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(54) Title: METHOD AND SYSTEM FOR SYNCHRONIZING THE OUTPUT OF TERMINALS
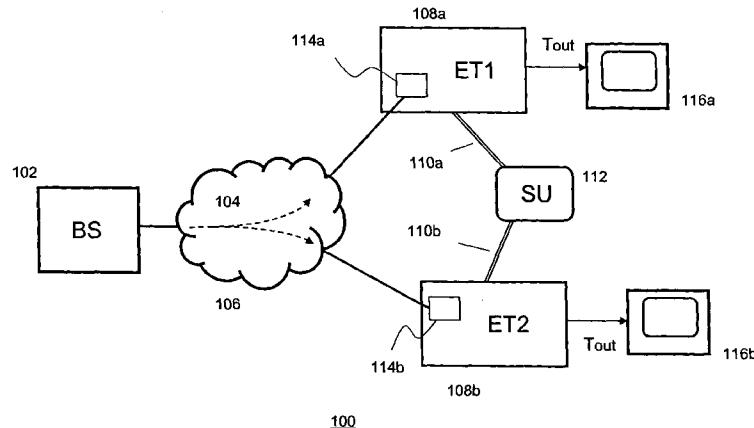
Figure 1

(57) Abstract: A Method is described for synchronizing the output of terminals. The method according to the invention may be
used in a system comprising a station, which transmits a packetized stream to at least a first and second terminal. Each terminal
comprises a variable delay unit and each terminal is connected through a low-delay communication channel to at least one synchro-
nization unit for calculating delay information. Further, each terminal is capable of determining media reference information of a
received media unit from the stream. The method comprising the steps of providing one or more low delay communication channels
between the terminals and a synchronization unit; the synchronization unit calculating delay information on the basis of synchro-
nization information received from the terminals via the one or more low delay communication channels; and transmitting the delay
information to at least one of the terminals allowing the at least one terminal to delay its output such that the output of the terminals
are substantially synchronized.

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Method and system for synchronizing the output of terminals

Field of the invention

        The invention relates to a method and a system for
synchronizing the output of terminals. The invention further
5   relates to a synchronization unit and a terminal for use in
such system.

Background of the invention

10   New multi-media techniques such as Voice over IP
(VoIP) and Internet Protocol Television (IPTV) open a whole
range of new multi-media services. One type of these services
enables a group of users to separately watch the same TV
channel, while communicating with each other via text, audio
15   and/or video using a separate real-time communication channel
(e.g. VoIP) for the direct communication. Such services
require that the output signal of the terminals is transmitted
at the same time to all users in the group so that each user
will experience a specific TV moment (e.g. a goal in a live
20   football match) at the same time. In other words, the outputs
of the display devices in the group, e.g. televisions, PDAs,
PCs or a combination thereof, should be synchronized.
        In an IPTV system the TV channel signal is typically
transmitted as one or more packetized streams over a high-
25   bandwidth IP network of an operator via edge routers and
access nodes to the terminals of the subscribers to such
services. During transmission of the streams, the packets are
subjected to unknown delays in the network such as
transmission delays, differences in network routes and
30   differences in coding and decoding delays. As a consequence
the temporal relationship between packets of audio and video
streams received at one terminal and those received at another
terminal will be disturbed.

To stream the IPTV content to the terminals usually
the Real-time Transport Protocol (RTP) is used. RTP provides
sequence numbering and time stamping. Using RTP the temporal
relation in one stream (intra-stream synchronization) and
5   between associated streams (inter-stream synchronization) can
be restored.

In order to achieve group-synchronization or inter-
destination synchronization (as required by the services as
referred to above) further measures are necessary. Several
10 techniques are known and all employ time-stamping and
variable-delay buffers in the terminals. A variable-delay
buffer is capable of delaying a stream for a certain amount of
time.

In the article "An Application-Level QoS Comparison
15 of Inter-Destination Synchronization Schemes for Continuous
Media Multicasting" by Nunome et al.(IEICE trans. Commun. vol.
87, 2004, pp. 3057-3067) two types of inter-destination
synchronization schemes are described. A first type uses a
central synchronization master, which collects timing
20 information from all terminals in the group and adjusts the
output timing by distributing control packets to the
terminals. A second type regards a distributed control scheme,
wherein each terminal multicasts all timing information to all
other terminals in the group. Implementation of such schemes
25 in a typical IPTV system introduces however certain problems.
One problem related to the schemes is the requirement of an
absolute or central clock, that synchronizes all local clocks
prior to the inter-destination synchronization of the streams.
Such local clock synchronization may be difficult to achieve
30 in practice. A further problem related to the prior art is the
limited scalability. Synchronization control packets are
distributed using dedicated multicast channels, which are a
limited resource, and a central synchronization master may
only be capable of handling a certain number of terminals.

One way of achieving group-synchronization in an IPTV
system is the synchronization of the network nodes in the
network of the operator so that all viewers connected with a
terminal, e.g. a set-top box, to these synchronized network
5   nodes are capable of viewing the broadcasted program at the
same time. That way, the terminals will always be in sync,
irrespective whether a particular service requires group-
synchronization. This solution, which is described in more
detail in a related European patent application no.
10   07020737.8, requires adaptation of the network nodes in the
network.

It is desirable to provide group-synchronization for
particular services without modification of the existing
network infrastructure of the provider.

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Summary of the invention

It is an object of the invention to reduce or
eliminate at least one of the drawbacks known in the prior art
20   and to provide to provide in a first aspect of the invention a
method of for synchronizing the output of at least two
terminals, wherein the method comprises the steps of:
providing one or more low delay communication channels between
the terminals and a synchronization unit; the synchronization
25   unit calculating delay information on the basis of
synchronization information received from the terminals via
the one or more low delay communication channels; and,
transmitting the delay information to at least one of the
terminals allowing the at least one terminal to delay its
30   output such that the output of the terminals are substantially
synchronized.

The invention is based on the insight that a certain
group of services, which enable a group of users to
communicate with each other via text, audio and/or video,

while watching the same TV channel, may often use a separate, high quality, low-delay communication channel for communication. The low-delay communication channel thus provides a very efficient and relatively fast connection for exchanging synchronization information between the terminals of the group of users and the one or more synchronization units. By using the method according to the invention, such low delay connection eliminates the use of an absolute clock for the synchronization of the local clocks of the terminals, prior to the inter-destination synchronization of the media stream. Moreover, the method provides a simple and low cost solution for providing group-synchronization in certain IPTV services, which does not require adaptation of the infrastructure of the network of the provider. The method only synchronizes those terminals, which really require group-synchronization.

In one embodiment the steps as defined by the method according to the invention are performed by the synchronization unit.

In a further embodiment each terminal comprises an input for receiving a multi-media signal and an output for transmitting the multi-media signal to an information presentation unit and each terminal comprises a variable delay unit for delaying the output signal wherein the method further comprising the steps of: transmitting a multi-media stream to the input of the terminals, preferably the multi-media stream comprising media units; delaying the output signal according to the received delay information.

Using terminals with variable delay units (buffers), each terminal can delay the output locally. This has the advantage that not the whole network of an operator needs to be equipped with variable delay buffers in the paths of all streams.

In yet a further embodiment the method further comprises the step of: each terminal sending synchronization information, preferably in response to a synchronization request, via a low delay communication channel to the

5   synchronization unit, the synchronization information comprising media unit reference (MUR) information representing the position of a media unit in a multi-media stream.

In further embodiments the MUR information comprises a frame number or a sequence number.

10   Because of the use of the low-delay channel, the time of receipt of the synchronization information by the synchronization unit, is substantially the same as the time the synchronization information was determined and sent by the terminal. Therefore the local clocks no longer need to provide

15   time (stamp) information of media units received with the synchronization information, and the local clocks of the terminals need no longer be synchronized, as was the case with prior art techniques. Only information about the relative position of a media unit in a stream (represented by MUR

20   information) is now required from the terminals.

In yet a further embodiment, the method further comprises the steps of: adding one or more time stamps to the MUR information received from the terminal; providing information on the frame rate of the multi-media stream

25   received by the terminals; calculating delay information for each terminal on the basis of the frame rate information and the time-stamped MUR information; sending delay information to at least one of the terminals.

By adding time stamps to the MUR information, and

30   being provided with the frame rate(s) of the stream(s), the synchronization unit may calculate the delay information (applicable delay) for each terminal involved in the synchronization. Since these delays are relative to the slowest stream (terminal), when only two terminals are

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involved in the synchronization, only one terminal need to be provide with delay information, taking the other terminal as a reference.

In one embodiment the method further comprises the
5   steps of: the synchronization unit sending a synchronization request, preferably simultaneously, via one or more low delay communication channels to the terminals; providing information on the frame rate of the multi-media stream received by the terminals; calculating delay information for each terminal on
10   the basis of the frame rate information and the MUR information; sending delay information to at least one of the terminals.

The synchronization process may be terminal initiated or synchronization unit initiated. In the latter case, the
15   synchronization unit will send a synchronization request to the terminals involved. If the request is sent simultaneously to all terminals involved via a low delay channel and the results (MUR information) are immediately sent back from the terminals to the synchronization unit via the low delay
20   channels, all results will substantially arrive at the same time. Consequently, depending on the level of synchronization required, the step of adding time stamps, may be left away and is no longer needed in the calculations of delay information. This has the advantage that the use of a clock and means for
25   time-stamping may no longer be needed by the synchronization unit, making the process and used equipment simpler and more efficient.

In a further embodiment, the low delay communication channel, used to transmit synchronization information to the
30   synchronization unit, is being established as part of a communication session or a broadcast session, more preferably a broadcast session as defined in ETSI TS 182 027.

This has the advantage that more efficient use of existing network resources is made in executing the method according to the invention.

In further embodiments the low delay communication channel is a Voice over IP (VoIP) channel, an USSD based channel over a GSM, UMTS or LTE network, an QoS-controlled channel in an IMS session, a dedicated channel in a communication session or a broadcast session, a dedicated Ethernet VLAN channel, a dedicated MPLS channel or a dedicated channel used by an IP Diffserv stream.

In one embodiment the synchronization information is carried by a stream within a SIP session associated with the low-delay communication channel. In another embodiment the synchronization information is carried by the RTP protocol associated with the low-delay communication channel or carried by the RTCP protocol associated with the RTP streams for audio, video and/or text or carried by the codec(s) for audio, video and/or text.

The method allows the synchronization information to be carried by the protocol which is used for setting up and maintaining the low-delay communication channel (or session) between the terminals in a group to which the terminals are connected to. In other words, one or more protocols for providing group synchronization is piggybacked over the protocols used for setting up and maintaining the low-delay communication channel.

The synchronization unit may be located in a server, preferably a SIP based application server, or, alternatively, in another embodiment the synchronization unit may be located in the first terminal and/or the second terminal.

In another embodiment the first terminal and the second terminal comprise a first and second synchronization unit respectively, wherein each terminal comprises means for communicating media unit reference information to the other

terminal, wherein the method further comprises the steps of:
(i) the first synchronization unit receiving via the low-
delay communication channel the second media unit reference
information transmitted by the second synchronization unit(ii)

5   the second synchronization unit receiving via the low-delay
communication channel the first media unit reference
information transmitted by the first synchronization unit; and
(iii) the first and second synchronization unit calculating a
first and second delay respectively on the basis of the first

10   and second media unit reference information enabling the
variable delay unit in the first and second terminal to delay
transmission such that the output of the group of terminals is
substantially synchronized.

    This way each terminal comprises a synchronization

15   unit thus enabling each terminal to determine the delay
information by itself.

    In a another aspect the invention relates to a system
for synchronizing the output of at least two terminals, the
system comprising a synchronization unit connected via one or

20   more low delay communication channels to at least two
terminals, wherein the synchronization unit is configured to
calculate delay information on the basis of synchronization
information received via one or more low delay communication
channels from the terminals and to transmit the delay

25   information to at least one of the terminals allowing each
terminal to delay its output such that the output of the
terminals are substantially synchronized.

    In one embodiment of the system, each terminal
comprises an input for a receiving multi-media signal and an

30   output for transmitting the multi-media signal to an
information presentation unit and a variable delay unit for
delaying the output signal according to the delay information,
the system further comprising a station transmitting a multi-

media stream to the terminals, the multi-media stream
comprising media units.

In a further aspect the invention relates to a
synchronization unit for use in a system as described above.
5   The unit comprises: a receiver for receiving via one or more
low delay communication channels synchronization information
from the terminals; a processor configured to calculate delay
information on the basis of the received synchronization
information; and, a transmitter for transmitting the delay
10 information to at least one of the terminals.

In one embodiment, the synchronization unit is
located in a server, preferably a SIP server, the first
terminal and/or the second terminal, or in a conference
bridge.
15   In yet another aspect the invention relates to an
terminal for use in a system as described above, wherein the
terminal comprises: a receiver configured to receive a
synchronization request from the synchronization unit and
configured to receive a multi-media stream; a transmitter
20 configured to transmit via one or more low delay communication
channels to the synchronization unit and configured to
transmit the multi-media signal to an information presentation
unit; and, a variable delay unit for delaying transmission of
the multi-media signal to the information presentation unit.
25   In an advantageous embodiment the terminal according
to the invention further comprises a synchronization unit
configured to calculate delay information on the basis of
synchronization information. This eliminates the need for a
centrally managed synchronization unit and may be used in
30 network environments where the synchronization service is not
provided by the operator.

In exemplary embodiments, the terminal is a set-top
box, a home computer, a mobile device, or a gaming console

The invention further relates to a computer program product comprising software code portions configured for, when run in the memory of one or more computing devices, preferably one or more network servers or terminals, executing the method steps of the invention as described above.

The invention will be further illustrated with reference to the attached drawing, which schematically show embodiments according to the invention. It will be understood that the invention is not in any way restricted to these specific embodiments.

Brief description of the drawings

Fig. 1 depicts an exemplary embodiment of a centrally synchronized system.

Fig. 2 depicts the flow of information in a system according to the invention comprising three terminals and a central synchronization unit.

Fig. 3 depicts an exemplary embodiment of a distributed system.

Fig. 4 depicts an exemplary embodiment of a synchronization session.

Fig. 5 depicts an exemplary architecture of a system configured for implementing the invention.

Fig. 6 depicts the flow of information in an exemplary architecture of a system configured for implementing the invention.

Detailed description

Fig. 1 illustrates a system **100** according to a first embodiment of the invention. The system comprises a broadcast station (BS) **102**, preferably an IPTV system having e.g. an IMS-type architecture, transmitting multimedia content via a

network **106**, e.g. a high bandwidth IP network, of an operator
to a number of access nodes. Examples of access nodes include
an Digital Subscriber Line Access Multiplexer (DSLAM), an
Cable Modem Termination System (CMTS), an optical access node

5   or an edge router.

The multimedia content may be transmitted via one or
more multimedia streams **104** to the access nodes. Typically,
the multimedia streams are divided into multi media units,
i.e. basic units of data used by the transport protocol, to

10   transport the content over one or more packet-switched
networks to the nodes. In one embodiment the multi-media
stream may be a packetized (MPEG) transport stream.

The audio, video and/or text content in the stream
may be compressed using e.g. MPEG-2, MPEG-4 or another

15   suitable multi-media data compression technique. Further, a
transport protocol such as the Real-time Transport Protocol
(RTP) and the Real-time Transport Control Protocol (RTCP) may
be used to stream the IPTV content over the network. RTCP
provides out-of-band control information for an RTP flow. The

20   services provided by RTP include sequence numbering, time
stamping and delivery monitoring allowing synchronization of
the packets in one stream and between associated streams so
that consecutive frames in a stream are played at the correct
time and in the correct time intervals.

25   Each access node is connected to a set of terminals
108a,108b each being connected to one or more information
presentation units **116a,116b**. In one embodiment, the terminal
may be a conditional access unit, e.g. a set-top box or the
like, connected to an information presentation unit. In

30   another embodiment the terminal may be a hardware unit or a
combined hardware/software unit located in the information
presentation unit. The sets of terminals form a group of
terminals to which one or more IPTV services may be delivered.
The information presentation unit may be a television, a

personal computer, a personal digital assistant (PDA) or any other device capable of presenting multi media content to a user. The terminal may use the Internet Group Management Protocol (IGMP) to request the access node to transmit a TV

5   channel in the multi-media stream to the terminal.

In a first step of the method according to the invention, a communication session between the terminals of the users is established. This communication session , which comprises one or more low-delay communication channels

10   **110a,110b** is set up by a particular service which offers real-time communication between the users of the service, while - at the same time - all users may be watching the same TV program in a substantially synchronized way.

Because of the Quality of Service (QoS) requirements,

15   such communication session uses one or more low-delay communication channels for exchanging voice, video, and/or text data. An intrinsic low-delay communication channel may be achieved by an operator-controlled network in which specific traffic flows are prioritized instead of providing only best-

20   effort QoS. For example, in such networks a voice over IP channel may have a maximum acceptable (one-way) latency without QoS degradation of around 150 ms. Other examples of low-delay communication channels are QoS-controlled IMS sessions, and may be established using a dedicated Ethernet

25   virtual LAN (VLAN), a dedicated Multi Protocol Label Switching (MPLS) path or a dedicated IP Diffserv stream. Alternatively a low-delay communication channel may use transport infrastructure completely independent of the channel of the packetized stream. For example a mobile TV scenario where the

30   stream is received via DVB-H and the low-delay communication channel is provided by Unstructured Supplementary Service Data (USSD) or another low-delay channel over a GSM/UMTS network. Such low-delay communication channels typically use different routes, buffers and QoS settings then the communication paths

used for TV signals, e.g. multicast streams, which are
optimized for efficient use of the network and picture
quality. Typically, the Session Initiation Protocol (SIP) is
used for setting up the session. Further, RTP and RTCP are
5 used for the transport of the media streams and the associated
out-of-band control information.

The one or more low-delay communication channels
between the terminals in the session may also be used for
exchanging synchronization information between the terminals.
10 This may be achieved by piggybacking the synchronization
protocol over one or more protocols used in low-delay
communication channels. For instance, the synchronization
information may be carried by the RTP stream in a SIP session.

Alternatively the synchronization protocol may use
15 its own dedicated low-delay communication channel as part of
the SIP session, or may use in-session SIP signaling, such as
the SIP INFO message, if SIP signaling is sent over a low-
delay communication channel.

In one embodiment the low-delay communication channel
20 **110a,110b** may be set-up as part of a first broadcast session
(e.g. a broadcast session as described in ETSI TISPAN TS 182
027, clause 8.3.1) between a first terminal 4a and an (IPTV)
server containing a synchronization unit, and a second
broadcast session between a second terminal and the (IPTV)
25 server. Hence, the synchronization information is carried by a
low-delay communication channel which is part of a broadcast
session. Although the low-delay communication channel is part
of the same (broadcast) session as the broadcasted IPTV stream
it may have different QoS characteristics to enforce the
30 required low-delay properties.

Alternatively, synchronization information packets
may be transported in one or more RTP streams associated with
the communication session. In this embodiment SIP establishes
separate RTP-streams for audio, video and/or text and the

synchronization information packets. Further, the synchronization information may be piggybacked over a RTCP stream associated with one or more RTP streams or, alternatively, over one or more codecs for (de)coding and/or

5   (de)compressing the audio, video and/or text streams.

All these embodiments may make use of the existing infrastructure for a particular service offering real-time communication between the users of the service and - at the same time - synchronization of the TV programs viewed by the

10   users of the service.

The use of one or more low-delay communication channels of the communication session as a low-delay communication channel for exchanging synchronization information allows for several alternative synchronization

15   schemes.

Referring to **Fig. 1**, synchronization of the output of the terminals to the group of users is realized by a synchronization unit **112** connected via the one or more low-delay communication channels to the terminals. The

20   synchronization unit may be located as a functional unit in a server, e.g. an application server or a dedicated synchronization server, in the network **106**. It allows the terminals to compensate for the network delays in the network **106** (e.g. the processing-, queuing-, transmission- and

25   propagation delays in the network and the delay caused by network congestion, which occurs when a link or node is carrying too much data). To that end, each terminal comprises a variable-delay unit, such as a variable delay buffer **114a,114b** capable of delaying the transmission of the stream

30   to be transmitted to the presentation units.

In one embodiment, the variable delay unit and the synchronization unit may be implemented in a client-server type model wherein the variable delay unit acts as a synchronization client and the synchronization unit acts as a

synchronization server. The synchronisation client (variable delay unit) may have a protocol socket enabling synchronization status information to be sent using a suitable protocol to the synchronization server (synchronization unit),

5   and synchronization settings instructions to be received from the synchronization server. Synchronization status information may include media unit reference information on stream reception (i.e. what media unit was received) and the current delay settings.

10   The media unit reference information provides an indicator to a specific point in the packetized stream. This indicator may comprise a frame number, timestamps, or sequence numbers. Media unit reference information may also include the perceived frame rate (frames per time unit) of the received

15   media stream. This way, a synchronization unit may be able to calculate delay information, even when terminals with different perceived frame rates participate in the inter-destination synchronization.

        Synchronization settings instructions may include

20   instructions on setting the variable delay unit.

        The synchronization server (synchronization unit) and synchronization client (variable delay unit) are configured to initiate and terminate synchronization sessions. A synchronization session is initiated when a synchronization

25   client sends an invitation message to the synchronization server, or vice versa. During a synchronization session, the synchronization server and the synchronization client may exchange synchronization status information and synchronization settings instructions. A synchronization

30   session is terminated when the synchronization client sends a termination message to the synchronization server, or vice versa. A synchronization server and a synchronization client may send return messages to accept the invitation to, or to confirm the termination of a synchronization session.

Generally speaking all of the above described types
of information related to the synchronization method according
to the invention may be referred to as synchronization
information.

5   **Fig. 1** illustrates a synchronization scheme in which
the synchronization unit **112** centrally collects
synchronization information from the terminals via the low-
delay communication channel **110a,110b** and calculates on the
basis of this information delay information for the variable-

10   delay buffer in each terminal. The examplary algorithm used by
the synchronization units assumes that the frame-rate, i.e.
the number of frames per second of the streaming content (e.g.
video), is known.

The information transfer between the synchronization

15   unit and the terminals is illustrated in more detail in the
flow diagram **200** of **Fig. 2**. In a first step **202**, the
synchronization unit requests, preferably via the low-delay
communication channel, the terminals to send the reference
information of a particular media unit (frame) in the stream

20   back to the synchronization unit. Subsequently the terminals
will send this information, typically RTP information of a
frame including the frame number received at the terminals, to
the synchronization unit via the low-delay communication
channel(step **204**). Next, the synchronization unit **112** is

25   capable of adding a timestamp to the frame numbers and
selecting one of the frame numbers, preferably the lowest or
highest reported by the terminals, as a reference frame and
calculating for each terminal the time related to this
reference frame using a known frame-rate. Thereafter, the

30   synchronization unit determines the most "lagged" terminal and
calculates the delays for the other terminal or terminals
(step **206**) and subsequently transmits these delays, preferably
via the low-delay communication line, to the terminals (step
208).

With reference to **Fig. 2,** some of the steps performed
by the synchronization are further illustrated in detail as
follows:
Synchonization unit **112** receives the following media unit
5   reference information from the terminals ET1, ET2 and ET3:

                ET1 received frame 6389
                ET2 received frame 6395
                ET3 received frame 6375

10

On receiving the reference information the synchronization
unit adds a timestamp:

                ET1 received frame 6389, received 14:46:59.2645 (T1)
15   ET2 received frame 6395, received 14:47:05.4112 (T2)
                ET3 received frame 6375, received 14:46:59.7600 (T3)

Because of the low-delay channel, the time stamps of the
synchronization unit are good representatives of the
20   respective times the frames were actually received by the
terminals. Preferably the terminals immediately transmit the
media reference information, once the reference information of
the last received media unit of the stream has been
determined, back to the synchronization unit. Alternatively
25   the terminals may also transmit additional internal delay
information (e.g. the delay between determining the media unit
reference information and sending the media unit reference
information) back to the synchronization unit.
        Given an exemplary frame rate of 25 frames per
30   second, the clock times for the lowest frame number, i.e.
frame 6375, for each terminal may then be calculated by the
synchronization unit as follows:
        The first terminal received frame 6375 at
approximately T1-(6389-6375)/25 = 14:46:58.7045 (T1'), the

second terminal received frame 6375 at approximately T2-(6395-
6375)/25 = 14:47:04.6112 (T2') and the third terminal received
frame 6375 at approximately T3 = 14:46:59.7600 (T3'=T3):

5   ET1 received frame 6375 at 14:46:58.7045 (T1')
               ET2 received frame 6375 at 14:47:04.6112 (T2')
               ET3 received frame 6375 at 14:46:59.7600 (T3'=T3)

          The most "lagged" terminal, i.e. the terminal which

10   received the reference frame 6375 last, is terminal ET2.
     Finally, the synchronization unit determines the delays
     (D1,D2,D3) for each terminal:

               Delay D1 for ET1 = T2' - T1' = 5.9067
15   Delay D2 for ET2 = 0
               Delay D3 for ET3 = T2' - T3' = 4.8512

          These delays are subsequently sent, preferably via
     the low-delay communication channel, to the terminals and used
20   by the variable delay buffer to delay transmission of the
     stream to the presentation unit. That way the content of a
     particular frame (media unit) in the originally transmitted
     stream is transmitted to all users in the group at the same
     time T_{out} as schematically indicated in **Fig. 1**.
25   In an embodiment, the synchronization unit
     simultaneously requests, via the low-delay channels, the frame
     numbers from all terminals involved in the inter-destination
     synchronisation. All terminals will upon receipt of the
     request, immediately determine the reference information of
30   the last received media unit in the stream and return via the
     low delay-channel the requested media unit reference
     information. The synchronization unit may now determine the
     delays based on only the framerate and received frame numbers,
     since all media unit reference information are determined at

substantially the same time, and therefore time stamps are no
longer required. This eliminates the use of a clock in the
synchronization units and eliminates steps in the calculation
process.

5   In a further embodiment a number of synchronization
units may be used, which are distributed over the network.
Fig. 3 depicts an example of such distributed system **300**
wherein each terminal **302,204,306** comprises a synchronization
unit SU1,SU2,SU3. Each synchronization unit is capable of

10   transmitting the media unit reference information to all other
synchronization units via the one or more low-delay
communication channels **308,310**. Each synchronization unit is
capable of calculating the appropriate delay time for the
variable-delay unit and delaying its output using a variable

15   delay buffer **312** in a similar way as discussed above.

          The synchronization unit may be a server in the
network hosting the synchronization function, e.g. a software
program, or alternatively it may be a functional unit in one
or more terminals or in a server, such as a SIP server, or in

20   a conference bridge that connects the media streams of two or
more terminals.

          In an embodiment, in order to further improve the
accuracy of the calculated delay information, the
synchronization unit measures or obtains the delay of the low-

25   delay communication channel itself, for example by
periodically polling the round-trip time or RTCP information,
and adjusts the calculated delay information of the stream for
the delay caused by the low-delay communication channel.

          Fig. 4 depicts an exemplary messaging flow of a

30   synchronization session between a synchronization client (SC)
and a synchronization server SynchS according to one
embodiment of the invention. The SC and the SynchS may be
implemented in an IMS-type architecture wherein the
synchronization client may be an elementary function of the

User Equipment (UE) and the Synchronization Server (SynchS) may be an elementary function of the IPTV Service Control Function (SCF) as defined in ETSI technical specification TS 182027.

5   In this embodiment, a synchronisation session for initiating, maintaining and terminating the exchange of synchronization information is established as part of the broadcast session as described in ETSI TISPAN TS 182 027, clause 8.3.1). In other words, the reference point (an

10   interface or a protocol) for setting up, maintaining and terminating the synchronization session is transmitted over the Gm (TS 182 027, clause 6.3) and ISC (TS 182 027, clause 6.8) reference points that are used by the UE to set up a broadcast session with the SCF. The exchange of

15   synchronization information within the synchronization session is transmitted in a low-delay communication channel that is set-up as part of the synchronization session initiation.

          The process of setting up a broadcast session and synchronisation session may comprise the following steps:

20   In a first step **400**, a broadcast session is set up between the UE (comprising the SC) and the SCF (comprising the SynchS) following the procedure described in TS 182 027, clause 8.3.1). In a second step **402** the SC sends a synchronization initiation request to the SynchS, indicating

25   that it wants to participate in the inter-destination synchronization process. The request includes the BCServiceId of the to-be-synchronized Broadcast channel. This message and all following messages are sent within the broadcast session that has been established in the first step. In a third step

30   **404** the SynchS confirms the participation of the SC in the inter-destination synchronization process. In a fourth step **406** the SC sends its synchronization status information to the SynchS. In a fifth step **408** the SynchS aggregates synchronization status information from multiple SC's and

calculates the appropriate synchronization settings for each
SC. Examples of algorithms to calculate the synchronization
settings instructions from collected synchronization status
information may be calculated using the algorithm as described
5   above in relation with **Fig. 2.** In a sixth step **410** the SynchS
sends a synchronization settings instruction to the SC. Steps
406-410 may be repeated at regular time intervals. When the
session needs to be terminated the SC sends, in a seventh step
412 a synchronization termination request, indicating that it
10   is no longer active in the inter-destination synchronization
process. In an eighth step **414** the SynchS confirms the
termination of the SC's participation in the inter-destination
synchronization process.

        Optionally the SC may initiate and terminate multiple
15   synchronization sessions within a broadcast session, both
consecutive and/or simultaneous.

        In a further embodiment another example of how the
synchronisation session may be initiated, is illustrated in
more detail. **Fig. 5** depicts an exemplary IMS-based IPTV
20   architecture **500** as defined by ETSI TISPAN. The architecture
may for example be used for a scenario, wherein two
subscribers of an IMS based IPTV service want to watch the
same TV program (e.g., a football game) in a synchronized
manner and communicate by (video) telephone or chat at the
25   same time. For an acceptable user experience the IPTV streams
on both TVs should be substantially synchronized (e.g., to
avoid hearing your friend shout 'goal!' seconds before you see
the actual goal on the TV).

        In order to achieve the substantial level of
30   synchronization required the following steps illustrated by
the flow diagram **600** of **Fig. 6** are performed.

        First the user may want to enable synchronization for the
existing unsynchronized IPTV broadcast session by requesting a
session modification (where the Media Distribution Function

MDF **502** is the transmitting station and the IPTV broadcast session **504** is the packetized stream)(step **604**). The session modification involves the User Equipment UE **506** (terminal) sending a SIP INVITE message to the Service Control Function

5   SCF **508** or vice versa, comprising an updated session description (using the Session Description Protocol SDP). The session description may comprise of information about which IPTV stream should be synchronized (e.g., indicated by the BCServiceId) and the UEs to be involved in the synchronization

10   session. The SIP INVITE message is routed via the Proxy Call Session Control Function (P-CSCF) **510**, located in the Core IMS **512** (steps **604,608**), whereby the P-CSCF forwards the session description information to the Resource Admission and Control Subsystem RACS **514** to reserve network resources in the Basic

15   Transport Function BTF **516**, in order to guarantee a low-delay communication channel for the exchange of synchronization information (step **606**).

Further the SCF **508** (or UE if the SCF initiated the request) may accept the request (step **610**) and may instruct

20   the Media Synchronisation Application Server MSAS (Synchronization Unit) to start the synchronization session for inter-destination synchronization. This may be achieved using an internal protocol, if the MSAS is located in the SCF, or alternatively the SIP protocol may be used when for example

25   the MS AS is located in the Media Control Function (MCF) **518** of the IMS architecture. The MCF is part of the IPTV Media Function (MF) **520**.

Finally the UEs participating in the inter-destination synchronization (session) send their synchronization status

30   information (comprising media unit reference information of the to-be synchronized stream) to the MSAS, as part of the modified broadcast session (now including a low-delay communication channel reserved by the RACS) (step **612**).

The MSAS then calculates the delay information for use in the variable delay unit for each UE and transmits the delay information (synchronization settings instructions) to the participating UEs.

5   In the exemplary embodiment above, the packetized stream (such as an IPTV broadcast) uses a regular broadcast channel, multi-casted from the Media Distribution Function (MDF), known from the IMS-based IPTV architecture (TS 182 027). This broadcast channel can be relatively slow, due to

10   the various manipulations that the packetized stream may undergo between source and destination. Moreover, it is typically unidirectional. A broadcast session is set up to e.g. reserve bandwidth for the broadcast channel, opening ports and to enable charging. The broadcast session including

15   the synchronisation session according to the embodiment, is preferably a SIP signalling session with a low-delay communication channel for exchanging synchronization information that uses a different communication path. In contrast to the regular broadcast channel, this different

20   communication path is a relatively fast bidirectional low-delay communication channel between the Service Control Function (comprising the MSAS) and the UE (comprising the SC).

The invention is not limited to the embodiments described above, which may be varied within the scope of the

25   accompanying claims.

CLAIMS

1. Method for synchronizing the output of at least
two terminals, the method comprising the steps of:
  - providing one or more low delay communication channels
    between the terminals and a synchronization unit;
  - the synchronization unit calculating delay information on
    the basis of synchronization information received from
    the terminals via the one or more low delay communication
    channels; and,
  - transmitting the delay information to at least one of the
    terminals allowing the at least one terminal to delay its
    output such that the output of the terminals are
    substantially synchronized.

2. Method according to claim 1, wherein each terminal
comprises an input for receiving a multi-media signal and an
output for transmitting the multi-media signal to an
information presentation unit and wherein each terminal
comprises a variable delay unit for delaying the output
signal, the method further comprising the steps of:
  - transmitting a multi-media stream to the input of the
    terminals, preferably the multi-media stream comprising
    media units;
  - delaying the output signal according to the received delay
    information.

3. Method according to claims 1 or 2, wherein the
method further comprises the step of:
  - each terminal sending synchronization information,
    preferably in response to a synchronization request, via
    a low delay communication channel to the synchronization

unit, the synchronization information comprising media unit reference (MUR) information representing the position of a media unit in a multi-media stream.

4. Method according to claim 3, wherein the MUR information comprises a frame number or a sequence number.

5. Method according to claims 3 or 4, wherein the method further comprises the steps of:
   - adding one or more time stamps to the MUR information received from the terminal;
   - providing information on the frame rate of the multi-media stream received by the terminals;
   - calculating delay information for each terminal on the basis of the frame rate information and the time-stamped MUR information;
   - sending delay information to at least one of the terminals.

6. Method according to claims 3 or 4, wherein the method further comprises the steps of:
   - the synchronization unit sending a synchronization request, preferably simultaneously, via one or more low delay communication channels to the terminals;
   - providing information on the frame rate of the multi-media stream received by the terminals;
   - calculating delay information for each terminal on the basis of the frame rate information and the MUR information;
   - sending delay information to at least one of the terminals.

7. Method according to any of claims 1 to 6, wherein the synchronization information is transmitted over a low delay communication channel to the synchronization unit, the low delay communication channel being established as part of a

5   communication session or a broadcast session, more preferably a broadcast session as defined in ETSI TS 182 027.

8. Method according to any of claims 1 to 6, wherein the low delay communication channel is a Voice over IP (VoIP)

10   channel, an USSD based channel over a GSM, UMTS or LTE network, an QoS-controlled channel in an IMS session, a dedicated channel in a communication session or a broadcast session, a dedicated Ethernet VLAN channel, a dedicated MPLS channel or a dedicated channel used by an IP Diffserv stream,

15   9. Method according to any of claims 1 to 8, wherein the synchronization unit is located in a server or in one or more terminals.

10. System for synchronizing the output of at least

20   two terminals, the system comprising a synchronization unit connected via one or more low delay communication channels to at least two terminals, wherein the synchronization unit is configured to calculate delay information on the basis of synchronization information received via one or more low delay

25   communication channels from the terminals and to transmit the delay information to at least one of the terminals allowing each terminal to delay its output such that the output of the terminals are substantially synchronized.

30   11. System according to claim 10, wherein each terminal comprises an input for a receiving multi-media signal and an output for transmitting the multi-media signal to an information presentation unit and a variable delay unit for

delaying the output signal according to the delay information, the system further comprising a station transmitting a multi-media stream to the terminals, the multi-media stream comprising media units.

5

12. Synchronization unit for use in a system according to claims 10 or 11, the unit comprising:

- a receiver for receiving via one or more low delay
10   communication channels synchronization information from the terminals;

- a processor configured to calculate delay information on the basis of the received synchronization information; and,

15   - a transmitter for transmitting the delay information to at least one of the terminals.

13. Terminal for use in a system according to claims 10 or 11, the terminal comprising:

20   - a receiver configured to receive a synchronization request from the synchronization unit and configured to receive a multi-media stream;

- a transmitter configured to transmit via one or more low delay communication channels to the synchronization unit
25   and configured to transmit the multi-media signal to an information presentation unit; and,

- a variable delay unit for delaying transmission of the multi-media signal to the information presentation unit.

30   14. Terminal according to claim 13, whereby the terminal is a set-top box, a home computer, a mobile device, or a gaming console

15. Terminal according to claim 13 or 14, whereby the terminal further comprises a synchronization unit configured to calculate delay information on the basis of synchronization information.

5

16. Computer program product comprising software code portions configured for, when run in the memory of one or more computing devices, preferably one or more network servers or terminals, executing the method steps according to claim 1.

10

Figure 1

Figure 2

200

Figure 3

Synch. S
(in SCF)

SC
(in UE)

400 Broadcast session initiation

402 Sync Initiation Request (BCServiceId)

Sync
session
initiation

404 Sync Initiation Response

406 Sync status Information

Repeat

Sync
session
in progress

408

CALC

410 Sync Settings Instruction

Sync
session
termination

412 Sync Termination Request

414 Sync Termination Response
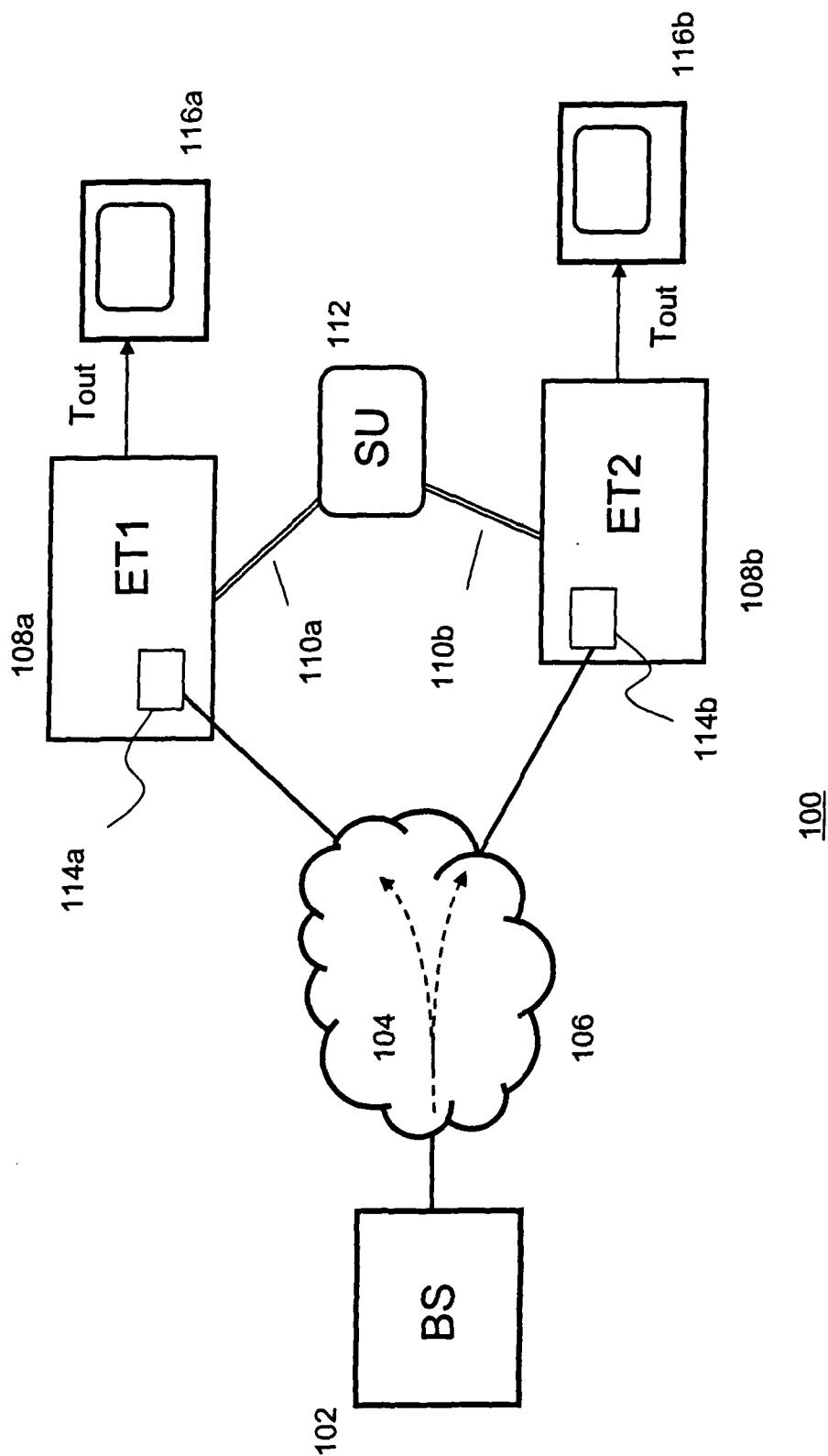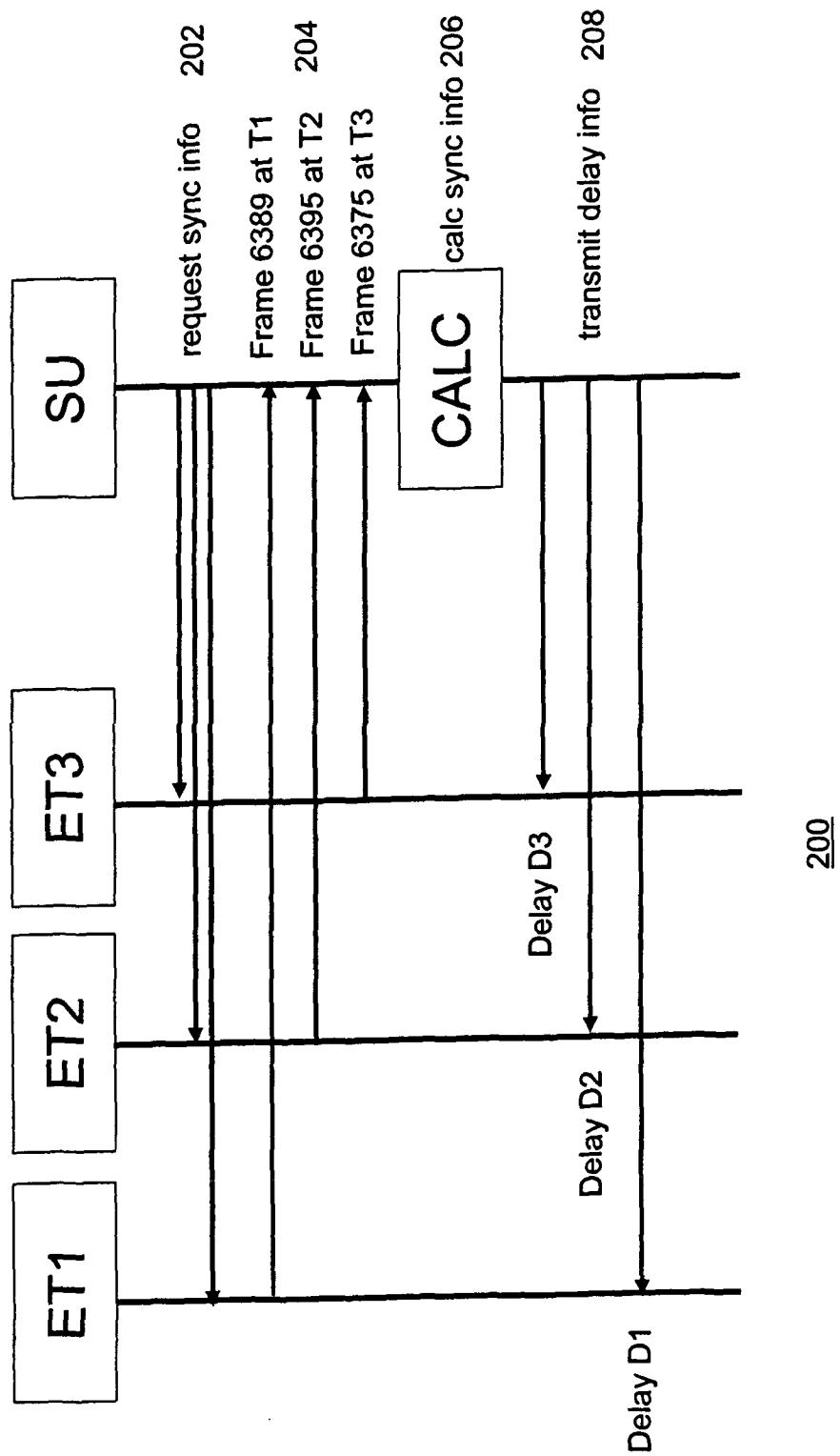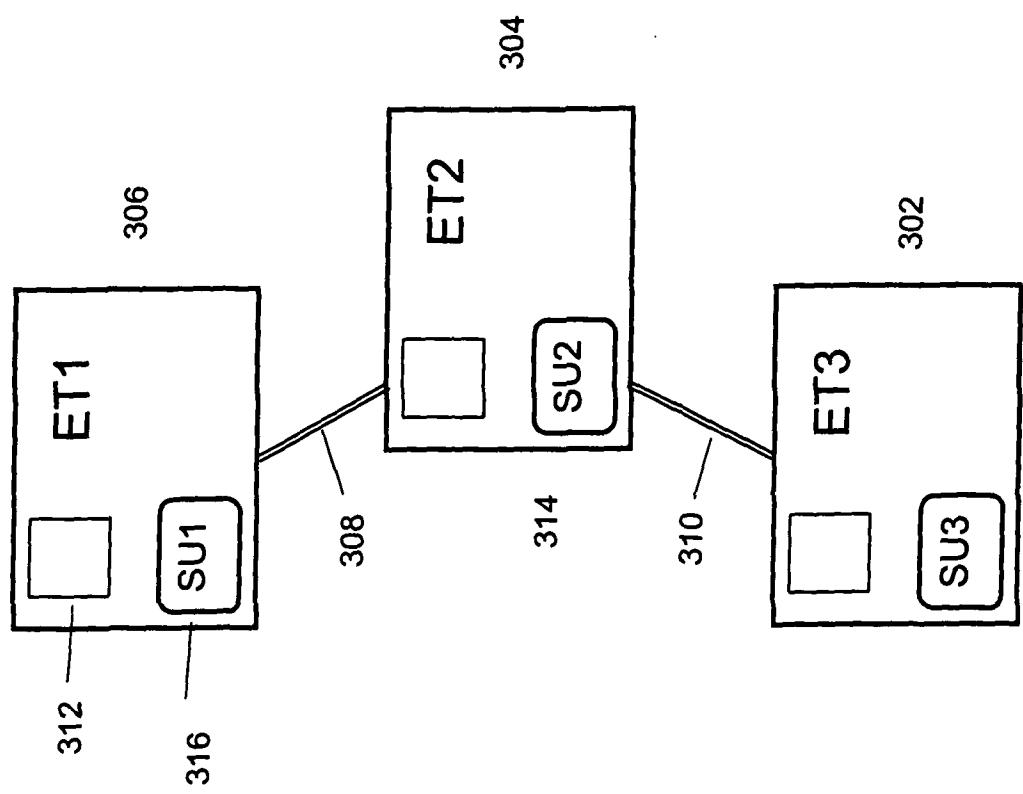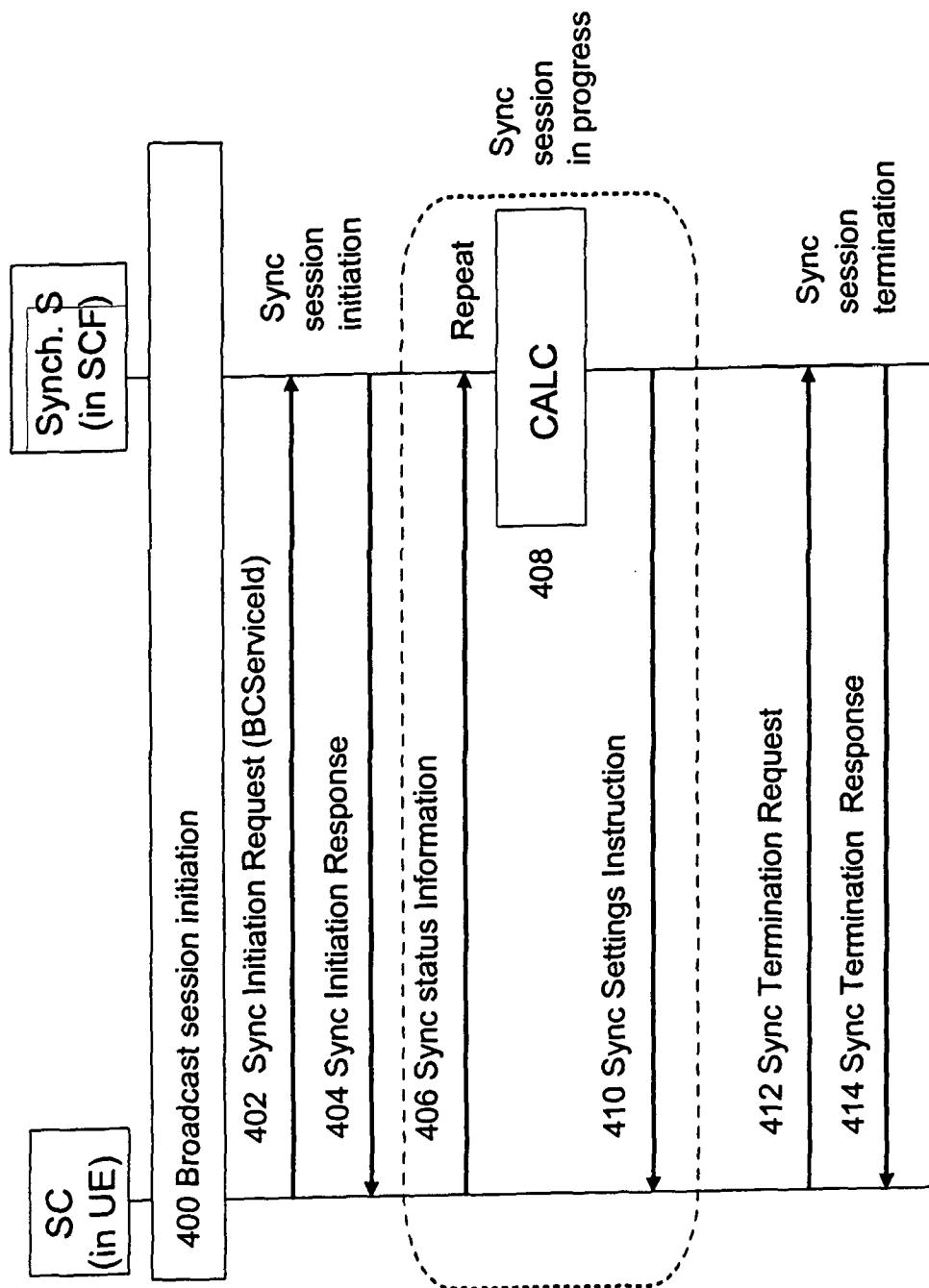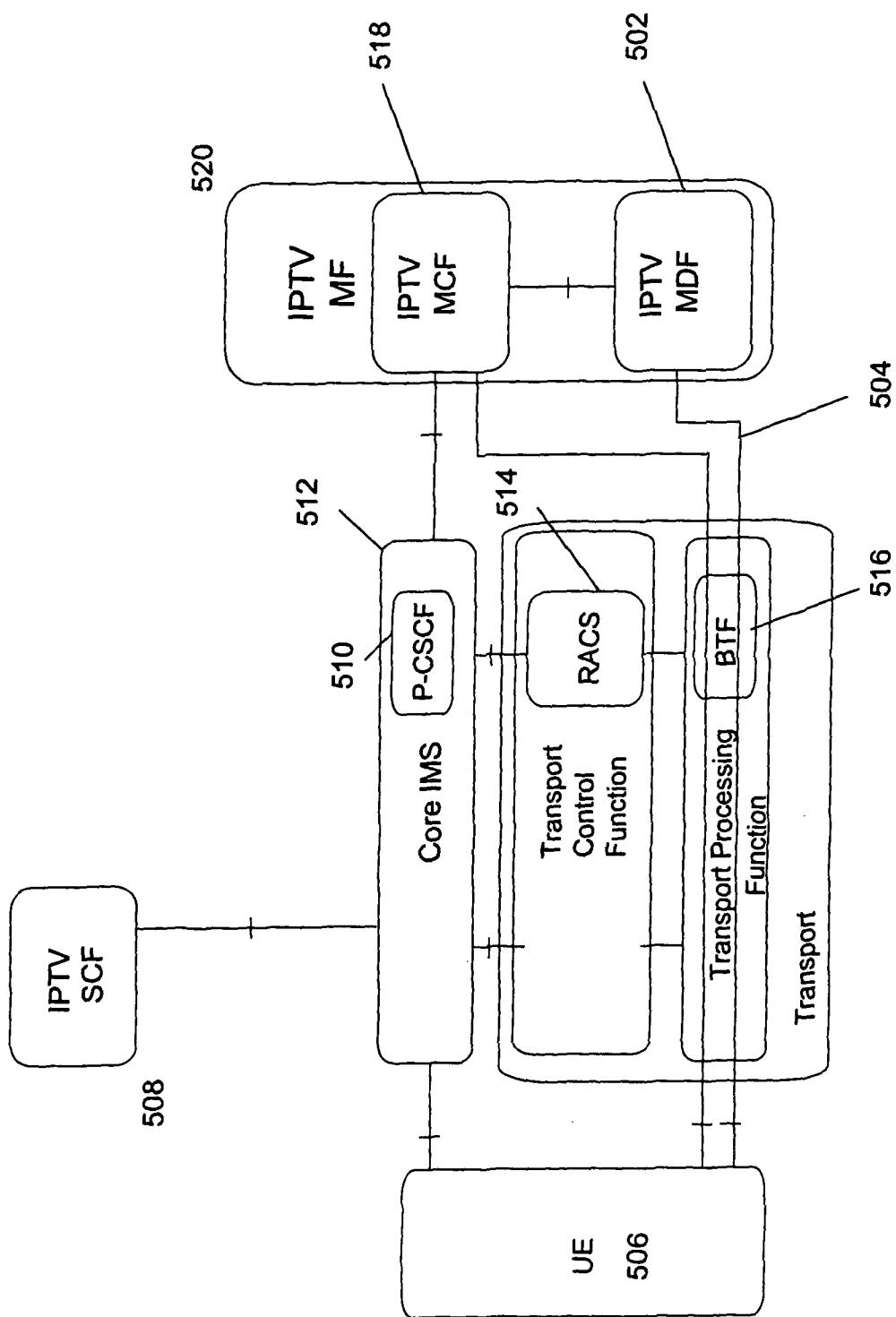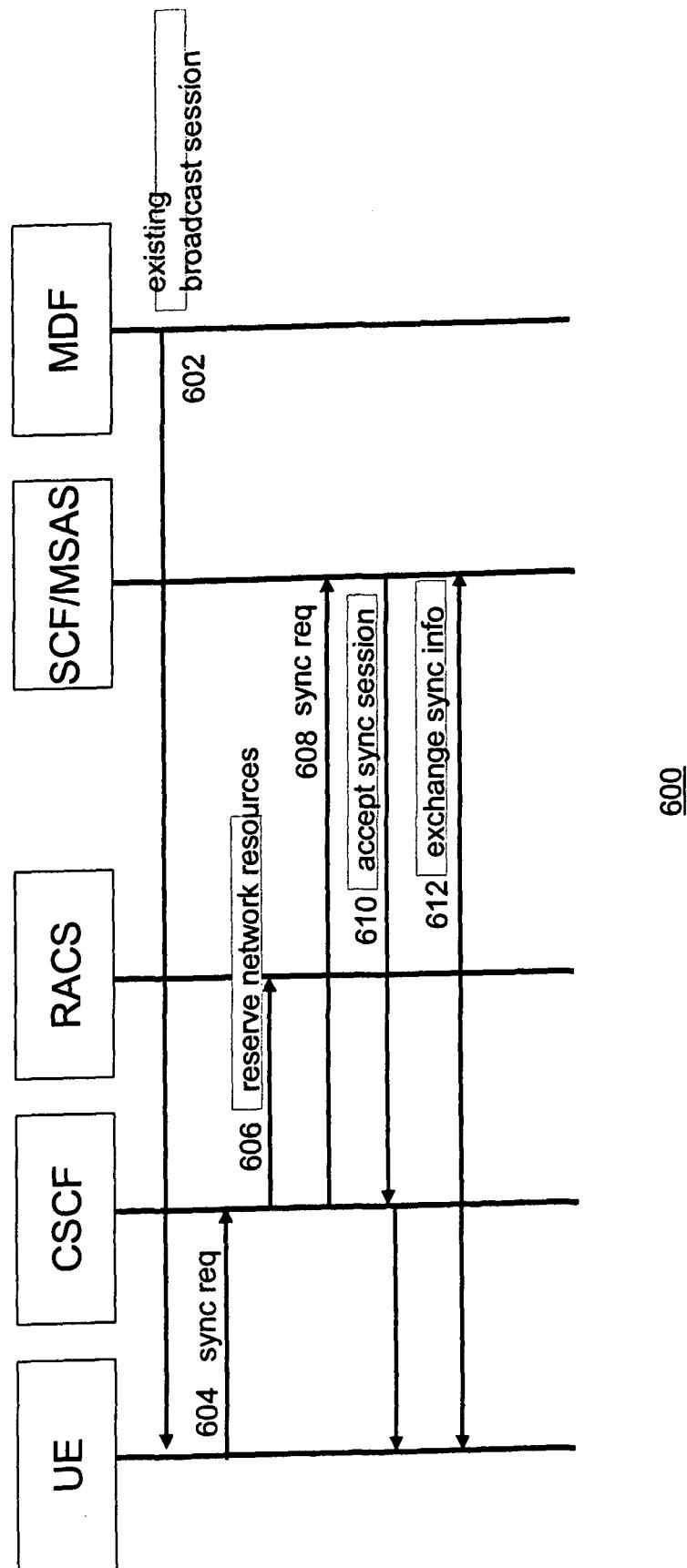
Figure 4

Figure 5

Figure 6

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/010355

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/06
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04J H04L

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ISHIBASHI Y ET AL: "A group synchronization mechanism for live media in multicast communications" GLOBAL TELECOMMUNICATIONS CONFERENCE, 1997. GLOBECOM '97., IEEE PHOENIX, AZ, USA 3-8 NOV. 1997, NEW YORK, NY, USA,IEEE, US, vol. 2, 3 November 1997 (1997-11-03), pages 746-752, XP010254701 ISBN: 0-7803-4198-8 the whole document -/--	1-16

☒ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

Date of the actual completion of the international search	Date of mailing of the international search report
27 January 2009	09/02/2009

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INTERNATIONAL SEARCH REPORT

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ISHIBASHI Y ET AL: "A group synchronization mechanism for stored media in multicast communications" INFOCOM '97. SIXTEENTH ANNUAL JOINT CONFERENCE OF THE IEEE COMPUTER AN D COMMUNICATIONS SOCIETIES. DRIVING THE INFORMATION REVOLUTION., PROCE EDINGS IEEE KOBE, JAPAN 7-11 APRIL 1997, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, US, vol. 2, 7 April 1997 (1997-04-07), pages 692-700, XP010252076 ISBN: 978-0-8186-7780-9 the whole document	1-16
P,X	"Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN integrated IPTV subsystem Architecture; ETSI TS 182 028" DRAFT ETSI TS 182 028 V3.1.0, [Online] no. v3.1.0, November 2008 (2008-11), pages 1-45, XP002512121 ETSI 2008-11 LIS, Sophia Antipolis CEDEX, France Retrieved from the Internet: URL:http://portal.etsi.org/docbox/tispan/O pen/NGN_LATEST_DRAFTS/RELEASE3/02074-ngn-r 3v310.pdf> [retrieved on 2009-01-26] 5.3.1 Inter-destination media synchronization 5.3.1.1 Functional entities MSAS and SC 5.3.1.2 Mapping onto the IPTV architecture 5.3.1.3 MSAS-SC reference point (Sync) Figure 2: NGN IPTV functional architecture	1-16
A	FERNANDO BORONAT SEGUI ET AL: "Multimedia Group Synchronization Algorithm Based on RTP/RTCP" MULTIMEDIA, 2006. ISM'06. EIGHTH IEEE INTERNATIONAL SYMPOSIUM ON, IEEE, PI, December 2006 (2006-12), pages 754-757, XP031041862 ISBN: 0-7695-2746-9 the whole document	1-16

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NUNOME T ET AL: "An application-level QoS comparison of inter-destination synchronization schemes for continuous media multicasting" GLOBECOM'03. 2003 – IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE. CONFERENCE PROCEEDINGS. SAN FRANCISCO, DEC. 1 – 5, 2003, IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE, NEW YORK, NY : IEEE, US, vol. VOL. 7 OF 7, 1 December 2003 (2003-12-01), pages 3602-3608, XP010677289 ISBN: 0-7803-7974-8 cited in the application the whole document	1-16