Introduction to CDN and VOD Principles

Overview

(Rev 1.7)
Introduction

This document describes the principles of high-bandwidth networks for delivery of broadcast quality video services. It provides an overview of the typical architecture and the type of equipment used in deploying such networks, followed by a list of typical services offered to the end-users, or consumers, of the video services. The document concludes with an overview of DVEO products that operators can take advantage of to implement high quality video services that feed into CDNs or, conversely, which can process CDN transmitted video services for final delivery to the consumers.

VOD Infrastructure Model – Content Delivery Network

The Content Delivery Network (CDN) concept originates from the web delivery system on the Internet, where a hierarchical storage and content caching system is overlaid on the traditional IP network to achieve fast content access, timely content ingest, and better overall bandwidth utilization.

While the Internet CDN works reasonably well for most web content, several specialist vendors have leveraged their years of experience in video-on-demand (VOD) equipment and infrastructure, and focused on designing CDNs for high quality video delivery. The result is an architecture with a rich set of interfaces that not only allow multiple vendors to integrate in an end-to-end video delivery system, but also leave ample room for each company to innovate and develop best-of-breed components.

The VOD Server and CDN model is designed specifically for network service providers to enable high bandwidth delivery of all video formats, both stored and live content, to end clients. CDN delivers innovations integrated with advances in data caching that provide flexibility, scalability, efficiency, reliability, and broad media compatibility.

CDN Server Types for VOD

A typical CDN deploys three kinds of servers as will be described in the following:

- Origin Server
- Regional Cache Server, and
- Edge Streamer

**Origin Server**

The Origin Server is a very large capacity storage server where the source content will be placed and originate from. It houses the VOD Media Library and is the repository of the primary copy of all available content, or media assets. An external content management system controls what content is stored in the library, and makes the content metadata available to video service operator head-end systems, such as middleware and electronic program guide (EPG) servers, for presentation to the users.

Content is ingested from various sources such as studios/content providers, content aggregators, network-attached storage (NAS) and Storage Area Networks (SAN), via FTP, or real-time encoders. Content is delivered downstream on request.

**Regional Cache Server**

Large capacity, distributed proxy caches are placed in the regional layer for delivering often-requested ("popular") downstream content from cache, to reduce the load on the central site. Content is pulled reactively from the origin server in response to user requests, or proactively as determined by policy. Content is delivered downstream on request.

Redundant servers can be configured depending on downstream load and available bandwidth from the central library.


**Edge Streamers**

Medium-capacity, high-bandwidth caching edge streamers deliver popular content from cache to the UDP QAMs (or other last mile delivery components) with precise timing and user playback control. Content is pulled reactively from the origin or regional cache server in response to user requests, or proactively as determined by policy. Content is delivered to the users under VOD back office control.

In the case of content requested infrequently, it is streamed through to the end clients without caching.

A CDN system has at least one origin server and some edge streamers. Regional caching gateways may or may not be needed, and can be placed in any intermediate tier, depending on the load, network topology, and network bandwidths of the system. Library capacity, caching capacity, and streaming capacity can all be scaled independently.
Video-Centric Cache Management

All regional caches and edge streamers selectively cache fragments reactively and proactively, using locally managed technologies to achieve load balancing, redundancy, and automatic failover.

Selective Caching

The cache handles requests from downstream for each fragment of an asset by checking the local cache. On a miss, the cache reads the fragment from the upstream cache or central library, and passes it downstream. The fragment may or may not be stored in the cache, based on historical popularity of both the specific fragment and the total asset. Popular fragments are immediately cached to avoid multiple cache fill reads from the network, while less requested fragments are not stored since they would else displace valuable cached fragments, waste cache bandwidth, and even shorten drive life.

Fragment Caching

Assets are managed as fragments so they can be individually cached. This allows efficient caching of assets, which are not played in their entirety, including VOD "trick files" and HTTP adaptive streaming files. Empirical data shows that a 70% fragment cache can achieve the same cache hit percentage as a 100% whole asset cache. UDP VOD and progressive download cache fragmentation and reassembly are handled at the edges of the CDN network by the input cache and edge streamers respectively. Adaptive HTTP cache fragmentation and reassembly are handled by the packaging software for the particular format and the client application.

Reactive and Proactive Caching

Reactive caching algorithms provide the required content distribution with minimal network load for unpredictable usage patterns. A proactive component allows the management system to preload the cache with content that is not currently requested but will be so within the preload time window. This avoids a large network spike that would result from many non-cached assets suddenly being requested, such as when new releases are added to the VOD EPG. It prepares the caches ahead of time and sets the preload time window to include the launch period. This reduces the cache fill network cost by smoothing peak usage, hence reducing the required bandwidth allocation.

Load Balancing and Redundancy

Downstream caches can consistently distribute fragments by reading them across multiple available upstream sources. Redundancy can be switched on at certain popularity levels, so that a failed edge or regional server does not force a large amount of traffic to go to the upstream network and servers. Failover to a new source is performed by the downstream target, reacting quickly to servers that are running slowly due to overload or minor problems. Controlling the load balancing and redundancy with downstream targets means there is no centralized management function needed to ensure smooth, high-bandwidth, fault-tolerant cache operation.

VOD Service Models

- **Subscription Video-on-Demand (SVOD)** is a service offered by cable systems, which charges their subscribers a monthly fee for accessing unlimited programs.

- **Near Video-on-Demand (NVOD)** is a pay-per-view (PPV) consumer video technique used by multi-channel broadcasters using high-bandwidth distribution mechanisms such as satellite and cable television. Multiple copies of a program are broadcast at short time intervals (typically 10–20 minutes) providing convenience for viewers, who can watch the program without needing to tune in at a scheduled point in time. This type of service is bandwidth intensive and is generally provided only by large operators with a great deal of network capacity. It is becoming less common as true VOD is implemented.
Push VOD is a technique used by a number of broadcasters on systems that lack two-way connectivity to provide true VOD, and by broadcasters wishing to optimize their video streaming infrastructure by pre-loading the most popular content on the consumer device, typically a personal video recorder (PVR). The PVR will be used to store a selection of content, often transmitted in spare network capacity overnight or all day long at low bandwidth ("trickling feeding"). Users can watch the downloaded content at the time they desire, immediately and without any buffering issue. As content occupies space on the PVR hard drive, downloaded content is usually deleted after a period of time to make way for newer programs. The limited space on a PVR hard drive means that the selection of programs is usually restricted to the most popular content. Newer Push VOD solutions use efficient error correction mechanisms, and can therefore free up bandwidth and deliver more types of content than just video, e.g. magazines and interactive applications.

IVOD (Interactive VOD) is the standard version of VOD services where consumers have the following features at their disposal:

1. Play/Resume – Start a program/movie from the beginning or resume after temporarily stopping the show.
2. Stop – Temporary or permanently stop the presentation of a program.
3. Pause – Freeze the picture.
4. Jump forward – Jump to a particular time in a program in a forward direction.
5. Jump backward – Jump to a particular time in a program in a backward direction.
6. Fast Forward (FF) – Browse through a program in the forward direction with picture and sound on.
7. Slow Down – Going forward at a lower rate than normal but with picture and sound.
8. Reverse – Playing a program in the reverse direction with picture and sound.
9. Fast Reverse – Browse a program backwards with picture and sound at a faster speed than standard reverse.
10. Slow Reverse – Go backward at a slower speed, with picture and sound.
11. Other interactive features include the ability to avoid or select advertisements, to investigate additional details about news events and to browse, select, and purchase goods.

EVOD (Exclusive VOD) is when a particular VOD service operator offers a function, service and/or program that nobody else can provide.

IVOD (Impulse VOD) is now typically referred to as VOD but in the past this term referred to the ability to order a VOD service without having to first phone in the order to the pay-TV operator.

QVOD (Quasi VOD) is the same as Near VOD except that the programming only will be presented if a minimum number of subscribers sign up for it.

TVOD (Transactional VOD) is the opposite of Subscription VOD. With TVOD the customer pays for each individual VOD program. Secure TVOD authenticates the device/user to the video server to verify payment and authorize the service based on IP address. Scale Engine Virtual Usher Ticket System authenticates for several TVOD distributors. With its opposite, SVOD, typically the subscriber pays a set amount (often monthly) for a set amount of - or unlimited - VOD. Netflix is the world's largest SVOD operator. Today TVOD is mostly referred to as VOD.
DVEO Atlas Media Server Family

High-Performance Turnkey Live and On-demand Media Servers

The video consumption habits of consumers have changed drastically over the past decade. Traditionally accustomed to broadcaster scheduled "appointment viewing", consumers today demand "prime time on my time." Moreover, the fixed location viewing in the family room, and perhaps on a desktop PC, is replaced by expectations of TV Everywhere with a proliferation of mobile devices capable of receiving streamed IP video, encouraged by more efficient encoding algorithms and streaming protocols. Progressive video operators stay at the forefront by constantly evaluating and adopting new IP-based production and delivery technologies, but it all must fit within limited budgets for capital expenditures (CAPEX) and operating expenses (OPEX).

The DVEO Atlas Media Server Family is a cost-efficient way to deliver live and on-demand multi-bitrate IPTV and OTT services. Offered turnkey with pre-configured hardware, software and DVCare™ customer support, these CAPEX friendly servers shorten time-to-market with reduced project risk compared to build-it-yourself software alternatives. Like the DVEO Encoder Transcoder Family, the DVEO media servers offer proven technology built on Linux OS and the Intel Xeon platform for 24/7 reliability, keeping OPEX in check, while supporting all common HTTP adaptive bitrate (ABR) streaming protocols and resolutions.

Moreover, DVEO’s award winning and patent pending DOZER technology guarantees error-free UDP video transport over any type of IP network including the public Internet. The product line’s advanced capabilities are enhanced by pre-integrated content security and digital rights management (DRM) from leaders such as Verimatrix®, and field-proven compatibility with major CDNs, enabling operators to respond with confidence to a rapidly evolving media landscape while containing both CAPEX and OPEX.

Applications

✓ Live and on-demand streaming for IPTV and OTT delivery over managed and unmanaged networks
✓ Ingest H.264 live streams over IP, then add wrappers such as HLS, HTTP Smooth Streaming, HTTP Dynamic Streaming, MPEG-DASH, or RTMP (Open Flash), supporting subtitles/closed captioning and multiple languages
✓ Ideal for multi-screen content delivery, network PVR, Go back TV, Catch up TV, and more
✓ Video server for hospitality, cruise ships, stadiums and public venues, education, ethnic channels, and so on
✓ Build low-cost high-quality video CDNs, utilizing the public Internet, enhanced by automated packet recovery

Features

Linux OS – Reliability 24x7

Linux is universally acknowledged as the most reliable and efficient OS for mission critical applications. It also happens to be extremely cost effective.

Multi-Screen Content Distribution Architecture

Groom and stream multi-screen live and on-demand content to a multitude of CE devices featuring multi-protocol and multi-wrapper IP input and output, including multiple HTTP ABR protocols, RTMP, RTSP (TCP/UDP), MPEG-TS, and patent pending DOZER Automated Packet Recovery technology for error-free video delivery over the Internet.

Remote GUI and Management

Control media servers from anywhere via the Remote GUI, including control of scheduling, and via standards-based APIs: SNMP, REST and SOAP.

DRM Protection

Use with industry leading content security, such as the Verimatrix® Video Content Authority System (VCAS™), to protect content and service revenues. Support for AES-128 encryption as well as Simulcrypt (ECMG).

Media Distribution Ecosystem

Connect to any streaming architecture and IP networks while accommodating diverse sets of live ingest and on-demand content. Deliver multi-screen services to smart TVs, IP-STBS/DVRs, iOS and Android smart phones and tablets, PCs, Macs, and game consoles. Use with leading CDNs and streaming service providers such as Akamai (incl. Octoshape), Limelight, Ustream, and Verizon (incl. Edgecast). Pair with DVEO Encoders/Transcoders and a wide variety of third-party equipment.

Three Models incl. TELCO

Available in 1 RU and 3 RU sizes and with dual power supplies, for streaming to as many as 8,000 simultaneous users.
DVEO Live Video and Multi-screen Deployment Examples

Figure 2: OTT Video Services Deployment to ~1,000 Users - Atlas I

Figure 3: Hospitality Deployment – Atlas II

Figure 4: Large-scale OTT/CDN Live Video Services Deployment – Atlas III

Atlas Media Servers can be stacked or racked to meet any deployment size, and used as Origin Server, Regional Servers and/or Edge Servers. For further details, download the DVEO Atlas Media Servers document, call +1 858 613-1818, or visit www.dveo.com