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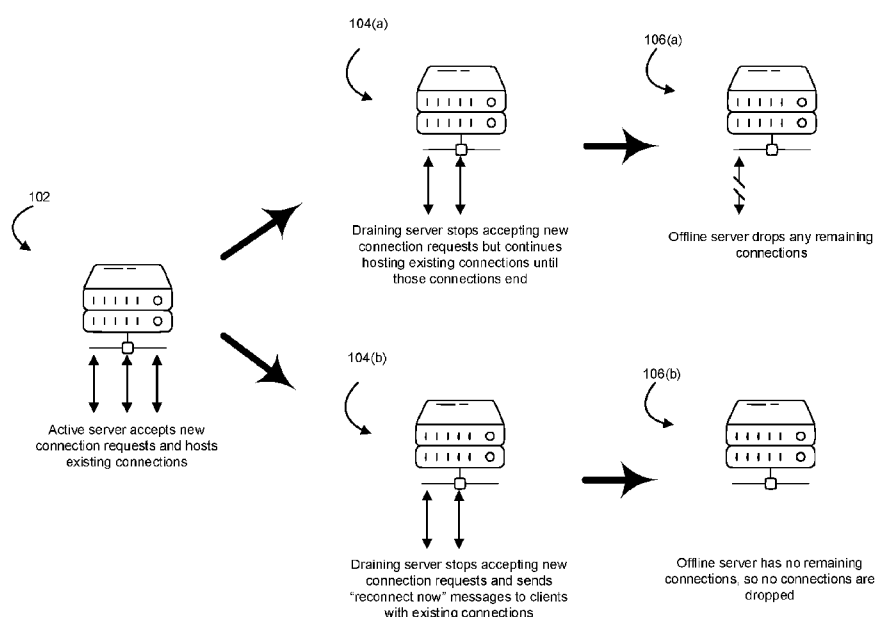


FIG. 1

(57) Abstract: A computer-implemented method for preserving media streams may include (i) identifying a media stream transmitted by a client device to a server that hosts the media stream for access by additional devices, (ii) detecting that the server is expected to go offline, (iii) sending, in response to detecting that the server is expected to go offline, a message to the client device indicating that the server is expected to go offline, (iv) receiving, at an additional server, a request from the client device to host the media stream, and (v) in response to receiving the request, hosting the media stream at the additional server while ceasing to host the media stream at the server that is expected to go offline. Various other methods, systems, and computer-readable media are also disclosed.

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SYSTEMS AND METHODS FOR PRESERVING MEDIA STREAMS

TECHNICAL FIELD

[0001] The present disclosure is generally directed to systems and methods for preserving media streams that may otherwise be disconnected when infrastructure components such as servers go offline for maintenance or other reasons.

BACKGROUND OF THE DISCLOSURE

[0002] A social media platform may enable users to stream live video and/or audio from their video-enabled devices to their social connections (friends, groups, etc.). For the duration of the live broadcast, the social media platform may maintain a connection to the client using any type of transport protocol, such as a lossless user datagram protocol (UDP) connection and/or a transmission control protocol (TCP) connection, and may use the connection to stream the media content. However, operational policies for operating system installation patching or other maintenance may assume network components can be taken offline after a short period of no longer accepting new requests (e.g., 45 minutes), referred to as a “draining” period. If a media stream is longer than the duration of the draining period, the stream may still be running when the server is taken offline, resulting in lost data or even lost streams.

SUMMARY OF THE DISCLOSURE

[0003] In accordance with a first aspect of the present disclosure, there is provided a computer-implemented method comprising: identifying a media stream transmitted by a client device to a server that hosts the media stream for access by additional devices; detecting that the server is expected to go offline; sending, in response to detecting that the server is expected to go offline, a message to the client device indicating that the server is expected to go offline; receiving, at an additional server, a request from the client device to host the media stream; and in response to receiving the request, hosting the media stream at the additional server while ceasing to host the media stream at the server that is expected to go offline.

[0004] In some embodiments, the media stream may comprise a live media stream being captured in real-time by the client device.

[0005] In some embodiments, the media stream may comprise a video stream.

[0006] In some embodiments, detecting that the server is expected to go offline may comprise detecting that the server is expected to go offline within a predetermined window

1 of time; and sending the message comprises sending the message in response to detecting
2 that the server is expected to go offline within the predetermined window of time.

3 **[0007]** In some embodiments, detecting that the server is expected to go offline may
4 comprise detecting that the server is scheduled for upcoming maintenance.

5 **[0008]** In some embodiments, detecting that the server is expected to go offline may
6 comprise detecting that the server has ceased accepting new connection requests.

7 **[0009]** In some embodiments, sending the message to the client device indicating that
8 the server is expected to go offline may comprise determining that the server has previously
9 received a message from the client device indicating that the client device supports
10 reconnection suggestion messages.

11 **[0010]** In some embodiments, the message to the client device indicating that the
12 server is expected to go offline may comprise an expected time at which the server is
13 expected to go offline.

14 **[0011]** In some embodiments, the message to the client device indicating that the
15 server is expected to go offline may include a session identifier associated with the media
16 stream.

17 **[0012]** In some embodiments, identifying the media stream transmitted by the client
18 device to the server may comprise identifying that the client device is transmitting the media
19 stream via a transmission control protocol.

20 **[0013]** In some embodiments, the transmission control protocol may comprise a real
21 time messaging protocol.

22 **[0014]** In some embodiments, sending the message to the client device indicating that
23 the server is expected to go offline may comprise sending the message via the transmission
24 control protocol.

25 **[0015]** In accordance with a further aspect of the present disclosure, there is provided
26 a computer-implemented method comprising: transmitting, by a client device, a media
27 stream to a server that hosts the media stream for access by additional devices; receiving, by
28 the client device, a message indicating that the server is expected to go offline; in response
29 to receiving the message, sending, by the client device to an additional server, a request to
30 host the media stream; and transmitting, by the client device, the media stream to the
31 additional server while ceasing to transmit the media stream to the server that is expected to
32 go offline.

1 **[0016]** In some embodiments, transmitting the media stream to the server may
2 comprise sending, by the client device, a message to the server indicating that the client
3 device accepts reconnection suggestion messages.

4 **[0017]** In some embodiments, the computer-implemented method may further
5 comprise sending, to the additional server, a session identifier associated with the media
6 stream.

7 **[0018]** In some embodiments, the message indicating that the server is expected to
8 go offline may include the session identifier; and sending, to the additional server, the session
9 identifier associated with the media stream comprises sending the session identifier received
10 from the server.

11 **[0019]** In some embodiments, transmitting, by the client device, the media stream to
12 the additional server while ceasing to transmit the media stream to the server that is expected
13 to go offline may comprise avoiding data loss by switching, by the client device, transmitting
14 the media stream from the server to the additional server at a segment boundary within the
15 media stream.

16 **[0020]** In accordance with a further aspect of the present disclosure, there is provided
17 a system comprising: a client device that transmits a media stream; a server that hosts the
18 media stream for access by additional devices; a stream preservation module that: detects
19 that the server that hosts the media stream is expected to go offline; and in response to
20 detecting that the server is expected to go offline, notifies the client device that the server is
21 expected to go offline; and an additional server that: receives a request from the client device
22 to host the media stream; and hosts the media stream.

23 **[0021]** In some embodiments, the media stream may comprise a live video stream
24 being captured in real-time by the client device.

25 **[0022]** In some embodiments, the client device may send the server a message
26 indicating that the client device accepts reconnection messages; the stream preservation
27 module notifies the client device that the server is expected to go offline in response to
28 detecting that the client device sent the server the message; and the client device, in response
29 to being notified by the stream preservation module that the server is expected to go offline,
30 sends the request to the additional server to host the media stream.

31 **[0023]** It will be appreciated that any features described herein as being suitable for
32 incorporation into one or more aspects or embodiments of the present disclosure are

intended to be generalizable across any and all aspects and embodiments of the present disclosure. Other aspects of the present disclosure can be understood by those skilled in the art in light of the description, the claims, and the drawings of the present disclosure. The foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The accompanying drawings illustrate a number of exemplary embodiments and are a part of the specification. Together with the following description, these drawings demonstrate and explain various principles of the instant disclosure.

[0025] FIG. 1 is an illustration of an exemplary system for preserving media streams.

[0026] FIG. 2 is a block diagram of an exemplary system for preserving media streams.

[0027] FIG. 3 is a flow diagram of an exemplary method for preserving media streams from the server perspective.

[0028] FIG. 4 is a flow diagram of an exemplary method for preserving media streams from the client perspective.

[0029] FIG. 5 is an illustration of an exemplary timeline of a system for preserving media streams.

[0030] Throughout the drawings, identical reference characters and descriptions indicate similar, but not necessarily identical, elements. While the exemplary embodiments described herein are susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. However, the exemplary embodiments described herein are not intended to be limited to the particular forms disclosed. Rather, the instant disclosure covers all modifications, equivalents, and alternatives falling within the scope of the appended claims.

[0031] Features from any of the embodiments described herein may be used in combination with one another in accordance with the general principles described herein. These and other embodiments, features, and advantages will be more fully understood upon reading the following detailed description in conjunction with the accompanying drawings and claims.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0032] The present disclosure is generally directed to systems and methods for preserving media streams that may otherwise be disconnected when infrastructure components such as

1 servers go offline for maintenance or other reasons. In one example, a social media platform
2 may enable users to stream live video and/or audio from their video-enabled devices to their
3 social connections (friends, groups, etc.). For the duration of the live broadcast, the social
4 media platform may maintain a connection to the client using any type of transport protocol,
5 such as a lossless user datagram protocol (UDP) connection and/or a transmission control
6 protocol (TCP) connection, and may use the connection to stream the media content.
7 However, operational policies for operating system installation patching or other
8 maintenance may assume network components can be taken offline after a short period of
9 no longer accepting new requests (e.g., 45 minutes), referred to as a “draining” period. If a
10 media stream is longer than the duration of the draining period, the stream may still be
11 running when the server is taken offline, resulting in lost data or even lost streams.

12 **[0033]** To solve this problem, the systems described herein may send a “reconnect now”
13 message to clients when a server is about to go offline. In some embodiments, the systems
14 described herein may configure the client to, upon receipt of this message, launch a new
15 connection to a different server. In one embodiment, the systems described herein may send
16 a reconnection message designed to avoid causing errors for clients that do not support the
17 reconnection protocol. Additionally or alternatively, the systems described herein may
18 configure clients to send a “supports reconnection” message when initiating a stream and
19 may only send reconnection messages to clients from which this message has been received.
20 In some examples, the client may change over the stream at a logical boundary to minimize
21 disruption to the stream. In some embodiments, the client may send a session identifier with
22 the reconnect request that enables backend systems to track the use of reconnection.

23 **[0034]** In some embodiments, the systems described herein may improve the functioning
24 of a computing device by enabling a computing device to stream media without a loss of
25 connection caused by infrastructure components going offline. Additionally, the systems
26 described herein may improve the functioning of a computing device by enabling an
27 infrastructure component to be taken offline for maintenance without disrupting media
28 streams. Additionally, the systems described herein may improve the fields of live media
29 streaming and/or network infrastructure maintenance by enable infrastructure components
30 to be taken offline for maintenance without disrupting and/or dropping live media streams
31 that are initially hosted by the infrastructure components in question.

32 **[0035]** The following will provide, with reference to FIG. 1, detailed descriptions of the

1 problem solved by preserving media streams via sending “reconnect now” signals from
2 servers that are about to go offline. Additionally, detailed descriptions of systems and
3 methods for preserving media streams will be provided with reference to FIGS. 2 and 3-4,
4 respectively. Detailed descriptions of a timeline for preserving media streams via sending a
5 “reconnect now” message will be provided in connection with FIG. 5.

6 **[0036]** In some embodiments, the systems described herein may prevent connections
7 from being disrupted and/or lost when servers or other infrastructure components go offline
8 (e.g., for planned maintenance). For example, as illustrated in FIG. 1, in active state 102, an
9 active server may accept new connection requests and host existing connections. At some
10 point, the server may send or receive a signal indicating that the server is expected to go
11 offline within the near future. For example, the server may be expected to go offline in a
12 predetermined period of time, such as ten minutes, thirty minutes, forty-five minutes, or one
13 hour. In one example, in draining state 104(a), a draining server may stop accepting new
14 connection requests but may continue hosting existing connections until those connections
15 end (e.g., due to being terminated by the client). In some examples, when the server enters
16 offline state 106(a), some existing connections may not yet have ended. For example, a live
17 video stream of a three-hour-long concert may not end during a draining period of forty-five
18 minutes. In these examples, the offline server may drop any remaining connections. In some
19 cases, the client may re-establish the connection to another server after several seconds of
20 disruption, while in other cases, the client may not re-establish the connection and the stream
21 may be lost. Either way, the disrupted and/or dropped stream may be a sub-optimal
22 experience for users who are transmitting, viewing, and/or recording the media stream.

23 **[0037]** By contrast, if a server is configured according to the systems described herein,
24 when the server enters draining state 104(b), the draining server may stop accepting new
25 connection requests as per draining state 104(a) but, unlike in draining state 104(a), may send
26 “reconnect now” messages to clients with existing connections. In some embodiments, the
27 server may send the messages as soon as the server enters the draining state, while in other
28 embodiments the server may send the messages at a predetermined time point before the
29 server goes offline. For example, a server may stop accepting new connections one hour
30 before planned maintenance and may send “reconnect now” messages five minutes before
31 the planned maintenance. In one embodiment, when a server enters offline state 106(b) from
32 draining state 104(b), the offline server may no longer have any remaining connections due

1 to all existing connections having been terminated by the clients connecting to a different
2 server after receiving “reconnect now” message, and no connections may be dropped.

3 **[0038]** In some embodiments, the systems described herein may be implemented on
4 one or more servers and/or clients. FIG. 2 is a block diagram of an exemplary system 200 for
5 preserving media streams. In one embodiment, and as will be described in greater detail
6 below, a server 206 may be configured with a stream preservation module 210 that may
7 detect that server 206 is hosting media stream 208 transmitted by a client device 202 (e.g.,
8 via a network 204) and is expected to go offline and, in response to detecting that server 206
9 is expected to go offline, may notify client device 202 that server 206 is expected to go offline.
10 In response to this notification, client device 202 may send a request to a server 216 to host
11 media stream 208 and may begin transmitting media stream 208 to server 216 instead of
12 server 206.

13 **[0039]** Servers 206 and/or 216 generally represent any type or form of backend computing
14 device that may host media streams. Examples of server 206 may include, without limitation,
15 media servers, application servers, database servers, and/or any other relevant type of server.
16 Although illustrated as independent entities in FIG. 2, server 206 and/or server 216 represent
17 a group of multiple servers that operate in conjunction with one another (e.g., as part of a
18 media hosting platform and/or social networking platform).

19 **[0040]** Client device 202 generally represents any type or form of computing device
20 capable of reading computer-executable instructions. For example, client device 202 may
21 represent a mobile computing device such as a smart phone. Additional examples of client
22 device 202 may include, without limitation, a laptop, a desktop, a wearable device, a network-
23 capable camera device, a smart device, an artificial reality device, a personal digital assistant
24 (PDA), etc.

25 **[0041]** Media stream 208 generally represents any type or form of streaming digital media.
26 In some embodiments, media stream 208 may include streaming video. Additionally or
27 alternatively, media stream 208 may include streaming audio metadata, and/or timed
28 metadata (e.g., captions, subtitles, timecode information, etc.). In some examples, media
29 stream 208 may be a live media stream being captured in real-time (e.g., by client device 202).
30 For example, media stream 208 may be a live stream of a performance, sporting event, social
31 event, political event, and/or any other type of event. In another example, media stream 208
32 may be a video and/or audio call between two or more participants.

1 **[0042]** As illustrated in FIG. 2, example system 200 may also include one or more
2 memory devices, such as memory 240. Memory 240 generally represents any type or form of
3 volatile or non-volatile storage device or medium capable of storing data and/or computer-
4 readable instructions. In one example, memory 240 may store, load, and/or maintain one or
5 more of the modules illustrated in FIG. 2. Examples of memory 240 include, without
6 limitation, Random Access Memory (RAM), Read Only Memory (ROM), flash memory, Hard
7 Disk Drives (HDDs), Solid-State Drives (SSDs), optical disk drives, caches, variations or
8 combinations of one or more of the same, and/or any other suitable storage memory.

9 **[0043]** As illustrated in FIG. 2, example system 200 may also include one or more
10 physical processors, such as physical processor 230. Physical processor 230 generally
11 represents any type or form of hardware-implemented processing unit capable of
12 interpreting and/or executing computer-readable instructions. In one example, physical
13 processor 230 may access and/or modify one or more of the modules stored in memory 240.
14 Additionally or alternatively, physical processor 230 may execute one or more of the modules.
15 Examples of physical processor 230 include, without limitation, microprocessors,
16 microcontrollers, Central Processing Units (CPUs), Field-Programmable Gate Arrays (FPGAs)
17 that implement softcore processors, Application-Specific Integrated Circuits (ASICs), portions
18 of one or more of the same, variations or combinations of one or more of the same, and/or
19 any other suitable physical processor.

20 **[0044]** FIG. 3 is a flow diagram of an exemplary method 300 for preserving media
21 streams as described from the server perspective. In some examples, at step 302, the systems
22 described herein may identify a media stream transmitted by a client device to a server that
23 hosts the media stream for access by additional devices. The systems described herein may
24 identify a media stream in a variety of ways and/or contexts. For example, the systems
25 described herein may identify a live video stream being transmitted by a smart phone to a
26 social media platform via a TCP connection using real time messaging protocol (RTMP). At
27 step 304, one or more of the systems described herein may detect that the server is expected
28 to go offline. The systems described herein may determine that the server is expected to go
29 offline in a variety of ways. For example, the systems described herein may detect that the
30 server is expected to go offline in five minutes for scheduled maintenance. In one example,
31 the systems described herein may monitor the maintenance schedule of servers. Additionally
32 or alternatively, the systems described herein may detect when a server has stopped

1 accepting new connection requests.

2 **[0045]** At step 306, one or more of the systems described herein may send, in
3 response to detecting that the server is expected to go offline, a message to the client
4 indicating that the server is expected to go offline. The systems described herein may send
5 the message in a variety of ways. For example, the systems described herein may send an
6 RTMP message with the command name set to “ReconnectNow” to the client device. In some
7 embodiments, the command object field of the message may include “SessionId” and/or a
8 “TimeRemaining” field. In some examples, “TimeRemaining” may tell the client how long they
9 have to reconnect and/or “SessionId” may be a string that the client will be expected to send
10 in conjunction with the client’s new connection request.

11 **[0046]** At step 308, one or more of the systems described herein may receive, at an
12 additional server, a request from the client to host the media stream. The systems described
13 herein may receive the request in a variety of ways. For example, another server that hosts
14 media streams for the same social networking platform as the original server may receive a
15 new connection request from the client. In some examples, the new connection request may
16 initiate a TCP handshake (e.g., similar to a TCP handshake used to initiate the original
17 connection). At step 310, in response to receiving the request, the systems described herein
18 may host the media stream at the additional server while ceasing to host the media stream
19 at the server that is expected to go offline. The systems described herein may host the media
20 stream in a variety of ways. For example, the additional server may host a live video stream
21 of an event, enabling the stream to continue without disruption while the original server goes
22 offline for maintenance. In some examples, the systems described herein may cease hosting
23 the media stream at the server that is expected to go offline because the client may have
24 ceased transmitting the media stream to that server.

25 **[0047]** In some embodiments, the systems described herein may configure a client
26 device (e.g., by configuring an application on the client device that streams media). FIG. 4 is a
27 flow diagram of an exemplary method 400 for preserving media streams as described from
28 the client perspective. As illustrated in FIG. 4, at step 402, one or more of the systems
29 described herein may transmit, by a client device, a media stream to a server that hosts the
30 media stream for access by additional devices. The client device may transmit the media
31 stream in a variety of ways and/or contexts. For example, a smart phone may transmit a live
32 video stream to a social networking platform for access by devices operated by social media

connections of the smart phone's operator. In some examples, the smart phone may transmit the live video stream via a TCP connection. At step 404, one or more of the systems described herein may receive, by the client device, a message indicating that the server is expected to go offline. The client device may receive the message in a variety of ways. In some examples, the client device may receive the message via the same connection and/or protocol the client is using to transmit the media stream. For example, a smart phone may receive a RTMP command message with "ReconnectNow" in the command name field. In some examples, the RTMP message may include a "SessionId" and/or a "TimeRemaining" field that may tell the client how long it has to reconnect and/or include a string that the client will be expected to send in conjunction with the client's new connection request, respectively.

[0048] At step 406, one or more of the systems described herein may transmit, by the client device, the media stream to the additional server while ceasing to transmit the media stream to the server that is expected to go offline. The client device may transition the media stream to a new server in a variety of ways. For example, upon receiving the "ReconnectNow" message, the client may create a new connection to the same platform (e.g., the same virtual Internet Protocol address) as previously. In some examples, the client may find a logical segment boundary in the video data to switch over to the new connection. In one example, the client may switch at an instantaneous decoder refresh (IDR) frame to ensure that no subsequent video frames reference any frames from previous segments, reducing the chances of any disruption to the media stream.

[0049] In some embodiments, upon reconnecting, the client may send an additional RTMP command message with the command name set to "ReconnectSuccess." In one embodiment, this message may have a command object containing a field "SessionId" set to the session identifier received from the server in the "ReconnectNow" message. This information may enable the server to attribute a successful reconnection to the reconnect message feature.

[0050] In some embodiments, the systems described herein may cause a series of messages to be sent between participating servers and clients at various points in the media streaming process. For example, as illustrated in FIG. 5, a client 502 may perform an initial RTMP handshake with a server that is part of a hosting platform 504. The client may then begin transmitting a media stream to the server. In one embodiment, the client may send a "supports reconnect" message to the server. For example, the client may send an RTMP

1 command message with "SupportsReconnect" as the command name. In some
2 embodiments, the server may mark the media stream and/or client 502 as supporting
3 reconnection messages.

4 **[0051]** At some point during the media stream, an element of hosting platform 504
5 (e.g., a stream preservation module on one or more servers) may detect that the server to
6 which client 502 is connected is about to go offline. In response, the server may send a
7 "reconnect now" message to client 502. In some examples, the "reconnect now" message
8 may include an identifier for the media streaming session. In some embodiments, the server
9 may only send the "reconnect now" message to client 502 if the server has previously
10 received a "supports reconnect" message from client 502. Additionally or alternatively, the
11 "reconnect now" message may be designed to ensure that legacy clients (e.g., clients that do
12 not support reconnect messages) are not negatively impacted (e.g., do not crash) upon
13 receiving the message.

14 **[0052]** After receiving the reconnection message, client 502 may create a new TCP
15 connection with an additional server within hosting platform 504. In some embodiments,
16 client 502 may then send a "reconnect success" message that includes the session identifier
17 previously provided by the prior server, enabling hosting platform 504 to track how many
18 media streams are impacted by the reconnect message feature.

19 **[0053]** As described above, the systems and methods described herein may preserve
20 media streams by signaling to clients that a server is about to go offline, enabling the client
21 to reconnect to a new server and transition at a logical boundary rather than gracelessly
22 dropping the client connection, resulting in disrupted and/or dropped streams. By designing
23 the reconnect message to avoid negatively impacting legacy clients and/or only sending the
24 reconnect message to clients which have affirmatively sent a message indicating they support
25 reconnect messages, the systems described herein may improve the video streaming
26 experience for all clients.

27 **[0054] Example Embodiments**

28 **[0055]** Example 1: A method for preserving streams may include (i) identifying a
29 media stream transmitted by a client device to a server that hosts the media stream for access
30 by additional devices, (ii) detecting that the server is expected to go offline, (iii) sending, in
31 response to detecting that the server is expected to go offline, a message to the client
32 indicating that the server is expected to go offline, (iv) receiving, at an additional server, a

1 request from the client to host the media stream, and (v) in response to receiving the request,
2 hosting the media stream at the additional server while ceasing to host the media stream at
3 the server that is expected to go offline.

4 **[0056]** Example 2: The computer-implemented method of example 1, where the
5 media stream may include a live media stream being captured in real-time by the client
6 device.

7 **[0057]** Example 3: The computer-implemented method of examples 1-2, where the
8 media stream may include a video stream.

9 **[0058]** Example 4: The computer-implemented method of examples 1-3, where
10 detecting that the server is expected to go offline includes detecting that the server is
11 expected to go offline within a predetermined window of time and sending the message
12 includes sending the message in response to detecting that the server is expected to go offline
13 within the predetermined window of time.

14 **[0059]** Example 5: The computer-implemented method of examples 1-4, where
15 detecting that the server is expected to go offline may include detecting that the server is
16 scheduled for upcoming maintenance.

17 **[0060]** Example 6: The computer-implemented method of examples 1-5, where
18 detecting that the server is expected to go offline may include detecting that the server has
19 ceased accepting new connection requests.

20 **[0061]** Example 7: The computer-implemented method of examples 1-6, where
21 sending the message to the client indicating that the server is expected to go offline may
22 include determining that the server has previously received a message from the client
23 indicating that the client device supports reconnection suggestion messages.

24 **[0062]** Example 8: The computer-implemented method of examples 1-7, where the
25 message to the client indicating that the server is expected to go offline includes an expected
26 time at which the server is expected to go offline.

27 **[0063]** Example 9: The computer-implemented method of examples 1-8, where the
28 message to the client indicating that the server is expected to go offline includes a session
29 identifier associated with the media stream.

30 **[0064]** Example 10: The computer-implemented method of examples 1-9, where
31 identifying the media stream transmitted by the client device to the server may include
32 identifying that the client device is transmitting the media stream via a transmission control

1 protocol.

2 **[0065]** Example 11: The computer-implemented method of examples 1-10, where the
3 transmission control protocol is a real time messaging protocol.

4 **[0066]** Example 12: The computer-implemented method of examples 1-11, where
5 sending the message to the client indicating that the server is expected to go offline may
6 include sending the message via the transmission control protocol.

7 **[0067]** Example 13: A method for preserving video streams may include (i)
8 transmitting, by a client device, a media stream to a server that hosts the media stream for
9 access by additional devices, (ii) receiving, by the client device, a message indicating that the
10 server is expected to go offline, (iii) in response to receiving the message, sending, by the
11 client device to an additional server, a request to host the media stream, and (iv) transmitting,
12 by the client device, the media stream to the additional server while ceasing to transmit the
13 media stream to the server that is expected to go offline.

14 **[0068]** Example 14: The system of example 13, where transmitting the media stream
15 to the server may include sending, by the client device, a message to the server indicating
16 that the client device accepts reconnection suggestion messages.

17 **[0069]** Example 15: The system of examples 13-14 may further include sending, to the
18 additional server, a session identifier associated with the media stream.

19 **[0070]** Example 16: The system of examples 13-15, where , the message indicating
20 that the server is expected to go offline includes the session identifier and sending, to the
21 additional server, the session identifier associated with the media stream includes sending
22 the session identifier received from the server.

23 **[0071]** Example 17: The system of examples 13-16, where transmitting, by the client
24 device, the media stream to the additional server while ceasing to transmit the media stream
25 to the server that is expected to go offline may include avoiding data loss by switching, by the
26 client device, transmitting the media stream from the server to the additional server at a
27 segment boundary within the media stream.

28 **[0072]** Example 18: A system for preserving media streams may include (i) a client
29 device that transmits a media stream, (ii) a server that hosts the media stream for access by
30 additional devices, (iii) a stream preservation module that (a) detects that the server that
31 hosts the media stream is expected to go offline and (b) in response to detecting that the
32 server is expected to go offline, notifies the client device that the server is expected to go

1 offline, and (iv) an additional server that receives a request from the client to host the media
2 stream and hosts the media stream.

3 **[0073]** Example 19: The system of example 18, where the media stream includes a live
4 video stream being captured in real-time by the client device.

5 **[0074]** Example 20: The system of examples 18-19, where the client device sends the
6 server a message indicating that the client device accepts reconnection messages, the stream
7 preservation module notifies the client device that the server is expected to go offline in
8 response to detecting that the client device sent the server the message, and the client
9 device, in response to being notified by the stream preservation module that the server is
10 expected to go offline, sends the request to the additional server to host the media stream.

11 **[0075]** As detailed above, the computing devices and systems described and/or illustrated
12 herein broadly represent any type or form of computing device or system capable of
13 executing computer-readable instructions, such as those contained within the modules
14 described herein. In their most basic configuration, these computing device(s) may each
15 include at least one memory device and at least one physical processor.

16 **[0076]** In some examples, the term “memory device” generally refers to any type or form
17 of volatile or non-volatile storage device or medium capable of storing data and/or computer-
18 readable instructions. In one example, a memory device may store, load, and/or maintain one
19 or more of the modules described herein. Examples of memory devices include, without
20 limitation, Random Access Memory (RAM), Read Only Memory (ROM), flash memory, Hard
21 Disk Drives (HDDs), Solid-State Drives (SSDs), optical disk drives, caches, variations or
22 combinations of one or more of the same, or any other suitable storage memory.

23 **[0077]** In some examples, the term “physical processor” generally refers to any type or
24 form of hardware-implemented processing unit capable of interpreting and/or executing
25 computer-readable instructions. In one example, a physical processor may access and/or
26 modify one or more modules stored in the above-described memory device. Examples of
27 physical processors include, without limitation, microprocessors, microcontrollers, Central
28 Processing Units (CPUs), Field-Programmable Gate Arrays (FPGAs) that implement softcore
29 processors, Application-Specific Integrated Circuits (ASICs), portions of one or more of the
30 same, variations or combinations of one or more of the same, or any other suitable physical
31 processor.

32 **[0078]** Although illustrated as separate elements, the modules described and/or

1 illustrated herein may represent portions of a single module or application. In addition, in
2 certain embodiments one or more of these modules may represent one or more software
3 applications or programs that, when executed by a computing device, may cause the
4 computing device to perform one or more tasks. For example, one or more of the modules
5 described and/or illustrated herein may represent modules stored and configured to run on
6 one or more of the computing devices or systems described and/or illustrated herein. One or
7 more of these modules may also represent all or portions of one or more special-purpose
8 computers configured to perform one or more tasks.

9 **[0079]** In addition, one or more of the modules described herein may transform data,
10 physical devices, and/or representations of physical devices from one form to another. For
11 example, one or more of the modules recited herein may receive image data to be
12 transformed, transform the image data into a data structure that stores user characteristic
13 data, output a result of the transformation to select a customized interactive ice breaker
14 widget relevant to the user, use the result of the transformation to present the widget to the
15 user, and store the result of the transformation to create a record of the presented widget.
16 Additionally or alternatively, one or more of the modules recited herein may transform a
17 processor, volatile memory, non-volatile memory, and/or any other portion of a physical
18 computing device from one form to another by executing on the computing device, storing
19 data on the computing device, and/or otherwise interacting with the computing device.

20 **[0080]** In some embodiments, the term “computer-readable medium” generally
21 refers to any form of device, carrier, or medium capable of storing or carrying computer-
22 readable instructions. Examples of computer-readable media include, without limitation,
23 transmission-type media, such as carrier waves, and non-transitory-type media, such as
24 magnetic-storage media (e.g., hard disk drives, tape drives, and floppy disks), optical-storage
25 media (e.g., Compact Disks (CDs), Digital Video Disks (DVDs), and BLU-RAY disks), electronic-
26 storage media (e.g., solid-state drives and flash media), and other distribution systems.

27 **[0081]** The process parameters and sequence of the steps described and/or
28 illustrated herein are given by way of example only and can be varied as desired. For example,
29 while the steps illustrated and/or described herein may be shown or discussed in a particular
30 order, these steps do not necessarily need to be performed in the order illustrated or
31 discussed. The various exemplary methods described and/or illustrated herein may also omit
32 one or more of the steps described or illustrated herein or include additional steps in addition

1 to those disclosed.

2 **[0082]** The preceding description has been provided to enable others skilled in the art
3 to best utilize various aspects of the exemplary embodiments disclosed herein. This
4 exemplary description is not intended to be exhaustive or to be limited to any precise form
5 disclosed. Many modifications and variations are possible without departing from the scope
6 of the claims. The embodiments disclosed herein should be considered in all respects
7 illustrative and not restrictive. Reference should be made to the appended claims and their
8 equivalents in determining the scope of the instant disclosure.

9 **[0083]** Unless otherwise noted, the terms “connected to” and “coupled to” (and their
10 derivatives), as used in the specification and claims, are to be construed as permitting both
11 direct and indirect (i.e., via other elements or components) connection. In addition, the terms
12 “a” or “an,” as used in the specification and claims, are to be construed as meaning “at least
13 one of.” Finally, for ease of use, the terms “including” and “having” (and their derivatives), as
14 used in the specification and claims, are interchangeable with and have the same meaning as
15 the word “comprising.”

16

1 CLAIMS:

2 1. A computer-implemented method comprising:
3 identifying a media stream transmitted by a client device to a server that hosts the
4 media stream for access by additional devices;
5 detecting that the server is expected to go offline;
6 sending, in response to detecting that the server is expected to go offline, a message
7 to the client device indicating that the server is expected to go offline;
8 receiving, at an additional server, a request from the client device to host the media
9 stream; and
10 in response to receiving the request, hosting the media stream at the additional server
11 while ceasing to host the media stream at the server that is expected to go offline.

12 2. The computer-implemented method of claim 1, wherein the media stream
13 comprises: a live media stream being captured in real-time by the client device, and/or a video
14 stream.

15 3. The computer-implemented method of claim 1 or claim 2, wherein:
16 detecting that the server is expected to go offline comprises detecting that the server
17 is expected to go offline within a predetermined window of time; and
18 sending the message comprises sending the message in response to detecting that the
19 server is expected to go offline within the predetermined window of time.

20 4. The computer-implemented method of claim 1, claim 2 or claim 3, wherein
21 detecting that the server is expected to go offline comprises:

- 22 i. detecting that the server is scheduled for upcoming maintenance; and/or
23 ii. detecting that the server has ceased accepting new connection requests;

24 5. The computer-implemented method of any one of the preceding claims,
25 wherein sending the message to the client device indicating that the server is expected to go
26 offline comprises determining that the server has previously received a message from the
27 client device indicating that the client device supports reconnection suggestion messages.

28 6. The computer-implemented method of any one of the preceding claims,
29 wherein the message to the client device indicating that the server is expected to go offline
30 comprises:

- 31 i. an expected time at which the server is expected to go offline; and/or
32 ii. a session identifier associated with the media stream.

1 7. The computer-implemented method of claim 1, wherein identifying the media
2 stream transmitted by the client device to the server comprises identifying that the client
3 device is transmitting the media stream via a transmission control protocol.

4 8. The computer-implemented method of claim 7, wherein the transmission
5 control protocol comprises a real time messaging protocol.

6 9. The computer-implemented method of claim 7 or claim 8, wherein sending the
7 message to the client device indicating that the server is expected to go offline comprises
8 sending the message via the transmission control protocol.

9 10. A computer-implemented method comprising:
10 transmitting, by a client device, a media stream to a server that hosts the media
11 stream for access by additional devices;
12 receiving, by the client device, a message indicating that the server is expected to go
13 offline;
14 in response to receiving the message, sending, by the client device to an additional
15 server, a request to host the media stream; and
16 transmitting, by the client device, the media stream to the additional server while
17 ceasing to transmit the media stream to the server that is expected to go offline.

18 11. The computer-implemented method of claim 10, wherein transmitting the
19 media stream to the server comprises sending, by the client device, a message to the server
20 indicating that the client device accepts reconnection suggestion messages.

21 12. The computer-implemented method of claim 10 or claim 11, further
22 comprising sending, to the additional server, a session identifier associated with the media
23 stream; and preferably wherein:

24 the message indicating that the server is expected to go offline includes the session
25 identifier; and

26 sending, to the additional server, the session identifier associated with the media
27 stream comprises sending the session identifier received from the server.

28 13. The computer-implemented method of claim 10, claim 11 or claim 12, wherein
29 transmitting, by the client device, the media stream to the additional server while ceasing to
30 transmit the media stream to the server that is expected to go offline comprises avoiding data
31 loss by switching, by the client device, transmitting the media stream from the server to the
32 additional server at a segment boundary within the media stream.

1 14. A system comprising:

2 a client device that transmits a media stream;

3 a server that hosts the media stream for access by additional devices;

4 a stream preservation module that:

5 detects that the server that hosts the media stream is expected to go offline;

6 and

7 in response to detecting that the server is expected to go offline, notifies the
8 client device that the server is expected to go offline; and

9 an additional server that:

10 receives a request from the client device to host the media stream; and

11 hosts the media stream.

12 15. The system of claim 14, wherein the media stream comprises a live video
13 stream being captured in real-time by the client device; and/or preferably wherein:

14 the client device sends the server a message indicating that the client device accepts
15 reconnection messages;

16 the stream preservation module notifies the client device that the server is expected
17 to go offline in response to detecting that the client device sent the server the message; and

18 the client device, in response to being notified by the stream preservation module
19 that the server is expected to go offline, sends the request to the additional server to host the
20 media stream.

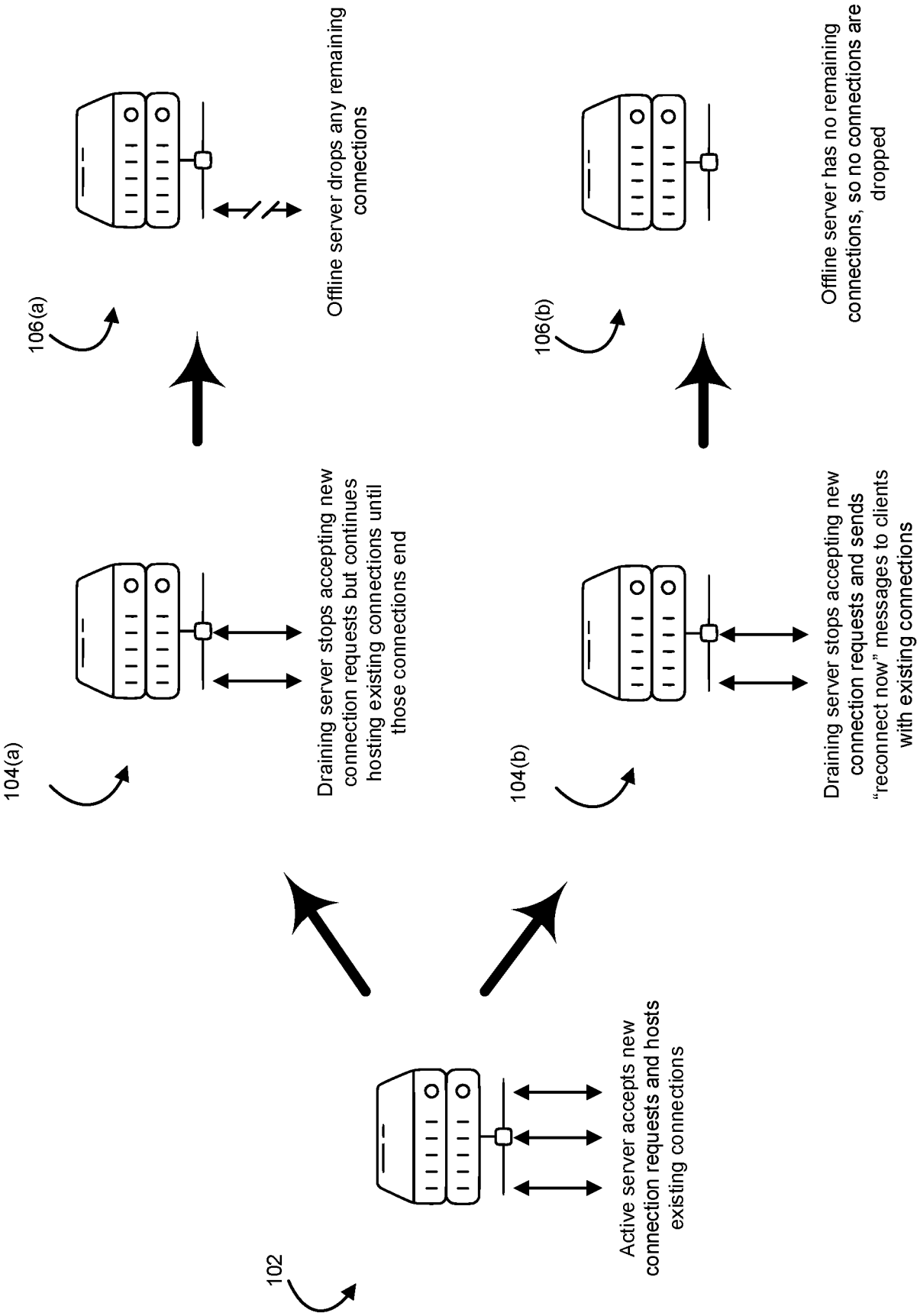
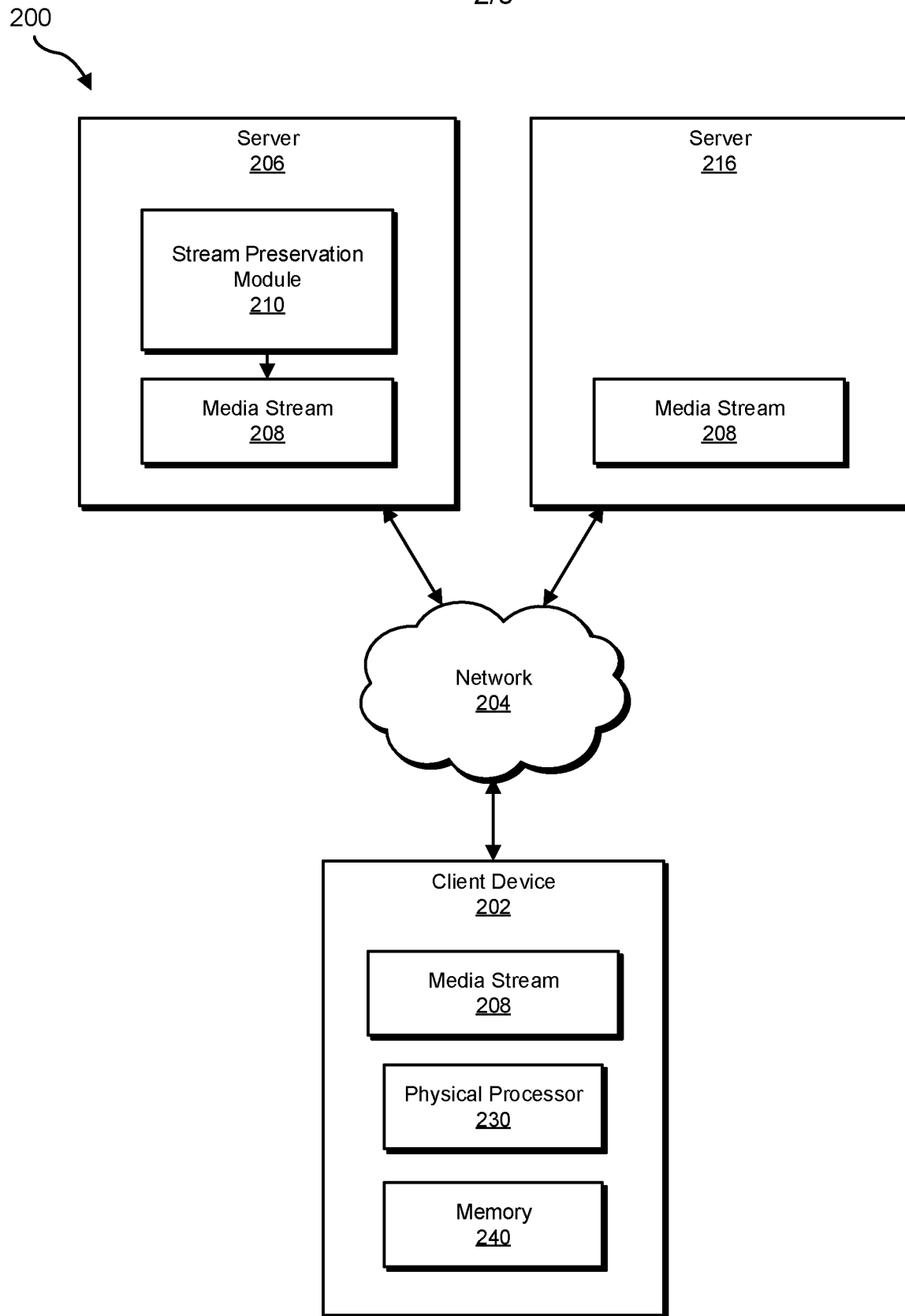
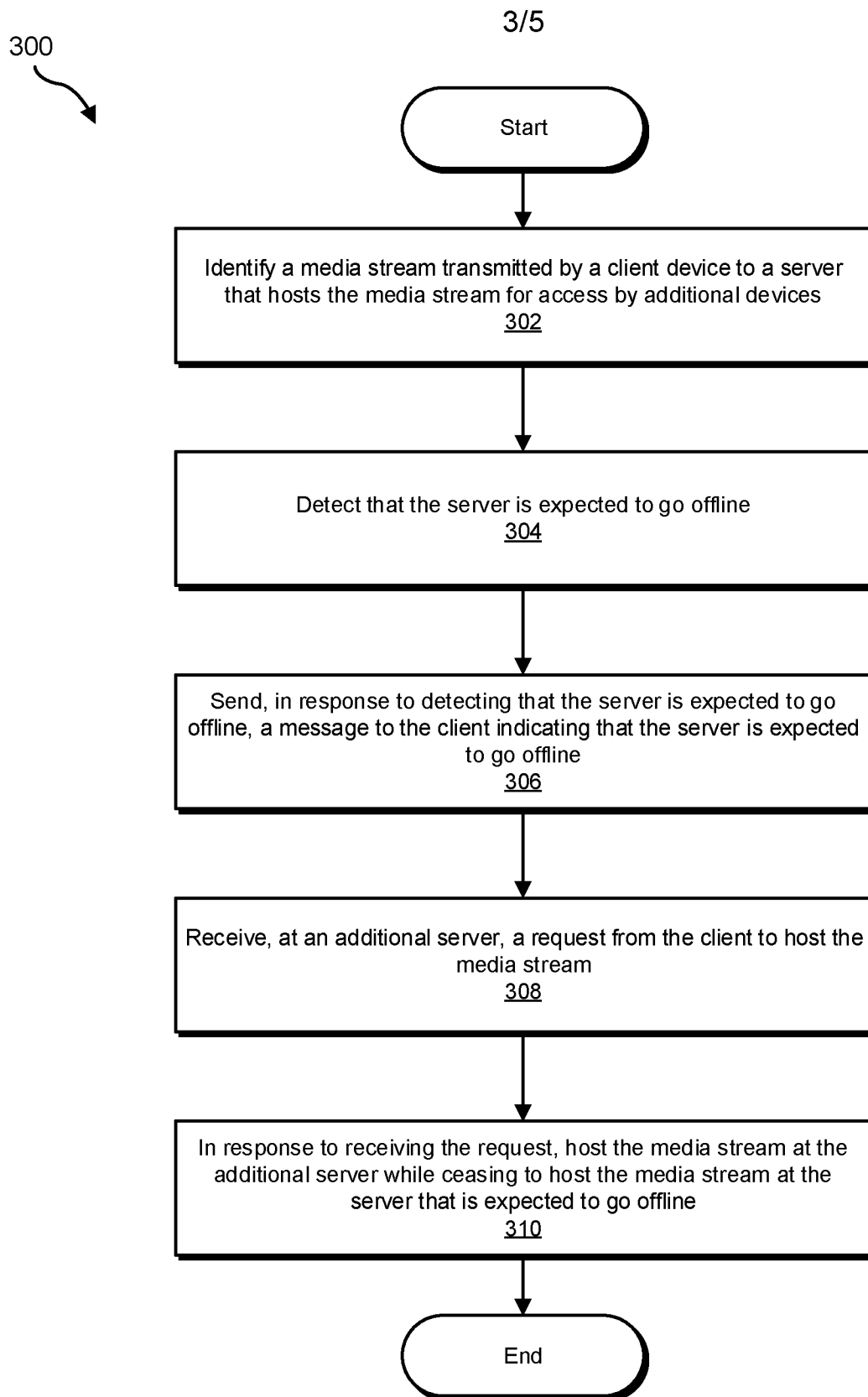
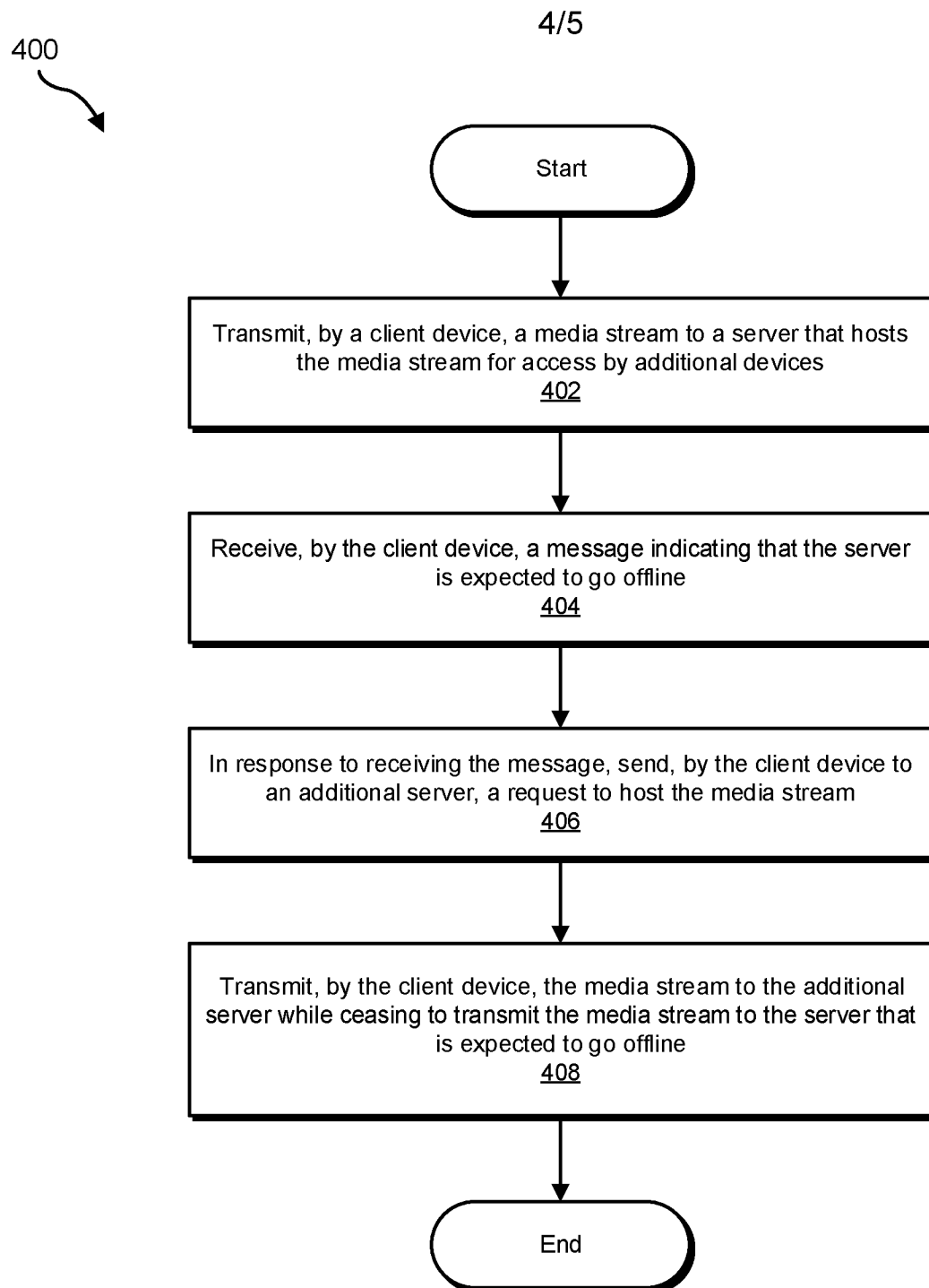


FIG. 1

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**FIG. 2**

**FIG. 3**

**FIG. 4**

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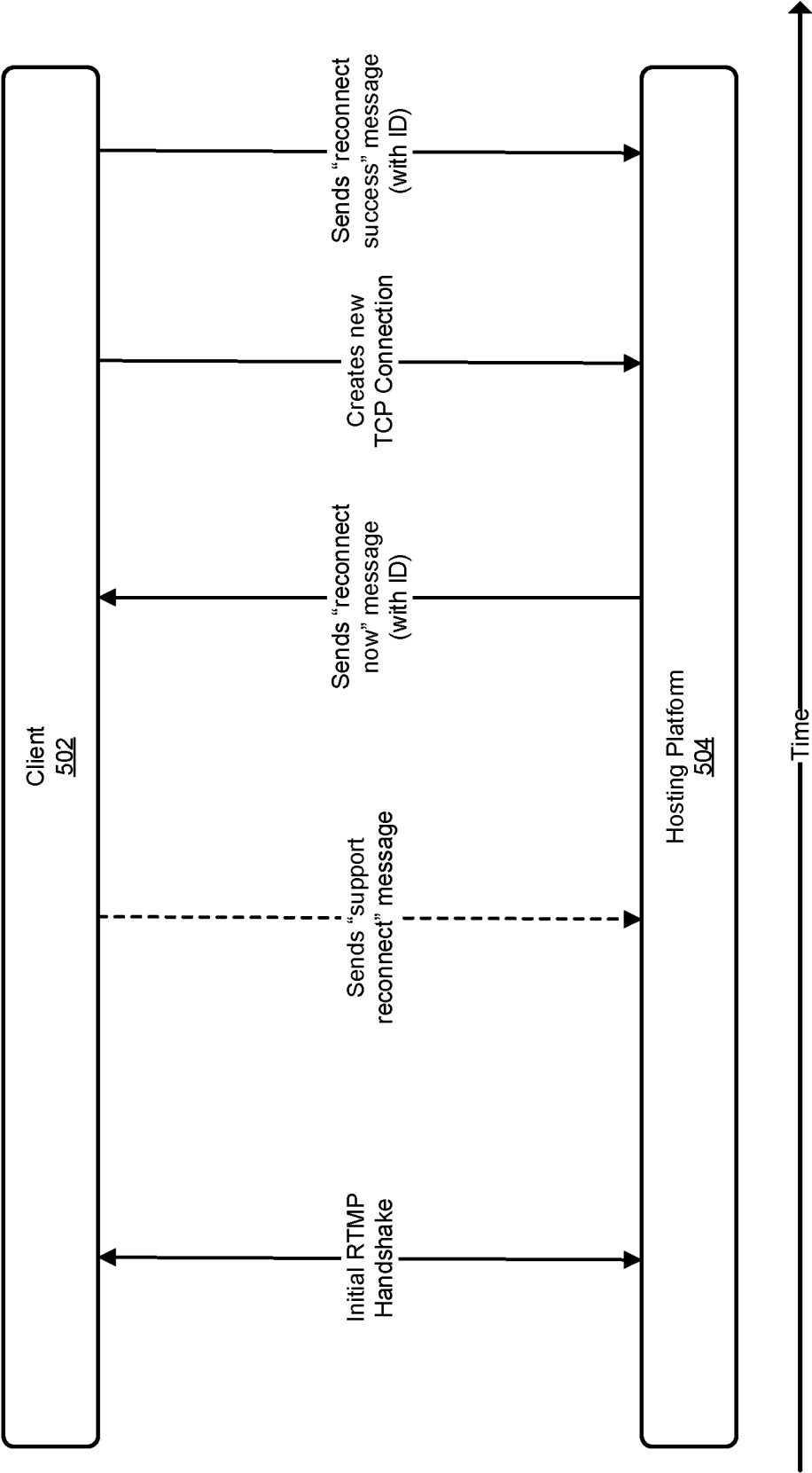


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2022/039655

A. CLASSIFICATION OF SUBJECT MATTER INV. H04N21/2743 H04L67/148 H04N21/6437 ADD.		
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) H04N 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 practicable, 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	US 2018/241825 A1 (BOLTON IAN CHARLES [GB] ET AL) 23 August 2018 (2018-08-23) paragraph [0016] - paragraph [0036]; figures 2, 5 -----	1-15
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 10 November 2022		Date of mailing of the international search report 18/11/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Santos Conde, José

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2022/039655

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018241825 A1	23-08-2018	CN 110326271 A	11-10-2019
		EP 3563559 A1	06-11-2019
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