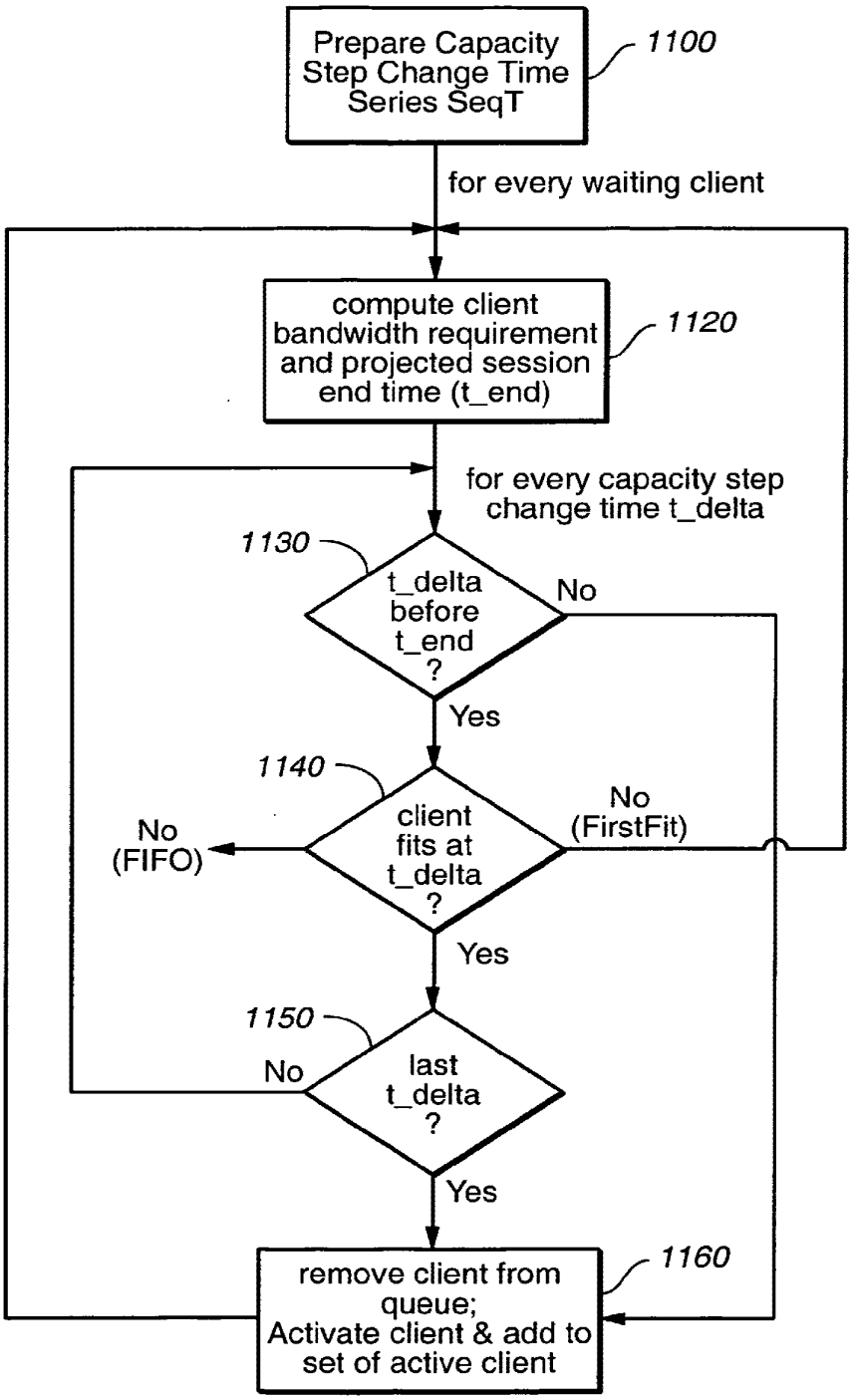

Prepare Capacity Step Change Time Series SeqT
1100
for every waiting client
compute client bandwidth requirement and projected session end time (t_end)
1120
for every capacity step change time t_delta
1130
t_delta before t_end ?
No
Yes
1140
client fits at t_delta ?
No (FIFO)
No (FirstFit)
Yes
1150
last t_delta ?
No
Yes
remove client from queue; Activate client & add to set of active client
1160

FIG._11

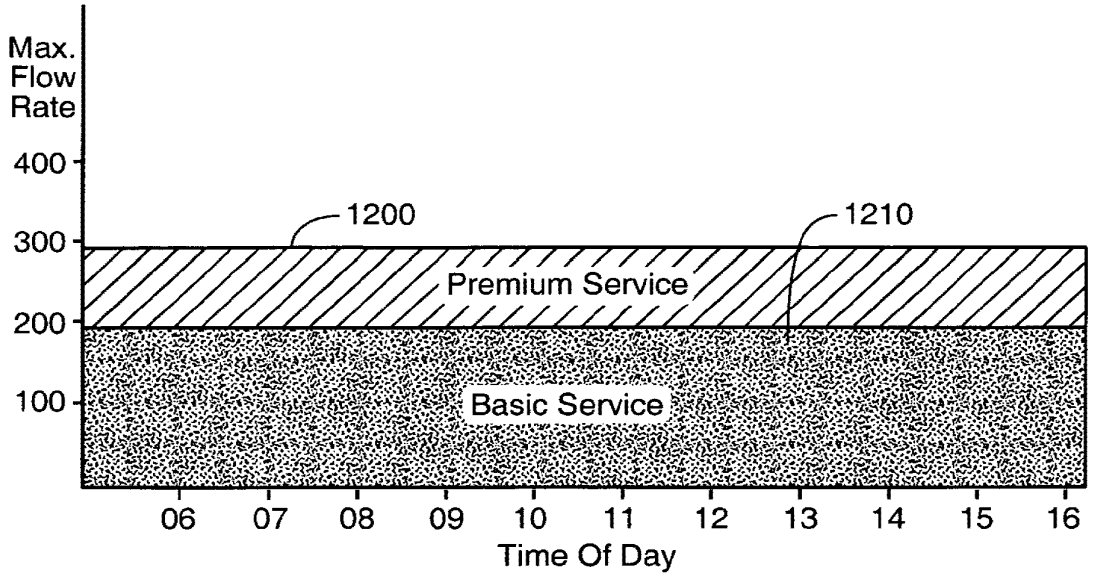

Max.
Flow
Rate
400
300
200
100
1200
1210
Premium Service
Basic Service
06
07
08
09
10
11
12
13
14
15
16
Time Of Day

FIG._12

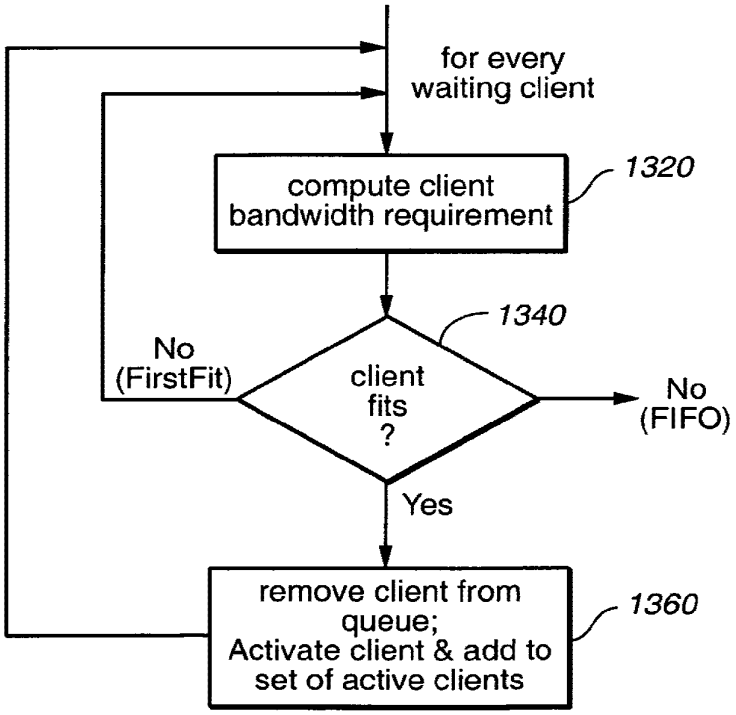

for every
waiting client
compute client
bandwidth requirement
1320
1340
No
(FirstFit)
client
fits
?
No
(FIFO)
Yes
remove client from
queue;
Activate client & add to
set of active clients
1360

FIG._13

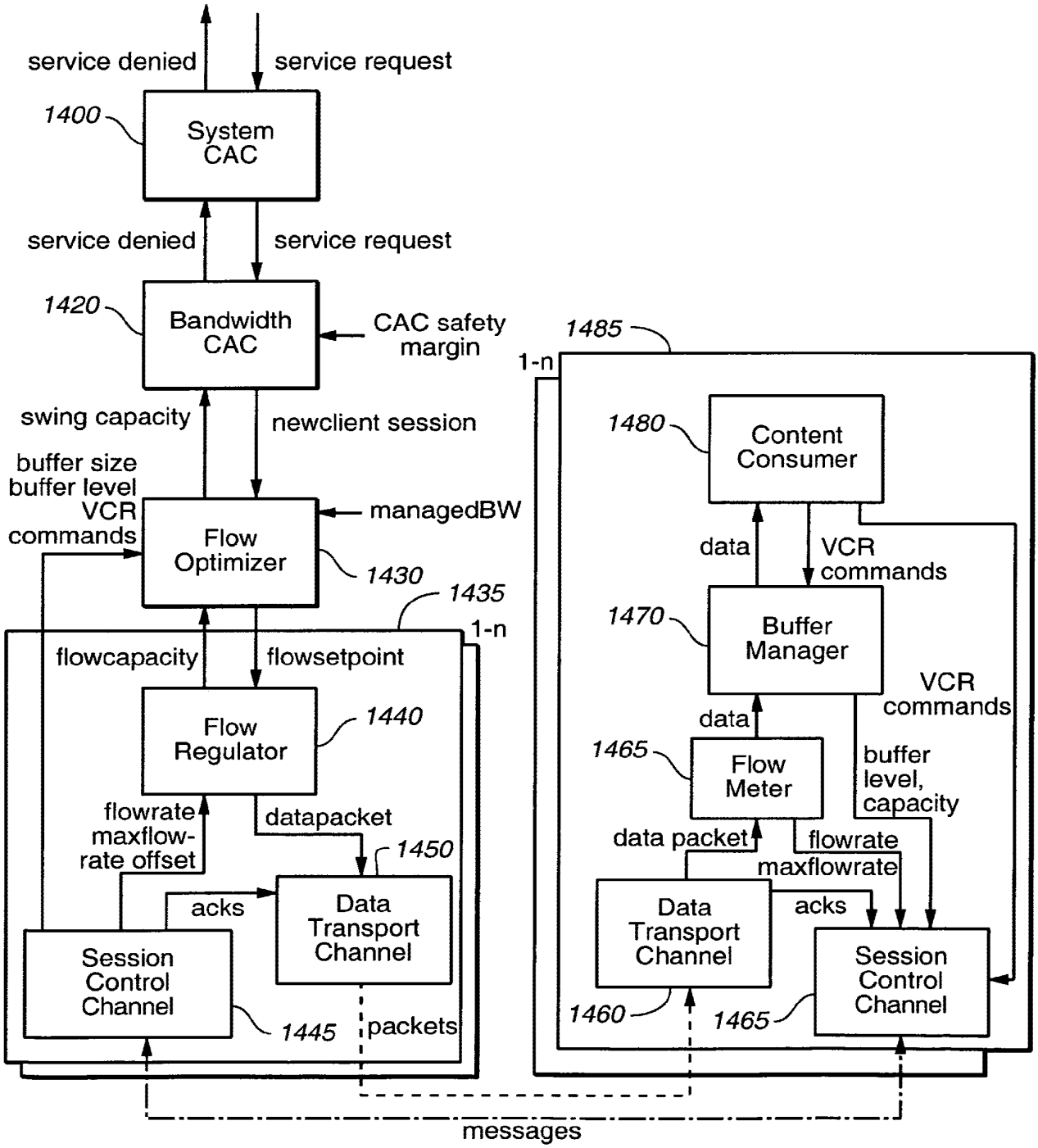

service denied
service request
1400
System CAC
service denied
service request
1420
Bandwidth CAC
CAC safety margin
swing capacity
newclient session
buffer size
buffer level
VCR commands
Flow Optimizer
managedBW
1430
1435
1-n
flowcapacity
flowsetpoint
Flow Regulator
1440
flowrate
maxflow-rate offset
datapacket
1450
acks
Data Transport Channel
Session Control Channel
1445
packets
1485
1-n
1480
Content Consumer
data
VCR commands
1470
Buffer Manager
VCR commands
data
1465
Flow Meter
buffer level, capacity
data packet
flowrate
maxflowrate
Data Transport Channel
acks
Session Control Channel
1460
1465
messages

FIG._14

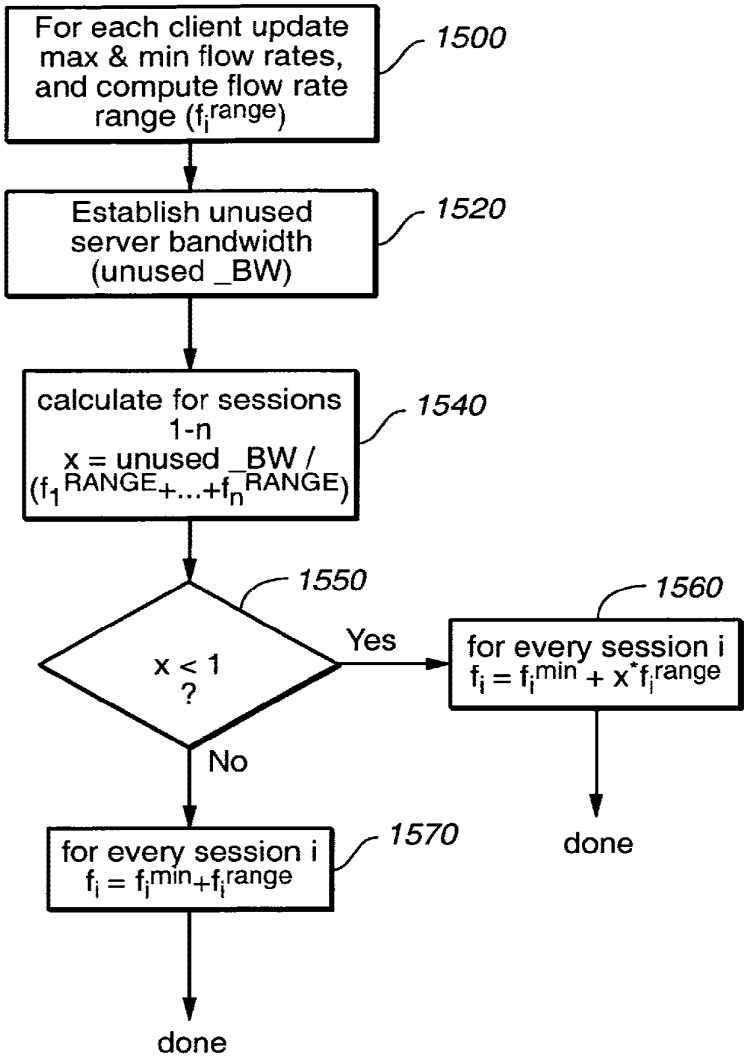

For each client update max & min flow rates, and compute flow rate range (f_i^{range})
1500
Establish unused server bandwidth (unused _BW)
1520
calculate for sessions 1-n
x = unused _BW / (f_1^{RANGE}+...+f_n^{RANGE})
1540
1550
x < 1 ?
Yes
No
1560
for every session i
$f_i = f_i^{min} + x^* f_i^{range}$
done
1570
for every session i
$f_i = f_i^{min} + f_i^{range}$
done

FIG._15

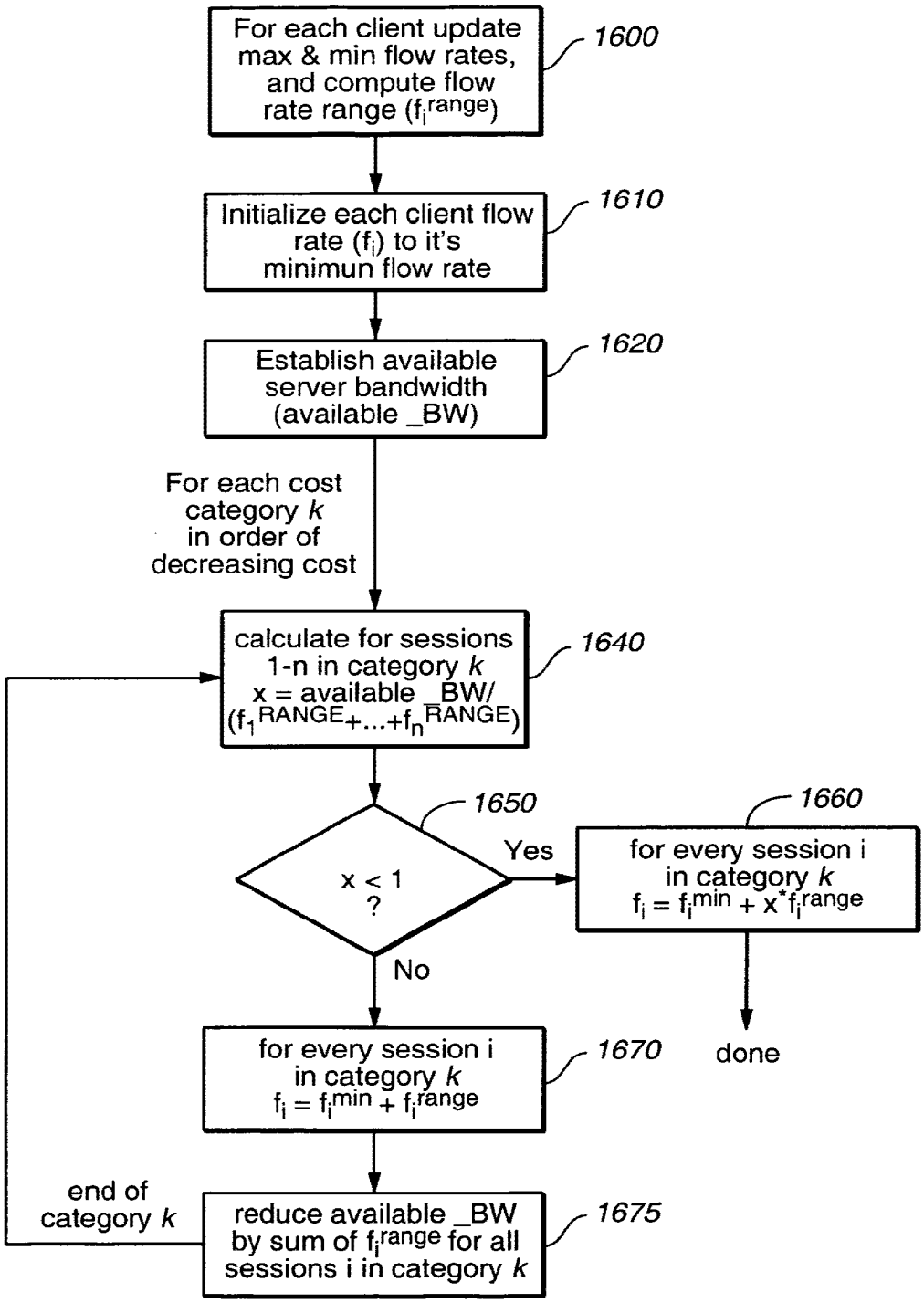

For each client update max & min flow rates, and compute flow rate range (f_i^{range})
1600
Initialize each client flow rate (f_i) to it's minimun flow rate
1610
Establish available server bandwidth (available _BW)
1620
For each cost category k in order of decreasing cost
calculate for sessions 1-n in category k x = available _BW/ (f_1^{RANGE}+...+f_n^{RANGE})
1640
1650
x < 1 ?
Yes
No
1660
for every session i in category k $f_i = f_i^{min} + x^* f_i^{range}$
done
for every session i in category k $f_i = f_i^{min} + f_i^{range}$
1670
end of category k
reduce available _BW by sum of f_i^{range} for all sessions i in category k
1675

FIG._16

Aylo Exhibit 1018
Page 1040 of 2308

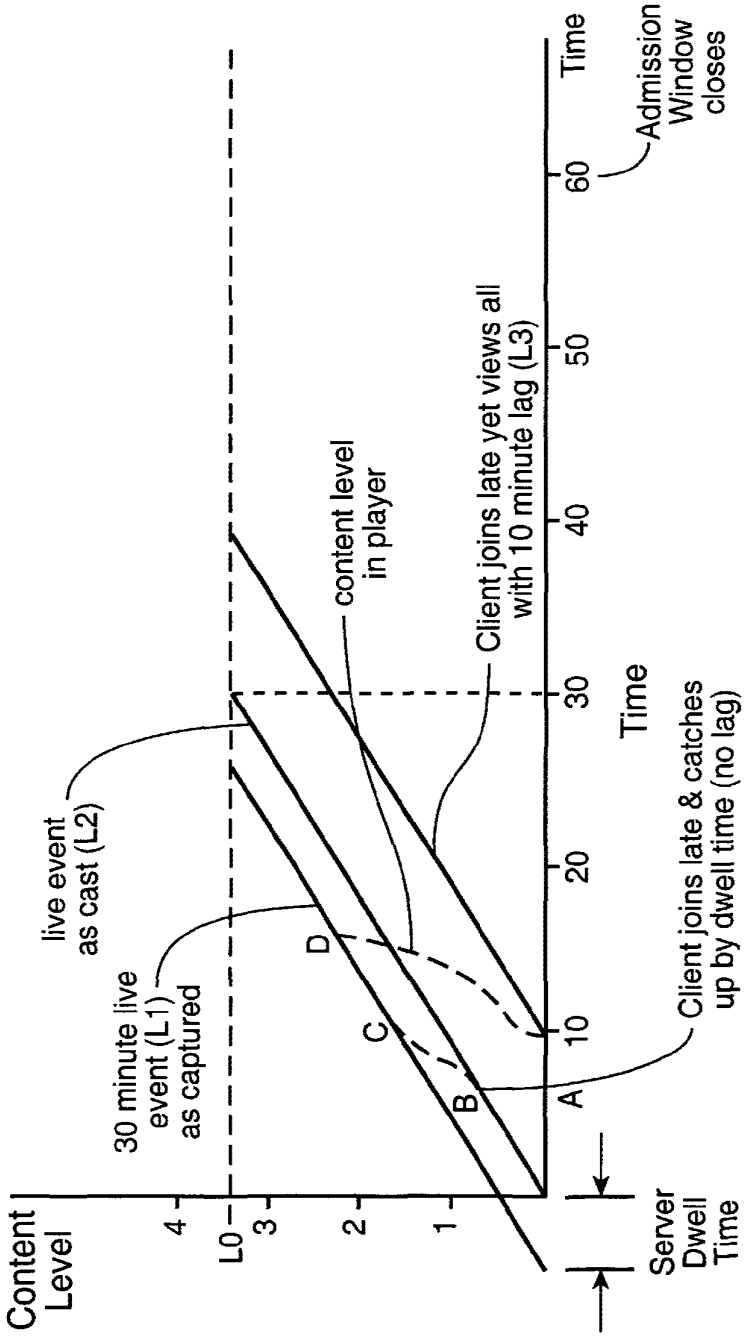


FIG._17

PATENT COOPERATION TREATY

RECEIVED
NOV 10 2008
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN
SUNNYVALE

From the INTERNATIONAL SEARCHING AUTHORITY

To:
LESTER J. VINCENT
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
SUNNYVALE, CA 94085-4040

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

RECEIVED
NOV 14 2008
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN

Date of mailing *(day/month/year)* 05 NOV 2008	
Applicant's or agent's file reference 8532P004PCT	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US 08/09281	International filing date *(day/month/year)* 01 August 2008 (01.08.2008)
Applicant MOVE NETWORKS, INC.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

Entered into PIP by: dlm

DATE IN TO FOREIGN DOCKETING 11/11/08
DOCKETED BY
REVIEWED BY
DATE OUT

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
LESTER J. VINCENT
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
SUNNYVALE, CA 94085-4040

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 05 NOV 2008
Applicant's or agent's file reference 8532P004PCT	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US 08/09281	International filing date *(day/month/year)* 01 August 2008 (01.08.2008)
Applicant MOVE NETWORKS, INC.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 8532P004PCT	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 08/09281	International filing date *(day/month/year)* 01 August 2008 (01.08.2008)	(Earliest) Priority Date *(day/month/year)* 06 August 2007 (06.08.2007)
Applicant MOVE NETWORKS, 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 9 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(b), 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 figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/09281

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 15/16 (2008.04)
USPC - 709/231
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)
USPC: 709/231

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 709/206, 207,.219, 225, 230-235

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Electronic Databases Searched: PubWEST (PGPB,USPT,USOC,EPAB,JPAB); GoogleScholar
Search Terms Used: streamlets, adaptive stream, multi-rate, multi-bitrate, rate-shifting, skip, ignore, scrub, streaming video/media, filter, block, simulcoding, timeline, live horizon, ratings, porn, mute etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0262257 A1 (MAJOR et al.) 24 November 2005 (24.11.2005) (shared author) entire document, especially: Abstract, para [0045], [0047], [0073]	1-26
Y	Clement, B., Page One PR, "Move Networks Closes $11.3 Million In First Round VC Funding," Move Networks, Inc. Press Releases, 07 February 2007 (07.02.2007) [retrieved 12 October 2008 (12.10.2008)] Retrieved from the Internet. <URL: http://www.move.tv/press/press20070207.html> entire document, especially: pg 1, para 4-6	1-26
Y	US 2006/0277564 A1 (JARMAN) 07 December 2006 (07.12.2006) entire document, especially: Abstract, para [0010], [0015], [0068]	4-6, 12-13, 17-19, 22-24
A	Move Networks, "The Next Generation Video Publishing System," 11 April 2007 (11.04.2007) [retrieved 13 October 2008 (13.10.2008)]. Retrieved from the Internet. <URL: http://www.movenetworks.com/wp-content/uploads/move-networks-publishing-system.pdf>	1-26

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

* 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 another 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
14 October 2008 (14.10.2008)	05 NOV 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
LESTER J. VINCENT
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
1279 OAKMEAD PARKWAY
SUNNYVALE, CA 94085-4040

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	05 NOV 2008
Applicant's or agent's file reference 8532P004PCT	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 08/09281	01 August 2008 (01.08.2008)	06 August 2007 (06.08.2007)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06F 15/16 (2008.04)
USPC - 709/231

Applicant MOVE NETWORKS, INC.

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 43*bis*.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 66.1*bis*(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.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	14 October 2008 (14.10.2008)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 06/09281

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. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/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 and/or table(s) relating thereto 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/US 08/09281

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

1. Statement

Novelty (N)	Claims	1-26	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-26	NO
Industrial applicability (IA)	Claims	1-26	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-3, 7-11, 14-16, 20-21 and 25-26 lack inventive step under PCT Article 33(3) as being obvious over US 2005/0262257 A1 to Major et al. (hereinafter 'Major') in view of the article entitled "Move Networks Closes $11.3 Million in First Round VC Funding," (Clement).

As to claims 1, 9, 15, 21 and 26, Major teaches a system, method, apparatus and computer program product for multi-bitrate content streaming (adaptive-rate shifting of streaming content, see Abstract), wherein the media content comprises a plurality of streamlets (plurality of streamlets, see Abstract); and at least one data module configured to maintain multi-bitrate streamlet information (staging module is configured to stage the streamlets and arrange the streamlets for playback, see Abstract).
Major does not expressly teach a timeline module configured to maintain a programming lineup of media content available over a network. However, Clement teaches multi-bitrate content streaming (adaptive stream that upshifts and downshifts to match the current constraints, see pg 1, para 4) and a timeline module configured to maintain a programming lineup of media content available over a network (TiVo style navigation, see pg 1, para 6) and a client module configured to acquire content based upon the programming lineup provided by the timeline module (Move Media Player - Viewer Controls, TiVo style, see para 6).
It would have been obvious to one of ordinary skill in the art to combine the timeline module, as taught by Clement, with the Major system for multi-bitrate content streaming in order to enable the user to efficiently select and manage their desired content, thus increasing the ease of use for the end-user and increasing the revenue potential for the content providers.

As to claims 2 and 10, Clement teaches each streamlet comprises a portion of the media content encapsulated as an independent media object (Each streamlet 212 may comprise a portion of the content contained in stream 210, encapsulated as an independent media object, see para [0047]), and wherein each streamlet comprises a predetermined duration of time (in one embodiment, the content contained in each streamlet 212 has a duration of two seconds, see para [0047]).

As to claims 3 and 11 and 16, Major teaches multi-bitrate streamlet information is selected from the group consisting of start time, end time, live video, publisher data, encryption, duration, bitrate values, frame size, channels, codecs, sample rate, and frames parser (content file 200 may also be live or archived content, see para [0045] and Fig. 2a).

As to claims 7 and 25, Clement teaches a content management system configured to dynamically replace portions of the media content (shows can even be pre-empted and replaced by alternative programming, see pg 1, para 5).

As to claim 8, Major teaches an anchor module configured to associate the start of the timeline module with a point in time such that playback of the media content begins at a point corresponding to a live horizon (presentation at the current playback time index, see pg 1, para [0073]).

As to claims 14 and 20, Clement teaches a content management system configured to dynamically replace portions of the media content (shows can even be pre-empted and replaced by alternative programming, see pg 1, para 5).

(See Supplemental Box)

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Box No. V --- Reasoned Statement
2. Citations and Explanations:

Claims 4-6, 12-13, 17-19 and 22-24 lack inventive step under PCT Article 33(3) as being obvious over Major in view of Clement as applied above, and further in view of US 2006/0277564 A1 (Jarman).

As to claims 4, 12, 17, 22 and 23, the combination of Major and Clement teach the apparatus of claim 1, the system of claim 9, the method of claim 15 and the computer program product of claim 21, and Major further teaches streamlets providing content (a staging module configured to stage the streamlets and arrange the streamlets for playback on a content player , see para [0015]), but the combination of Major and Clement does not expressly teach a module configured to skip content in response to a rating system level. However, Jarman teaches a programming content distribution system which further comprising a client module configured to skip content in response to a rating system (selectively mutes context specific words as a function of program specific criteria, see Abstract). It would have been obvious to one of ordinary skill in the art to combine the Jarman content filtering system with the content distribution system taught by Major and Clement because this would enable the user to instruct the more precisely control the desired viewing content; further, Clement suggests content filtering (complete editing and publishing control, see pg 1, para 4) such as that taught by the Jarman content filtering system.

As to claims 5 and 18, Jarman teaches the client module is configured to skip streamlets that do not conform to a selected rating level (allow play of only programs associate with selected program specific information; and blocking display of all programs not including the selected program specific information, see para [0010]).

As to claim 6, Jarman teaches the client module is configured to mute the audio of streamlets that do not conform to a selected rating level (mute words for an audio or audio/video presentation that may be objectionable in one context, see para [0068]).

As to claims 13, 19 and 24, the combination of Major and Clement teach the system of claim 9 and the method of claim 15, but does not expressly teach the client module is configured to mute the audio of streamlets that do not conform to a selected rating level. However, Jarman teaches multi-bitrate content streaming (adaptive stream that upshifts and downshifts to match the current constraints, see pg 1, para 4) and a timeline module configured to maintain a programming lineup of media content available over a network (TiVo style navigation, see pg 1, para 6) and wherein the client module is configured to mute the audio of streamlets that do not conform to a selected rating level (electively mutes context specific words as a function of program specific criteria, see Abstract. It would have been obvious to combine the Jarman selective content filtering and muting system with the content distribution system taught by Major and Clement because this would enable the user to instruct the more precisely control the desired viewing content; further, Clement suggests content filtering (complete editing and publishing control, see pg 1, para 4).

Claims 1-26 have industrial applicability as defined by PCT Article 33(4) because the subject matter claimed can be made or used in industry.

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*, a publication of WIPO.

In these Notes, "Article," "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Volume I/A, Annexes B1 and B2).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide*, Volume I/A, paragraph 296).

What parts of the international application may be amended ?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Preliminary Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When ? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments ?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How ? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments ?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

Aylo Exhibit 1018
Page 1049 of 2308

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
BRIAN C. KUNZLER
8 EAST BROADWAY, SUITE 600
SALT LAKE CITY, UT 84111

RECEIVED
JAN 09 2009

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 2082.2.4PCT	Date of mailing *(day month year)* 12 DEC 2008
International application No. PCT/US 08/61035 8532P003PCT	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
Applicant MOVE NETWORKS, INC.	International filing date *(day month year)* 21 April 2008 (21.04.2008)

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

Date In to SV FF: 1-12-09
Docketed by: MFA
Reviewed by:
Sent Out by SV FF on:

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2082.2.4PCT	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 08/61035	International filing date *(day/month/year)* 21 April 2008 (21.04.2008)	(Earliest) Priority Date *(day/month/year)* 19 April 2007 (19.04.2007)
Applicant MOVE NETWORKS, 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 9 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(b), 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. 4

☐ 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 figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/61035

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 15/16 (2008.04)
USPC - 709/227
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)
USPC: 709/227

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 709/201, 203, 223, 227, 228, 238; 715/736, 744, 748, 968

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest(PGPB,USPT,USOC,EPAB,JPAB); Google
Search Terms Used: content acquisition, resilient, networks, tcp, directive handling module, content acquisition module, directive server, network connection, remote host etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0188051 A1 (SNEH) 25 August 2005 (25.08.2005), para [0005], para [0055]-[0097], para [0121]-[0136], para [0188]	1-36
Y	US 2003/0014684 A1 (KASHYAP) 16 January 2003 (16.01.2003), para [0101]	1-36
A	US 2006/0206246 A1 (WALKER) 14 September 2006 (14.09.2006)	1-36

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

* 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 another 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
25 November 2008 (25.11.2008)	12 DEC 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
BRIAN C. KUNZLER
8 EAST BROADWAY, SUITE 600
SALT LAKE CITY, UT 84111

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	12 DEC 2008
Applicant's or agent's file reference 2082.2.4PCT	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date *(day month year)*	Priority date *(day month year)*
PCT/US 08/61035	21 April 2008 (21.04.2008)	19 April 2007 (19.04.2007)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06F 15/16 (2008.04)
USPC - 709/227

Applicant MOVE NETWORKS, INC.

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 43*bis*.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 66.1*bis*(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.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	26 November 2008 (26.11.2008)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 08/61035

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. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/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 and/or table(s) relating thereto 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/US 08/61035

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

1. Statement

Novelty (N)	Claims	1-36	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-36	NO
Industrial applicability (IA)	Claims	1-36	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-36 lack an inventive step under PCT Article 33(3) as being obvious over US 2005/0188051 A1 (Sneh) in view of US 2003/0014684 A1 (Kashyap).

Regarding claim 1, Sneh discloses an apparatus for resilient content acquisition (content, para [0005]), the apparatus comprising: a directive handling module configured to implement a directive (directives, para [0055]); wherein the directive defines requirements for establishing, locating, and maintaining a network connection (maintain download state, para [0097]); and a content acquisition module configured to acquire content over a network according to the directive (content acquisition, para [0081]). Sneh does not expressly disclose maintaining a network connection with a remote host. Kashyap teaches maintaining a network connection with a remote host (remote host, para [0101]). It would have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the method of Sneh to include maintaining a network connection with a remote host as taught by Kashyap because for the advantage of expanding the network beyond immediate systems for content acquisition.

Regarding claim 2, in the combination of Sneh and Kashyap, Sneh further discloses the content acquisition module is further configured to transmit a directive server query to a directive server (CA Server, para [0136]).

Regarding claim 3, in the combination of Sneh and Kashyap, Sneh further discloses the directive handling module is further configured to receive the directive from the directive server (directives, para [0055]).

Regarding claim 4, in the combination of Sneh and Kashyap, Sneh further discloses the content acquisition module is further configured to locate the content, authorize the content, retrieve the content, display the content, and report statistics in accordance with the directive (content acquisition, para [0081]).

Regarding claim 5, in the combination of Sneh and Kashyap, Sneh further discloses a directive server module configured to maintain a list of directive servers and to select a directive server for each directive request (CA Server, para [0136]).

Regarding claim 6, in the combination of Sneh and Kashyap, Sneh further discloses a server status module configured to maintain a status indicator for each of a plurality of content delivery network servers (status, para [0188]).

Regarding claim 7, in the combination of Sneh and Kashyap, Sneh further discloses a broadcast module configured to broadcast content availability over a network such that a second apparatus acquires the content from the apparatus over the network (content acquisition, para [0081]).

Regarding claim 8, in the combination of Sneh and Kashyap, Kashyap further discloses a discovery module configured to discover available content on the network such that content is acquired from a second apparatus (remote host, para [0101]).

Regarding claim 9, in the combination of Sneh and Kashyap, Kashyap further discloses the directive is further configured to identify a plurality of backup remote hosts (remote host, para [0101]).

(See Supplemental Box)

Supplemental Box

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

Continuation of:
Box No. V — Reasoned statement
2. Citations & explanations:

Regarding claim 10, Sneh discloses a system for resilient content acquisition (content, para [0005]), the system comprising: a client module in communication with a network (modules, para [0121]-[0127]), the client module comprising: a directive handling module configured to implement a directive (directives, para [0055]); wherein the directive defines requirements for establishing, locating, and maintaining a network connection (maintain download state, para [0097]); a content acquisition module configured to acquire content over the network according to the directive (content acquisition, para [0081]); wherein the content acquisition module is further configured to communicate a directive server query with a directive server (CA Server, para [0136]); and wherein the directive server is configured to parse the content request and generate a directive in response to the content request (CA Server, para [0136]). Sneh does not expressly disclose maintaining a network connection with a remote host. Kashyap teaches maintaining a network connection with a remote host (remote host, para [0101]). It would have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the method of Sneh to include maintaining a network connection with a remote host as taught by Kashyap because for the advantage of expanding the network beyond immediate systems for content acquisition.

Regarding claim 11, in the combination of Sneh and Kashyap, Sneh further discloses the directive handling module is further configured to receive the directive from the directive server (directives, para [0055]).

Regarding claim 12, in the combination of Sneh and Kashyap, Sneh further discloses the content acquisition module is further configured to locate the content, authorize the content, retrieve the content, display the content, and report statistics in accordance with the directive (content acquisition, para [0081]).

Regarding claim 13, in the combination of Sneh and Kashyap, Sneh further discloses a directive server module configured to maintain a list of directive servers and to select a directive server for each directive request (CA Server, para [0136]).

Regarding claim 14, in the combination of Sneh and Kashyap, Sneh further discloses a server status module configured to maintain a status indicator for each of a plurality of content delivery network servers (status, para [0188]).

Regarding claim 15, in the combination of Sneh and Kashyap, Sneh further discloses a broadcast module configured to broadcast content availability over a local network such that a second apparatus acquires the content from the apparatus over the network (content acquisition, para [0081]).

Regarding claim 16, in the combination of Sneh and Kashyap, Kashyap further discloses a discovery module configured to discover available content on a network such that content is acquired from a second apparatus (remote host, para [0101]).

Regarding claims 17, 25 and 33, Sneh discloses a method, computer program product, and apparatus for resilient content acquisition (content, para [0005]), comprising: implementing a directive (directives, para [0055]); defining requirements for locating, establishing, and maintaining a network connection (maintain download state, para [0097]); and acquiring content over a network according to the directive (content acquisition, para [0081]). Sneh does not expressly disclose maintaining a network connection with a remote host. Kashyap teaches maintaining a network connection with a remote host (remote host, para [0101]). It would have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the method of Sneh to include maintaining a network connection with a remote host as taught by Kashyap for the advantage of expanding the network beyond immediate systems for content acquisition.

Regarding claims 18 and 26, in the combination of Sneh and Kashyap, Sneh further discloses transmitting a directive server query to a directive server (CA Server, para [0136]).

Regarding claims 19 and 27, in the combination of Sneh and Kashyap, Sneh further discloses receiving the directive from the directive server (CA Server, para [0136]).

Regarding claims 20 and 28, in the combination of Sneh and Kashyap, Sneh further discloses locating the content, authorizing the content, retrieving the content, displaying the content, and reporting statistics in accordance with the directive (content acquisition, para [0081]).

Regarding claims 21 and 29, in the combination of Sneh and Kashyap, Sneh further discloses maintaining a list of directive servers and selecting a directive server for each directive request (CA Server, para [0136]).

Regarding claims 22 and 30, in the combination of Sneh and Kashyap, Sneh further discloses maintaining a status indicator for each of a plurality of content delivery network servers (status, para [0188]).

Regarding claims 23 and 31, in the combination of Sneh and Kashyap, Kashyap further discloses broadcasting content availability over a local network such that a second apparatus acquires the content from the apparatus over the network (remote host, para [0101]).

Regarding claims 24 and 32, in the combination of Sneh and Kashyap, Kashyap further discloses discovering available content on a network such that content is acquired from a second apparatus (remote host, para [0101]).

(See Next Supplemental Box)

Supplemental Box

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

Continuation of:
Preceding Supplemental Box
Box No. V --- Reasoned statement
2. Citations & explanations:

Regarding claim 34, Sneh discloses an apparatus for resilient content delivery (content, para [0005]), the system comprising: a parsing module configured to receive a content request from a source and identify content information (modules, para [0121]-[0127]); a response module configured to generate a directive in response to the content information (directives, para [0055]), wherein the directive defines requirements for establishing, locating, and maintaining a network connection (maintain download state, para [0097]); and wherein the response module is further configured to communicate the directive with the source (content acquisition, para [0081]). Sneh does not expressly disclose maintaining a network connection with a remote host. Kashyap teaches maintaining a network connection with a remote host (remote host, para [0101]). It would have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the method of Sneh to include maintaining a network connection with a remote host as taught by Kashyap because for the advantage of expanding the network beyond immediate systems for content acquisition.

Regarding claim 35, in the combination of Sneh and Kashyap, Sneh further discloses the content information is selected from a group consisting of host, domain, content request source, path, and content name (content acquisition, para [0081]).

Regarding claim 36, in the combination of Sneh and Kashyap, Sneh further discloses the response module is further configured to update and communicate the directive with the source (CA Server, para [0136]).

Claims 1-36 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

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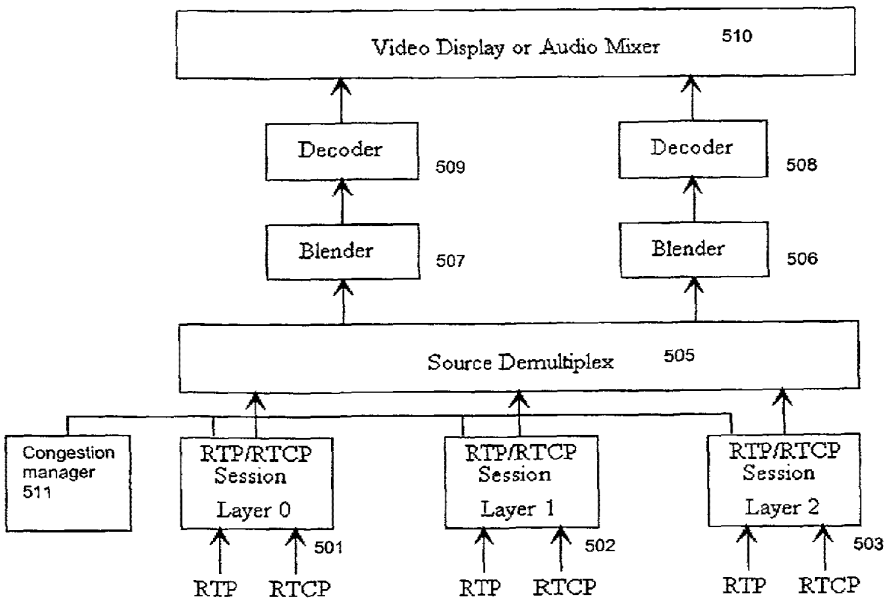
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[Continued on next page]

(54) Title: VIDEO STREAM SWITCHING



(57) Abstract: A technique is described for providing a client on a packet based network with a stream of encoded video data. The system is able to maximise the bit-rate of the video stream by adapting to fluctuations in network capacity. The technique is characterised in that adaptation of the bit-rate of the transmitted encoded video data is timed to occur upon a scene change in the video sequence. In this way the interruption to the viewer when the perceived quality of the video sequence increases or decreases is minimised as it is 'hidden' in the scene change. The technique is described as applied to hierarchically encoded video data but equally may be applied to other encoding techniques which adapt to network conditions.

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— *with international search 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.

Video Stream Switching

The invention is in the field of video streaming over packet networks and in particular concerns the adaptive transmission of data in response to network congestion.

In recent years, the Internet has experienced a proliferation in transmission of real-time multimedia, mainly in the form of streamed audio-visual content, either delivered live or from pre-recorded sources. Furthermore, traditional forms of multimedia such as streaming and conferencing are being followed by applications with richer content such as Internet multi-channel TV and complex immersive environments. This increase in traffic will put strains on the network and it is therefore desirable that application programs are designed to respond to congestion if stability of the network is to be maintained. It is desirable that network conditions are monitored and output bit-rates adjusted to the available bandwidth.

There is a more immediate advantage to the user in having an adaptive output bit-rate which is that the highest possible transmission bit-rate that the network will allow is used and therefore the user will always receive the best possible image quality. There are a number of known approaches to adaptive quality video streaming, one of which is hierarchical coding. In this technique the original video data is encoded into a number of discreet streams called layers, where the first layer consists of basic data of a relatively poor quality and where successive layers represent more detailed information so that layers can be added to increase the image quality or layers can be taken away, depending on the available bandwidth.

As the bit-rate available to a session is subject to significant variations in the number of layers that are transmitted, quality fluctuations occur in the decoded image as layers are added or dropped. When layers are added or dropped frequently the fluctuations in quality may become disturbing to a viewer.

In a first embodiment of the present invention there is provided a method of operating a multimedia server, said method comprising:

providing a stream of video data representing a video sequence to an output of the multimedia server, wherein the output of the media server is connected to a packet based network,

measuring a property of the video data in order to determine the occurrence of a scene change in the video sequence,

detecting the available bandwidth on the network,

varying the bit-rate of the stream of video data,

wherein the method is characterised in that

variation in the bit-rate of the video data is controlled to occur in response to variations in the capacity of the network (203) and preferentially with a scene change in the video sequence.

The term preferentially used herein is meant to indicate that in certain circumstances (discussed in greater detail below) it may not be practical to wait for a change of scene to occur in the video sequence before varying the bit-rate of the video stream, and in such circumstances the bit-rate will be changed at points in the video stream which do not correspond to a change of scene.

The term scene change (or change of scene) is intended to refer to a sudden change in a video sequence within the space of a one or a very few frames such as typically occurs at a change of scene, whether or not there has been an actual change of scene.

Embodiments of the present invention will now be described, by way of example only, with reference to the following figures, where;

Figure 1 is a schematic diagram of the content-based inter-stream session bandwidth sharing architecture.

Figure 2 shows the order of packets in a layered coding system.

Figure 3 is a diagram of a media server.

Figure 4 is a diagram of the network interface of the media server shown in Figure 3.

Figure 5 is a diagram of a client.

Figure 6 is a diagram of a client according to a first embodiment of the present invention.

The client/ server arrangement for a known hierarchical streaming technology is shown in Figure 1. A media server 202 is provided which has access to compressed audiovisual data 201, which may be fed 'live' from an outside broadcast or may be pre-compressed and stored in a database. The data source 201 may be on the same premises as the media server 202 and linked via an intranet. The media server 202 runs on a suitable server computer and which has access to the Internet 203.

A video viewer, hitherto referred to as the client 204, running on a PC suitably configured to have access to the Internet 203, may connect to the media server 202 via the Internet 203 and thus the client 204 is able to access content. A suitable PC terminal is used.

Layered video compression is achieved with the 1998 version of H.263 but equally may be any other codec, such as MPEG4. Each layer in the hierarchy is coded in such a way as to allow the quality of individual pictures to be enhanced and their resolution to be increased, and additional pictures to be included to increase the overall picture rate, as explained with reference to Figure 2. Figure 2 illustrates a typical dependency between pictures in an H.263 scalable layered coder, with the boxes representing the frames for each layer and arrows showing the dependency between frames. The lowest row shows original, un-coded frames. The next row shows the lowest layer (Layer 0) of the hierarchy which is coded at half the frame rate of Layer 1. Frames in Layer 0 are predicted from the previously encoded frame, as in conventional video compression. Frames in Layer 1 may be predicted from the previously encoded frame in Layer 1 and, if present, the temporally simultaneous Layer 0 encoded frame. Frames in Layer 2 may be predicted from the previously encoded frame in Layer 2 and, if present, the temporally simultaneous Layer 1 or Layer 0 encoded frame. The H.263 specification allows for 15 layers; in the present embodiment server and client software is not limited in the number of layers that can be used, but in this case a database has been generated with video streams containing four layers.

Figure 3 shows the architecture of media server 201. In the present embodiment the audiovisual source is a database 301 of compressed video data and the media server 201 is responsible for reading the compressed data from a database, packetising and distributing it. The data is distributed according to the

Real-time Transport Protocol (RTP) which provides end-to-end network transport functions suitable for applications transmitting real-time data such as audio, video or simulation data. RTP does not address resource reservation and does not guarantee quality-of-service for real-time services. The data transport is augmented by a control protocol (RTCP) to allow monitoring of the data delivery and to provide minimal control and identification functionality. RTP and RTCP are designed to be independent of the underlying transport and network layers. The media server 201 has four major components: database reader 302, video RTP packetiser 303, audio RTP packetiser 305 and a network interface 304. Video and audio data are stored as files of compressed bits in the database 301. The database reader 302 retrieves and synchronises the compressed audio and video from the database 301.

The audio and video data is then sent to a RTP packetiser 303,305. Audio and video information is transmitted over the IP network using the User Datagram Protocol (UDP) and Real-time Transport Protocol (RTP) packetisation. UDP provides a checksum to detect transmission errors, but does not guarantee data delivery: packets may be lost, duplicated or re-ordered. RTP provides end-to-end delivery services, such as payload type identification, sequence numbering, time-stamping and delivery monitoring. RTP packetisers 303,305 attach the RTP Header and, in the case of video packets, the H.263 Payload Header which provides some protection from packet loss. The Payload Header contains information specific to the video stream, such as motion vector predictors, which is obtained by decoding the compressed bit stream.

The rate at which data is read from the database 301 is controlled from the network interface 304, which is illustrated in greater detail in Figure 4. With reference to Figure 4 the arrangement of the network interface 304 for the video data will now be described. A packet numbering module 401 assigns a number to each packet of data. These packet numbers are used by the client to assemble packets into the sequence required for decoding. The number of bits produced by compressing a picture is in general not constant, even when the transmission rate is constant. The first picture of a new scene will usually produce a larger number of bits than a picture where there is little movement or detail. The encoding process will use a control strategy together with an output data buffer to smooth these variations in preparation for transmission at a

constant bit rate. In the case of layered coding, each layer has its own control strategy and buffer as it has its own constant bit rate constraint to meet. The delay across each of these buffers will not be constant and will not be the same for each layer. Delay variation between the layers is therefore introduced at the source of the data. Transmission across a network may cause this delay variation to increase. A packet numbering scheme is therefore needed to ensure that a client can arrange the packets it receives into the order required for decoding. This scheme is required to handle the cases of the client not receiving all of the layers and of packet loss in the layers that it does receive.

Each layer is transmitted as an independent RTP Session on a separate IP address by a session handler 403, 405, 407, 409. The rate at which data is transmitted is controlled by the Transfer Rate Control module 402, which counts Layer 0 bytes to ensure that the correct number are transmitted in a given period of time. The transmission rate of the other layers is smoothed and locked to the rate of Layer 0 using First-In First-Out (FIFO) buffer elements 404, 406, 408.

The client 204 of the known hierarchical streaming technology will now be described with reference to Figure 5. Each RTP/RTCP Session associated with each layer of encoded data has a session handler 501, 502, 503, 504 at the client which is responsible for receiving RTP packets from the network.

The packets are then passed to a source demultiplex module 505. This receives packets from all layers and all sources, demultiplexes them by source, and routes them to a blender module 506, 507 for that source.

The blender module 506, 507 receives packets from all layers from one source in the order that they were received from the network. This may not be the order required for decoding because of packet inter-arrival jitter or packet loss. The blender module 506, 507 uses the packet numbers in the RTP headers to arrange the packets from each layer in order and then combines the packets from all layers together. The output of the blender module 506, 507 is a single stream of packets which are in the correct order for decoding. This is the same order as they come out of the packet numbering module 401 of the media server 202.

Packets are then sent to the decoder 508, 509 where the packets are decoded into 20ms blocks of audio samples or to video pictures. In the case of pictures, these are rendered to a window on the display 508.

Also provided is a congestion manager 511 to which the session handlers 501-504 report packet loss. If packets are being consistently lost, indicating network congestion, the congestion manager 511 will instruct the session handler responsible for the highest layer of compressed data to terminate the RTP/RTCP Session. Periodically the congestion manager 511 will instruct an experimental joining of a layer via the appropriate session handler to test whether there is available bandwidth in the network. If this experiment is successful, i.e. that substantially all of the packets of each layer are getting reaching the client, then the new layer will be adopted. In this way the maximum available bandwidth is employed.

It possible for the congestion manager 509 to instruct layers to be dropped and restored rapidly as the network bandwidth fluctuates. This could be annoying for a viewer and so a way of 'hiding' the shift is employed. The layered encoding method described above is adapted so that if a layer is to be dropped or added, the changeover preferentially occurs during a scene-change in the video data. A video scene is typically perceived as the number of consecutive frames within a video sequence that do not show significant changes in the video content. Within a video scene or shot, the camera action may be fixed or may exhibit a number of relatively uniform changes like panning, zooming, tracking etc. Scene changes may be recognised as abrupt transitions of the camera action or gradual transitions. In order to identify the scenes within a video sequence the assumption is that the levels of motion energy as well as those of luminance and colour do not change much between successive frames within a single scene. Techniques of scene boundary identification include pixel differencing, motion vector and block matching techniques. A very sudden change in the content of temporally adjacent frames will thus appear as a change of scene; clearly it is conceivable that such a change might not actually relate to a scene change at all, but, for example, may instead be the consequence of a large foreground object coming rapidly into view. However, such an abrupt change will nonetheless be a good place to add or remove a

session layer and thus the term scene change is meant to cover such large changes in frame content from one frame to another.

Figure 6 illustrates a system which detects congestion in the network and also imposes the extra condition of adding or dropping a layer upon a scene change. The server 601 comprises the components of the media server 202 of Figure 1 and the unit 603 comprises the components of the client 204 also shown in Figure 1. Video data from the audiovisual source is also passed to a content analyser 604 which segments the video sequence into scenes. The segmented video is then passed to an objective quality assessment module (OQAM) 605 which assesses the contribution to the perceived quality of a scene that each component layer provides.

These results are then passed to an inter layer adaptation module (ILAM) 607. The function of the ILAM 607 is to continuously calculate the number of layers that maximise the perceived quality for the session. The ILAM 607 also receives input from a sender congestion manager 608 which reports on the bandwidth available to the session on the network 203. The sender congestion manager 608 receives feedback from a client congestion manager 609 on the number of packets that have been received. If this matches the number of packets that were sent then the bandwidth is known to be the current transmission rate. If packets are being lost then the bandwidth available to the session is less than the transmission rate, in which case the sender congestion manager 608 informs the ILAM 607 that a layer should be dropped.

In order to select which layer should be dropped the ILAM 607 couples the bandwidth required by a layer with its contribution to the quality of the complete image, as calculated by the OQAM 605. The ILAM 607 performs an exhaustive search on all of the bandwidth/quality values. When the ILAM 607 has selected which layer is to be dropped from a particular scene, the timing of the drop is preferentially set to coincide with the transmission of that particular scene. In this way the drop in quality occurs with the scene change and is thus much less noticeable to a viewer than if the quality change had occurred during a scene. In the case that no packets have been lost for a preset period of time the sender congestion manager 608 will request the ILAM 607 to add in a layer to test

whether all of the available bandwidth is being employed. If no packets are lost during this experiment then the newly added layer is maintained. This process of experimentation with adding layers is continued until a significant proportion of packets are lost, in which instance the system can be confident that all of the available bandwidth is being employed. Again, the timing of the introduction of a layer is set to occur preferentially as the scene changes.

Under a given bit-rate allocation the levels of perceived quality do not change considerably within a scene, but scene cuts cause considerable changes in perceived quality, especially when the content features (spatial and motion energy) change a lot between subsequent scenes. As a consequence there will also be a significant difference in the corresponding quality scores for those successive scenes which may justify a rescheduling of the number of layers in the stream.

The invention is not limited in use to hierarchical encoding schemes. The invention is suitable for use in any encoding technique where the adaptation of transmission bit-rate to accommodate fluctuations in network capacity occurs. For instance the invention may be applied to a transcoding system where encoded data streams are transcoded from a high bit-rate to a low bit-rate or from a low bit-rate to a high bit-rate. The present invention would be suitable to reduce the impact for the viewer as the output bit-rate shifts in response to network conditions by timing the transition to occur upon a scene change in the encoded video sequence. Another example of an adaptive video streaming technique to which the invention may be applied is where multiple independent video streams of different bit-rates are transmitted. In this case the client chooses which stream to accept based on session bandwidth. The client may switch from one stream to another as bandwidth fluctuates; the present invention ensures that the switch is timed to coincide with a scene change in the encoded video stream.

Naturally, there may be times when a change of scene is such a long way away that it is advantageous to switch from one bit-rate to another other than during a change of scene. For example, consider the case where multiple independent video streams at different bit-rates are available for transmission by a media server to a client as, for example, described in co-pending European patent

application No. 00310594.7 the contents of which are hereby incorporated herein by way of reference. In such a case, the server may be capable of transmitting a first stream at a bit-rate of 500kbit/s and a second, higher quality stream at a bit-rate of 1500kbit/s. The client may initially request that the server transmit the first stream at a transmission rate of 1000kbit/s. If the network is not congested and all of the packets transmitted are successfully received by the client, the receive buffer at the client will start to fill with data at a rate of 500kbit/s, since the client will only be removing data from the buffer at a rate of 500kbit/s. After say 10 seconds of filling up the buffer at this rate, the client will have a buffer of ten seconds worth of data at which point it may decide it can attempt to receive the higher bit-rate second stream of video data from the server and thus sends an appropriate request to the server to this effect. If, however, the server is aware that the client has a receive buffer of 5 Mbytes size, it knows that it may continue sending data from the first stream at the rate of 1000kbit/s for at least another 150 seconds before the receive buffer overflows, causing problems for the client. Therefore, the server may attempt to wait for a specified period to see if a scene change occurs during this interval. If so, a switch to the second higher bit-rate signal is not made until the change of scene occurs. Of course, if there is no change of scene within the determined period, the server switches to the higher rate anyway. In this example, a period of only ten seconds is deemed appropriate as the waiting time.

Note that instead of simply waiting to see if a change of scene occurs in the specified period and switching at the end of the period if no such change of scene is detected, an alternative method would be to pre-analyse the video to be sent (clearly this only applies to pre-stored video data and not live video) and to note when changes of scene occur. In such a case, the server, upon receipt of a request from the client to switch streams, could search to see if a suitable change of scene will occur within the predetermined period and if not to switch immediately to the new bit stream.

In the present example, upon switching to the higher rate bit stream, the client may have requested a transmission rate of 1500kbit/s corresponding to the rate at which the data will be drawn from the receive buffer by the client. In such a case, the buffer size of 10 seconds should remain constant so long as all of the

transmitted packets are successfully received by the client. However, in the event of congestion on the network, a proportion of packets may fail to arrive at the client. In such a case, the server will be warned of this via the RTCP. If the congestion is sufficiently severe, the server may deduce that the buffer is in danger of emptying which would cause a break in the video displayed by the client to occur. To prevent this, the server may switch back to the lower bit rate stream. Via the notification of how many packets are being lost, the server can deduce how long it will be before the buffer is emptied. For this time, the server can wait to see if a change of scene occurs, and if so, the new stream will be switched to at that point. Note that it would also be possible for the client to simply request that the new stream be switched to upon detecting that its receive buffer is emptying at an unsustainable rate.

Note that the amount of data in the buffer is actually of less significance than the rate of change of the amount of data in the buffer. Thus it is preferably this quantity which either the server or the client measures in order to determine whether to change from one bit stream to another (or whether to add or drop a layer in the first example).

CLAIMS

1. A method of operating a multimedia server (202), said method comprising;

providing a stream of video data representing a video sequence to an output of the multimedia server (202), wherein the output of the media server (202) is connected to a packet based network (203),

measuring a property of the video data in order to determine the occurrence of a scene change in the video sequence,

detecting the available bandwidth on the network (203),

varying the bit-rate of the stream of video data,

wherein the method is characterised in that

variation in the bit-rate of the video data is controlled to occur in response to variations in the capacity of the network (203) and preferentially with a scene change in the video sequence.

2. A method of operating a multimedia server (202) in accordance with claim 1 wherein upon detecting a decrease in the available bandwidth the bit-rate of the video data is decreased.

3. A method of operating a multimedia server (202) in accordance with claim 1 wherein the bit-rate of the video data is periodically increased in order to ensure that all of the available bandwidth is being used.

4. A method of operating a multimedia server 202 in accordance with claims 1 to 3 wherein said stream of video data is comprised of a plurality of hierarchically encoded layers.

5. A method of operating a multimedia server (202) in accordance with claim 4 wherein the bit-rate of the video data is varied by adding or dropping layers from the stream of data transferred to the output port.

6. A method of operating a multimedia server (202) in accordance with claims 4 or 5 wherein the objective quality contribution of each layer to the

overall quality of the video sequence is measured in order to determine which of the layers is to be added or dropped from the stream of data transferred to the output port.

7. A method of operating a multimedia server 202 in accordance with claims 1 to 3 wherein said stream of video data is comprised of a plurality of independently encoded flows each of which encoded at different bit-rates.

8. A method of operating a multimedia server (202) in accordance with claim 7 wherein the bit-rate of the video data is varied by switching between independently encoded flows.

9. A method of operating a multimedia server 202 in accordance with any of the preceding claims in which the source 201 of video data is stored in encoded form in a database.

10. A method of operating a multimedia server 202 in accordance with any of claims 1 to 8 in which the source 201 of video data is encoded in real-time.

11. A method of operating a multimedia server 202 in accordance with any of the preceding claims wherein, upon detecting a variation in the capacity of the network such as to render it appropriate for a change in bit rate to occur, the server waits for a predetermined time to attempt to detect a change of scene, and if such a change of scene is detected within the predetermined time, the change of bit rate is caused to occur at the time of the change of scene, but if a change of scene is not detected within the predetermined time, then the change of bit rate is caused to occur at the expiry of the predetermined time.

12. A method of operating a multimedia server 202 in accordance with any of the preceding claims wherein, upon detecting a variation in the capacity of the network such as to render it appropriate for a change in bit rate to occur, the server determines if there is going to be a change of scene within a predetermined time, and if it is determined that there will be such a change of scene within the predetermined time, the change of bit rate is caused to occur at the time of the change of scene, but if it is determined that there is not going to

be a change of scene within the predetermined time, then the change of bit rate is caused to occur substantially immediately after having made such a determination.

13. The method of claim 12 further including the step of, prior to providing a stream of video data to the output of the media server, processing the video data to determine the positions within the video data in which changes of scenes occur and making this information available for permitting whether a scene change will occur within a predetermined period at any point along the stream of video data.

14. A multimedia server (202) comprising;

a reader (302) for reading video data representing a video sequence from a source (301),

a scene change detector (604) for detecting changes of scene in the video sequence,

a bit-rate controller (607) for controlling the rate at which the video data is transferred from the reader to an output port, wherein the output port is capable of communicating with a client (204) on a packet network (203);

the media server further comprising means (608) for detecting available bandwidth between the multimedia server (202) and client (204) on the packet network,

characterised in that

the bit-rate controller (607) is arranged to vary the bit-rate of the video data transferred to the output port in dependence on the detected bandwidth preferentially in correlation with a scene change detected by the scene change detector (604).

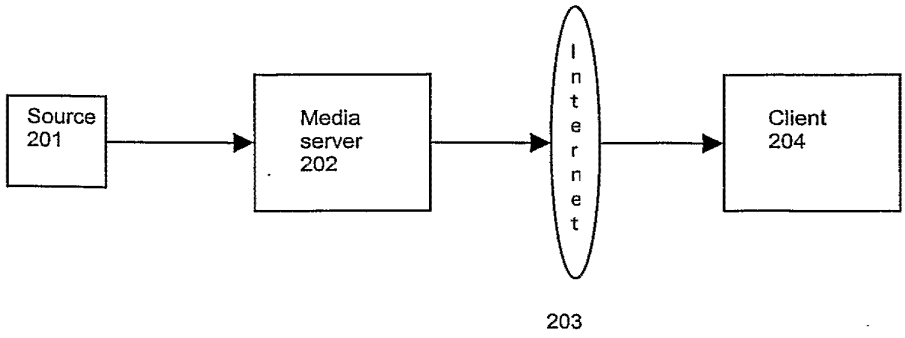


Figure 1

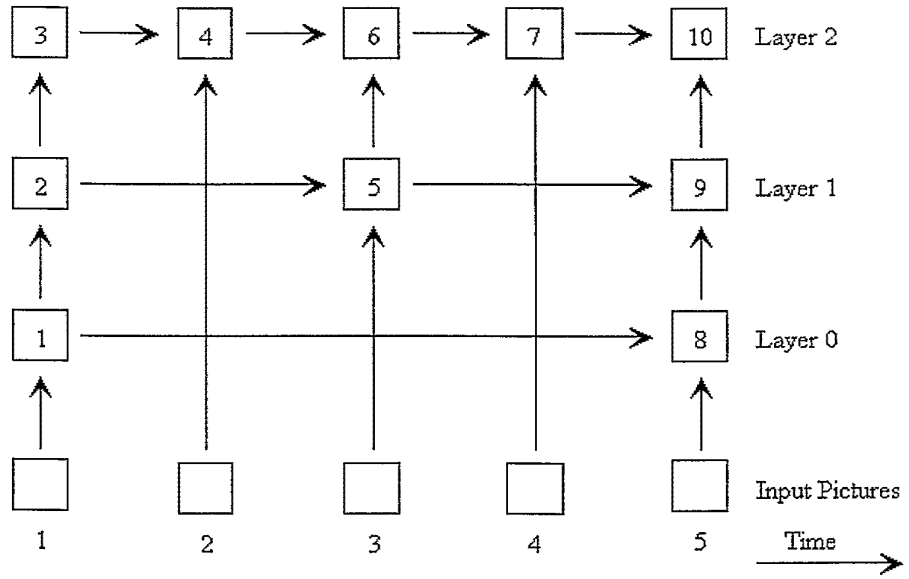


Figure 2

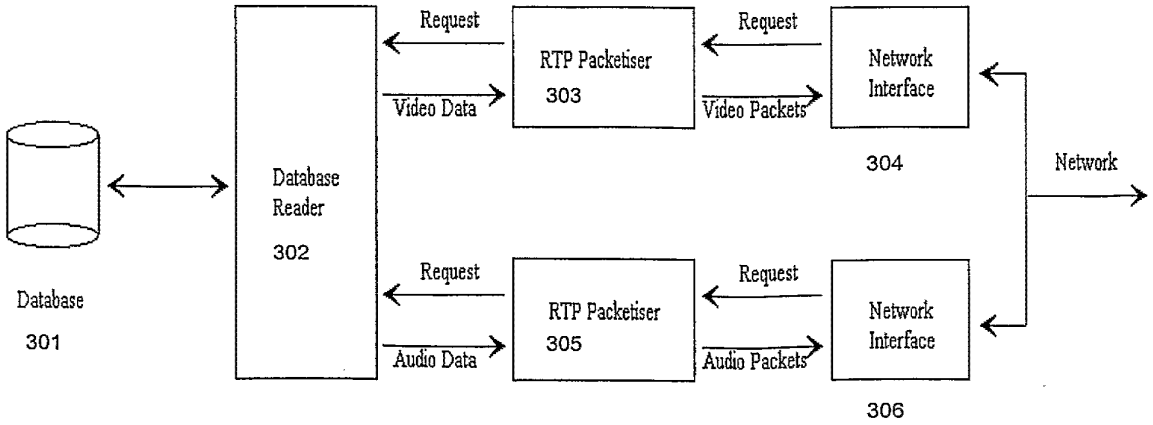


Figure 3

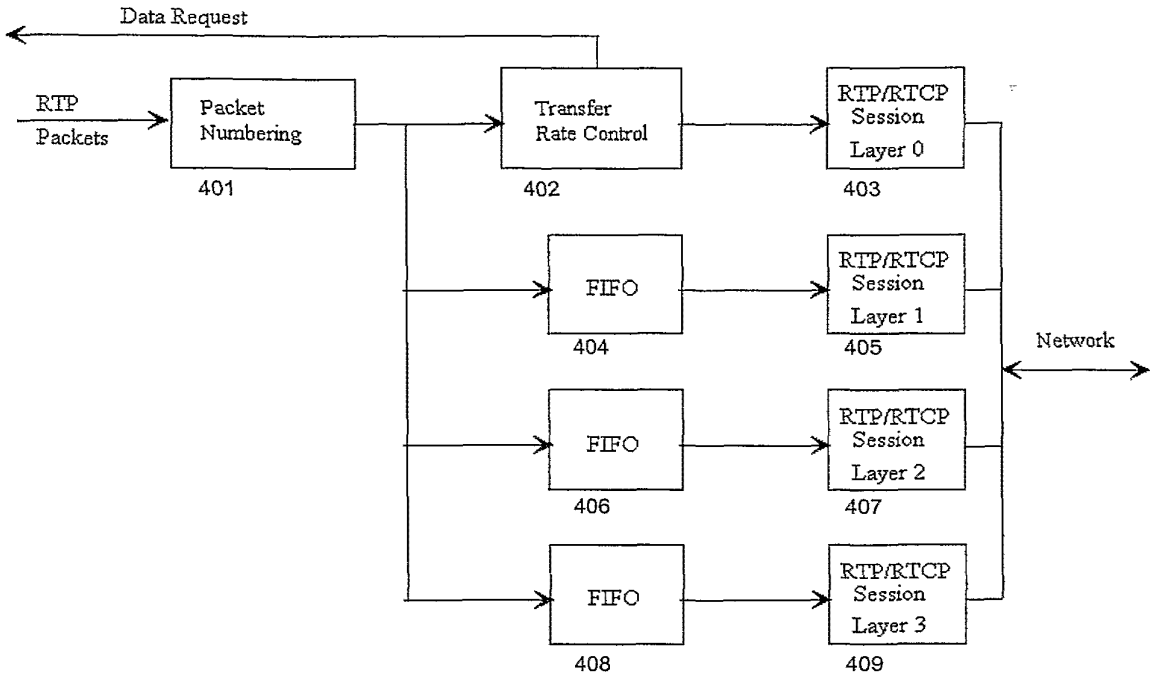


Figure 4

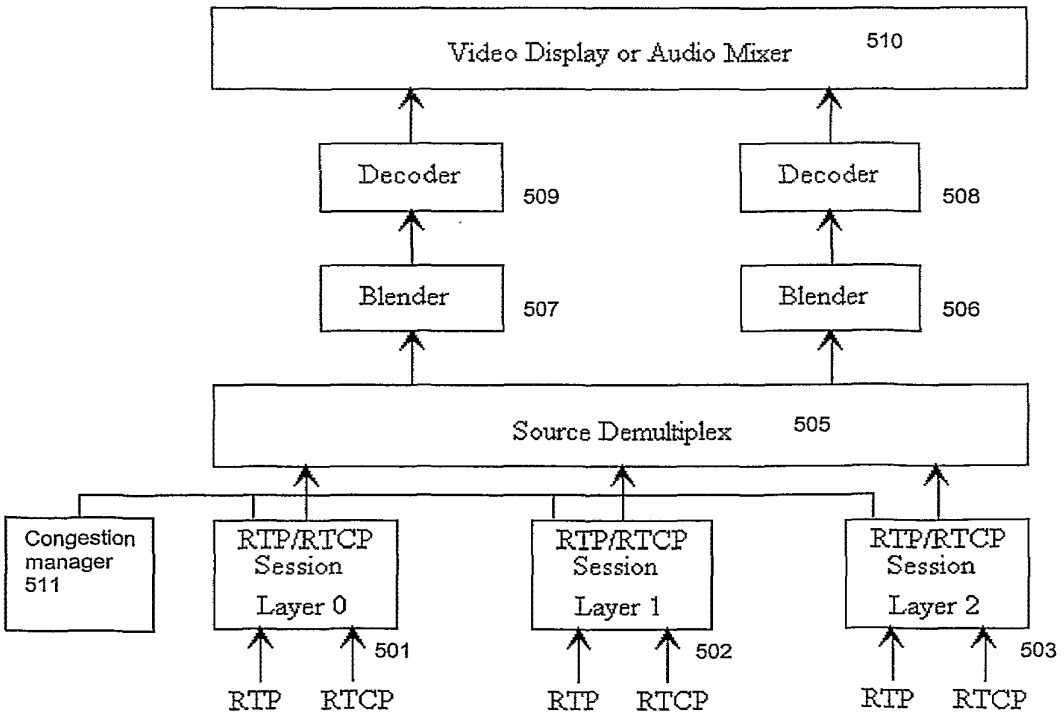


Figure 5

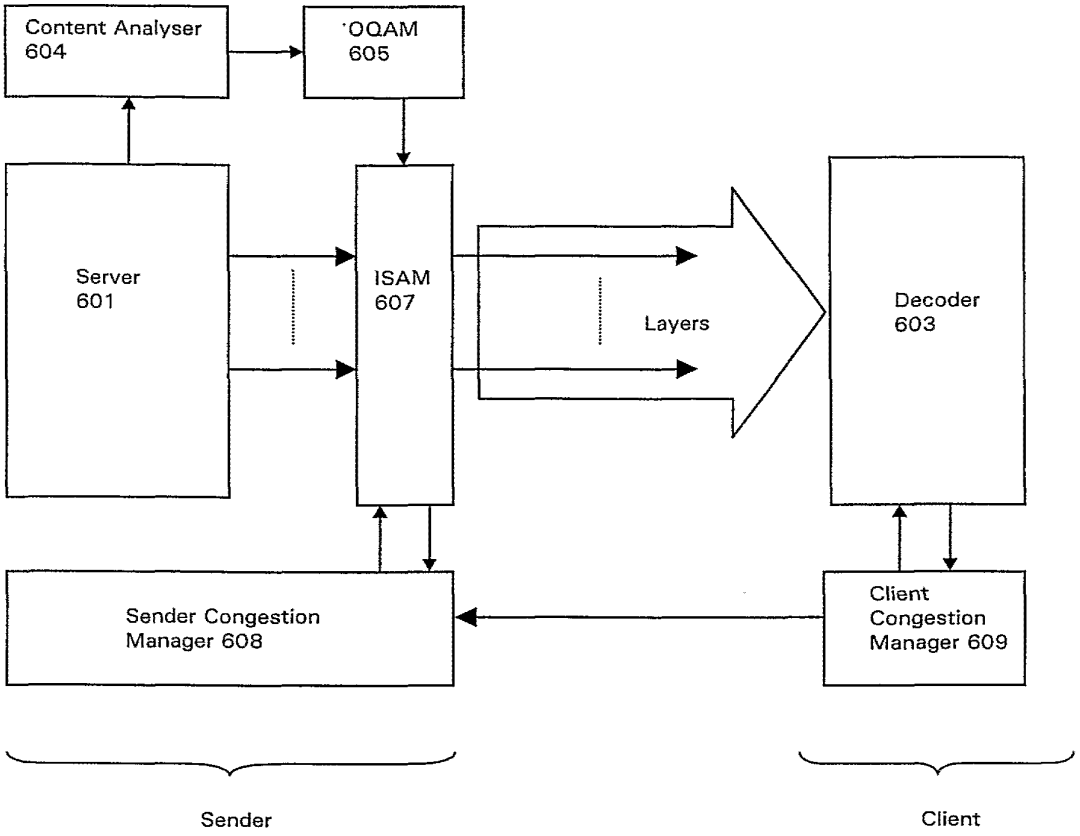

Content Analyser
604
OQAM
605
Server
601
ISAM
607
Layers
Decoder
603
Sender Congestion
Manager 608
Client
Congestion
Manager 609
Sender
Client

Figure 6

INTERNATIONAL SEARCH REPORT

ational Application No
PCT/GB 02/03307

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N5/00 H04N7/24

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)
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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 practical, search terms used)
EPO-Internal, PAJ, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 014 694 A (AHARONI AMIR ET AL) 11 January 2000 (2000-01-11)	1-10,14
Y	abstract column 2, line 29 - line 65 column 3, line 62 -column 4, line 34 column 8, line 54 -column 9, line 35 column 10, line 34 - line 49 column 14, line 34 -column 15, line 6	11-13
X	ANONYMOUS: "Method to Deliver Scalable Video across a Distributed Computer System" IBM TECHNICAL DISCLOSURE BULLETIN, IBM CORP. NEW YORK, US, vol. 5, no. 37, 1 May 1994 (1994-05-01), pages 251-256, XP002079392 ISSN: 0018-8689	1-10,14
A	the whole document	11-13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2002	23/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Fantini, F

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6 038 000 A (HURST JR ROBERT NORMAN) 14 March 2000 (2000-03-14)	11-13
A	column 2, line 52 -column 3, line 22 column 4, line 20 - line 49 column 6, line 9 - line 45 column 7, line 1 - line 24 column 13, line 46 -column 14, line 18 column 20, line 13 - line 30	1,14
A	EP 1 079 631 A (SONY UK LTD) 28 February 2001 (2001-02-28) page 3, line 1 - line 4	1-14
A	US 5 990 945 A (DENTENEER THEODORUS J J ET AL) 23 November 1999 (1999-11-23) abstract column 3, line 13 - line 35 column 4, line 42 - line 44 column 5, line 37 - line 39	11-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

ıtional Application No
PCT/GB 02/03307

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			EP	0992160 A1	12-04-2000
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(51) INT CL[7]
H03M 7/30 , H04L 1/00

(52) UK CL (Edition T)
H4P PDCFM

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WO 98/09387 A1 **WO 00/72601 A2**
US 5847760 A

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UK CL (Edition S) **H4P PDCFM PDCFP PDCFX PF**
INT CL[7] **H03M 7/30 , H04L 1/00 , H04N 7/26 7/32**
Online: WPI, EPODOC, JAPIO

(54) Abstract Title
Streaming of media file data over a dynamically variable bandwidth channel

(57) A method of transmitting data streams over a variable bandwidth channel, comprising modifying the quantity of data to be injected into the channel to accord with a measured capacity or bandwidth of the channel. An input stream is passed through a plurality of parallel compressors 40.1-40.4 which each produce an output stream of a different rate to the other streams. Each stream preferably comprises key or reference frames and delta frames. The reference frames are synchronized between the streams so that a data unit in one stream contains the same information as the corresponding data unit in another stream, but is compressed to a different extent. A data stream for transmission along the channel is produced by selecting data units from more than one compressor output stream so as to produce a stream which makes optimum use of the available channel bandwidth. In one embodiment the duration of the data units are one of a group comprising fixed predetermined durations and duration determined by changes in the channel bandwidth. The method is useful in sending multimedia data streams such as audio and video over a channel such as a cellular telephone network or the internet.

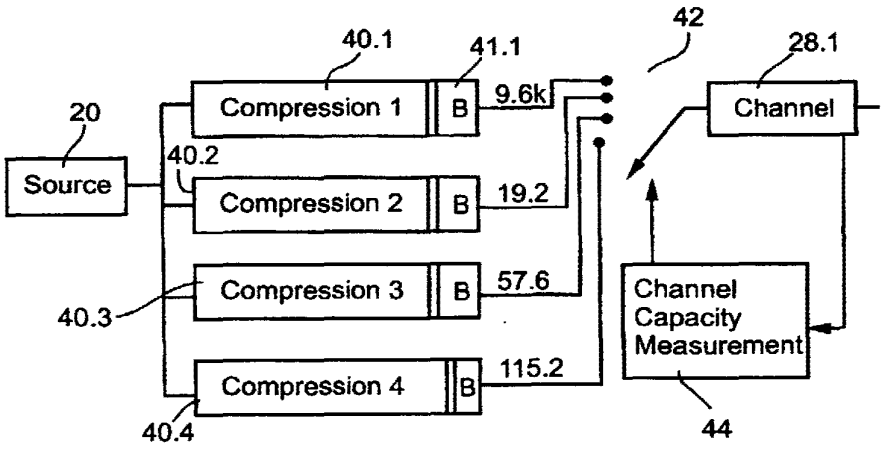


Fig. 4

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 367 219 A

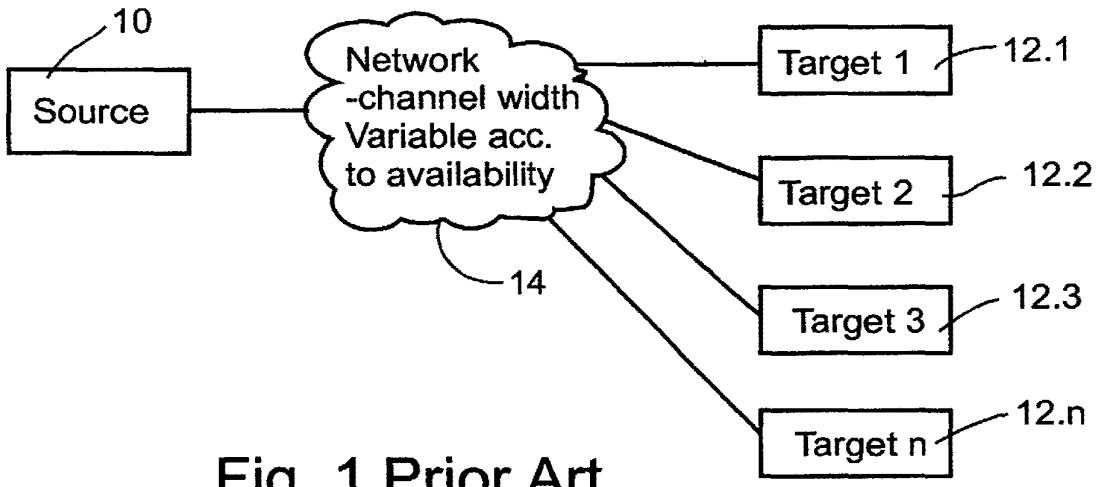


Fig. 1 Prior Art

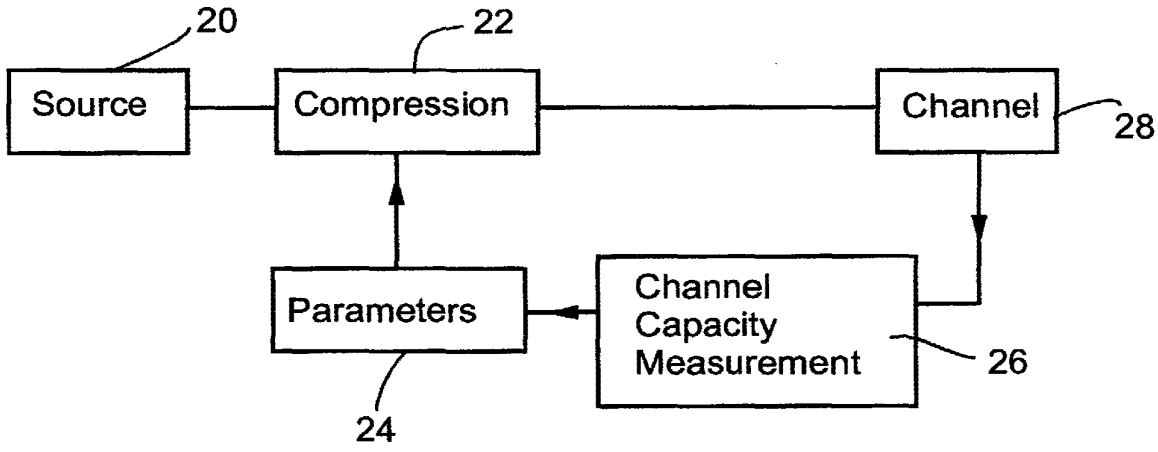


Fig. 2

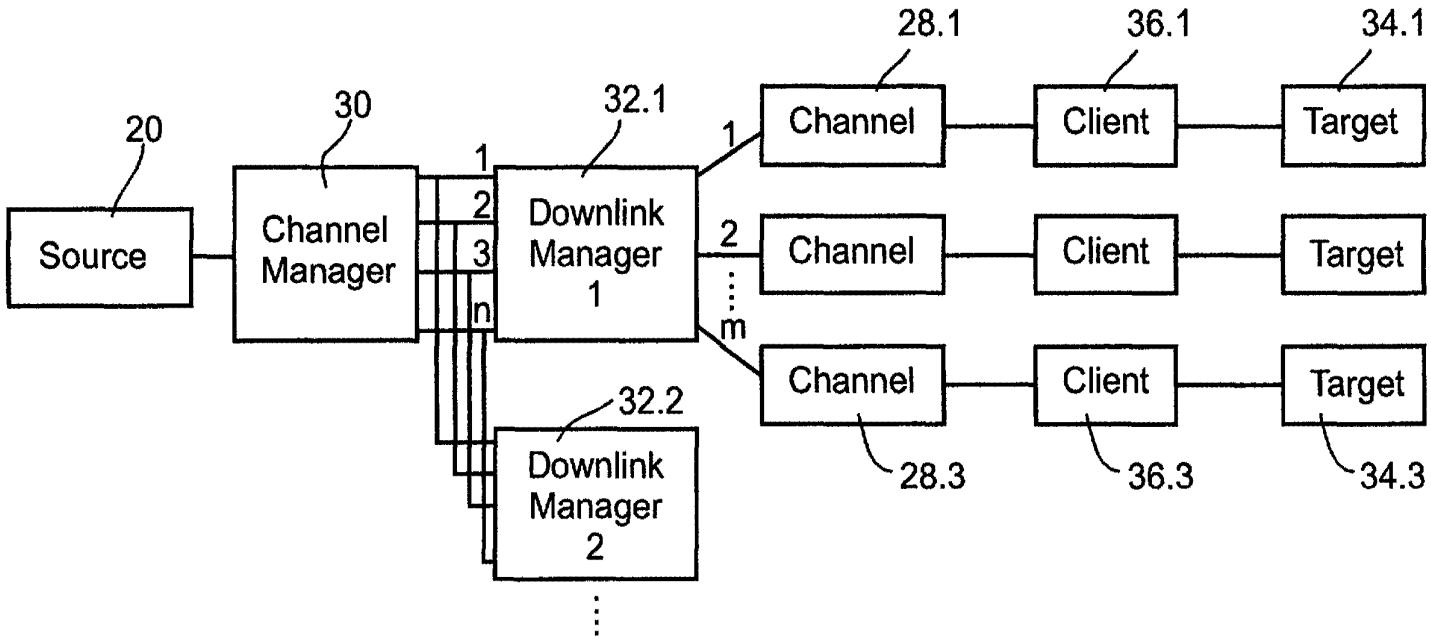

Source
20
Channel Manager
30
Downlink Manager 1
32.1
Downlink Manager 2
32.2
1
2
3
n
1
2
m
Channel
Client
Target
28.1
36.1
34.1
Channel
Client
Target
Channel
Client
Target
28.3
36.3
34.3

Fig. 3

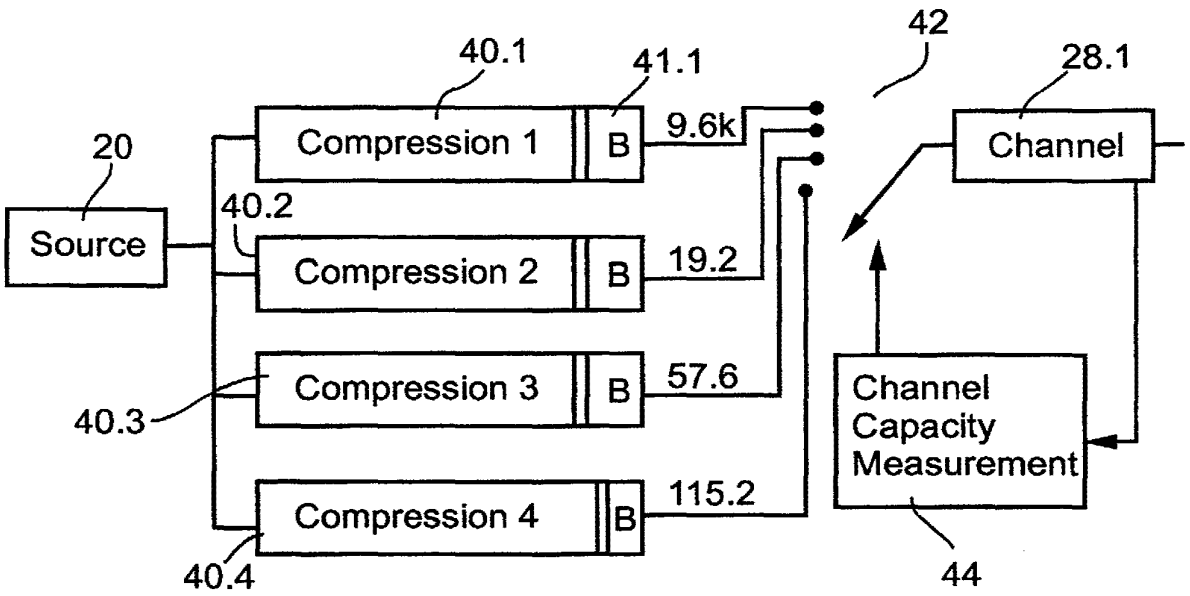

40.1
41.1
42
28.1
20
Compression 1
B
9.6k
Channel
40.2
Source
Compression 2
B
19.2
Compression 3
B
57.6
Channel
Capacity
Measurement
40.3
Compression 4
B
115.2
40.4
44

Fig. 4

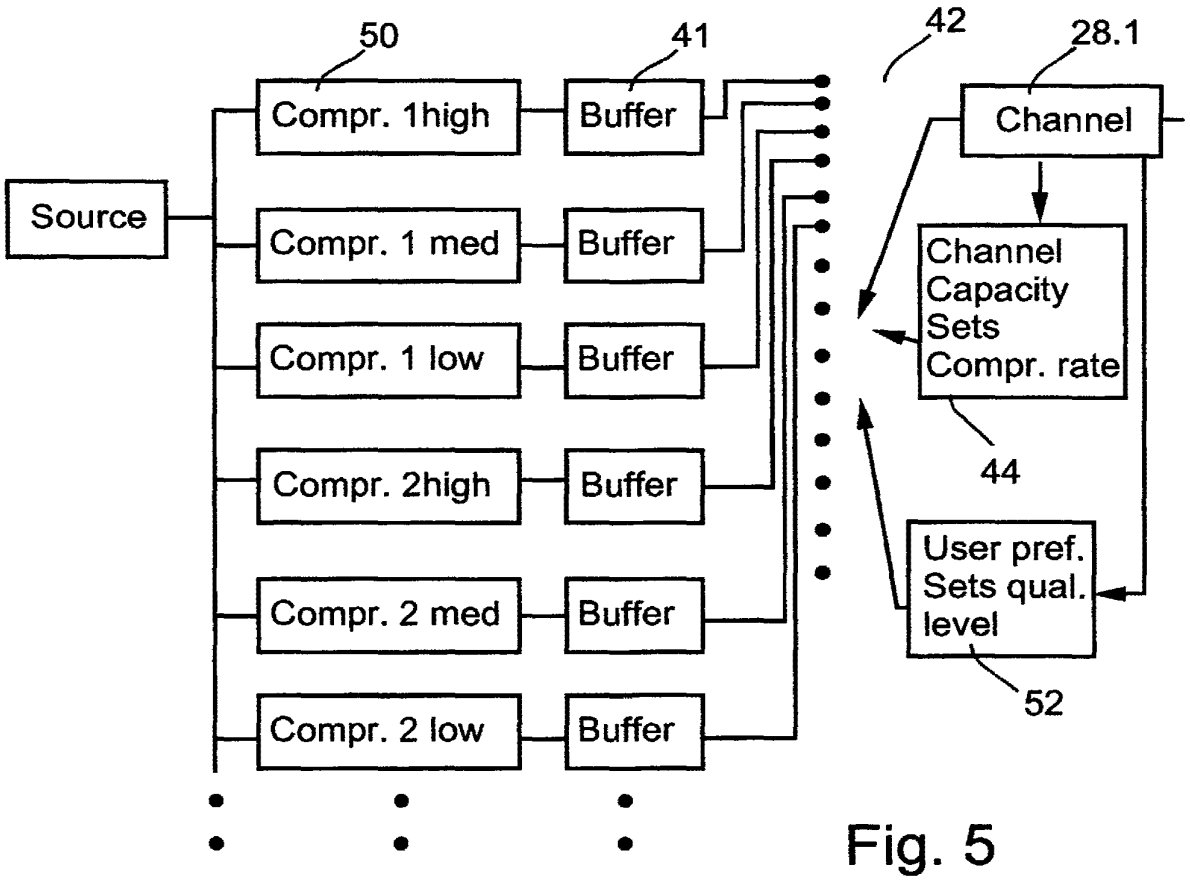

50
41
42
28.1
Compr. 1high
Buffer
Channel
Source
Compr. 1 med
Buffer
Channel
Capacity
Sets
Compr. rate
Compr. 1 low
Buffer
44
Compr. 2high
Buffer
User pref.
Sets qual.
level
Compr. 2 med
Buffer
52
Compr. 2 low
Buffer

Fig. 5

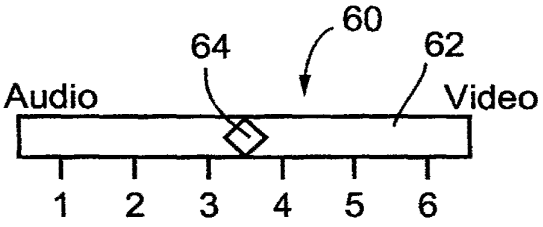


Fig. 6

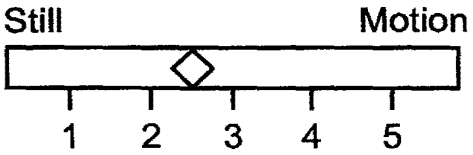


Fig. 7

00/20757 -UK. 9/12/00

Title of the Invention

Streaming of Media File Data Over a Dynamically Variable Bandwidth Channel

Field of the Invention

The present invention relates to streaming of media file data over a channel having a dynamically variable bandwidth, and more particularly but not exclusively to streaming of multimedia data such as video and /or audio data over a channel having a dynamically variable bandwidth.

Background of the Invention

Dynamically varying channel bandwidths are particularly encountered over the Internet and like networks and over radio and cellular telephone links. On the Internet the total bandwidth is fixed and the bandwidth available per channel tends to depend on the amount of usage, the greater the usage the smaller the bandwidth available per user. In radio and cellular links the available bandwidth depends on usage, but the overall capacity may also be dependent on environmental factors.

The Internet relies on packet switched communication, whereas radio and cellular telephone links may be either circuit-switched or packet switched. Either way, the same considerations of channel bandwidth broadly apply.

As the bandwidth changes, a number of approaches are currently in use. One of these is simply to buffer received video frames, to start to show the frames as soon as the buffer is full, and to continue to show the video until the buffer is empty, then to halt the display until the buffer is full again. Another method is to show the video at a real time rate, displaying all frames that arrive in time and dropping all frames that arrive too late.

In both of these methods, data is sent at the same high rate. In the first method, unacceptable delays in showing the data are experienced. In the second method, valuable channel bandwidth is wasted transmitting data that does not get used.

Whether the network is a cellular telephone network or the Internet or like wide area data network, the bandwidth of the data network is variable. In all cases the

larger the number of users the lower the bandwidth per user, and radio-based networks may also suffer from reduced bandwidth due to environmental conditions. Furthermore, in the case of cellular telephone networks, events such as handover between two base stations may also affect the available bandwidth.

In general, cellular networks are able to absorb changes in bandwidth without the user noticing a change in the quality of the voice signal. However, it is desirable to go beyond mere voice communication over cellular telephone networks. Already, low level data capability is being built into mobile telephones and it is envisaged that within the next few years, mobile telephones will be able to receive and display multimedia data. Multimedia data uses large amounts of bandwidth and generally requires to be displayed in real time. Thus bandwidth fluctuations will be immediately noticeable. Currently, however, transmission of video data over cellular phone channels is not being attempted on a commercial basis.

At present, mobile telephone systems are on their second generation and a third generation is on the drawing board but will not be available for some years. The problem is particularly associated with the design of advanced second generation equipment (generation 2.5) which, it is envisaged will be able to provide multimedia within the limitations of second generation capacity. It should be noted however that the same considerations apply to further generations of mobile telephones and also to other environments in which it is desired to transmit multimedia data, such as the Internet.

Generally, multimedia data is sent over a network as a datastream in compressed form. There are numerous algorithms for compressing data, and different forms of compression are appropriate for compressing different forms of data. Furthermore, a single form of compression may give rise to different levels of compression according to compression parameters that may be set. The greater the compression the lower will be the resulting data rate and a high level of compression may be used to overcome channel capacity constraints. A solution may involve selection of the compression parameters to meet a likely worst-case scenario. However, the solution is not complete as a high level of compression leads to low quality output and no advantage is taken of the availability for most of the transmission time of a higher bandwidth availability.

US Patent No. 6,014,694, Aharoni et al, discloses a system for adaptively transporting video over networks wherein the bandwidth varies with time. The

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system comprises a video/audio codec that functions to compress, encode, decode and decompress video streams that are transmitted over networks having available bandwidths that vary with time and location. Depending on the channel bandwidth, the system adjusts the compression ration to accommodate a plurality of bandwidths ranging from 20kbps for POTS to several Mbps for switched LAN and ATM environments. Bandwidth adjustability is provided by offering a trade-off between video resolution, frame rate and individual frame quality. The system generates a video data stream comprising of key, P and B frames from a raw video source. Each frame type is further comprised of multiple levels of data representing varying degrees of quality. In addition, several video server platforms can be utilized in tandem to transmit video/audio information with each video server platform transmitting information for a single compression/resolution level.

P and B frames are delta frames that depend on previous frames to allow a complete picture to be generated. Thus it is not possible simply to mix groups of frames of different quality levels since the deltas between frames are different. The above US Patent solves the problem by taking advantage of what is known as a group of pictures (GOP) which is a self-contained unit such as a scene. Because they are self-contained, GOPs of different compression levels can be successfully mixed. However, GOP boundaries are content related and thus irregular. When GOP boundaries are widely spaced, dynamic following of bandwidth changes are highly inaccurate or generate delays for new users.

Summary of the Invention

Embodiments of the present invention attempt to solve the above problems by modifying the quantity of data to be injected into the channel to accord with a measured capacity or bandwidth of the channel. The quantity of data is preferably modified only by altering compression parameters, so that data fully usable in real time can be received from the channel. Thus a reduction in bandwidth of the channel leads to a drop in quality of the received signal and not to dropped frames or a reduction in performance.

According to a first aspect of the present invention there is thus a device for streaming of media file data to be sent over at least one channel having a dynamically variable bandwidth, comprising

an input for receiving media file data at a first rate,

a multiple stream creator for creating a plurality of streams of said media file data, each stream compressed to predetermined other rates, each stream comprising a series of autonomous compressed data units which are mutually compatible, and

a stream selector for dynamically matching a bandwidth of the channel to rates of said streams to send said data file as a combination of said autonomous units from said streams via said channel,

wherein said autonomous units have durations which are one of a group comprising fixed predetermined durations and durations determined by changes in said channel bandwidth.

Preferably, said stream selector is operable to select a combination of said streams in succession said combination being chosen to produce an average stream rate over a period of time which matches said channel bandwidth.

Preferably, said bandwidth of said channel is liable to vary dynamically and wherein said stream selector is operable to repeat said matching throughout said streaming operation.

Preferably, said bandwidth of said channel is liable to vary dynamically and wherein said stream selector is operable to repeat said matching throughout said streaming operation.

Preferably, said autonomous units match each other across said plurality of streams, thereby to enable switching between said streams.

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Preferably, said data file is arranged in said streams in a compressed media format utilizing reference frames and delta frames and wherein each autonomous unit is self-contained in respect of reference frames.

In an embodiment, said channel is a cellular telephone channel. Alternatively, said channel is an Internet channel.

Preferably, the predetermined other rate is different for each stream. In another embodiment, the predetermined other rate is identical for a set of said streams, each stream in said set being assigned a different balance between quality and speed of said media.

A preferred device comprises a plurality of media types, said predetermined other rate being identical for a set of said streams, each stream in said set being assigned a different balance between quality of said different media types.

Preferably, streams in said set are selectable by a signal received from said channel.

Preferably, streams in said set are selectable by a signal received from said channel.

An embodiment comprises a detector for detecting a change in the bandwidth of said at least one channel and operable to request a corresponding change in the data rate, and wherein the device is operable, upon receipt of said request, to set a delay, and to issue a reference frame within said delay.

The device preferably issues said reference frame at the end of said delay.

The device alternatively issues said reference frame at the occurrence of a largest detected interframe change within the time delay.

According to a second aspect of the invention there is provided a multiple stream creator for receiving a data stream at a first data rate and converting said data stream into a plurality of data streams at a plurality of data rates, said creator comprising an input for receiving said data stream at said first data rate, and a plurality of outputs, each operable to receive said data stream at said first rate and to output said data stream at a predetermined rate individually set for each output as a series of autonomous units having a duration, and wherein said duration is one of a group comprising a fixed predetermined duration and a duration dynamically changeable in accordance with bandwidth conditions in a transmission channel.

Preferably said outputs each comprise data buffers.

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The multiple stream creator preferably comprises a data stream processor for processing said data stream received at said first rate into said plurality of autonomous units, said autonomous units being synchronized blocks, thereby allowing said output streams to be mixed in said transmission channel to produce continuously usable output.

Preferably, said received data stream is in an uncompressed data format and said data is compressed into a compressed data format independently for each one of said output data streams.

According to a third aspect of the invention there is provided a method of sending a datastream over a variable bandwidth channel comprising modifying a quantity of data to be injected into the channel to accord with a measured capacity of the channel, said method comprising the steps of

compressing the datastream, using an algorithm having compression parameters, to produce a plurality of compressed datastreams each comprising reference frames and delta frames, each compressed datastream produced by using the algorithm together with different parameters, and

synchronizing reference frames between the compressed datastreams so that combinations of said compressed datastreams can be sent via said channel.

Preferably, said step of synchronizing reference frames is carried out at intervals determined by a dynamic status of said channel bandwidth.

Alternatively or additionally, said step of synchronizing reference frames is carried out at predetermined intervals.

Alternatively or additionally, said combination of said compressed datastreams is selected substantially dynamically to match the measured capacity of the channel.

Preferably, a change in bandwidth of a channel causes a request for commencement of a new autonomous unit, and wherein said request causes initiation of measurement of a time delay, and wherein a new autonomous unit is commenced within said time delay.

Preferably, the new autonomous unit is commenced at the end of said time delay.

Preferably, the step is provided of determining the largest delta frame during the time delay and sending a reference frame, to initiate said new autonomous unit, in place of said determined largest delta frame.

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According to a fourth aspect of the present invention there is provided a tool for controlling receipt of media file data over a network, wherein said media file data is available at a plurality of quality levels, the tool comprising a quality selector to enable a user to select between said different quality levels for receipt.

Preferably, said media file comprises a plurality of data groups and each quality level is a different balance between quality levels of the plurality of data groups.

Preferably, said quality selector comprises a slider operable to be moved along a scale, the position of the slider on the scale indicating a quality level.

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings, in which:

Fig. 1 is a generalized diagram showing a data source sending data to a series of targets over a variable bandwidth network,

Fig. 2 is a generalized block diagram showing a first embodiment of the present invention in which feedback concerning available bandwidth within a channel is used to modify parameters governing compression of the datastream,

Fig. 3 is a generalized block diagram showing a second embodiment of the present invention in which a series of compressed datastreams are continually created and are selected for use in individual channels according to measured parameters of the channel,

Fig. 4 is a generalized block diagram showing the channel manager and part of a downlink manager of Fig. 3 in greater detail,

Fig. 5 is a generalized block diagram showing a third embodiment of the present invention in which the user is able to set a quality level of the data that is being sent,

Fig. 6 is a generalized schematic diagram of a quality level selection tool for use by a user in selecting a quality level in the embodiment of Fig. 5, and

Fig. 7 is a generalized schematic diagram of another quality level selection tool for use with the device of Fig. 5.

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Description of the Preferred Embodiments

Reference is now made to Fig. 1, which is a generalized diagram showing a data source 10 sending data to a series of targets 12.1..12.n over a variable bandwidth network 14. The network may be a cellular telephone network or the Internet or like wide area data network or a combination. In both cases, the bandwidth of the data network is variable. In all cases the larger the number of users the lower the bandwidth per user, and radio-based networks may also suffer from reduced bandwidth due to environmental conditions. Furthermore, in the case of cellular telephone networks, events such as handover between two base stations may also affect the available bandwidth.

Data is generally compressed before sending over the channel. The level of compression may be preselected to accord with known or likely channel capabilities, as described in the introduction. However such a solution has to concentrate on the lower margins of available bandwidth and thus fails to make full use of higher bandwidth levels when available. Conversely, solutions which send datastreams at higher data rates and do not take the lower bandwidth levels into account lead to unacceptable breaks and delays in performance at the receiving end.

Reference is now made to Fig. 2 which is a generalized block diagram showing a first embodiment of the present invention in which feedback concerning available bandwidth within a channel is used to modify parameters governing compression of a datastream.

A multimedia datastream is received from a source 20 such as a host or server. The datastream may be a video datastream and may be in uncompressed or barely compressed format, for example AVI or MPEG1. The datastream is passed to a compression unit 22 which compresses the data into a very low bit-rate stream using compression parameters. A typical format that may be used for the very low bit-rate stream is MPEG 4 which uses a system based on reference frames and delta frames to compress the image part of the video data. H.263 is another typical format that may be used. A video frame is selected as a reference frame and encoded in its entirety. Then a series of subsequent frames are selected, but for each of these frames, the only data that is encoded is that which has changed with respect to the previous frame. The encoded changes form what is known as the delta frame.

Whichever of the available compression formats are used, compression is governed by a series of parameters 24. This allows the compression level to be raised

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or lowered depending on the data rate required and the quality of picture desired. A greater level of compression gives a lower quality of data at a lower data rate and a lower level of compression gives a higher quality of data at a higher data rate.

In the embodiment of Fig. 2 a channel capacity measurement 26 is received from a channel 28 over which the transmission occurs. The measurement may be received from a receiving client who simply reports the received data rate. If the received data rate is reported to be lower than the rate at which data is being sent then it is assumed that data is being produced too fast for the channel and the parameters 24 are altered to increase the compression level until the data output rate is the same as the channel rate. Conversely, if the data rate rises at the receiving end, the parameters 24 may be altered to reduce the compression level and increase the output data rate.

Reference is now made to Fig. 3, which is a generalized block diagram showing a second embodiment of the present invention in which a series of compressed datastreams are continually created and are selected for use in individual channels according to measured parameters of the channel. Parts that are the same as those mentioned in previous embodiments are given the same reference numerals and are not referred to again except as necessary for an understanding of the present embodiment.

In the embodiment of Fig. 3, an input datastream is received from a source 20 as before. The stream is passed to a channel manager 30, which compresses the input datastream. However, instead of compressing it once only, it compresses it into a plurality of output data streams, each one using different compression parameters so as to produce a plurality of streams each having a different data rate. The various streams are then passed to one or more downlink managers 32.1...32.n, each of which is able to manage a limited number of channels 28 for sending output data to a limited number of targets 34. Each target 34 is associated with a client 36, typically client software located at the target 34, which is able to send back, to the downlink manager 32, feedback data such as the received channel rate.

The downlink manager 32 simply obtains the received channel rate from the client 36 and mixes the various streams from the channel manager to produce an average stream rate which matches the channel rate as closely as possible. For example if the received channel rate is 39.5 kbits/sec and the downlink manager has available a 35 kbits/sec stream and a 45 kbits/sec stream then the downlink manager

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will attempt to mix the two streams in suitable proportions to match the 39.5 kbits/sec channel. Thus the target 36 may receive a continuous stream of data, the quality of the channel influencing only the quality of the data and not the continuity.

It will be recalled that the compression systems in use include reference and delta frame style compression. Such compression systems, when used to produce streams at different data rates, do not produce delta frames which are interchangeable between the different data rates. Thus in order to create streams that are interchangeable, it is preferable to arrange all of the streams as a series of self-contained packets of given time duration. Each of the packets is self-contained in that it begins with a reference frame and hence does not depend on previously transmitted data. Thus the target is able to use consecutive packets from different streams without any data discontinuity.

The self-contained units are preferably of relatively short duration. The shorter the duration the better the system is able to follow dynamically changes in the bandwidth of the connection. On the other hand, since each unit must start with a reference or key frame, and such frames are very costly in bandwidth since they must be transmitted in full, the use of short self-contained units itself increases the required bandwidth. A compromise unit length of less than ten seconds, preferably 3, 5 or 7 seconds, is preferred.

In an alternative embodiment the length of the self-contained unit is itself allowed to vary dynamically in accordance with circumstances. When the downlink manager 32 detects a significant change in the channel bandwidth it issues a request for a new data rate from the channel manager 30. Alternatively, a new target may be requesting the data feed. The channel manager 30 initiates a time delay when a first request is received, the delay being less than ten seconds, as discussed above, and at the end of the delay starts new self-contained units at all data rates. Thus dynamic following of changes in bandwidth is provided whilst transmitting the minimum possible number of key or reference frames. If no request is received, then the system continues to use delta frames as long as it is practical.

In a variation of the above, instead of waiting to the end of the time delay, the channel manager first of all looks ahead at the approaching data stream and checks whether there is a reference frame approaching during the time delay period in any case. If so, no further action is needed. If there is no reference frame then the channel manager looks ahead to find the biggest delta frame, representing the biggest

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instantaneous change in the picture, over the delay time period. A reference frame is then inserted in place of the identified largest delta frame. Thus, the insertion of a full reference frame is optimized to the data.

Reference is now made to Fig. 4 which is a generalized block diagram showing the channel manager 30 and a part of a downlink manager 32 of Fig. 3 in greater detail. Parts that are the same as those mentioned in previous embodiments are given the same reference numerals and are not referred to again except as necessary for an understanding of the present embodiment.

As shown in Fig. 4, the channel manager 30 comprises a series of compression units 40.1, 40.2, 40.3, etc. Each of these compression units is preferably operative to compress an input signal received from source 20, using a different compression parameter or set of compression parameters to produce an output having a different data rate. Each compression unit is followed by a buffer 41. The buffer 41 may be used to arranged the compressed data into packets of fixed time duration.

The downlink manager 32 comprises a series of selector switches 42, one for each channel being managed. For the sake of simplicity, only one such switch 42 is shown in the figure. The switch 42 receives each one of the data streams produced by the source 20 and selects one of them at any given time to be sent to the channel 28. Selection is carried out based on a channel capacity measurement 44, which is received from the client 36.

Reference is now made to Fig. 5, which is a generalized block diagram showing a third embodiment of the present invention in which the user is able to set a quality level of the data that is being sent. Parts that are the same as those mentioned in previous embodiments are given the same reference numerals and are not referred to again except as necessary for an understanding of the present embodiment. As described above, compression parameters are altered in order to change the data rate. Generally speaking, there are numerous parameters that can be set in order to alter the data rate, and there are numerous combinations of these parameters that can give the same data rate. For example, parameters that may be altered include:

the extent of image compression within an individual frame,

the number of frames per second to be transmitted,

the proportion of reference frames to delta frames, and

a balance between compression levels of different parts of the data – for example video data includes both sound and image. It is possible to increase a level

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of compression to the image and to decrease a level of compression to the sound or vice versa.

In Fig. 5, part of a channel manager 30 is shown as well as a switch 42 of a downlink manager. In the channel manager of the embodiment of Fig. 5, a series of data compressors 50 are provided for each required data rate. The data compressors are labeled high, medium and low, although in fact they are different compromises between compression parameters. For example "high" may indicate high image quality but low frame rate, whereas "low" may indicate low image quality but high frame rate. The selector switch 48 is the same as in the previous embodiment except that it now chooses channels based on two different items of information. One item of information is the received channel rate 44, which selects the data rate as before. The other item of information is a data quality request which is received from the target. This selects, within the given data rate, between the different quality levels.

Reference is now made to Fig. 6, which is a generalized schematic diagram of a quality level selection tool 60 for use by a user in selecting a quality level in the embodiment of Fig. 5. The selection tool 60 comprises a simple longitudinal bar 62 which may be marked with labels and numbers, and a slider 64 for moving along the bar 62. The bar shown in Fig, 6 indicates that the user may select different compromises between sound quality and image quality.

Reference is now made to Fig. 7, which is a generalized schematic diagram of another quality level selection tool 70 for use by a user in selecting a quality level in the embodiment of Fig. 5. The selection tool 70 is likewise in the form of a bar and slider but this time the choice is between high quality images at a low frame rate (marked "still") and low quality images at a high frame rate (marked "motion"). It will be appreciated that a low bandwidth "high" may yield a lower image quality than a high bandwidth "low" and vice versa.

Embodiments of the present invention thus provide a system and method in which the measured received data level of a channel is used to select a transmitted data rate so that full advantage may be taken of fluctuating channel capacity levels to send the highest possible quality multimedia data.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention

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which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined by the appended claims and includes both combinations and subcombinations of the various features described hereinabove as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description.

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Claims

1. A device for streaming of media file data to be sent over at least one channel having a dynamically variable bandwidth, comprising

an input for receiving media file data at a first rate,

a multiple stream creator for creating a plurality of streams of said media file data, each stream compressed to predetermined other rates, each stream comprising a series of autonomous compressed data units which are mutually compatible, and

a stream selector for dynamically matching a bandwidth of the channel to rates of said streams to send said data file as a combination of said autonomous units from said streams via said channel,

wherein said autonomous units have durations which are one of a group comprising fixed predetermined durations and durations determined by changes in said channel bandwidth.

2. A device according to claim 1, wherein said stream selector is operable to select a combination of said streams in succession said combination being chosen to produce an average stream rate over a period of time which matches said channel bandwidth.

3. A device according to claim 1, wherein said bandwidth of said channel is liable to vary dynamically and wherein said stream selector is operable to repeat said matching throughout said streaming operation.

4. A device according to claim 2, wherein said bandwidth of said channel is liable to vary dynamically and wherein said stream selector is operable to repeat said matching throughout said streaming operation.

5. A device according to claim 1, wherein said autonomous units match each other across said plurality of streams, thereby to enable switching between said streams.

6. A device according to claim 5, wherein said data file is arranged in said streams in a compressed media format utilizing reference frames and

delta frames and wherein each autonomous unit is self-contained in respect of reference frames.

7. A device according to claim 1, wherein said channel is a cellular telephone channel.

8. A device according to claim 1, wherein said channel is an Internet channel.

9. A device according to claim 1, said predetermined other rate being different for each stream.

10. A device according to claim 1, said predetermined other rate being identical for a set of said streams, each stream in said set being assigned a different balance between quality and speed of said media.

11. A device according to claim 1, said media file comprising a plurality of media types, said predetermined other rate being identical for a set of said streams, each stream in said set being assigned a different balance between quality of said different media types.

12. A device according to claim 10, said streams in said set being selectable by a signal received from said channel.

13. A device according to claim 11, said streams in said set being selectable by a signal received from said channel.

14. A device according to claim 1, comprising a detector for detecting a change in the bandwidth of said at least one channel and operable to request a corresponding change in the data rate, and wherein the device is operable, upon receipt of said request, to set a delay, and to issue a reference frame within said delay.

15. A device according to claim 14, operable to issue said reference frame at the end of said delay.

16. A device according to claim 14, operable to issue said reference frame at the occurrence of a largest detected interframe change within the time delay.

17. A multiple stream creator for receiving a data stream at a first data rate and converting said data stream into a plurality of data streams at a plurality of data rates, said creator comprising an input for receiving said data stream at said first data rate, and a plurality of outputs, each operable to receive said data stream at said first rate and to output said data stream at a predetermined rate individually set for each output as a series of autonomous units having a duration, and wherein said duration is one of a group comprising a fixed predetermined duration and a duration dynamically changeable in accordance with bandwidth conditions in a transmission channel.

18. A multiple stream creator according to claim 17, wherein said outputs each comprise data buffers.

19. A multiple stream creator according to claim 17, comprising a data stream processor for processing said data stream received at said first rate into said plurality of autonomous units, said autonomous units being synchronized blocks, thereby allowing said output streams to be mixed in said transmission channel to produce continuously usable output.

20. A multiple stream creator according to claim 17, wherein said received data stream is in an uncompressed data format and wherein said data is compressed into a compressed data format independently for each one of said output data streams.

21. A method of sending a datastream over a variable bandwidth channel comprising modifying a quantity of data to be injected into the channel to accord with a measured capacity of the channel, said method comprising the steps of

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compressing the datastream, using an algorithm having compression parameters, to produce a plurality of compressed datastreams each comprising reference frames and delta frames, each compressed datastream produced by using the algorithm together with different parameters, and

synchronizing reference frames between the compressed datastreams so that combinations of said compressed datastreams can be sent via said channel.

22. A method according to claim 21, wherein said step of synchronizing reference frames is carried out at intervals determined by a dynamic status of said channel bandwidth.

23. A method according to claim 21, wherein said step of synchronizing reference frames is carried out at predetermined intervals.

24. A method according to claim 21, wherein said combination of said compressed datastreams is selected substantially dynamically to match the measured capacity of the channel.

25. A method according to claim 22, wherein a change in bandwidth of a channel causes a request for commencement of a new autonomous unit, and wherein said request causes initiation of measurement of a time delay, and wherein a new autonomous unit is commenced within said time delay.

26. A method according to claim 25, wherein said new autonomous unit is commenced at the end of said time delay.

27. A method according to claim 25, comprising the step of determining the largest delta frame during the time delay and sending a reference frame, to initiate said new autonomous unit, in place of said determined largest delta frame.

28. A tool for controlling receipt of media file data over a network, wherein said media file data is available at a plurality of quality levels, the

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tool comprising a quality selector to enable a user to select between said different quality levels for receipt.

29. A tool according to claim 28, wherein said media file comprises a plurality of data groups and wherein each quality level is a different balance between quality levels of the plurality of data groups.

30. A tool according to claim 28, wherein said quality selector comprises a slider operable to be moved along a scale, the position of the slider on the scale indicating a quality level.

31. A device for streaming of media file data to be sent over at least one channel having a dynamically variable bandwidth, substantially as hereinbefore described with reference to the accompanying drawings.

32. A multiple stream creator for receiving a data stream at a first data rate and converting said data stream into a plurality of data streams at a plurality of data rates, substantially as hereinbefore described with reference to the accompanying drawings.

33. A method of sending a datastream over a variable bandwidth channel comprising modifying a quantity of data to be injected into the channel to accord with a measured capacity of the channel, substantially as hereinbefore described with reference to the accompanying drawings.

34. A tool for controlling receipt of media file data over a network, substantially as hereinbefore described with reference to the accompanying drawings.

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INVESTOR IN PEOPLE

Application No: GB 0023062.3 **Examiner:** John Cullen
Claims searched: 1-27, 31-33 **Date of search:** 6 November 2001

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.S): H4P (PDCFM, PDCFP, PDCFX, PF)

Int Cl (Ed.7): H03M 7/30; H04L 1/00; H04N 7/26, 7/32

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A, E	EP 1049074 A1	(LUCENT) See Abstract, Figs. 2 and 4, and paragraphs 14-18 and 28-35.	---
A, E	WO 00/72601 A2	(BIGBAND NETWORKS) See Figs. 1-4, 6, 7 and 9, line 26 of p15 to line 24 of p17 and line 10 of p21 to line 2 of p22.	---
A	WO 99/00984 A1	(CITRIX) See Fig. 15 and line 13 of p30 to line 14 of p33.	---
A	WO 98/09387 A1	(ERICSSON) See Figs. 3A, 6 and 7, and line 35 of p14 to line 26 of p15.	---
A	US 5847760	(OPTIBASE) See whole document.	---

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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(54) Data transmission apparatus and method

(57) A data transmission apparatus comprises a network condition determination device for determining a transmission condition of the transmission channel in the transmitter (103) based on at least Jitter information or a packet loss rate obtained from a receiver (104), and a video encoder (102) including means for changing at least one of a bit rate of transmission data and a error resilience level according to the transmission condition.

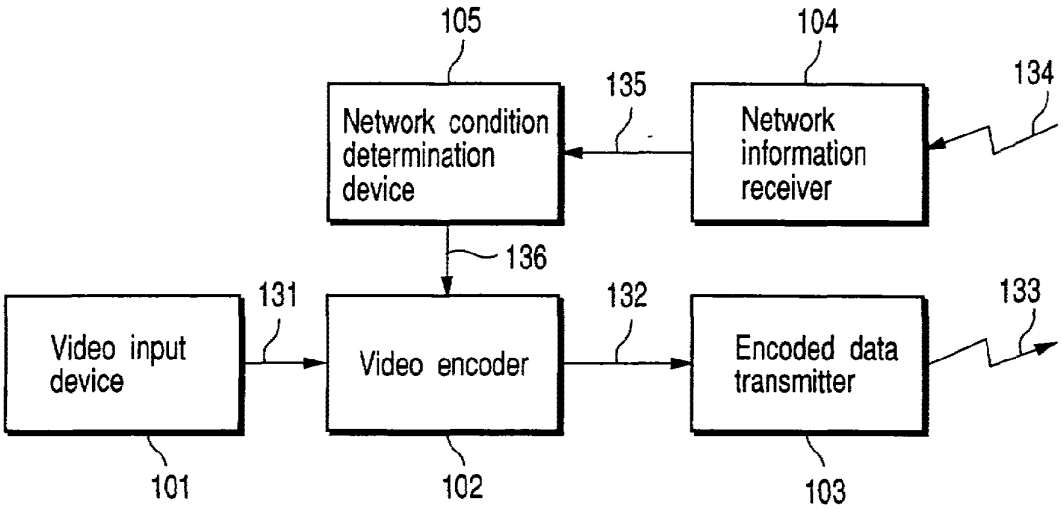


FIG. 1

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Description

[0001] The present invention relates to a data transmission method for transmitting encoded moving/still picture by using a wired communication network such as ISDN (Integrated Services Digital Network) or a wireless communication network such as PHS (Personal handy-phone System) or satellite communication and a data transmission apparatus to which such method is applied.

[0002] In recent years, with progress of digital encoding technology of a variety of information such as image and a broadband network technology, the development of applications using these technologies becomes active, and a system of transmitting compression-encoded image by utilizing a communication network is developed.

[0003] For example, an input video signal is encoded at a video encoder, the obtained encoded data is provided to an encoded data transmitter, and transmission data is transmitted to a transmission channel. In this way, a video is encoded and transmitted. In recent years, with the spread of Internet/Intranet, there has been increased an application or system of transmitting/receiving a packet of data. Providing data as a packet is very effective means for efficiently sharing a bandwidth of a communication channel by a plurality of users.

[0004] In the meantime, as a protocol for transmitting/receiving packet data via Internet/Intranet, there exists TCP/IP (Transmission Control Protocol/Internet Protocol) or UDP/IP (User Datagram Protocol/Internet Protocol) and the like.

[0005] Among them, TCP/IP is an Internet standard protocol. This protocol is applied as the world's best known protocol to Intranet or LAN as well as Internet. TCP works in a transport layer that is a fourth layer of an OSI basic reference model, and IP works in a network layer that is a third layer.

[0006] In addition, UDP/IP is one of the TCP/IP suite transport layer protocols. TCP is a connection type protocol. UDP is a disconnection type protocol. As with TCP, a host application is identified by using a port number. This protocol is often used to carry short data for monitor control of a network or real time oriented data such as audio data or video data.

[0007] TCP/IP incorporates a frame such as retransmission. Thus, this protocol is strong against errors or the like. Even if a large amount of time is required, this protocol is effective to download type applications if an attempt is made to validly receive data. However, this protocol is not powerful for applications requiring real time properties.

[0008] In contrast, although UDP/IP does not have a retransmission frame, a delay associated with retransmission does not occur. Thus, this protocol is very effective to applications requiring real time processing.

[0009] Transmission of moving picture is exemplified as a typical example of application requiring real time processing. However, in the case of general video communication, video data has a very large amount of data, and overflows a network bandwidth in most cases. In this case, a technique for encoding a video data signal, and transmitting a reduced amount of data is used. Techniques such as motion compensation, discrete cosine transform (DCT), sub-band encoding, pyramid encoding, and variable-length encoding or a combination of these techniques are developed as compression-encoding of a video signal.

[0010] As an international standard system for moving picture encoding, there are ISO MPEG-1, MPEG-2, ITU-T H. 261, H. 262, and H. 263. In addition, as an international standard system for multiplying an encoded data stream having a speech/audio signal compressed or other data, there are an ISO MPEG system, ITU-T H. 221, and H. 223.

[0011] Internet or the like is encompassed via an infinite number of networks. Usually, no one knows which network is used or what state is. In addition, an amount of data flowing a network changes from time to time. Thus, a system of judging what amount of data can be communicated in a real time is required.

[0012] Therefore, with further advancement from real time applications utilizing UDP/IP, there have been increased in number applications using a packet format called RTP (Real-time Transport Protocol) for adding and transmitting time information or the like to a packet.

[0013] This RTP is a protocol for transferring audio data signal or video data signal ruled in RFC 1889 in real time. Usually, data is carried on UDP (User Datagram Protocol). This protocol is assumed to be applied to a multimedia system such as video conference, and data can be exchanged in a real time interactive scheme. However, the protocol has no sound quality or picture quality assurance function. Sequential number or time stamp data is assigned into an RTP header, thereby supporting a read time operation.

[0014] RFC is an abbreviation of Request for Comments, and denotes a document such as technical proposal or comments disclosed by TETF (Internet Engineering Task Force). Many de-fact standards such as a variety of protocols of TCP/IP suite are described in RFC.

[0015] By utilizing this RTP, time information and a packet number are added to a packet, so that a receiver can display a voice or image by using correct time information, can determine a packet or the like whose order is replaced in a network, and can detect that a packet is lost by referring to a packet number.

[0016] Moreover, the RTP provides with a system (RTCP) for notifying network state information such as jitter or packet loss rate from a transmitter to a receiver.

[0017] However, how this RTCP information is utilized depends on applications, and is not determined in standards.

[0018] In addition, in the case of an image, a bandwidth corresponding to video transmission cannot be al-

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located in a network bandwidth, thus making it necessary to compress and deliver a video signal in an encoding system such as MPEG, as described previously. Although this encoding system is effective in a decreased amount of data, the system becomes very fragile to a packet loss or error entry by supplying data to unstable Internet. This is because a moving picture encoding system transmits only a difference between a current frame and a previous frame. Thus, partial data missing causes a very serious problem. In the case of using the UDP or RTP, data retransmission is not basically carried out, thus making it necessary to counteract this problem.

[0019] There generally exist two modes in picture encoding, that is, one is an inter-frame encoding mode for transmitting a difference between the current frame and the previous frame and an intra-frame encoding mode for carrying out encoding in one frame. In general, intra-frame encoded pictures are provided at a proper timing, and inter-frame encoded pictures are provided between them. An interval between the frames encoded in an intra-frame encoding mode is called a GOP (Group of Picture) interval.

[0020] When an encoded picture is missing during transmission to the decoder, the decoded picture corresponding to the missing encoded picture is destroyed. Thereafter, the intra-encoded pictures following the missing encoded picture are decoded based on the destroyed picture. Thus, all the subsequent decoding pictures are affected by the destroyed picture, and decoding cannot be carried out correctly. Therefore, an intra-frame encoded picture is inserted in the way of a stream of frames to cut off a propagation of missing error and recover adequate decoding.

[0021] In a conventional technology, it can determine that errors occur in a network. However, how to utilize the determination result has been unknown. Also, a system for notifying the network information to the transmitter in an unique format is conceived. However, the system is based on the specification of associated applications and lacks a general-purpose use. The system receives transmission data using an information receiver, and controls a video encoder within a range of the information received from the network via a transmission channel.

[0022] A conventional network condition determination is conceived on assumption of network congestion. However, since Internet is popularized in mobile environment, it is required to consider an error or the like in wireless environment. Current technique does not assume countermeasures against such error.

[0023] Further, in the case of dealing with the error, a case in which a network condition changes, and an error rate is not constant is not considered. If a short GOP interval is set in order to counteract a case in which errors frequently occur, the intra-frame encoding increases resulting in impairing the encoding efficiency. When errors occur frequently qualitatively, it may be required to establish such state in which such errors occur frequently. However, in the case of a network in which an error hardly occurs in a normal state, and an error occurs only at one moment, this setting is very wasteful. Conversely, when a long GOP interval is set, it is troublesome that a great influence occurs when an error occurs.

[0024] Thus, a real time transmission using RTP is noted. As described above, by utilizing the RTP that is a protocol for transferring audio data signal or video data signal in real time, time information and a packet number are added to a packet, whereby the receiver can display a voice or image by using correct time information, can determine a packet or the like whose order is replaced in a network, or can detect that a packet is lost by referring to a packet number.

[0025] Moreover, at the RTP, there is provided a system (RTCP) for notifying network state information such as jitter or packet loss rate from the transmitter or receiver.

[0026] It is an object of the present invention to provide a data transmission apparatus and method capable of adjusting a transmission rate by using the RTP characteristics in accordance with a transmission state of a transmission channel based on notification of network state information such as jitter or packet loss rate, obtained from the receiver in the transmitter or capable of carrying out controls such as changing error resilience, thereby making it possible to efficiently transmit data to the maximum, and fully utilize transmission that requires real time properties.

[0027] According to an aspect of the invention, there is provided a data transmission apparatus that transmits transmission data from a transmitter to a receiver via a transmission channel, comprising: an estimation device configured to estimate a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and a controller configured to change at least one of a bit rate of transmission data and a error resilience level according to the estimated transmission condition.

[0028] According to another aspect of the invention, there is provided a data transmission method comprising: estimating a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and changing at least one of a bit rate of transmission data and an error resilience level according to the estimated transmission condition.

[0029] According to another aspect of the invention, there is provided a data transmission program stored on a computer readable medium, comprising: instruction means for instructing a computer to estimate a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and instruction means for instructing the computer to change at least

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one of a bit rate of transmission data and a error resilience level according to the estimated transmission condition.

[0030] This summary of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

[0031] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view showing a basic configuration of a data transmission apparatus according to a first embodiment of the present invention;
FIG. 2 is a view showing another configuration in the present embodiment;
FIG. 3 is a view showing a configuration of a network condition determination device in the present embodiment;
FIG. 4 is a view showing a configuration of a video encoder in the present embodiment;
FIG. 5 is a view showing a configuration of an encoded parameter determining device in the present embodiment;
FIG. 6 is a view showing a basic configuration of a data transmission apparatus in a second embodiment of the present invention;
FIG. 7 is a view showing a configuration of an encoded data switch device in the present embodiment;
FIG. 8 is a view illustrating a timing of encoded data switching at an encoded data switch device in the present embodiment;
FIG. 9 is a view illustrating a timing of switching encoded data with its different frame interval at the encoded data switch device in the present embodiment;
FIG. 10 is a flow chart showing a basic example of the network condition determination method at the network condition determination device in the first embodiment of the present invention;
FIG. 11 is a flow chart showing a basic example when a delay is forced to occur by using the network condition determination method at the network condition determination device in the first embodiment of the present invention;
FIG. 12 is a flow chart showing a basic example considering a time direction change with the network condition determination method at the network condition determination device in the present embodiment;
FIG. 13 is a view showing an exemplary configuration according to a third embodiment of the present invention;
FIG. 14 is a flow chart showing an example of a GOP interval calculation method at a GOP interval calculator in the present embodiment;
FIG. 15 is a flow chart showing another example of a GOP interval calculation method at a GOP interval calculator in the present embodiment; and
FIG. 16 is a flow chart showing still another example of a GOP interval calculation method at a GOP interval calculator in the present embodiment.

[0032] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings.

[0033] The present invention utilizes RTP or RTCP that is a protocol for transferring audio data signal or video data signal in real time. The transmitter performs controls such as adjusting a transmission rate or changing error resilience in accordance with a transmission state of a transmission channel based on notification of network state information acquired from the receiver such as jitter (Jitter information) or packet loss rate. In this manner, data transmission can be carried out efficiently to the maximum. Hereinafter, embodiments of the present invention will be described in detail.

(First Embodiment)

[0034] FIG. 1 shows a basic configuration of an image transmission apparatus according to a first embodiment of the present invention. In FIG. 1, a video signal 131 input from an image input device 101 is processed to be encoded. That is, an encoded data transmitter 103 processes encoded data 132 that has been encoded by a video decoder 102 in the form which conforms to a network, and transmits the encoded data to a receiver. A network information receiver 104 receives network information 134 delivered from the receiver, and outputs the received information to a network condition determination device 105. This network condition determination device 105 has a function that determines a network condition from network information 135 output from the network information receiver 104, and notifies the result as network condition information 136 to the video encoder 102.

[0035] The video encoder 102 encodes the video signal 131 using the network condition information 136. This encoding is carried out as follows. That is, in the case of RTP or RTCP, a packet loss rate or Jitter information is provided to the network condition determination device 105. The network condition determination device 105 determines that, if a packet loss rate is not "0" or if a delay time is longer than a predetermined value, any load is applied to a network, and a presumed amount of data cannot be supplied. Then, the network condition determination device 105 is configured so as to carry out processing so as to issue an instruction (network condition information 136) for lowering a bit rate to the video encoder 102, and to lowly set a target bit rate in encoding.

[0036] According to the thus configured apparatus, when the video signal 131 is inputted from the image input device 101, the inputted video signal 131 is encod-

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ed by the video encoder 102. Encoded data 132 encoded by the video encoder 102 is inputted to the encoded data transmitter 103.

[0037] The encoded data transmitter 103 processes the encoded data in the form suitable to a network, and receives the processed data to a receiver. The network information receiver 104 receives the network information 134 delivered from the receiver, and outputs the received information to the network condition determination device 105.

[0038] The network condition determination device 105 determines a network condition from the network information 135 outputted from a network information receiver, and notifies the result as the network condition information 136 to the video encoder 102.

[0039] The video encoder 102 encodes the video signal 131 using the thus notified network condition information 136.

[0040] FIG. 10 shows a very simple example of a method for determining a network condition at the network condition determination device 105 by way of showing a flow chart.

[0041] According to this flow chart, at the step S1001, a packet loss rate of network information is checked to see if the rate is "0" or not. As the result of this check, if the packet loss is not "0", an effective bit rate is calculated from the packet loss rate in accordance with the step S1002. This bit rate can be calculated by formula (1) shown below.

$$b' = b \times (1 - r) \quad (1)$$

where "b" denotes a current bit rate, b' denotes a new bit rate, and "r" denotes a packet loss rate.

[0042] Next, at the step S1003, a parameter (encoding parameter) obtained at the step S1002 is notified to the video encoder 102. Here, the above parameter is used to determine a rate control or error resilience level for encode processing at the image encoder 102. This parameter is also used for adjustments such as adjusting and controlling the encode processing speed of the input image signal 131 to this parameter, thereby changing a bit rate, a frame interval, or an error resilience level.

[0043] On the other hand, at the step S1001, when the packet loss rate is "0", no parameter change occurs at the step S1004. This determination method is provided as a mere example. It is possible to employ any other method for obtaining a bit rate based on a case in which the criterion of the step S1001 is determined by thresholds without being set to "0" or others or based on a formula other than the above formula (1).

[0044] Therefore, according to the first embodiment, even when a transmission network bandwidth is unknown or when the bandwidth changes halfway, it is possible to reset a parameter or the like based on the receiver's network information, and then, encode and transmit an image in accordance with the parameter suitable to a current network. In this manner, even in the case of a network congestion, although a bit rate is automatically lowered, and an image quality is lowered, it is possible to communicate an image without an occurrence of a phenomenon that an image is destroyed due to such packet loss. This method is very effective in image transmission in real time.

[0045] The first embodiment can be carried out by modifying it as follows. For example, as shown in FIG. 11, a method other than that shown in FIG. 10 is employed as a method for determining a network condition at the network condition determination device 105. That is, in the flow chart shown in FIG. 10, a parameter is set at only a packet loss rate. In contrast, in the method shown in FIG. 11, even when no packet loss occurs at the step S1104, a delay quantity is checked. As a result of this check, if a delay occurs in excess of a predetermined value, it is determined that a network is congested. When it is determined that a network is congested, a bit rate is calculated, and a new parameter is set by using formula (2) below, for example, at the step S1105.

$$b' = b \times \{(TN-TS)+(d-dth)\}/(TN-TS) \quad (2)$$

where "b" denotes a delay time, b' denotes a new bit rate, TN denotes a current time, TS denotes a start time, "d" denotes a delay time, and "dth" denotes delay time thresholds.

[0046] FIG. 2 shows an example when the network condition determination device 105 is provided with a function for generating the network condition information 136 so as to provide the information to the image encoder 102 by extending the configuration shown in FIG. 1.

[0047] According to a configuration shown in FIG. 2, the network condition determination device 105 is provided with a function for acquiring a current parameter at the current image encoder 102 and a function for generating the network condition information 136 on what parameter should be set next from the thus acquired current parameter and network information 135, thereby providing the parameter to the image encoder 102.

[0048] In the case of this construction, the network condition determination device 105 can recognize a state of a video parameter, i.e., a state of the encode processing currently done at the video encoder 102, thus making it possible for the network condition determination device to calculate and grasp a bit rate or the like. This construction is advantageous in the case of determining a network condition by comparing the network information 135 with parameter information 137. Thus, a system is realized which is capable of changing a parameter so as to set an optimal bit rate in accordance with the network condition, and providing the parameter to the video encoder 102, thereby adjusting the encode processing.

[0049] In this way, according to the present invention,

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transmission is adjusted in accordance with a transmission state of a transmission channel or error resilience is changed. The transmission state is adjusted by changing a bit rate or changing a frame interval. With respect to a change in quality of a transmission channel, the error resilience is changed according to the transmission state of the transmission channel (for example, the error resilience is changed by changing an interval of an MPEG4 synchronous signal). Therefore, data transmission can be carried out efficiently to the maximum, thereby enabling data transmission that makes it possible to fully utilize transmission requiring real time processing.

[0050] FIG. 3 shows a configuration when the configuration shown in FIG. 2 is further developed. This network condition determination device 105 comprises a network information storage device 301 that stores past network information and an encoded parameter information storage device 302 that stores encoded parameter information supplied to the current video encoder 102. A network condition determination device 303 recognizes the past network information and the current encoded parameter from these elements, decides an elapse of time in network condition from these elements to determine an optimal parameter assigned to the video encoder 102, and provides the parameter to the video encoder 102.

[0051] With this construction, it is possible to determine a network condition more accurately by referring to an elapse of time relevant to network information. FIG. 12 shows a flow chart of a network condition determination method in the case of using this system. Processing at the network condition determination device 303 will be described in accordance with this flow chart. First, the network condition determination device 303 determines whether or not packet loss is "0" at the step S1201. As a result of this determination, when the packet loss is present, it is determined by the step S1202 whether or not the past packet loss occurs. As a result, when the past packet loss occurs, the loss rate is compared with the current rate. If the current packet loss rate is higher than the past packet loss rate, it can be determined that the past correction has been invalid.

[0052] It is understood from this determination that the bandwidth overflow of transmission data such as network congestion is not troublesome, but a possibility that a noise or the like occurs over a channel resulting in destroying is high. Therefore, the network condition determination device 303 does not change a bit rate at the step S1204, and carries out parameter setting to ensure reliable error correction, and notifies the fact to the video encoder 102 at the step S1205.

[0053] If the current packet loss rate is lower than the past packet loss rate at the step S1203, the network condition determination device 303 determines that the past change works efficiently, and re-calculates a valid bit rate from the packet loss rate at the step S1206. When the past packet loss does not occur at the step S1202, the last loss is determined as a channel noise, and processing goes to the step S1204.

[0054] On the other hand, when no packet loss occurs at the step S1201, the network condition determination device 303 checks a delay quantity at the step S1207. As a result, when the delay quantity exceeds thresholds "Th", a valid bit rate is calculated from the delay quantity at the step S1208, and the calculation result is notified to the video encoder 102 at the step S1205.

[0055] Lastly, when the delay quantity does not exceeds the thresholds "Th", the network condition determination device 303 determines that successful communication is established, and does not change a parameter at the step S1209.

[0056] By causing the network condition determination device 303 to carry out such processing, the network condition determination device 105 can have a function capable of determining whether a packet loss occurs on a transmission channel due to network congestion or whether a noise is generated, and the loss occurs due to the impairment of a channel state such as radio equipment.

[0057] This function is provided as a mere example. For example, when the past packet loss does not occur at the step S1202, a control for lowering a bit rate may be made by determining network congestion instead of determination of noise. If the current packet loss rate is improved more remarkably than the past packet loss rate at the step S1203, similar parameter change may be made after checking how the past change has been made. In this way, in this system, a variety of determination systems can be set according to a network.

[0058] In the foregoing, although there has been shown an example in which the video encoder 102 carries out encode processing based on encoded parameters determined and assigned at the network condition determination device 105, a configuration for the video encoder 102 to determine a parameter can be provided without being limited to the network condition determination device 105. An example is shown in FIG. 4.

[0059] FIG. 4 is a block diagram depicting an inclusive configuration when the video encoder 102 determines an encoded parameter. In the case of this example, the video encoder 102 comprises an encoded parameter determination device 401 and a signal processor 402.

[0060] In the case of this configuration, the network condition determination device 105 is configured to output the network condition information 136 from the network condition determination device 303, and then, provide the information to the video encoder 102.

[0061] In such a configuration, the network condition determination device 105 provides the network condition information 136 delivered from the network condition determination device 303 to the video encoder 102. Then, the video encoder 102 first inputs the network condition information 136 to an encoded parameter determination device 401. Then, the encoded parameter determination device 401 recognizes a network condi-

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tion from this network condition information 136, and generates an encoded parameter 431 in the form suitable to the network condition.

[0062] The thus generated encoded parameter 431 is inputted to a signal processor 402. Then, this signal processor 402 encodes the video signal 131 inputted from the video input device 101 by using this encoded parameter 431.

[0063] Encoding information 432 such as the number of encoded bits after encoding is inputted to the encoded parameter determination device 401, and is used for the next encoded parameter determination. Encoded data 132 encoded at the signal processor 402 is output to the encoded data transmitter 103.

[0064] FIG. 5 is a block diagram depicting a configuration including a intra-frame encoding determination device 501 that forcibly sets intra-frame encoding at the encoded parameter determination device 401 shown in FIG. 4. As shown in the figure, the encoded parameter determination device 401 comprises an intra-frame encoding/determination device 501 and an encoded parameter determination device 502.

[0065] In the case of this configuration, the network condition information 136 outputted from the network condition determination device 105 is input to the encoded parameter determination device 502 possessed by the encoded parameter determination device 401. Then, encoded parameter information 531 corresponding to the network condition information 136 is output from the encoded parameter determination device 502.

[0066] The encoded parameter information 531 is input to the intra-frame encoding determination device 501, and it is determined whether inter-frame encoding is carried out as is or intra-frame encoding is forcibly carried out. When it is determined as intra-frame encoding, the encoding parameter information 531 is updated so as to carry out intra-frame encoding, and is output as the encoded,parameter information 431 to the signal processor 402 of the video encoder 102.

[0067] By doing this, even if the past data is not transmitted correctly to a receiver, when the data can be received correctly after parameter change, a correct image can be reproduced.

[0068] It is possible to configure a video encoder capable of determining a network condition, which has functions of the video encoder 102 and network condition determination device 105, thereby making it possible to provide the previously described function in one block.

[0069] The encoded parameter determination device 401 or network condition determination device 105 makes determination concerning the next encoded parameter setting. However, if a picture quality is changed suddenly due to temporary instability of network, an unclear picture may be produced. In order to suppress such a phenomenon, it is possible to incorporate a mechanism in which a change in encoded parameter is suppressed within its predetermined range. In the above described circumstance, this mechanism functions efficiently.

[0070] Although a bit rate or an error resilience parameter may be set as its calculated value, it is possible to employ a method of predetermining some patterns, and then, selecting the closest pattern from among them. Further, instead of the closest pattern, it is possible to make a selection of the closest bit rate which is lower than the calculated bit rate. This makes it possible to prevent the generation of a video image with its unexpected image quality due to a combination of a variety of parameters, and makes it possible to prepare a combination of encoded parameters that have been tested to some extent.

[0071] In the foregoing example, when the packet loss rate is not "0" or when a delay exceeds the thresholds, there has been made a control such that parameters such as bit rate or error resilience are changed, and the changed is reset to that suitable to the current state.

[0072] However, after recovery of a network condition, when no packet loss occurs or when a small delay occurs, it is possible to make a control for increasing a bit rate or decreasing an error resilience parameter.

[0073] The foregoing example will be described below according to a second embodiment.

(Second Embodiment)

[0074] FIG. 6 is a view showing a basic configuration of an image transmission apparatus according to the second embodiment of the present invention. The image transmission apparatus shown in FIG. 6 comprises a plurality of media 601, an encoded data switch device 602, an encoded data selector 603, an encoded data transmitter 103, a network information receiver 104, and a network condition determination device 105.

[0075] The storage media 601 are used to store encoded data 631 on contents that have been encoded in advance. The storage media 601 each store encoded data on the same contents encoded by different encoded parameters, respectively.

[0076] The encoded data switch device 602 selects one of a plurality of storage media 601, and provides encoding data 631 stored in the thus selected storage medium 601 to the encoded data transmitter 103. A selection of the storage media is carried out in accordance with switch information 632 from the encoded data selector 603.

[0077] The network information receiver 104 has a function that receives network information 134 such as packet loss rate or Jitter information delivered from a receiver or a network, and provides the received information as network information 135 to the network condition determination device 105.

[0078] The network condition determination device 105 determines a network condition from the input network information 135, and outputs the result as network condition information 136 to the encoded data selector

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603. The encoded data selector 603 has a function for estimating, from this network condition information 136, which of the encoded data on encoding parameters is optimal to the current network, and then, outputting to the encoded data switch device 602 the switch information 632 used for switching in order to select encoded data caused by the estimated optimal encoding parameter as an output.

[0079] The encoded data switch device 602 selects one item of encoded data from among the input encoded data 631, and outputs encoded data 132.

[0080] With such a configuration, the encoded data 631 encoded in advance and store in the storage medium 601 or the like is input to an encoding data switch device 602 when the data is reproduced from the storage medium 601. That is, respective encoded data encoded by the differential encoding parameters are maintained in a plurality of storage media 601. As a result of reproducing these items of data, the encoded data encoded by the different encoding parameters, respectively, is inputted. The encoded data switch device 602 selects one from among these items of data, and outputs it to the encoded data transmitter 103.

[0081] This selection is carried out in accordance with switch information 632 from the encoded data selector 603.

[0082] On the other hand, network information 134 such as packet loss rate or Jitter information from a receiver is received at the network information receiver 104, and then, the received information is delivered to the network condition determination device 105. The network condition determination device 105 determines a network condition from the inputted network information 135, and outputs the result as network condition information 136 to an encoded data selector 603.

[0083] The encoded data selector 603 estimates, from the network condition information 136, which of the encoded data of the encoding parameters is optimal to the current network, and outputs the switch information 632 to the encoded data switch device 602.

[0084] The encoded data switch device 602 selects one item of the encoded data from among the input encoded data 631, and outputs encoded data 132.

[0085] The present embodiment will be described by way of a specific example.

[0086] Now, assume that there exist five storage media 601a to 601e each having stored therein five items of encoded data encoded at 384 kbps, 128 kbps, 64 kbps, 32 kbps, and 16 kbps.

[0087] That is, for example, a storage medium having stored therein encoded data on contents encoded at 384 kbps is defined as a storage medium 601a; a storage medium having stored therein encoded data on contents encoded at 128 kbps is defined as a storage medium 601b; a storage medium having stored therein encoded data on contents encoded at 64 kbps is defined as a storage medium 601c; a storage medium having stored therein encoded data on contents encoded at 32 kbps is defined as a storage medium 601d; and a storage medium having stored therein encoded data on contents encoded at 16 kbps is defined as a storage medium 601e.

[0088] In the case of using a transmission channel having its quality capable of being transmitted at 384 kbps, first, reproduced encoded data is selected by the storage medium 601a that is a storage medium having stored therein encoded data on contents encoded at 384 kbps; transmission is started at 384 kbps, and reception of network information from the receiver starts at the same time.

[0089] Although network information is received at a predetermined interval, if a problem occurs with a network based on the received information, a valid bit rate is calculated at a stage at which a packet loss or delay occurs. The encoded data selector 603 selects encoded data on a bit rate close to the calculated bit rate, and the encoded data switch device 602 switches and transmits the selected data.

[0090] For example, the calculated bit rate is 140 kbps, a value close to this bit rate is 128 kbps. In this case, the above switch device selects and switches encoded data reproduced from the storage medium 601b having stored therein encoded data on contents encoded at 128 kbps. In addition, if the calculated bit rate is 100 kbps, a value close to a bit rate lower than the calculated bit rate is 64 kbps. In this case, the switch device selects and switches encoded data reproduced from the storage medium 601c having stored therein encoded data on contents encoded at 64 kbps.

[0091] In this way, in the present embodiment, contents are prepared after encoded in advance for type of transmission bit rate, and a current optimal transmission rate is obtained based on network information such as packet loss rate or Jitter information from a receiver that is a function possessed by RTP. A storage medium having stored therein encoded data obtained at the bit rate corresponding to this transmission rate is selected by the switch 602, and reproduced encoded data output of the storage medium is transmitted. In this manner, there is no need for a server to carry out encode processing in real time, making it possible to reduce a load on the server. This is very effective in distributing a pre-produced video such as broadcast in particular.

[0092] Now, a modified example of the second embodiment will be described here. FIG. 7 is a block diagram depicting a method for carrying out control for a switch timing of encoded data to be inputted at the encoded data switch device 602.

[0093] Encoded data 631 is inputted to the switching position detecting device 701 and a switch device 702. Switch information 632 is inputted to the switching position detecting device 701. If there occurs a need to execute switching from the current encoded data to the other encoded data according to the switch information 632, the switching position detecting device 701 analyzes encoded data, and detects a switching enable posi-

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tion.

[0094] This means that a search is made for a frame encoded by intra-frame encoding (I-Picture).

[0095] When the switching enable position is set, an instruction for switching encoded data is supplied to the switch device 702 by using the switching instruction information 731. FIG. 8 shows an example of this instruction. Assume that encoded data A is currently selected, and there occurs a need to execute switching to encoded data B according to the switch information 632.

[0096] At this stage, assume that a frame is processed at the time of "switching instruction" shown in FIG. 8. In such a case, if encoded data is switched, an unmatched image occurs. This is because a difference from the previous image is encoded in intra-frame encoding (P-Picture). Therefore, if encoded data is switched at the time of P-Picture, an attempt is made to reproduce the next picture (picture P11 of encoded data (B)) by using immediately preceding picture (decoded picture 111 of encoding data (A)). This provides a problem that a correct decode picture cannot be obtained, and a picture is destroyed. Thus, there occurs a need to execute switching at a timing of a picture of intra-frame encoding (I-Picture) undergoing encoding by that frame only. This timing is defined as a timing at a position marked with "execute switching".

[0097] As in FIG. 9, a case in which the number of frames or time position differs depending on encoded data is considered. In this case as well, a switching enable position of encoded data at a switching destination is detected, and switching of encoded data is executed when the switching enable position is set.

[0098] At the switching position detecting device 701 shown in FIG. 7, when a need to execute switching according to the switch information 632 occurs, it is possible to employ a method for temporarily stopping an output 132 to the encoded data transmitter 103, and then, outputting new encoded data to the encoded data transmitter 103 at a stage at which the switching position is set.

[0099] This method is effective when it is necessary to suppress a buffer overflow or the like by switching encoded data. When an underflow is problematic, a stuffing bit is forcibly inserted, thereby making it possible to counteract such an underflow.

(Third Embodiment)

[0100] Now, a third embodiment according to the present invention will be described here.

[0101] The present embodiment describes an exemplary configuration of an encoding parameter determination device 401 of the video encoder 102 shown in FIG. 4 according to the first embodiment when a time interval (GOP interval) between frames encoded in a intra-frame encoded mode is adjusted based on the network condition information 136 outputted from the network state determination device 105. Here, a description will be given by focusing on differences from the first embodiment.

[0102] FIG. 13 shows an exemplary configuration of the encoding parameter determination device 401. This device comprises a GOP interval calculator (GOP interval calculator) 1501 and an encoding parameter determination device 502.

[0103] The network condition information 136 outputted from the network condition determination device 105 (including at least packet loss rate information) is input to an encoding parameter determination device 502. The parameter determination device 502 inputs packet loss rate information 1531 of the network condition information 136 to the GOP interval calculator 1501. The GOP interval calculator 1501 calculates a GOP interval from the packet loss rate information 1531. The GOP interval information 1532 is notified to the encoding parameter determination device 401. The encoding parameter determination device 401 outputs encoding parameter information 431 that contains the inputted GOP interval information 1532. When internally generated parameter information exists, the encoding parameter determination device 401 outputs GOP interval information 1532 and encoding parameter information 431 that contains the internally generated parameter information.

[0104] FIG. 14 shows an example of a method for determining a GOP interval at the GOP interval calculator.

[0105] At the step S1601, it is determined whether or not a packet loss occurs from the network condition information 136. When such a packet loss occurs, the GOP interval is estimated by formula (3) below, for example, at the step S1602.

$$Gop = (TN - TL)/\{(FN - FL) \times r\} \quad (3)$$

where "gop" denotes a GOP interval, "r" denotes a packet loss rate, FN denotes a total number of current frames, FL denotes a total number of frames during past calculation, TN denotes a time, and TL denotes a time during past calculation.

[0106] The GOP interval obtained at the step S1602 is notified to the signal processor 402 at the step S1603, and encoding is carried out based on the notified value.

[0107] On the other hand, when no packet loss has occurred at the step S1601, the default GOP thresholds are read out at the step S1604. At the step S1603, this value is notified to the signal processor 402.

[0108] According to the present embodiment, it is possible to change dynamically the GOP interval to a value suitable to a network. In this manner, when a small number of errors occur, the GOP interval is increased, thereby making it possible to reduce wasteful intra-frame encoded modes in number. In contrast, when a large number of errors occur, the GOP interval is decreased, and a frame in the intra-frame encoded mode appears quickly, thereby making it possible to acceler-

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ate recovery. In the present embodiment, it is possible to efficiently select an intra-frame encoded mode.

[0109] FIG. 15 shows another example of a method for determining a GOP interval at the GOP interval calculator in accordance with a flow chart.

[0110] In this example, even when packet loss is fewer than that in the system shown in FIG. 14, the network condition is estimated from the past history of packet loss at the step S1704, and an optimal GOP interval is calculated. This technique makes it possible to estimate whether a network is completely free of an error or an error may occurs by checking the past history instead of resetting the GOP interval to the default value by determining that no packet loss occurs at one moment. In this manner, it is possible to determine the network condition more accurately.

[0111] FIG. 16 shows still another example of a method for determining a GOP interval at the GOP internal calculator in accordance with a flow chart.

[0112] In this example, the GOP interval is determined by a unique calculation system instead of determination based on the presence/absence of a packet loss. This system can be used to determine the GOP interval from the current packet loss rate in accordance with a single formula or to determine the most suitable GOP interval by checking the past history.

[0113] The following formula (4) shows an example of calculation formula for determining the GOP interval.

$$Gop = [(TN - TL)/\{(FN - FL) \times r\}] \times \alpha \qquad (4)$$

where "gop" denotes a GOP interval, "r" denotes a packet loss rate, α denotes a sensitivity coefficient, FB denotes a total number of current frames, FL denotes a total number of frames during past calculation, TN denotes a current time, and TL denotes a time during past calculation.

[0114] In this example, the GOP interval calculated from an actual value is multiplied by a sensitivity coefficient, thereby making it possible to meet a requirement for accelerating recovery by sacrificing efficiency or a requirement when one does not take care even if an effect of error is somewhat extended. For example, if the sensitivity coefficient α is set to be smaller than 1, a GOP interval which is smaller than that calculated from an actually measured value is output. In this manner, although the efficiency is sacrificed, when an error occurs, it is possible to estimate faster recovery.

[0115] The present embodiment is not limited to formulas (3) and (4). For example, in these formulas, a value is calculated by using an increment during past calculation and subsequent, it is possible to calculate the value by taking a margin such as the n preceding increment. In this manner, it is possible to cope with a gradual change hidden in a change in detailed state or to eliminate a temporal change to some extent. Similarly, algorithms are not limited to those shown in the present embodiment.

[0116] The foregoing embodiment has described an exemplary configuration when a time interval (GOP interval) is adjusted, the time interval being between the frames encoded in the intra-frame encoded mode based on the network condition information 136 at the encoding parameter determination device 401 of the video encoder 102 shown in FIG. 4 according to the first embodiment. Alternatively, there can be provided a configuration in which the network condition determination device 105 according to the first embodiment (FIGS. 1, 2, or 3) determines a time interval (GOP interval) encoded in the intra-frame encoded mode based on information from the network information or information from the network information receiver 104 and information from the video encoder 102, and provides the encoded time interval to the image encoder 102.

[0117] As described in the first embodiment, it is possible to configure a video encoder capable of determining a network condition, the video encoder having functions of the video encoder 102 and network condition determination device 105, thereby providing the previously described functions in one block.

[0118] In the foregoing, although a variety of embodiments have been described, in short, the present invention utilizes characteristics of RTP, and comprises a system (RTCP) for notifying network state information such as jitter or packet loss rate from a transmitter or receiver. At the transmitter, a bit rate of transmission data at the transmitter is adjusted according to a transmission state of a transmission channel based on the notification of network state information acquired from the receiver in the transmitter such as jitter or packet loss rate so that control such as change of the error resilience level can be carried out. Therefore, according to the above described present invention, data can be transmitted efficiently to the maximum so as to achieve data transmission that makes it possible to fully utilize transmission requiring real time properties as well.

[0119] The techniques described in the embodiments of the present invention can be distributed to be stored as a computer executable program in a recording medium such as a magnetic disk (such as a flexible disk or a hard disk); an optical disk (such as CD-ROM, CD-R, CD-RW, DVD, or MO), and a recording medium such as a semiconductor memory. Further, the above program can be distributed by means of transmission via a network.

[0120] According to the present invention, it is possible to determine a network condition, and then, optimally set an encoding parameter. In addition, when a packet loss caused by congestion and a loss of a channel error coexist in a network, it is possible to determine the loss, and then, to set a parameter.

[0121] Therefore, according to the present invention, there can be provided a data transmission apparatus and method in which data can be transmitted efficiently to the maximum so as to achieve data transmission that

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makes it possible to fully utilize transmission requiring real time properties.

Claims

1. A data transmission apparatus for transmitting transmission data from a transmitter to a receiver via a transmission channel, **characterized by** comprising:

   means (105) for estimating a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and
   means (102) for changing at least one of a bit rate of transmission data and an error resilience level according to the estimated transmission condition.

2. An apparatus according to claim 1, **characterized in that** the transmitter includes means (102) for generating encoded data obtained by encoding a single content at different transmission rates, and means (603) for selecting optimum encoded data having optimum bit rate from the encoded data of the encoded data generating means (102) to adjust a bit rate of the transmission data in the transmitter according to the estimated transmission condition.

3. A data transmission method of transmitting transmission data from a transmitter to a receiver via a transmission channel, **characterized by** comprising:

   generating encoded data obtained by encoding a single content at different transmission rates;
   estimating a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and
   selecting optimum encoded data having an optimum bit rate from the encoded data to adjust a bit rate of the transmission data in the transmitter according to the estimated transmission condition.

4. A data transmission method **characterized by** comprising:

   estimating a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and
   changing at least one of a bit rate of transmission data and an error resilience level according to the estimated transmission condition.

5. A data transmitting apparatus that transmits transmission data from a transmitter to a receiver via a transmission channel, **characterized by** comprising:

   means (102) for generating plural encoded data obtained by encoding a single content at different bit rates, in the transmitter;
   means (105) for estimating a condition of the transmission channel based on Jitter information or packet loss rate; and
   means (603) for selecting encoded data having an optimum transmission rate from the plural encoded data according to the estimated transmission condition.

6. A method of transmitting transmission data from a transmitter to a receiver via a transmission channel, the method **characterized by** comprising:

   storing plural encoded data obtained by encoding a content at different bit rates;
   estimating a condition of the transmission channel based on Jitter information or packet loss rate;
   selecting encoded data having optimum transmission rate from the plural encoded data to adjust a bit rate of the transmission data in the transmitter.

7. A data transmission program stored on a computer readable medium, the program **characterized by** comprising:

   instruction means for instructing a computer to estimate a transmission condition of the transmission channel in the transmitter based on at least Jitter information or a packet loss rate obtained from the receiver; and
   instruction means for instructing the computer to change at least one of a bit rate of transmission data and a error resilience level according to the estimated transmission condition.

8. A data transmission apparatus, **characterized by** comprising:

   receiver means (104) for receiving network information regarding a condition of a network;
   determination means (105) for determining a network condition based on the network information from the receiver means;
   encoder means (102) for encoding a video data signal to generate encoded video data and control a bit rate or an error resilience level of the encoded video data according to the network condition information; and
   transmitter means (103) for transmitting the en-

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coded video data to the network.

9. An apparatus according to claim 6, **characterized in that** the encoder means (102) is supplied with an encoding parameter as the network condition information and generates encoded data whose bit rate is adjusted according to the encoding parameter,

the determination means (105) includes first storage means (302) for storing encoding parameter information obtained by the encoder means, second storage means (301) storing the network information input by the network information receiver, and determination means (303) for determine the encoding parameter by deciding the network condition based on network information input by the network information receiver, past encoding parameter information from the first storage means and past network information from the second storage means.

10. An apparatus according to claim 8, **characterized in that** the encoder means (102) includes parameter determination means (401) for determining the encoding parameter from the network condition information input from the receiver means, the encoder means (102) encoding the video data signal to generate the encoded video data whose bit rate is adjusted in correspondence with the encoding parameter determined by the determination means (401).

11. An apparatus according to claim 10, **characterized by** including encoding determination means (501) determine whether a next frame is to be encoded forcibly in an intra-frame encoding mode, when the parameter determination means (401) determines the encoding parameter using the network condition information.

12. An apparatus according to claim 8 or 9, **characterized in that** the determination means (105) includes computation means for computing a GPO interval from the network information input from the receiver means (104) to generate network condition information including GOP interval information indicating the GOP interval obtained by the computation means, and the encoder means (102) encodes the video data signal according to the GOP interval information included in the network condition information.

13. An apparatus according to claim 8 or 10, **characterized in that** the encoder means (102) includes GOP interval computation means for computing a GOP interval based on the network information input from the receiver means (104) and encodes the video data signal according to the GOP interval information indicating the GOP interval computed by the GOP interval computation means.

14. An apparatus according to claim 12 or 13, **characterized in that** the determination means (105) determines at least a packet loss rate as the network condition, and the GOP interval computation means computes the GOP interval based on at least the packet loss rate.

15. An apparatus according to claim 8, **characterized by** including switching means (602) for switching among plural encoded data encoded at different transmission rates, respectively, to select encoded data having a transmission rate corresponding to switching information, and selector means (603) for selecting a transmission rate of encoded data to be transmitted from the transmitter based on the network condition information outputted from the determination means (105) and output the selected transmission rate as the switching information to the switching means.

16. An apparatus according to claim 15, **characterized in that** the switching means (602) includes a switching position detector for detecting a switching position at which one of the encoded data can be switched to the other, and when an encoded data switching signal is generated by the switching information output from the selector means (603), the switching position detector detects the switching position, to switch the encoded data at the switching position.

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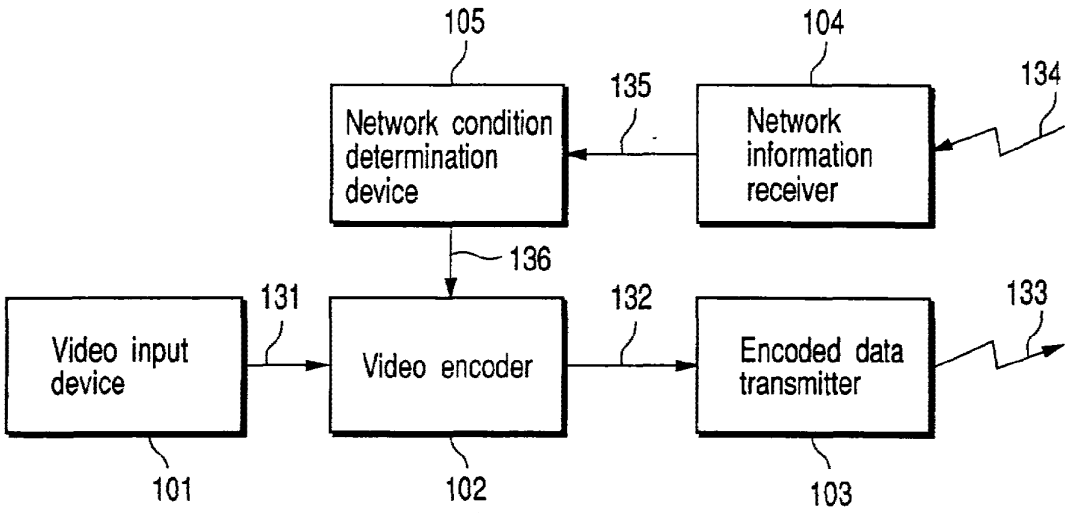


FIG. 1

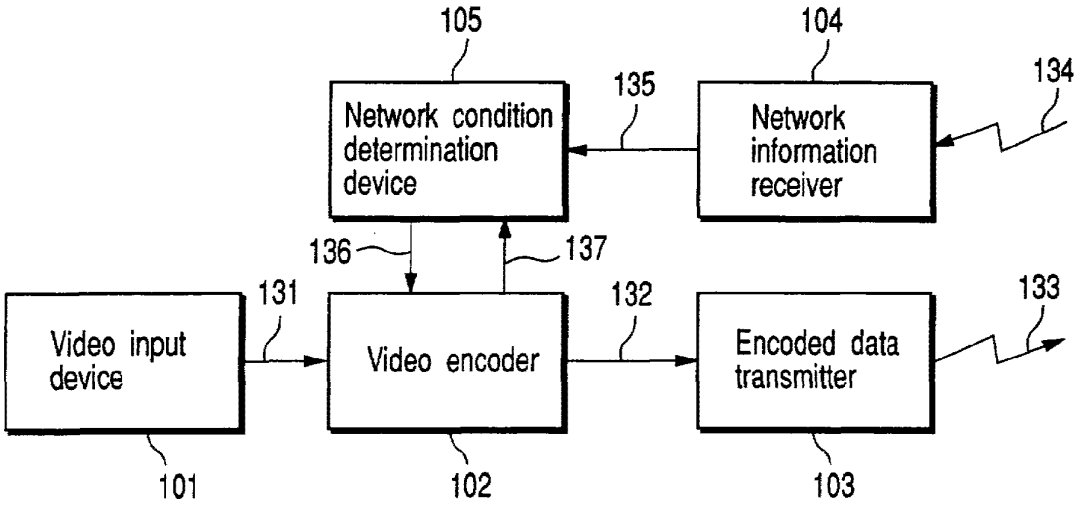


FIG. 2

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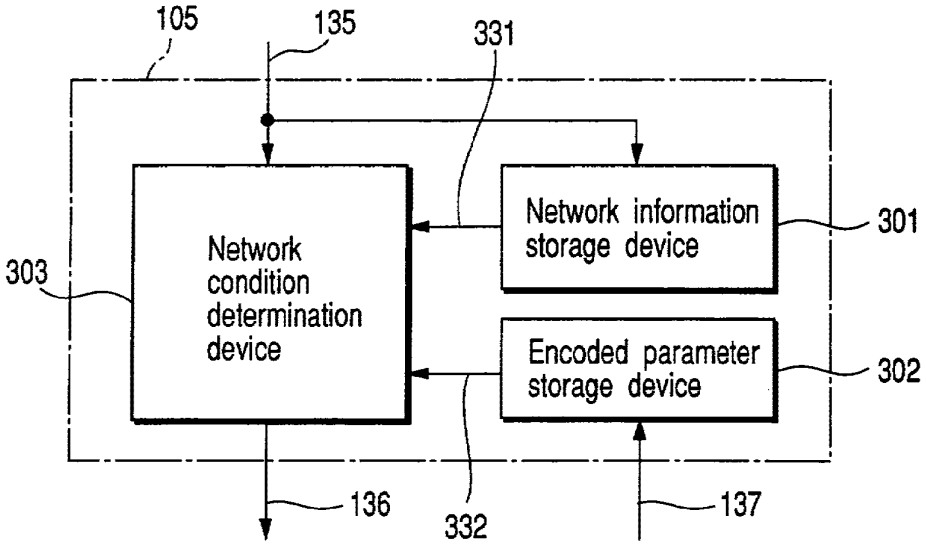


FIG. 3

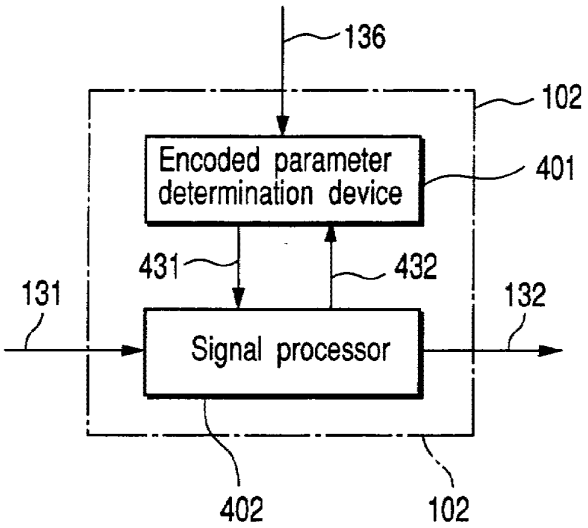


FIG. 4

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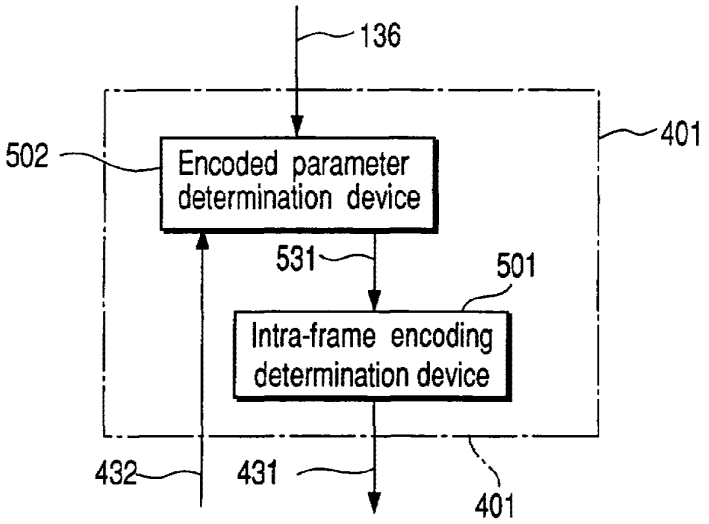


FIG. 5

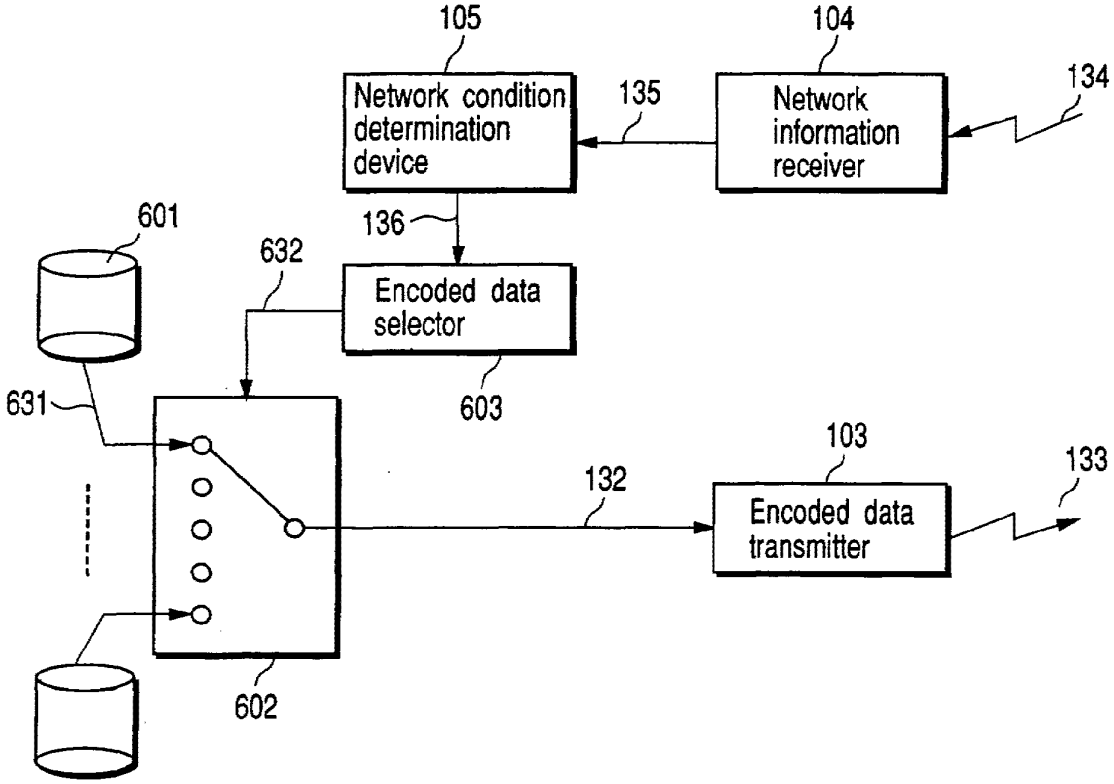


FIG. 6

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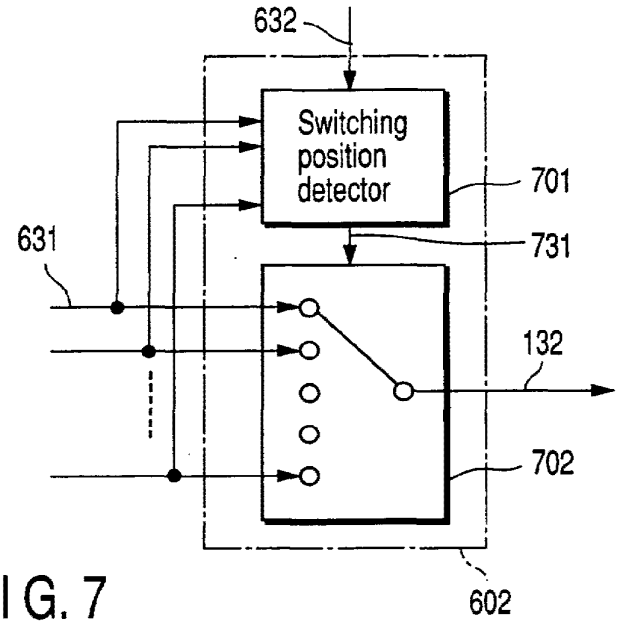


FIG. 7

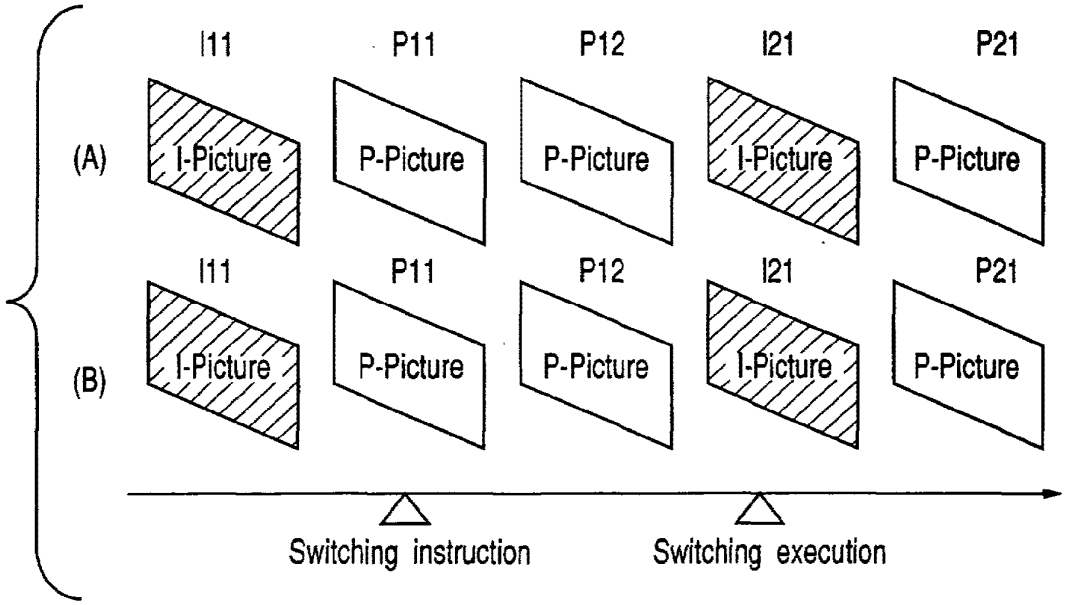


FIG. 8

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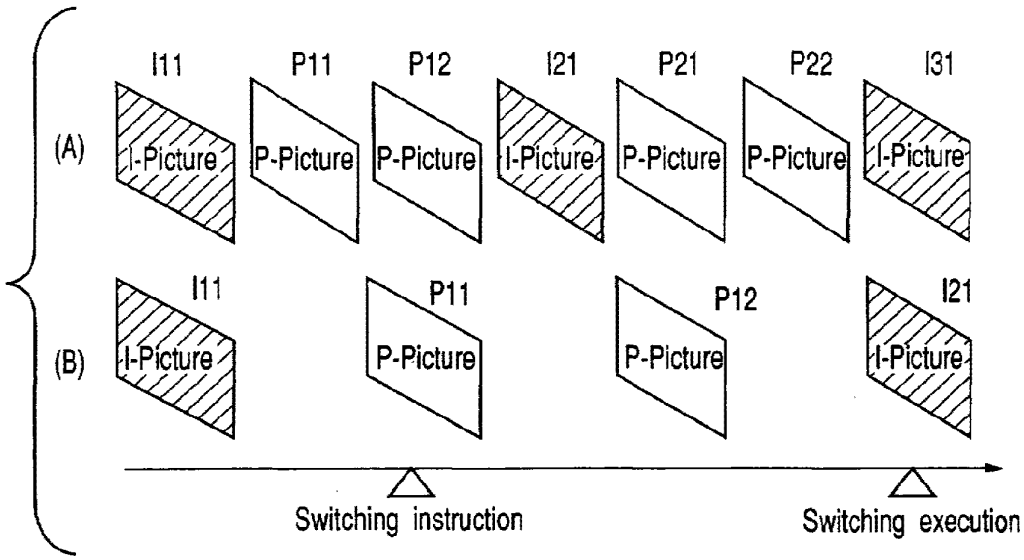


FIG. 9

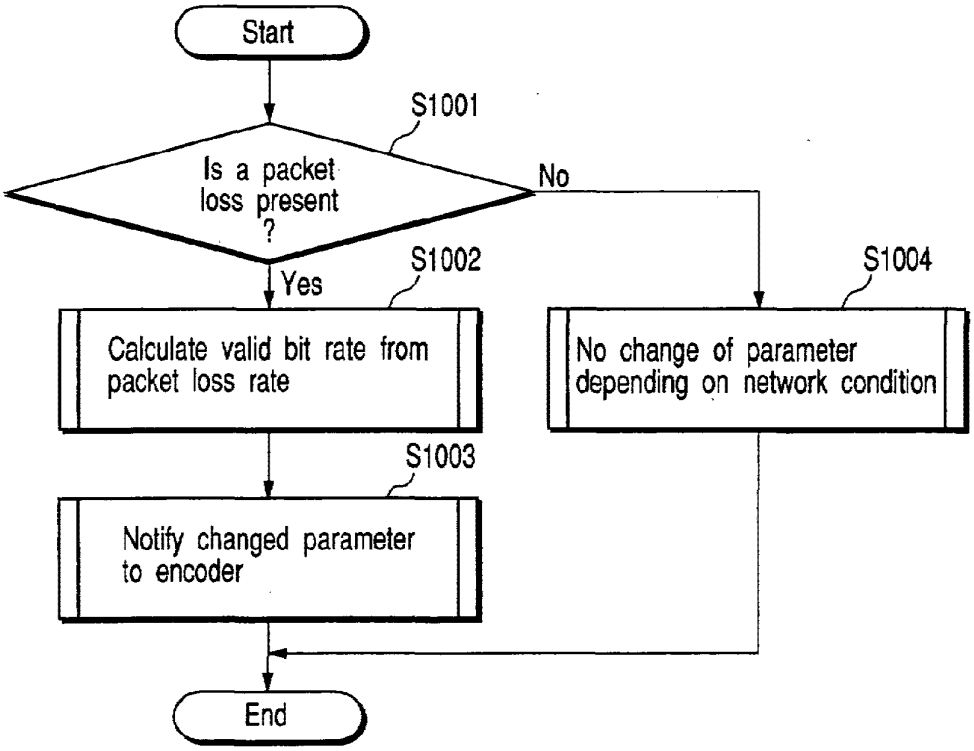


FIG. 10

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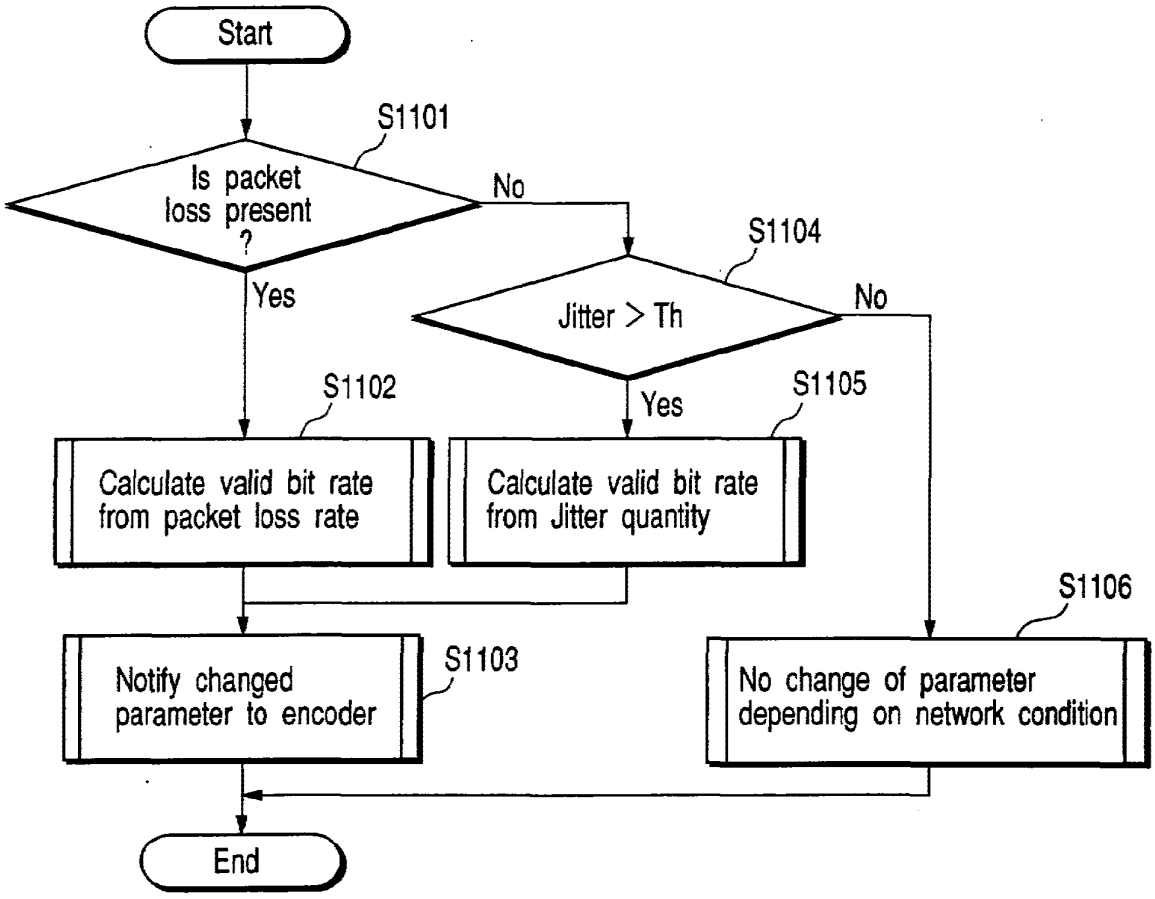


FIG. 11

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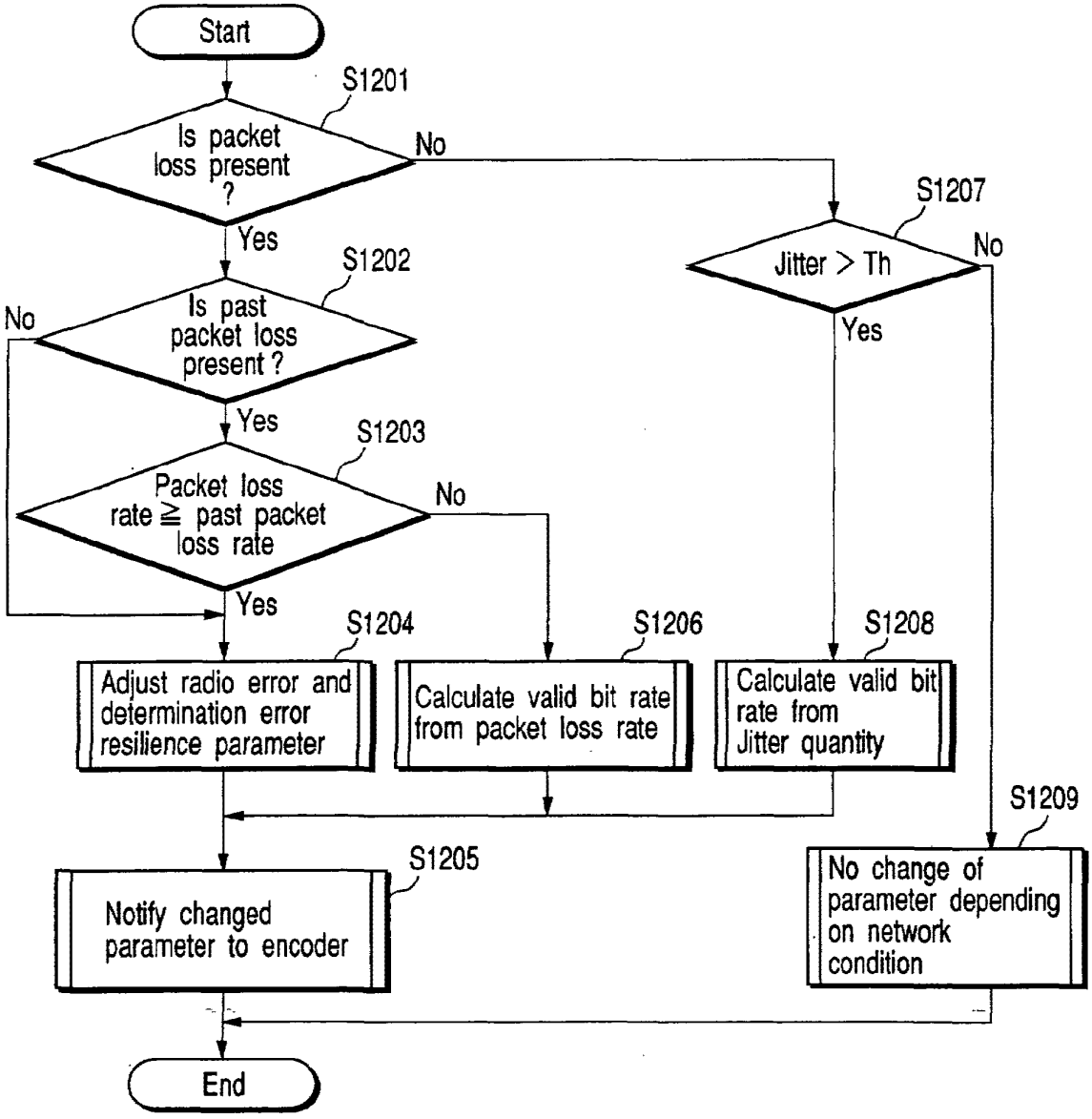


FIG. 12

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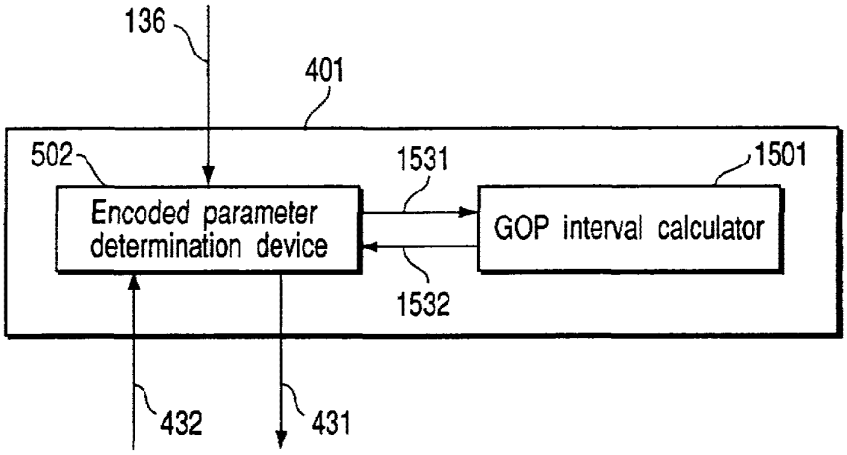


FIG. 13

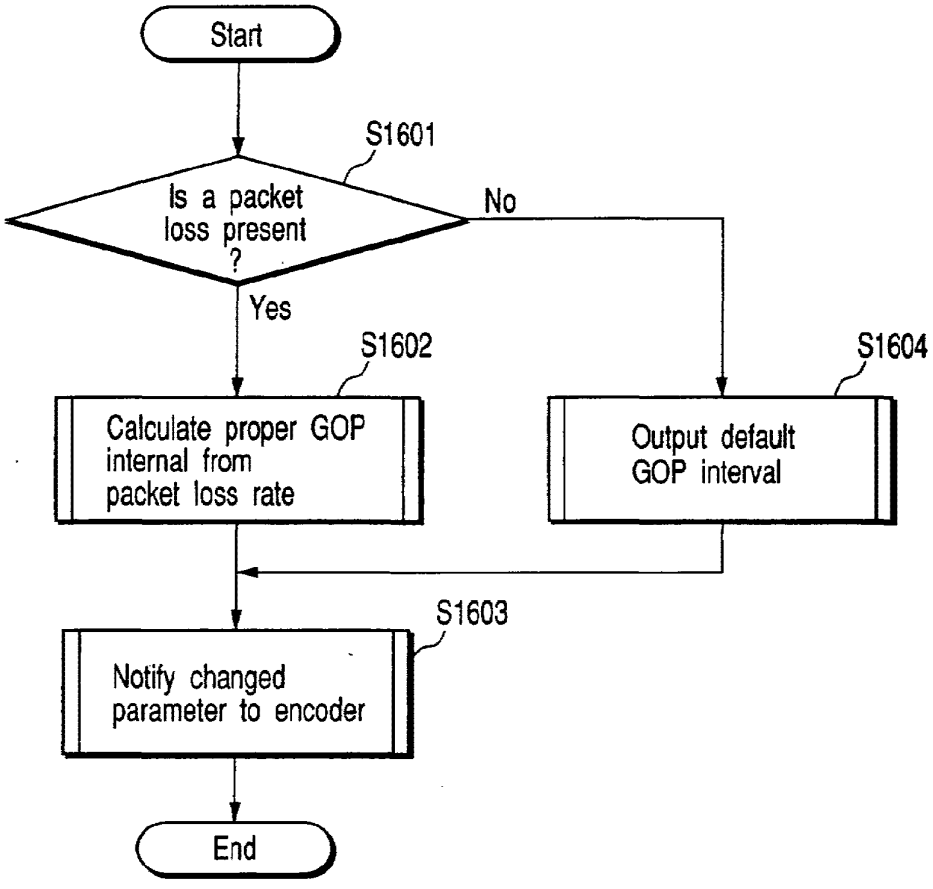


FIG. 14

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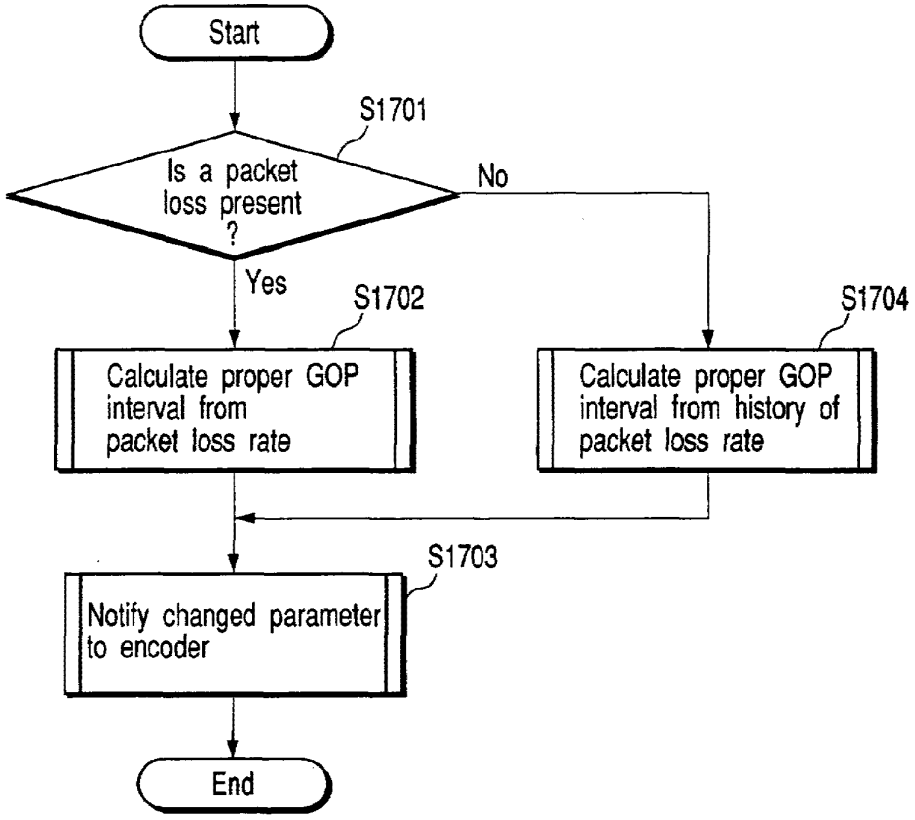


FIG. 15

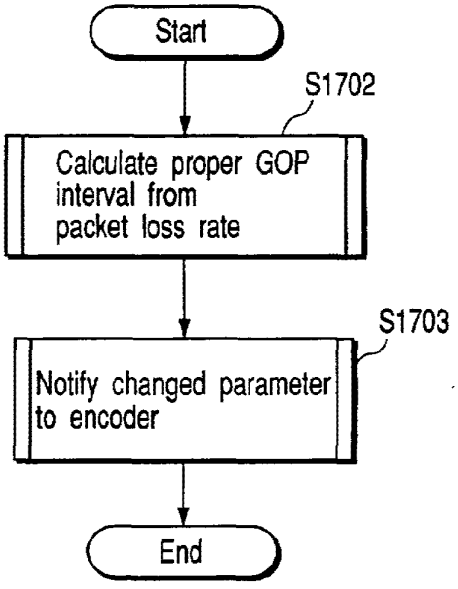


FIG. 16

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(54) Adaptive media stream

(57) This invention relates to media streams transmitted in a network, such as the Internet. The idea is to change the source of the content of a media stream when an available transmission speed rate changes. Each source contains essentially the same information (such as video and voice), but the suitability of each source for transmission has been adjusted to a certain speed rate.

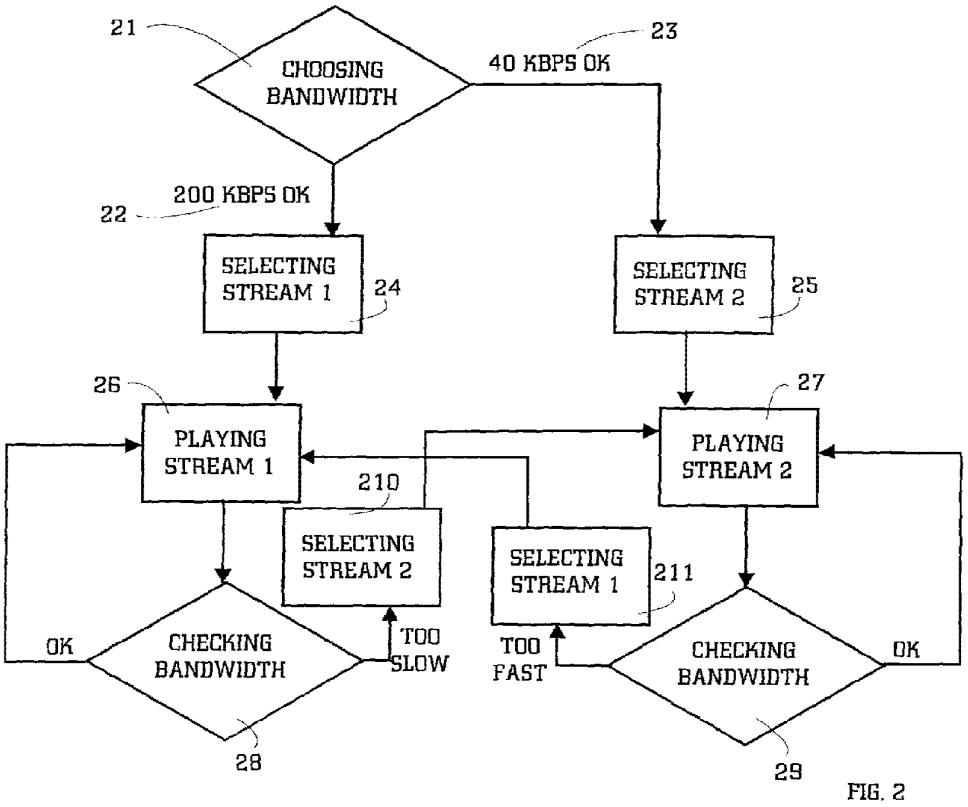


FIG. 2

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Description

FIELD OF THE INVENTION

[0001] This invention relates to media streams transmitted in a network, such as the Internet. Especially, the invention relates to media streams concerning video pictures and voice.

BACKGROUND OF THE INVENTION

[0002] When media streams that contain continuous data, for example video pictures and voice, are transmitted in a network, such as the Internet, the speeds of the media streams have to be adjusted with the speed of the transmission connection available at the time. Often, in the case of video pictures, the adjustment is made by changing the visual quality of the pictures. The speed of a transmission connection in the Internet depends strongly on a user's Internet terminal. Some terminals support technically higher speed rates than others (usually older terminals). Thus, speed adjusted media streams must be offered for a variety of terminals.

[0003] Transmission speed may also vary with time. For example, when congestion happens in the network, the transmission speed may decrease considerably. After the congestion, the transmission speed returns to the normal speed rate.

[0004] Nowadays, most of the content of the Internet is in WWW servers, which use the HTTP protocol for transmitting desired contents to users. Originally, the HTTP protocol was not designed for continuous media streams (video, voice). The problem of the known solutions is that when a media stream has to be adjusted for a changed transmission condition, i.e. to be an adaptive media stream, a special software or protocol must be used, instead of the HTTP protocol. Real Server® (RealNetworks Inc, Seattle, Washington), Quicktime® Server (Apple Computers, Cupertino California), and Windows Media Server® (Microsoft, Redmond, Washington) are commercial server software, which support adaptive media streams. These software packages use special protocols, such as RTP (Real-Time Transport Protocol) and RTSP (Real Time Streaming Protocol), which are designed for the adaptive media streams.

[0005] However, using these software packages usually requires a user to invest and maintain parallel devices and software in addition to the WWW server that is used to serve other Internet content, such as web pages. User communities such as corporations require support staff which must be educated to use these systems. For a service provider this means in practice that a special media stream server must be maintained. The goal of this invention is to eliminate these drawbacks. This is achieved in a way described in the claims.

SUMMARY OF THE INVENTION

[0006] The following definitions should be kept in mind when reading these specifications:

Connection: A transport layer virtual circuit established between two programs for the purpose of communication. A connection can have varying transmission speed rates.

HTTP transport: An application layer transmission of data from a file on a server computer to a user terminal using HTTP 1.1 protocol. One HTTP 1.1 connection can consist of one or several HTTP 1.1 transports.

Stream: A continuous transmission of data over for example HTTP transport

[0007] An important aspect of the invention is to change the source of an adaptive media stream when an available connection speed rate changes. Each source contains essentially the same information (such as video and voice), but the suitability of each source for transmission has been adjusted to a certain connection speed rate. The coding of the source information can be different among the sources, which affects the speed rate. The picture information can be black-and-white instead of a color picture. The picture size can be smaller or larger. The video can be with or without voice. When the source is changed, also a new HTTP transmission for the new source is started for a new stream containing the information of the new source. In other words, the adaptive media stream, i.e. the adaptive stream, comprises at least one media stream for transmitting information.

[0008] In an arrangement according to the invention a source file is formed. The source file contains a plurality of sources intended for different media streams, according to such parameters as bandwidth, computing capability of the receiving terminal, etc. At the beginning of the transmission the optimal transmission speed rate at the time is chosen according to an information transfer condition. The source in the source file, which corresponds to the available speed rate, is selected to be the source of the adaptive media stream. When the available transmission speed rate changes, either to be faster or slower, a command for changing the source of the adaptive media stream, is sent from the user's terminal to the service provider's server, i.e. the source server, wherein the file of the service is. Preferably commands are sent using an HTTP protocol. When the available transmission speed rate changes again, a new command for changing the source is sent from the user's terminal to the source server. The commands are sent when it is possible to use a higher speed rate or when a lower speed rate must be used.

[0009] In one aspect, the invention thus provides a method for providing an adaptive media stream between a sending terminal and a user's terminal wherein

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the adaptive media stream comprises at least one media stream and the method comprises the steps of choosing a transmission speed rate for the media stream, selecting a suitable data source for the media stream among sources containing essentially the same information content, each source intended for a certain information transfer condition and playing the media stream. During such playing, checking the suitability of the actual transmission speed rate, and continuing playing the media stream if the transmission speed is still suitable or selecting a new data source, which is suitable at the moment as a response for the selection of the new data source, playing a new media stream. Those selection actions continue until the played stream stops.

[0010] Optionally, the step of choosing comprises the phase of reading a header field of a file, which contains at least two data sources, the header indicating the starting points of the sources and to which transmission speed rate each source is indented. Yet another option calls for the selecting step to include the phase of starting to read from the starting point of the selected source.

[0011] Other aspect of the invention provide for the step of monitoring to include the phase of monitoring a filling degree of a buffer for incoming data in the user's terminal, e.g. if the buffer is becoming empty or full, then selecting to continue to play the present media stream or to start playing another media stream. The information of the selection of the new data source may transmitted from the user's terminal to the sending terminal using a GET method of an HTTP protocol with an optional RANGE field. When a new stream is played, an optional phases of terminating the old media stream after starting to play the new media stream and creating the new media stream before playing the new media stream is also contemplated.

[0012] If a new stream is selected, according to another aspect of the invention, the step of reading timing marks in said adaptive media stream for defining the right point to start playing the new media stream is also performed. Further, the step of selecting the initial speed may comprise the phase of reading a header field of files, where each contains one data source, the header indicating the starting points of the source and to which transmission speed rate the source is indented.

[0013] An arrangement for providing an adaptive media stream between a sending terminal and a user's terminal, is also contemplated, wherein the adaptive media stream comprises at least one media stream and the arrangement comprises:

a) Means in the client terminal for choosing a transmission speed rate for the media stream,
b) A data structure in the sending terminal comprising at least two data sources containing essentially the same information, each source intended for a certain transmission speed rate,
c) Means in the client terminal and the sending terminal for selecting a suitable data source from among the sources for the media stream,
d) Means in the user's terminal for checking the suitability of the transmission speed rate when the media stream is played,
e) Means in the user's terminal for reselecting a suitable data source from among the sources for a new media stream.

[0014] An arrangement as described above may further comprise means for playing the data structure in a way that the playing is started from the right point of the data structure. Preferably, means a) comprises means for reading a message from the user's terminal, which defines alternative transmission speed rates. Further preferably, each source comprises timing marks, which indicate the corresponding point in the other sources. More preferably, the arrangement further comprises a GET method of an HTTP protocol with an optional RANGE field for transmitting the information of the reselection of the suitable data source from the user's terminal to the sending terminal. In another preferable embodiment, means d) comprises means for monitoring a filling degree of a buffer for incoming data in the user's terminal. It also preferable that the data structure is a file containing the data sources. Alternatively, the data structure may be a number of files, each of them containing one data source.

[0015] Means c) may further comprise means for reading a header of the data structure, which indicates the starting points of the sources and to which transmission speed rate each source is intended. Means c) may further comprise means for reading headers of the files, which indicate the starting point of the source and to which transmission speed rate the source is intended.

[0016] In yet another aspect, the invention teaches a method for storing adaptive media stream data comprising the steps of storing a plurality of media streams, each representing a substantially similar information content, and each adapted for a different set of information transfer conditions; and providing a plurality of pointers into a first of said media streams, said pointers associated with a source location in one of said media streams and pointing to at least one target location in a second of said media streams; wherein the information content of said target location is substantially a continuation of the information content prior to said source location.

[0017] Preferably, said plurality of media streams is contained in a single file. Said pointers are preferably embedded within said adaptive media stream data, and comprise target locations pointer comprises a byte offset into said single file. Alternatively, said target location pointer comprises an offset into said second source stream, within said single file. Another alternative teaches that said target locations pointers comprise a pointer to another file containing said second media stream or a portion thereof. Optionally in this case, said target location pointer further comprises a byte offset into said

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other file.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In the following the invention is described in more detail by means of Figs. **1 - 3** in the attached drawings where.

FIG. **1** illustrates an example of the structure of a file according to the invention,
FIG. **2** illustrates an example of a flow chart describing the function of the inventive arrangement,
FIG. **3** illustrates an example of an arrangement according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] FIG. **1** describes an example of a file structure according to the invention. The file is in the service provider's server (source server) from where users can stream it. For example the file contains a video in two different formats. At the beginning of the file there exists a header **1**, which contains starting bytes for two different media sources - the sources for the media stream. Source 1, called stream 1 contains video data in a resolution of 320*240, for a speed rate 200 kbps (kilobit per second) **2.** The starting byte **4** for that video data is byte 2000 in the file. Source 2, called stream 2 contains video data in a resolution of 160*120 optimized for a speed rate 40 kbps **3.** The starting byte of that video data **5** in the file is at byte 800000. If the network and a user's terminal support the transmission speed rate 200 kbps then stream 1 is sent to the user - otherwise stream 2 is sent. In this embodiment, all data feeds are assumed to support communication at a speed of at least 40 kbps. It should be noted that stream 1 and 2 are sources i.e. the parts of the file structures in this example, and a media stream is a continuous transmission of data of a source over a transmission protocol. The transmission protocol used can be any protocol, in this text the HTTP protocol is used.

[0020] Stream 1 is sent, i.e. streamed, to the user. Stream 1 (and the media stream for it as well) contains timing marks **6, 7, 8, 9.** The timing marks are embedded in stream 1 at a various locations, and correlate the information in the two separate resolution streams. Thus the timing marks of stream 1 in the example of Fig. 1 indicate the byte of the file where the stream is running at the time and the corresponding byte **6A, 7A, 8A, 9A,** in stream 2. If for some reason, the network can not transmit stream 1 with 200 kbps, or the user's terminal can not receive at this speed rate, the transmission of the video is changed to stream 2. For example, when the need to change the speed rate to a lower one is noticed and the most recently received (or alternatively the next) timing mark is, let's say, the mark **7** indicating time 1000 ms, it tells the corresponding byte 805000 in stream 2 to where the source of the transmission of the video transfers **11.**

[0021] Similarly, stream 2 (and the media stream for it) contains timing marks **10**, **11**, **12**, **13**, which point to the location of corresponding information in stream 1, as shown by the corresponding byte **10A, 11A**, **12A**, **13A**, in stream 1. When the capability of transmitting 200 kbps is noticed during the transmission at 40 kbps rate, the transmission of the video is changed to stream 1. For example, when the availability of the higher speed rate is noticed and the next timing mark is the mark **13** indicating time 3000 ms, the corresponding byte 77000, located in stream 1, points to the location of corresponding information in stream 1 so the source of transmission is shifted to stream 1, using data stored in location **9** onwards.

[0022] FIG. **2** shows an example of a flow chart, which illustrates a function and method of the invention. FIG. **3** shows an example of the inventive arrangement. When a user visits a home page of a service provider, he/she may find something he wants to order, such as a video show. The video player client running in the user terminal sends **34** a request message from the terminal **33** to the service provider's server **31** through the network **32**, such as the Internet, to get the show using a GET method, which is one of the methods defined in the HTTP1.1 protocol. Let the request be:

GET http://www.serviceprovider.com/video/music/song1.video. **HTTP/1.1**

[0023] Often, the connection speed rate depends on the available (and optional) connection and processing speeds of the terminal. At the beginning, the first stream which is sent works like a test stream. The test stream, i.e. the first stream preferably forms the first part of the file structure, which preferably contains data for the lowest bandwidth. Thus the first stream over the HTTP transport also contains a list of alternative speed rates. The player in the client terminal chooses **21** one of the supported speed rate from the list. (It should be noted that the server can be informed of the capability of a terminal or the available bandwidth using other techniques and the specific method of learning the link capabilities is a matter of technical choice to one skilled in the art.) In this example, the user's terminal supports speed rates of 200 kbps and 40 kbps. Let's assume that the desired file **36** is the file in FIG. **1**. If the speed rate of 200 kbps **22** is available, stream 1 is selected **24**. Otherwise, the speed rate of 40 kbps **23** is chosen and stream 2 is selected **25.** (Notice that the higher speed rate means the higher bandwidth.)

[0024] In the selection of the speed rate of 200 kbps the server starts to play **26** stream 1 beginning at byte (2000) of the file. The data and the timing marks are sent **35** to the user's terminal during the play. The terminal checks **28** frequently that the currently available bandwidth is sufficient for the selected stream. If the bandwidth is sufficient, playing stream 1 is continued. If the bandwidth becomes unavailable for stream 1, stream 2 is selected **210** and stream 2 starts to play **27**, **311** be-

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ginning at the byte of the file defined by the latest timing mark. The bandwidth of stream 2 is checked **29** similarly as the bandwidth of stream 1, and when the bandwidth is again available for the speed rate of 200 kbps, stream 1 is selected **211**.

[0025] In the selection of the speed rate of 40 kbps the server starts to play **25** stream 2 from the right byte (800000) of the file. The data and the timing marks are sent **35** to the user's terminal during the play. The terminal checks **29** frequently that the bandwidth is okay for the selected stream. If the bandwidth is still restricted to 40 kbps, playing stream 2 is continued. If the bandwidth rise to a level sufficient to support 200 kbps transmission, stream 1 is selected **211** and stream 1 starts to play **26**, and is sent **311** to the terminal **33** beginning at the byte of the file defined by the latest timing mark. The bandwidth of stream 1 is checked **28** similarly as the bandwidth of stream 2, and when the bandwidth is again too slow for the speed rate of 200 kbps, stream 2 is selected **210**.

[0026] The checking of the bandwidth of the streams can be made, for example, measuring a filling degree of a buffer for incoming data connection in the user's terminal. When the buffer is becoming empty, the required bandwidth for current stream is too high compared to what is available through the network connection, and the speed rate should be dropped. When the buffer is becoming full, bandwidth for current stream is lower than what is available through the network connection, and the speed rate can be raised. After the measurement, the suitable stream source is selected **210, 211** and a GET command with an additional field RANGE is sent **310** from the user's terminal to the server for changing the stream. For example, let the GET command be GET http://www.serviceprovider.com/video/music/song3video RANGE: bytes= 805000- when the transmission speed rate changes from 200 kbps to 40 kbps.

[0027] It is worth noting that preferably, when a stream is changed, a new HTTP transport (and naturally a new media stream) is started and the old media stream is terminated after the new media stream starts playing. From the view of the user the desired file, such as a video show, seems to continue without any break because the new stream starts playing from the byte indicated by the timing mark, thus the information continuity is maintained, despite the media stream switch. So, when the source is changed, also a new HTTP transport is created for the new stream, i.e. media stream, instance and for the new source. Thus the adaptive media stream, i. e. the adaptive stream, is made up of one media stream or several consecutive media streams. Since the consecutive media streams carry essentially the same data, a user gets a visual impression of continuous shows. In other words, the adaptive media stream comprises at least one media stream for transmitting information. The HTTP 1.1 protocol provides a feature called Persistent Connections. Persistent Connection means that several requests (such as GET), can be sent via one TCP connection. Thus one connection may carry several consecutive streams. However, it should be noted that several TCP connections may be needed or used for transmitting consecutive streams.

[0028] Furthermore, it may be said that the adaptive media stream comprises several (or one if the speed rate remains the same during the whole transmission) instances (separate streams) of the same object (the adaptive media stream containing information such as video). Naturally, there are more ways to model the adaptive media stream, but common for these models are that transmission of information of the adaptive stream, (the stream of a continuous data, such as video over one or several connections) happens in one or several consecutive media streams over a transport protocol, each media stream adapted for certain conditions, and certain links or pointers periodically connect or cross connect the media streams in essentially content coherent fashion. Thus varying transmission conditions may dictate how many suitable media streams are sent forming together the adaptive stream.

[0029] For creating the inventive arrangement an initial selection module **39** (i.e. means) for choosing an original transmission speed rate and selecting a suitable source in a service provider's server is needed. In a user's terminal another estimation module **37** (i.e. means for checking transmission rate) is needed, for checking the suitability of the transmission speed rate as reselection module **38** (i.e. means) for reselecting a suitable source are needed.

[0030] Although, the processing and network connection speed of a user's terminal is mostly the decisive element when selecting a suitable transmission speed rate, it may happen that the network itself becomes congested. In congestion, the available speed rate decreases and the transmission speed rate must be lowered. On the other hand, if the network allows a higher speed, the transmission speed rate may be increased.

[0031] Using the inventive arrangement, an adaptive media stream can be served from with a common HTTP server. Therefore, there is no need for the use of a special media stream server, or parallel devices and software. Remarkable cost savings are achieved, since usually service providers and users support the HTTP protocol. Also the reliability of the system increases because of fewer sources of faults.

[0032] It is clear that inventive arrangement can be implemented in many ways. For example, the time period between two timing marks can be different than in the example of this text. It can be any suitable period depending on the features of a solution, such as 2 or 4 seconds. The format of the inventive file can be any suitable format as well, such as MPEG or another.

[0033] The inventive file may comprise more than two different streams (containing the same content), from which the most suitable stream is selected at any given time. Therefore, timing marks must contain a number of references for the corresponding byte in the other data

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sources.

[0034] All the sources do not have to be in the same file, but each source can be a separate file. However, the use of this kind of structure is not as efficient when attempting to use as little processing power as possible compared to the use of one file structure. In the structure of several files, timing marks must indicate the right file with the corresponding byte.

[0035] Although, a sending terminal have been described to be a server in the examples above, it is clear that the sending terminal can be another terminal capable of sending information.

[0036] Similarly other mechanisms are known and suitable to measure and select the most appropriate source. Such methods may be server based or user terminal based, or even utilize intermediate network nodes to estimate network congestion and bandwidth, and similar measurements that are indicative of total node to node capacity, as well as specific node capabilities, and the selection of sources (and media streams) may be carried out in various ways that will provide the best end-user experience according to varying conditions.

[0037] According to the above-mentioned matters, it is evident that the invention is not restricted to the solutions described in this text, but it can be modified for various solutions, in the scope of the inventive idea.

Claims

1. A method for providing an adaptive media stream between a sending terminal and a user's terminal **characterized in that** the adaptive media stream comprises at least one media stream and the method comprises the steps of:

    a) choosing a transmission speed rate for the media stream,
    b) selecting a suitable data source for the media stream among sources containing essentially the same information, each source intended for a certain transmission speed rate,
    c) playing the media stream,
    d) checking the suitability of the transmission speed rate,
    e) either continuing playing the media stream if the transmission speed is still suitable or,
    f) selecting a new data source, which is suitable at the moment,
    g) as a response for the selection of the new data source, playing a new media stream,
    h) repeating steps d) to g) until the stream, which is played, stops.

2. A method according to claim 1 **characterized in that** step b) comprises the phase of reading a header field of a file, which contains at least two data sources, the header indicating the starting points of the sources and to which transmission speed rate each source is intended.

3. A method according to claim 2 **characterized in that** step c) comprises the phase of starting to read from the starting point of the selected source.

4. A method according to claim 1 or 3 **characterized in that** step d) comprises the phase of monitoring a filling degree of a buffer for incoming data in the user's terminal.

5. A method according to claim 4 **characterized in that** if the buffer is becoming empty or full, then step f) is chosen, else step e) is chosen.

6. A method according to claim 1 or 5 **characterized in that** the information of the selection of the new data source is transmitted from the user's terminal to the sending terminal using a GET method of an HTTP protocol with an optional RANGE field.

7. A method according to claim 1 **characterized in that** step g) comprises phases of terminating the old media stream after starting to play the new media stream and creating the new media stream before playing the new media stream.

8. A method according to claim 1 or 7, **characterized in that** step g) further comprises the phase of reading timing marks in the data source for defining the right point to start playing the new media stream.

9. A method according to claim 1 **characterized in that** step b) comprises the phase of reading a header field of files, where each contains one data source, the header indicating the starting points of the source and to which transmission speed rate the source is intended.

10. An arrangement for providing an adaptive media stream between a sending terminal and a user's terminal, **characterized in that** the adaptive media stream comprises at least one media stream and the arrangement comprises:

    a) means in the sending terminal for choosing a transmission speed rate for the media stream,
    b) a data structure in the sending terminal comprising at least two data sources containing essentially the same information, each source intended for a certain transmission speed rate,
    c) means in the sending terminal for selecting a suitable data source from among the sources for the media stream,
    d) means in the user's terminal for checking the suitability of the transmission speed rate when the media stream is played,

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e) means in the user's terminal for reselecting a suitable data source from among the sources for a new media stream.

11. An arrangement according to claim 10, **characterized in that** the arrangement further comprises means for playing the data structure in a way that the playing is started from the right point of the data structure.

12. An arrangement according to claim 11, **characterized in that** means a) comprises means for reading a message from the user's terminal, which defines alternative transmission speed rates.

13. An arrangement according to claim 11, **characterized in that** each source comprises timing marks, which indicate the corresponding point in the other sources.

14. An arrangement according to claim 13, **characterized in that** the arrangement further comprises a GET method of an HTTP protocol with an optional RANGE field for transmitting the information of the reselection of the suitable data source from the user's terminal to the sending terminal.

15. An arrangement according to claim 11, **characterized in that** means d) comprises means for monitoring a filling degree of a buffer for incoming data in the user's terminal.

16. An arrangement according to claim 11, **characterized in that** the data structure is a file containing the data sources.

17. An arrangement according to claim 16, **characterized in that** means c) comprises means for reading a header of the data structure, which indicates the starting points of the sources and to which transmission speed rate each source is intended.

18. An arrangement according to claim 11, **characterized in that** the data structure is a number of files, each of them containing one data source.

19. An arrangement according to claim 18, **characterized in that** means c) comprises means for reading headers of the files, which indicate the starting point of the source and to which transmission speed rate the source is intended.

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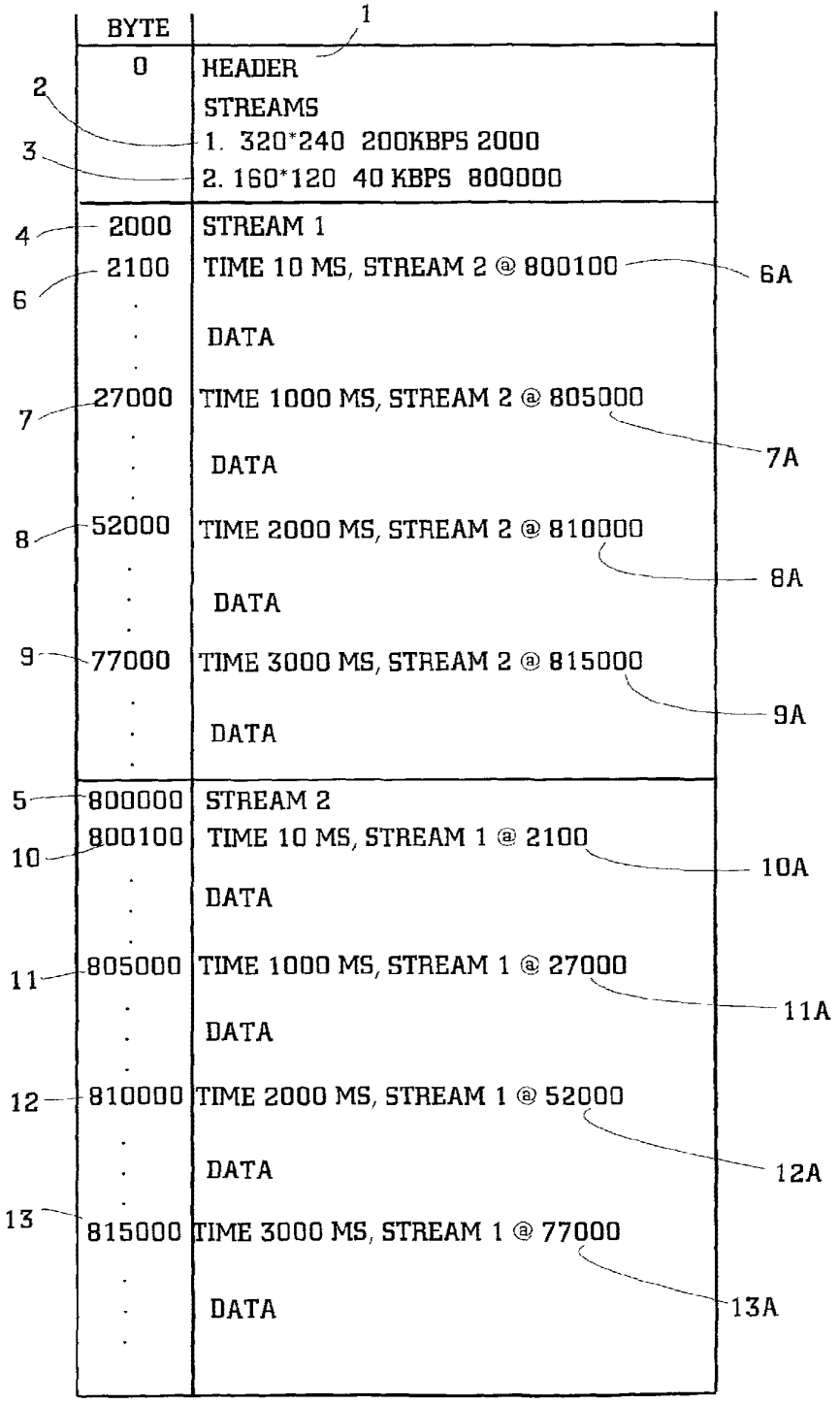


FIG. 1

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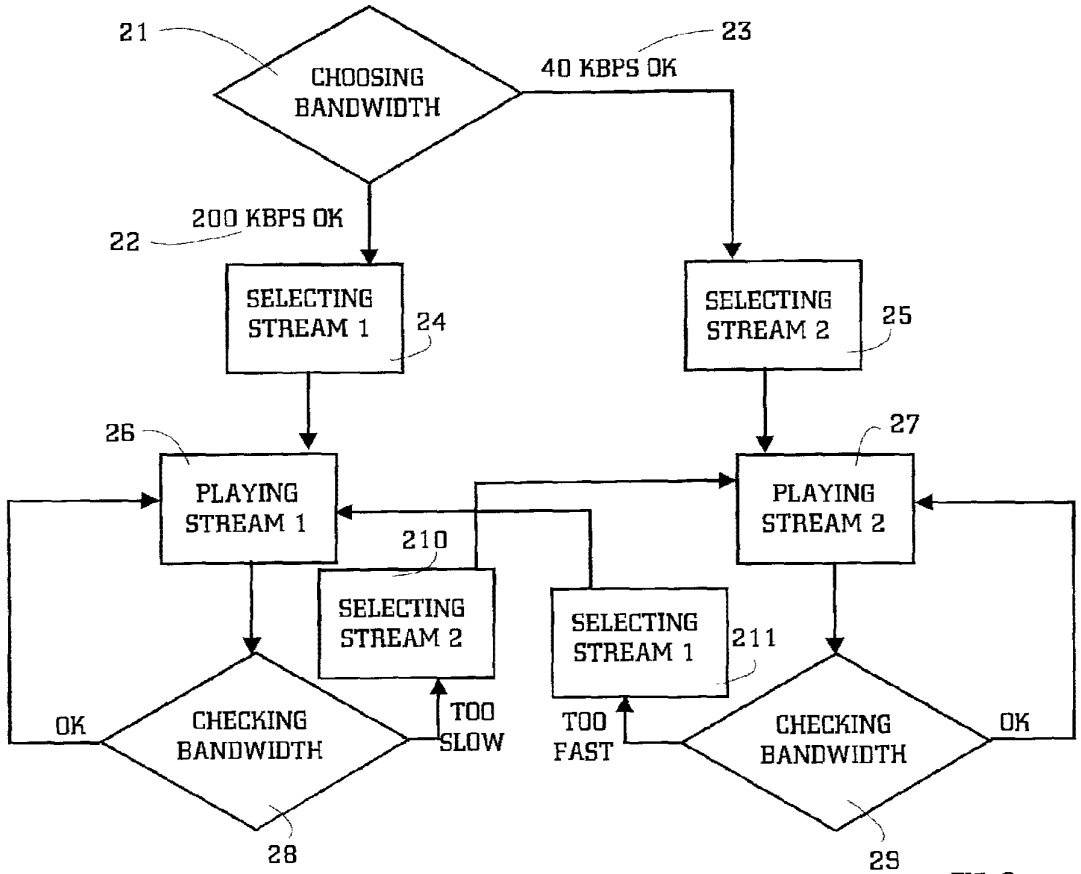


FIG. 2

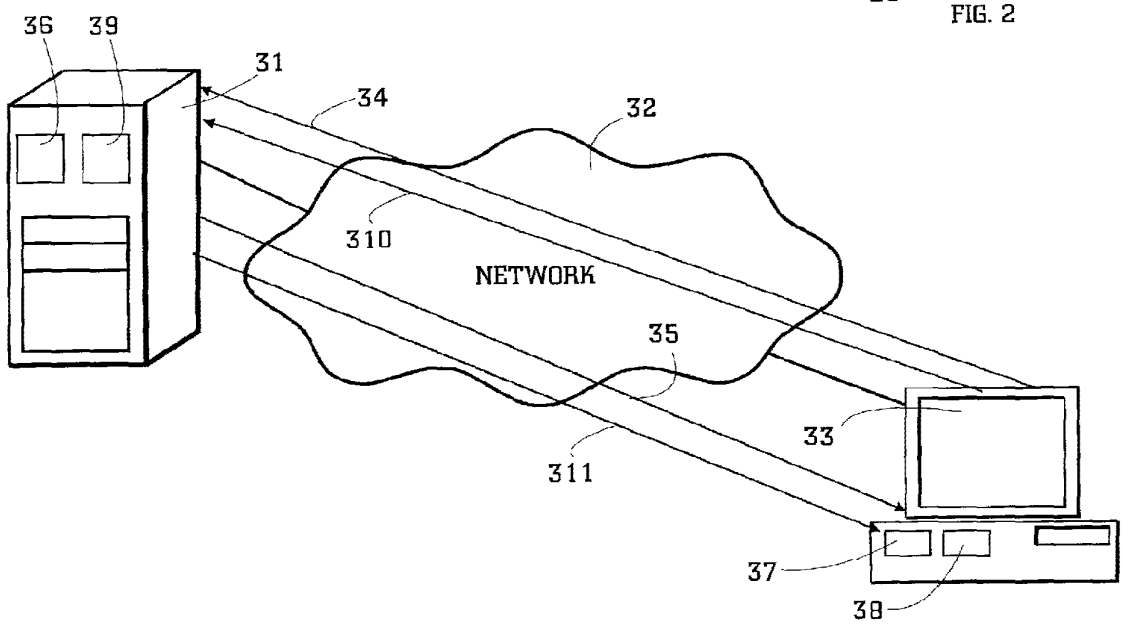


FIG. 3

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PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-201343
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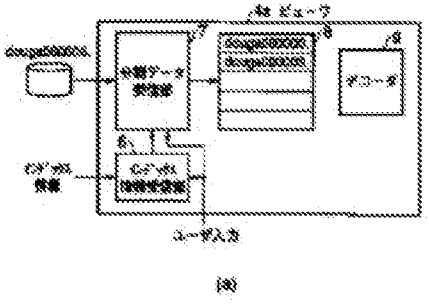
(51)Int.Cl. H04N 7/173

(21)Application number : 11-000497
(22)Date of filing : 05.01.1999

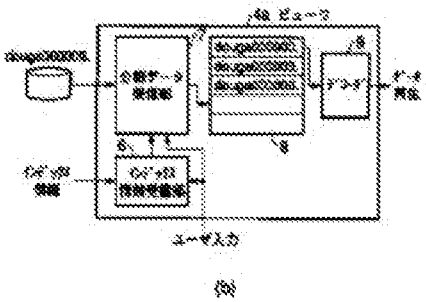
(71)Applicant : TOSHIBA CORP
(72)Inventor : CHIJITANI MASAHIDE

(54) MOVING IMAGE DATA REPRODUCING DEVICE, MOVING IMAGE DATA DIVIDING DEVICE AND RECORDING MEDIUM READABLE BY COMPUTER IN WHICH PROGRAM IS RECORDED

(57)Abstract:
PROBLEM TO BE SOLVED: To enable random access to moving image data without changing a server function.
SOLUTION: A moving image data reproducing device with an index information receiving means 6 to receive index information to be generated by relating plural pieces of divided data to be obtained by deviding the moving image data to its reproduction time information by requesting the information to a server, a divided data receiving means 7 to receive the divided data related to reproduction time information at the reproduction time information to which starting of reproducing is instructed and afterward by successively requesting the information to the server by referring to the index information received by the index information receiving means 6, a storage means 9 to store the divided data received by the divided data receiving means 7 and a reproducing means to successively reproduce the divided data stored in the storage means 9 according to the index information received by the index information receiving means 6 is provided.



(a)



(b)

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Page 1133 of 2308

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(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード（参考）
Ｈ０４Ｎ　7/173	６３０	Ｈ０４Ｎ　7/173	６３０	５Ｃ０６４

審査請求　未請求　請求項の数13　ＯＬ　（全 13 頁）

(21)出願番号　特願平11－497

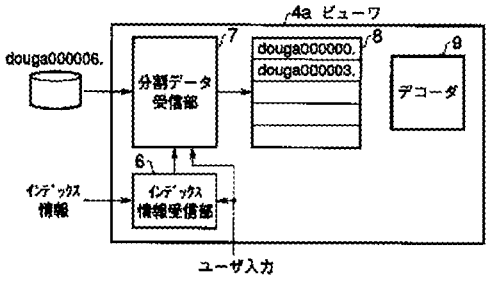
(22)出願日　平成11年１月５日(1999.1.5)

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弁理士　鈴江　武彦　（外６名）

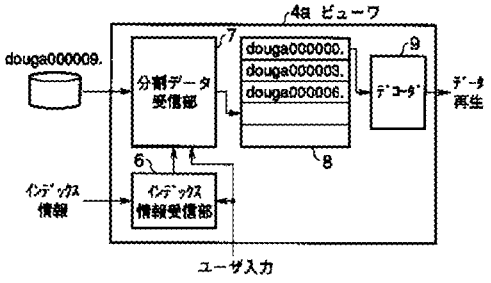
Ｆターム(参考)　5C064 BA07 BB10 BC16 BC20 BC27 BD16

(54)【発明の名称】　動画像データ再生装置及び動画像データ分割装置並びにプログラムを記録したコンピュータ読み取り可能な記録媒体

(57)【要約】
【課題】サーバの機能を変更することなく、動画像データのランダムアクセスを可能にする。
【解決手段】動画像データが分割されて得られる複数の分割データとその再生時刻情報とを関連付けて生成されるインデックス情報を、サーバに要求して受信するインデックス情報受信手段と、当該インデックス情報受信手段に受信されたインデックス情報を参照し、再生開始を指示された再生時刻情報以降の再生時刻情報に関連付けられた分割データをサーバに順次要求して受信する分割データ受信手段と、当該分割データ受信手段に受信された分割データを記憶する記憶手段と、インデックス情報受信手段に受信されたインデックス情報にしたがって、記憶手段に記憶されている分割データを順次再生させる再生手段とを具備した動画像データ再生装置を提供する。



(a)



(b)

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【特許請求の範囲】

【請求項１】　動画像データが分割されて得られる複数の分割データとそれぞれの再生時刻情報とを関連付けて生成されるインデックス情報を、サーバに要求して受信するインデックス情報受信手段と、

当該インデックス情報受信手段に受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられた分割データを、サーバに順次要求して受信する分割データ受信手段と、

当該分割データ受信手段によって受信された分割データを記憶する記憶手段と、

前記記憶手段に記憶されている分割データを順次再生させる再生手段とを具備したことを特徴とする動画像データ再生装置。

【請求項２】　請求項１記載の動画像データ再生装置において、

前記分割データの送信をサーバに要求してから、この分割データを受信するまでの時間を推定する時間推定手段を付加し、

前記分割データ受信手段は、当該時間推定手段によって推定された時間とほぼ同じ時間分の分割データが前記記憶手段に記憶されていない場合に、前記インデックス情報にしたがってサーバに分割データを要求し、

前記再生手段は、前記時間推定手段によって推定された時間とほぼ同じ時間分の分割データが前記記憶手段に記憶された場合に、この記憶手段に記憶されている分割データの再生を開始することを特徴とする動画像データ再生装置。

【請求項３】　動画像データが分割されて得られる複数の分割データについて伝送速度が異なる複数の種別が生成されている場合に、この複数種別の各分割データとそれぞれの再生時刻情報とを関連付けて生成されるインデックス情報を、サーバに要求して受信するインデックス情報受信手段と、

前記分割データの送信をサーバに要求してから、この分割データを受信するまでの時間を推定する時間推定手段と、

当該時間推定手段によって推定された時間に基づいて、要求する分割データの種別を選択する分割データ選択手段と、

前記インデックス情報受信手段に受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられ、かつ前記分割データ選択手段によって選択されている種別の分割データを、サーバに順次要求して受信する分割データ受信手段と、

当該分割データ受信手段によって受信された分割データを記憶する記憶手段と、

前記記憶手段に記憶されている分割データを順次再生させる再生手段とを具備したことを特徴とする動画像データ再生装置。

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【請求項４】　請求項３記載の動画像データ再生装置において、

前記分割データ受信手段は、前記時間推定手段に推定された時間とほぼ同じ時間分の分割データが前記記憶手段に記憶されていない場合に、前記データ選択手段によって選択されている種別の分割データを、前記インデックス情報にしたがって前記サーバに要求し、

前記再生手段は、前記時間推定手段によって推定された時間とほぼ同じ時間分の分割データが前記記憶手段に記憶された場合に、この記憶手段に記憶されている分割データの再生を開始することを特徴とする動画像データ再生装置。

【請求項５】　動画像データを複数に分割して複数の分割データを生成し、かつ前記複数の分割データとこの分割データの再生時刻情報とを関連付けたインデックス情報を生成する動画像データ分割装置。

【請求項６】　動画像データが分割されて得られる複数の分割データについて伝送速度が異なる複数の種別を生成し、この複数の種別の各分割データをそれぞれの再生時刻情報に関連付けたインデックス情報を生成する動画像データ分割装置。

【請求項７】　コンピュータに、

動画像データが分割されて得られる複数の分割データとそれぞれの再生時刻情報とを関連付けて生成されるインデックス情報を、サーバに要求して受信するインデックス情報受信機能と、

当該インデックス情報受信機能によって受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられた分割データを、サーバに順次要求して受信する分割データ受信機能と、

当該分割データ受信機能によって受信された分割データを記憶する記憶機能と、

前記記憶機能によって記憶されている分割データを順次再生させる再生機能とを実現させるためのプログラムを記録したコンピュータ読み取り可能な記録媒体。

【請求項８】　請求項７記載のコンピュータ読み取り可能な記録媒体において、

前記分割データの送信をサーバに要求してから、この分割データを受信するまでの時間を推定する時間推定機能を付加し、

前記分割データ受信機能は、当該時間推定機能によって推定された時間とほぼ同じ時間分の分割データが前記記憶機能によって記憶されていない場合に、前記インデックス情報にしたがってサーバに分割データを要求し、

前記再生機能は、前記時間推定機能によって推定された時間とほぼ同じ時間分の分割データが前記記憶機能によって記憶された場合に、この記憶機能によって記憶され

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ている分割データの再生を開始することを特徴とするコンピュータ読み取り可能な記録媒体。

【請求項９】　コンピュータに、
動画像データが分割されて得られる複数の分割データについて伝送速度が異なる複数の種別が生成されている場合に、この複数種別の各分割データとそれぞれの再生時刻情報とを関連付けて生成されるインデックス情報をサーバに要求して受信するインデックス情報受信機能と、
前記分割データの送信をサーバに要求してから、この分割データを受信するまでの時間を推定する時間推定機能と、
当該時間推定機能によって推定された時間に基づいて、要求する分割データの種別を選択する分割データ選択機能と、
前記インデックス情報受信機能によって受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられ、かつ前記分割データ選択機能によって選択されている種別の分割データを、サーバに順次要求して受信する分割データ受信機能と、
当該分割データ受信機能によって受信された分割データを記憶する記憶機能と、
前記記憶機能によって記憶されている分割データを順次再生させる再生機能とを実現させるためのプログラムを記録したコンピュータ読み取り可能な記録媒体。

【請求項１０】　請求項９記載のコンピュータ読み取り可能な記録媒体において、
前記分割データ受信機能は、前記時間推定機能によって推定された時間とほぼ同じ時間分の分割データが前記記憶機能に記憶されていない場合に、前記データ選択機能によって選択されている種別の分割データを、前記インデックス情報にしたがって前記サーバに要求し、
前記再生機能は、前記時間推定機能によって推定された時間とほぼ同じ時間分の分割データが前記記憶機能によって記憶された場合に、この記憶機能によって記憶されている分割データの再生を開始することを特徴とするコンピュータ読み取り可能な記録媒体。

【請求項１１】　コンピュータに、
動画像データを複数に分割して複数の分割データを生成し、かつ前記複数の分割データとこの分割データの再生時刻情報とを関連付けたインデックス情報を生成する機能を実現させるためのプログラムを記録したコンピュータ読み取り可能な記録媒体。

【請求項１２】　コンピュータに、
動画像データが分割されて得られる複数の分割データについて伝送速度が異なる複数の種別を生成し、この複数の種別の各分割データをそれぞれの再生時刻情報に関連付けたインデックス情報を生成する機能を実現させるためのプログラムを記録したコンピュータ読み取り可能な記録媒体。

【請求項１３】　サーバに記憶されている動画像データをクライアントに配信する動画像データ配信システムにおいて、
前記サーバは、
前記動画像データが分割されて得られる複数の分割データと、この各分割データとそれぞれの再生時刻情報とを関連付けたインデックス情報とを保持し、
前記クライアントは、
前記インデックス情報を前記サーバに要求して受信するインデックス情報受信手段と、
当該インデックス情報受信手段に受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられた分割データを前記サーバに順次要求して受信する分割データ受信手段と、
当該分割データ受信手段によって受信された分割データを記憶する記憶手段と、
前記記憶手段に記憶されている分割データを順次再生させる再生手段とを備えることを特徴とする動画像データ配信システム。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、サーバの構成及び機能を変更することなく、動画像データのランダムアクセスを可能にするための動画像データ再生装置及び動画像データ分割装置並びにプログラムを記録したコンピュータ読み取り可能な記録媒体に関する。

【０００２】

【従来の技術】従来の動画像データ配信システムは、主にクライアントとＷＷＷサーバとから構成される。この従来の動画像データ配信システムでは、まずクライアントからＷＷＷサーバに再生を求める動画像データ（動画コンテンツ）の伝送要求が送信される。

【０００３】ＷＷＷサーバは各種データを保持しており、このデータの中から要求された動画像データを選択し送信する。

【０００４】送信された動画像データは、伝送要求を送信したクライアントに受信され、ストリーム再生がなされる。

【０００５】このような従来の動画像データ配信システムにおいて、クライアント及びＷＷＷサーバがインターネットを介して接続されている場合には、一般的にＨＴＴＰプロトコルにより動画像データの伝送がなされる。

【０００６】ここで、例えば動画像データの再生を求めるユーザの中には、動画像データの途中位置からの再生（以下、「ランダムアクセス」という）を求める者もいる。

【０００７】従来の動画像データ配信システムによってランダムアクセスを実現するためには、ランダムアクセスを可能とする専用のＨＴＴＰサーバをこの動画像デー

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タ配信システムに適用する必要がある。

【０００８】また、別の手法として、ランダムアクセスを可能とする専用のプログラムであるＣＧＩ（Common Gateway Interface）をWWWサーバに実装させる必要がある。

【０００９】この専用のＨＴＴＰサーバや、ＣＧＩを実装したWWWサーバは、動画像データを再生するクライアントから独自の要求を受信し、動画像データを指定された位置からＨＴＴＰプロトコルによって送信する機能を持つ。

【００１０】

【発明が解決しようとする課題】しかしながら、上記のように、ランダムアクセスを可能とするために専用のＨＴＴＰサーバを用いたり、サーバにＣＧＩを実装する方法においては、従来の動画像データ配信システムのWWWサーバに手を加える必要があり、現状のインフラのままでは実現することができない。

【００１１】したがって、ランダムアクセスの実現、導入が困難であり、作業が複雑である。

【００１２】また、この従来の方法では、ランダムアクセスのための処理が主にサーバでなされるため、サーバの負荷が増加するという問題が生じる。特に、動画像データ配信システムが複数のクライアントを有する場合には、その傾向が強くなる。

【００１３】本発明は、以上のような実状に鑑みてなされたもので、サーバの構成や機能に手を加えることなく動画像データのランダムアクセスを可能とするための動画像データ再生装置及び動画像データ分割装置並びにプログラムを記録したコンピュータ読み取り可能な記録媒体を提供することを目的とする。

【００１４】

【課題を解決するための手段】本発明の骨子は、動画像データを複数の分割して分割データとし、この分割データにそれぞれの再生時間を示す再生時刻情報を関連づけてインデックス情報とし、このインデックス情報にしたがって分割データを順次再生する点にある。

【００１５】以下、本発明を実現するにあたって講じた具体的手段について説明する。

【００１６】第１の発明は、動画像データが分割されて得られる複数の分割データとそれぞれの再生時刻情報とを関連付けて生成されるインデックス情報をサーバに要求して受信するインデックス情報受信手段と、当該インデックス情報受信手段に受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられた分割データをサーバに順次要求して受信する分割データ受信手段と、当該分割データ受信手段によって受信された分割データを記憶する記憶手段と、インデックス情報受信手段に受信されたインデックス情報の再生時刻情報にしたがって、記憶手段に記憶されている分割データを順次再生させる再生手段とを具備した動画像データ再生装置である。

【００１７】この第１の発明の動画像データ再生装置においては、再生開始を指示された再生時刻情報以降の分割データが順次受信されストリーム再生される。

【００１８】また、この動画像データ再生装置を適用する場合には、サーバは自己が保持するデータのうち要求されたデータを送信する機能を有していればよい。

【００１９】したがって、第１の発明においては、サーバに新しい構成や機能を付加することなく容易にランダムアクセスが実現される。

【００２０】また、ランダムアクセスを実現させるための処理が、サーバではなく動画像データ再生装置（クライアント）側によって実行されるため、サーバの負荷の増加を防止することができる。

【００２１】第２の発明は、第１の発明の動画像データ再生装置において、分割データの送信をサーバに要求してから、この分割データを受信するまでの時間を推定する時間推定手段を付加し、分割データ受信手段は、当該時間推定手段によって推定された時間とほぼ同じ時間分の分割データが記憶手段に記憶されていない場合に、前記インデックス情報にしたがってサーバに分割データを要求し、再生手段は、時間推定手段によって推定された時間とほぼ同じ時間分の分割データが記憶手段に記憶された場合に、この記憶手段に記憶されている分割データの順次再生を開始する動画像データ再生装置である。

【００２２】この第２の発明の動画像データ再生装置においては、分割データを要求してから受信するまでの間に再生されると推測される分割データが、記憶手段に保持される。

【００２３】したがって、この第２の発明においては、第１の発明と同様の作用効果に加えて、必要最低限の量の分割データが格納されしだい、動画像データの再生がなされるため、再生が開始されるまでの時間を最適化することができる。

【００２４】これにより、再生開始までの時間を短縮させることができる。

【００２５】また、次の分割データが要求されてから受信されるまでの間に必要な分割データは確保済みであるため、動画像データの再生が途切れることを防止することができる。

【００２６】さらに、分割データをサーバに要求してから受信するまでの時間が逐次測定され、この時間にしたがって再生可能な状態で記憶しておく分割データの量が決定される。

【００２７】ゆえに、回線の動的な負荷変動にも対応することができ、適切な量の分割データが確保される。

【００２８】したがって、スムーズなストリーム再生が可能となる。

【００２９】第３の発明は、動画像データが分割されて得られる複数の分割データについて伝送速度が異なる複

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数の種別が生成されている場合に、この複数種別の各分割データとそれぞれの再生時刻情報とを関連付けて生成されるインデックス情報をサーバに要求して受信するインデックス情報受信手段と、分割データの送信をサーバに要求してから、この分割データを受信するまでの時間を推定する時間推定手段と、当該時間推定手段によって推定された時間に基づいて、要求する分割データの種別を選択する分割データ選択手段と、インデックス情報受信手段に受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられ、かつ分割データ選択手段によって選択されている種別の分割データをサーバに順次要求して受信する分割データ受信手段と、当該分割データ受信手段によって受信された分割データを記憶する記憶手段と、インデックス情報受信手段に受信されたインデックス情報の再生時刻情報にしたがって、記憶手段に記憶されている分割データを順次再生させる再生手段とを具備した動画像データ再生装置である。

【００３０】この第３の発明の動画像データ再生装置においては、伝送速度の異なる複数種別の分割データのうち、回線の負荷変動を考慮して適した伝送速度の分割データが選択され受信される。

【００３１】したがって、回線の伝送速度が遅い場合には、高速伝送可能な分割データにより伝送がなされるため、再生すべきデータが未伝送となることを防止することができる。

【００３２】また、第１の発明と同様の作用により、サーバを変更することなく、ランダムアクセスが可能である。

【００３３】第４の発明は、第３の発明の動画像データ再生装置において、分割データ受信手段は、時間推定手段に推定された時間とほぼ同じ時間分の分割データが記憶手段に記憶されていない場合に、データ選択手段によって選択されている種別の分割データを、インデックス情報にしたがってサーバに要求し、再生手段は、時間推定手段によって推定された時間とほぼ同じ時間分の分割データが記憶手段に記憶された場合に、この記憶手段に記憶されている分割データの順次再生を開始する動画像データ再生装置である。

【００３４】この第４の発明の動画像データ再生装置においては、第３の発明と同様の作用効果に加えて、分割データをサーバに要求してから受信するまでの間の再生に必要と推測される分の分割データが記憶手段に保持される。

【００３５】したがって、先の第２の発明と同様の効果を得ることができる。

【００３６】第５の発明は、動画像データを複数に分割して複数の分割データを生成し、かつ前記複数の分割データとこの分割データの再生時刻情報とを関連付けたインデックス情報を生成する動画像データ分割装置である。

【００３７】この第５の発明の動画像データ分割装置を用いて複数の分割データ及びインデックス情報を作成してサーバに備え、第１又は第２の発明の動画像データ再生装置を用いることで、サーバの構成、機能に手を加えることなくランダムアクセスが可能となる。

【００３８】また、この動画像データ分割装置を用いることで、複数の分割データ及びインデックス情報を容易に作成できる。

【００３９】第６の発明は、動画像データが分割されて得られる複数の分割データについて伝送速度が異なる複数の種別を生成し、この複数の種別の各分割データをそれぞれの再生時刻情報に関連付けたインデックス情報を生成する動画像データ分割装置である。

【００４０】この第６の発明の動画像データ分割装置を用いて複数種別の各分割データ及びインデックス情報を作成してサーバに備え、第３又は第４の発明の動画像データ再生装置を用いることで、サーバの構成、機能に手を加えることなくランダムアクセスが可能となり、伝送にかかる時間を調節することができる。

【００４１】また、この動画像データ分割装置を用いることで、複数種別の分割データ及びインデックス情報を容易に作成できる。

【００４２】第７乃至第１２の発明は、それぞれ上記第１乃至第６の発明と同様の機能をコンピュータに実現させるためのプログラムを記録したコンピュータ読み取り可能な記録媒体である。

【００４３】この第７乃至第１２の発明のようなプログラムを記録した記録媒体を用いることによって、上述した機能を有していない装置や、計算機においても、簡単に上述した機能を付加することができる。

【００４４】第１３の発明は、サーバに記憶されている動画像データをクライアントに配信する動画像データ配信システムにおいて、サーバは、動画像データが分割されて得られる複数の分割データと、この各分割データとそれぞれの再生時刻情報とを関連付けたインデックス情報とを保持し、クライアントは、インデックス情報をサーバに要求して受信するインデックス情報受信手段と、当該インデックス情報受信手段に受信されたインデックス情報にしたがって、再生開始を指示された再生時刻情報及びその後の再生時刻情報に関連付けられた分割データをサーバに順次要求して受信する分割データ受信手段と、当該分割データ受信手段によって受信された分割データを記憶する記憶手段と、インデックス情報受信手段に受信されたインデックス情報の再生時刻情報にしたがって、記憶手段に記憶されている分割データを順次再生させる再生手段とを備える動画像データ配信システムである。

【００４５】この第１３の発明の動画像データ配信システムにおいては、クライアントが先の第１の発明の動画

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像データ再生装置と同様に機能する。

【００４６】これにより、第１の発明と同様の作用効果を得ることができる。

【００４７】なお、第２乃至第１２の発明も、この第１３の発明と同様に、動画像データ配信システムに適用可能である。

【００４８】

【発明の実施の形態】以下、図面を参照しながら本発明の実施の形態について説明する。

【００４９】（第１の実施の形態）本実施の形態においては、動画像データ（動画コンテンツ）を複数に分割した分割データと、この複数の分割データとそれぞれの再生時間情報を関連付けたインデックス情報とを用いることで、サーバを変更することなく動画像データのランダムアクセスを可能とする動画像データ配信システムについて説明する。

【００５０】図１は、本実施の形態に係る動画像データ配信システムの構成を示すブロック図である。

【００５１】この動画像データ配信システム１は、動画像データから分割データとインデックス情報とを生成するエンコーダ２と、内部の記憶装置３ａに各種データをファイル形式で記憶するサーバ３と、動画像データ再生用のビューワ４ａを有するクライアント４とから構成されている。

【００５２】この動画像データ配信システム１では、動画像データがスプライスポイントでファイル分割されており、ビューワ４ａがインデックス情報に基づいて好きな位置の分割データをサーバ３に要求し、受信する。

【００５３】以下、この動画像データ配信システム１の各構成要素について詳しく説明する。

【００５４】図２は、本実施の形態に係る動画像データ配信システム１に備えられるエンコーダ２の機能を示すブロック図である。

【００５５】このエンコーダ２は、動画エンコード時に、ビデオ等の動画素材からなる動画像データ（動画コンテンツ）を所定のスプライスポイント毎に分割して複数の分割データを生成する。また生成した各分割データには異なるファイル名を付けて出力する。この図２では、分割データのファイル名の例として「douga000000」、「douga000003」、「douga000006」等が示されている。

【００５６】なお、この各分割データは、ビューワ４ａ内の受信ページバッファの１ページ内に収まるサイズで生成される。

【００５７】さらに、このエンコーダ２は、各分割データのファイル名と、それぞれの再生時刻の情報とを関係付けてインデックス情報５を生成し、ファイル形式で出力する。

【００５８】図３は、本実施の形態に係る動画像データ配信システム１に備えられるサーバ３の構成を示すブロック図である。

【００５９】サーバ３は、主に記憶装置３ａと、サーバ本体３ｂとから構成される。

【００６０】サーバ本体３ｂは、記憶装置３ａに様々なデータを蓄積する機能と、クライアント４からの要求にしたがって記憶装置３ａの内容を読み出して送信する機能を有する。

【００６１】記憶装置３ａは、各種のデータを記憶し、ここではエンコーダ２によって生成された複数の分割データ及びインデックス情報５も記憶している。

【００６２】クライアント４は、図１で示すように、主にクライアント本体４ｂと、動画像データ再生装置として機能するビューワ４ａとから構成されており、クライアント本体４ｂ上でビューワ４ａが稼働する。

【００６３】図４は、本実施の形態に係る動画像データ配信システム１に備えられるビューワ４ａの機能を示すブロック図である。

【００６４】なお、図４（ａ）は再生開始前のバッファリング中の状態を示し、３ページ分の分割データがページバッファに格納されるまでの状態を示している。

【００６５】一方、図４（ｂ）は再生中の状態を示しており、１ページ分の分割データがデコーダに読み出されると、再びサーバ３から分割データが読み出される状態を示している。

【００６６】このビューワ４ａは、動画像データを再生する装置であり、インデックス情報受信部６、分割データ受信部７、ページバッファ８、デコーダ９から構成される。

【００６７】インデックス情報受信部６は、再生を求める動画像データの指定をユーザから入力する。また、指定された動画像データに関するインデックス情報５をサーバ３に要求し、この要求の応答としてサーバ３からインデックス情報５を受信して保持する。

【００６８】分割データ受信部７は、動画像データの再生開始位置となる再生時刻情報をユーザから入力する。また、インデックス情報受信部６のインデックス情報５を参照し、ユーザから入力された再生時刻情報以降の再生時刻情報に関連付けられているファイルの送信をサーバ３に要求する。この要求は、ページバッファ８に格納された分割データの量が一定量（ここでは３つとする）になるまで順次出力する。

【００６９】そして、この分割データ受信部７は、この要求の応答として分割データを順次受信し、ページバッファ８に出力する。

【００７０】ページバッファ８は、複数のページからなり、各ページ毎に一つの分割データをバッファリングする。また、各ページの内容を再生時刻順に並び替えて記憶する。さらに、デコーダ９によって読み出されたページ内の分割データを破棄し、次に入力される分割データを新規に確保する。

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