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(54) METHODS AND APPARATUS FOR USING TUNERS EFFICIENTLY FOR DELIVERING ONE OR MORE PROGRAMS

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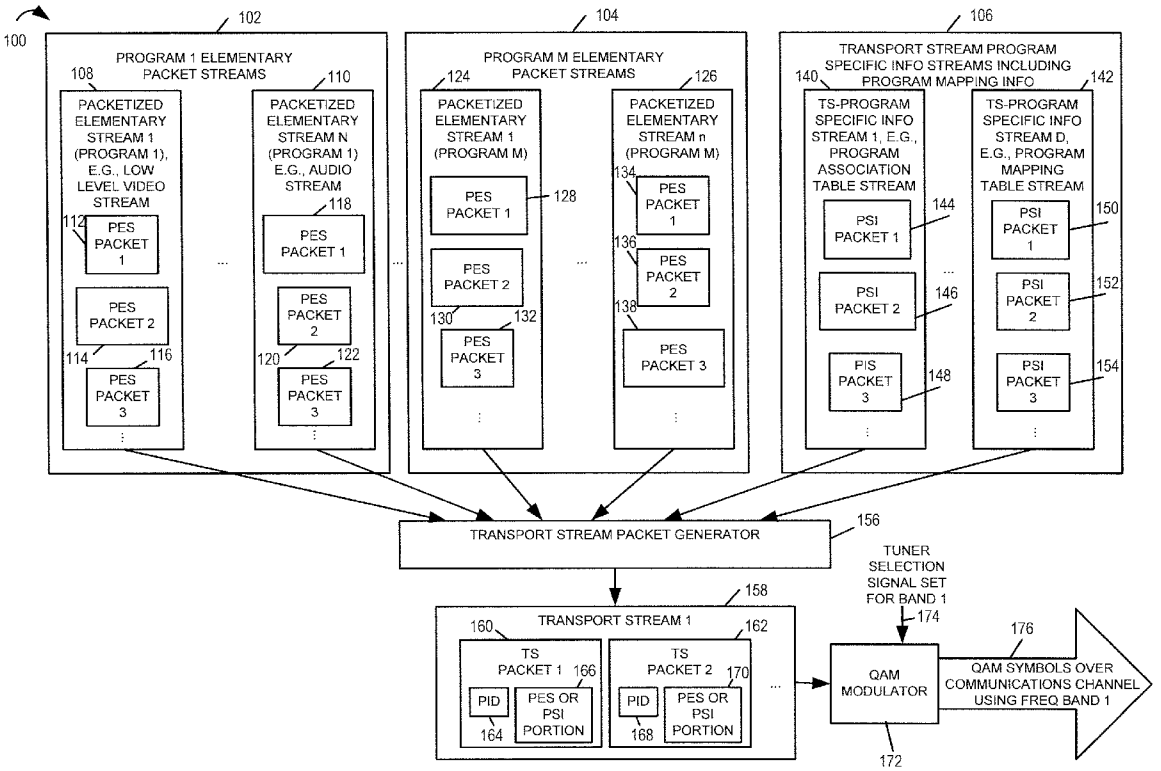
(57) **ABSTRACT**

In response to user requests for content, content may be dynamically mapped to communications channels, e.g., QAM channels, used to communicate multiple programs during the same transmission time slot, e.g., through the use of multiplexed MPEG streams. A customer premise device, e.g., STB, uses a tuner tuned to the QAM channel to receive the communicated stream, recovers multiple programs communicated using the single communications channel, and records and/or displays the recovered programs. In this manner, more programs can be received and recorded than there are tuners in the customer premise device, e.g., STB. In some embodiments a content service provider control node processes user requests for content, maps requested programs to transport streams, communicates mapping decision information to a content distribution node, and communicates QAM tuning information to the user devices which can then receive and record multiple programs communicated via a single communications channel. In some embodiments a customer premise device utilizes program information to direct demultiplexed program channels to local or remote recorders (for storing) or decoders (for playback).



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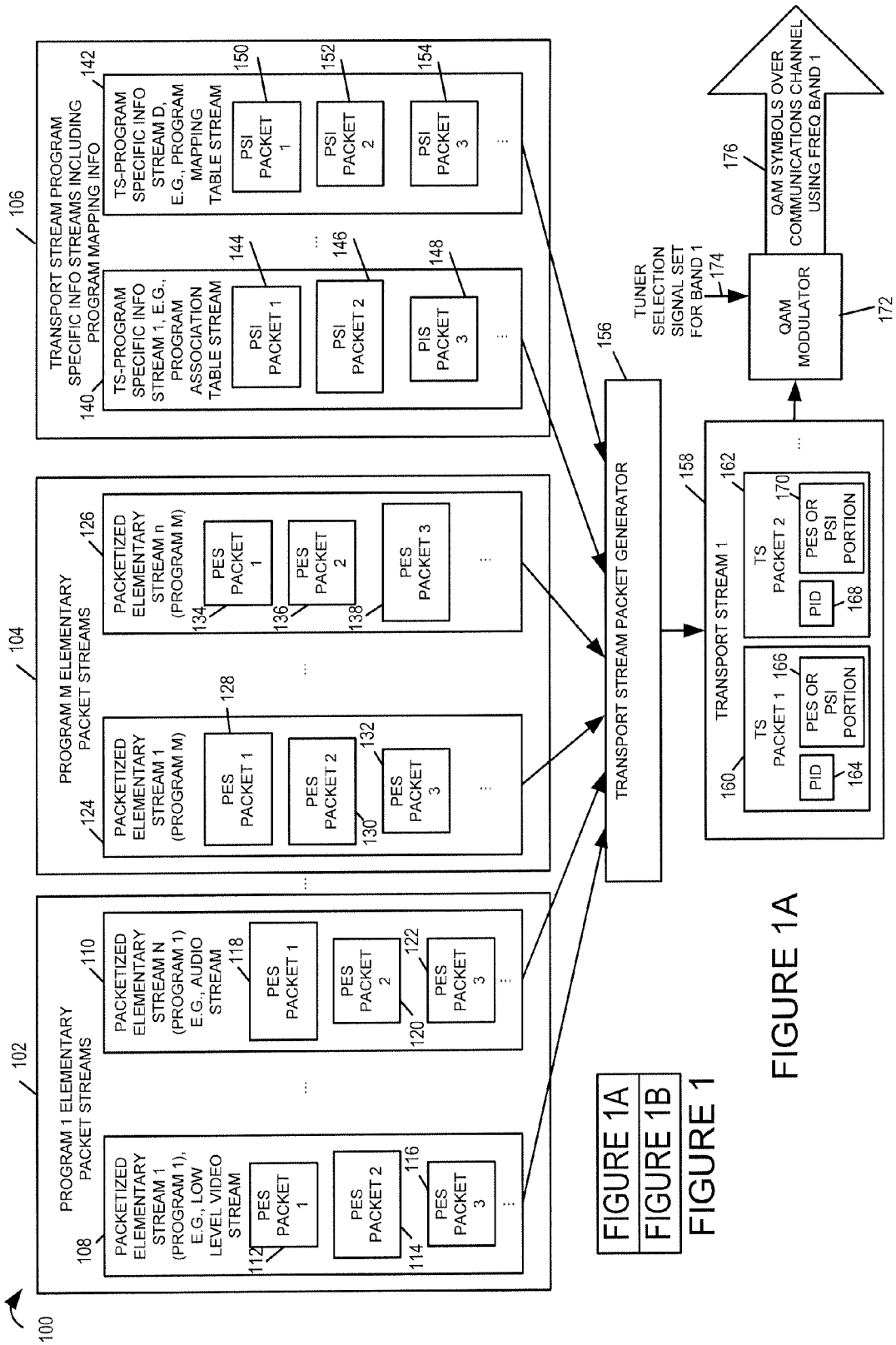

FIGURE 1A

FIGURE 1A
FIGURE 1B
FIGURE 1

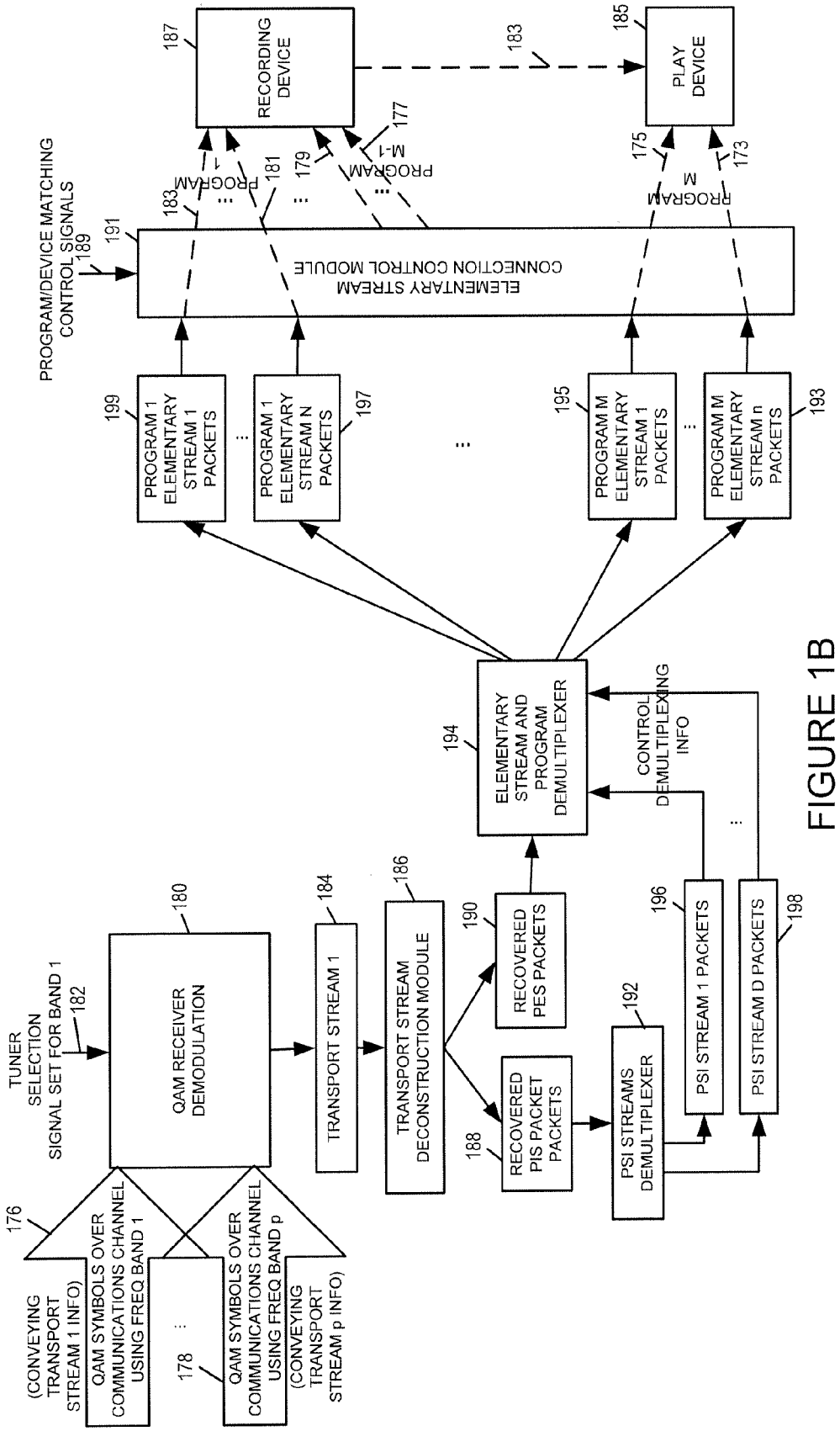
TUNER SELECTION SIGNAL SET FOR BAND 1
182
QAM RECEIVER DEMODULATION
180
176
(CONVEYING TRANSPORT STREAM 1 INFO)
QAM SYMBOLS OVER COMMUNICATIONS CHANNEL USING FREQ BAND 1
178
QAM SYMBOLS OVER COMMUNICATIONS CHANNEL USING FREQ BAND p
(CONVEYING TRANSPORT STREAM p INFO)
TRANSPORT STREAM 1
184
TRANSPORT STREAM DECONSTRUCTION MODULE
186
RECOVERED PES PACKETS
190
RECOVERED PIS PACKET PACKETS
188
PSI STREAMS DEMULTIPLEXER
192
PSI STREAM 1 PACKETS
196
PSI STREAM D PACKETS
198
ELEMENTARY STREAM AND PROGRAM DEMULTIPLEXER
194
CONTROL DEMULTIPLEXING INFO
PROGRAM 1 ELEMENTARY STREAM 1 PACKETS
199
PROGRAM 1 ELEMENTARY STREAM N PACKETS
197
PROGRAM M ELEMENTARY STREAM 1 PACKETS
195
PROGRAM M ELEMENTARY STREAM n PACKETS
193
ELEMENTARY STREAM CONNECTION CONTROL MODULE
191
PROGRAM/DEVICE MATCHING CONTROL SIGNALS
189
PROGRAM 1
183
181
179
PROGRAM M-1
177
PROGRAM M
175
173
RECORDING DEVICE
187
183
PLAY DEVICE
185

FIGURE 1B

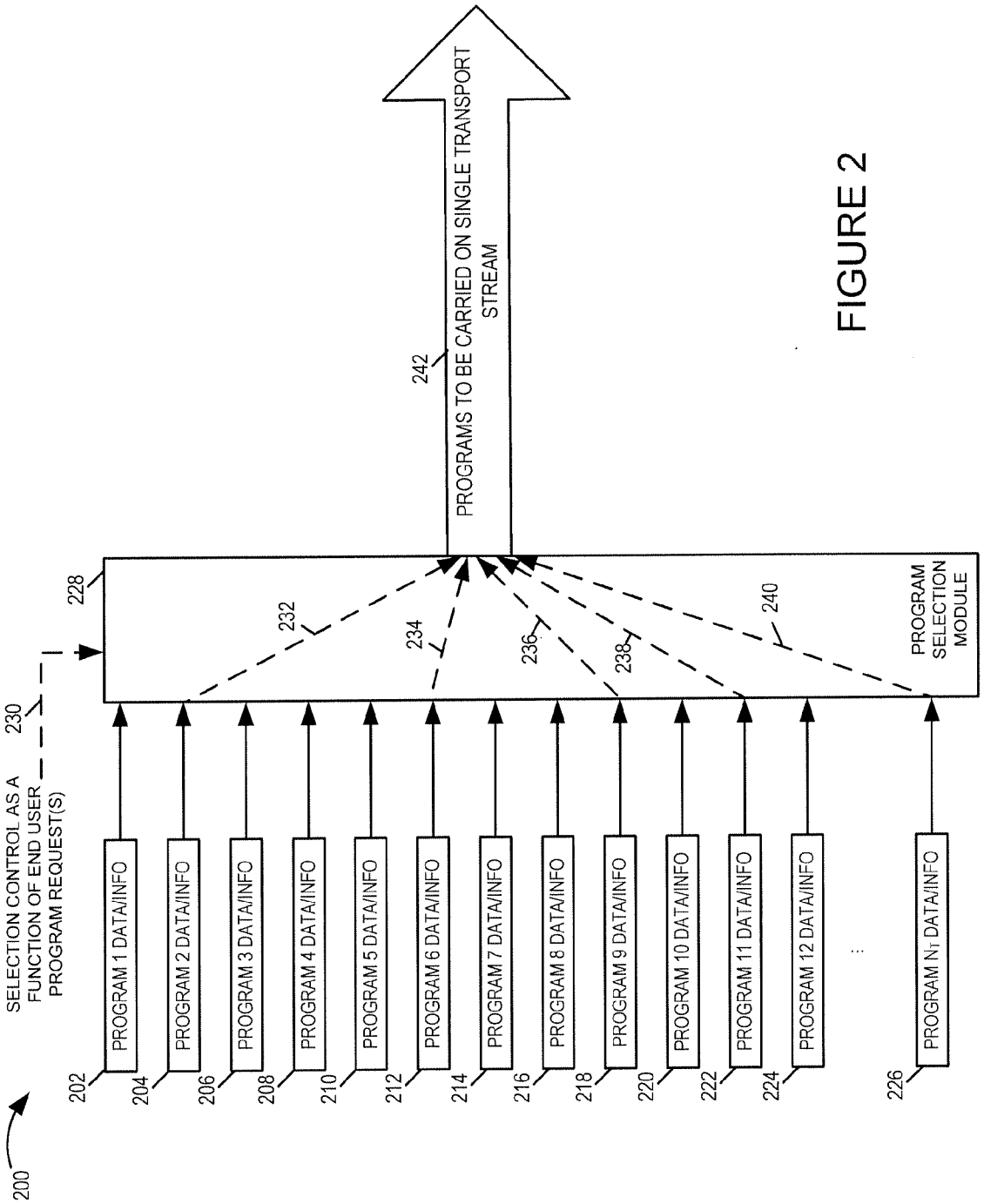
200
SELECTION CONTROL AS A FUNCTION OF END USER PROGRAM REQUEST(S)
230
228
PROGRAM 1 DATA/INFO
PROGRAM 2 DATA/INFO
PROGRAM 3 DATA/INFO
PROGRAM 4 DATA/INFO
PROGRAM 5 DATA/INFO
PROGRAM 6 DATA/INFO
PROGRAM 7 DATA/INFO
PROGRAM 8 DATA/INFO
PROGRAM 9 DATA/INFO
PROGRAM 10 DATA/INFO
PROGRAM 11 DATA/INFO
PROGRAM 12 DATA/INFO
PROGRAM N_T DATA/INFO
202
204
206
208
210
212
214
216
218
220
222
224
226
232
234
236
238
240
PROGRAM SELECTION MODULE
242
PROGRAMS TO BE CARRIED ON SINGLE TRANSPORT STREAM

FIGURE 2

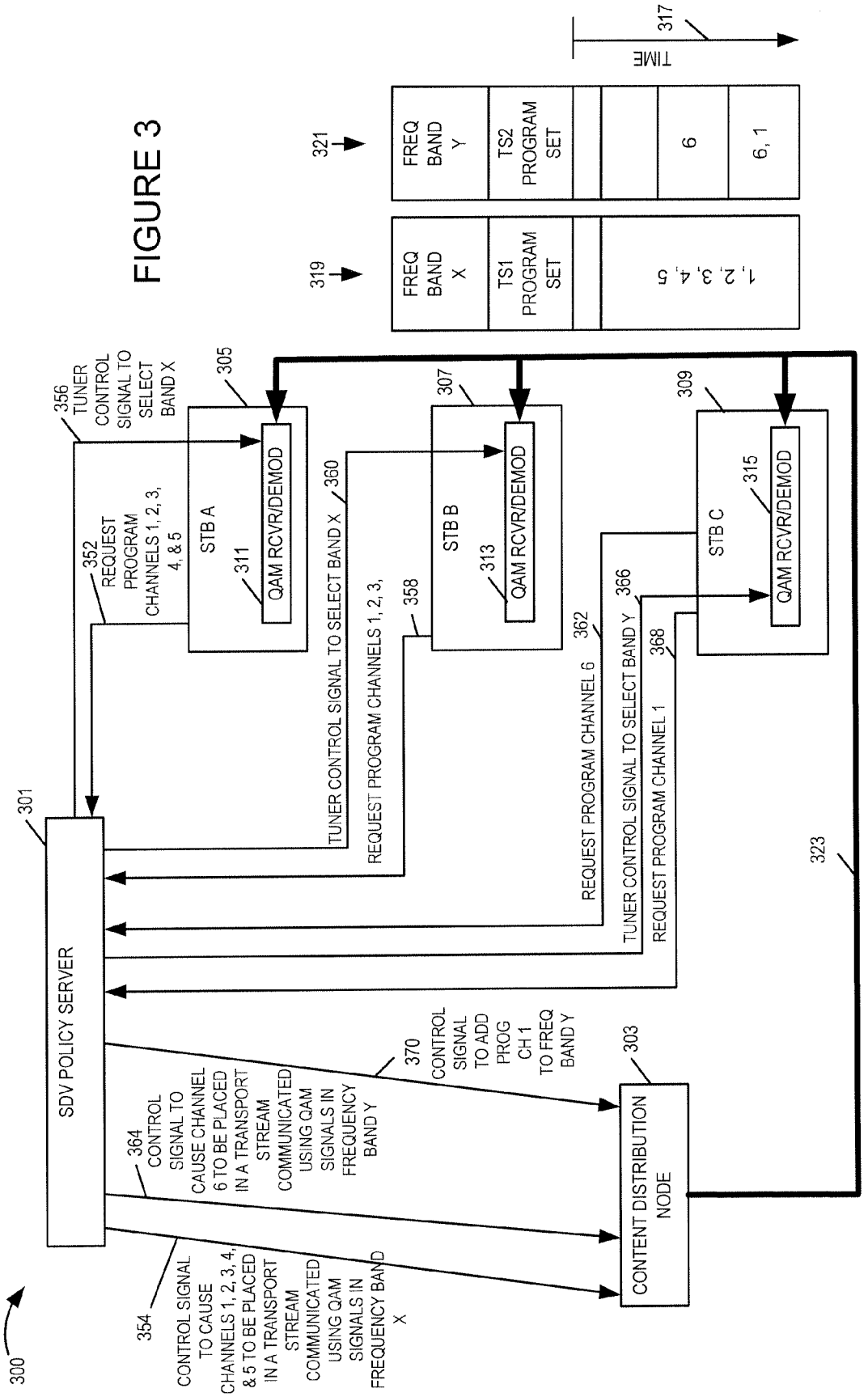
FIGURE 3
300
301
SDV POLICY SERVER
303
CONTENT DISTRIBUTION NODE
305
STB A
311
QAM RCVR/DEMOD
307
STB B
313
QAM RCVR/DEMOD
309
STB C
315
QAM RCVR/DEMOD
319
FREQ BAND X
TS1 PROGRAM SET
1, 2, 3, 4, 5
321
FREQ BAND Y
TS2 PROGRAM SET
6
6, 1
TIME
317
323
352
REQUEST PROGRAM CHANNELS 1, 2, 3, 4, & 5
356
TUNER CONTROL SIGNAL TO SELECT BAND X
354
CONTROL SIGNAL TO CAUSE CHANNELS 1, 2, 3, 4, & 5 TO BE PLACED IN A TRANSPORT STREAM COMMUNICATED USING QAM SIGNALS IN FREQUENCY BAND X
364
CONTROL SIGNAL TO CAUSE CHANNEL 6 TO BE PLACED IN A TRANSPORT STREAM COMMUNICATED USING QAM SIGNALS IN FREQUENCY BAND Y
370
CONTROL SIGNAL TO ADD PROG CH 1 TO FREQ BAND Y
360
TUNER CONTROL SIGNAL TO SELECT BAND X
358
REQUEST PROGRAM CHANNELS 1, 2, 3,
362
REQUEST PROGRAM CHANNEL 6
366
TUNER CONTROL SIGNAL TO SELECT BAND Y
368
REQUEST PROGRAM CHANNEL 1

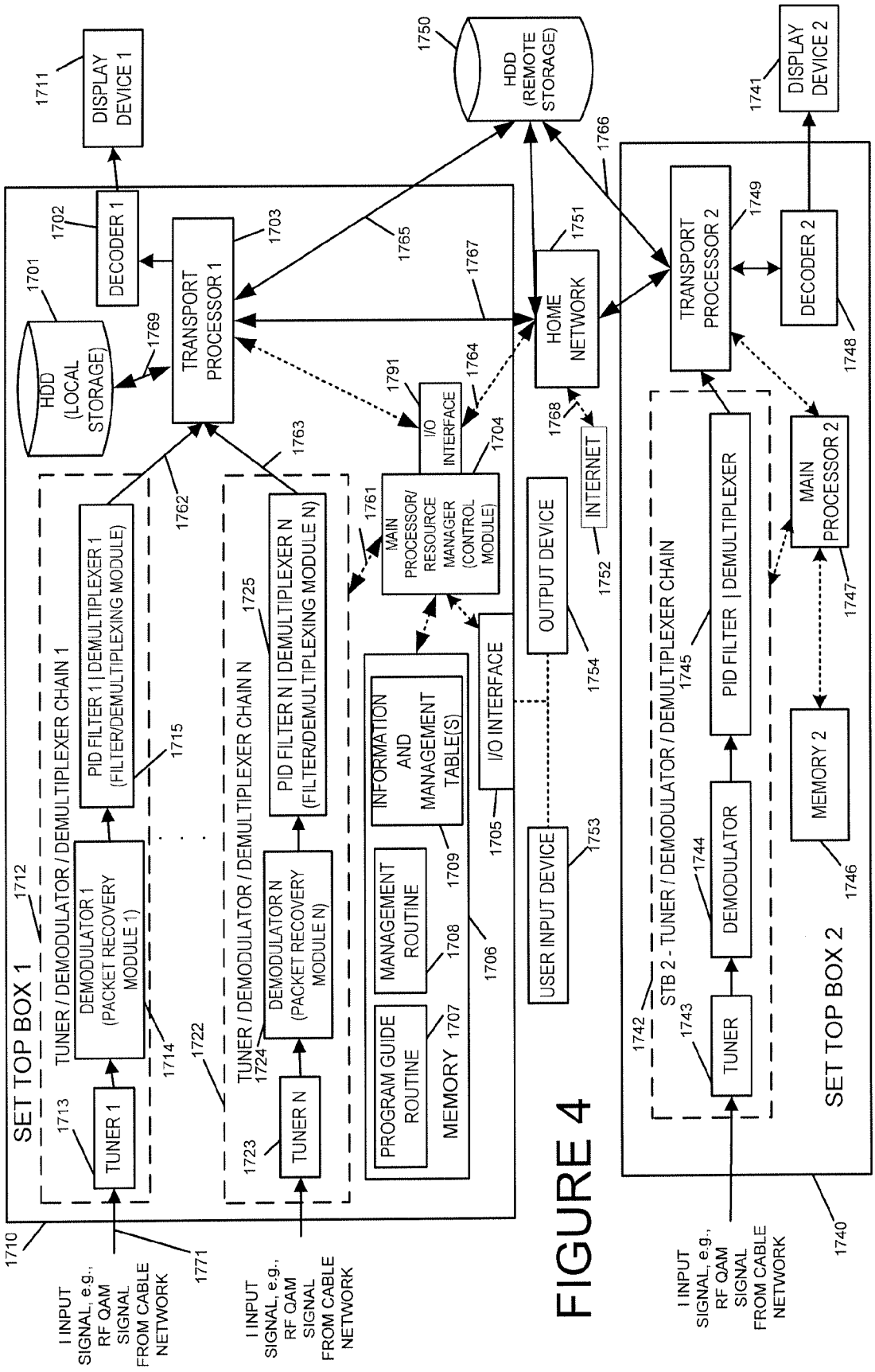
SET TOP BOX 1
1710
TUNER / DEMODULATOR / DEMULTIPLEXER CHAIN 1
1712
TUNER 1
1713
DEMODULATOR 1 (PACKET RECOVERY MODULE 1)
1714
PID FILTER 1 | DEMULTIPLEXER 1 (FILTER/DEMULTIPLEXING MODULE)
1715
TUNER / DEMODULATOR / DEMULTIPLEXER CHAIN N
1722
TUNER N
1723
DEMODULATOR N (PACKET RECOVERY MODULE N)
1724
PID FILTER N | DEMULTIPLEXER N (FILTER/DEMULTIPLEXING MODULE N)
1725
I INPUT SIGNAL, e.g., RF QAM SIGNAL FROM CABLE NETWORK
1771
I INPUT SIGNAL, e.g., RF QAM SIGNAL FROM CABLE NETWORK
HDD (LOCAL STORAGE)
1701
1769
TRANSPORT PROCESSOR 1
1703
1762
1763
DECODER 1
1702
DISPLAY DEVICE 1
1711
1765
1767
HDD (REMOTE STORAGE)
1750
I/O INTERFACE
1791
1764
MAIN PROCESSOR/ RESOURCE MANAGER (CONTROL MODULE)
1761
1704
MEMORY
1706
PROGRAM GUIDE ROUTINE
1707
MANAGEMENT ROUTINE
1708
INFORMATION AND MANAGEMENT TABLE(S)
1709
I/O INTERFACE
1705
USER INPUT DEVICE
1753
OUTPUT DEVICE
1754
HOME NETWORK
1751
1768
INTERNET
1752
1766
SET TOP BOX 2
1740
STB 2 - TUNER / DEMODULATOR / DEMULTIPLEXER CHAIN
1742
TUNER
1743
DEMODULATOR
1744
PID FILTER | DEMULTIPLEXER
1745
MEMORY 2
1746
MAIN PROCESSOR 2
1747
TRANSPORT PROCESSOR 2
1749
DECODER 2
1748
DISPLAY DEVICE 2
1741
I INPUT SIGNAL, e.g., RF QAM SIGNAL FROM CABLE NETWORK

FIGURE 4

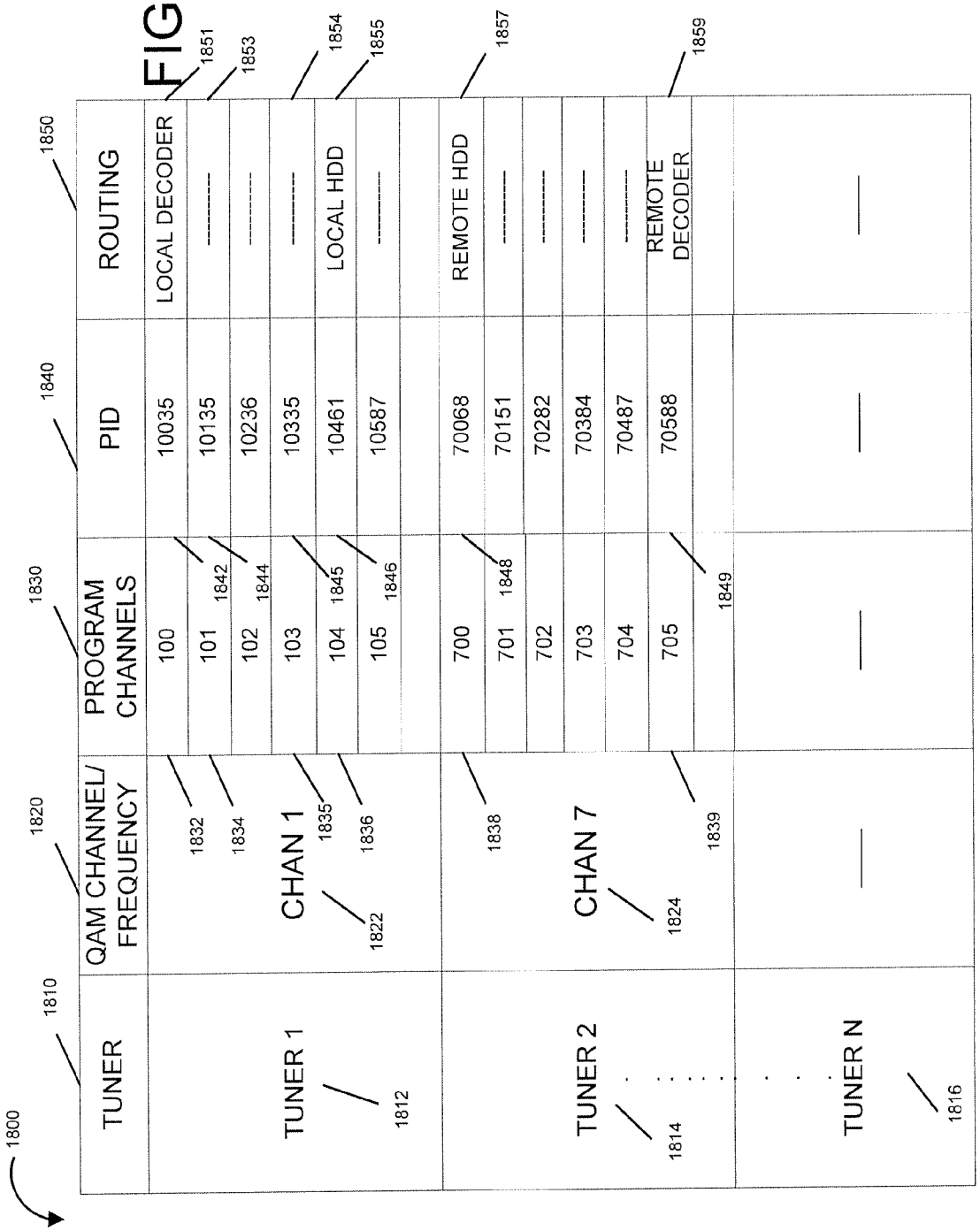
1800
1810
1820
1830
1840
1850
TUNER
QAM CHANNEL/ FREQUENCY
PROGRAM CHANNELS
PID
ROUTING
TUNER 1
1812
CHAN 1
1822
1832
1834
1835
1836
100
101
102
103
104
105
1842
1844
1845
1846
10035
10135
10236
10335
10461
10587
LOCAL DECODER
LOCAL HDD
1851
1853
1854
1855
TUNER 2
1814
CHAN 7
1824
1838
1839
700
701
702
703
704
705
1848
1849
70068
70151
70282
70384
70487
70588
REMOTE HDD
REMOTE DECODER
1857
1859
TUNER N
1816

FIGURE 5

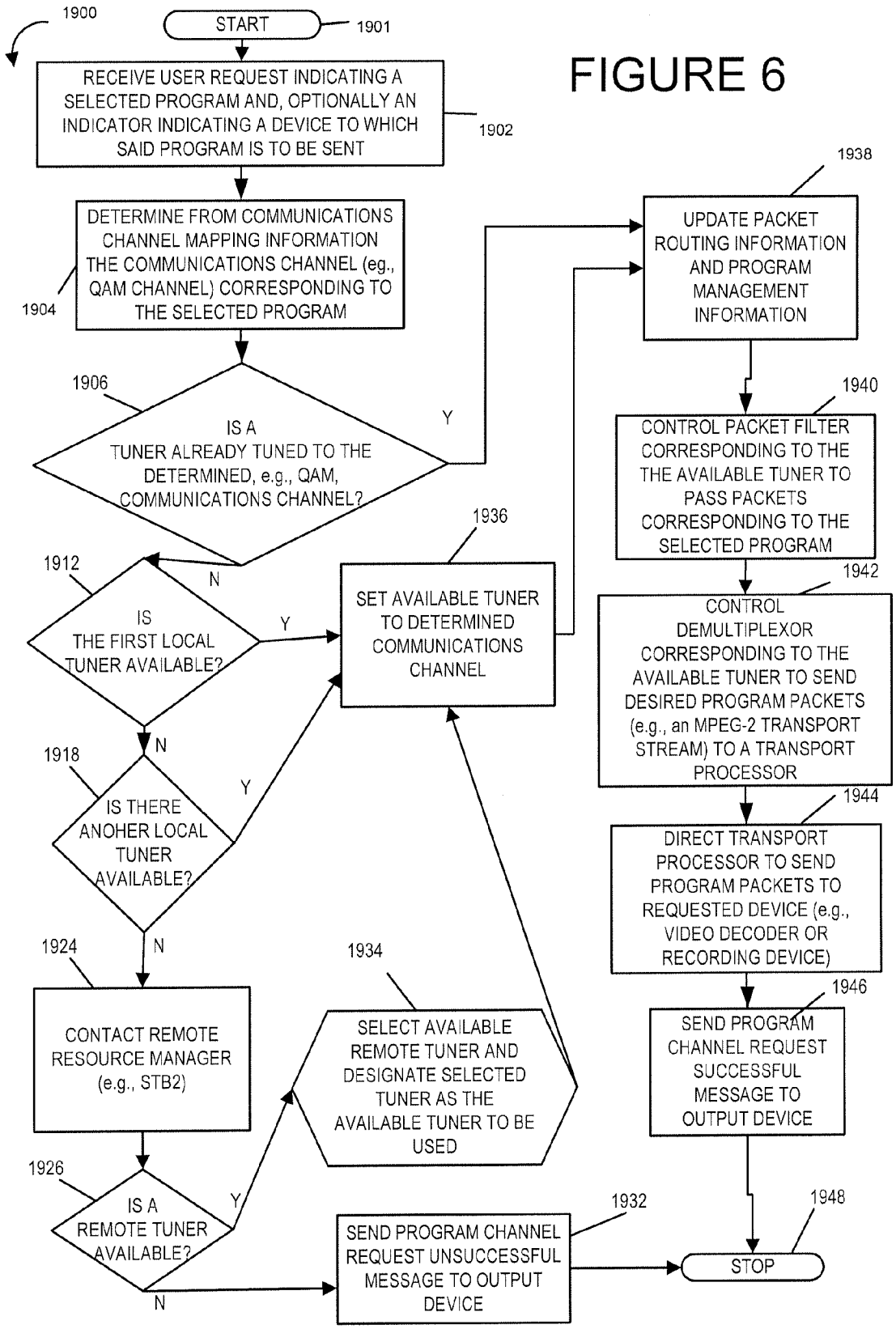
1900
START
1901
RECEIVE USER REQUEST INDICATING A SELECTED PROGRAM AND, OPTIONALLY AN INDICATOR INDICATING A DEVICE TO WHICH SAID PROGRAM IS TO BE SENT
1902
DETERMINE FROM COMMUNICATIONS CHANNEL MAPPING INFORMATION THE COMMUNICATIONS CHANNEL (eg., QAM CHANNEL) CORRESPONDING TO THE SELECTED PROGRAM
1904
1906
IS A TUNER ALREADY TUNED TO THE DETERMINED, e.g., QAM, COMMUNICATIONS CHANNEL?
Y
N
1912
IS THE FIRST LOCAL TUNER AVAILABLE?
Y
N
1918
IS THERE ANOHER LOCAL TUNER AVAILABLE?
Y
N
1924
CONTACT REMOTE RESOURCE MANAGER (e.g., STB2)
1926
IS A REMOTE TUNER AVAILABLE?
Y
N
1934
SELECT AVAILABLE REMOTE TUNER AND DESIGNATE SELECTED TUNER AS THE AVAILABLE TUNER TO BE USED
1936
SET AVAILABLE TUNER TO DETERMINED COMMUNICATIONS CHANNEL
1932
SEND PROGRAM CHANNEL REQUEST UNSUCCESSFUL MESSAGE TO OUTPUT DEVICE
1938
UPDATE PACKET ROUTING INFORMATION AND PROGRAM MANAGEMENT INFORMATION
1940
CONTROL PACKET FILTER CORRESPONDING TO THE THE AVAILABLE TUNER TO PASS PACKETS CORRESPONDING TO THE SELECTED PROGRAM
1942
CONTROL DEMULTIPLEXOR CORRESPONDING TO THE AVAILABLE TUNER TO SEND DESIRED PROGRAM PACKETS (e.g., an MPEG-2 TRANSPORT STREAM) TO A TRANSPORT PROCESSOR
1944
DIRECT TRANSPORT PROCESSOR TO SEND PROGRAM PACKETS TO REQUESTED DEVICE (e.g., VIDEO DECODER OR RECORDING DEVICE)
1946
SEND PROGRAM CHANNEL REQUEST SUCCESSFUL MESSAGE TO OUTPUT DEVICE
1948
STOP

FIGURE 6

METHODS AND APPARATUS FOR USING TUNERS EFFICIENTLY FOR DELIVERING ONE OR MORE PROGRAMS

FIELD OF THE INVENTION

[0001] The present invention is directed to improved content delivery methods and apparatus and, more particularly, to video content delivery methods and apparatus which allow for one or more tuners to be used efficiently as part of receiving, recording and/or viewing multiple programs.

BACKGROUND

[0002] A typical set top box (STB) has a limited number of RF tuners in it, e.g., one or two such tuners. Each tuner allows the STB to tune to one communications channel, e.g., QAM channel at a time. Normally one program, e.g., TV program or movie, is recovered and displayed or recorded from each communications channel. Thus, in many known systems, a STB is designed to support recovery and recording and/or display of a number of programs up to the number of tuners in the STB. If a STB has only two RF tuners, then with existing implementations, it can typically only record two different program channels simultaneously, or record one program channel while e.g., while a user views another program channel.

[0003] STBs are increasingly being paired with recording devices and/or include data storage capability which can be used to record and playback programs at a later time.

[0004] As the number of television and other program channels continues to increase, customers are faced with the increasing potential that programs of interest to the customer will be broadcast during the same time slots, on the same or different program channels. Given that set top boxes frequently only include one or two tuners, customers are frequently presented with more programs, movies or other content of interest being broadcast in a given time slot than there are tuners in the customer's STB. This presents the customer with the dilemma of having to use multiple STBs and corresponding recording devices if the customer desires to record more programs during a given time period than there are tuners in the customer's individual STB.

[0005] From a content provider's perspective, in order to provide customers an opportunity to record or view content to the extent desired, the content provider may have to repeat a broadcast of one or more programs to provide multiple recording/viewing opportunities to allow customers adequate opportunity to view/record the communicated content. Such repeated transmissions can be an inefficient use of communications resources since the repeated transmission of one communication may preclude the communication of new content or another program since communications bandwidth is a limited resource.

[0006] While the need to retransmit content can be inefficient in the case of broadcast programs such as television programs, the inefficient use of communications bandwidth can be particularly costly in the case of content delivery in the case of on demand or premium content delivery. In such applications the number of communications channels available for on-demand content or premium events may be relatively limited and the need to repeatedly transmit a title or other program may result in foregoing revenue that could have been obtained by delivering additional content, e.g., on demand or on a premium channel.

[0007] In view of the above discussion, it should be appreciated that it would be desirable if the number of different programs which could be simultaneously received and recorded or viewed by a customer could be increased. Adding tuners to STBs may be one way of achieving this objective. However, the cost of adding additional tuners can be cost prohibitive given the price sensitivity many consumers exhibit with regard to consumer electronics. Furthermore, given the large number of STBs deployed by a cable company and/or other content provider such as satellite providers, the cost of adding one or more tuners to each of a large number of STBs can represent a significant investment which may or may not be justified by the increased efficiency and/or premium channel or pay per view revenues that may be made possible by the additional hardware.

[0008] It should also be appreciated that there is a need for improved methods and/or apparatus that can be used to allow a set top box or other device to receive multiple programs at the same time and then record or display the programs. It would be highly desirable if the number of programs which could be received during a given time period and then recorded or displayed could exceed the number of tuners in the device, e.g., STB or other receiver, at the customer's premises.

[0009] In addition to improved methods and/or apparatus for implementing customer premise devices, such as STBs and/or satellite receivers, it may be desirable if improved methods of communicating programs to the customer premise devices could be devised which could be used in conjunction with improved customer device methods to make more efficient use of limited communications resources available for content delivery. For instance, it would be desirable for a device, e.g., STB, to be able to identify and utilize resources, e.g., tuners, in an efficient manner. It would be desirable if, in some embodiments a device was able to identify and use remote resources, e.g., one or more tuners located in a physically remote STB or device, when local resources are not available.

SUMMARY

[0010] Various features of the present invention are directed to customer premise device methods and apparatus. Some exemplary methods and apparatus allow a customer premise device, e.g., a set top box, to receive and then record and/or display more programs than the customer premise device includes tuners. Still other features of the invention are directed to improved utilization of unused resources, e.g., "remote" devices, such as tuners or other components of STB's in other locations, in order to meet the user's needs for viewing and/or recording of programs, e.g., multiple programs at the same time. The methods and apparatus described herein can be used alone and/or in combination with one or more of the methods and/or apparatus described in U.S. patent application Ser. No. 11/681,774, titled "METHODS AND APPARATUS FOR IMPROVED CONTENT DELIVERY INCLUDING CONTENT DELIVERY STREAMS DYNAMICALLY POPULATED IN RESPONSE TO USER REQUESTS" which was filed on Mar. 3, 2007, and which is hereby expressly incorporated by reference.

[0011] At the customer's premises, a user device, e.g., STB or satellite receiver, can receive multiple programs during the same time period on a single communications channel, e.g., QAM channel, recover the communicated program information and record or display the content corresponding to the

multiple programs. Assuming a single tuner can be used to recover N programs from a single QAM channel and the user's STB has M tuners, where M and N are positive integers, a single STB can be used to recover and record or playback M×N programs without the need for more than M tuners. Assuming, for example that 6 programs can be transmitted simultaneously using a single QAM channel, and that a STB included two tuners, the STB could be used to support recording of 12 programs transmitted during a given transmission period as compared to 2 in the case where the STB is limited to supporting one program per tuner.

[0012] In accordance with some features, efficient use of resources is accomplished by providing one or more sets of information, e.g., a table of available communications channels and associated program channels. Information relating a selected program and/or program channel to a destination device is also stored, e.g., in the table. When a new request for a program is received from a user, a main processor/resource manager can identify from the available, e.g., stored information, the desired program channel, and determine whether a tuner, beyond any tuner already in use, is required to be tuned to the communications channel, e.g., QAM communications channel, corresponding to the selected program channel. When a tuner is required to receive the communications channel determined to include a desired program channel an available tuner is selected. The selected tuner may be a local tuner or one of a plurality of different remote tuners which could be accessed over the home network. The selected program received via the program channel can then be sent to storage and/or one or more playback devices. The program, e.g., in the form of a stream of packets recovered from the signal passed by the tuner, can be communicated over the home network thereby allowing the tuner, recording and/or playback resources to be local or remote from one another.

[0013] The methods and apparatus of the present invention take advantage of a communications channel's ability to support a data rate that allows multiple programs to be delivered using the same communications channel during a program delivery period. For example, a single QAM communications channel may support the delivery of content corresponding to multiple program channels at the same time. Thus, a single QAM channel may deliver program content corresponding to, e.g., four or more programs or titles at the same time, e.g., by delivering the content corresponding to the different programs in a multiplexed content delivery stream. While in some previous systems the content corresponding to a single program corresponding to a communications channel, e.g., a QAM channel would be recorded or displayed, in accordance with the invention the content corresponding to multiple programs communicated using the same channel are recorded and/or displayed. Thus, the number of programs which can be recorded and/or displayed is not limited to the number of tuners since individual communications channels to which a tuner may be tuned can be used to provide data corresponding to multiple programs.

[0014] Content delivery streams are used to deliver content to users. A content delivery stream may include data corresponding to one or more programs. Different content delivery steams may be delivered using different communications channels, e.g., QAM channels. In accordance with the invention, a tuner can be controlled to tune to a particular communications channel and receive via that channel content corresponding to multiple program channels.

[0015] Some, but not necessarily all, embodiments include the mapping of programs to communications channels in response to user requests for program content, e.g., video on-demand requests and/or orders for premium content. This process may involve the construction, e.g., dynamic allocation of program content to a content delivery stream, e.g., MPEG-2 Transport stream, in response to user requests for program content and the delivery of the transport stream including content corresponding to multiple programs via a communications channel, e.g., a QAM communications channel.

[0016] Some embodiments of the present invention allow a tuner resource, e.g., a tuner in a STB, to supply multiple program streams. This can reduce the number of tuner resources deployed in a home as compared to system where each tuner is used to recover a single program or program channel at a time. Some embodiments of the present invention provide for systems, methods, and apparatus for determining whether a tuner resource is already tuned to a communications channel which provides a program or programs that a user wishes to view or record. If a tuner is already tuned to the communications channel which provides the desired program channel, an additional tuner resource need not be used; even if another program channel corresponding to the same communications channel is already being recovered from the signal passed by the tuner. If a tuner is not already tuned to the communications channel used to communicate the selected program, the present invention identifies and uses a local or remote tuner. Some embodiments allow packets corresponding to the selected programs to be directed to recording and/or playback devices, which may be local or remote from the tuner resource used to recover the program. The packets may be communicated, such as would be found in a home network.

[0017] A user with one tuner and one decoder can receive several program streams simultaneously via the one tuner, store the streams in a recorder, and then send individual programs from the recorder to a video decoder to sequentially view each of the simultaneously transmitted programs. Optionally, one or more of the program streams may be decoded and viewed instead of being recorded and/or viewed in addition to being recorded. In addition, remote tuners and/or decoders may be used when local resources are not available.

[0018] While various embodiments have been discussed in the summary above, it should be appreciated that not necessarily all embodiments include the same features and some of the features described above are not necessary but can be desirable in some embodiments. Various additional features, advantages, and/or embodiments of the present invention are discussed in the detailed description which follows.

BRIEF DESCRIPTION OF THE FIGURES

[0019] FIG. **1** comprising the combination of FIG. **1**A and FIG. **1**B is a drawing illustrating exemplary communication, recording and playing of program information in accordance with various embodiments of the present invention.

[0020] FIG. **2** illustrates a feature of various embodiments of the present invention, in which the selection of programs to be carried by a transport stream is a function of end user program selection.

[0021] FIG. **3** is a drawing illustrating exemplary end user program selection, control signaling, transport stream construction, and content delivery in accordance with various embodiments of the present invention.

[0022] FIG. **4** illustrates an exemplary system for receiving, recording, and playback implemented in accordance with an exemplary embodiment of the present invention.

[0023] FIG. **5** illustrates a matrix of an exemplary program, tuner, routing and other information stored and used in accordance with some exemplary embodiments.

[0024] FIG. **6** is a flowchart showing exemplary steps of a method of operating a system used for receiving, recording, and playback of programs in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION

[0025] Various exemplary methods and apparatus of the present invention will now be discussed and described with reference to the figures.

[0026] FIG. **1** comprising the combination of FIG. **1**A and FIG. **1**B is a drawing **100** illustrating exemplary communication, recording and playing of program information in accordance with various embodiments of the present invention. For each program to be communicated there are one or more elementary packet streams. Exemplary elementary streams corresponding to a program include, e.g., a low level video stream, an intermediate level video stream, a high level video stream and an audio stream. In FIG. **1** there are M exemplary programs to be communicated. Program 1 elementary packet streams information **102** includes a plurality of elementary packet streams (packetized elementary stream 1 **108**, . . . , packetized elementary stream N **110**). Packetized elementary stream 1 **108** includes a plurality of packetized elementary stream packets (PES packet 1 **112**, PES packet 2 **114**, PES packet 3 **116**, . . .). Packetized elementary stream N **110** includes a plurality of packetized elementary stream packets (PES packet 1 **118**, PES packet 2 **120**, PES packet 3 **122**, . . .). Program M elementary packet streams information **104** includes a plurality of elementary packet streams (packetized elementary stream 1 **124**, . . . , packetized elementary stream n **126**). Packetized elementary stream 1 **124** includes a plurality of packetized elementary stream packets (PES packet 1 **128**, PES packet 2 **130**, PES packet 3 **132**, . . .). Packetized elementary stream n **126** includes a plurality of packetized elementary stream packets (PES packet 1 **134**, PES packet 2 **136**, PES packet 3 **138**, . . .). PES packets can be, and sometimes are, of different size.

[0027] In addition to the elementary packets streams, there are also one or more transport stream program specific information streams including program mapping information to be communicated. Exemplary transport streams program specific information streams information **106** includes a TS program specific information stream 1 **140**, e.g., a program association table stream and TS program specific information stream D **142**, e.g., a program mapping table stream. TS program specific information stream 1 **140** includes a plurality of program information stream (PSI) packets (PSI packet 1 **144**, PSI packet 2 **146**, PSI packet 3 **148**, . . .). TS program specific information stream D **142** includes a plurality of program information stream (PSI) packets (PSI packet 1 **150**, PSI packet 2 **152**, PSI packet 3 **154**, . . .). PSI packets can be, and sometimes are, of different size.

[0028] Packets from the various program elementary streams (**108**, **110**, **124**, **126**) and programs specific information streams (**140**, **142**) are input to a transport stream packet generator module **156** which generates and outputs transport stream 1 **158**. Transport stream 1 **158** includes a plurality of transport stream packets (TS packet 1 **160**, TS packet 2 **162**, . . .). Each transport stream packet is of the same size. Each transport stream packet includes a packet identifier (PID) and a PES packet portion or a PSI packet portion. TS packet 1 **160** includes PID **164** and PES or PSI packet portion **166**. TS packet 2 **162** includes PID **168** and PES or PSI packet portion **170**.

[0029] Generated transport stream 1 **158** is input to a QAM modulator **172**. A tuner selection signal **174** for the QAM modulator is set for frequency band 1. The QAM modulator generates and outputs QAM symbols over a communications channel using frequency band 1, as represented by large arrow **176**, the generated QAM symbols conveying the transport stream 1 **158**.

[0030] In FIG. **1**B, QAM receiver demodulator **180**, which is controllable, can receive information and process information corresponding to different transport streams, at different times. Large arrow **176**, which is the output of FIG. **1**A, represents QAM symbols over a communications channel using frequency band 1 conveying transport stream 1 information. Large arrow **178** represents QAM symbols over a communications channel using frequency band p conveying transport stream p information. QAM receiver demodulator **180** receives tuner selection signal **182**, which at this time is set for band 1. QAM receiver demodulator receives and processes QAM symbols signals **176** and outputs transport stream 1 **184**. Transport stream 1 **184** is input to transport stream deconstruction module **186** which recovers and outputs recovered PSI packets **188** and recovered PES packets **190**. The recovered PSI packets are input to a PSI streams multiplexer **192** which recovers and outputs one or more PSI streams (PSI stream 1 packets **196**, . . . , PSI stream D packets **198**). Elementary stream and program demultiplexer module **194** receives recovered PES packets **190** and PSI stream 1 packets **196** and PSI stream D packets **198** as inputs. The packets of the PSI streams (**196**, . . . , **198**) provide control demuxing information, which module **194** uses to map particular recovered packets PES packets back to a program elementary stream of a particular program. Elementary streams corresponding to the M programs are output from module **194**. Corresponding to program 1, program 1 elementary stream 1 packets **199**, . . . , program 1 elementary stream N packets **197** are recovered. Corresponding to program M, program M elementary stream 1 packets **195**, . . . , program 1 elementary stream n packets **193** are recovered.

[0031] The various elementary streams ((**199**, . . . , **197**), . . . , (**195**, . . . , **193**)) are input to elementary stream connection control module **191**. The elementary stream connection control module **191** can, and sometimes does, couple a set of elementary streams corresponding to a program to one or more of a recording device **187** and a play device **185**. Program/device matching control signals **189**, input to connection control module **191**, are used by module **191** to control coupling selection. In this example, at this time, control signals **189** control programs 1 through program M-1 to be coupled to recording device **187**, as indicated by arrows ((**183**, **181**), (**179**, **177**)) and program M to be coupled to play device **185**, as indicated by arrows (**175**, **173**). Thus, play device **185** can be playing program M at the same time that recording device **187** is recording program 1 through program M-1. Arrow **183** from recording device **187** to play device **185** indicates that a recorded program stored on recording device **187** may be accessed and played by play device **185**.

[0032] At different times, different programs may be, and sometimes are, coupled to different devices. Sometimes, in

some embodiments, some programs from the set of programs communicated in the transport stream which is recovered are coupled through module **191**, which other programs from the set of programs communicated in the same transport stream are not coupled through module **191**. In some embodiments, at some times, some of the elementary transport streams corresponding to a program are coupled and/or used by recording device **187** and/or play device **185**, while other elementary streams corresponding to the same program are not coupled and/or used by the recording device and/or play device **185**. In some such embodiments, control signals **189** also control selection of subsets of elementary streams. For example, a user's play device **185** may not have high definition capability; therefore, elementary streams used for high definition are not forwarded to recording device **187** and/or play device **185**. As another example, high definition video is a premium service to which a particular user has not subscribed; and therefore elementary streams used for high definition are not forwarded to recording device **187** and/or play device **185**.

[0033] In one exemplary embodiment, the transport stream packet generator **158** and QAM modulator **172** are part of a content distribution node. In some such embodiments, the tuner selection signal **174** is generated by a policy server node, e.g., a switched digital video (SDV) policy server node. In various embodiments, the QAM receiver demodulator **180**, transport stream deconstruction module **186**, PSI streams demultiplexer **192**, elementary stream and program multiplexer **194** and elementary stream connection control module **191** are included as part of a set top box (STB). In various embodiments, the recording device **187** is a digital storage device, e.g., a DVR, at the customer premise corresponding to the STB, and the play device **185** is, e.g., a television set, at the customer premise corresponding to the STB.

[0034] FIG. **2** illustrates in drawing **200** a feature of various embodiments of the present invention, in which the selection of programs to be carried by a transport stream is a function of end user program selection. In the example of FIG. **2**, there are NT available programs (program 1 data/information **202**, program 2 data/information **204**, program 3 data/information **206**, program 4 data/information **208**, program 5 data/information **210**, program 6 data/information **212**, program 7 data/information **214**, program 8 data/information **216**, program 9 data/information **218**, program 10 data/information **220**, program 11 data/information **222**, program 12 data/information **224**, . . . , program N_T data/information **226**. Each set of program data/information, e.g., program 2 data/information **204** includes one or more elementary packet streams, e.g., a low level video stream, an intermediate level video stream, a high level video stream, an audio stream, a first closed caption stream, a second closed caption stream, a foreign language audio stream, etc.

[0035] The program data/information (**202**, **204**, **206**, **208**, **210**, **212**, **214**, **216**, **218**, **220**, **222**, **224**, . . . , **226**) are available as inputs to program selection module **228**. Selection control signals **230**, which are a function of end user program request (s), are used by program selection module **228** to control population of a transport stream. At this particular time the selection control signal **230** indicates that programs (2, 6, 9, 11 and N_T) are to be carried by a single transport stream, and module **228** forwards the corresponding data/information as indicated by dashed line arrows (**232**, **234**, **236**, **238**, **240**). Large arrow **242** represents that a plurality of selected programs are being carried on a single transport stream, wherein at least some of the selected programs were selected in response to end user program requests. The transport stream packets corresponding to the plurality of selected programs are typically multiplexed in the transport stream.

[0036] FIG. **3** is a drawing **300** illustrating exemplary end user program selection, control signaling, transport stream construction, and content delivery in accordance with various embodiments of the present invention.

[0037] In drawing **300** there is a content delivery system including an SDV policy server **301**, a content distribution node **303**, and a plurality of set top boxes (STB A **305**, STB B **307**, STB C **309**). STB A **305** sends signal **352** to SDV policy server **301** to request program channels 1, 2, 3, 4 & 5. The SDV policy server **301** receives the request signal **352** and generates control signal **354**, which it sends to content distribution node **303**. Control signal **354** commands that channels 1, 2, 3, 4, & 5 be placed in a transport stream communicated using QAM signals in frequency band X. Content distribution node **303** implements the command. SDV policy server **301** sends tuner control signal **356** to STB A **305** notifying STB A **305** to set its QAM receiver/demodulator **311** to select band X.

[0038] Next, STB B **307** sends signal **358** to SDV policy server **301** to request program channels 1, 2, 3. The SDV policy server **301** receives the request signal **358**, recognizes that the requested changes are already available on frequency band X and generates tuner control signal **360**, which it sends to STB B **307**. Tuner control signal **360** notifies STB B **307** to set its QAM receiver/demodulator **313** to select band X.

[0039] Next, STB C **309** sends signal **362** to SDV policy server **301** to request program channel 6. The SDV policy server **301** receives the request signal **362** and generates control signal **364**, which it sends to content distribution node **303**. In this example, a transport stream corresponding to a frequency band can carry up to 5 multiplexed program channels; therefore, the transport stream for frequency band X is currently full. Control signal **364** commands that channel 6 be placed in a transport stream communicated using QAM signals in frequency band Y. Content distribution mode **303** implements the command. SDV policy server **301** sends tuner control signal **366** to STB C **309** notifying STB C **309** to set its QAM receiver/demodulator **315** to select band Y.

[0040] Next, STC **309** sends signal **368** to SDV policy server **301**, requesting program channel 1. SDV policy server **301** sends control signal **370** to content distribution node **303** commanding node **303** to add program channel 1 to frequency band Y. Content distribution node **303** implements the request.

[0041] Drawing **300** also includes information **319** identifying the programs being carried by transport stream 1 using frequency band X over time, and information **321** identifying the programs being carried by transport stream 1 using frequency band X over time. Information **319** and **321** identifies conveyed information in signals **323** being output from content distribution node **303** and which is available at the inputs to STBs (**305**, **307**, **309**). Time line **317** corresponds to information **319** and **321**. Initially neither frequency band is carrying any user requested program channels. Then user requested programs channels 1, 2, 3, 4, and 5 are placed in transport stream 1 and communicated using QAM signals in frequency band X. At a later point in time, program channel 6 is placed into transport stream 2 and communicated using QAM signals in frequency band Y. At a still later point in time program channel 1 is also placed into transport stream 2 and

communicated using QAM signals in frequency band Y. The program setting for frequency band X has remained for the duration of the example.

[0042] In various embodiments, multiple program channels may be received on each QAM communications channel, e.g., during the same program transmission time period. By utilizing the above described delivery of QAM channels (communications channels) with associated program channels to the premises, desired program channels extracted from the QAM channels, for example, can be distributed, e.g., simultaneously or during the same transmission period, to local or remote recording or playback devices as directed by a processor and/or resource manager of a user device, such as a STB. Alternatively, the resource management functions could be centralized in a device outside the STB, either in whole or in part. The resource manager can access a table of tuner and management information which would allow the resource manager to identify desired (user-selected) programs, determine whether or not those programs are already included in a communications channel, e.g., a QAM channel, being received and processed, e.g., at a tuner, and if not, assign a tuner which could be either local or remote, to tune the appropriate communications channel. Then, based on the request of the user to either store or immediately view the desired program (the program in the appropriate time slot of the associated program channel), the resource manager can determine the appropriate device, either local or remote, for delivery of the desired program, either by default or under the direction of the user.

[0043] FIG. **4** is a drawing of exemplary receiving, recording, and playback system implemented in accordance with some embodiments of the present invention. Two STB's, set top box 1 **1710** and set top box 2 **1740** are shown, along with user input device **1753**, output device **1754**, home network **1751**, internet access **1752**, display device 1 **1711**, display device 2 **1741**, and HDD remote storage **1750**.

[0044] Set top box 1 **1710** includes tuner/demodulator/demultiplexer chain 1 **1712** through tuner/demodulator/demultiplexer chain N **1722**. Tuner/demodulator/demultiplexer chain 1 **1712** includes tuner 1 **1713**, packet recovery module such as demodulator module 1 **1714**, and PID filter I demultiplexer 1 **1715**. Tuner/demodulator/demultiplexer chain N **1722** contains tuner N **1723**, demodulator N **1724**, and PID filter N|demultiplexer N **1725**. Each chain receives an input signal, e.g., a signal including a set of RF QAM signals from the cable network corresponding to different communications channels. The tuner is tuned to one of the communications channels. The demodulator module **1714** is a packet recovery module which outputs packets which are supplied to the input of the PID filter 1/demultiplexer 1 module **1715**. The filtering may precede or follow demultiplexing. The PID filter passes packets corresponding to selected program channels/programs and rejects, e.g., blocks, packets corresponding to programs and/or channels which have not been selected. Packets which have been demultiplexed and passed by the PID filter of the chains **1712**, **1722** are sent to the transport processor 1 **1703** over links **1762** through **1763** respectively. The chains **1712**, **1725** are in communication with the transport processor via link **1761** and work under the direction of, main processor/resource manager **1704** which can communicate with other devices via interface **1791** and/or I/O interface **1705**. The main processor/resource manager **1704** is a control module which can control the use of both local and remote resources, e.g., tuner/demodulator chains and/or transport processors **1703**, **1749** and can communicate with the various devices of the network via direct links and/or home network **1751**. Although link **1761** is depicted as connected to tuner/demodulator/demultiplexer chain N, it should be appreciated that it is connected with each of the tuner/demodulator/demultiplexer chains and may be implemented as a communications bus.

[0045] As an example of the operation of the tuner/demodulator/demultiplexer chains, tuner/demodulator/demultiplexer chain 1 **1712** will be described in more detail. A typical RF signal enters set top box 1 **1710** at input **1771** with multiple carriers between, e.g., frequencies 50-1000 MHz. Tuner 1 **1713**, under the direction of main processor/resource manager **1704**, is tuned to or otherwise controlled to selects a single 6 MHz carrier frequency and passes the signal corresponding to the band to demodulator **1714** while filtering out other bands. Demodulator **1714** converts the data transmitted on the tuned carrier frequency to the digital data, e.g., by performing a demodulation, symbol recovery operation and/or packet recovery operation. In some embodiments, the output of demodulator **1714** is series of packets which correspond to a standard MPEG 2 Multi Program Transport Stream (MPTS). The MPTS enters PID filter 1|demultiplexer 1 **1715**. PID filter 1 is a Program Identifier (PID) filter which is able to distinguish between packets corresponding to different programs, e.g., based on program identification information which may be, for example, an identifier included within the header of packets. The PID filter allows demultiplexer 1 to locate and pass the packets corresponding to a Single Program Transport Stream (SPTS) of interest while rejecting or outputting the packets of another stream on another output. PID filter 1|demultiplexer 1 **1715** allows multiple SPTS's to be selected and sent from PID filter 1|demultiplexer 1 **1715** to transport processor 1 **1703** over link **1762**. Transport processor 1 **1703** is responsible for receiving the SPTS streams and then forwarding each stream to the appropriate destination, as directed by main processor/resource manager **1704**. If the packet contents were encrypted, in some embodiments the transport processor performs a decryption operation, e.g., before communicating the program stream to its destination, e.g., a video decoder. Each stream can be directed to one or more of: internal HDD (local storage) **1701**, typically a hard drive, e.g., over link **1769**, for storage of the stream; to local decoder 1 **1702** in order to view the stream on display device 1 **1711**; to home network **1751** over link **1767** to access display device 2 **1741**, via transport processor 2 **1749** and decoder 2 **1748** of set top box 2 **1740**; and/or via link **1765** to HDD (remote storage) **1750**.

[0046] The user can initiate a request for a particular program by utilizing user input device **1753**. This device is connected to set top box 1 **1710** via I/O interface **1705**. This can be done via infrared (IR) signaling device or other type of remote control, for example. Alternatively, user input device **1753** could be incorporated into set top box 1 **1710**, e.g., as a keypad of a control panel. I/O device **1705** transfers the program request, which could be a particular program channel during a particular time slot, a program name, or other indication of a desired program, and could optionally include a desired device to receive the program, such as decoder/display **1702**, **1711**, decoder/display 2 **1748**, **1741**, HDD (local storage) **1701**, or HDD (remote storage) **1750**. One alternative is for main processor/resource manager **1704** to access the Internet, via communications link **1764**, home network **1751**, and the Internet **1752** over link **1768**, in order

to correlate the user's request for a particular program name, or other indication of a requested program, with a program channel. Alternatively, the system could default to display the program on the local display device (display device 1 **1711** for set top box 1 **1710**) unless a specific alternative destination is requested by the user.

[0047] Once main processor/resource manager **1704** receives the program request, it accesses memory **1705** to determine how to proceed. Memory **1705** includes program guide routine **1707**, management routine **1708**, and information and management table(s) **1709**. Main processor/resource manager **1704** runs program guide routine **1707**, which accesses information and management table(s) **1709** to identify the communications channel that includes the desired program, by identifying the program channel associated with the desired program, and cross-referencing the program channel makeup of each of the available communications channels. This is discussed below in more detail below in relation to FIG. **5**. As should be appreciated the stored information may be stored in memory in a variety of different ways, e.g., as one or multiple information tables.

[0048] Once the program guide routine **1707** determines the program channel and time slot of the requested program, main processor/resource manager **1704**, operating under control of management routine **1708** in memory **1705**, determines how best to access the appropriate communications channel. For example, if the desired communications channel was already being tuned at tuner 1 **1713**, main processor/resource manager **1704** would instruct PID filter 1/demultiplexer 1 **1715** to additionally strip off, e.g., pass, the desired program channel to send to transport processor 1 **1703**. If no local tuners were tuned to the desired communications channel, main processor/resource manager **1704** determines whether a remote tuner, such as tuner **1743** of set top box 2 **1740** is available. The determination of available remote resources may be made by communicating with various devices via home network **1751** including transport processor 2 **1749**, and main processor 2 **1747** and/or various remote tuners. The determination may include determining if a remote tuner is already tuned to the appropriate communications channel. The main processor/resource manager **1704** could have a direct communications link to main processor 2 **1747** avoiding the need to communicate via the home network or some other indirect communications path.

[0049] If no tuners were currently tuned to the appropriate communications channel associated with the requested program, then management routine **1708** would, in various embodiments, find an available tuner by consulting information and management table(s) **1709**. If no tuner was available, a message would be sent from main processor/resource manager **1704** to output device **1754**, via I/O interface **1705**, indicating that the requested program cannot be obtained in the requested time slot, due to insufficient resources. Output device **1754** could be a stand alone device, incorporated with user input device **1753**, or consist simply of an indicator incorporated into set top box 1 **1710**.

[0050] Management routine **1708** utilizes information and management table(s) **1709** in order to determine the communications channel, e.g., QAM channel, including the appropriate program, and to determine the tuner which should be tuned to the appropriate communications channel.

[0051] If, for example, tuner **1743** in STB **2**—tuner/demodulator/demultiplexer chain **1742** was selected to receive a particular program channel containing the desired program, it would operate in a similar fashion to the operation described above in relation to tuner/demodulator/demultiplexer chain 1 **1712**. Main processor/resource manager **1704** would direct main processor 2 **1747** to cause tuner **1743** to filter the RF QAM input signal received at tuner **1743** to output the desired communications channel to demodulator **1744**, which would output the demodulated signal to PID filter|demultiplexer **1745**, which would then output the resultant program channel stream to transport processor 2 **1749**. This may be done under control of communications with main processor 2 **1747**. Transport processor 2 **1749** could send the program channel to set top box 1 **1710** via home network **1751**, HDD (remote storage) **1750** over link **1766**, or decoder 2 **1748**, associated with display device 2 **1741**. Main processor 2 **1747**, similar to main processor/resource manager **1704**, would be in communication with memory 2 **1746**, which is used in the same or a similar manner as memory **1706** of set top box 1 **1710**.

[0052] FIG. **5** illustrates an exemplary set of tuner and program management information **1800**, such as would be found in information and management table(s) **1709** of FIG. **4**. The information in table **1800** can be stored in and utilized by the resource manager, such as main processor/resource manager **1704** of FIG. **4**. The first column **1810** lists tuners that can be controlled by the resource manager, accomplished by utilizing program guide routine **1707** of FIG. **4**, e.g., in response to program display and/or recording selections made by the user. In the FIG. **5** example, N tuners may be controlled in response to user selections (tuner 1 **1812**, tuner 2 **1814**, thru tuner N **1816**). The tuners may be local, e.g., within the local STB which maintains and uses the set of information shown in FIG. **4**, or within a remote STB, such as in a different room of the home.

[0053] The second column **1820** indicates the communications channel, e.g., QAM channel, to which the tuner listed in column 1 **1810** to the left of the channel information is tuned. The third column **1830** includes information indicating the program channels corresponding to the QAM channel to which the tuner is tuned. The fourth column **1840** includes for each program channel listed in the third column the program ID (or packet ID, program name, etc.) used to identify packets corresponding to the program channel identified in the same row as the program ID during a particular time slot. The last column **1850** includes the routing information used to control routing of packets corresponding to the program stream of the program identified by the PID included in the same row as the routing information.

[0054] The resource management module (program guide routine used in conjunction with the main processor/resource manager) controls which communications channel, and thus frequency, to which a particular tuner is set. It also updates the routing information in response to user selections, e.g., recording and/or display selections made with respect to particular programs. The routing information is used to control the filtering and forwarding of recovered packets based on the PIDs included in the packets within the communications channel data. As illustrated, based on user selections, and as described more fully above in relation to FIG. **4**, program packets may be routed to a local decoder, a remote decoder and/or a recording device such as a hard disk driver as indicated by the letters "HDD". A dash is used to indicate program packets (SPTS's—Single Program Transport Streams) which should be discarded upon recovery from a transport multiplex (MPTS—Multi Program Transport Stream).

[0055] Consider, for example, the information shown for tuner 1 **1812** in FIG. **5**. Tuner 1 **1812** is tuned to QAM channel 1 **1822** which corresponds to programs channels **100**, **101**, **102**, **103**, **104**, and **105** during the time slot for which information is shown in FIG. **5**. The packets corresponding to the program on channel **100 1832** are identified by PID value **10035 1842** and are to be routed to a local decoder **1851**, e.g., for decoding and display via local display device 1 **1711** of FIG. **4**. The packets corresponding to program channel **101 1834**, with a PID of **10135 1844**, are to be discarded as indicated by the presence of "-" **1853** in the routing information column **1850**. Similarly, program channels **102**, **103** and **105** of column **1830** are to be discarded. The routing information **1855** for program channel **104 1836** indicates that packets corresponding to this program channel are to be streamed to a local HDD (LHDD), for recording. This may be a hard disk drive included in the STB which maintains the set of information shown in FIG. **5** such as HDD (local storage) **1701** of FIG. **4**.

[0056] The information included in FIG. **5** indicates that tuner 2 **1814** is set to QAM channel 7 **1824**, that this communications channel provides program channels **700** through **705** and that the packets corresponding to program channel **700 1838** are to be sent to a remote hard disk driver (RHDD) **1857** for recording (such as, e.g., HDD remote storage **1750** of FIG. **4**) while packets corresponding to channel **705 1839** are to be sent to a remote video decoder **1859**, e.g., for decoding and playback on a display device located in another room in the house in which the STB using the table shown in FIG. **5** is located, such as display device 2 **1741** of FIG. **4**. It should be appreciated that in various embodiments, packets corresponding to different programs received via a single QAM channel may be sent to several different locations, e.g., the packets corresponding to a first group of one or more programs may be sent to a local recoding device, packets corresponding to a second group of one or more programs may be sent to a remote recording device, packets corresponding to another program group may be sent to a local decoding device, while packets corresponding to yet another group of one or more programs may be sent to one or more different remote decoding devices. Thus, from a single tuner which is tuned to a single communications channel, a transport multiplex of programs may be recovered and the packets corresponding to the various programs in the transport multiplex may be routed and processed differently in accordance with the invention. In this manner, multiple programs corresponding to the same program time slot may be recovered from a communications channel and processed differently, e.g., in response to user menu selections and commands.

[0057] For example, if a user requested the storage of a program with the PID of **10335**, the information on FIG. **5** could be accessed to determine that this program (**10335 1845**) is part of QAM channel 1 **1822**. The main processor/resource manager, in conjunction with the program guide routine, would then determine from the information **1800** that channel 1 was currently being tuned by tuner 1 **1812**. The main processor/resource manager, in conjunction with the management routine, would cause the appropriate PID filter|demultiplexer associated with tuner 1 to separate out and forward packets corresponding to program channel **103 1835** (determined from information **1800**), send this program to a local storage device, and change the "----" **1854** in information **1800** to "Local HDD".

[0058] In some embodiments of the present invention, the main processor/resource manager operates in conjunction with a program guide routine and a management routine, to access information and one or more management tables, to control the process of receiving a user request, determining the program channel and associated communications channel required to meet that request, and operate the appropriate tuner, demodulator, PID filter, and demultiplexer to strip off the requested program from the communications channel, and direct the resultant packets, via a transport processor, to either a decoder and associated display device, or to a storage device. The program guide and management routines could either be stand alone, or combined in the main processor/resource manager. Likewise, the information and management tables could be in a remote memory, or integrated within the main processor and/or resource manager.

[0059] FIG. **6** is a drawing of a flowchart **1900** of an exemplary method of operating a system of STB's, display devices, and storage devices. The processing in response to user requests proceeds each time a request is made by a user.

[0060] Operation starts in step **1901**, where the various devices are powered on and initialized and monitoring for user input starts. Then in step **1902** main processor/resource manager receives a user request The request may be from, e.g., user input device **1753** of FIG. **4** and may indicate a selected program and, optionally an indicator indicating a device to which said program is to be sent.

[0061] In step **1904**, the main processor/resource manager, using the program guide routine, determines from the communications channel mapping information of the information and management tables for the communications channel (e.g., QAM channel) corresponding to the selected program, e.g., the program or program channel selected by the user.

[0062] In step **1906**, the main processor/resource manager determines if a tuner is already tuned to the determined, e.g., QAM, communications channel. If a tuner is already tuned to the determined communications channel, the packet routing information and program management information of the information and management tables is updated to reflect the destination of the determined program channel within the communications channel in step **1938**.

[0063] If a tuner is not already tuned to the determined communications channel in step **1906**, then in step **1912**, the main processor/resource manager determines if the first local tuner is available to be tuned. If it is available, operation proceeds to step **1936**, which sets that available tuner to the determined communications channel, and then proceeds to step **1938**, wherein the packet routing information and program management information of the information and management tables is updated to reflect the tuning of the first local tuner to the determined communications channel in step **1938**.

[0064] If the first local tuner is not available in step **1912**, the main processor/resource manager determines if another local tuner is available in step **1918**. If one is available, the operation proceeds to step **1936**, wherein that available tuner is set to the determined communications channel.

[0065] If no other local tuner is available in step **1918**, the main processor/resource manager contacts a remote resource manager (e.g., STB**2**) in step **1924**. This might be a STB in another room from the first STB containing the main processor/resource manager.

[0066] In step **1926**, this remote resource manager is directed to determine if a remote tuner, e.g., a tuner associated

with the remote resource manager, is available. If so, in step **1934**, the remote resource manager would select that available remote tuner and designate the selected tuner as the "available tuner" to be used. Operation would then proceed to step **1936**, where that "available tuner" would be set to the determined communications channel, and in step **1938**, the packet routing information and program management information of the information and management tables is updated to reflect the tuning of the remote tuner to the determined communications channel in step **1938**. This updated information could be reflected in the local STB's information and management tables, or the remote STB's information and management tables, or in both.

[0067] If no remote tuner is available in step **1926**, indicating that no tuner is available given that a local tuner was also not found to be available, the main processor/resource manager sends a "program channel request unsuccessful" message to the output device, letting the user know that his last request could not be accomplished. The process **1900** for that particular user request would then stop in step **1948**. Returning to step **1938**, once the appropriate packet routing information and program management information has been updated, the main processor associated with the available tuner would control the packet filter corresponding to the available tuner to pass packets (comprising the program channel) corresponding to the selected program.

[0068] In step **1942**, the associated main processor would control the demultiplexer corresponding to the available tuner to send the desired program packets (e.g., an MPEG-2 transport stream) to a transport processor.

[0069] In step **1944**, the associated main processor would direct the transport processor to send program packets to the requested device, e.g., video decoder or recording device. The main processor would utilize the management routine in conjunction with the information and management tables in order to control the functions of the PID filter, demultiplexer, and transport processor.

[0070] In step **1946**, the associated main processor sends a "program channel request successful" message to the output device, informing the user that his request was carried out. The process regarding this user request would stop at step **1948**.

[0071] With this process, a user could have a greater number of requests for programs carried out than the number of tuners available in the user's system.

[0072] In various embodiments system elements described herein are implemented using one or more modules which are used to perform the steps corresponding to one or more methods of the present invention, for example, request processing, program guide routines, management routines, content to stream assignment, content recovery, multiplexing, demultiplexing, display generation, recording of multiple programs in a QAM channel, etc. Such modules may be implemented using software, hardware or a combination of software and hardware. Each step may be performed by one or more different software instructions executed by a processor, e.g., CPU.

[0073] At least one system implemented in accordance with the present invention includes a means for implementing the various steps which are part of the methods of the present invention. Each means may be, e.g., an instruction, processor, hardware circuit and/or combination of elements used to implement a described step.

[0074] Many of the above described methods or method steps can be implemented using machine executable instructions, such as software, included in a machine readable medium such as a memory device, e.g., RAM, floppy disk, etc. to control a machine, e.g., general purpose computer with or without additional hardware, to implement all or portions of the above described methods, e.g., in one or more nodes. Accordingly, among other things, the present invention is directed to a machine-readable medium including machine executable instructions for causing a machine, e.g., processor and associated hardware, to perform one or more of the steps of the above-described method(s).

[0075] Numerous additional embodiments, within the scope of the present invention, will be apparent to those of ordinary skill in the art in view of the above description and the claims which follow.

What is claimed is:

1. A method of operating a communications device in a content distribution network, the method comprising:

storing tuner and program management information including information indicating a first communications channel to which a first tuner is tuned, program identifiers of programs corresponding to said first communications channel; and routing information corresponding to at least one of said program identifiers; and

using said stored information to control routing of packets corresponding to a plurality of different programs communicated via the first communications channel.

2. The method of claim **1**, wherein using said stored information to control routing of packets includes routing packets received via said first communications channel as a part of a transport multiplex to multiple destination devices.

3. The method of claim **2**, wherein one of said destination devices is a recording device and another one of said destination devices is a video decoder.

4. The method of claim **3**, further comprising:

operating a packet filter to discard packets received from said first communications channel as part of a transport multiplex which corresponds to programs for which a routing destination is not specified in said program management information.

5. The method of claim **2**, wherein said program identifiers correspond to programs which correspond to the same program time slot.

6. The method of claim **1**, further comprising:

receiving program selection information from a user of said communications device;

determining from channel mapping information the communications channel to which the selected program corresponds; and

determining from the set of resource management information if the first tuner is tuned to the communications channel to which the selected program corresponds.

7. The method of claim **6**, further comprising:

if it is determined that the first tuner is already tuned to the communications channel to which the selected program corresponds, updating routing information in said set of tuner and program management information to control routing of packets corresponding to said program to a device corresponding to a user selection.

8. The method of claim **7**,

wherein said user selection is a selection by said user to record said selected program and

wherein said step of updating said routing information includes indicating that packets corresponding to said selected program are to be routed to a recording device.

9. The method of claim **7**,

wherein said user selection is a selection by said user to view said selected program and

wherein said step of updating said packet routing information includes updating said routing information to indicate that packets corresponding to said selected program are to be routed to a video decoder.

10. The method of claim **9**, further comprising:

receiving additional program selection information from the user of said communications device, the additional program selection information indicating a second selected program corresponding to the same program time slot and communications channel as said selected program; and

updating routing information in said set of tuner and program management information to control routing of packets corresponding to said second selected program to a remote device.

11. The method of claim **10**, wherein said video decoder is a local video decoder and said remote device is a remote video decoder.

12. The method of claim **11**, wherein said remote video decoder is located in a different physical location than the local video decoder.

13. The method of claim **12**, wherein said communications device is a cable television set top box, wherein said local video decoder is included in said set top box, and wherein said remote video decoder is located in a video playback device included at the same customer premises but in a different physical location from said set top box.

14. The method of claim **9**, further comprising:

receiving program to communications channel mapping information, said mapping information indicating a plurality of programs corresponding to a program time slot mapping to a QAM communications channel; and

using said received program to communications channel mapping information as part of an MPEG-2 transport stream; and

wherein said received program to communications channel mapping information is used in said step of determining the communications channel to which the selected program corresponds.

15. The method of claim **6**, further comprising:

if it is determined that the first tuner is not already tuned to the communications channel to which the selected program corresponds, determining if another local tuner is available for tuning to said communications channel.

16. The method of claim **15**, wherein if it is determined that another local tuner is not available for tuning to said communications channel, determining if a remote tuner is available for tuning to said communications channel to which the selected program corresponds.

17. The method of claim **16**, wherein said communications device is a set top box, wherein said set top box includes said first tuner and at least one additional tuner, said tuners included in said set top box being local tuners and wherein said remote tuner is outside said set top box and is coupled to said set top box by a communications link.

18. The method of claim **16**,

wherein when it is determined that a remote tuner is available for tuning to said communications channel, controlling said remote tuner to tune to said communications channel; and

updating routing information in said set of resource management information to control routing of packets corresponding to said selected program, output by said remote tuner, to one of a recording device and video decoder.

19. A method of operating a communications device in a content distribution network, the method comprising:

receiving program selection information from a user of said communications device;

determining from program to communications channel mapping information the communications channel to which the selected program corresponds; and

determining if a first tuner is tuned to a communications channel to which the selected program corresponds.

20. The method of claim **19** wherein the program selection information includes a requested destination device.

21. The method of claim **19**, further comprising:

if it is determined that the first tuner is already tuned to the communications channel to which the selected program corresponds, updating routing information in said set of tuner and program management information to control routing of packets corresponding to said program to a device corresponding to a user selection.

22. The method of claim **19**, further comprising:

if it is determined that the first tuner is not in use, tuning the first tuner to the communications channel to which the selected program corresponds.

23. The method of claim **19**, further comprising:

if it is determined that the first tuner is tuned to a communications channel other than the communications channel to which the selected program corresponds, determining if another tuner is available.

24. The method of claim **23**, further comprising:

if it is determined that another tuner is available, tuning said another tuner to the communications channel to which the selected program corresponds.

25. A method of operating a communications device in a content distribution network, the method comprising:

storing tuner and program management information, said tuner and program management information including information corresponding to a plurality of tuners, said plurality of tuners including a first tuner, said tuner and program management information including for the first tuner information indicating a first communications channel to which the tuner is tuned and program identifiers of programs corresponding to said first communications channel; and

controlling filtering of packets using said stored program identifiers.

26. The method of claim **25**, wherein said tuner and program management information further includes:

routing information corresponding to at least one of said program identifiers; the method further comprising:

routing packets including packet identifiers corresponding to a selected program based on stored routing information.

27. A communications system for use with a content distribution network, comprising:

a storage unit for storing tuner and program management information including information indicating a first

communications channel to which a first tuner is tuned, program identifiers of programs corresponding to said first communications channel; and routing information corresponding to at least one of said program identifiers; and

a packet filter for passing packets corresponding to one or more selected programs and for filtering out packets which do not correspond to non-selected programs.

28. The communications system of claim **27**, further comprising:

a routing device for routing packets corresponding to selected programs to devices in accordance with stored routing information included in said stored information.

29. The communications system of claim **28**, wherein said routing device is a transport processor and wherein routing packets includes routing packets received via said first communications channel as a part of a transport multiplex to different destination devices.

30. The communications system of claim **27**, further comprising:

a tuner for filtering an signal including communications channel to pass a communications channel signal including a selected program channel;

a demodulator and packet recovery module coupled to said local tuner for demodulating the communication channel signal passed by said tuner and recovering packets therefrom, packets generated by said demodulator and packet recovery module being supplied to said packet filter.

31. The communications device of claim **30**, wherein said tuner is a local tuner, the system further comprising:

an input device located in a defined physical space with said local tuner;

a home network;

a remote tuner located in a different physical space from said local tuner; and

a control module for controlling use of said local tuner and remote tuner in response to user input received from said input device.

32. The communications device of claim **31**, wherein said control module controls the routing of packets produced from signals processed by said local and remote tuners.

33. A device for processing communications signals comprising:

a first controllable tuner tunable to a communications channel;

a first packet recovery module coupled to said first tuner; and

a packet filter and demultiplexing module coupled to said first packet recovery module for passing and demultiplexing packets corresponding to one or more selected program channels; and

and a control module for controlling said packet filter and demultiplexing module to pass packets corresponding to selected program channels and reject packets corresponding to non-selected program channels.

34. The device of claim **33**, wherein said packet filter and demultiplexing module outputs packets corresponding to multiple different program streams communicated during the same program transmission time interval when multiple program channels corresponding to a single communications channel have been selected.

35. The device of claim **33**, further comprising:

a second controllable tuner; and

wherein said control module operates to select a tuner to be used for recovering a program channel in response to a user selecting a program channel or program corresponding to a program channel.

36. The device of claim **34**, further comprising:

an interface for communicating with remote devices to determine resource availability.

37. The device of claim **36**, further comprising:

memory including stored information indicating tuner resource utilization and program identifiers corresponding to multiple programs to be recovered from a communications channel using a single tuner.

38. The device of claim **37**, wherein said memory further includes information indicating different routing destinations for packets corresponding to different programs recovered from the same communications channel.

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