

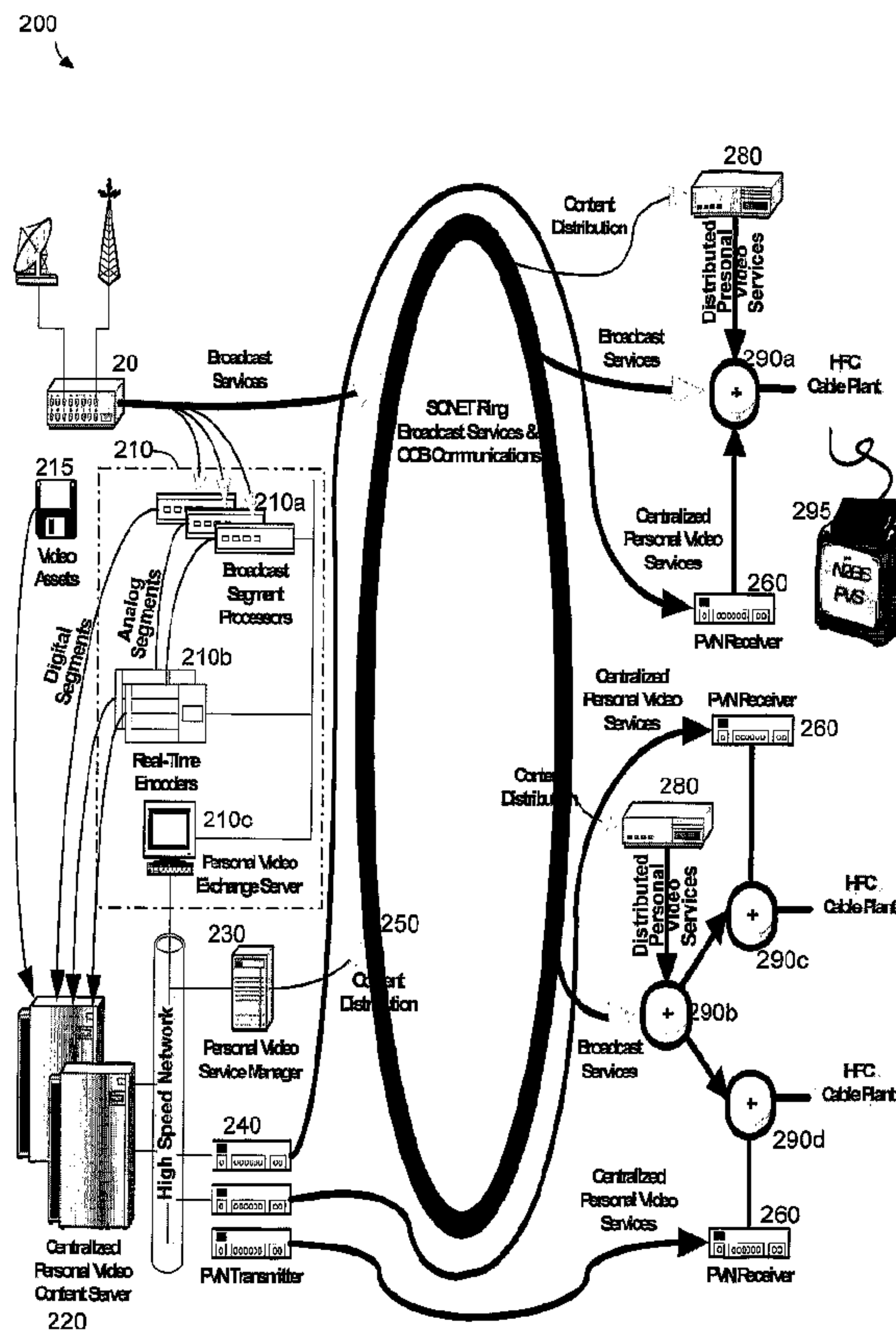


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(54) Title: SYSTEM AND METHOD FOR DISTRIBUTING NETWORK-BASED PERSONAL VIDEO



(57) Abrégé/Abstract:

A personal video service manager can store one or more personal video assets on a server. A personal video asset can comprise a recording of a broadcast stream of a broadcast asset or an asset that has been pre-authored in a personal video asset format. Upon receiving a request from a subscriber to receive the personal video asset, the personal video service manager can facilitate a connection between the server and the subscriber for distributing the personal video asset from the server to the subscriber.



**ABSTRACT**

A personal video service manager can store one or more personal video assets on a server. A personal video asset can comprise a recording of a broadcast stream of a broadcast asset or an asset that has been pre-authored in a personal video asset format.

- 5 Upon receiving a request from a subscriber to receive the personal video asset, the personal video service manager can facilitate a connection between the server and the subscriber for distributing the personal video asset from the server to the subscriber.

## **SYSTEM AND METHOD FOR DISTRIBUTING NETWORK-BASED PERSONAL VIDEO**

### **FIELD OF THE INVENTION**

The present invention is generally directed to video networks. More particularly described, the present invention supports the management and the distribution of personal video assets upon receiving requests from cable subscribers to view the personal video  
5 assets.

### **BACKGROUND OF THE INVENTION**

Recent developments in the cable television industry have allowed content providers (or "asset providers"), such as Home Box Office, NBC, and Warner Bros., to  
10 provide a variety of cable television services to cable subscribers. For example, a Movie-on-Demand service allows a cable subscriber to view a movie over the cable network with the same type of control that a person typically has over a video cassette recorder ("VCR") or digital versatile disk ("DVD") player. More specifically, the Movie-on-Demand service allows a cable subscriber to view a movie over the cable network at any  
15 time and to control the delivery of the movie using fast-forward, stop, pause, or rewind functions. However, one limitation of conventional Movie-on-Demand services is that content providers must pre-package Movie-on-Demand assets in a Movie-on-Demand format and distribute the asset to each cable headend that will make the asset available to cable subscribers. In other words, cable subscribers can only request to view those  
20 assets that have been specifically formatted by the content providers for Movie-on-Demand viewing and distributed to one or more cable headends.

5           In addition, the television industry has recently witnessed the introduction  
of Personal Video Recorder ("PVR") devices, which allow subscribers to record  
television content and to view the recorded content at a later time. In the  
conventional art, a PVR device installed in a subscriber's home can record and  
store television content in digital format on the hard disk of the PVR device. In  
10 this way, a subscriber can control the delivery of recorded television content using  
stop, pause, rewind, and fast forward commands similar to those used on a VCR  
or DVD player.

PVR devices, however, have several limitations. First, a PVR device is  
limited in the amount of digital television content it can store on its hard disk.  
15 Additionally, a cable subscriber must first manually pre-select the television  
content it wants to record (or the PVR device must record the television content  
according to a pre-defined profile for the cable subscriber) before the cable  
subscriber can actually view the recorded television content at a later time. In  
other words, a cable subscriber cannot view at a later time any television content  
20 that has not been previously recorded by the PVR device. Moreover, a PVR  
device is limited to the number of television programs it can record at one time by  
the number of tuners it has available.

Additionally, once a PVR device records television content, content  
providers no longer have any control over the delivery of the content. For  
25 example, when viewing television content recorded on the PVR device, cable  
subscribers can avoid viewing television commercials by fast-forwarding past  
them. Similarly, once the television content is recorded, the content providers and  
the cable headends can no longer supplement old television commercials with  
newer television commercials based upon when the cable subscriber chooses to  
30 view the recorded television content. Finally, the cost of installing and  
maintaining PVR devices in the customers' homes is very expensive compared to  
the current class of digital set top boxes used to provide television services.

Consequently, there is a need in the art for a system and method that  
allows a cable subscriber to select and view television content on-demand at any  
35 time without first requiring the cable subscriber to have recorded the television

5 content on an in-home recording device. Additionally, there is a need in the art  
for a system and method that does not limit the amount of television content that a  
cable subscriber can view on-demand. Similarly, there is a need in the art for a  
system and method that does not limit when a cable subscriber can view television  
content. Finally, there is a need in the art for a system and method that allows a  
10 content provider or cable headend to maintain control over television content that  
is made available for on-demand viewing by cable subscribers.

### **BRIEF DESCRIPTION OF DRAWINGS**

Figure 1 is a functional block diagram illustrating an exemplary  
15 environment in which assets are distributed by multiple asset providers to multiple  
receivers.

Figure 2a is a functional block diagram illustrating an exemplary  
operating environment for a personal video network in accordance with one  
exemplary embodiment of the present invention.

20 Figure 2b is a functional block diagram illustrating an exemplary  
environment in which segments of a media asset are extracted and stored at a  
headend.

Figure 3 is a logic flow diagram illustrating an exemplary process  
for adding personal video assets to a personal video network in accordance with  
25 one exemplary embodiment of the present invention.

Figure 4 is a logic flow diagram illustrating an exemplary sub-  
process of Figure 3 for adding a personal video asset to the personal video  
network.

30 Figure 5 is a logic flow diagram illustrating an exemplary process  
for distributing a personal video asset to a cable subscriber upon receiving a  
request from the cable subscriber to view the personal video asset in accordance  
with one exemplary embodiment of the present invention.

35 Figure 6 is a logic flow diagram illustrating an exemplary sub-  
process of Figure 5 for creating a personalized playlist in accordance with one  
exemplary embodiment of the present invention.

## SUMMARY OF THE INVENTION

The present invention can solve the aforementioned problems by providing a system and method for managing one or more personal video assets. In one aspect of the present invention a personal video service manager can store one or more  
5 personal video assets on a server. A personal video asset can comprise a recording of a broadcast stream of a broadcast asset or an asset that has been pre-authored in a personal video asset format. Upon receiving a request from a subscriber to receive the personal video asset, the personal video service manager can facilitate a connection between the server and the subscriber for distributing the personal video asset from  
10 the server to the subscriber.

The invention in a broad aspect seeks to provide a system for distributing a personal video asset to at least one subscriber via a video network, comprising a server, operative to store the personal video asset, wherein the personal video asset comprises a recording of a broadcast stream of a broadcast asset and metadata that  
15 describes a format of the personal video asset. The metadata comprises a default playlist for the personal video asset, wherein the default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with the personal video asset. The personal video service manager is coupled to the video network, and is operative to store the personal video asset on the server, to  
20 create a personalized playlist from the default playlist that instructs the server how to assemble the personal video asset during playback, and how to facilitate a connection for distributing the personal video asset from the server to the subscriber upon receiving a request from the subscriber to receive the personal video asset.

The invention also provides a system for distributing a selected one of a  
25 plurality of personal video assets to a subscriber via a video network, comprising a plurality of servers, operative to store the personal video assets, wherein each personal video asset comprises a recording of a broadcast stream of a broadcast asset and metadata that describes a format of the personal video asset. The metadata comprises a default playlist for the personal video asset, wherein the default playlist informs a  
30 personal video service manager how at least one other video asset is inserted into or associated with the personal video asset. A personal video service manager is coupled to the video network, and is operative to manage the personal video assets stored on the servers, to create a playlist from the default playlist that instructs the server how

to assemble the personal video asset during playback and, upon receiving a request from the subscriber to receive the selected personal video asset, is operative to identify a selected one of the plurality of servers that stores the selected personal video asset and to facilitate a connection between the subscriber and the selected server for  
5 distributing the selected personal video asset to the subscriber.

In a still further aspect, the invention comprehends a method for managing a personal video asset, comprising the steps of recording an identified broadcast asset from a broadcast stream and formatting the recorded broadcast asset as the personal video asset, the personal video asset further comprising metadata that describes a  
10 format of the personal video asset. The metadata comprises a default playlist for the personal video asset. The default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with the personal video asset, stores the formatted personal video asset on a selected one of a plurality of servers, creates a playlist from the default playlist that instructs the server how to  
15 assemble the personal video asset during playback, and facilitates a connection between a subscriber and the selected server upon receiving a request from the subscriber to view the personal video asset.

Still further, the invention provides a method for managing a plurality of personal video assets, comprising the steps of formatting a recording of a broadcast  
20 stream of a broadcast asset as a selected one of the plurality of personal video assets, each of the personal video assets further comprising metadata that describes a format of each personal video asset, the metadata comprising a default playlist for each personal video asset. The default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with each personal  
25 video asset, receives a request to view the selected personal video asset, identifies a server that stores the selected personal video asset, creates a playlist from the default playlist that instructs the server how to assemble the personal video asset during playback, inserts at least one other asset into the personal video asset in accordance with the personalized playlist, and facilitates a connection between the server and an  
30 entity issuing the request.

Various aspects of the present invention may be more clearly understood and appreciated from a review of the following detailed description of the disclosed embodiments and by reference to the drawings and claims.

**DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS**

Although the illustrative embodiments will be generally described in the context of the cable television industry, those skilled in the art will recognize that other exemplary embodiments of the present invention may be implemented for any application in which  
5 assets are made available upon receiving a request from an entity to view or receive the asset. Moreover, those skilled in the art will also recognize that an asset can comprise any type of media content, including and not limited to MP3 files, digital video files, digital audio or music files, and other digital media and multimedia content.

In one exemplary embodiment of the present invention, one or more asset  
10 providers can distribute one or more media broadcast assets, such as television movies, television series, television episodes, commercials, news programs, sporting events, other broadcast events and programs, or a combination thereof, to one or more exemplary receivers (typically located at cable headends), for further distribution to an audience, such as cable subscribers. An asset provider can comprise any entity that  
15 distributes the asset to one or more receivers. An exemplary receiver at a cable headend can receive assets from one or more asset



5 providers. The cable headend can record a broadcast asset or a portion of a  
broadcast asset as it is aired to cable subscribers using processing and recording  
equipment. Each recorded broadcast asset can then be formatted for viewing as a  
personal video asset and stored on exemplary centralized personal video content  
servers. The cable headend can also receive broadcast assets directly from an  
10 asset provider that have already been formatted by the asset provider for viewing  
as a personal video asset. Stated differently, an asset provider can “pre-author” a  
broadcast asset in a personal video asset format and send the pre-authored asset to  
one or more cable headends. The cable headend can store the personal video  
assets (whether they are pre-authored assets or whether they are recordings of  
15 previously-aired broadcast assets) on one or more centralized personal video  
content servers.

An exemplary personal video service manager can control the delivery and  
distribution of personal video assets from the centralized personal video content  
servers throughout the personal video network. In one exemplary embodiment of  
20 the present invention, the personal video service manager can direct the recording  
and processing equipment to record a broadcast asset or a portion of a broadcast  
asset as it is aired to cable subscribers, and can store the recorded broadcast asset  
as a personal video asset in a centralized personal video content server. The  
personal video service manager can determine which personal video assets stored  
25 in the centralized personal video content servers to distribute to exemplary  
distributed personal video servers. For example, distributed personal video  
servers can be used to store the most frequently viewed or requested personal  
video assets. Each distributed personal video server can service one or more  
service groups of cable subscribers. In this way, a cable subscriber can have  
30 access to the personal video assets stored on the distributed personal video server  
that services its service group and to the personal video assets stored on the  
centralized personal video content servers.

The personal video service manager can also receive a request to view a  
particular personal video asset from a cable subscriber. In response to receiving  
35 the request, the personal video service manager can determine whether the cable

5 subscriber is authorized to view the requested personal video asset. If the cable  
subscriber is authorized to view the personal video asset, the personal video  
service manager can connect the requesting cable subscriber to the cable  
subscriber's distributed personal video server, if the personal video asset is stored  
10 on the distributed personal video server. If the personal video asset is not stored  
on the distributed personal video server, then the personal video service manager  
can connect the requesting cable subscriber to the centralized personal video  
content server on which the personal video asset is stored. In another exemplary  
embodiment of the present invention, upon receiving a request from the cable  
15 subscriber, the personal video service manager can send the personal video asset  
from the centralized personal video content server via an exemplary transmitter to  
a receiver that services the service group to which the requesting cable subscriber  
belongs and can store the personal video asset on the distributed personal video  
server that services the cable subscriber. The personal video service manager can  
20 then connect the requesting cable subscriber to the distributed personal video  
server on which the personal video asset has been stored.

Once the personal video service manager connects the requesting cable  
subscriber to the server on which the personal video asset is stored, the personal  
video service manager can build a personalized playlist that instructs the server  
how to play the personal video asset for the requesting cable subscriber. For  
25 example, the personalized playlist can instruct the server to play the personal  
video asset with other assets, such as with targeted advertisements. In other  
words, the personal video service manager can instruct the server to play certain  
advertisements with the personal video asset based upon a cable subscriber's  
profile, geographic location, age, or based upon any other demographic  
30 information.

Additionally, a personalized playlist can instruct the server how much  
control a cable subscriber has in viewing the personal video asset. For example, a  
cable subscriber may have unlimited control in navigating through the viewing of  
a personal video asset and the advertising associated with the personal video asset.  
35 On the other hand, a cable subscriber may have unlimited control in navigating

5 through the viewing of the personal video asset but have no control in navigating through (or skipping) advertisements associated with the personal video asset.

Referring now to the drawings in which like numerals represent like elements throughout the several figures, exemplary embodiments of the present invention and the illustrative operating environment will be described.

10 Figure 1 is a functional block diagram illustrating an exemplary environment 100 in which assets are distributed by multiple asset providers 10 to multiple receivers 20. Though individual components are illustrated in the exemplary environment of Figure 1, multiple components can be employed without departing from the scope of the present invention.

15 The exemplary environment 100 can comprise one or more asset providers 10 and receivers 20 coupled to a communications medium 30 and operative to communicate with a satellite 25. Asset providers 10 with a finite number of asset delivery resources can distribute assets to the receivers 20 over various types of network technologies. The asset providers 10 can distribute assets to the receivers  
20 20 via the satellite 25 or a alternative communications link 30 using a broadcast, multicast, or unicast communications methodology. Receivers 20 with a finite number of available resources receive assets from one or more asset providers 10 at cable headends. In one exemplary embodiment, a receiver 20 receives assets from multiple asset providers 20 via multiple satellite transponders at varying  
25 times. In another exemplary embodiment, a receiver 20 receives assets from multiple asset providers 20 via multiple satellite transponders concurrently. In other exemplary embodiments, the receiver 20 can comprise multiple receivers 20, or the receiver 20 can receive assets from other receivers 20 via an IP or other communication network 30, or the receiver 20 can comprise multiple receivers 20  
30 and receive assets from other receivers 20 via a communication network 30.

Figure 2a is a functional block diagram illustrating an exemplary operating environment for a personal video network 200 in accordance with one exemplary embodiment of the present invention. Though individual components are illustrated in the exemplary environment of Figure 2a, multiple components can  
35 be employed without departing from the scope of the present invention.

5           The personal video network **200** comprises a receiver **20**, which receives assets from one or more asset providers **10** at a cable headend. The cable headend distributes the assets via a distribution network **250** to cable subscribers **295**. The cable headend also records each media asset as it is aired (or specific media assets as they are aired) to cable subscribers **295** using processing and recording  
10           equipment **210**. In one exemplary embodiment, processing and recording equipment **210** located at a headend comprises a broadcast segment processor **210a**, a real-time encoder **210b**, a personal video exchange server **210c**, and a live pool (not shown). A broadcast segment processor **210a** extracts a portion of a broadcast stream of a broadcast asset. A real time encoder **210b** formats the  
15           broadcast stream into a format that allows the extracted portion of the broadcast asset to be viewed upon request by a cable subscriber **295**. In one exemplary embodiment, the real time encoder **210b** receives analog audio and video broadcast streams and converts the analog audio and video streams into Moving Picture Experts Group (MPEG) video and Dolby audio files. In another  
20           exemplary embodiment, the real time encoder **210b** receives digital broadcast streams and formats the received digital broadcast stream to a compatible digital format for on-demand viewing by cable subscribers **295**. The extracted and formatted portion of the broadcast asset can be stored in a personal video exchange server **210c**.

25           More specifically described, segments of a media asset are tagged with metadata, which describes each segment in a manner that allows a broadcast segment processor **210a** to extract the segments and store the segments for later playback. The asset provider **10** adds the metadata describing a segment of the media asset to the broadcast stream. The authoring of the metadata by the asset  
30           provider **10** may occur either before the media asset is broadcast or after the media asset has been broadcast. The segments that are extracted by the broadcast segment processor **210a** may be used for various purposes, including but not limited to applications that comprise on-demand viewing, advertisement-insertion, local affiliate archiving, and distance learning applications.

5           Figure 2b is a functional block diagram illustrating an exemplary environment 211 in which segments of a media asset are extracted and stored at a headend. Though individual components are illustrated in the exemplary environment of Figure 2b, multiple components can be employed without departing from the scope of the present invention.

10           An asset provider 10 comprises an authoring application 210d. Using the authoring application 210d, the asset provider 10 produces the metadata files that are inserted into a broadcast stream. Metadata comprises either stream metadata or segment package metadata. Stream metadata is used to deliver instructions to the broadcast segment processor 210a located at the headend. The stream  
15 metadata defines the physical attributes of a segment, such as start time code, duration, and encoding parameters. The asset provider 10 determines the segment's start time code and its duration using standard time codes or other industry standard authoring mechanisms.

          The broadcast segment processor 210a uses the stream metadata to  
20 determine which segments of a media asset are to be packaged and archived. In other words, the metadata defines which segments the broadcast segment processor 210a should extract. Stream metadata commands include but are not limited to live spool cache controls, real-time encoder 210b controls, and segment creation controls. In one exemplary embodiment, the stream metadata is  
25 represented in XML format.

          Segment package metadata comprises the identity and lifecycle of a package. This metadata is packaged with the segments of a media asset to create a segment package. The segment identity information provides information about the segment and is used to build a catalog of stored segments. The catalog may  
30 be presented to a subscriber so that he or she can select a segment for viewing on-demand. The segment lifecycle information determines the amount of time that a segment is stored in the personal video exchange server 210c and the times when the segment may be viewed by a cable subscriber 295. In one exemplary embodiment, package metadata is represented in XML format. Additionally, in  
35 one exemplary embodiment, the package metadata is transmitted either in-band

5 with the segment or out-of-band in a separate transport stream and may be sent at any time before the segment is broadcast.

If the starting time-code and duration of the segment is known before the segment is broadcast, the asset provider **10** can pre-author the metadata and schedule the metadata for insertion at the appropriate time. If the pre-authored metadata is sent before the segment is broadcast, the broadcast segment processor **210a** captures the described segment from the broadcast stream and sends it to the personal video exchange server **210c** for storage.

On the other hand, if the pre-authored metadata is sent during or after the segment broadcast has started and the segment is being cached in a live spool **210e** at the headend, the segment is packaged from the live spool **210e** and sent to the personal video exchange server **210c**. In other words, if permitted by the asset provider **10**, the live spool **210e** stores a portion of the broadcast. This spooled data may be real-time encoded or re-encoded to a different format as it is being spooled if necessary. In one exemplary embodiment, if storage space on the live spool **210e** is exhausted, as new content is received by the live spool **210e**, the oldest content is removed from the live spool **210e**. Nonetheless, the asset provider **10** may provide stream metadata that modifies this first-in-first-out algorithm of the live spool **210e**. For example, an asset provider **10** can send an instruction to the live spool **210e** to save a portion of a broadcast stream in the live spool **210e** for a specified period of time. Thus, the saved portion of the broadcast stream will not be deleted by the live spool **210e** when new content arrives.

An exemplary multiplexor and scheduling processor **210f** determines how the segments are managed and extracted at the headend. For example, the multiplexor and scheduling processor **210f** determines when a particular metadata file is inserted into the broadcast stream. Specifically, the multiplexor and scheduling processor **210f** determines when the metadata for a segment is combined into the transport stream, how often metadata is sent, and how the metadata is sent. In one exemplary embodiment, in the case of an analog broadcast, the metadata is inserted into the vertical blanking interval (VBI)

5 portion of the programming using the ATVEF specification. However, other mechanisms for inserting metadata can be used. In another exemplary embodiment, in the case of digital broadcast, the metadata is sent as private data in a Moving Pictures Expert Group (MPEG) transport stream. For example, this metadata may be sent in an elementary stream comprising private data. The elementary stream may be associated with a specific program (i.e. CNN metadata sent in the CNN transport stream); with the entire multiplex (i.e. CNN, CNNfn, CNNsi, CNNhn, etc); or an elementary stream in a separate transport stream (i.e. metadata for multiple transport streams sent in a transport stream that carries an elementary stream for this metadata), in which a single receiver 20 is tuned to different transport streams to extract segments. The metadata can be inserted into the MPEG transport stream using the ATVEF specification. However, other mechanisms for inserting metadata can be used without departing from the scope of the present invention. In another exemplary embodiment, metadata is sent through a transport mechanism that is not a part of the broadcast channel. For example, the multiplexor and scheduling processor 210f sends the metadata to a receiver 20 over a wide area network (WAN) connection such as the Internet.

Additionally, the multiplexor and scheduling processor 210f controls the operation of the live spool 210e at the headend, and it determines which assets and how many assets are available in the live spool 210e. The multiplexing and scheduling processor 210f also maintains a log of all changes made to metadata.

If the channel being scheduled supports a segment cache at the headend, segments may be authored from a broadcast stream. The authoring application 210d spools the broadcast stream into a local live spool 210h along with the time codes associated with the broadcast time codes. The asset provider 10 uses this spooled content to determine the details of segments to be generated. For channels that can cache broadcast streams in a live spool 210e at the headend, the metadata may also be sent after the segment has started. The time period that the metadata may be sent depends on the amount of storage in the live spool 210e at the headend.

5           Those skilled in the art will recognize that the metadata and content may  
be delivered over communications networks other than satellite multicast or  
broadcast networks without departing from the scope of the present  
invention, and that applications other than video services may also be provided or  
enabled without departing from the scope of the present invention. For  
10   example, the metadata may be distributed separately from the broadcast content,  
such as via an IP network or other communications network.

The headend delivers the broadcast stream to a broadcast segment  
processor 210a that extracts metadata and segments of the broadcast stream to  
create segment packages for later playback. Specifically, a broadcast segment  
15   processor 210a at the headend extracts the segments from the stream and stores  
the segments in a personal video exchange server 210c. The stream metadata that  
the broadcast segment processor 210a receives comprises the scheduling  
information for segments that it packages. The stream also comprises segment  
package metadata that has lifecycle and identity information about the segment.

20           When the time for a scheduled segment arrives, the broadcast segment  
processor 210a selects the appropriate transport stream and captures the segment  
for the scheduled amount of time. The content is, if necessary, converted by a  
real-time encoder 210b to the appropriate format for storage. Specifically, the  
converted content and its associated metadata are packaged into a segment  
25   package and delivered to a personal video exchange server 210c for storage. In  
one exemplary embodiment, the segment package is distributed using Pegasus  
Asset Distribution Interface (ADI). In other exemplary embodiments, other  
distribution mechanisms may be used.

The broadcast segment processor 210a also maintains a log of segments  
30   that are received and any errors that are encountered. A log is maintained as  
segments are converted and delivered to one or more personal video exchange  
servers 210c. The segments are stored in a package format that comprises the  
segment of the media asset and the package metadata extracted from the broadcast  
metadata that describes the segment package.



5           If a live spool **210e** is used to cache broadcast content, the broadcast  
segment processor **210a** may be instructed to convert all content received during a  
period of time and pass the converted content to the live spool **210e** along with  
any package metadata. A live spool **210e** allows the asset provider **10** to  
determine if a segment should be packaged and added to the personal video  
10 exchange server **210c** after the content has been broadcast. The live spool **210e**  
stores all content passed to it from the broadcast segment processor **210a** using  
the same time codes that were broadcast with the original content. Additionally,  
the live spool **210e** allows the asset provider **10** to determine the start time,  
duration, and package metadata of the segment after it has been delivered.

15           The personal video exchange server **210c** maintains an archive of the  
segment packages that are received from the broadcast segment processor **210a**  
and the associated lifecycle and identity metadata. These segments are  
maintained according to the lifecycle metadata. This metadata determines when  
the segment may be played and when the segment should be deleted from the  
20 personal video exchange server **210c**.

          Additionally, the personal video exchange server **210c** maintains a log of  
all segment activity, including the addition and deletion of segments, changes to  
configuration, and each time the segment is played. The personal video exchange  
server **210c** may also be connected to a billing/authorization system that  
25 determines who may play a segment and how much to charge for the playing of  
that segment. In another exemplary embodiment, a set-top box **210g** may store  
the lifecycle and identity metadata instead of the personal video exchange server  
**210c**. In yet another exemplary embodiment, a distribution network hub or node  
(such as a digital cable TV network hub or node) may store the lifecycle and  
30 identity metadata instead of the personal video exchange server **210c**.

          Referring back to Figure 2a, once the media asset is recorded by the  
processing and recording equipment **210**, the recorded media asset is then  
formatted for viewing as a personal video asset and stored on centralized personal  
video content servers **220**. For example, the cable headend can format how long  
35 the personal video asset will be available to cable subscribers **295** in the personal

5 video network **200**, which cable subscribers **295** or group of cable subscribers **295** can have access to the personal video asset, and the amount of control a cable subscriber **295** has in viewing the personal video asset or in skipping over commercials associated with the personal video asset.

In another exemplary embodiment of the present invention, the cable  
10 headend receives pre-authored personal video assets **215** directly from an asset provider **10** and stores the personal video assets on the centralized personal video content server **220**. Thus, the asset provider **10** can format how long the personal video asset will be available to cable subscribers **295** in the personal video network **200**, which cable subscribers **295** or group of cable subscribers **295** can  
15 have access to the personal video asset, and the amount of control a cable subscriber **295** has in viewing the personal video asset or in skipping over commercials associated with the personal video asset.

A formatted personal video asset comprises the actual asset and metadata that describes the format of the asset. The asset may be stored as a single file, or it  
20 may be segmented into multiple pieces. The metadata that describes the personal video asset comprises a default playlist for that asset. The default playlist informs the personal video service manager **230** how advertisements, or other assets, can be inserted into (or associated with) the personal video asset. For example, if the asset is stored as a single file, the default playlist comprises an index that indicates  
25 each location in the file where advertisements may be inserted during playback to a cable subscriber **295** who has requested to view the personal video asset. In the case of multiple segments, the metadata may simply comprise a list of the segments. In the segmented model, advertisements can be inserted between the segments. The metadata associated with a single file or a segmented file also  
30 comprises information as to the amount of time available for the insertion of advertisements.

Additionally, the default playlist controls how the cable subscriber **295** navigates through the asset. For example, a cable subscriber **295** can navigate through the personal video asset without any limitation. Thus, the cable  
35 subscriber **295** can fast-forward or rewind through the personal video asset and the

5 advertisements displayed with the personal video asset. On the other hand, if the  
personal video asset is advertisement-supported, the playlist may insert a number  
of advertisements around certain segments of the personal video asset. In this  
case, the default playlist may comprise instructions that prevent the cable  
subscriber **295** from skipping any advertisements but allow the cable subscriber  
10 **295** to navigate through the personal video asset itself without limitation. In other  
cases, the default playlist comprises instructions that prohibit the cable subscriber  
**295** from navigating through the personal video asset or the advertisements  
associated with the personal video asset entirely.

Based upon the default playlist, the personal video service manager **230**  
15 can build a personalized playlist for the requested personal video asset, which  
instructs a video server, such as a centralized personal video content server **220** or  
a distributed personal video server **280**, how to assemble the segments when the  
asset is played out to the requesting cable subscriber **295**. Additionally, the  
personal video service manager **230** determines which assets (such as targeted  
20 advertising), if any, are to be inserted into (or associated with) the personal video  
asset. In one exemplary embodiment of the present invention, the personal video  
service manager **230** makes this determination based upon the personal video  
asset requested and the cable subscriber's subscription service. In another  
exemplary embodiment, the personal video service manager **230** makes this  
25 determination based upon any instructions it has from (or contracts it has with) the  
asset provider **10** that provided the cable headend with the personal video asset.

Additionally, the personal video service manager **230** can specify in the  
personalized playlist how the requesting cable subscriber **295** can navigate  
through the personal video asset and advertisements associated with the personal  
30 video asset. For example, in creating the personalized playlist, the personal video  
service manager **230** can prohibit the requesting cable subscriber **295** from  
skipping through the advertisements associated with the personal video asset, even  
if the default playlist generally permits cable subscribers **295** to navigate through  
advertisements without limitation.

5           The centralized personal video content servers **220** store all of the personal  
video assets available in the personal video network **200**. One or more centralized  
personal video content servers **220** are located at the cable headend. A personal  
video service manager **230** controls the delivery and distribution of personal video  
assets from the centralized personal video content servers **220** throughout the  
10 personal video network **200**. The personal video service manager **230** determines  
which personal video assets stored in the centralized personal video content  
servers **220** to distribute to distributed personal video servers **280**. In one  
exemplary embodiment of the present invention, distributed personal video  
servers **280** are used to store the personal video assets that are most frequently  
15 viewed or most frequently requested by cable subscribers **295**. By using  
distributed personal video servers **280** throughout the personal video network **200**,  
less bandwidth is needed between the cable headend and cable subscribers **295** to  
distribute personal video assets. In other words, by storing the most popular  
personal video assets throughout the personal video network **200** on distributed  
20 personal video servers **280**, the cable headend will need to distribute fewer  
personal video assets from the centralized personal video content servers **220** to  
the cable subscribers **295** in response to receiving requests for personal video  
assets that are stored on the centralized personal video content servers **220**.

Each distributed personal video server **280** services one or more service  
25 groups of cable subscribers **295**. Thus, a cable subscriber **295** has access to the  
personal video assets stored on the distributed personal video server **280** that  
services its service group and to the personal video assets stored on the centralized  
personal video content servers **220**. Additionally, each distributed personal video  
server **280** may store a unique combination of personal video assets. For example,  
30 a personal video service manager **230** may decide which personal video assets to  
distribute from the centralized personal video content servers **220** to each  
distributed personal video server **280** depending upon the demographic of the  
service group associated with the distributed personal video server **280** or based  
upon the personal video assets that are typically requested by the service group  
35 associated with the distributed personal video server **280**.

5           The personal video service manager **230** also receives a request to view a particular personal video asset from a cable subscriber **295**. In response to receiving the request, the personal video service manager **230** determines whether the cable subscriber **295** is authorized to view the requested personal video asset. Whether a cable subscriber **295** is authorized to view a particular personal video  
10   asset may depend upon the cable subscriber's cable subscription. If the cable subscriber **295** is authorized to view the personal video asset, the personal video service manager **230** determines where the personal video asset is stored in the personal video network **200**. If the personal video asset is stored on the distributed personal video server **280** that services the cable subscriber's service  
15   group, then the personal video service manager **230** connects the requesting cable subscriber **295** to the cable subscriber's distributed personal video server **280**. If the personal video asset is not stored on the distributed personal video server **280**, in one exemplary embodiment, the personal video service manager **230** sends the personal video asset from the centralized personal video content server **220** via a  
20   transmitter **240** to a receiver **260** that services the service group to which the requesting cable subscriber **295** belongs. The receiver **260** receives the personal video asset and stores the personal video asset on the distributed personal video server **280**. The personal video service manager **230** then connects the cable subscriber **295** with the distributed personal video server **280**. In another  
25   exemplary embodiment of the present invention, if the personal video asset is stored on a centralized personal video content server **220**, then the personal video service manager **230** connects the requesting cable subscriber **295** to the centralized personal video content server **220**.

30           The exemplary personal video network **200** also comprises service combination points **290a**, **290b**, **290c**, **290d** where personal video assets are combined with other cable services. For example, cable broadcast channels can be combined with personal video assets on the same broadband multiplex. In this way, a variety of cable services may be combined at various points in the personal video network **200**.

5 Certain steps in the processes described below in connection with Figures  
3 through Figure 5 must naturally precede others for the present invention to  
function as described. However, the present invention is not limited to the order  
of the steps described, if such order or sequence does not alter the functionality of  
the present invention. It is recognized that some steps may be performed before  
10 or after other steps without departing from the scope of the present invention.  
invention.

Figure 3 is a logic flow diagram illustrating an exemplary process 300 for  
adding personal video assets to a personal video network 200. Step 310 is the first  
step in the exemplary process 300. In Step 310, the personal video service  
15 manager 230 determines whether a personal video asset is to be added to the  
personal video network 200. In one exemplary embodiment of the present  
invention, if a particular television episode currently aired by the cable headend is  
to be available as a personal video asset, the personal video service manager 230  
instructs the processing and recording equipment 210 to record and format the  
20 aired episode as a personal video asset. Exemplary processing and recording  
equipment 210 comprise a broadcast segment processor 210a, a real-time encoder  
210b, a personal video exchange server 210c, and a live spool 210e. An  
exemplary segment processor 210a extracts a portion of a broadcast stream of a  
broadcast asset. An exemplary real time encoder 210b formats the broadcast  
25 stream into a format that allows the extracted portion of the broadcast asset to be  
viewed upon request by a cable subscriber 295. In one exemplary embodiment,  
the real time encoder 210b receives analog audio and video broadcast streams and  
converts the analog audio and video streams into MPEG video files and Dolby  
audio files. In another exemplary embodiment, the real time encoder 210b  
30 receives digital broadcast streams and formats the received digital broadcast  
stream to a compatible digital format for on-demand viewing by cable subscribers  
295. The extracted and formatted portion of the broadcast asset can be stored in  
an exemplary personal video exchange server 210c.

If a personal video asset is to be added to the personal video network 200,  
35 then in Step 320, the personal video service manager 230 adds the personal video

5 asset to the personal video network **200**. In Step **330**, the personal video service manager **230** determines whether another asset is to be added to the personal video network **200**. If another personal video asset is to be added, then the process branches to Step **320**. If no more assets are to be added to the personal video network **200**, then the process ends.

10 Figure 4 is a logic flow diagram illustrating an exemplary sub-process or routine **320** for adding a personal video asset to the personal video network **200**. Step **410** is the first step in the exemplary sub-process **320**. In Step **410**, the personal video service manager **230** identifies the asset that is to be available to cable subscribers **295** in the personal video network **200**. In Step **420**, the  
15 personal video service manager **230** stores the personal video asset on the centralized personal video content server **220**. In Step **430**, the personal video service manager **230** determines whether the personal video asset is to be sent to one or more distributed personal video servers **280**. In one exemplary embodiment of the present invention, a personal video service manager **230** may  
20 decide which personal video assets to distribute from the centralized personal video content servers **220** to each distributed personal video server **280** depending upon the demographic of the service group associated with the distributed personal video server **280** or based upon the personal video assets that are typically requested by the service group associated with the distributed personal  
25 video server **280**. In another exemplary embodiment, a personal video service manager **230** may distribute a personal video asset from the centralized personal video content server **220** to a distributed personal video server **280** only when a cable subscriber **295** serviced by the distributed personal video server **280** requests to view the personal video asset. In yet another exemplary embodiment,  
30 a personal video service manager **230** may distribute a personal video asset from the centralized personal video content server **220** to a distributed personal video server **280** only when a certain number of cable subscribers **295** serviced by the distributed personal video server **280** request to view the personal video asset.

If the personal video asset is to be sent to one or more distributed personal  
35 video servers **280**, then in Step **440**, the personal video service manager **230**

5 routes the personal video asset to the one or more distributed personal video servers **280**. In one exemplary embodiment of the present invention, the personal video service manager **230** can multicast, broadcast, or unicast the personal video asset to one or more distributed personal video servers **280**. In another exemplary embodiment, the personal video service manager **230** can send the personal video  
10 asset to the distributed personal video servers **280** using File Transfer Protocol (FTP) or other communication protocols. In Step **450**, the personal video service manager **230** makes the personal video asset available for viewing to cable subscribers **295**. In one exemplary embodiment, the personal video service manager **230** makes the personal video asset available to cable subscribers **295** by  
15 updating an interactive program guide to reflect that the personal video asset is available to be selected for viewing.

Figure 5 is a logic flow diagram illustrating an exemplary process **500** for distributing a personal video asset to a cable subscriber **295** upon receiving a request from the cable subscriber **295** to view the personal video asset. Step **510**  
20 is the first step in the exemplary process. In Step **510**, the personal video service manager **230** determines whether it has received a request from a cable subscriber **295** to view a personal video asset. If the personal video service manager **230** has received such a request, then in Step **520**, the personal video service manager **230** determines whether the cable subscriber **295** is authorized to view the requested  
25 personal video asset. For example, whether a cable subscriber **295** is authorized to view a particular personal video asset may depend upon the cable subscriber's cable subscription. If the cable subscriber **295** is not authorized to view the personal video asset, then the process branches to Step **560**. If the cable subscriber **295** is authorized, then in Step **530**, the personal video service manager  
30 **230** determines on which server **220**, **280** the personal video asset is stored. For example, the personal video asset may be stored on the one or more distributed personal video servers **280** that service the service group to which the cable subscriber **295** belongs. Additionally, the personal video asset may be stored on a centralized personal video content server **220**.



5           In Step **540**, the personal video service manager **230** sets up a connection between the cable subscriber **295** and the server **220**, **280** on which the personal video asset is stored. If the personal video asset is stored on the distributed personal video server **280** that services the cable subscriber's service group, then the personal video service manager **230** sets up a connection between the distributed personal video server **280** and the cable subscriber **295**. If the personal video asset is not stored on the distributed personal video server **280**, in one exemplary embodiment, the personal video service manager **230** sends the personal video asset from the centralized personal video content server **220** via a transmitter **240** to a receiver **260** that services the service group to which the requesting cable subscriber **295** belongs. The receiver **260** receives the personal video asset and stores the personal video asset on the distributed personal video server **280**. The receiver **260** multiplexes the personal video asset with other assets for that service group, performs quadrature amplitude modulation on the assets, and then converts the signals to the correct radio channel frequency. This channel is then combined with other radio frequency channels for delivery to the subscribers' **295** homes. The personal video service manager **230** then connects the cable subscriber **295** with the distributed personal video server **280**. In another exemplary embodiment of the present invention, if the personal video asset is stored on a centralized personal video content server **220**, then the personal video service manager **230** connects the requesting cable subscriber **295** to the centralized personal video content server **220**.

          In Step **545**, the personal video service manager **230** determines whether it should create a personalized playlist. If the personal video service manager **230** determines that it should create a personalized playlist, then in Step **550**, the personal video service manager **230** creates a personalized playlist.

          In Step **560**, the personal video service manager **230** determines whether it has received another request to view a personal video asset. If the personal video service manager **230** has received such a request, then the process branches to Step **520**.

5           Figure 6 is a logic flow diagram illustrating an exemplary sub-process or routine **550** of Figure 5 for creating a personalized playlist. Step **610** is the first step in the exemplary sub-process **550**. In Step **610**, the personal video service manager **230** retrieves the default playlist for the personal video asset requested by the cable subscriber **295**. In one exemplary embodiment, the default playlist for  
10 the personal video asset is packaged and stored with the personal video asset on a centralized personal video content server **220** or a distributed personal video server **280**. In another exemplary embodiment, the default playlist is stored as part of the metadata package for the personal video asset on another storage device.

15           In Step **620**, the personal video service manager **230** retrieves the profile of the cable subscriber **295** requesting the personal video asset. In one exemplary embodiment, the profile of each cable subscriber **295** is stored in a storage device local to (and managed by) the personal video service manager **230**. In another exemplary embodiment, the profiles are stored in another storage device in the  
20 personal video network **200**.

          In Step **630**, the personal video service manager **230** determines whether an asset, such as a targeted advertisement, should be viewed by the cable subscriber **295** with the requested personal video asset. For example, a personal video service manager **230** can select certain targeted advertisements to be viewed  
25 by the cable subscriber **295** with the requested personal video asset. If such an asset should be viewed with the personal video asset, in Step **640**, the personal video service manager **230** inserts an asset identifier associated with the asset into the personalized playlist. In one exemplary embodiment, a personal video service manager **230** selects an asset (such as targeted advertising) to be viewed with the  
30 personal video asset based upon certain factors. Such factors can comprise the cable subscriber's personal profile, the personal video asset requested, and the viewing history of the cable subscriber **295**. The personal video service manager **230** also defines in the personalized playlist the amount of control the cable subscriber **295** has in navigating through the personal video asset and the asset  
35 viewed with the personal video asset.

5

In Step 650, the personal video service manager 230 determines whether another asset should be viewed with the personal video asset. If another asset should be viewed, then the process branches to Step 640.

Those skilled in the art will appreciate that the exemplary personal video network 200 allows a cable subscriber 295 to select and view personal video assets on-demand at any time without first requiring the cable subscriber 295 to have recorded the personal video assets. For example, the exemplary personal video network 200 stores personal video assets for on-demand viewing on centralized personal video content servers 220 and distributed personal video servers 280. Additionally, those skilled in the art will appreciate that the exemplary personal video network 200 neither limits the amount of personal video assets that a cable subscriber 295 can view on-demand nor limits when the personal video assets can be viewed or recorded by a cable subscriber 295. Finally, those skilled in the art will appreciate that the exemplary personal video network 200 allows asset providers 10 and cable headends can maintain control over personal video assets by maintaining the personal video assets at centralized personal video content servers 220 and distributed personal video servers 280.

It should be understood that the foregoing relates only to illustrative embodiments of the present invention, and that numerous changes may be made therein without departing from the scope and spirit of the invention as defined by the following claims.

**WHAT IS CLAIMED IS:**

1. A system for distributing a personal video asset to at least one subscriber via a video network, comprising:

a server, operative to store the personal video asset, wherein the personal video asset comprises a recording of a broadcast stream of a broadcast asset and metadata that describes a format of the personal video asset, the metadata comprising a default playlist for the personal video asset, wherein the default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with the personal video asset; and

the personal video service manager, coupled to the video network, operative to store the personal video asset on the server, to create a personalized playlist from the default playlist that instructs the server how to assemble the personal video asset during playback, and to facilitate a connection for distributing the personal video asset from the server to the subscriber upon receiving a request from the subscriber to receive the personal video asset.

2. The system for distributing a personal video asset of claim 1, further comprising:

a transmitter, operative to send the personal video asset to the subscriber via the video network upon receiving the request; and

a receiver, operative to receive the personal video asset from the transmitter via the video network and to distribute the personal video asset to the subscriber.

3. The system for distributing a personal video asset of claim 1, further comprising a broadcast segment processor, operative to record the broadcast stream of the broadcast asset and to format the recording as the personal video asset.

4. The system for distributing a personal video asset of claim 3, wherein the broadcast segment processor is further operative to record the broadcast stream of the broadcast asset in response to receiving a request from the personal video service manager to record the broadcast stream.

5. The system for distributing a personal video asset of claim 1, wherein the server comprises a distributed personal video server, operative to service at least one group of subscribers and to receive the personal video asset via the video network from the personal video service manager.
6. The system for distributing a personal video asset of claim 1, wherein the personal video service manager is further operative to receive an asset from an asset provider, wherein the asset is pre-authored by the asset provider in a personal video asset format.
7. The system for distributing a personal video asset of claim 1, wherein the personalized playlist further identifies how the subscriber can navigate through the personal video asset and the other video asset.
8. The system for distributing a personal video asset of claim 1, wherein the personalized playlist comprises an index that indicates each location in the personal video asset where the at least one other video asset may be inserted during playback.
9. The system for distributing a personal video asset of claim 1, wherein the personal video service manager determines whether to insert the at least one other video asset based on the personal video asset requested and the subscribers subscription service.
10. The system for distributing a personal video asset of claim 1, wherein the personal video service manager determines whether to insert the at least one other video asset based on instructions received from an asset provider.

11. A system for distributing a selected one of a plurality of personal video assets to a subscriber via a video network, comprising:

a plurality of servers, operative to store the personal video assets, wherein each personal video asset comprises a recording of a broadcast stream of a broadcast asset and metadata that describes a format of the personal video asset, the metadata comprising a default playlist for the personal video asset, wherein the default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with the personal video asset; and

a personal video service manager, coupled to the video network, operative to manage the personal video assets stored on the servers, to create a playlist from the default playlist that instructs the server how to assemble the personal video asset during playback, and upon receiving a request from the subscriber to receive the selected personal video asset, operative to identify a selected one of the plurality of servers that stores the selected personal video asset and to facilitate a connection between the subscriber and the selected server for distributing the selected personal video asset to the subscriber.

12. The system of claim 11, further comprising:

a transmitter, operative to send the selected personal video asset via the video network to the subscriber; and

a receiver, operative to receive the selected personal video asset from the transmitter via the video network and to distribute the selected personal video asset to the subscriber.

13. The system of claim 11, further comprising a broadcast segment processor, operative to record the broadcast stream of the broadcast asset and to format the recording as the personal video asset in response to receiving a request from the personal video service manager to record the broadcast stream.

14. A method for managing a personal video asset, comprising the steps of:

recording an identified broadcast asset from a broadcast stream and formatting the recorded broadcast asset as the personal video asset, the personal video asset further comprising metadata that describes a format of the personal video asset, the metadata comprising

a default playlist for the personal video asset, wherein the default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with the personal video asset;

storing the formatted personal video asset on a selected one of a plurality of servers;

creating a playlist from the default playlist that instructs the server how to assemble the personal video asset during playback; and

facilitating a connection between a subscriber and the selected server upon receiving a request from the subscriber to view the personal video asset.

15. The method for managing a personal video asset of claim 14, wherein the facilitating step comprises the steps of:

identifying the selected server that stores the personal video asset; and

distributing the personal video asset from the selected server to the subscriber via a video network.

16. The method for managing a personal video asset of claim 15, wherein the distributing step comprises the steps of:

retrieving the personal video asset from the selected server; and

sending the personal video asset from a transmitter via the video network.

17. The method for managing a personal video asset of claim 15, further comprising the steps of determining whether to distribute the personal video asset to at least one distributed personal video server; and

sending the personal video asset to the at least one distributed personal video server via the video network, if the personal video asset is to be distributed to the distributed personal video server.

18. A method for managing a plurality of personal video assets, comprising the steps of:

formatting a recording of a broadcast stream of a broadcast asset as a selected one of the plurality of personal video assets, each of the personal video assets further comprising metadata that describes a format of each personal video asset, the metadata comprising a default playlist for each personal video asset, wherein the default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with each personal video asset;

receiving a request to view the selected personal video asset;

identifying a server that stores the selected personal video asset;

creating a playlist from the default playlist that instructs the server how to assemble the personal video asset during playback;

inserting at least one other asset into the personal video asset in accordance with the personalized playlist; and

facilitating a connection between the server and an entity issuing the request.

19. The method of claim 18, comprising the step of storing each personal video asset on at least one of a plurality of servers.

20. The method of claim 18, comprising the steps of:

distributing the personal video asset to at least one of a plurality of distributed personal video servers; and

storing the personal video asset on the at least one distributed personal video server.

21. The method of claim 20, wherein the server comprises the distributed personal video server.

22. The method of claim 18, wherein the server comprises a centralized personal video content server.



23. The method of claim 18, comprising the step of recording the broadcast stream of the broadcast asset in response to receiving a request to record the broadcast stream.

24. The method of claim 18, wherein at least one of the plurality of personal video assets comprises a pre-authored personal video asset received from an asset provider.

25. A system for distributing a personal video asset to at least one subscriber via a video network, comprising:

a server, operative to store the personal video asset, wherein the personal video asset comprises a recording of a broadcast stream of a broadcast asset and metadata that describes a format of the personal video asset, the metadata comprising a default playlist for the personal video asset, wherein the default playlist informs a personal video service manager how at least one other video asset is inserted into or associated with the personal video asset;

a broadcast segment processor, operative to record the broadcast stream of the broadcast asset and to format the recording as the personal video asset; and

a personal video service manager, coupled to the video network, operative to store the personal video asset on the server, to create a personalized playlist from the default playlist that instructs the server how to assemble the personal video asset during playback and inserts at least one other asset into the personal video asset in accordance with the personalized playlist, and to facilitate a connection for distributing the personal video asset from the server to the subscriber upon receiving a request from the subscriber to receive the personal video asset.

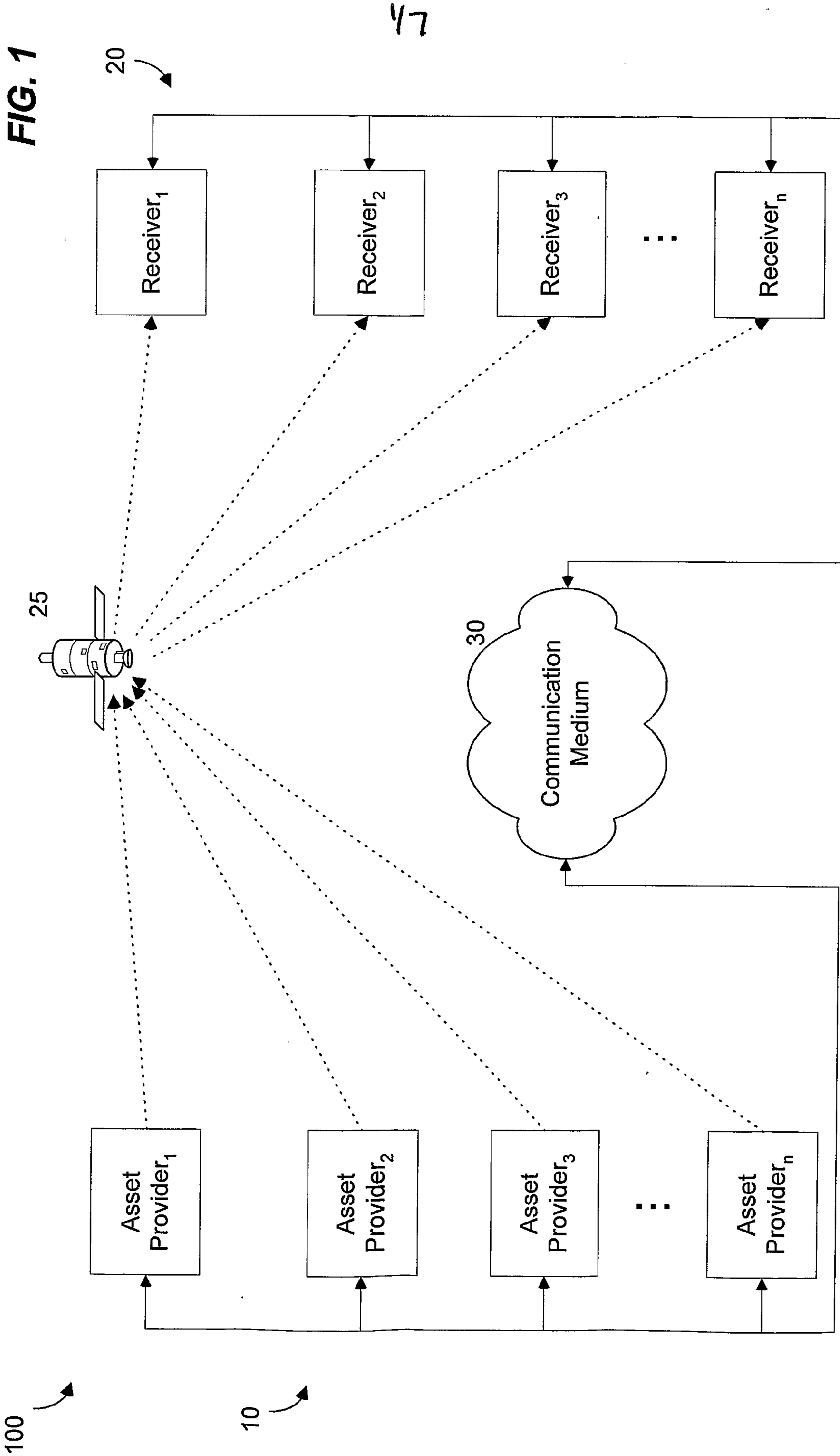
26. The system for distributing a personal video asset of claim 25, wherein the broadcast segment processor is further operative to record the broadcast stream of the broadcast asset in response to receiving a request from the personal video service manager to record the broadcast stream.

27. The system for distributing a personal video asset of claim 25, wherein the server comprises a distributed personal video server, operative to service at least one group of subscribers and to receive the personal video asset via the video network from the personal video service manager.

28. The system for distributing a personal video asset of claim 25, wherein the personal video service manager is further operative to receive a pre-authored personal video asset from an asset provider.

29. The system for distributing a personal video asset of claim 25, wherein the personalized playlist comprises an index that indicates each location in the personal video asset where the at least one other video asset may be inserted during playback.

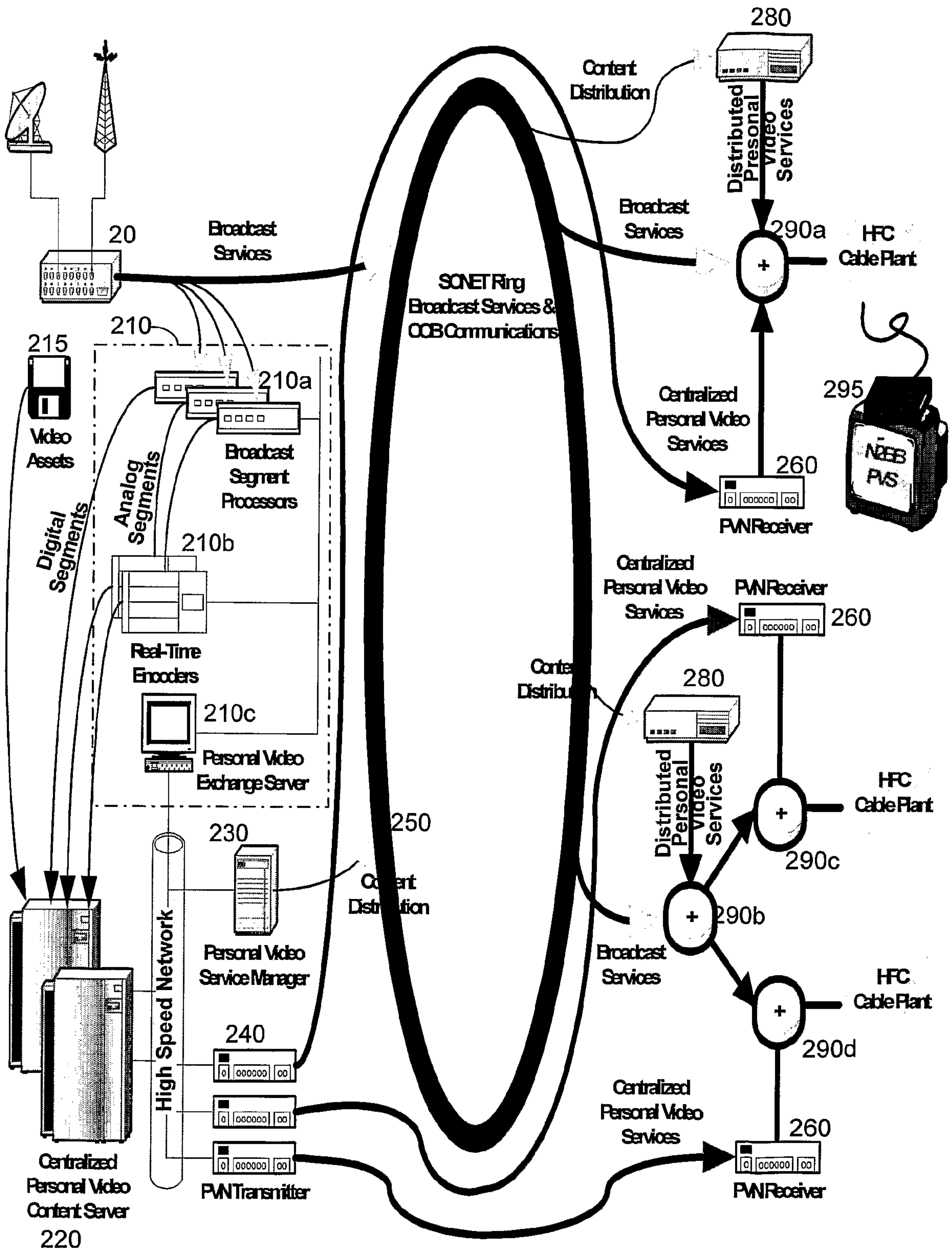
30. The system for distributing a personal video asset of claim 25, wherein the personal video service manager determines whether to insert the at least one other video asset based on the personal video asset requested and the subscriber's subscription service.



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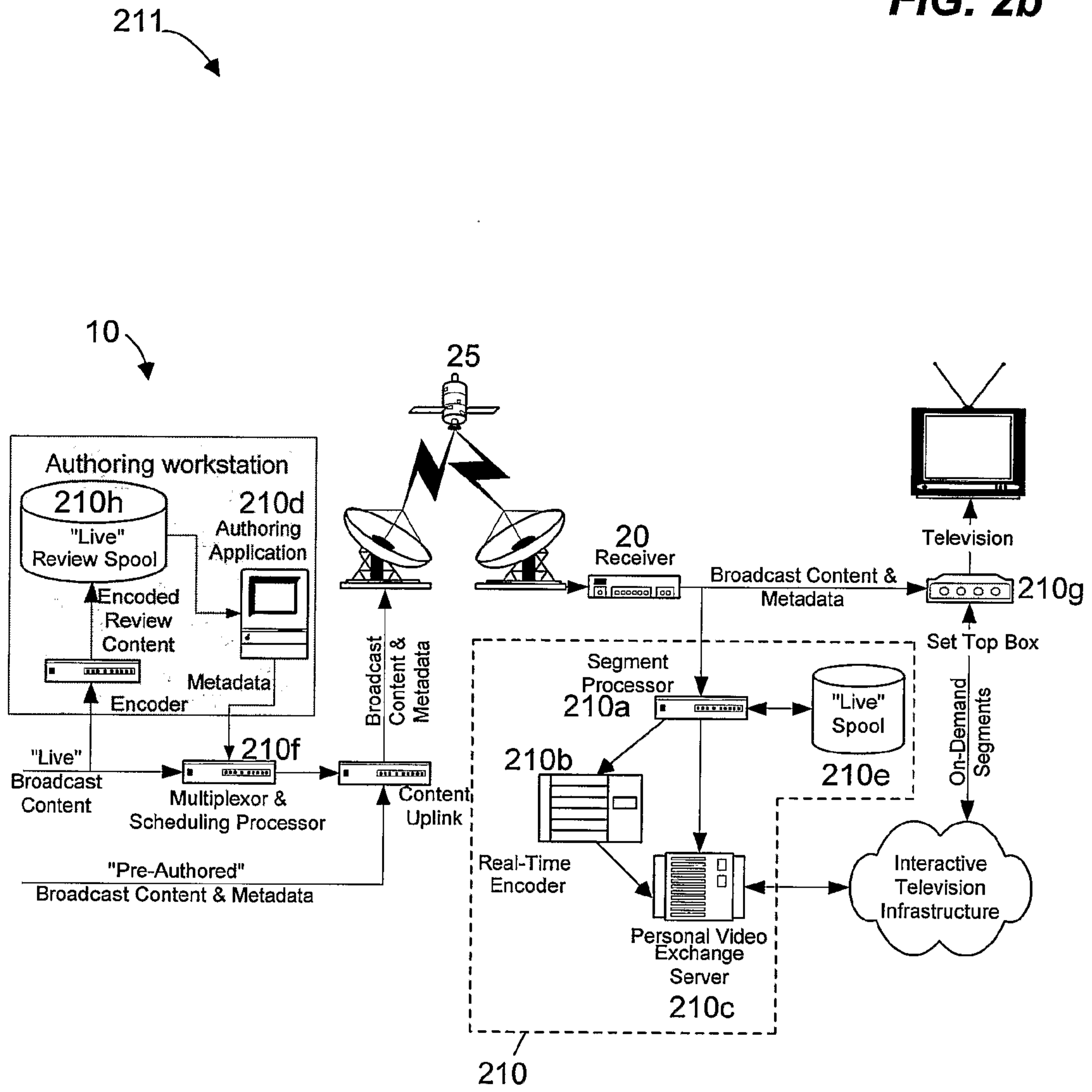
200

FIG. 2a



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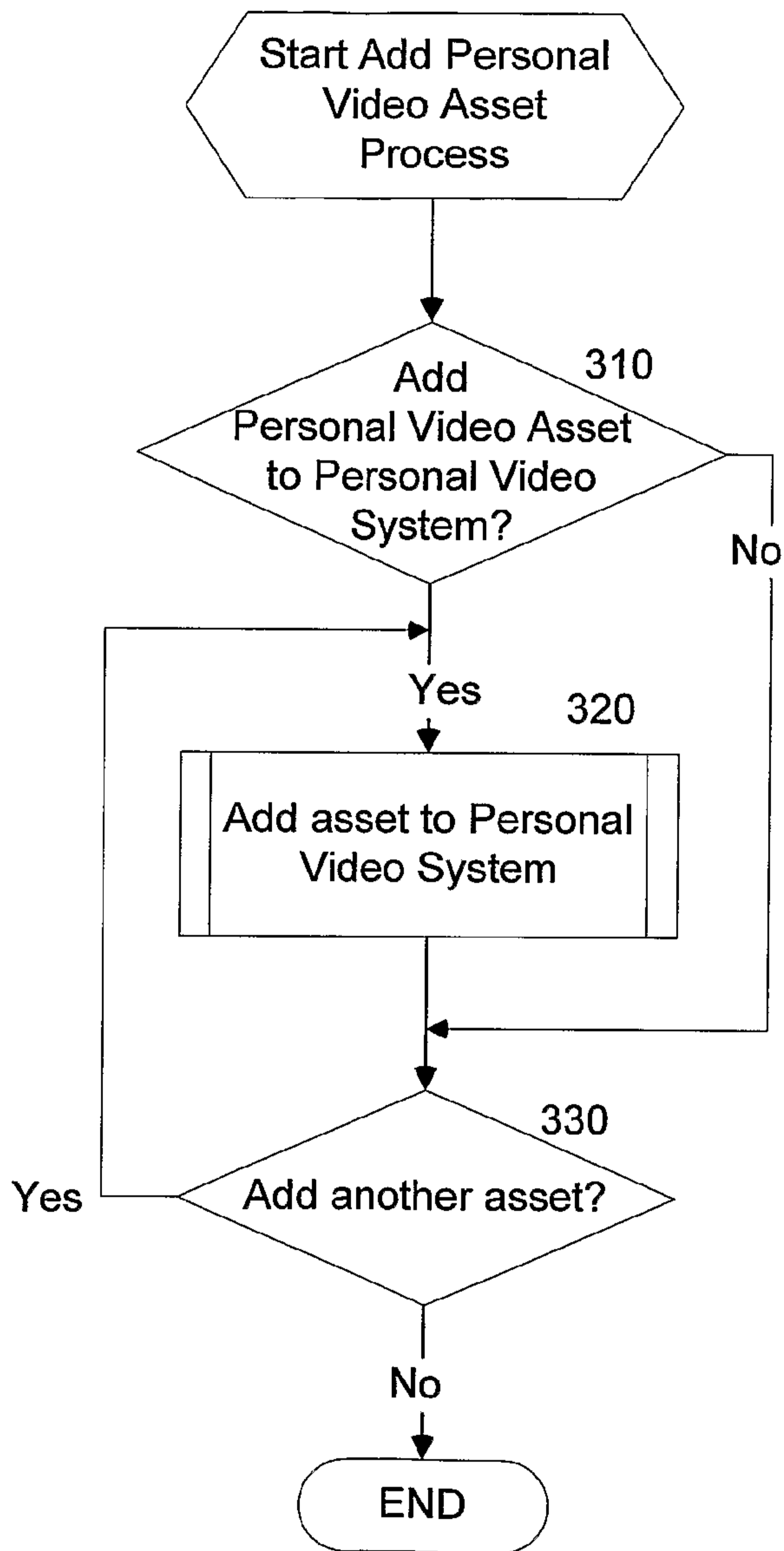
FIG. 2b



300  
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417

**FIG. 3**



517

FIG. 4

320  
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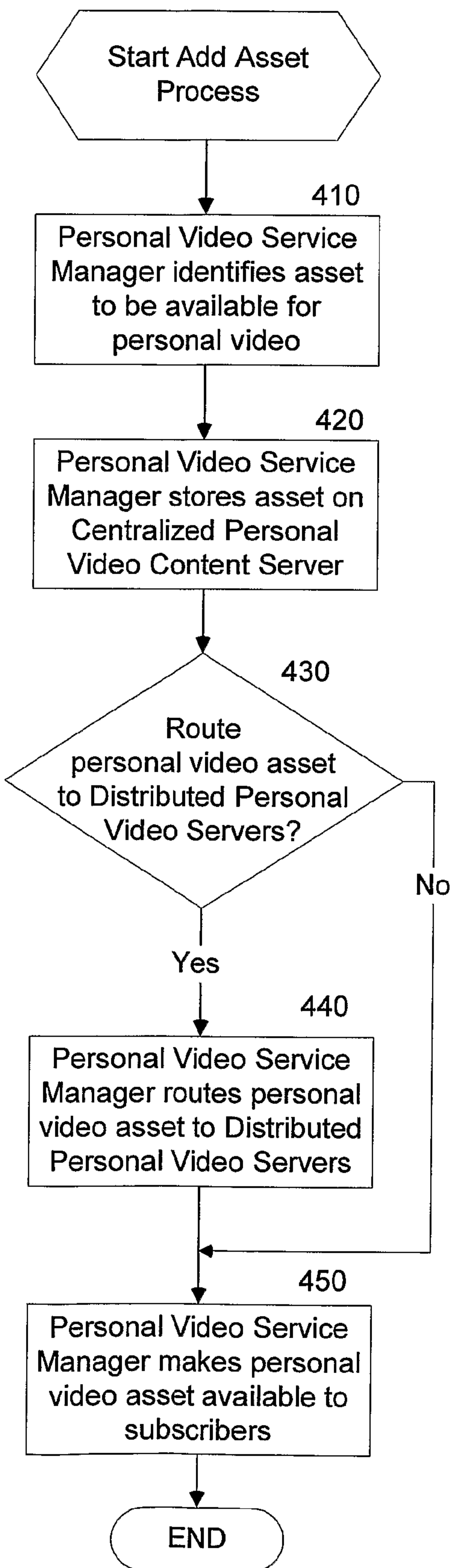
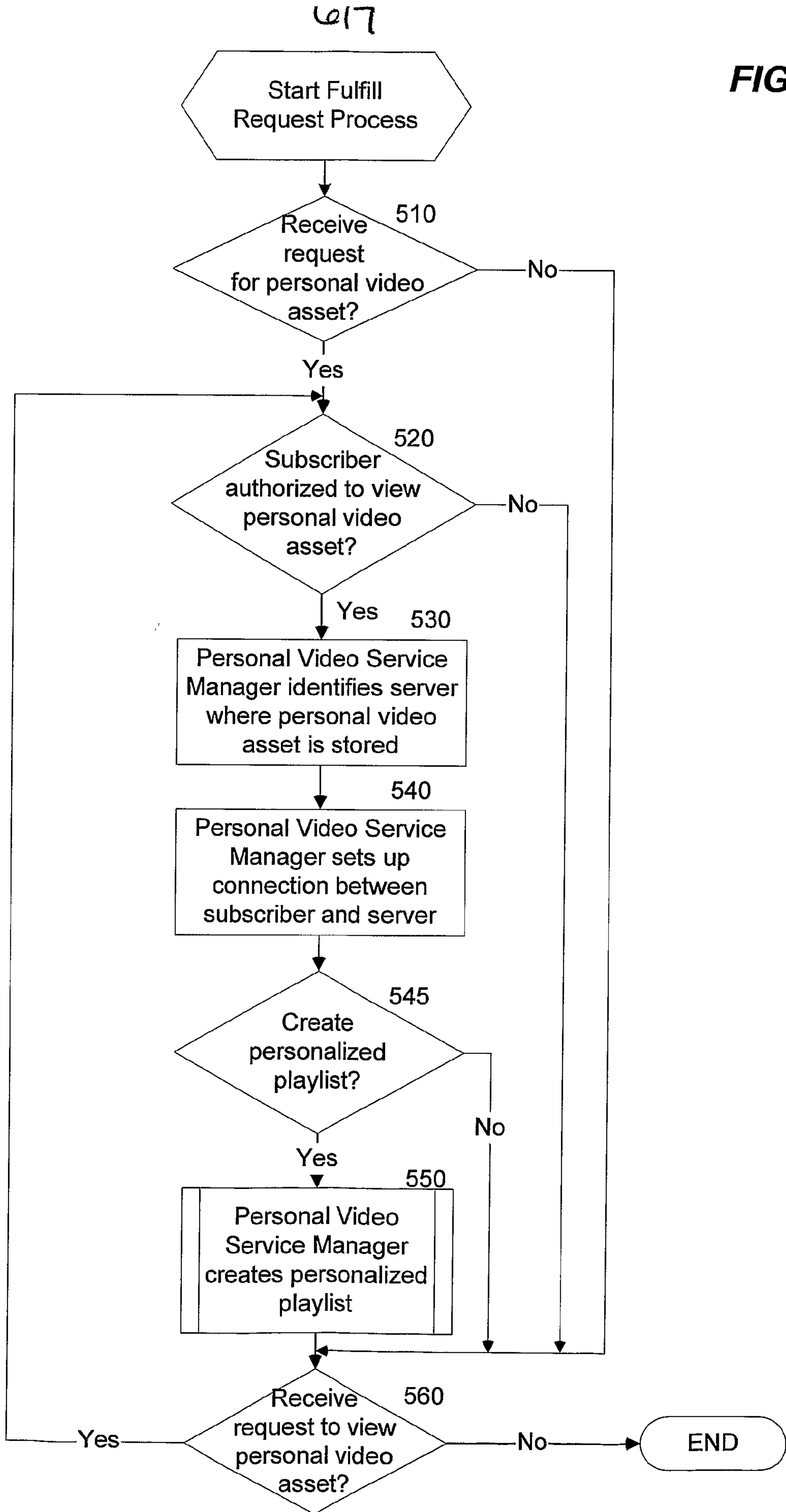


FIG. 5

500  
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550  
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**FIG. 6**

