WHITE PAPER

ixia

Reliable Streaming Media Delivery

Table of Contents

Overview

Streaming media is an evolving set of technologies that deliver multimedia content over the Internet and private networks. A number of service businesses are dedicated to streaming media delivery, including YouTube, Brightcove, Vimeo, Metacafe, BBC iPlayer, and Hulu. Streaming video delivery is growing dramatically: according to the comScore Video Metrix1, Americans viewed a significantly higher number of videos in 2009 than in 2008 (up 19%) due to both increased content consumption and the growing number of video ads delivered. In January of 2010, more than 170 million viewers watched videos online. The average online viewer consumed 187 videos in December of 2009, up 95% over the previous year, and the average video duration grew from 3.2 to 4.1 minutes. Hulu, for example, in that same month delivered more than 1 billion streams for a total of 97 million hours.

According to comScore, the character of video viewing is changing as well, with more people watching longer content.

The average online viewer consumed 187 videos in December of 2009, up 95% over the previous year, and the average video duration grew from 3.2 to 4.1 minutes.

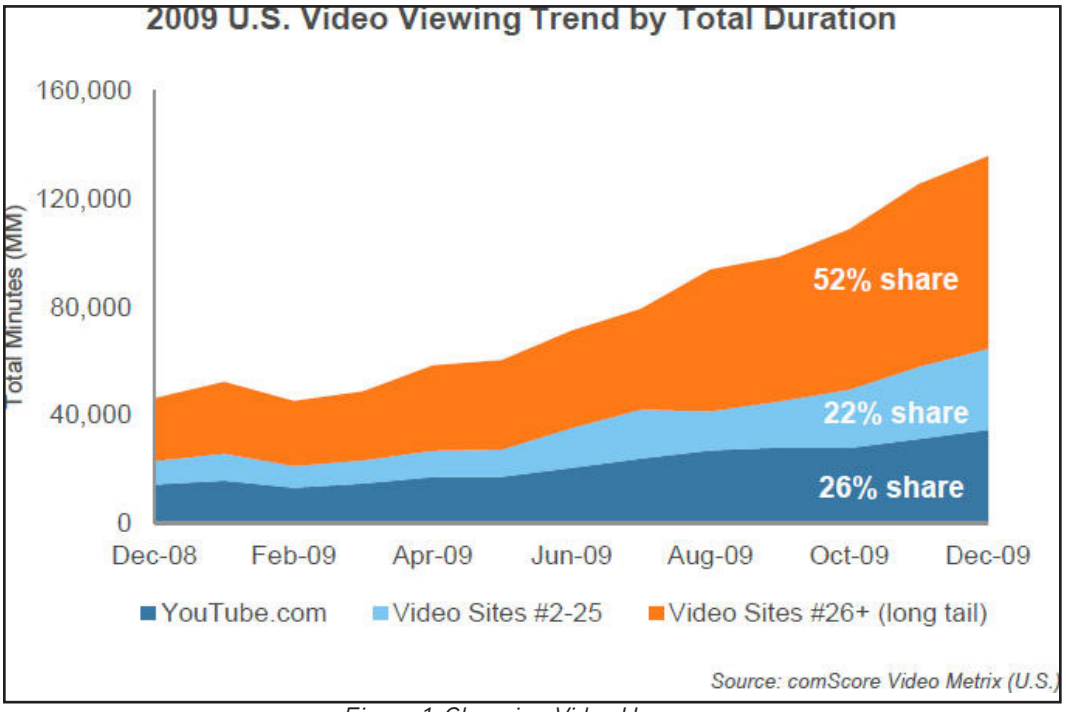

Figure 1. Changing Video Usage

In fact, there's a growing effort by broadcasters to make regular TV content available online. The BBC has developed the BBC iPlayer™ and the bbc.co.uk web site to support replication of most BBC broadcast material. The service has been outstandingly successful: 79.3 million requests were serviced in October of 2009. Most recently, NBC coverage of the 2010 Winter Olympics included live and recently recorded content, complete with commercials.

Whenever there's the possibility of a large or dynamic viewer audience, a reliable distribution content delivery network (CDN) is required. CDNs, once only used to replicate web site content around the world, have expanded dramatically to handle streaming media. Research and Markets estimated the value of CDN services for 2008 at $1.25 billion, up 32% from 2007. Top CDNs include Akamai, Mirror Image Internet, Limelight Networks,

1 The comScore 2009 U.S. Digital Year in Review.

CDNetworks and Level 3. Streaming media services must deal with content collected from disparate sources and distributed to a growing number of devices. A generic aggregation/distribution network is shown in Figure 2.

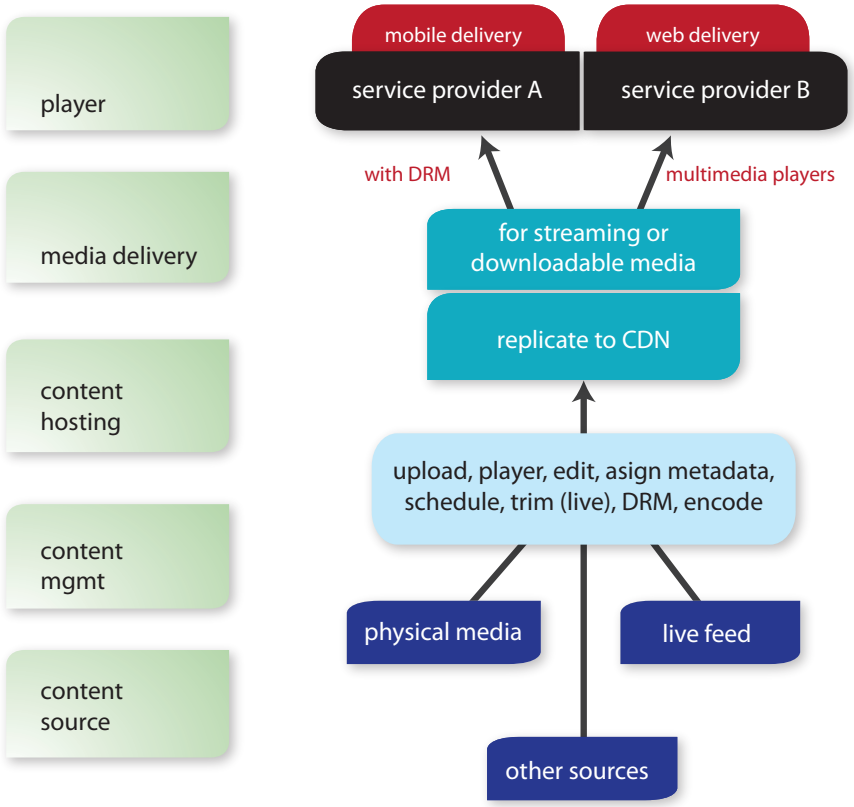

Figure 2. Generic Streaming Media Service

Whenever there's the possibility of a large or dynamic viewer audience, a reliable distribution content delivery network (CDN) is required.

The five stages shown of an aggregation/distribution network are:

- Content sourcing – aggregation of content from physical media, live feeds and other sources.
- Content management – editing and management of the content, including uploading with digital rights management, with content encoded for multiple forms of delivery.
- Content hosting – centralized library of video content, plus replication to other levels of a content delivery network (CDN).
- Media delivery – the process of providing content in response to user requests, either through bulk download or via streaming, with optional digital rights management (DRM).
- Player – the software application on the end-user device used to view and interact with content.

The number and types of destination devices are continually growing, and include set-top boxes (STBs), personal computers, Apple iPhone, as well as various other Internet connected smart phones and Netbooks.

Business Trends

But who's making money here? Server hardware and software vendors, and CDNs can charge for their premium services. Content owners, however, are still trying to find a business model that will allow them to get a return on their investment in their content. There are three emerging business models being pursued to generate revenue:

- **Based purely on advertisements**. An online property is used as an aggregation site for a variety of content, with advertisements as the primary revenue source. Hulu's effort in particular is on a very large scale, and depends solely on advertising income at the moment. As a venture of NBC Universal, News Corp, the Walt Disney Company, and Providence Equity Partners, Hulu offers more than 1,700 current primetime TV hits using Adobe Flash™ as its delivery mechanism. Large advertisement networks from Tremor Media and Brightroll provide intelligent advertising platforms.
- **Based on consumer subscription**. Customers pay for access to premium and syndicated content. Networks such as the XBOX marketplace provides consumers with access not only to gaming, but also to significant content that can be purchased. Netflix was the first to offer a subscription video rental service, and it is highly regarded by its customer base for quality and content.
- **Based on enterprise subscription**, pay per use. Enterprises customers leverage expert platforms to create a significant online brand presence. Brightcove is a leading platform used by enterprises with a complete video management platform that performs functions from uploading videos, to syndication, to seamless multiplatform distribution.

Server hardwareand software vendors, and CDNs can charge for their premium services. Content owners, however, are still trying to find a business model that will allow them to get a return on their investment in their content.

Operators in three categories are also searching for income-generating business models:

- **Traditional MSOs and service providers.** Carriers in particular are promoting "TV everywhere," a feature that makes original broadcast TV programming available as "catch up TV" for its subscriber base, free of charge. An ad-supported model is frequently used to recoup the cost of this distribution. Service providers are also working towards a harmonious delivery of Internet content for in-home and on-TV entertainment as a way to create differentiation and embrace the new medium. Others are looking to increase their average revenue per user (ARPU) by offering alternate means of viewing broadcast and other content by making it available for purchase using video-on-demand services.
- **Stand-alone players and independents.** These are the new players in the video delivery market, and include online platforms or connected devices placed in homes that provide consumers access to movies, TV shows, and web content for a nominal, recurring fee. Independent operators often do not need to share revenue with service providers that offer Internet access, but instead compete with TV operators in some cases. Companies such as Apple TV, Blockbuster, Netflix, Boxee, Hulu, XBOX360 Marketplace, and TiVO are good examples. Wal-mart recently announced their intention to buy Vudu in order to distribute films and movies over the Internet in 2010.
- **Content owners**. National television channels with years of valuable content and highly acclaimed new content are also generating revenue through delivery to online and mobile audiences. Content owners often leverage global CDNs to syndicate and distribute their content.

Technology Trends

Video delivery began as a limited service, delivered over closed, private networks. This has moved rapidly to syndicated delivery over multiple networks: private networks, the public Internet, and mobile delivery. At the same time, video sources have broadened to include live and recorded material, potentially interspersed with commercial messages. Free services have given way to paid services as well. The ability to receive video content on multiple devices via multiple networks is essential. There is a critical need for flexible and pervasive end-user technologies that requests and receives content.

The most common network protocol used to transport video over IP networks is real-time streaming protocol (RTSP). RTSP is a stateful protocol used to establish and control media sessions between a media server and client viewer. RTSP clients issue VCR-like comments to control media playback. The transmission of the audio/video stream itself is most often handled by the real-time transport protocol (RTP), although some vendors have implemented their own transport protocol. RTSP and RTP are almost universally used to implement IPTV's video on demand (VoD) features.

Most video players, such as the Adobe Flash Player, use proprietary protocols that provide additional functionality and flexibility. Adobe Flash has an almost total presence on PCs and MACs, and is used to deliver over 80% of online videos. The Adobe Flash Player is a lightweight client embedded in web browsers. Adobe uses the real-time messaging protocol (RTMP) to deliver streaming content, providing multiple independent channels which are used to control and deliver content.

Most video players, such as the Adobe Flash Player, use proprietary protocols that provide additional functionality and flexibility.

First released in 2007, Microsoft's Silverlight™ is growing in popularity within the player market. Silverlight uses HTTP as its top-level transport mechanism and for media streaming. Using HTTP as a single transport mechanism can result in significant internal cost reduction for end-to-end delivery. A unique feature of Silverlight is adaptive streaming capability, which allows the player to adjust the stream playback quality based on real-time network conditions. Silverlight includes digital rights management (DRM) similar features to those available in Adobe Flash.

Hardware platforms used for streaming delivery can be as straight forward as off-the-shelf hardware and standard software, or can involve custom platforms and applications. Large-scale, virtualized servers are frequently used to provide continuously expanded capacity and failover protection.

CDNs are most often custom-designed multi-layer networks that deliver differentiated, economical, and highly reliable services. Recently Cisco and others have offered packaged content delivery solutions. Cisco's Medianet™solution, for example, includes a virtual video infrastructure with a centralized content library that automatically distributes content to caching nodes and streaming systems.

Building in Reliability

The ultimate measure of reliable delivery is user satisfaction, often referred to as their quality of experience (QoE). For streaming media delivery, the key QoE factors are:

- Continuous play – without start/stop pauses
- Absence of video or audio skips
- Quick response to user actions that select and start the video, as well as pause, rewind and fast-forward operations
- Availability of low and high resolution versions

Jitter, loss, and latency are inherent in every IP network. These factors are compensated for by buffering at multiple network levels. Players commonly buffer data before beginning a presentation and read ahead to guarantee error-free delivery. CDN nodes provide buffering as well, although usually with larger blocks of data. Other techniques that are often employed in IPTV deployments are not suitable for Internet video delivery, including forward error correction (FEC) and periodic retransmission of lost segments.

Rigorous testing of all streaming media delivery chain components is required to ensure user QoE. Components and networks must be tested under load to determine their limits.

There are many network levels, however, that must be transited between the streaming source and the destination – the core Internet, edge and aggregation networks, wireless networks, and enterprise LANs. These uncontrolled elements contribute to jitter and loss levels that cannot be compensated for by client-side buffering alone.

Rigorous testing of all streaming media delivery chain components is required to ensure user QoE. Components and networks must be tested under load to determine their limits. Streaming media audiences can be extremely dynamic – responding to special events or viral popularity. It is especially important to test the devices that perform special handling on media flows:

- **Media servers –** establish client connections, and convert and deliver content.
- **Content delivery networks** – with sophisticated, multi-level architectures that distribute content from a central site to caching nodes and then finally to streaming servers located regionally and globally. Each level, and combination of levels, must be tested – especially for delay. For example, the first viewer who requests a video that is only present at the central library site must not experience undue delay as the content is distributed to caching and streaming servers.
- **Data center components** – the data centers maintained by service providers must balance their voice, video and data traffic to deliver QoE in all categories. Sophisticated devices, such as application delivery controllers (ADCs) that utilize deep packet inspection (DPI), inspect information flows to determine their required priorities and characteristics.
- **Wireless networks** – especially 3G and LTE networks are experiencing increased video traffic destined for mobile devices. Wireless network nodes must perform functions similar to those found in the data center – identifying flows and prioritizing video and voice traffic over data traffic.

Pre-deployment testing is the only certain way of measuring maximum performance and true reliability at all load levels. Live network testing can be performed in low volume and QoE measurements can be made on individual streams to determine instantaneous network quality.

Ixia's Test Solutions

Ixia offers solutions for all types of IP and wireless network testing. IxLoad is Ixia's premier solution for testing multiplay delivery devices and networks. It is used to test servers and forwarding devices of all types used in the delivery of layer 4-7 data, especially streaming media.

IxLoad tests application layer devices and networks with large-scale emulation of subscribers and servers. Figure 3 demonstrates how IxLoad emulates both clients and servers. IxLoad emulated clients can directly send requests to and receive responses from media servers. In conjunction with emulated media servers, IxLoad tests forwarding devices such as load balancers and caching devices.

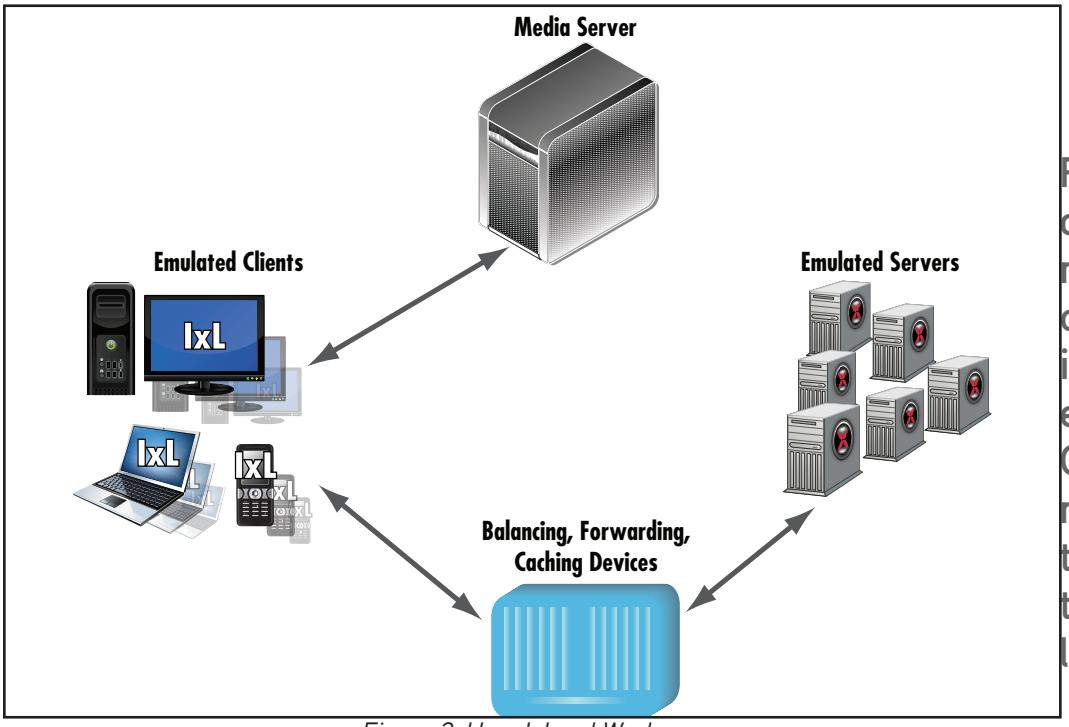

Figure 3. How IxLoad Works

Rigorous testing of all streaming media delivery chain components is required to ensure user QoE. Components and networks must be tested under load to determine their limits.

With respect to streaming media, IxLoad provides large-scale emulation of streaming media clients, such as Adobe Flash Player and Microsoft Silverlight.

IxLoad's Adobe Flash Player emulation, for example, offers:

- True end-user emulation
- Playback of recorded media, including FLV, F4V, MP3, M4V, and MP4 formatted content
- Live event streaming
- Dynamic user actions: playback, mid-stream pause, forward and back backward seek
- Extensive format support, including H.264, VP6, and VP7 content

By emulating thousands of user sessions, streaming media testing measures the performance and scalability of:

- Edge and origin media servers
- Content proxies
- CDN components and networks
- Media load balancers

IxLoad's unique subscriber modeling creates complete, stateful sessions that closely mimic the dynamic nature of subscriber behavior. Subscriber modeling, combined with IxLoad's ability to emulate large numbers of users, assesses the real-world performance of service delivery devices and networks for network equipment manufacturers and service providers.

Few networks are used solely for video streaming, and usually transport information of all types. IxLoad's ability to include all types of Internet traffic – including web, email, FTP and peer-to-peer – allowing streaming media QoE to be measured in a realistic background of non-streaming traffic.

Subscriber modeling, combined with IxLoad's ability to emulate large numbers of users, assesses the real-world performance of service delivery devices and networks for network equipment manufacturers and service providers.

Subscriber modeling allows test engineers to prepare tests that mimic communities of users, specifying which applications are used and their proportions, upstream/downstream bandwidth limits for each subscriber, and model usage over any period of time.

IxLoad provides the essential key performance indicators necessary to properly evaluate network performance. In addition, IxLoad's QoE detective is a troubleshooting tool that gives insight into the test with comprehensive per-subscriber statistics. IxLoad captures individual streams for detailed analysis, and its unique drill-down capabilities allow individual poor performing flows to be quickly identified.

Streaming Media Test Scenarios

Testing can be performed in three typical scenarios:

- Media server
- Content proxy/cache
- Delivery network

In all cases, large numbers of client devices are emulated. Each client performs a designated sequence of operations, including play, pause, and seek across a series of video files. Where caching and content delivery networks are used, tests specifically target content at different levels of the network. Clients are added to the test so as to determine the:

- Maximum number of supported users, maximum session connection rate, and maximum transaction rate
- Total transmit and receive throughput
- Min/max/average response time across all requests
- Min/max/average response time when content is cached or not
- Quality metrics, including latency, jitter, loss, and QoE
- Average and peak video I-, P- and B-frame bandwidth

In order to diagnose device and network anomalies, other per-subscriber statistics are made available, including:

- Active stream count
- RTMP messages, handshakes, and connections
- Audio, video, and data packets received
- Total streams played, paused, successful, and failed

Media Server Testing

Media servers deliver content files by formatting them into audio and video content streams. Modern media servers are very high capacity, servicing thousands of requests at a time. Testing media servers requires the emulation of thousands of users requesting content, with additional pause and seek requests.

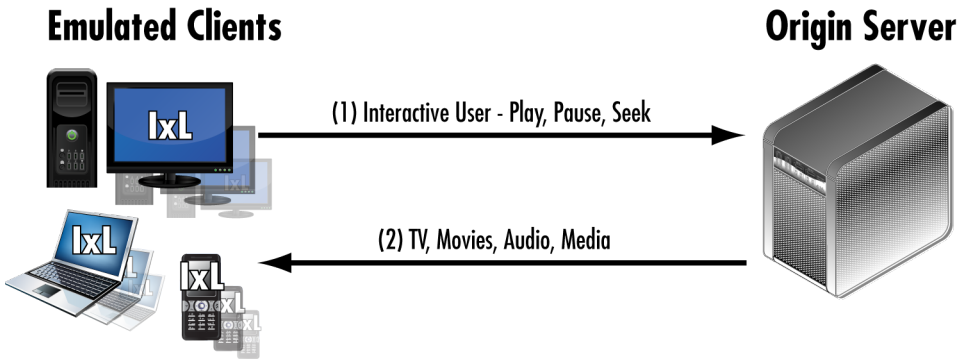

Figure 3. Media Server Testing

Content Proxy/Cache Testing

Content proxies and caches are the front-end systems that handle user content requests. Requests can be satisfied directly out of the cache through a media streamer, or require that content be fetched from the originating server in the CDN. Testing must be performed before deployment to determine capacity and quality. The scale of these systems is very high, and testing requires tens of thousands of emulated users.

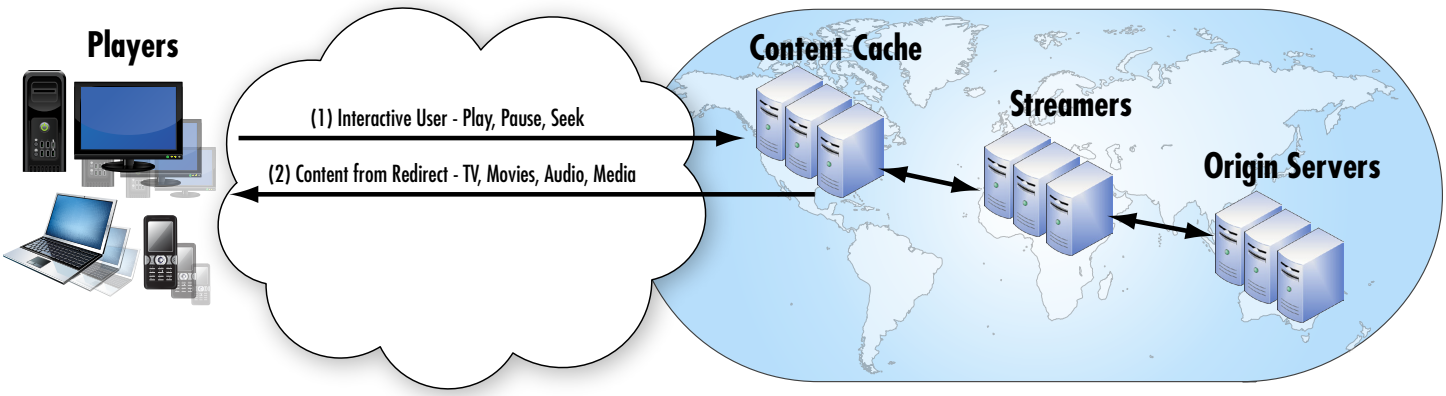

Figure 4. Content Proxy/Cache Testing

Content Delivery Network Testing

Video content is delivered through a multi-level content delivery network, in addition to networks associated with the user connection. Mobile users connect through a radio access network and wireless core networks. Home and enterprise users connect through Wi-Fi and LAN networks. Different networks have individual latency, jitter, and loss characteristics that contribute to the user experience. End-to-end testing is required across all paths to ensure users' quality of experience.

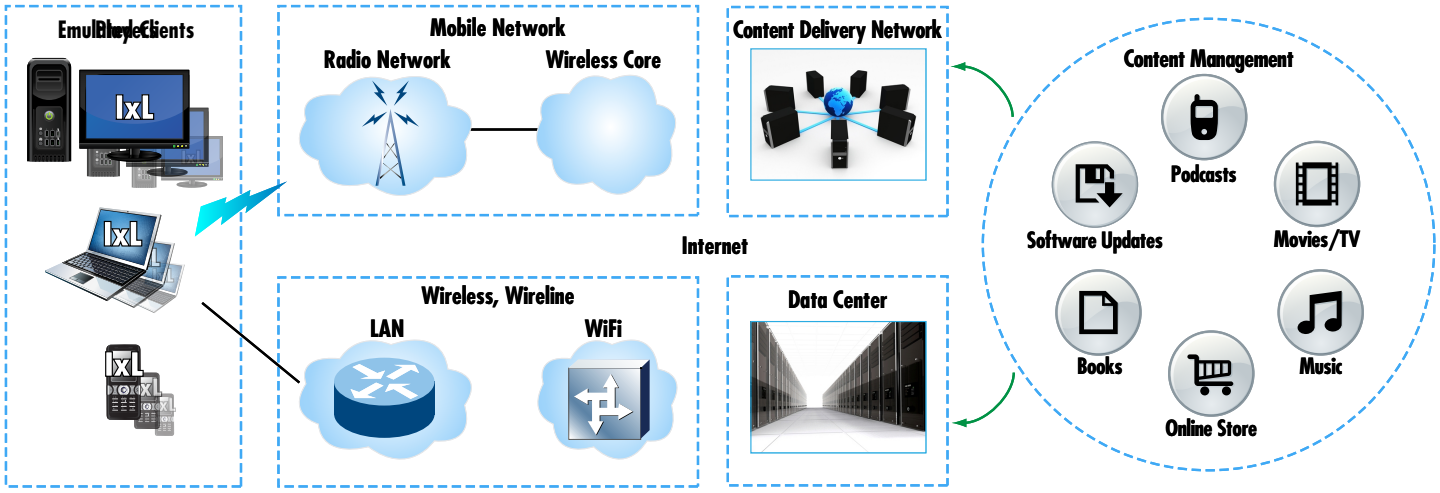

Figure 5. Content Delivery Network Testing

Conclusion

The largest part of Internet traffic growth will be associated with video delivery. Substantial infrastructure components will be purchased over the next decade to handle delivery of vast amounts of video content. Testing of the components and networks associated with that delivery are essential in order to bring quality services to market, properly scale the network and ensure end-user quality of experience.

Ixia Worldwide Headquarters
26601 Agoura Rd.
Calabasas, CA 91302

(Toll Free North America)
1.877.367.4942

(Outside North America)
+1.818.871.1800
(Fax) 818.871.1805
www.ixiacom.com

Ixia European Headquarters
Ixia Technologies Europe Ltd
Clarion House, Norreys Drive
Maidenhead SL6 4FL
United Kingdom

Sales +44 1628 408750
(Fax) +44 1628 639916

Ixia Asia Pacific Headquarters
21 Serangoon North Avenue 3
#04-01
Singapore 554864

Sales +65.6332.0125
Fax +65.6332.0127

P/N 915-1767-01 Rev B January 2014