White Paper

Retail Content Delivery Networks: Build a Profitable Multiscreen Experience

What You Will Learn

Service providers must deliver more types of content to more devices than ever before. But video networks of the past designed for one primary device, the managed set-top box (STB), are challenged in supporting modern, cloud-based service delivery. To address this problem, service providers are turning to content delivery networks (CDNs). Retail CDNs provide the tools to both efficiently cache content throughout the network and to stream content to unmanaged IP devices, enabling new multiscreen video services. This document describes the essential requirements of a successful retail CDN, including:

- Support for multiple devices, protocols, networks, and formats
- Adaptive bit rate (ABR) streaming capabilities
- Scalable, efficient content caching and distribution
- Strong content security
- In-depth analytics and reporting

The Cisco Videoscape™ Distribution Suite for Internet Streaming (VDS-IS) meets all of these requirements, and augments core CDN capabilities with advanced service routing and content streaming intelligence. Cisco can help service providers take full advantage of CDN technology to reduce costs, deliver amazing multiscreen experiences, and capitalize on the cloud revolution.

Delivering Media in a Multiscreen World

Just a few years ago, video service delivery meant providing one or two types of service (linear or on-demand TV) to one type of device (the managed STB) in one location (the subscriber's home). Today, consumers expect to be able to watch any content, anywhere, on any screen or device. A number of factors are promoting this media revolution, including:

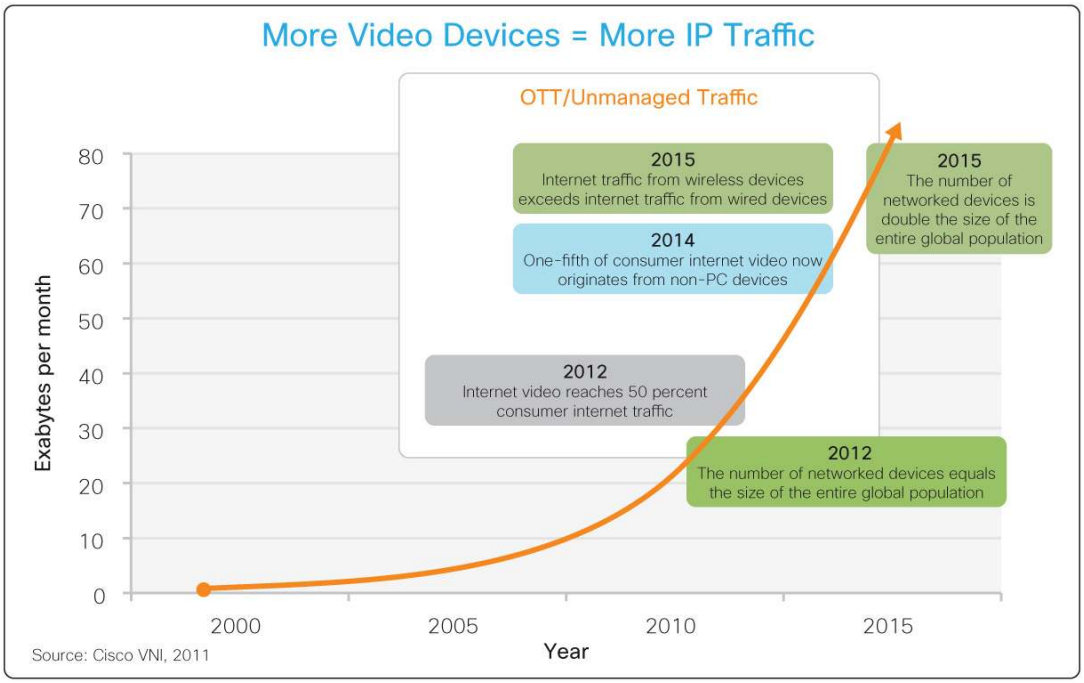
- **Changing consumer behavior:** Consumer demand for video is seemingly insatiable, with video consumption over the Internet and mobile devices growing at unprecedented rates. The Cisco® Visual Networking Index (VNI) forecasts that video will account for 90 percent of consumer IP traffic by 2015, and 66 percent of mobile traffic. At that time, 1 million minutes of video content will cross worldwide operator networks every second.
- **Billions of new video-capable devices:** Cisco VNI projects there will be two IP-connected devices for every man, woman, and child on the planet by 2015, many of which will be video-capable. Cisco VNI also forecasts that video traffic to tablets and smartphones will grow at a compound annual growth rate (CAGR) of 216 percent and 144 percent, respectively in the same timeframe. According to a recent Nielsen survey, 143 million U.S. consumers watched video over the Internet on a computer in 2011, and 30 million watched video on their mobile phones.

- **New market entrants offering multiscreen video services:** Over-the-top (OTT) online video offerings from aggregators such as Netflix, Amazon, and Apple have become major players in the video landscape. Services like Netflix and DailyMotion today have millions of subscribers. Independent content providers such as HBO and BBC have also launched online video services, and traditional pay TV providers are now launching multiscreen video offerings as well.

This shifting media landscape presents two challenges for service providers. First, IP video traffic is placing extreme bandwidth pressure on service provider networks, yet operators have no good way to monetize this OTT content to fund the necessary upgrades (Figure 1). In addition, traditional service providers are seeing new cloud-based content aggregators such as Netflix and DailyMotion eat away at their subscriber base with the ability to offer easy-to-access video content on multiple screens. Service providers can ill afford to cede multiscreen video services to these competitors; they need to get into the cloud game.

Fortunately, service providers are ideally positioned to capitalize on cloud media delivery and give subscribers more of the content they crave, anywhere, on any screen. By taking advantage of their unparalleled network capabilities and their strong relationships with content providers, service providers can offer not just a competitive cloud video service, but a better one.

Figure 1. Growing IP Video Traffic



Retail CDNs: A Platform for Multiscreen Media Services

Retail business-to-consumer (B2C) content delivery networks play a central role in helping service providers capitalize on new cloud delivery models and changing consumer demands. A well-designed CDN optimizes content distribution across the service provider footprint to radically reduce bandwidth consumption, while empowering the service provider to deliver content to new unmanaged devices.

Some smaller service providers are choosing to outsource these requirements to a third-party CDN service provider, just as most content providers and aggregators do. For large network operators, however, the economics clearly favor building an internal CDN infrastructure rather than leasing CDN services. (See the Cisco white paper Wholesale CDN Networks http://www.cisco.com/en/US/partner/products/ps7127/index.html.

More than just an economic calculation, however, building a CDN is quickly becoming a strategic imperative. To stay competitive in a media landscape dominated by the cloud, service providers need to establish core competency in delivering video to unmanaged devices beyond the traditional managed network footprint.

Understanding Retail CDNs

At the highest level, a CDN encompasses a network of IP content caching and streaming technologies that distribute localized content caching and multiscreen streaming capabilities out toward the edge of the network, closer to users.

An effective CDN solution provides:

- Media delivery to multiple devices, with support for multiple media types, protocols, and networks
- Content streaming at multiple bit rates
- Scalable, efficient content caching and distribution to reduce video traffic traversing the network
- Content security
- Reporting and analytics
- Integration with the operator's larger video delivery ecosystem

The following sections describe these CDN attributes in more detail.

Multiscreen Media Delivery

For the service provider, the most important strategic value of a CDN is the ability to deliver content to unmanaged devices beyond the traditional network footprint. CDNs make this possible by distributing localized multiservice, multiprotocol content streaming capabilities to the network edge. By positioning these resources close to users, CDNs make it possible to serve a much larger variety of devices (with their associated screen sizes, formats, and streaming protocols) than would be possible under the traditional model of using a dedicated head-end and data center infrastructure for each distribution channel.

A CDN streaming solution supports:

- **Multiple media options:** CDNs allow the operator to deliver any type of content, including video-on-demand (VoD) titles, downloadable content, and even linear TV. Service providers should be able to use the CDN to extend the full TV experience users enjoy to any connected IP endpoint.
- **Multiple device types:** CDNs allow the operator to deliver this content beyond the managed STB to virtually any connected IP device. This includes PCs, tablets, mobile phones and media players, game consoles, connected TVs and BluRay players, and more.
- **Multiple protocols:** The CDN must be able to stream content in the presentation language each device understands. It should support a variety of streaming video protocols, including those used by major streaming video technologies from Apple, Microsoft, and Adobe.

- **Delivery over multiple networks:** Whether users are connecting “on-net” over the managed network footprint, or “off-net,” for example, over a Wi-Fi network or third- or fourth-generation (3G or 4G) cellular network, the CDN must be able to optimize the video stream to provide an excellent experience. The CDN should also apply this intelligence dynamically, accounting for changing or adverse network conditions (such as congestion), and even shifting from one network to another, without disrupting the consumer experience.

Streaming at Multiple Bit Rates

To deliver a high-quality experience to unmanaged devices, service providers need the ability to optimize the media stream based on the capabilities of each device and real-time conditions in the network. Typically, streaming media technologies accomplish this by encoding multiple versions of content at different bit rates, and communicating with the client player to select the optimal bit rate for that device at that time.

Previous-generation streaming media technologies including Windows Media Player and Adobe Flash use multi-bitrate (MBR) techniques to accomplish this. The media server stores content in multiple bit rates, and the client requests a particular bit rate based on network conditions. Client and server then maintain a persistent Transport Control Protocol (TCP) session to stream the content.

Hypertext Transport Protocol (HTTP) ABR Streaming

Most modern streaming technologies now use ABR streaming based on HTTP. First introduced with the Apple iPhone, HTTP ABR allows the client to adapt to changing network conditions by requesting fragments of video at a time, rather than maintaining a persistent session. Just as a web browser builds a web page by making multiple requests for each element of the page, HTTP ABR continually requests fragments of video content encoded at a particular bit rate, based on continual monitoring of real-time network conditions.

Like previous MBR mechanisms, ABR detects network bandwidth and congestion for the requesting device in real time, and adjusts the streaming bit rate accordingly. Because ABR can shift the bit rate up or down every few seconds, it can adapt the media stream much more transparently. ABR is also inherently scalable, as it was designed to operate over large HTTP networks such as the Internet, and versatile enough to support both the highest-quality connections and low-bandwidth sessions.

Because of these advantages, Microsoft, Apple, and Adobe all have transitioned to HTTP ABR in their current streaming media technologies. To provide the most versatile solution and serve the largest number of consumer devices in the highest quality, the CDN should support these ABR approaches, as well as legacy MBR technologies.

Operators can choose to implement ABR through purpose-built hardware solutions or through software running on standard hardware. Many operators today are choosing the software-based approach, as it allows them to take advantage of continually increasing CPU speeds in accordance with Moore’s Law.

Scalable, Efficient Content Caching and Distribution

A CDN employs distributed caches that store copies of content closer to subscribers, usually in edge and aggregation networks. When a client requests a piece of content, the network directs the request first to the cache to see if it can be filled from that location. If the cache contains that title, the content streams from that location, rather than streaming across the core network. If the cache does not contain the content, it fills the request from the content source and then stores the title in the cache, which can then fill all subsequent requests. In this way, CDNs dynamically fill distributed caches with the most popular content and optimize bandwidth utilization across the entire infrastructure.

To provide the most efficient content distribution, modern CDNs use “hierarchical” caches, employing multiple tiers of caches from the data center through aggregation and edge networks. The CDN distributes the most popular content as close to the edge of the network as possible, while caching less popular content farther upstream. Hierarchical caches allow network operators to invest in network infrastructure upgrades more organically, scaling video delivery capabilities at the edge as market demand grows, instead of having to scale the entire network infrastructure. CDN caching also allows network operators to deliver higher quality to subscribers by streaming video to the requesting client from a closer source and minimizing the impact of unfavorable network conditions such as congestion, which may be localized to one part of the network.

Intelligent Request Routing

As operators move caching resources closer to end users, they create a highly distributed CDN that requires a sophisticated service request routing capability to assure that content requests are filled from the most efficient possible cache in the network.

A CDN should use the most accurate possible service routing intelligence to achieve higher cache hit ratios to fill more requests from caches rather than the content source. Better algorithms and routing technologies translate directly to more efficient CDN utilization and, ultimately, lower network infrastructure and operating costs. This intelligence can only come when the CDN application-layer intelligence is tightly linked with IP-layer intelligence in the network, so that the network can determine the optimal cache.

Content Security

No multiscreen video service can survive if content owners are not confident that it will protect their content rights, so any viable CDN solution must provide complete content security. Because a CDN inherently supports a wide range of devices, connections, and streaming protocols, this task becomes far more complex than in a traditional cable or IPTV video infrastructure. To provide the most flexibility and versatility, CDNs should support:

- **Multiple Digital Rights Management (DRM) technologies:** DRM content security employs an externally provided key to authenticate the user and device and unlock content rights. A multiscreen CDN that serves a variety of devices must support a variety of DRM systems, such as Google Widevine (used in many STBs), Marlin (used in connected TVs), Open Mobile Alliance (OMA) DRM (used on many mobile devices), and Microsoft PlayReady and Adobe Flash Access, which are commonly used on PCs and consumer electronic devices. A modern CDN should also support the UltraViolet cloud-based authentication and licensing system, which is now used by film studios, device manufacturers, service providers, and other media industry stakeholders.
- **Encrypted connections:** As more premium content is delivered to unmanaged devices such as gaming consoles and PCs, content owners are demanding an additional layer of security, even for content protected by DRM. Many content owners now demand HTTP Secure (HTTPS) communication when streaming to such devices, using an encrypted Secure Sockets Layer (SSL) connection.
- **Session-based encryption:** Some cable operators, especially in North America, are taking secure connectivity a step further with HTTP ABR session-based encryption. Each HTTP ABR fragment payload is encrypted with a unique key per subscriber, maintaining an HTTP session, but encrypting the payload.

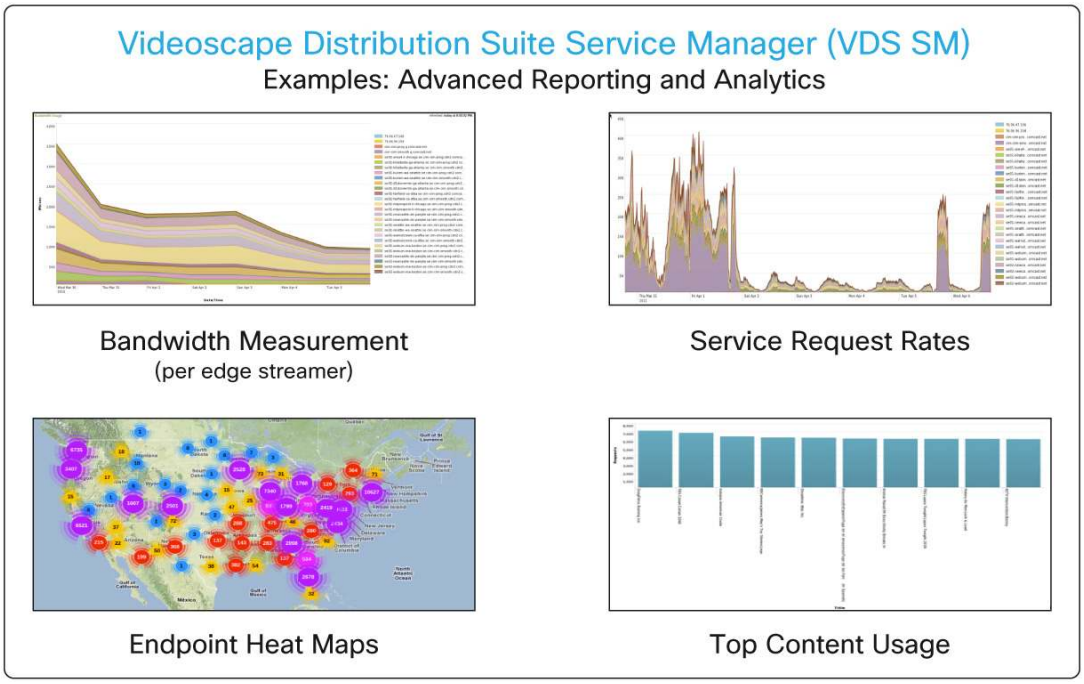
Reporting and Analytics

A successful CDN solution should give service providers a competitive edge by providing detailed information about how consumers are using the service and the content they value most. The best CDN platforms provide this intelligence through in-depth reporting and analytics (Figure 2).

CDN analytics solutions, such as those offered through the Cisco Videoscape Distribution Suite Service Manager (VDS-SM), should provide a comprehensive view into the health and operations of the CDN, including:

- **Traffic distribution** to allow operators to allocate resources according to peaks and troughs in demand
- **Capacity utilization** to support better capacity planning
- **Asset popularity** to configure the CDN to cache the content that subscribers watch most
- **Billing trends** to help operators analyze consumption behavior and create the most attractive package offerings
- **Bandwidth consumption** to monitor subscriber usage and provide alerts when they reach usage thresholds

Figure 2. Cisco Videoscape Distribution Suite Service Manager



Armed with these detailed analytics capabilities, service providers can make better decisions in planning and managing their video offerings, informed by the real-world behavior of their customers.

Cisco Videoscape Distribution Suite: An Ideal CDN Platform

Recognizing all of these diverse requirements, Cisco has created an ideal retail CDN platform based on the Cisco VDS-IS solution. Cisco VDS-IS applications and content delivery engines provide all of the multidevice streaming, caching, and security capabilities that a successful multiscreen video offering requires, with one of the industry's most powerful CDN analytics and reporting platforms.

Cisco VDS-IS also incorporates unique Cisco routing and video streaming innovations. These include sophisticated service request routing intelligence to optimize cache efficiency and high-performance ABR streaming capabilities that allow operators to deliver advanced multiscreen services.

Cisco VDS-IS Elements

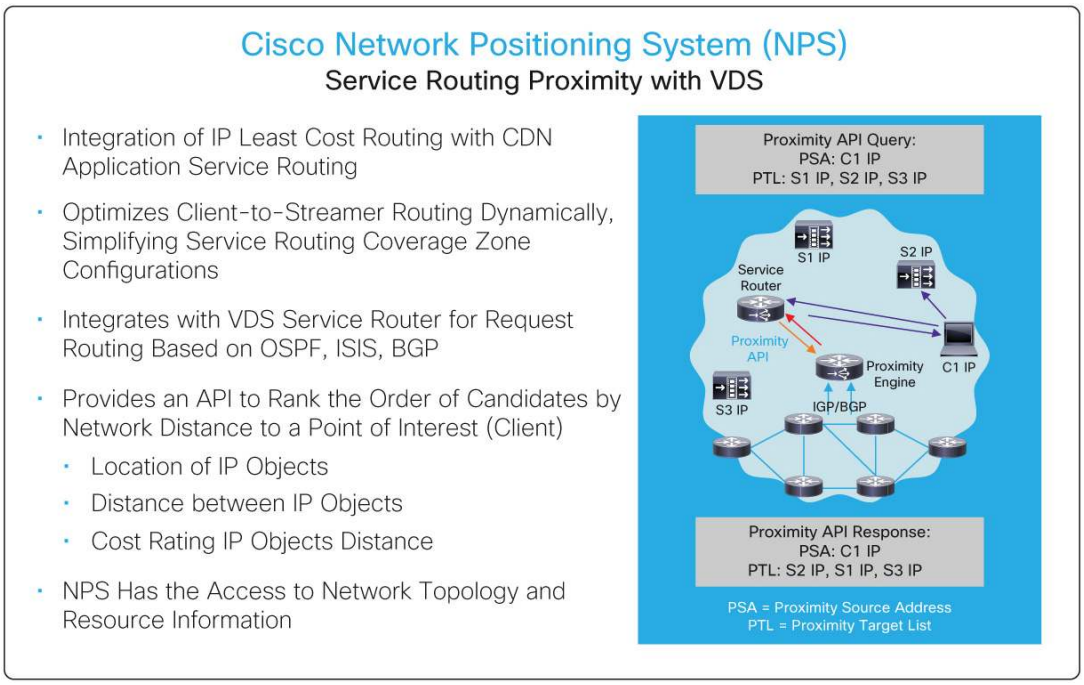
The Cisco VDS-IS solution includes the following functional elements:

- **Cisco VDS Manager:** Cisco VDS Manager provides centralized element management, with an intuitive graphical user interface and HTTP APIs to integrate easily with the video network.
- **Cisco VDS Service Router:** Cisco VDS Service Router provides advanced request routing intelligence, allowing the system to route content requests to the best available Cisco VDS Content Streamer. Request routing decision criteria include subscriber location, content location, and streamer load. Optimized streamer selection improves the CDN cache-hit rate while reducing network utilization.
- **Cisco VDS Content Acquirer:** This software element provides the capability to ingest live and VoD content into the hierarchical CDN. It dynamically splits live video streams and fills caches with VoD content based on real-time subscriber popularity.
- **Cisco VDS Content Streamer:** This software element provides high-performance, multiprotocol live and VoD streaming at the network edge to deliver content to managed and unmanaged consumer devices.
- **Cisco Content Delivery Engines (CDEs):** The Cisco CDE family provides a hardware foundation to power the Cisco VDS-IS solution. Cisco CDEs combine with Cisco VDS software elements to provide carrier-class caching and streaming performance, and scalability to thousands of live channels and hundreds of thousands of hours of VoD content.
- **Cisco Unified Computing System™ (Cisco UCS®):** Cisco UCS provides a next-generation, high-performance, Intel-based server platform for Cisco VDS-IS. Cisco UCS includes computing hardware, virtualization support, switching fabric, and management software.

The Cisco Difference: Intelligent Service Request Routing

Different CDNs use different mechanisms to route client requests to the appropriate cache. Many employ "coarse" metrics to identify the cache source to deliver a request, such as the Domain Name System (DNS) proxy IP address of the requesting client. Cisco has implemented a more accurate cache selection mechanism that uses tightly linked network- and application-layer intelligence to make better request routing decisions. With this mechanism, Dynamic Network Proximity Routing (NPS), the IP network draws on IP routing protocols, management statistics, and policy databases to recommend the best possible cache to fill each request (Figure 3).

Figure 3. Cisco Dynamic NPS Capability



Consider a scenario in which a client requests a piece of content that resides in multiple caches across a large geographic region. The network aggregates all network- and application-layer intelligence to identify the location of the cache with the most efficient, lowest-cost path to fill the request, taking into account real-time network conditions (not just geographical distance). In this way, the CDN navigates the IP network much the way a car uses GPS information to navigate a highway.

In addition to Dynamic NPS, Cisco VDS-IS supports a variety of other cache selection mechanisms to give service providers more flexibility to optimize cache efficiency. These include:

- **Static request routing:** While Dynamic NPS allows the CDN to automatically adjust to changing network conditions, there may be instances when a service provider wants to fill requests from a specific cache. Static routing allows the operator to configure the service router with rules for routing specific client requests, based on the requesting client's IP address. So for example, the operator can define rules to route all requesting clients in a given IP address range to one content streaming engine, and process requests from clients in another address range differently.
- **Load-aware request routing:** To provide a high-quality service to all subscribers, service providers must assure that the system does not redirect client requests to content delivery engines that have exceeded their load threshold. Cisco VDS-IS supports load-aware request routing mechanisms that continuously update the network with each content delivery engine's real-time load information.
- **Content-aware request routing:** To serve high-demand locations, service providers may use clusters of collocated content delivery engines. While each streamer in a cluster shares the same proximity to the requesting client, however, each contains different content, depending on the cache fill requests it has processed. Cisco VDS-IS uses advanced routing algorithms to route requests to the specific streamer with the requested content. As a result, service providers can achieve higher cache hit ratios and reduce the replication of content across multiple caches in a cluster.

- **Geo-blocking:** Operators may have business and content rights rules governing the geographic locations where users can access content. For example, sports broadcasts may be “blacked out” in certain markets, and content that is licensed for viewing in the United Kingdom may not be authorized in Italy. Geo-blocking allows the CDN to verify whether the subscriber requesting a content title resides within a location authorized to receive that content, and block delivery to those who do not.
- **Geo-lookup:** All of the previous mechanisms route content requests based on the source IP address of the requesting client. When streaming content to “off-net” clients, however, an IP address alone may not be sufficient to identify the geographic location of the requester. For example, a user requesting content from a smartphone over a third-party cellular network may have a unique IP address allocated by the mobile network operator. Or, for operators who participate in a CDN federation (where multiple operators link their CDNs to provide a larger national or even global CDN footprint), each network in the federation uses its own IP allocation. Geo-lookup capabilities allow the CDN to map the client source IP address to a specific geographic location to correctly apply proximity intelligence and geography-based content rules.

All of these request routing capabilities can contribute to achieving the most efficient CDN caching, yet very few CDN solutions support all of them. Cisco VDS-IS gives service providers a comprehensive service request routing tool chest to realize the most capital and operational value from their retail CDN.

The Cisco Difference: High-Performance ABR Streaming

Cisco VDS-IS uses a highly optimized HTTP protocol stack, as well as an OS kernel optimized for high-performance HTTP content ingestion and delivery. Third-generation Cisco CDE 250 content delivery engines also support a range of solid-state storage from 3 to 12 terabytes, as well as 10-Gbps interfaces. This combination of a highly-optimized HTTP stack and large, scalable solid-state storage creates an extremely efficient, high-performance streaming capability. In fact, in a recent test of Cisco VDS-IS, Light Reading confirmed that a single Cisco CDE platform scales to more than 12,000 concurrent video streams, delivering up to 40 Gbps of streaming video traffic. This is twice the performance of the nearest Cisco competitor.

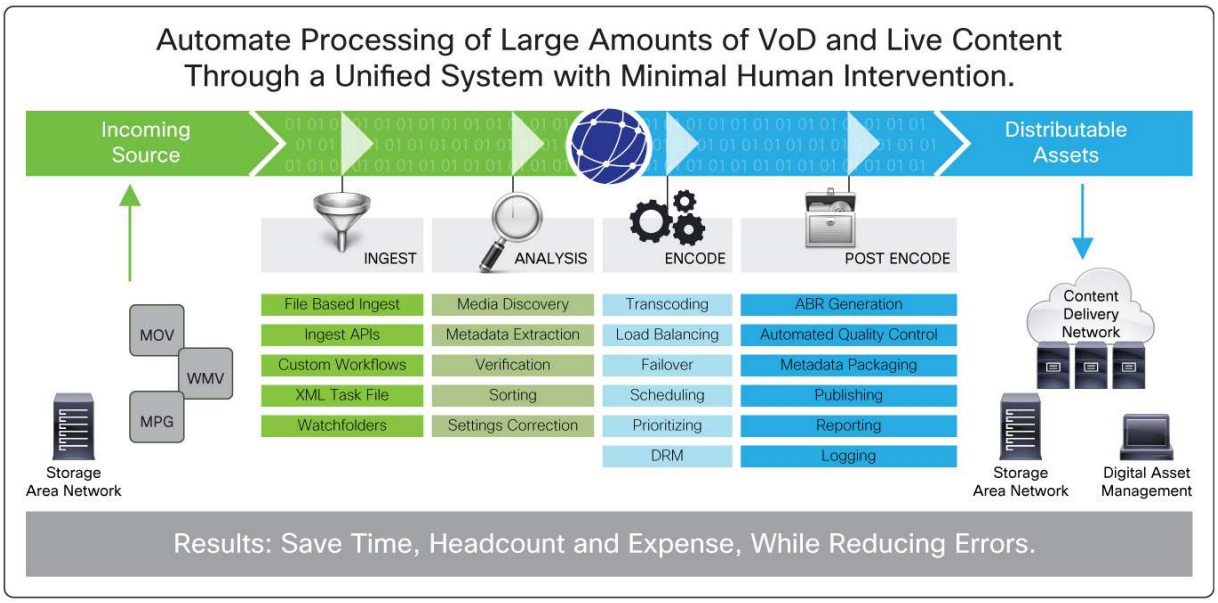
Advanced CDN Applications

Cisco VDS-IS brings unparalleled ABR performance, delivering a high-quality experience for all multiscreen VoD and linear TV services (Figure 4). When paired with the Cisco Virtual Origin Server (VOS), Cisco VDS-IS also provides an excellent platform for network-based time-shift TV services, including:

- **Start Over TV,** which allows users to restart any linear program from the beginning during the time it airs
- **Catch Up TV,** which allows users to access any linear TV program that has completed airing immediately after it airs in the on-demand library

Cisco VDS-IS also supports VoD Smooth Streaming to Microsoft Media Room 2.0 STBs allowing operators to extend highly efficient ABR VoD streaming to managed STBs, as well as to unmanaged IP devices.

Figure 4. Cisco ABR Solutions



Cisco VDS-IS Spotlight: Telecom Italia

Telecom Italia (TI) is the largest Italian telecommunications and media company, supporting 71 percent of all voice services in Italy, 9 million broadband lines, 30 million mobile phones, and 390,000 IPTV subscribers. The company launched an online video portal in 2004, which allowed users to access movies, news, sports, and music from their PCs. The portal was well received, but as online video consumption in Italy grew, the company wanted to give viewers a more dynamic and compelling video experience.

Challenge

TI wanted to extend its online video service across more consumer devices, including PCs, tablets, and mobile phones, and add support for live TV channels. The company also wanted to enhance the user interface and increase bandwidth efficiency, and shift from a pure subscription and pay-per-use business model to an ad-supported model offered free to TI subscribers.

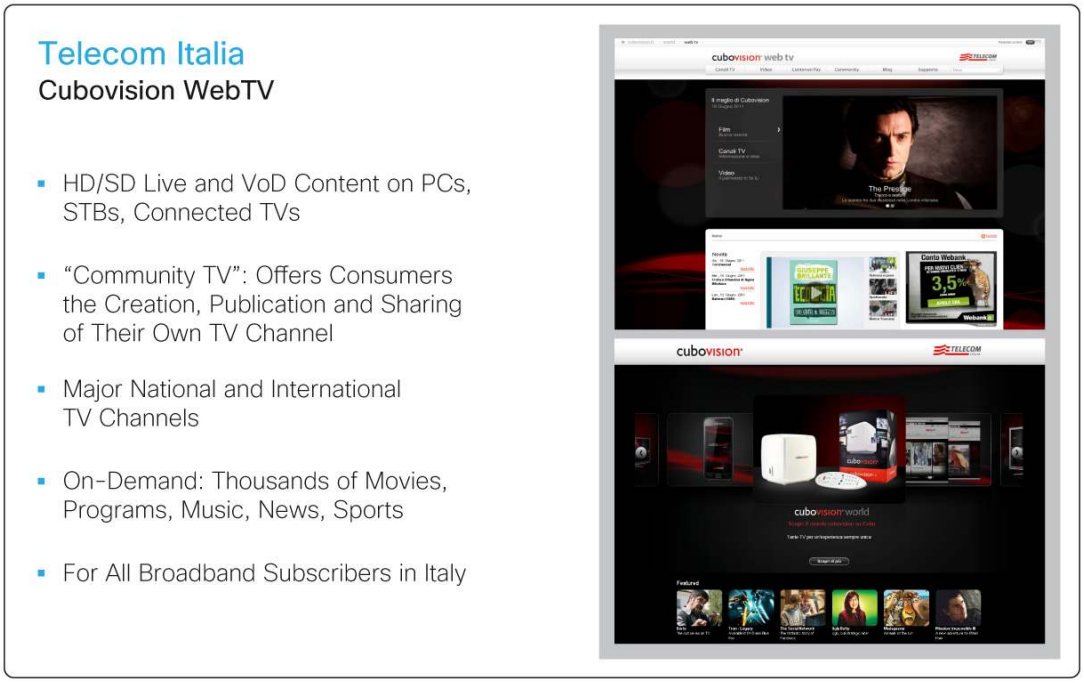
Solution

After an intensive investigation and evaluation process, TI chose the Cisco VDS-IS platform to support the video service upgrade. TI leaders believed that Cisco VDS-IS offered the scalability and service velocity to easily facilitate new features, services, and users. Combined with support for all popular protocols and formats, as well as the ability to stream both live and on-demand content from the same platform, Cisco VDS-IS gave TI the flexibility to easily adapt to changing market trends.

Results

Today, 9 million TI broadband subscribers have access to the new TI video portal, Cubovision WebTV. Users can watch 19 live TV channels and view 40,000 on-demand titles from almost any IP device. They can also create, share, and publish their own TV channel playlists with friends in the Cubovision social network community (Figure 5). All of these capabilities have allowed TI to differentiate its service from competing OTT offerings, increase subscriber loyalty, and generate new revenues through targeted advertisement insertion.

Figure 5. Cisco CDS Powers Telecom Italia Video Portal



For more details about how Cisco VDS-IS helped Telecom Italia deliver its unique multiscreen video offering, visit: http://www.cisco.com/en/US/prod/collateral/video/ps7191/ps7127/case_study_c36-663728.html.

Conclusion

The media services landscape will continue to evolve, presenting new challenges for traditional service providers. As operators seek to deliver new revenue-generating services, contend with massive IP video traffic, and differentiate themselves from new and traditional competitors, they are increasingly turning to retail CDNs.

Retail CDNs provide a highly efficient and scalable mechanism to extend media services to new screens and devices, both on-net and off. They allow service providers to dramatically improve bandwidth efficiency in their networks and deliver more compelling services at a lower cost. Even more important, they help service providers strengthen their core value proposition in the new cloud media ecosystem. Effectively, service providers can transition from a business model focused on delivering video to STBs in their own footprint, to one focused on delivering all forms of consumer video, in the highest possible quality, to any screen, anywhere.

Cisco understands all of the diverse requirements of a modern retail CDN. With the Cisco VDS-IS solution, Cisco can provide all of the flexibility, efficiency, and performance that service providers need to deliver new multiscreen services and capitalize on the cloud media revolution.

Cisco VDS-IS provides:

- **A comprehensive solution for multiscreen media delivery:** Cisco VDS-IS supports concurrent delivery of all video formats and applications from the same server, to any network. This includes the full range of media services, streaming video protocols, and connected endpoints, as well as advanced adaptive streaming intelligence to optimize delivery over any managed or unmanaged network.

- **Platform flexibility:** Cisco VDS-IS gives service providers a variety of options in hardware platforms and cache storage options. Options include:
  - High-performance Cisco CDE 250 content delivery engines with both solid-state and hard-disk cache options and 10-Gb per second (Gbps) connectivity.
  - Flexible rack-mount server and blade deployment options with Cisco UCS.
  - Integrated caching and streaming capabilities with a Cisco VDS integrated services module (ISM) for the Cisco ASR 9000 Aggregation Services Router.
- **Scalability:** Cisco CDEs scale to thousands of live channels and hundreds of thousands of VoD hours to support the largest national and global video networks. Cisco VDS-IS also supports advanced service routing intelligence to provide optimal cache efficiency with global and local load-balancing.
- **Investment protection:** An open platform, Cisco VDS-IS allows service providers to rapidly adapt their CDNs to support new protocols and changing market demands. The solution's software-based architecture also means that operators can take advantage of Moore's Law to continually upgrade performance at a lower cost-something that is not possible with purpose-built CDN hardware. Cisco VDS-IS also provides optimal business flexibility, with the ability to support both a retail CDN implementation as well as wholesale CDN services for content provider partners.

For More Information

To learn more about the Cisco VDS-IS solution, contact your local Cisco account representative, or visit: http://www.cisco.com/en/US/partner/products/ps7127/index.html.

For more details about Cisco CDE 250 Content Delivery Engines, including models, specifications, and ordering information, visit: http://www.cisco.com/en/US/partner/products/ps7127/index.html.

For more information on the software elements of the Cisco VDS-IS solution, visit: http://www.cisco.com/en/US/partner/products/ps7127/index.html.

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