

US Patent & Trademark Office

Patent Public Search | Text View

United States Patent Application Publication

20250254386

Kind Code

A1

Publication Date

August 07, 2025

Inventor(s)

Hassler; Garey

METHODS AND SYSTEMS FOR CONTENT DELIVERY

Abstract

Methods and systems for delivering content are described. A content distribution network may utilize multiple content sources and datacenters when delivering content to a requesting device. One or more service metrics associated with the content as it is being prepared for delivery at each of the datacenters may be monitored by a quality agent. The quality agent may use the one or more service metrics to select a distribution datacenter to deliver the content to the requesting device. The quality agent may instruct the remaining datacenters to disable delivery of the content to the requesting device.

Inventors: Hassler; Garey (Castle Pines, CO)

Applicant: Comcast Cable Communications, LLC (Philadelphia, PA)

Family ID: 72423595

Appl. No.: 19/012473

Filed: January 07, 2025

Related U.S. Application Data

parent US continuation 18302419 20230418 parent-grant-document US 12231722 child US 19012473

parent US continuation 16521264 20190724 parent-grant-document US 11671653 child US 18302419

us-provisional-application US 62818452 20190314

Publication Classification

Int. Cl.: H04N21/44 (20110101); H04N21/437 (20110101); H04N21/442 (20110101);
H04N21/83 (20110101)

U.S. Cl.:

CPC **H04N21/44008** (20130101); **H04N21/437** (20130101); **H04N21/442** (20130101);
 H04N21/83 (20130101);

Background/Summary

CROSS REFERENCE TO RELATED PATENT APPLICATION [0001] This application is a continuation of U.S. application Ser. No. 16/521,264, filed Jul. 24, 2019, which claims priority to U.S. Application No. 62/818,452, filed on Mar. 14, 2019, which are herein incorporated by reference in their entirety.

BACKGROUND

[0002] In content distribution networks, latency in preparing a given content item for delivery may cause errors, failed content delivery attempts, and a poor content consumption experience. Content distribution networks may employ a process in which requests for a given content item are received by intermediate devices that forward the requests to a series of other devices that obtain the given content item. Computational times required for these devices to determine if they are equipped to process a request for the given content item, or to implement redundancy processes when they cannot process the request, contribute to latency in a content distribution network and increase the overall content delivery time. These and other considerations are addressed by the present description.

SUMMARY

[0003] It is to be understood that both the following general description and the following detailed description are exemplary and explanatory only and are not restrictive. Methods and systems for content delivery are described. In order to provide optimal quality, a content distribution network may utilize multiple content sources and multiple datacenters when delivering a given content item to a requesting device. The given content item may be delivered to the requesting device via a first content source, irrespective of the requesting device having requested the content item to be delivered via a second content source. One or more service metrics associated with the given content item as it is being prepared for delivery at each of the datacenters may be monitored by a quality agent. The quality agent may use the one or more service metrics to select a distribution datacenter to deliver the given content item to the requesting device, and the quality agent may instruct the remaining datacenters to disable delivery of the given content item to the requesting device. This summary is not intended to identify critical or essential features of the disclosure, but merely to summarize certain features and variations thereof. Other details and features will be described in the sections that follow.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The accompanying drawings, which are incorporated in and constitute a part of the present description serve to explain the principles of the methods and systems described herein:

[0005] FIG. 1 shows a system for delivering content;

[0006] FIG. 2 shows a system for delivering content;

[0007] FIG. 3 shows a system for delivering content;

[0008] FIG. 4 shows a series of communication flows for a system for delivering content;

[0009] FIG. 5 shows a series of communication flows for a system for delivering content;

[0010] FIG. 6 shows a system for delivering content;

[0011] FIG. 7 shows a system for delivering content;
[0012] FIGS. 8A and 8B show a system for delivering content;
[0013] FIG. 9 shows a flowchart of a method for delivering content;
[0014] FIG. 10 shows a flowchart of a method for delivering content;
[0015] FIG. 11 shows a flowchart of a method for delivering content; and
[0016] FIG. 12 shows a block diagram of a computing device for delivering content.

DETAILED DESCRIPTION

[0017] As used in the specification and the appended claims, the singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise. Ranges may be expressed herein as from “about” one particular value, and/or to “about” another particular value. When such a range is expressed, another configuration includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about,” it will be understood that the particular value forms another configuration. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0018] “Optional” or “optionally” means that the subsequently described event or circumstance may or may not occur, and that the description includes cases where said event or circumstance occurs and cases where it does not.

[0019] Throughout the description and claims of this specification, the word “comprise” and variations of the word, such as “comprising” and “comprises,” means “including but not limited to,” and is not intended to exclude, for example, other components, integers or steps. “Exemplary” means “an example of” and is not intended to convey an indication of a preferred or ideal configuration. “Such as” is not used in a restrictive sense, but for explanatory purposes.

[0020] It is understood that when combinations, subsets, interactions, groups, etc. of components are described that, while specific reference of each various individual and collective combinations and permutations of these may not be explicitly described, each is specifically contemplated and described herein. This applies to all parts of this application including, but not limited to, steps in described methods. Thus, if there are a variety of additional steps that may be performed it is understood that each of these additional steps may be performed with any specific configuration or combination of configurations of the described methods.

[0021] As will be appreciated by one skilled in the art, hardware, software, or a combination of software and hardware may be implemented. Furthermore, a computer program product on a computer-readable storage medium (e.g., non-transitory) having processor-executable instructions (e.g., computer software) embodied in the storage medium. Any suitable computer-readable storage medium may be utilized including hard disks, CD-ROMs, optical storage devices, magnetic storage devices, memresistors, Non-Volatile Random Access Memory (NVRAM), flash memory, or a combination thereof.

[0022] Throughout this application reference is made to block diagrams and flowcharts. It will be understood that each block of the block diagrams and flowcharts, and combinations of blocks in the block diagrams and flowcharts, respectively, may be implemented by processor-executable instructions. These processor-executable instructions may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the processor-executable instructions which execute on the computer or other programmable data processing apparatus create a device for implementing the functions specified in the flowchart block or blocks.

[0023] These processor-executable instructions may also be stored in a computer-readable memory that may direct a computer or other programmable data processing apparatus to function in a particular manner, such that the processor-executable instructions stored in the computer-readable memory produce an article of manufacture including processor-executable instructions for implementing the function specified in the flowchart block or blocks. The processor-executable

instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the processor-executable instructions that execute on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks.

[0024] Blocks of the block diagrams and flowcharts support combinations of devices for performing the specified functions, combinations of steps for performing the specified functions and program instruction means for performing the specified functions. It will also be understood that each block of the block diagrams and flowcharts, and combinations of blocks in the block diagrams and flowcharts, may be implemented by special purpose hardware-based computer systems that perform the specified functions or steps, or combinations of special purpose hardware and computer instructions.

[0025] “Content items,” as the phrase is used herein, may also be referred to as “content,” “content data,” “content information,” “content asset,” “multimedia asset data file,” or simply “data” or “information”. Content items may be any information or data that may be licensed to one or more individuals (or other entities, such as business or group). Content may be electronic representations of video, audio, text and/or graphics, which may be but is not limited to electronic representations of videos, movies, or other multimedia, which may be but is not limited to data files adhering to MPEG2, MPEG, MPEG4 UHD, HDR, 4k, 8k, Adobe® Flash® Video (.FLV) format or some other video file format whether such format is presently known or developed in the future. The content items described herein may be electronic representations of music, spoken words, or other audio, which may be but is not limited to data files adhering to the MPEG-1 Audio Layer 3 (.MP3) format, Adobe®, CableLabs 1.0,1.1, 3.0, AVC, HEVC, H.264, Nielsen watermarks, V-chip data and Secondary Audio Programs (SAP). Sound Document (.ASND) format or some other format configured to store electronic audio whether such format is presently known or developed in the future. In some cases, content may be data files adhering to the following formats: Portable Document Format (.PDF), Electronic Publication (.EPUB) format created by the International Digital Publishing Forum (IDPF), JPEG (.JPG) format, Portable Network Graphics (.PNG) format, dynamic ad insertion data (.csv), Adobe® Photoshop® (.PSD) format or some other format for electronically storing text, graphics and/or other information whether such format is presently known or developed in the future. Content items may be any combination of the above-described formats.

[0026] “Consuming content” or the “consumption of content,” as those phrases are used herein, may also be referred to as “accessing” content, “providing” content, “sending” content, “viewing” content, “listening” to content, “rendering” content, or “playing” content, among other things. In some cases, the particular term utilized may be dependent on the context in which it is used. Consuming video may also be referred to as viewing or playing the video. Consuming audio may also be referred to as listening to or playing the audio.

[0027] This detailed description may refer to a given entity performing some action. It should be understood that this language may in some cases mean that a system (e.g., a computer) owned and/or controlled by the given entity is actually performing the action.

[0028] A content distribution network may use a plurality of video quality agents to optimize delivery of requested content from one or more content sources. The plurality of video quality agents may each be resident in separate datacenters of the content distribution network. Each distribution datacenter may receive requested content from a unique content source. The plurality of video quality agents may share information relating to one or more service metrics associated with preparation of the requested content for delivery at each distribution datacenter. In this way, the plurality of video quality agents may operate in unison and ensure that requested content is received, packaged, and delivered by the distribution datacenter having a highest service metric associated with the requested content. The plurality of video quality agents may facilitate delivery

of the requested content from an alternate content source when delivery of the requested content from a first content source would result in sub-optimal delivery quality. The present description thus provides an improvement to computing technology in at least that the present description provides intelligent delivery processes that improve the overall architecture and robustness of the content distribution network.

[0029] FIG. 1 shows a system **100** for content delivery. Those skilled in the art will appreciate that digital equipment and/or analog equipment may be employed. One skilled in the art will appreciate that provided herein is a functional description and that the respective functions may be performed by software, hardware, or a combination of software and hardware. The system **100** may have a central location **101** (e.g., a headend), which may receive content (e.g., data, input programming, and the like) from multiple sources. The central location **101** may combine the content from the various sources and may distribute the content to user (e.g., subscriber) locations (e.g., a user location **119**) via a network **116** (e.g., content distribution and/or access system).

[0030] The central location **101** may receive content from a variety of sources **102a**, **102b**, and **102c**. Each of the sources **102a**, **102b**, and **102c** may be a datacenter having one or more packaging devices, transcoding devices, and content quality devices (e.g., as shown in FIG. 2 and discussed below). The content may be sent from any of the sources **102a**, **102b**, or **102c** to the central location **101** via a variety of transmission paths, including wireless paths (e.g., satellite paths **103a**, **103b**) and terrestrial paths **104**. The central location **101** may also receive content from a direct feed source **106** via a direct line **105** (e.g., one or more communication links and/or one or more communication paths). Other input sources may be capture devices such as a video camera **109** or a server **110**. The content sent by the content sources may comprise a single content item, a portion of a content item (e.g., content fragment), a content stream, a multiplex that includes several content items, and/or the like. The content item may be an advertisement.

[0031] The central location **101** may have one or a plurality of receivers **111a**, **111b**, **111c**, **111d** that are associated with one or more corresponding input sources. The central location **101** may comprise one or more encoders **112**, switches **113**, multiplexers, and/or the like. An encoder **112** may compress, encrypt, transform, and/or otherwise encode content. The encoder **112** may encode content based on one or more compression standards, such as MPEG. The encoder may receive content from the video camera **109** and/or other source and apply one or more encoding algorithms to the received content. A switch **113** may provide access to server **110**, which may be a Pay-Per-View server, a data server, an internet router, a network system, a phone system, and the like. Some signals may require additional processing, such as signal multiplexing, prior to being modulated. Such multiplexing may be performed by a multiplexer **114**.

[0032] The central location **101** may comprise one or more modulators **115** for interfacing with a network **116**. A modulator may receive content from a receiver **111**, encoder **112**, multiplexer **114**, and/or the like. A modulator **115** may convert the received content into a modulated output signal suitable for transmission over the network **116**. A modulator **115** may map portions of the content to data bits expressed as signals (e.g., sinusoidal signals) at corresponding subcarrier frequencies of a data symbol. The output signals from the modulator **115** may be combined (e.g., packaged), using equipment such as a combiner **117** (e.g., a packaging device), for input into the network **116**.

[0033] The network **116** may be a content distribution network, a content access network, and/or the like. The network **116** may be configured to send content from a variety of sources using a variety of network paths, protocols, devices, and/or the like. The content distribution network and/or content access network may be managed (e.g., deployed, serviced) by a content provider, a service provider, and/or the like. The network **116** may have a plurality of communication links connecting a plurality of devices.

[0034] A control system **118** may permit a system operator to control and monitor the functions and performance of system **100**. The control system **118** may interface, monitor, and/or control a variety of functions, including, but not limited to, the channel lineup for a television system, billing

for each user, conditional access for content distributed to users, and the like. The control system **118** may provide input to the modulators **115** for setting operating parameters, such as system specific MPEG table packet organization or conditional access information. The control system **118** may be located at the central location **101** or at a remote location.

[0035] The network **116** may distribute signals from the central location **101** to user locations, such as a user location **119**. The network **116** may be an optical fiber network, a coaxial cable network, a hybrid fiber-coaxial network, a wireless network, a satellite system, a direct broadcast system, an Ethernet network, a high-definition multimedia interface network, a Universal Serial Bus (USB) network, or any combination thereof.

[0036] A multitude of users may be connected to the network **116**. At the user location **119**, a media device **120** may demodulate and/or decode, if needed, the signals for display on a display device **121**, such as on a television set (TV) or a computer monitor. The media device **120** may be a demodulator, decoder, frequency tuner, and/or the like. The media device **120** may be directly connected to the network **116** (e.g., for communications via in-band and/or out-of-band signals of a content delivery network) and/or connected to the network **116** via a communication terminal **122** ("CT") (e.g., for communications via a packet switched network). The media device **120** may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. The media device **120** may implement one or more applications, such as content viewers, social media applications, news applications, gaming applications, content stores, electronic program guides, and/or the like. Those skilled in the art will appreciate that the signal may be demodulated and/or decoded in a variety of equipment, including the communication terminal **122**, a computer, a TV, a monitor, or a satellite dish.

[0037] The communication terminal **122** may be located at the user location **119**. The communication terminal **122** may be configured to communicate with the network **116**. The communication terminal **122** may be a modem (e.g., cable modem), a router, a gateway, a switch, a network terminal (e.g., optical network unit), and/or the like. The communication terminal **122** may be configured for communication with the network **116** via a variety of protocols, such as internet protocol, transmission control protocol, file transfer protocol, session initiation protocol, voice over internet protocol, and/or the like. The communication terminal **122**, for a cable network, may be configured to provide network access via a variety of communication protocols and standards, such as Data Over Cable Service Interface Specification (DOCSIS).

[0038] A first access point **123** (e.g., a wireless access point) may be located at the user location **119**. The first access point **123** may be configured to provide one or more wireless networks in at least a portion of the user location **119**. The first access point **123** may be configured to provide access to the network **116** to devices configured with a compatible wireless radio, such as a mobile device **124**, the media device **120**, the display device **121**, or other computing devices (e.g., laptops, sensor devices, security devices). The first access point **123** may provide a user managed network (e.g., local area network), a service provider managed network (e.g., public network for users of the service provider), and/or the like. It should be noted that in some configurations, some or all of the first access point **123**, the communication terminal **122**, the media device **120**, and the display device **121** may be implemented as a single device.

[0039] The user location **119** may not necessarily be fixed. A user may receive content from the network **116** on the mobile device **124**. The mobile device **124** may be a laptop computer, a tablet device, a computer station, a personal data assistant (PDA), a smart device (e.g., smart phone, smart apparel, smart watch, smart glasses), GPS, a vehicle entertainment system, a portable media player, a combination thereof, and/or the like. The mobile device **124** may communicate with a variety of access points (e.g., at different times and locations or simultaneously if within range of multiple access points). The mobile device **124** may communicate with a second access point **125**. The second access point **125** may be a cell tower, a wireless hotspot, another mobile device, and/or

other remote access point. The second access point **125** may be within range of the user location **119** or remote from the user location **119**. The second access point **125** may be located along a travel route, within a business or residence, or other useful locations (e.g., travel stop, city center, park, etc.).

[0040] The system **100** may have an application server **126**. The application server **126** may provide services related to applications. The application server **126** may have an application store. The application store may be configured to allow users to purchase, download, install, upgrade, and/or otherwise manage applications. The application server **126** may be configured to allow users to download applications to a device, such as the mobile device **124**, communications terminal **122**, the media device **120**, the display device **121**, and/or the like. The application server **126** may run one or more application services to send data, handle requests, and/or otherwise facilitate operation of applications for the user.

[0041] The system **100** may have one or more content sources **127**. The content source **127** may be configured to send content (e.g., video, audio, games, applications, data) to the user. The content source **127** may be configured to send streaming media, such as on-demand content (e.g., video on-demand), content recordings, and/or the like. The content source **127** may be managed by third party content providers, service providers, online content providers, over-the-top content providers, and/or the like. The content may be provided via a subscription, by individual item purchase or rental, and/or the like. The content source **127** may be configured to send the content via a packet switched network path, such as via an internet protocol (IP) based connection. The content may be accessed by users via applications, such as mobile applications, television applications, set-top box applications, gaming device applications, and/or the like. An application may be a custom application (e.g., by content provider, for a specific device), a general content browser (e.g., web browser), an electronic program guide, and/or the like.

[0042] The system **100** may have an edge device **128**. The edge device **128** may be configured to provide content, services, and/or the like to the user location **119**. The edge device **128** may be one of a plurality of edge devices distributed across the network **116**. The edge device **128** may be located in a region proximate to the user location **119**. A request for content from the user may be directed to the edge device **128** (e.g., due to the location of the edge device and/or network conditions). The edge device **128** may be configured to receive packaged content (e.g., from the central location **101** and/or any of the sources **102a**, **102b**, or **102c**) for delivery to the user, convert content for delivery to the user (e.g., in a specific format requested by a user device), send the user a manifest file (e.g., or other index file describing portions of the content), send streaming content (e.g., unicast, multicast), provide a file transfer, and/or the like. The edge device **128** may cache or otherwise store content (e.g., frequently requested content) to enable faster delivery of content to users.

[0043] The edge device **128** may receive a request for content from the user location **119**. The edge device **128** may receive a request for content from a client device (e.g., the media device **120**, the communication terminal **122**, etc.). The edge device **128** may establish a communication link with the client device. The edge device **128** may determine whether the edge device **128** has access to the requested content. The edge device **128** may determine whether the edge device **128** has access to the requested content after receiving the request for content from the client device. The edge device **128** may determine whether a cache associated with the edge device **128** has the requested content (e.g., a mid-tier cache, such as the central location **101**). If the edge device **128** does not have access to the requested content, the edge device **128** may request the requested content from the central location **101**, a different edge device **128** and/or the content source **127**.

[0044] The edge device **128** may establish a communication link with the central location **101**, a different edge device **128** and/or the content source **127** to receive the requested content. The edge device **128** may track the content received from the central location **101**, a different edge device **128** and/or the content source **127**. The control system **118** may determine that the central location

101 does not have access to the requested content. The control system **118** may establish a communication link with input source **102a** (e.g., based on the request for the content). The input source **102a** may send a redirect message to the control system **118** indicating that the requested content is available from input source **102b**. The central location may receive the requested content from input source **102b** and provide the requested content to the edge device **128** for delivery to the user.

[0045] The network **116** may have a network component **129**. The network component **129** may be any device, module, and/or the like communicatively coupled to the network **116**. The network component **129** may be a router, a switch, a splitter, a packager, a gateway, an encoder, a storage device, a multiplexer, a network access location (e.g., tap), physical link, and/or the like.

[0046] FIG. 2 shows a system **200** for content delivery. The system **200** may receive content from a content source **202** at a datacenter **204** (e.g., input source **102a**, **102b**, **102c** of FIG. 1). The system **200** may receive content from the content source **202** at a datacenter **214** (e.g., input source **102a**, **102b**, **102c** of FIG. 1). The content may be sent from the content source **202** to the datacenter **204** and/or the datacenter **214** via a variety of transmission paths, including a wireless path (e.g., satellite paths **103a**, **103b**) and/or a terrestrial path (e.g., terrestrial path **104**). The system **200** may have a mid-tier cache **224** (e.g., any of the caching devices shown in FIG. 1 or in FIGS. 3-8). The system **200** may be a content distribution network. While not shown for case of explanation, a person skilled in the art would appreciate that the system **200** may have any number of content sources **202**, datacenters **204**, **214**, and mid-tier caches **224**.

[0047] The datacenter **204** may have a transcoder **206**, a video quality (“VQ”) measurer **208**, a packager **210**, and a video quality (“VQ”) agent **212**. The transcoder **206** may receive a first portion of a content item from content source **202**, encode (e.g., format) the received first portion of the content item, and send the encoded first portion of the content item as well as other data (e.g., a score determined by the packager **210** based on the encoded first portion of the content item) to the packager **210**. The VQ measurer **208** may receive the encoded first portion of the content item (e.g., as well as the score determined by the packager **210**) from the transcoder **206** and determine an associated transcoded quality level. The VQ measurer **208** may determine a first quality level based on the transcoded quality level, a source quality level associated with the content source **202** and the content item, the score determined by the packager **210**; and/or a packaged quality level associated with the one or more portions of the content item previously packaged by the packager **210**. The VQ measurer **208** may send an indication of the first quality level associated with the encoded first portion of the content item (e.g., an indication of a level of quality associated with the encoded first portion of the content item) to the VQ agent **212**. The VQ measurer **208** may also send an indication of one or more of the transcoded quality level, the source quality level, the score determined by the packager **210**; and/or the packaged quality level to the VQ agent **212**.

[0048] The VQ agent **212** may determine the first quality level rather than the VQ measurer **208**. Put differently, the VQ agent **212** may receive the first portion of the content item from the content source **202** and the encoded first portion of the content item from the transcoder **206**. The VQ agent **212** may determine the first quality level by comparing the first portion of the content item received from the content source **202** to the encoded first portion of the content item received from the transcoder **206** (e.g., to determine whether the portion has been properly encoded). The transcoder **206** may send the encoded first portion of the content item to the packager **210** for packaging of the encoded first portion of the content item for delivery to the mid-tier cache **224**.

[0049] The packager **210** may send to the VQ agent **212** an indication of one or more packaging errors associated with the packaged first portion of the content item. The one or more packaging errors may be based on one or more packaging errors (e.g., a loss of a packet identifier associated with the packaged first portion of the content item, an encoder boundary point misalignment associated with the packaged first portion of the content item, a loss of an audio packet identifier associated with the packaged first portion of the content item, a change in metadata associated with

the content item, or any other aspect of packaging the content item that may be observable by the packager **210**). The VQ agent **212** may determine a first service metric associated with the first portion of the content item encoded by the transcoder **206** and/or the first portion of the content item packaged by the packager **210**. The first service metric may be based on the first quality level associated with the first portion of the content item encoded by the transcoder **206**; the transcoded quality level, the source quality level, the score determined by the packager **210**; the packaged quality level and/or the one or more packaging errors associated with the first portion of the content item packaged by the packager **210**. The VQ agent **212** may permit the packager **210** to deliver the packaged first portion of the content item to the mid-tier cache **224** based on the first service metric satisfying a threshold (e.g., a video quality threshold). The VQ agent **212** may disable the packager **210** from delivering the packaged first portion of the content item to the mid-tier cache **224** based on the first service metric not satisfying a threshold (e.g., a video quality threshold).

[0050] The datacenter **214** may have a transcoder **216**, a video quality (“VQ”) measurer **218**, a packager **220**, and a video quality (“VQ”) agent **222**. The transcoder **216** may receive the first portion of the content item from content source **202**, encode (e.g., format) the received first portion of the content item, and send the encoded first portion of the content item as well as other data (e.g., a score determined by the packager **220** based on the encoded first portion of the content item) to the packager **220**. The VQ measurer **218** may receive the encoded first portion of the content item (e.g., as well as the score determined by the packager **220**) from the transcoder **216** and determine an associated transcoded quality level. The VQ measurer **218** may determine a first quality level based on the transcoded quality level, a source quality level associated with the content source **202** and the content item, the score determined by the packager **220**; and/or a packaged quality level associated with the one or more portions of the content item previously packaged by the packager **220**. The VQ measurer **218** may send an indication of a second quality level associated with the encoded first portion of the content item (e.g., an indication of a level of quality associated with the encoded first portion of the content item) to the VQ agent **222**. The VQ measurer **218** may also send an indication of one or more of the transcoded quality level, the source quality level, the score determined by the packager **220**; and/or the packaged quality level to the VQ agent **212**. The VQ agent **218** may determine the second quality level rather than the VQ measurer **218**. Put differently, the VQ agent **218** may receive the second portion of the content item from the content source **202** and the encoded second portion of the content item from the transcoder **206**. The VQ agent **212** may determine the second quality level by comparing the second portion of the content item received from the content source **202** to the encoded second portion of the content item received from the transcoder **216** (e.g., to determine whether the portion has been properly encoded). The transcoder **216** may send the encoded first portion of the content item to the packager **220** for packaging of the encoded first portion of the content item for delivery to the mid-tier cache **224**.

[0051] The transcoder **206** may establish a communication link with the transcoder **216**. The transcoder **206** and the transcoder **216** may use the communication link to synchronize an alignment of a video portion of the content item, an audio portion of the content item (e.g., audio metadata), label(s) associated with the content item, encoder boundary points, advertisement insertion signals, an alignment indication flag for each encoded portion of the content item, and the like. The transcoder **206** and the transcoder **216** may use the communication link to synchronize the first portion of the content item to be encoded (e.g., to ensure the first portion of the content item encoded by the transcoder **206** corresponds to the first portion of the content item encoded by the transcoder **216**). The transcoder **206** and the transcoder **216** may synchronize the first portion of the content item to be encoded based on a manifest file associated with the content item (e.g., received from the source), a name or identifier associated with the first portion of the content item, an encoder boundary point associated with the first portion of the content item, and/or the like.

[0052] The packager **220** may send an indication of one or more packaging errors associated with

the packaged first portion of the content item to the VQ agent **222**. The one or more packaging errors may be based on one or more packaging errors (e.g., a loss of a packet identifier associated with the packaged first portion of the content item, an encoder boundary point misalignment associated with the packaged first portion of the content item, a loss of an audio packet identifier associated with the packaged first portion of the content item, a change in metadata associated with the content item, or any other aspect of packaging the content item that may be observable by the packager **220**). The VQ agent **212** may determine a second service metric associated with the first portion of the content item encoded by the transcoder **216** and/or the first portion of the content item packaged by the packager **220**. The second service metric may be based on the second quality level associated with the first portion of the content item encoded by the transcoder **216**; the one or more packaging errors associated with the first portion of the content item packaged by the packager **220**; the transcoded quality level, the source quality level, the score determined by the packager **210**; and/or the packaged quality level. The VQ agent **222** may permit the packager **220** to deliver the packaged first portion of the content item to the mid-tier cache **224** based on the second service metric satisfying a threshold (e.g., a video quality threshold). The VQ agent **222** may disable the packager **220** from delivering the packaged first portion of the content item to the mid-tier cache **224** based on the second service metric not satisfying a threshold (e.g., a video quality threshold).

[0053] The first quality level and/or the second quality level may be numerical (e.g., ranging between 0 (indicating poor service quality) to 1 (indicating a high service quality)). The first quality level and/or the second quality level may be based on the first portion of the content item received from the content source **202**. The first service metric and/or the second service metric may be numerical (e.g., ranging between 0 (indicating poor service quality) to 1 (indicating a high service quality)). Each of the one or more packaging errors may be associated with a numerical score (e.g., ranging between -1 (indicating a higher-impact packaging error) to 0 (indicating a lower-impact packaging error); ranging between 1 (indicating a higher-impact packaging error) to 0 (indicating a lower-impact packaging error); a percentage (positive or negative), and the like). The first service metric may be based on a weighted average of the first quality level and a numerical score(s) associated with a packaging error(s). The second service metric may be based on a weighted average of the second quality level and a numerical score(s) associated with a packaging error(s). The VQ agent **212** may establish a communication link with the VQ agent **222**. Though FIG. 2 shows a single connection path between the VQ agents **212**, **222**, one of skill in the art can appreciate that the system **200** may incorporate one or more redundant connection paths between the VQ agents **212**, **222** to ensure that a communication link between the VQ agents **212**, **222** may be established despite a failure of any given connection path. In this way, the VQ agents **212**, **222** may maintain high availability during times of system congestion and/or partial failure.

[0054] The VQ agent **212** may establish the communication link with the VQ agent **222** for sending the first service metric to the VQ agent **222**. The VQ agent **222** may establish a communication link with the VQ agent **212** for sending the second service metric to the VQ agent **212**. The VQ agent **222** may determine that the first service metric is indicative of a higher quality of service, as compared to the second service metric, based on the first service metric satisfying a threshold (e.g., the first service metric is greater than or equal to a threshold service metric) and the second service metric not satisfying the threshold (e.g., the second service metric is less than a threshold service metric). The VQ agent **222** may send the VQ agent **212** an indication that the first service metric satisfies the threshold and the second service metric does not satisfy the threshold. The VQ agent **222** may disable the packager **220** from delivering the packaged content to the mid-tier cache **224** based on the second service metric not satisfying the threshold. The VQ agent **212** may permit the packager **210** to deliver the packaged content to the mid-tier cache **224** based on the first service metric satisfying the threshold.

[0055] The packager **210** and/or the packager **220** may communicate with the mid-tier cache **224**

(e.g., to send packaged portions of a content item to the mid-tier cache **204**). The mid-tier cache **224** may open and/or create a communication link to communicate with the packager **210** and/or the packager **220**. The communication link may be based on a first request for a portion of a content item received by the mid-tier cache **224** (e.g., from a first requesting device). The first request for the portion of a content item may indicate that the content item is to be received from a first source. After the communication link is established, the packager **210** and/or the packager **220** may send a portion of the content item received from the first source (e.g., portions of packaged content) to the mid-tier cache **224**. The packager **210** and/or the packager **220** may send further portions of the content item from the first source to the mid-tier cache **224** without the mid-tier cache **224** requesting any, or all, of the further portions of the content item from the first source. The packager **210** and/or the packager **220** may send the further portions of the content item from the first source to the mid-tier cache **224** based on a second request received (e.g., by the packager **210**, the packager **220**, the VQ agent **212**, and/or the VQ agent **222**) from the mid-tier cache **224**. The second request may indicate that the further portions of the content item are to be received from a second source (e.g., a second requesting device may request the content item from the second source via the mid-tier cache **224**). Based on the second request, the VQ agent **212** and/or the VQ agent **222** may determine that the packager **210** and/or the packager **220** already received the further portions of the content item from a source other than the second source (e.g., from the first source). The VQ agent **212** and/or the VQ agent **222** may cause the packager **210** and/or the packager **220** to send the further portions of the content item received from the source other than the second source (e.g., the first source) to the mid-tier cache **224**.

[0056] The VQ agent **212** and/or the VQ agent **222** may send an indication to the packager **210** that the packager **210** may provide the content item on behalf of the packager **220** (e.g., the packager **210** may deliver the content item to a requesting device that expects to receive the content item from the packager **220**). The packager **210** may include origination information (e.g., via a hypertext transfer protocol header) associated with the content item as part of providing any portion of the content item to the mid-tier cache **224**. The VQ agent **212** and/or the VQ agent **222** may send an indication to the packager **220** that the packager **220** may provide the content item on behalf of the packager **210** (e.g., the packager **220** may deliver the content item to a requesting device that expects to receive the content item from the packager **210**). The packager **220** may include origination information (e.g., via a hypertext transfer protocol header) associated with the content item as part of providing any portion of the content item to the mid-tier cache **224**. In this way, the mid-tier cache **224** may provide the content item to a requesting device in response to one or more further requests for the content item received by the mid-tier cache **224** from the requesting device, regardless of which source is indicated in the one or more further requests. Put differently, the mid-tier cache **224** may determine based on the origination information that any further request for the content item indicating that the content item should be retrieved from a source associated with a given packager (e.g., packager **220**) may be fulfilled (e.g., the content item may be served to the requesting device) using portion(s) of the content item received by the mid-tier cache **224** from any packager (e.g., packager **210**) included in the origination information.

[0057] While the system **200** as described and shown in FIG. 2 has one content source **202**, two datacenters **204**, **216**, and one mid-tier cache **224** for case of explanation, a person skilled in the art would appreciate there could be a plurality of each of these features. Also, while a single communication link is shown between several of the features of the system **200** as shown in FIG. 2, a person skilled in the art would appreciate there may be multiple communication links between these features, such as a communication link for a manifest, another communication link for video content, a third communication link for audio content, and so forth.

[0058] FIG. 3 shows a system **300** for distributing content from an origination (e.g., a source) to a device (e.g., a user device for consuming content). While FIG. 3 shows connection pathways (e.g., communication links) between certain devices, it is to be understood that the connection pathways

as shown are for illustrative purposes only and that any of the devices depicted in FIG. 3 may communicate with any other device depicted therein.

[0059] The system **300** may have a content source **302** (e.g., the content source **127** of FIG. 1 and/or content source **202** of FIG. 2) and a content source **304** (e.g., content source **127** of FIG. 1 and/or content source **202** of FIG. 2). Each of the content sources **302**, **304** may provide content to each of datacenter **306** (e.g., input sources **102a**, **102b**, **102c**, **106** of FIG. 1 and/or datacenter **204** or datacenter **214** of FIG. 2), datacenter **308** (e.g., input sources **102a**, **102b**, **102c**, **106** of FIG. 1 and/or datacenter **204** or datacenter **214** of FIG. 2), and datacenter **310** (e.g., input sources **102a**, **102b**, **102c**, **106** of FIG. 1 and/or datacenter **204** or datacenter **214** of FIG. 2). Each of the datacenters **306**, **308**, **310** may provide content (e.g., received from content source **302** and/or content source **304**) to each of mid-tier cache **312** (e.g., central location **101** of FIG. 1 and/or mid-tier cache **224** of FIG. 2), mid-tier cache **314** (e.g., central location **101** of FIG. 1 and/or mid-tier cache **224** of FIG. 2), and mid-tier cache **316** (e.g., central location **101** of FIG. 1 and/or mid-tier cache **224** of FIG. 2). Each of the mid-tier caches **312**, **314**, **316** may provide content (e.g., received from datacenter **304**, datacenter **308**, and/or datacenter **310**) to each of edge cache **318** (e.g., edge device **128** of FIG. 1), edge cache **320** (e.g., edge device **128** of FIG. 1), and edge cache **322** (e.g., edge device **128** of FIG. 1).

[0060] The system **300** may be configured to provide origination information (e.g., via a hypertext transfer protocol header) associated with a requested content item as the content item is being distributed throughout the system **300** (e.g., from a content source **302**, **304** to an edge cache **318**, **320**, **322**). The edge cache **318** may send a request for a content item to be delivered from content source **302**. The mid-tier cache **312** may receive the request for the content item and determine that it does not have the content item from the content source **302** stored in cache. The mid-tier cache **312** may then request that the content item be delivered from the content source **302** via the datacenter **306**. The datacenter **306** may receive the request for the content item from the mid-tier cache **312** and determine that it does not have the content item from the content source **302** stored in cache. The datacenter **306** may request the content item from the content source **302**.

[0061] The request for the content item may have a first hypertext transfer protocol (“HTTP”) header indicating that the content item is to be received from the content source **302**. The first HTTP header may be formatted as shown below: [0062] GET/first_content_item.m3u8 [0063] HTTP/1.1 [0064] Host: source1.net [0065] User-Agent: curl/7.54.0 [0066] Accept: */*

[0067] The content source **302** may provide the content item as well as origination information associated with the content item. The origination information may have a second HTTP header indicating that the content item was received from the content source **302**. The second HTTP header may also indicate that the content item is available from the content source **304**. The second HTTP header may be formatted as shown below: [0068] HTTP/1.1 200 OK [0069] Date: Wed, 7 Nov. 2018 16:28:27 GMT [0070] Server: Pillar/1.11.3 [0071] Last-Modified: Wed, 7 Nov. 2018 16:28:24 GMT [0072] Content-Length: 11253 [0073] Content-Type: application/vnd.apple.mpegurl [0074] Age: 2 [0075] Connection: keep-alive [0076] Origins: source 1.net, source2.net

[0077] The datacenter **306** may receive the content item as well as the origination information from the content source **302**. The datacenter **306** may send the origination information (e.g., via a VQ agent of the datacenter **306**) as well as an indication that the datacenter **306** received the content item from the content source **302** to the datacenter **308** (e.g., via a VQ agent of datacenter **308**) and/or the datacenter **310** (e.g., via a VQ agent of datacenter **310**). The content item may be sent by the datacenter **306** to the mid-tier cache **312**, which may send the first content item to the edge cache **318**.

[0078] The edge cache **320** may send a request for the content item to be delivered from the content source **304**. The mid-tier cache **314** may receive the request from the edge cache **320** and determine that it does not have the content item from the content source **304** stored in cache. The mid-tier cache **314** may then request that the content item be delivered from the content source **304** via the

datacenter **308**. The datacenter **308** may receive the request from the mid-tier cache **314** and determine that it does not have the content item from the content source **304** stored in cache. The datacenter **308** may determine, based on the origination information and the indication received from the datacenter **306**, that the content item is also available from the content source **302** and that the datacenter **306** has already received the content item from the content source **302**. The datacenter **308** may then request (e.g., via VQ agent **222**) that the datacenter **306** provide the content item to the mid-tier cache **314** (e.g., despite the request from the mid-tier cache **314** indicating that the content item was to be delivered by the content source **304**). The mid-tier cache **314** may send the content item received from the datacenter **306** to the edge cache **320**.

[0079] Each of the datacenter **308** and the datacenter **310** may have a transcoder (e.g., transcoder **206**, **216** of FIG. 2), a VQ measurer (e.g., VQ measurer **208**, **218** of FIG. 2), a packaging device (e.g., packager **210**, **220** of FIG. 2), and a VQ agent (e.g., VQ agent **212**, **222** of FIG. 2). The datacenter **308** may receive a portion of the content item from the content source **302** based on a request for the portion of the content item received by the datacenter **308** from the mid-tier cache **314**. The datacenter **310** may receive the portion of the content item from the content source **304** based on a request for the portion of the content item received by the datacenter **310** from the mid-tier cache **316**.

[0080] The datacenter **308** may establish a communication link with the datacenter **310**. The datacenter **308** may use the communication link to provide the origination information associated with the content item to the datacenter **310**. The datacenter **308** and the datacenter **310** may use the communication link to synchronize the portion of the content item to be encoded (e.g., to ensure the portion of the content item encoded by the transcoder of the datacenter **308** corresponds to the portion of the content item encoded by the transcoder of the datacenter **310**).

[0081] The transcoder of the datacenter **308** may encode (e.g., format) the portion of the content item received from content source **302** and send the encoded portion of the content item to the packager of the datacenter **308**. The VQ measurer of the datacenter **308** may send an indication of a quality level associated with the encoded portion of the content item received from the content source **302** (e.g., an indication of a level of quality associated with the encoded portion of the content item) to the VQ agent of the datacenter **308**. The VQ agent of the datacenter **308** may determine the quality level rather than the VQ measurer of the datacenter **308**. Put differently, the VQ agent of the datacenter **308** may receive the portion of the content item from the content source **302** and the encoded portion of the content item from the transcoder of the datacenter **308**. The VQ agent of datacenter **308** may determine the quality level by comparing the portion of the content item received from the content source **302** to the encoded portion of the content item received from the transcoder of the datacenter **308** (e.g., to determine whether the portion has been properly encoded). The transcoder of the datacenter **308** may send the encoded portion of the content item received from the content source **302** to the packager of datacenter **308** for packaging of the encoded first portion of the content item for delivery to the mid-tier cache **314**.

[0082] The packager of the datacenter **308** may send an indication of one or more packaging errors associated with the packaged portion of the content item received from the content source **302** to the VQ agent of the datacenter **308**. The VQ agent of the datacenter **308** may determine a service metric associated with the portion of the content item received from the content source **302** based on the portion of the content item encoded by the transcoder of the datacenter **308** and/or the portion of the content item packaged by the packager of the datacenter **308**.

[0083] The transcoder of the datacenter **310** may encode (e.g., format) the portion of the content item received from the content source **304** and send the encoded portion of the content item to the packager of the datacenter **310**. The VQ measurer of the datacenter **310** may send an indication of a quality level associated with the encoded portion of the content item received from the content source **304** (e.g., an indication of a level of quality associated with the encoded portion of the content item) to the VQ agent of the datacenter **310**. The VQ agent of the datacenter **310** may

determine the quality level rather than the VQ measurer of the datacenter **310**. Put differently, the VQ agent of the datacenter **310** may receive the portion of the content item from the content source **304** and the encoded portion of the content item from the transcoder of the datacenter **308**. The VQ agent of the datacenter **310** may determine the quality level by comparing the portion of the content item received from the content source **304** to the encoded portion of the content item received from the transcoder of the datacenter **310** (e.g., to determine whether the portion has been properly encoded). The transcoder of the datacenter **310** may send the encoded portion of the content item received from the content source **304** to the packager of the datacenter **310** for packaging of the encoded first portion of the content item for delivery to the mid-tier cache **316**.

[0084] The packager of the datacenter **310** may send an indication of one or more packaging errors associated with the packaged portion of the content item received from the content source **304** to the VQ agent of the datacenter **310**. The VQ agent of the datacenter **310** may determine a service metric associated with the portion of the content item received from the content source **304** based on the portion of the content item encoded by the transcoder of the datacenter **310** and/or the portion of the content item packaged by the packager of the datacenter **310**.

[0085] The VQ agent of the datacenter **308** may establish a communication link with the VQ agent of the datacenter **310** for sending the service metric associated with the portion of the content item received from the content source **302** to the VQ agent of the datacenter **310**. The VQ agent of the datacenter **310** may establish a communication link with the VQ agent of the datacenter **308** for sending the service metric associated with the portion of the content item received from the content source **304** to the VQ agent of the datacenter **308**. The VQ agent of the datacenter **308** may determine that the service metric associated with the portion of the content item received from the content source **302** is indicative of a higher quality of service as compared to the service metric associated with the portion of the content item received from the content source **304** (e.g., based on the service metric associated with the portion of the content item received from the content source **302** satisfying a threshold and the service metric associated with the portion of the content item received from the content source **304** not satisfying the threshold). The VQ agent of the datacenter **308** may send the VQ agent of the datacenter **310** an indication that the service metric associated with the portion of the content item received from the content source **302** satisfies a threshold and the second service metric associated with the portion of the content item received from the content source **304** does not satisfy the threshold.

[0086] The VQ agent of the datacenter **310** may disable the packager of the datacenter **310** from delivering the packaged portion of the content item to the mid-tier cache **316** based on the service metric associated with the portion of the content item received from the content source **304** not satisfying the threshold. The VQ agent of the datacenter **310** may permit the packager of the datacenter **310** to deliver the packaged portion of the content item to the mid-tier cache **316** and/or the mid-tier cache **314** based on the service metric associated with the portion of the content item received from the content source **302** satisfying the threshold.

[0087] In an instance where a VQ agent associated with a datacenter **306**, **308**, or **310** cannot communicate with one or more of the other VQ agents in the other datacenters (an “offline VQ agent”), content may nevertheless be provided by the transcoder associated with the offline VQ agent. The mid-tier cache **314** may receive a request from a requesting device for a portion of a content item, which may be sent by the mid-tier cache **314** to the datacenter associated the offline VQ agent. Despite not being not in communication with one or more of the other VQ agents, the offline VQ agent may cause its corresponding transcoder (e.g., located at the same datacenter as the offline VQ agent) to provide the requested portion of the content item to the mid-tier cache **314** (e.g., without providing origination information associated with the content item).

[0088] FIG. 4 shows a plurality of communication flows that the system **100** of FIG. 1, the system **200** of FIG. 2, and/or the system **300** of FIG. 3 may implement when distributing content in accordance with the present description. At communication flow **416**, a client **414** (e.g., the media

device **120** or the mobile device **124** of FIG. **1**) may establish a communication link (e.g., a transport control protocol session) with a router **412** (e.g., first access point **123** of FIG. **1**) in order to request a content item. In establishing the communication link, the client **414** may send a content request to the router **412** at communication flow **418**. The content request (e.g., a HTTP 1.1 GET request) may be a request to receive a first manifest associated with the content item (e.g., an MPEG-DASH manifest, or the like). At communication flow **420**, the router **412** may send a message to the client **414** (e.g., a HTTP 302 redirect) instructing the client **414** to request the first manifest from edge device **408** (e.g., edge device **128** of FIG. **1**; or edge cache **318**, edge cache **320**, or edge cache **322** of FIG. **3**). At communication flow **422**, the router **414** may terminate (e.g., close) the established communication link with the client **414**.

[0089] At communication flow **424**, the client **414** may establish a communication link (e.g., a transport control protocol session) with the edge device **408** based on the message received from the router **412** instructing the client **414** to request the first manifest from edge device **408**. In establishing the communication link with the edge device **408**, the client **414** may send a content request at communication flow **426**. The content request sent by the client **414** to the edge device **408** may be a request to receive the first manifest (e.g., via a HTTP 1.1 GET request). At communication flow **428**, the edge device **408** may determine that the first manifest is not stored in a cache of the edge device **408**. At communication flow **430**, the edge device **408** may establish a communication link (e.g., a transport control protocol session) with a formatter **410** (e.g., a device that converts a content item from a first format to a second format for delivery to a client) based on the determination that the first manifest is not stored in the cache of the edge device **408**. In establishing the communication link with the formatter **410**, the edge device **408** may send a content request to the formatter **410** at communication flow **432**. The content request sent to the formatter **410** may be a request to receive the first manifest (e.g., via a HTTP 1.1 GET request). At communication flow **434**, the formatter **410** may determine that the first manifest is not stored in a cache of the formatter **410**. At communication flow **436**, the formatter **410** may establish a communication link (e.g., a transport control protocol session) with the edge device **408** based on the determination that the first manifest is not stored in the cache of the formatter **410**. In establishing the communication link with the edge device **408**, the formatter **410** may send a content request to the edge device **408** at communication flow **438**. The request sent to the edge device **408** at communication flow **438** may be a request (e.g., via a HTTP 1.1 GET request) to receive an origin manifest associated with the content item (e.g., a common intermediate format (“CIF”) manifest, or the like).

[0090] At communication flow **440**, the edge device **408** may determine that the origin manifest is not stored in a cache of the edge device **408**. At communication flow **442**, the edge device **408** may establish a communication link (e.g., a transport control protocol session) with a mid-tier cache **406** (e.g., central location **101** of FIG. **1**; mid-tier cache **224** of FIG. **2**; mid-tier cache **312**, mid-tier cache **314**, or mid-tier cache **316** of FIG. **3**). The edge device **408** may establish the communication link with the mid-tier cache **406** based on the determination that the origin manifest is not stored in the cache of the edge device **408**. In establishing the communication link with the mid-tier cache **406**, the edge device **408** may send a content request to the mid-tier cache **406** at communication flow **444**. The request sent to the mid-tier cache **406** at communication flow **444** may be a request (e.g., via a HTTP 1.1 GET request) to receive the origin manifest associated with the content item.

[0091] At communication flow **446**, the mid-tier cache **406** may determine that the origin manifest is not stored in a cache of the mid-tier cache **406**. At communication flow **448**, the mid-tier cache **406** may establish a communication link (e.g., a transport control protocol session) with a packager **402** (e.g., combiner **117** of FIG. **1** or packager **210**, **220** of FIG. **2**) based on the determination that the origin manifest is not stored in the cache of the mid-tier cache **406**. In establishing the communication link with the packager **402**, the mid-tier cache **406** may send a content request to the packager **402** at communication flow **450**. The request sent to the packager **402** at

communication flow **450** may be a request (e.g., via a HTTP 1.1 GET request) to receive the origin manifest associated with the content item. At communication flow **452**, the packager **402** may send a message to the mid-tier cache **406** (e.g., a HTTP 302 redirect) instructing the mid-tier cache **406** to request the origin manifest from packager **404** (e.g., combiner **117** of FIG. 1 or packager **210**, **220** of FIG. 2). The packager **402** may send the instruction to request the origin manifest from packager **404** based on a determination (e.g., by a VQ agent associated with the packager **402** and the packager **404**) that a portion of the content item packaged by packager **404** is of a higher quality (e.g., based on a service metric) than the portion of the content item packaged by packager **402**. At communication flow **454**, the packager **402** may terminate (e.g., close) the established communication link with the mid-tier cache **406**.

[0092] At communication flow **456**, the mid-tier cache **406** may establish a communication link (e.g., a transport control protocol session) with the packager **404** based on the message received from the packager **402** instructing the mid-tier cache **406** to request the origin manifest from packager **404**. In establishing the communication link with the packager **404**, at communication flow **458** the mid-tier cache **406** may send a content request to the packager **404**. The request sent to the packager **402** at communication flow **458** may be a request (e.g., via a HTTP 1.1 GET request) to receive the first manifest associated with the content item. At communication flow **460** the packager **404** may send the origin manifest associated with the content item to the mid-tier cache **406** (e.g., via a HTTP 1.1 200 OK message). At communication flow **462**, the mid-tier cache **406** may send the origin manifest associated with the content item to the edge device **408**. At communication flow **464**, the edge device **408** may send the origin manifest associated with the content item to the formatter **410**. At communication flow **466**, the formatter **410** may send the content item to the client **414** in a format that is acceptable to (e.g., compatible with) the client **414**. Though not depicted in FIG. 4, the formatter **410** may send the content item (e.g., in the format that is acceptable to the client **414**) to the edge device **408**. The edge device **408** may store (e.g., cache) the content item as-received by the formatter **510** (e.g., to permit delivery of the content item to other clients that require the content item in a format as-received by the edge device **408** from the formatter **410**).

[0093] FIG. 5 shows a plurality of communication flows that the system **100** of FIG. 1, the system **200** of FIG. 2, and/or the system **300** of FIG. 3 may implement when distributing content in accordance with the present description. At communication flow **520**, a client **514** (e.g., media device **120** or mobile device **124** of FIG. 1) may send a request (e.g., via a HTTP 1.1 GET request) for a manifest associated with a content item (e.g., an MPEG-DASH manifest, or the like) to a formatter **510** (e.g., a device that converts a content item from a first format to a second format for delivery to a client). The request at communication flow **520** may indicate (e.g., via a HTTP header) that the manifest is to be received via a first packager **502** (e.g., combiner **117** of FIG. 1 or packager **210**, **220** of FIG. 2). The first packager **502** may receive the manifest from a first source (e.g., content source **127** of FIG. 1; content source **202** of FIG. 2; or content source **302**, **304** of FIG. 3). At communication flow **522**, a client **515** (e.g., media device **120** or mobile device **124** of FIG. 1) may send a request (e.g., via a HTTP 1.1 GET request) for the manifest associated with the content item (e.g., an updated version of a MPEG-DASH manifest, or the like) to the formatter **510**. The request at communication flow **522** may indicate (e.g., via a HTTP header) that the manifest is to be received via a second packager **504** (e.g., combiner **117** of FIG. 1 or packager **210**, **220** of FIG. 2). The second packager **504** may receive the manifest from a second source (e.g., content source **127** of FIG. 1; content source **202** of FIG. 2; or content source **302**, **304** of FIG. 3).

[0094] At communication flow **524**, the formatter **510** may send the request for the manifest to be delivered from the first packager **502** to an edge device **508** (e.g., edge device **128** of FIG. 1; or edge cache **318**, edge cache **320**, or edge cache **322** of FIG. 3). At communication flow **526**, the formatter **510** may send the request for the manifest to be delivered from the second packager **504** to the edge device **508**. At communication flow **530**, the edge device **508** may send the request for

the manifest to be delivered from the first packager **502** to a mid-tier cache **506** (e.g., central location **101** of FIG. 1; mid-tier cache **224** of FIG. 2; mid-tier cache **312**, mid-tier cache **314**, or mid-tier cache **316** of FIG. 3). At communication flow **532**, the mid-tier cache **506** may send the request for the manifest to the first packager **502**. The first packager **502**, at communication flow **534**, may respond to the request and send (e.g., via a HTTP 1.1 200 OK message) the manifest to the mid-tier cache **506** as well as an origination header (e.g., a HTTP header). The origination header may indicate that further requests for the manifest to be received via packager **504** (e.g., requests indicating that the content item is to be received from a content source associated with packager **504**) may be fulfilled (e.g., delivered) by the first packager **502**. The first packager **502** may send the origination header based on a determination (e.g., by a VQ agent associated with the packager **502** and the packager **504**) that a portion of the content item packaged by packager **502** is of a higher quality (e.g., based on a service metric) than the portion of the content item packaged by packager **504**.

[0095] At communication flow **536**, the mid-tier cache **506** may store the origination header (e.g., in memory). At communication flow **540**, based on the origination header, the mid-tier cache **506** may respond to the request to receive the manifest from the first packager **502** by sending to the edge cache **508** an indication (e.g., via a HTTP 1.1 200 OK message) that further requests for the manifest should be delivered by the first packager **502**. At communication flow **542**, the edge cache **508** may send (e.g., based on the indication that further requests for the manifest should be delivered by the first packager **502**) a request for the manifest to be delivered by the first packager **504**. At communication flow **544**, the edge cache **508** may store the origination header (e.g., in memory). At communication flow **546**, the mid-tier cache **506** may send the manifest received from the first packager **502** to the edge device **508**. At communication flow **548**, the edge device **508** may send the manifest received from the first packager **502** to the formatter **510** for delivery to the client **514**. At communication flow **550**, the edge device **508** may send the manifest received from the first packager **502** to the formatter **510** for delivery to the client **515**. At communication flow **552**, the formatter **510** may send the manifest received from the first packager **502** to the client **514**, and at communication flow **554** the formatter **510** may send the manifest received from the first packager **502** to the client **515**.

[0096] FIG. 6 shows a system **600**. The system **600** may have a packaging device **602** (e.g., any of the packagers shown in FIGS. 2-5), a mid-tier cache **604** (e.g., any of the mid-tier caches shown in FIGS. 1-5), an edge cache **606** (e.g., any of the edge devices shown in FIGS. 1-5), and a client device **608** (e.g., the media device **120**, the communication terminal **122**, and/or the mobile device **124** of FIG. 1). Though not shown in FIG. 6, the system **600** may utilize a VQ agent as described above with respect to FIGS. 2-5. Specifically, the packaging device **602** may send content to another device based on an instruction received from a VQ agent (e.g., the VQ agent may determine that a portion of content packaged by the packager **602** is of a higher quality than the portion packaged by another packager in communication with the VQ agent). While not shown for case of explanation, a person skilled in the art would appreciate that the system **600** may have any number of packaging devices **602**, mid-tier caches **604**, edge caches **606**, and client devices **608**.

[0097] As shown, the packaging device **602** may have a packager module **610**, a cache **612**, a session management module **614**, and a server module **616**. The packaging device **602** may receive content and package the received content (e.g., using the packager module **610**) to send the content to another device (e.g., the mid-tier cache **604**). The packaging device **602** may store the received content in the cache **612**. The packaging device **602** may also store packaged content ready to be sent to another device in the cache **612**. The cache **612** may also remove content after the effective life of the content is ended. The cache **612** may remove data based on a Cache-Control time-to-live protocol.

[0098] The server module **616** may be configured to communicate with another device. The server module **616** may communicate with the mid-tier cache **604**, as well as send the mid-tier cache **604**

with content. The server module **616** may be configured to handle communications from the packaging device **602** to the mid-tier cache **604**. Specifically, the server module **616** may open and/or create a communication link to communicate with the mid-tier cache **604**. The server module **616** may wait to receive new attempts to establish a communication link for content from a device (e.g., the mid-tier cache **604**). When the server module **616** receives a new attempt to establish a communication link, the server module **616** may verify that the requesting device supports a communication protocol that allows the server module **616** to communicate with the requesting device. The server module **616** may verify that the requesting device supports the HTTP 2.0 protocol. When the server module **616** receives the new attempt to establish the communication link, the server module **616** may verify (e.g., authenticate/validate) that the requesting device is authorized to receive the requested content. The server module **616** creates or updates information associated with the requesting device and/or the communication link (e.g., after verifying that the requesting device is authorized to receive the requested content). The server module **616** indicates to the session management module **614** that a new communication link has been established.

[0099] The server module **616** may send content to the mid-tier cache tier **604** via the opened/created communication link. After the communication link is established, the server module **616** may send a plurality of content fragments to the requesting device (e.g., the mid-tier cache **604**). The server module **616** may push content fragments to the mid-tier cache **604** without the mid-tier cache **604** requesting content. Stated differently, the server module **616** may push content fragments to the mid-tier cache **604** based on the established communication link without the mid-tier cache **604** requesting content, because the server module **616** may determine the content the mid-tier cache **604** needs based on the communication link. The server module **616** may push content fragments to the mid-tier cache **604** without the mid-tier cache **604** requesting additional content. Stated differently, once the mid-tier cache **604** requests content from the packaging device **602**, the server module **616** may push the content fragments to the mid-tier cache **604** without the mid-tier cache needing to request each of the content fragments. The server module **616** may continue to push content fragments to the mid-tier cache **604** until the communication link between the packaging device **602** and the mid-tier cache **604** is closed.

[0100] The packaging device **602** may have a session management module **614**. The session management module **614** may manage some or all established communication links associated with the packaging device **602**. The session management module **614** may manage the communication link between the packaging device **602** and the mid-tier cache **604**. After the server module **616** establishes a communication link with the mid-tier cache **604**, the server module **616** indicates to the session management module **614** that a communication link has been established so that the session management module **614** may manage the newly established communication link. The session management module **614** may then ensure that the mid-tier cache **604** receives content based on the content requested by the mid-tier cache **614**. The session management module **614** may send the requested content, as well as any subsequent content, to the mid-tier cache **604**. The session management module **614** may push content to the mid-tier cache **604** as soon as the content is available for distribution to the mid-tier cache **604**. In this manner, the session management module **614** ensures that the mid-tier cache **604** has the most up to date content without mid-tier cache **604** needing to communicate at regular intervals with the packaging device **602**. That is, once the communication link is established between the packaging device **602** and the mid-tier cache **604**, the session management module **614** may continue to push content to the mid-tier cache **604** until the communication link is closed.

[0101] The session management module **614** may be configured to group or associate a plurality of communication links for the same content. If there are three mid-tier caches **604** that are requesting the same content, the session management module **614** may treat the three separate communication links as associated for efficient management of the communication links.

[0102] The session management module **614** may have stateful logic for managing the

communications links associated with the packaging device **602**. The session management module **614** may set the state of a communication link as active in order to send content to the requesting device. The session management module **614** may monitor the communication link to ensure the communication link is still active (e.g., that the requesting device is still desiring to receive and/or consume the content). The session management module **614** may continue to push content to the requesting device as long as the communication link is open and/or active. The communication link may be closed and/or deactivated by the packaging device **602** if there is no content to send to the mid-tier cache **604**. The communication link may be closed and/or deactivated by the mid-tier cache **604** because the mid-tier cache **604** no longer needs the content associated with the communication link.

[0103] Once the communication link is closed and/or deactivated, the session management module **614** may change the stateful logic associated with the communication link to indicate the communication link is closed. Once the session management module **614** determines the communication link is closed, the session management module **614** determines whether there are any additional communication links requesting the same content associated with the now closed communication link. If there are no other communication links requesting the same content, then the session management module **614** may instruct the cache **612** to remove the content as there is no longer a need for the content because no device is requesting the content. In this manner, the session management module **614** clears the cache **612** of any unnecessary data from any closed and/or deactivated communication links.

[0104] The session management module **614** may use one or more tokens (e.g., counters, timers, etc.) when managing the communication links. The session management module **614** may increment a counter associated with each communication link each time a packet is sent via the communication link. Each packet may be 2 seconds in length, and the counter may be incremented each time a packet is sent. Thus, if the counter indicates 30 packets have been sent, the counter may indicate that 60 seconds have passed. The session management module **614** may close and/or deactivate communication links after a period of time. If 60 seconds have passed and the session management module **614** does not receive a communication from the requesting device (e.g., the mid-tier cache **604**), the session management module **614** may assume the requesting device is no longer consuming the content and closes and/or deactivates the communication link. In this manner, the session management module **614** may use counters to manage the communication links associated with the packaging device **602**.

[0105] The session management module **614** may close and/or deactivate communication links without communicating with another device (e.g., the mid-tier cache **604**). A counter may be incremented each time a new communication link is added, as well as the counter may be decremented each time a communication link is removed so that the session management module **614** may track the active communication links associated with the packaging device **602**.

[0106] The session management module **614** may keep track of the number of devices associated with a specific type of content. The session management module **614** may use a counter to keep track of the number of devices that have requested the specific content. That is, three devices (e.g., three mid-tier caches **604**) may request the specific content. The session management module **614** may maintain the content in the cache **612** until there are no more devices requesting the specific content. A counter may be used to keep track (e.g., count) the number of devices associated with the specific content.

[0107] The session management module **614** may use a token (e.g., a counter, a timer, etc.) to ensure a communication link is active. A counter may be incremented each time the packaging device **602** packages data for transmission. The counter may be decremented when the packaging device **602** sends data to a device (e.g., the mid-tier cache **604**). If the counter satisfies a threshold (e.g., reaches 30 counts), the session management module **614** may determine that the communication link with the mid-tier cache **604** is closed since data is not being sent to the mid-

tier cache **604** because the counter has not been decremented to indicate data has been sent. In turn, the session management module **614** may close the communication link with the mid-tier cache **604** as well as decrement the counter associated with the communication links managed by the session management module **614**. The session management module **614** may determine that the communication link with the mid-tier cache **604** is closed because the mid-tier cache **604** closes a socket associated with the communication link so that the packaging device **602** may no longer send data via the communication link. In this manner, the session management module **614** is able to close and/or maintain communications links with other devices without the need for the devices to communicate back and forth by using a counter.

[0108] As shown, the mid-tier cache **604** may have a client module **618**, a cache **620**, a session management module **622**, and a server module **624**. The mid-tier cache **604** may receive content and store the received content in the cache **620**. The server **624** may communicate with another device. The server **624** may communicate with the packaging device **602** and/or the edge cache device **606**. The mid-tier cache **604** may receive pushed content from the packaging device **602**. The mid-tier cache **604** may also send content to the edge cache **606**. The mid-tier cache **604** may push content to the edge cache **606** as the content becomes available. That is, when the mid-tier cache **604** receives pushed content from the packaging device **602**, the mid-tier cache **604** may push the content to the edge cache **606**.

[0109] The cache **620** may store content. The cache **620** may store content received from the packaging device **602**, as well as content for distributing to the edge cache **606**. The content stored for distributing to the edge cache **606** may be stored with origination information associated with the content (e.g., as described above with respect to FIG. 5) to permit the cache **620** to provide the content in response to requests for the content to be received via a packaging device other than packaging device **602**. The cache **620** may also update content stored within the cache **620** based on the received content. The cache **620** may also remove content after the effective life of the content is ended. The cache **620** may remove data based on a Cache-Control time-to-live.

[0110] The client module **618** may communicate with another device. The client module **618** may communicate with the packaging device **602**. The client module **618** may establish a communication link with the packaging device **602** in order to receive content from the packaging device **602**. The client module **618** may request content that is not in the cache **620**. The mid-tier cache **604** may receive a request for content (e.g., from the edge cache **606**), and may determine that the cache **620** does not have the requested content. Thus, the client module **618** establishes the communication link with the packaging device **602** to request the missing content. Once the mid-tier cache **604** receives the missing content, the client module **618** may push the content to the requesting device (e.g., the edge cache **606**).

[0111] The server module **624** may be configured to communicate with another device. The server module **624** may communicate with the edge cache **606**, as well as send the edge cache **606** content. The server module **624** may be configured to handle communications for the mid-tier cache **604** to the edge cache **606**. Specifically, the server module **624** may open and/or create a communication link to communicate with the edge cache **606**. The server module **624** waits to receive new attempts to establish a communication link for content from a device (e.g., the edge cache **606**). When the server module **624** receives a new attempt to establish a communication link, the server module **624** may verify that the requesting device supports a communication protocol that allows the server module **624** to communicate with the requesting device. The server module **624** may verify that the requesting device supports the HTTP 2.0 protocol. The server module **624** creates or updates information associated with the requesting device and/or the communication link. The server module **624** indicates to the session management module **622** that a new communication link has been established.

[0112] The server module **624** may send content to the edge cache **606** via the opened/created communication link. After the communication link is established, the server module **624** sends a

plurality of content fragments to the requesting device (e.g., the edge cache **606**). The server module **624** may push content fragments to the edge cache **606** without the edge cache **606** requesting content. Stated differently, the server module **624** may push content fragments to the edge cache **606** based on the established communication link without the edge cache **606** requesting content because the server module **624** determines the content the edge cache **606** desires based on the communication link. The server module **624** may push content fragments to the edge cache **606** without the edge cache **606** sending additional requests for content. Stated differently, once the edge cache **606** requests content from the mid-tier cache **604**, the server module **624** may push the content fragments to the edge cache **606** without the edge cache **606** needing to request each of the content fragments. The server module **624** continues to push content fragments to the edge cache **606** until the communication link between the mid-tier cache **604** and the edge cache **606** is closed.

[0113] The mid-tier cache **604** may have a session management module **622**. The session management module **622** manages all established communication links associated with the mid-tier cache **604**. The session management module **614** manages the communication links between the mid-tier cache **604** and the packaging device **602**, as well as the communication links between the mid-tier cache **604** and the edge cache **606**.

[0114] After the server module **624** establishes a communication link with the edge cache **606**, the server module **624** indicates to the session management module **622** that a communication link has been established so that the session management module **622** may manage the newly established communication link. The session management module **622** may then ensure that the edge cache **606** receives content based on the content requested by the edge cache **606**. The session management module **622** may send the requested content, as well as any subsequent content, to the edge cache **606**. The session management module **622** may push content to the edge cache **606** as soon as the content is available for distribution to the edge cache **606**.

[0115] After the client module **618** establishes a communication link with the packaging device **602**, the client module **618** indicates to the session management module **622** that a communication link has been established so that the session management module **622** may manage the newly established communication link. The session management module **622** may then ensure that the mid-tier cache **604** receives the content requested from the packing device **602**. In this manner, the session management module **622** ensures that the mid-tier cache **604**, as well as the edge cache **606**, have the most up to date content from the packaging device **602**. That is, once the communication link is established between the packaging device **602** and the mid-tier cache **604**, the session management module **622** may push the content received from the packaging device **602** to the edge cache **606** until the communication link is closed between the mid-tier cache **604** and the edge cache **606**, or until the communication link is closed between the mid-tier cache **604** and the packaging device **602**.

[0116] The session management module **622** may be configured to group or associate a plurality of communication links for the same content. If there are three edge caches **606** that are requesting the same content, the session management module **622** may treat the three separate communication links as associated for efficient management of the communication links.

[0117] The session management module **622** may have stateful logic for managing the communications links associated with the mid-tier cache **604**. The session management module **622** may set the state of a communication link as active in order to send content to a device requesting content (e.g., the edge cache **606**). The session management module **622** may monitor the communication link to ensure the communication link is still active (e.g., that the requesting device is still desiring to receive and/or consume the content). The session management module **622** may continue to push content to the requesting device as long as the communication link is open and/or active. The communication link may be closed and/or deactivated by the mid-tier cache **604** if there is no content to send to the edge cache **606**. The communication link may be

closed and/or deactivated by the edge cache **606** because the edge cache **606** no longer needs the content associated with the communication link.

[0118] Once the communication link is closed and/or deactivated, the session management module **622** may change the stateful logic associated with the communication link to indicate the communication link is closed. Once the edge cache **606** closes the communication link with the mid-tier cache **604**, the session management module **622** may close a communication link with the packaging device **602**. Stated differently, when all communication links to downstream devices (e.g., the edge cache **606**) are closed, the mid-tier cache **604** may close a communication link with the packaging device **602** because the mid-tier cache **604** no longer needs the content from the packaging device **602** since the edge cache **606** is no longer requesting the content. The mid-tier cache **604** may request content from the packaging device **602** to send to the edge cache **606**. Thus, a communication link may be established between the packaging device **602** and the mid-tier cache **604** in order to send content to the edge cache **606**. However, once the edge cache **606** indicates that the edge cache **606** no longer needs the content (e.g., closes and/or deactivates the communication link between the edge cache **606** and the mid-tier cache **604**), the session management module **622** closes the communication link between the packaging device **602** and the mid-tier cache **604** because the content associated with the aforementioned communication link is no longer needed. In this manner, the session management module **622** may manage multiple associated communication links. The mid-tier cache **604** may close the communication link with the edge cache **606** and/or the packaging device **602** in response to, and/or based on, the client device **608** closing the communication link with the edge cache **606**.

[0119] Once the session management module **622** determines the communication link is closed, the session management module **622** determines whether there are any additional communication links requesting the same content associated with the now closed communication link. If there are no other communication links (e.g., active communication links) requesting the same content, then the session management module **622** may instruct the cache **620** to remove the content as there is no longer a need for the content because no device is requesting the content. In this manner, the session management module **622** clears the cache **620** of any unnecessary data from any closed and/or deactivated communication links.

[0120] The session management module **622** may use one or more tokens (e.g., counters, timers, etc.) when managing the communication links. The session management module **622** may increment a counter associated with each communication link each time a packet is sent via the communication link. Each packet may be 2 seconds in length, and the counter is incremented each time a packet is sent. Thus, if the counter indicates 30 packets have been sent, the counter indicates that 60 seconds have passed. The session management module **622** may close and/or deactivate communication links after a period of time. If 60 seconds have passed, and the session management module **622** does not receive a communication from the requesting device (e.g., the edge cache **606**), the session management module **622** may assume the requesting device is no longer consuming the content and closes and/or deactivates the communication link. In this manner, the session management module **622** may use counters to manage the communication links associated with the mid-tier cache **604**.

[0121] The session management module **622** may close and/or deactivate communication links without communicating with another device (e.g., the packaging device **602**, the edge cache **606**, etc.). A counter may be incremented each time a new communication link is added, as well as the counter may be decremented each time a communication link is removed so that the session management module **622** may track the active communication links associated with the mid-tier cache **604**.

[0122] The session management module **622** may keep track of the number of devices associated with a specific type of content. The session management module **622** may use a counter to keep track of the number of client devices that have requested the specific content. That is, three client

devices (e.g., edge caches **606**) may request the specific content from the mid-tier cache **604**. Each of the three edge caches **606** may have a communication link associated with each of the edge caches **606**. A counter may be used to keep track of (e.g., count) the number of client devices (e.g., edge caches **606**) associated with the specific content. The counter may keep track of (e.g., count) the number of communication links associated with the specific content. When a client device (e.g., one of the edge caches **606**) closes a communication link, the counter may be updated to reflect the removal of a client device. The counter may be decremented until the counter satisfies a threshold (e.g., the counter reaches zero to indicate there are no active communication links or client devices associated with the specific content). The counter may be incremented if additional client devices request content from the mid-tier cache **604**.

[0123] When the counter satisfies the threshold (e.g., the counter reaches zero to indicate there are no active communication links or client devices associated with the specific content), the session management module **622** may close a communication link to a device that the mid-tier cache **604** is receiving content from. The session management module **622** may close a communication link associated with the packaging device **602** that sent the content to the mid-tier cache **604** for distribution to the client devices (e.g., the three edge caches **606**). The session management module **622** may close a communication link associated with the packaging device **602** based on the counter satisfying a threshold (e.g., the counter reaches zero). That is, when there are no longer any client devices associated with a specific content, the session management module **622** may close a communication link to a device that is supplying the specific content to the mid-tier cache **604** because the mid-tier cache **604** no longer needs the specific content. In this manner, the session management module **622** may close communication links with an upstream device (e.g., the packaging device **602**) based on the mid-tier cache **604** having no client devices (e.g., the edge cache **606**) that are requesting the content that the upstream device was sending to the mid-tier cache **604**. Similarly, the session management module **622** may close communication links with downstream devices (e.g., the edge cache **606**), if the communication link with the upstream device (e.g., the packaging device **602**) is terminated or rendered inactive. In this manner, the session management module **622** allows the mid-tier cache **604** to dynamically control communication sessions associated with the mid-tier cache **604**.

[0124] The session management module **622** may use a token (e.g., a counter, a timer, etc.) to ensure a communication link is active. A counter may be incremented each time the mid-tier cache **604** receives data (e.g., from the packaging device **602**). The counter may be decremented when the mid-tier cache **604** sends data to a device (e.g., the edge cache **606**). If the counter satisfies a threshold (e.g., reaches 30 counts), the session management module **622** may determine that the communication link with the edge cache **606** is closed since data is not being sent to the edge cache **606** because the counter has not been decremented to indicate data has been sent. In turn, the session management module **622** may close the communication link with the edge cache **606** as well as decrement the counter associated with the communication links managed by the session management module **622**. The session management module **622** may determine that the communication link with the edge cache **606** is closed because the edge cache **606** closes a socket associated with the communication link so that the mid-tier cache **604** may no longer send data via the communication link. In this manner, the session management **622** is able to close and/or maintain communications links with other devices without the need for the devices to communicate back and forth by using a counter.

[0125] As shown, the edge cache **606** may have a client **626**, a cache **628**, a session management **630**, and a server **632**. The edge cache **606** may receive content and store the received content in the cache **628**. The cache **628** may store content. The cache **628** may store content received from the mid-tier cache **604**, as well as content for distributing to the client device **608**. The cache **628** may also update content stored within the cache **628** based on the received content. The cache **628** may also remove content after the effective life of the content is ended. The cache **628** may remove

data based on a Cache-Control time-to-live.

[0126] The client module **626** may communicate with another device. The client module **626** communicates with the mid-tier cache **604**. The client module **626** establishes a communication link with the mid-tier cache **604** in order to receive content from the mid-tier cache **604**. The client module **626** may request content that is not in the cache **628**. The edge cache **606** may receive a request for content (e.g., from the client device **608**), and may determine that the cache **628** does not have the requested content. Thus, the client module **626** establishes the communication link with the mid-tier cache **604** to request the missing content. Once the edge cache **606** receives the missing content, the client module **626** may push the content to the requesting device (e.g., the client device **608**).

[0127] The server module **632** may be configured to communicate with another device. The server module **632** may communicate with the client device **608**, as well as provide the client device **608** with content. The server module **632** may be configured to handle communications for the edge cache **606** to the client device **608**. Specifically, the server module **632** may open and/or create a communication link to communicate with the client device **608**. The server module **632** waits to receive new attempts to establish a communication link for content from a device (e.g., the client device **608**). When the server module **632** receives a new attempt to establish a communication link, the server module **632** may verify that the requesting device supports a communication protocol that allows the server module **632** to communicate with the requesting device. The server module **632** may verify that the requesting device supports the HTTP 2.0 protocol. The server module **632** creates or updates information associated with the requesting device and/or the communication link. The server module **632** indicates to the session management module **630** that a new communication link has been established.

[0128] The server module **632** may send content to client device **608** via the opened/created communication link. After the communication link is established, the server module **632** sends a plurality of content fragments to the requesting device (e.g., the client device **608**). The server module **632** may push content fragments to the client device **608** without the client device **608** requesting content. Stated differently, the server module **632** may push content fragments to the client device **608** based on the established communication link without the client device **608** requesting content because the server module **632** determines the content the client device **608** desires based on the communication link. The server module **632** may push content fragments to the client device **608** without the client device **608** sending additional requests for content. Stated differently, once the client device requests content from the edge cache **606**, the server module **632** may push the content fragments to the client device **608** without the client device **608** needing to request each of the content fragments. The server module **632** continues to push content fragments to the client device **608** until the communication link between the edge cache **606** and the client device **608** is closed.

[0129] The edge cache **606** may have a session management module **630**. The session management module **630** manages all established communication links associated with the edge cache **606**. The session management module **630** manages the communication links between the edge cache **606** and the mid-tier cache **604**, as well as the communication links between the edge cache **606** and the client device **608**.

[0130] After the server module **630** establishes a communication link with the client device **608**, the server module **632** indicates to the session management module **630** that a communication link has been established so that the session management module **630** may manage the newly established communication link. The session management module **630** may then ensure that the client device **608** receives content based on the content requested by the client device **608**. The session management module **630** may send the requested content, as well as any subsequent content, to the client device **608**. The session management module **630** may push content to the client device **608** as soon as the content is available for distribution to the client device **608**.

[0131] After the client module **626** establishes a communication link with the mid-tier cache **604**, the client module **626** indicates to the session management module **630** that a communication link has been established so that the session management module **630** may manage the newly established communication link. The session management module **630** may then ensure that the edge cache **606** receives the content requested from the mid-tier cache **604**. In this manner, the session management module **630** ensures that the edge cache **606**, as well as the client device **608**, have the most up to date content from the mid-tier cache **604**. That is, once the communication link is established between the edge cache **606** and the mid-tier cache **604**, the session management module **630** may push the content received from the mid-tier cache to the client device **608** until the communication link is closed between the edge cache **606** and the client device **608**, or until the communication link is closed between the edge cache **606** and the mid-tier cache **604**.

[0132] The session management module **630** may be configured to group or associate a plurality of communication links for the same content. If there are three client device **608** that are requesting the same content, the session management module **630** may treat the three separate communication links as associated for efficient management of the communication links.

[0133] The session management module **630** may have stateful logic for managing the communications links associated with the edge cache **606**. The session management module **630** may set the state of a communication link as active in order to provide content to a device requesting content (e.g., the client device **608**). The session management module **630** may monitor the communication link to ensure the communication link is still active (e.g., that the requesting device is still desiring to receive and/or consume the content). The session management module **630** may continue to push content to the requesting device as long as the communication link is open and/or active. The communication link may be closed and/or deactivated by the edge cache **606** if there is no content to send to the client device **608**. The communication link may be closed and/or deactivated by the client device **608** because the client device **608** no longer needs the content associated with the communication link.

[0134] Once the communication link is closed and/or deactivated, the session management module **630** may change the stateful logic associated with the communication link to indicate the communication link is closed. Once the client device **608** closes the communication link with the edge cache **606**, the session management module **630** may close a communication link with the mid-tier cache **604**. Stated differently, when all communication links to downstream devices (e.g., the client device **608**) are closed, the edge cache **606** may close a communication link with the mid-tier cache **604** because the edge cache **606** no longer needs the content from the mid-tier cache **604**. The edge cache **606** may request content from the mid-tier cache **604** to send to the client device **608**. Thus, a communication link may be established between the edge cache **606** and the mid-tier cache **604** in order to send content to the client device **608**. However, once the client device **608** indicates that the client device **608** no longer needs the content (e.g., closes and/or deactivates the communication link between the client device **608** and the edge cache **606**), the session management module **630** closes the communication link between the edge cache **606** and the mid-tier cache **604** because the content associated with the aforementioned communication link is no longer needed. The edge cache **606** may close the communication link with the mid-tier cache **604** in response to, and/or based on, the client device **608** closing the communication link with the edge cache **606**. In this manner, the session management module **630** may manage multiple associated communication links.

[0135] Once the session management module **630** determines the communication link is closed, the session management module **630** determines whether there are any additional communication links requesting the same content associated with the now closed communication link. If there are no other communication links requesting the same content, then the session management module **630** may instruct the cache **628** to remove the content as there is no longer a need for the content because no device is requesting the content. In this manner, the session management module **630**

clears the cache **628** of any unnecessary data from any closed and/or deactivated communication links.

[0136] The session management module **630** may use one or more tokens (e.g., counters, timers, etc.) when managing the communication links. The session management module **630** may increment a counter associated with each communication link each time a packet is sent via the communication link. Each packet may be 2 seconds in length, and the counter is incremented each time a packet is sent. Thus, if the counter indicates 30 packets have been sent, the counter indicates that 60 seconds have passed. The session management module **630** may close and/or deactivate communication links after a period of time. If 60 seconds have passed, and the session management module **630** does not receive a communication from the requesting device (e.g., the client device **608**), the session management module **630** may assume that the requesting device is no longer consuming the content and closes and/or deactivates the communication link. In this manner, the session management module **630** may use counters to manage the communication links associated with the edge cache **606**.

[0137] The session management module **630** may close and/or deactivate communication links without communicating with another device (e.g., the mid-tier cache **604**, the client device **608**, etc.). A counter may be incremented each time a new communication link is added, as well as the counter may be decremented each time a communication link is removed so that the session management module **630** may track the active communication links associated with the edge cache **606**.

[0138] The session management module **630** may keep track of the number of devices associated with a specific type of content. The session management module **630** may use a counter to keep track of the number of client devices that have requested the specific content. That is, three client devices (e.g., client devices **608**) may request the specific content from the edge cache **606**. Each of the three client devices **608** may have a communication link associated with each of the client devices **608**. A counter may be used to keep track of (e.g., count) the number of client devices (e.g., client device **608**) associated with the specific content. The counter may keep track of (e.g., count) the number of communication links associated with the specific content. When a client device (e.g., one of the client devices **608**) closes a communication link, the counter may be updated to reflect the removal of a client device. The counter may be decremented until the counter satisfies a threshold (e.g., the counter reaches zero to indicate there are no active communication links or client devices associated with the specific content). The counter may be incremented if additional client devices request content from the edge cache **606**.

[0139] When the counter satisfies the threshold (e.g., the counter reaches zero to indicate there are no active communication links or client devices associated with the specific content), the session management module **630** may close a communication link to a device that the mid-tier cache **604** is receiving content from. The session management module **630** may close a communication link associated with the packaging device **602** that sent the content to the mid-tier cache **604** for distribution to the client devices (e.g., the three edge caches **606**). The session management module **630** may close a communication link associated with the packaging device **602** based on the counter satisfying a threshold (e.g., the counter reaches zero). That is, when there are no longer any client devices associated with a specific content, the session management module **630** may close a communication link to a device that is supplying the specific content to the mid-tier cache **604** because the mid-tier cache **604** no longer needs the specific content. In this manner, the session management module **630** may close communication links with an upstream device (e.g., the packaging device **602**) based on the mid-tier cache **604** having no client devices (e.g., the edge cache **606**) that are requesting the content that the upstream device was sending to the mid-tier cache **604**. Similarly, the session management module **630** may close communication links with downstream devices (e.g., the client device **608**), if the communication link with the upstream device (e.g., the mid-tier cache **604**) is terminated or rendered inactive. In this manner, the session

management module **630** allows the edge cache **606** to dynamically control communication sessions associated with the edge cache **606**.

[0140] The session management module **630** may use a token (e.g., a counter, a timer, etc.) to ensure a communication link is active. A counter may be incremented each time the edge cache **606** receives data (e.g., from the mid-tier cache **604**). The counter may be decremented when the edge cache **606** sends data to a device (e.g., the client device **608**). If the counter satisfies a threshold (e.g., reaches 30 counts), the session management module **630** may determine that the communication link with the client device **608** is closed since data is not being sent to the client device **608** because the counter has not been decremented to indicate data has been sent. In turn, the session management module **630** may close the communication link with the client device **608** as well as decrement the counter associated with the communication links managed by the session management module **630**. The session management module **630** may determine that the communication link with the client device **608** is closed because the client device **608** closes a socket associated with the communication link so that the edge cache **606** may no longer send data via the communication link. In this manner, the session management **630** is able to close and/or maintain communications links with other devices without the need for the devices to communicate back and forth by using a counter.

[0141] As shown, the client device **608** may have a client **634**, a cache **636**, and a session management **638**. The cache **636** may store content. The cache **636** may store content received from the edge cache **606**. The cache **636** may also update content stored within the cache **636** based on the received content. The cache **636** may also remove content after the effective life of the content is ended. The cache **636** may remove data based on a Cache-Control time-to-live.

[0142] The client module **634** may communicate with another device. The client module **634** communicates with the edge cache **606**. The client module **634** establishes a communication link with the edge cache **606** in order to receive content from the edge cache **606**. The client module **634** may request content that is not in the cache **636**. The client device **608** may receive a request for content (e.g., from a user of the client device), and may determine that the cache **636** does not have the requested content. Thus, the client module **634** establishes the communication link with the edge cache **606** to request the missing content. After requesting the content from the edge cache **606**, the edge cache **606** may in turn create a communication link with the mid-tier cache **604**. Thus, the client device **608** requesting content may result in the edge cache **606** requesting content to fulfill the request. Stated differently, a downstream device (e.g., the client device **608**) may cause an upstream device (e.g., the edge cache **606**, the mid-tier cache **604**, and/or the packaging device **602**) to create one or more communication links to facilitate completion of the request. Once the client device **608** receives the missing content, the client module **634** may display the content (e.g., on a display device).

[0143] The client device **608** may have a session management module **638**. The session management module **638** manages all established communication links associated with the client device **608**. The session management module **638** manages the communication links between the client device **608** and the edge cache **606**. The session management module **638** manage the communication links between the client device **608** and a plurality of edge caches **606**.

[0144] After the client module **634** establishes a communication link with the edge cache **606**, the client module **634** indicates to the session management module **638** that a communication link has been established so that the session management module **638** may manage the newly established communication link. The session management module **638** may then ensure that the client device **608** receives the content requested from the edge cache **606**. In this manner, the session management module **638** ensures that the client device **608** has the most up to date content from the edge cache **606**. That is, once the communication link is established between the edge cache **606** and the client device **608**, the session management module **638** may ensure the requested content is received from the edge cache **606** until the communication link is closed between the

edge cache **606** and the client device **608**. The communication link may be closed by the edge cache **606**. The communication link may be closed by the client device **608** (e.g., upon termination of a rendering of the content by the client device **608**).

[0145] The session management module **638** may have stateful logic for managing the communications links associated with the client device **608**. The session management module **638** may set the state of a communication link as active in order to receive content. The session management module **638** may monitor the communication link to ensure the communication link is still active. The communication link may be closed and/or deactivated by the client device **608** because the client device **608** no longer needs the content associated with the communication link. A user of the client device **608** may indicate to the client device **608** that the user no longer wishes to consume the content. Thus, the client device **608** closes and/or deactivates the communication link between the client device **608** and the edge cache **606**.

[0146] Once the session management module **638** determines the communication link is closed, the session management module **638** may instruct the cache **636** to remove the content as there is no longer a need for the content. In this manner, the session management module **638** clears the cache **636** of any unnecessary data from any closed and/or deactivated communication links.

[0147] The client device **608** may not have the session management **638**. The client device **608** may not support HTTP 2.0, which may allow the device **608** to use the session management **638**. Rather, the client device **608** may use a legacy protocol. When the client device has a legacy protocol, the session management **638** is bypassed and a request/response model is used for the client device **608**. In this manner, the system **600** may be configured to communicate with devices that have a legacy protocol, as well as devices that implement session management.

[0148] While FIG. **6** is described with only one packaging device **602**, one mid-tier cache **604**, one edge cache **606**, and one client device **608** for case of explanation, a person skilled in the art would appreciate there could a plurality of each of the devices. Also, while a single communication link is shown between each of the packaging device **602**, the mid-tier cache **604**, the edge cache **606**, and the client device **608** for case of explanation, a person skilled in the art would appreciate there may be multiple communication links between the devices, such as a communication link for a manifest, another communication link for video content, a third communication link for audio content, and so forth. Further, while FIG. **6** shows each device (e.g., the packaging device **602**, the mid-tier cache **604**, the edge cache **606**, and the client device **608**) as having a session management module for case of explanation, a person skilled in the art would appreciate that the devices do not have to have a session management module, and it is contemplated that all, some, and/or none of the devices of FIG. **6** have to have a session management module.

[0149] FIG. **7** shows a system **700**. The system **700** may have a content source **702** (e.g., the central location **101** and/or the content source **127** of FIG. **1**; the content source **202** of FIG. **2**; and/or the content sources **302**, **304** of FIG. **3**; the packaging device **602** and/or the mid-tier cache **604** of FIG. **6**), a cache device **704** (e.g., the edge device **128** of FIG. **1**; the mid-tier cache **604** and/or the edge cache **606** of FIG. **6**), and a client device **706** (e.g., the media device **120**, the communication terminal **122**, and/or the mobile device **124** of FIG. **1**; the mid-tier cache **604**, the edge cache **606**, and/or the client device **606** of FIG. **6**). Though not shown in FIG. **7**, the system **700** may utilize a VQ agent as discussed above with respect to FIGS. **2-5**. Specifically, the content source **702** may send content to another device based on an instruction received from a VQ agent (e.g., the VQ agent may determine that a portion of content prepared for delivery by the content source **702** is of a higher quality than the portion prepared for delivery by another content source in communication with the VQ agent). The content source **702** may send content to the cache device **704** via a communication link. The cache device **704** may send the received content to the client device **706**.

[0150] The content may be received and/or sent in packets. The cache device **704** may monitor the received content (e.g., the received packets) and/or the sent content (e.g., the sent packets) using a content token **708**. That is, the content token **708** may indicate a status associated with the content.

The content token **708** may be a counter, a timer, or other token for indicating the received content. The content token **708** may be updated (e.g., incremented, decremented, reset, etc.). The content token **708** may increment and/or decrement based on the received content. The content token **708** may increment and/or decrement based on each packet of the received content. The content token **708** may increment and/or decrement based on the sent content. The content token **708** may increment and/or decrement based on each packet of the sent content. The content token **708** may be reset (e.g., to a default value) based on the received and/or sent content. The content token **708** may be decremented and/or reset based on the packets received by the cache device **704** (e.g., from the content source **702**), and the content token **708** may be incremented based on the packets sent by the cache device **704** (e.g., to the client device **706**).

[0151] The content token **708** may have a state associated with the content token **708**. The state of the content token **708** may indicate the current state of the content token **708** (e.g., a value of a counter, a current time of a timer, etc.). The state of the content token **708** may be updated (e.g., incremented, decremented, reset, etc.) to reflect changes associated with the content token **708**.

[0152] The cache device **704** may take an action based on the content token **708** satisfying a threshold. The cache device **704** may terminate the communication link (e.g., close a socket associated with the communication link) with the client device **706** based on the content token **708** satisfying the threshold. The threshold may be a value associated with a counter (e.g., 1, 15, 70, 100, etc.), a time period associated with a timer (e.g., 1 ms, 5 ms, 1 second, 1 minute, etc.), or any threshold that may be associated with the content token **708**. The threshold may indicate a problem (e.g., a failure, termination of, etc.) of the communication link with the content source **702**. The cache device **704** may terminate the communication link with the client device **706** based on the content token **708** satisfying the threshold because the content token **708** indicates that the cache device **704** may no longer be receiving content from the content source **702**. Thus, the cache device **704** may manage communication links between the content source **702** and the client device **706** by utilizing the content token **708**.

[0153] The cache device **704** may have a device token **710**. The device token **710** may be a counter, a timer, or other token for indicating devices associated with the cache device **704**. The device token **710** may indicate client devices (e.g., the client device **706**) receiving content from the cache device **704**. The device token **710** may increment and/or decrement based on a client device (e.g., the client device **706**) establishing or terminating a communication link with the cache device **704**. The client device **706** may request content from the cache device **704**, and a communication link may be established between the cache device **704** and the client device **706**. The device token **710** may be incremented to indicate an increase in the number of devices receiving content from the cache device **704**. The client device **706** may terminate (e.g., close a socket associated with) the communication link with the cache device **704**. The device token **710** may be decremented to indicate a decrease in the number of devices receiving content from the cache device **704**.

[0154] The device token **710** may have a state associated with the device token **710**. The state of the device token **710** may indicate the current state of the device token **710** (e.g., a value of a counter, a current time of a timer, etc.). The state of the device token **710** may be updated (e.g., incremented, decremented, reset, etc.) to reflect changes associated with the device token **710**.

[0155] The cache device **704** may take an action based on the device token **710** satisfying a threshold. The cache device **704** may terminate the communication link (e.g., close a socket associated with the communication link) with the content source **702** based on the device token **710** satisfying the threshold. The threshold may be a value associated with a counter (e.g., 1, 15, 70, 100, etc.), a time period associated with a timer (e.g., 1 ms, 5 ms, 1 second, 1 minute, etc.), or any threshold that may be associated with the device token **710**. The threshold may indicate that the cache device **704** no longer needs content from the content source **702**. The device token **710** may be decremented based on the client device **706** terminating the communication link, and the device token **710** may satisfy a threshold that indicates that there are no client devices **706** receiving

content from the cache device **704**. The cache device **704** may terminate (e.g., close a socket associated with) the communication link with the content source **702** because the cache device **704** no longer needs content from the content source **704** since there are no client devices **706** receiving content from the cache device **704**. Thus, the cache device **704** may manage communication links between the content source **702** and the client device **706** by utilizing the device token **710**.

[0156] While a single content source **702**, a single cache device **704**, and a single client device **706** are used for ease of explanation, a person skilled in the art would appreciate that the system **700** may have any number of content sources **702**, cache devices **704**, and client devices **706**.

[0157] FIG. **8A** shows a system **800**. The system **800** may have a content source **802** (e.g., the central location **101** and/or the content source **127** of FIG. **1**; the packaging device **602** and/or the mid-tier cache **604** of FIG. **6**; and/or the content source **702** of FIG. **7**), a cache device **804** (e.g., the edge device **128** of FIG. **1**; the mid-tier cache **604** and/or the edge cache **606** of FIG. **6**; and/or the cache device **704** of FIG. **7**), and client devices **806a**, **806b**, and **806c** (e.g., the media device **120**, the communication terminal **122**, and/or the mobile device **124** of FIG. **1**; the mid-tier cache **604**, the edge cache **606**, and/or the client device **606** of FIG. **6**; and/or the client device **706** of FIG. **7**). Though not shown in FIG. **8A**, the system **800** may utilize a VQ agent as discussed above with respect to FIGS. **2-5**. Specifically, the content source **802** may send content to another device based on an instruction received from a VQ agent (e.g., the VQ agent may determine that a portion of content prepared for delivery by the content source **802** is of a higher quality than the portion of content prepared for delivery by another content source in communication with the VQ agent). The content source **802** may send content to the cache device **804** via one or more communication links (e.g., the communication links **812a** and **812b**). The cache device **804** may receive the content, and send the received content to the client devices **806a**, **806b**, and **806c** via one or more communication links (e.g., the communication links **812c**, **812d**, and **812e**).

[0158] The client devices **806a**, **806b**, and **806c** may request content from the cache device **804**. The client devices **806a** and **806b** may request a first content, and the client device **806c** may request a second content. The first content and the second content may be the same, or different, content. The cache device **804** may request content from the content source **802** based on the requests from the client devices **806a**, **806b**, and **806c**. The cache **804** may request the first content and the second content from the content source **802**.

[0159] The content source **802** may send the requested content to the cache device **804**. The content source **802** may send the requested content on two separate communication links (e.g., the communication links **812a**, **812b**). The content source **802** may send the first content on the communication link **812a**, and the content source **802** may send the second content on the communication link **812b**. The cache device **804** may receive the content items from the content source **802** via the communication links **812a** and **812b**, and send the content items to the client devices **806a**, **806b**, and **806c** via the communication links **812c**, **812d**, and **812e**. The cache device **804** may send the first content to the client devices **806a** and **806b** via the communication links **812c** and **812d**, and may send the second content to the client device **806c** via the communication link **812e**.

[0160] The cache device **804** may have content tokens **808a** and **808b**. The content tokens **808a** and **808b** may be associated with specific content, as well as specific communication links. The content token **808a** may be associated with the first content. The content token **808a** may be associated with the communication links **812a** (e.g., the communication link **812** that the cache device **804** receives the first content) and the communication links **812c** and **812d** (e.g., the communication links **812** that the cache device sends the first content). The content token **808a** may increment when a packet of content (e.g., a packet of the first content from the content source **802** via the communication link **812a**) is sent to a client device **806** (e.g., the client devices **806a**, **806b** via the communication links **812c**, **812d**). The content token **808a** may decrement and/or reset to a default value (e.g., 0) when a packet is received from the content source **802**.

[0161] The content token **808b** may be associated with the second content. The content token **808b** may be associated with the communication links **812b** (e.g., the communication link **812** that the cache device **804** receives the second content) and the communication link **812e** (e.g., the communication link **812** that the cache device sends the second content). The content token **808b** may increment when a packet of content (e.g., a packet of the second content from the content source **802** via the communication link **812b**) is sent to a client device **806** (e.g., the client device **806c** via the communication link **812e**). The content token **808b** may decrement and/or reset to a default value (e.g., 0) when a packet is received from the content source **802**.

[0162] The cache device **804** may have device tokens **810a** and **810b**. The device tokens **810a** and **810b** may be a counter, a timer, or other token for indicating devices associated with the cache device **704**. The device tokens **810a** and **810b** may indicate client devices (e.g., the client devices **806a**, **806b**, **806c**) receiving content from the cache device **804**. The device tokens **810a** and **810b** may increment and/or decrement based on a client device **806** establishing or terminating a communication link with the cache device **804**. The device tokens **810a** and **810b** may be associated with specific content and/or specific communication links. The device tokens **810a** and **810b** may indicate the client devices **806** associated with the specific content and/or the specific communication links. The device token **810a**, similar to the content token **808a**, may be associated with the first content and the client devices **806a** and **806b**. The device token **810a** may indicate that there are two client devices (e.g., the client devices **806a** and **806b**) receiving the first content from the cache device **804**. The device token **810b**, similar to the content token **808b**, may be associated with the second content and the client device **806c**. The device token **810b** may indicate that there is one client device (e.g., the client device **806c**) receiving the second content from the cache device **804**.

[0163] FIG. **8B** shows a system **850**. The system **850** may have a content source **802** (e.g., the central location **101** and/or the content source **127** of FIG. **1**; the packaging device **602** and/or the mid-tier cache **604** of FIG. **6**; and/or the content source **702** of FIG. **7**), a cache device **804** (e.g., the edge device **128** of FIG. **1**; the mid-tier cache **604** and/or the edge cache **606** of FIG. **6**; and/or the cache device **704** of FIG. **7**), and client devices **806a**, **806b**, and **806c** (e.g., the media device **120**, the communication terminal **122**, and/or the mobile device **124** of FIG. **1**; the mid-tier cache **604**, the edge cache **606**, and/or the client device **606** of FIG. **6**; and/or the client device **706** of FIG. **7**). The system **850** is similar to the system **800** of FIG. **8A**, but the communication links **812c** and **812d** associated the client devices **806a** and **806b**, respectively, are terminated and/or closed. Though not shown in FIG. **8B**, the system **850** may utilize a VQ agent as discussed above with respect to FIGS. **2-5**. Specifically, the content source **802** may send content to another device based on an instruction received from a VQ agent (e.g., the VQ agent may determine that a portion of content prepared for delivery by the content source **802** is of a higher quality than the portion of content prepared for delivery by another content source in communication with the VQ agent).

[0164] The cache device **804** may take an action based on the device tokens **810a** and/or **810b** satisfying a threshold. The cache device **804** may terminate a communication link (e.g., close a socket associated with the communication link) with the content source **802** based on the device tokens **810a** and/or **810b** satisfying the threshold. The threshold may indicate that the cache device **804** no longer needs content from the content source **804**.

[0165] The client devices **806a** and **806b** may terminate and/or close the communication links **812c** and **812d**. Thus, the client devices **806a** and **806b** are no longer receiving content from the cache device **804**. The device token **810a** may be decremented to indicate that the cache device **804** is no longer sending content to the client devices **806a** and **806b**. The device token **810a** may satisfy a threshold after decrementing to indicate that the cache device **804** is no longer sending content to the client devices **806a** and **806b**. The cache device **804**, based on the device token **810a** satisfying the threshold, may terminate and/or close the communication link associated with the content being sent to the client devices **806a** and **806b** (e.g., close and/or terminate the communication link **812a**)

because the cache device **804** no longer needs the content associated with the communication link **812a** as there are no client devices requesting the content associated with the communication link **812a** as indicated by the device token **810a**. However, the cache device **804** may allow the communication links **812b** and **812e** to remain active and/or open because the device token **810b** indicates there is a client device (e.g., the client device **806c**) still requesting content. Thus, the cache device **804** may determine which communication links **812** are terminated and/or closed based on the device tokens **810a** and **810b**.

[0166] FIG. **9** is a flowchart of a method **900** for distributing content in accordance with the present description. Method **900** may be implemented using the system **100** of FIG. **1**, the system **200** of FIG. **2**, the system **300** of FIG. **3**, the communication flows of FIGS. **4** and **6**; the system **600** of FIG. **6**; the system **700** of FIG. **7** and/or the system **800** or the system **850** of FIG. **8**. At step **910**, a portion of a content item to be delivered to a requesting device may be received at a first packaging device and at a second packaging device. The portion of the content item may be a number of frames of video content, a duration of audio content, a number of data packets of video content and/or audio content, and the like. The requesting device may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. Each of the first packaging device and the second packaging device may be a combiner, such as combiner **117** of FIG. **1**, and/or a packaging device, such as any of the packaging devices shown in FIGS. **2**, **4**, **5**, and **6**, and the like. The first packaging device may be part of a first network (e.g., a datacenter, central location, etc.) and the second packaging device may be part of a second network (e.g., a datacenter, central location, etc.). The portion of the content item received by the first packaging device and the second packaging device may originate from a first source, such as any of input sources **102a**, **102b**, or **102c**; content source **202**, content source **302**, content source **304**, content source **702**, content source **802**, and the like. The first packaging device and the second packaging device may each receive the portion of the content item from the first source.

[0167] At step **920**, a first service metric associated with the first packaging device and a second service metric associated with the second packaging device may each be received (e.g., separately or collectively as one message). The first service metric may be received from a first video quality agent associated with the first network. The second service metric may be received from a second video quality agent associated with the second network. At step **930**, a portion of the content item packaged by the first packaging device may be determined to satisfy a quality threshold. The determination at step **930** may be based on the first service metric and the second service metric (e.g., the first service metric may be indicative of a higher quality than the second service metric). The first service metric may be based on one or more packaging errors (e.g., a loss of a packet identifier, an encoder boundary point misalignment, a loss of an audio packet identifier associated with a portion of the content item packaged by the first packaging device, a change in metadata associated with the content item, or any other aspect of packaging the content item that may be observable by the first packaging device). The second service metric may be based on one or more packaging errors (e.g., a loss of a packet identifier, an encoder boundary point misalignment, a loss of an audio packet identifier with a portion of the content item packaged by the second packaging device, a change in metadata associated with the content item, or any other aspect of packaging the content item that may be observable by the second packaging device).

[0168] At step **940**, the first packaging device may deliver the packaged portion of the content item to the requesting device. The first packaging device may deliver the packaged portion of the content item to the requesting device based on the packaged portion of the content item satisfying the quality threshold. At step **950**, a disable message (e.g., an instruction) associated with the portion of the content item may be sent to the second packaging device. The disable message may be sent based on a determination that a portion of the content item packaged by the second packaging device does not satisfy the quality threshold. The disable message may be sent based on

a determination that the portion of the content item packaged by the second packaging device satisfies the quality threshold to a lesser degree than the portion of the content item packaged by the first packaging device (e.g., the portion packaged by the first packaging device is determined to be of a higher quality as compared to the portion packaged by the second packaging device). The disable message may be sent based on a determination that the first service metric is associated with a higher quality of packaged content as compared to the second service metric. The disable message may cause the second packaging device to disable delivery of the portion of the content item packaged by the second packaging device to the requesting device.

[0169] A second portion of the content item may be received from the first source at the first packaging device and at the second packaging device. The second portion of the content item may be packaged at the first packaging device and at the second packaging device. A request for the second portion of the content item to be delivered from a second source may be received from a second requesting device. The second source may be a content source such as any of input sources **102a**, **102b**, or **102c**; content source **202**, content source **302**, content source **304**, content source **702**, content source **802**, and the like. The second requesting device may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. A determination may be made that the second portion of the content item received from the first source and packaged by the second packaging device satisfies the quality threshold. The determination may be based on a third service metric associated with the second packaging device and the second portion of the content item received from the first source and packaged by the second packaging device. Based on the determination that the second portion of the content item packaged by the second packaging device satisfies the quality threshold, the second packaging device may deliver the second portion of the content item received from the first source to the second requesting device (e.g., despite the request from the second requesting device indicating that the second portion of the content item was to be delivered by the second content source).

[0170] FIG. **10** is a flowchart of a method **1000** for distributing content in accordance with the present description. Method **1000** may be implemented using the system **100** of FIG. **1**, the system **200** of FIG. **2**, the system **300** of FIG. **3**, the communication flows of FIGS. **4** and **6**; the system **600** of FIG. **6**; the system **700** of FIG. **7** and/or the system **800** or the system **850** of FIG. **8**. At step **1010**, a portion of a content item to be delivered to a requesting device may be received by a computing device. The portion of the content item may be a number of frames of video content, a duration of audio content, a number of data packets of video content and/or audio content, and the like. The requesting device may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. The computing device may be a packaging device on a first network (e.g., a datacenter, central location, etc.). The computing device may receive the portion of the content item from a first source, such as any of input sources **102a**, **102b**, or **102c**; content source **202**, content source **302**, content source **304**, content source **702**, content source **802**, and the like. At step **1020**, the computing device may package the portion of the content item. The computing device may package the portion of the content item based on the requesting device (e.g., a suitable format(s) compatible with the requesting device).

[0171] At step **1030**, indicia of a service metric associated with the packaged portion of the content item may be sent (e.g., by the computing device) to a video quality agent. The indicia of the service metric may indicate one or more packaging errors (e.g., a loss of a packet identifier, an indication of an encoder boundary point misalignment, an indication of a loss of an audio packet identifier associated with the portion of the content item packaged by the computing device, a change in metadata associated with the content item, or any other aspect of packaging the content item that

may be observable by the computing device).

[0172] At step **1040**, a disable message (e.g., an instruction) associated with the portion of the content item packaged by the computing device may be received (e.g., based on the indicia of the service metric). The disable message may be received from the video quality agent. The video quality agent may be part of the first network or part of a second network (e.g., a datacenter, central location, etc.). The video quality agent may send the disable message based on a determination that the portion of the content item packaged by the computing device does not satisfy a quality threshold (e.g., based on the indicia of the service metric). The video quality agent may send the disable message based on a determination that the indicia of the service metric is associated with a lower quality of packaged content as compared to a portion of the content item packaged by another computing device (e.g., a packaging device such as combiner **117** of FIG. **1** or any of the packaging devices shown in FIGS. **2**, **4**, **5**, and **6**, and the like).

[0173] At step **1050**, delivery of the portion of the content item packaged by the computing device may be disabled (e.g., caused to be disabled based on the disable message/instruction received from the video quality agent). The computing device may receive a second portion of the content item. The second portion of the content item may be received by the computing device from the first source. The computing device may package the second portion of the content item for delivery to a requesting device. The computing device may receive an instruction (e.g., from the video quality agent) to deliver the second portion of the content item to a second requesting device. The second requesting device may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. The instruction may be received based on a request (e.g., via a HTTP 1.1 GET request) sent by the second requesting device. The request sent by the second requesting device may indicate that the second portion of the content item is to be received from (e.g., originate from) a second source. The second source may be a content source such as any of input sources **102a**, **102b**, or **102c**; content source **202**, content source **302**, content source **304**, content source **702**, content source **802**, and the like. Based on the instruction sent by the second requesting device, the computing device may send the packaged second portion of the content item received by the computing device from the first source to the second requesting device. (e.g., despite the request from the second requesting device indicating that the second portion of the content item was to be delivered by the second content source).

[0174] FIG. **11** is a flowchart of a method **1100** for distributing content in accordance with the present description. Method **1100** may be implemented using the system **100** of FIG. **1**, the system **200** of FIG. **2**, the system **300** of FIG. **3**, the communication flows of FIGS. **4** and **6**; the system **600** of FIG. **6**; the system **700** of FIG. **7** and/or the system **800** or the system **850** of FIG. **8**. At step **1110**, a portion of a content item to be delivered to a first requesting device may be received. The portion of the content item may be a number of frames of video content, a duration of audio content, a number of data packets of video content and/or audio content, and the like. The first requesting device may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. The portion of the content item may be received from a first source, such as any of input sources **102a**, **102b**, or **102c**; content source **202**, content source **302**, content source **304**, content source **702**, content source **802**, and the like. The portion of the content item may be received at a first packaging device and at a second packaging device. Each of the first packaging device and the second packaging device may be a combiner, such as combiner **117** of FIG. **1**, and/or a packaging device, such as any of the packaging devices shown in FIGS. **2**, **4**, **5**, and **6**, and the like. The first packaging device may be part of a first network (e.g., a datacenter, central location, etc.) and the second packaging device may be part of a second network (e.g., a datacenter, central location, etc.). At step **1120**, an

origination message (e.g., a HTTP 1.1 200 OK message and/or an origination header) indicating one or more sources associated with the content item may be generated.

[0175] At step **1130**, the first packaging device may deliver a first portion of the content item packaged by the first packaging device to the requesting device. The first packaging device may deliver the packaged first portion of the content item based on a determination that the packaged first portion of the content item satisfies a quality threshold. The determination may be based on a first service metric and a second service metric. The first service metric may be received by a first computing device (e.g., a video quality agent associated with the first packaging device). The first computing device may be part of the first network, the second network, or a third network. The second service metric may be received by a second computing device (e.g., a video quality agent associated with the first packaging device). The second computing device may be part of the first network, the second network, or a third network. The first service metric may be associated with the first portion of the content item packaged by the first packaging device. The second service metric may be associated with the first portion of the content item packaged by the second packaging device. The first service metric and the second service metric may each be based on one or more packaging errors (e.g., a loss of a packet identifier, an encoder boundary point misalignment, or a loss of an audio packet identifier associated with the first portion of the content item, a change in metadata associated with the content item, or any other aspect of packaging the content item that may be observable by the first packaging device).

[0176] At step **1140**, the first packaging device and the second packaging device may each package a second portion of the content item. The second portion of the content item may be received by each of the first packaging device and the second packaging from the first source. At step **1150**, a request for the second portion of the content item may be received from a second requesting device. The second requesting device may be a set-top box, a digital streaming device, a gaming device, a media storage device, a digital recording device, a computing device, a mobile computing device (e.g., a laptop, a smartphone, a tablet, etc.), a combination thereof, and/or the like. The request for the second portion of the content item may indicate that the second requesting device is to receive the second portion of the content item from a packaging device that received the second portion of the content item from a second source, such as any of input sources **102a**, **102b**, or **102c**; content source **202**, content source **302**, content source **304**, content source **702**, content source **802**, and the like. At step **1160**, the second packaging device may deliver the second portion of the content item to the second requesting device. The second packaging device may be caused to deliver the second portion of the content item to the second requesting device based on a determination that the second portion of the content item packaged by the second packaging device satisfies the quality threshold. The second packaging device may be caused to deliver the second portion of the content item to the second requesting device based on a determination that the second portion of the content item packaged by the second packaging device satisfies the quality threshold to a greater degree than the second portion of the content item packaged by the first packaging device (e.g., the second portion packaged by the second packaging device is determined to be of a higher quality as compared to the second portion packaged by the first packaging device).

[0177] FIG. **12** shows a system **1200** for distributing content in accordance with the present description. The central location **101**, the server **110**, the mobile device **126**, the application server **126**, the content source **127**, and/or the edge device **128** of FIG. **1** may each be a computer **1201** as shown in FIG. **12**. Each of the devices/entities shown in FIGS. **2-5** may be a computer **1201** as shown in FIG. **12**. The computer **1201** may comprise one or more processors **1203**, a system memory **1212**, and a bus **1213** that couples various system components including the one or more processors **1203** to the system memory **1212**. In the case of multiple processors **1203**, the computer **1201** may utilize parallel computing. The bus **1213** is one or more of several possible types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, or local bus using any of a variety of bus architectures.

[0178] The computer **1201** may operate on and/or comprise a variety of computer readable media (e.g., non-transitory media). The readable media may be any available media that is accessible by the computer **1201** and may include both volatile and non-volatile media, removable and non-removable media. The system memory **1212** has computer readable media in the form of volatile memory, such as random access memory (RAM), and/or non-volatile memory, such as read only memory (ROM). The system memory **1212** may store data such as the distribution data **1207** and/or program modules such as the operating system **1205** and the distribution software **1206** that are accessible to and/or are operated on by the one or more processors **1203**.

[0179] The computer **1201** may also have other removable/non-removable, volatile/non-volatile computer storage media. FIG. **12** shows the mass storage device **1204** which may provide non-volatile storage of computer code, computer readable instructions, data structures, program modules, and other data for the computer **1201**. The mass storage device **1204** may be a hard disk, a removable magnetic disk, a removable optical disk, magnetic cassettes or other magnetic storage devices, flash memory cards, CD-ROM, digital versatile disks (DVD) or other optical storage, random access memories (RAM), read only memories (ROM), electrically erasable programmable read-only memory (EEPROM), and the like.

[0180] Any number of program modules may be stored on the mass storage device **1204**, such as the operating system **1205** and the distribution software **1206**. Each of the operating system **1205** and the distribution software **1206** (e.g., or some combination thereof) may have elements of the program modules and the distribution software **1206**. The distribution data **1207** may also be stored on the mass storage device **1204**. The distribution data **1207** may be stored in any of one or more databases known in the art. Such databases may be DB2®, Microsoft® Access, Microsoft® SQL Server, Oracle®, MySQL, PostgreSQL, and the like. The databases may be centralized or distributed across locations within the network **1215**.

[0181] A user may enter commands and information into the computer **1201** via an input device (not shown). Examples of such input devices comprise, but are not limited to, a keyboard, pointing device (e.g., a computer mouse, remote control), a microphone, a joystick, a scanner, tactile input devices such as gloves, and other body coverings, motion sensor, and the like. These and other input devices may be connected to the one or more processors **1203** via a human machine interface **1202** that is coupled to the bus **1213**, but may be connected by other interface and bus structures, such as a parallel port, game port, an IEEE 1394 Port (also known as a Firewire port), a serial port, network adapter **1208**, and/or a universal serial bus (USB).

[0182] The display device **1211** may also be connected to the bus **1213** via an interface, such as the display adapter **1209**. It is contemplated that the computer **1201** may have more than one display adapter **1209** and the computer **1201** may have more than one display device **1211**. The display device **1211** may be a monitor, an LCD (Liquid Crystal Display), light emitting diode (LED) display, television, smart lens, smart glass, and/or a projector. In addition to the display device **1211**, other output peripheral devices may be components such as speakers (not shown) and a printer (not shown) which may be connected to the computer **1201** via the Input/Output Interface **1210**. Any step and/or result of the methods may be output (or caused to be output) in any form to an output device. Such output may be any form of visual representation, including, but not limited to, textual, graphical, animation, audio, tactile, and the like. The display device **1211** and computer **1201** may be part of one device, or separate devices.

[0183] The computer **1201** may operate in a networked environment using logical connections to one or more remote computing devices **1214a,b,c**. A remote computing device may be a personal computer, computing station (e.g., workstation), portable computer (e.g., laptop, mobile phone, tablet device), smart device (e.g., smartphone, smart watch, activity tracker, smart apparel, smart accessory), security and/or monitoring device, a server, a router, a network computer, a peer device, edge device, and so on. Logical connections between the computer **1201** and a remote computing device **1214a,b,c** may be made via a network **1215**, such as a local area network (LAN) and/or a

general wide area network (WAN). Such network connections may be through the network adapter **1208**. The network adapter **1208** may be implemented in both wired and wireless environments. Such networking environments are conventional and commonplace in dwellings, offices, enterprise-wide computer networks, intranets, and the Internet.

[0184] Application programs and other executable program components such as the operating system **1205** are shown herein as discrete blocks, although it is recognized that such programs and components reside at various times in different storage components of the computing device **1201**, and are executed by the one or more processors **1203** of the computer. An implementation of the distribution software **1206** may be stored on or sent across some form of computer readable media. Any of the described methods may be performed by processor-executable instructions embodied on computer readable media.

[0185] While specific configurations have been described, it is not intended that the scope be limited to the particular configurations set forth, as the configurations herein are intended in all respects to be possible configurations rather than restrictive. Unless otherwise expressly stated, it is in no way intended that any method set forth herein be construed as requiring that its steps be performed in a specific order. Accordingly, where a method claim does not actually recite an order to be followed by its steps or it is not otherwise specifically stated in the claims or descriptions that the steps are to be limited to a specific order, it is in no way intended that an order be inferred, in any respect. This holds for any possible non-express basis for interpretation, including: matters of logic with respect to arrangement of steps or operational flow; plain meaning derived from grammatical organization or punctuation; the number or type of configurations described in the specification.

[0186] It will be apparent to those skilled in the art that various modifications and variations may be made without departing from the scope or spirit. Other configurations will be apparent to those skilled in the art from consideration of the specification and practice described herein. It is intended that the specification and described configurations be considered as exemplary only, with a true scope and spirit being indicated by the following claims.

Claims

1. A method comprising: determining, by a computing device, a first version of a portion of a content item located at a first video processing device and a second version of the portion of the content item located at a second video processing device; causing, based on a service metric associated with the first version of the portion of the content item, the first video processing device to send the first version of the portion of the content item; and causing the second video processing device to refrain from sending the second version of the portion of the content item.
2. The method of claim 1, wherein the service metric is based on one or more packaging errors associated with the first version of the portion of the content item.
3. The method of claim 1, wherein the first video processing device is part of a first network and the second video processing device is part of a second network.
4. The method of claim 3, further comprising: receiving the service metric from a video quality component associated with the first network; and receiving a second service metric from a video quality component associated with the second network, wherein the second service metric is based on one or more packaging errors associated with the second version of the portion of the content item.
5. The method of claim 3, wherein the computing device is part of the first network or the second network.
6. The method of claim 1, wherein the first version of the portion of the content item and the second version of the portion of the content item originate from a content source.
7. The method of claim 6, wherein the first video processing device generates the first version of

the portion of the content item based on processing the portion of the content item originating from the content source and the second video processing device generates the second version of the portion of the content item based on processing the portion of the content item originating from the content source.

8. An apparatus comprising: one or more processors; and a memory storing processor-executable instructions that, when executed by the one or more processors, cause the apparatus to: determine a first version of a portion of a content item located at a first video processing device and a second version of the portion of the content item located at a second video processing device; cause, based on a service metric associated with the first version of the portion of the content item, the first video processing device to send the first version of the portion of the content item; and cause the second video processing device to refrain from sending the second version of the portion of the content item.

9. The apparatus of claim 8, wherein the service metric is based on one or more packaging errors associated with the first version of the portion of the content item.

10. The apparatus of claim 8, wherein the first video processing device is part of a first network and the second video processing device is part of a second network.

11. The apparatus of claim 10, wherein the processor-executable instructions, when executed by the one or more processors, further cause the apparatus to: receive the service metric from a video quality component associated with the first network; and receive a second service metric from a video quality component associated with the second network, wherein the second service metric is based on one or more packaging errors associated with the second version of the portion of the content item.

12. The apparatus of claim 10, wherein the apparatus is part of the first network or the second network.

13. The apparatus of claim 8, wherein the first version of the portion of the content item and the second version of the portion of the content item originate from a content source.

14. The apparatus of claim 13, wherein the first video processing device generates the first version of the portion of the content item based on processing the portion of the content item originating from the content source and the second video processing device generates the second version of the portion of the content item based on processing the portion of the content item originating from the content source.

15. One or more non-transitory computer-readable media storing processor-executable instructions that, when executed by at least one processor, cause the at least one processor to: determine, by a computing device, a first version of a portion of a content item located at a first video processing device and a second version of the portion of the content item located at a second video processing device; cause, based on a service metric associated with the first version of the portion of the content item, the first video processing device to send the first version of the portion of the content item; and cause the second video processing device to refrain from sending the second version of the portion of the content item.

16. The non-transitory computer-readable media of claim 15, wherein the service metric is based on one or more packaging errors associated with the first version of the portion of the content item.

17. The non-transitory computer-readable media of claim 15, wherein the first video processing device is part of a first network and the second video processing device is part of a second network.

18. The non-transitory computer-readable media of claim 17, wherein the processor-executable instructions, when executed by the at least one processor, further cause the at least one processor to: receive the service metric from a video quality component associated with the first network; and receive a second service metric from a video quality component associated with the second network, wherein the second service metric is based on one or more packaging errors associated with the second version of the portion of the content item.

19. The non-transitory computer-readable media of claim 17, wherein the computing device is part

of the first network or the second network.

20. The non-transitory computer-readable media of claim 15, wherein the first version of the portion of the content item and the second version of the portion of the content item originate from a content source.

21. The non-transitory computer-readable media of claim 20, wherein the first video processing device generates the first version of the portion of the content item based on processing the portion of the content item originating from the content source and the second video processing device generates the second version of the portion of the content item based on processing the portion of the content item originating from the content source.

22. A system comprising: a first video processing device configured to generate, based on processing a portion of a content item, a first version of the portion of the content item; a second video processing device configured to generate, based on processing the portion of the content item, a second version of the portion of the content item; a computing device configured to: determine the first version of the portion of the content item located at the first video processing device and the second version of the portion of the content item located at the second video processing device; cause, based on a service metric associated with the first version of the portion of the content item, the first video processing device to send the first version of the portion of the content item; and cause the second video processing device to refrain from sending the second version of the portion of the content item.

23. The system of claim 22, wherein the service metric is based on one or more packaging errors associated with the first version of the portion of the content item.

24. The system of claim 22, wherein the first video processing device is part of a first network and the second video processing device is part of a second network.

25. The system of claim 24, wherein the computing device is further configured to: receive the service metric from a video quality component associated with the first network; and receive a second service metric from a video quality component associated with the second network, wherein the second service metric is based on one or more packaging errors associated with the second version of the portion of the content item.

26. The system of claim 24, wherein the computing device is part of the first network or the second network.

27. The system of claim 22, wherein the portion of the content item originate from a content source.
