XOR Media CDN Architecture for Video on Demand Solutions

Seamless Content Propagation and Content Availability Anytime

Overview

The XOR Media group is a veteran VOD technology specialist for over a decade. More than 5,000 of its VOD servers are deployed in over 120 systems worldwide in support of 2 million streams. With a comprehensive software and hardware portfolio supporting open interfaces, XOR continues to pioneer the latest VOD infrastructure model that will save costs, simplify operations, increase customer satisfaction, monetize content, and allow the rapid introduction of new revenue generating services.

Traditional VOD Infrastructure Model

Through years of collaboration with their partners and customers, XOR has long realized the deficiencies of the traditional VOD infrastructure model. Content is replicated in all the sites, requiring large deployment footprint at each site, including servers, rack space, power, air conditioning, and hundreds of spinning disks that constantly require manual replacements. Storage scalability is severely limited as any storage expansion would require new server purchase and deployment at each site. Making new content available to subscribers is extremely slow as it sometimes takes days to replicate the new content in all the sites. New service introduction is impeded, requiring server upgrade or replacement at each site.
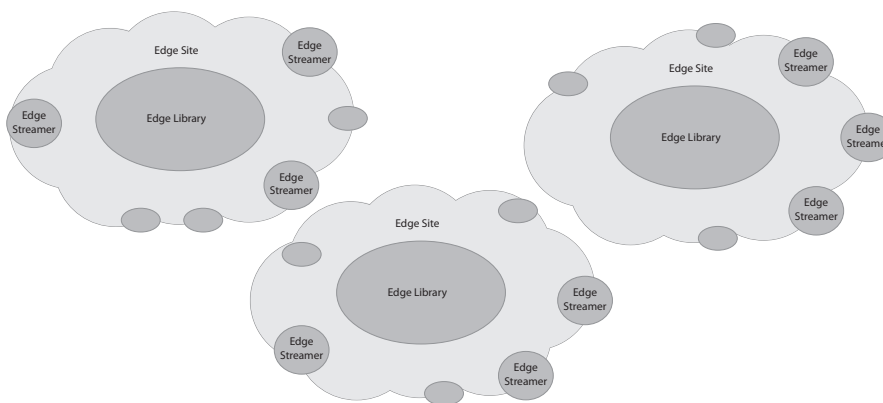

The XOR Way

To address these deficiencies, XOR started to work with some of the world's leading operators and technology providers on a new VOD infrastructure model – Content Deliver Network (CDN). This 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 network bandwidth reduction.

While the Internet CDN works reasonably well for web content, XOR and its partners leveraged on their years of experience in VOD and focused on designing a CDN for high-bandwidth 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 vendor to innovate and come up with its own best-of- class components.

The XOR CDN model is designed specifically for network service providers to provide high bandwidth delivery of all video formats, stored and live, to end clients. XOR CDN delivers innovations of high-density solid-state disk servers, integrated with advances in data caching which provide flexibility, scalability, efficiency, reliability, and broad media compatibility.

Content Delivery System Architecture for VOD
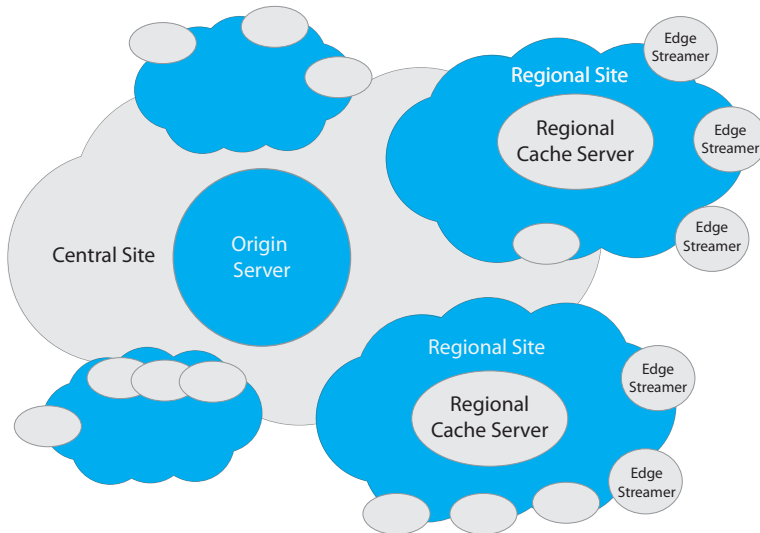
Origin Server

The origin server serves as the repository of the primary copy of all available assets. An external content management system such as AssetFlow controls what content is stored in the library, and makes the content metadata available to back office systems for presentation to the users. Content is ingested from various sources such as content provider, NAS, FTP, or real-time channel encoders. Content is delivered downstream on request.

Regional Cache Server

Distributed proxy caches are placed in the regional layer for delivering 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.

Edge Streamers

High-bandwidth caching streamers deliver popular content from cache to the UDP QAMs with precise timing and user playback control. Content is pulled reactively from the origin server or regional cache 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 unpopular content, it is streamed through without caching.

Features and Benefits of XOR CDN

Sophisticated Solid-State Disk (SSD) Management

XOR edge streamers have a sophisticated SSD-aware cache algorithm and storage control engine that avoids excessive SSD wear, which prolongs the life of the solid-state disk. This proprietary technology increases system reliability, reduces operational costs, and minimizes frequent replacement of drives.

Video-Centric Cache Management

All regional caches and edge streamers selectively cache fragments reactively and proactively, using locally managed, load balanced, redundant, and failover technologies.

• 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 is not always stored in the cache. It is stored 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. Unpopular fragments are not stored because they displace valuable cached fragments, waste cache bandwidth, and 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, 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 popular, but will be within the preload time window. This avoids a large network spike from many uncached assets suddenly being played, such as when new releases are added to the VOD user menus. It sets up the caches ahead of time, setting the preload time window to include the launch period. This reduces the cache fill network cost by smoothing peak usage, lowering 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, avoiding rigid HA pairs and expensive hardware load balancers, reacting quickly to servers that are running slowly due to overload or minor errors.

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.

As a result, XOR CDN has self-tuning and auto load-balancing capabilities. Optimization does not need to be done real-time, but designing the system according to network topology, anticipated library size, and subscriber count. Once the components are in place and configured, they will react to load changes and equipment downtime automatically.

XOR CDN Components:
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.

XOR provides the following systems for use in the three CDN tiers:

ORIGIN SERVER
The Universal MediaLibrary (UML) is a very large capacity storage server with RAID 6 data protection and dual high-availability heads for server fault tolerance. A single UML chas a capacity of up to 216TB and output 17Gbps.

• **Server Pair**
- 2RU rack-mountable servers
- HTTP for CDN reactive cache-fill
- FTP/CIFS, NFS for content ingest
- Distributed file system
- Infiniband cluster interconnect
- Redundant power supply
- 230W start up power
- 200W operating power

• **Matrix Storage Array**
- 5RU rack-mountable chassis
- 72 drives, 6 blades of 12 drives each
- Hot-swappable disk drives, cooling fans, power supplies, and blades
- 1300W start-up power (1TB or 2TB SAS drives)
- 900W (1TB), 1200W (2TB) operating power

REGIONAL CACHE SERVER

The Universal MediaGateway (UMG) is a large-capacity proxy cache server. Redundant servers can be configured but may not be necessary, depending on downstream load and available bandwidth from the central library.

A single UMG has 20TB of usable storage and can output 7.2 Gbps.

- 2RU rack-mountable server
- Reduce network traffic between central library and regional sites
- Cache fill popular content, stream through long-tail content
- Self-managed, load balance, fault resilient, online expansion across multiple gateways

EDGE STREAMERS

The FMS 5000 is a medium-capacity, high-speed edge streamer. A single FMS 5000 can provide 2.56TB fragment cache capacity and output 18.75Gbps.

- 2RU rack-mountable server
- 2500 x 3.75Mbps SD MPEG streams
- N+1 data protection
- Cache popular content, stream through long-tail
- Redundant power supply

In addition to the servers and streamers, the following appliances control and manage the storage and streaming servers in the CDN:

- Storage Control Service (SCS) Server Pair is a complete video content storage solution using the Universal MediaLibrary. It is responsible for managing the CDN central storage, creating trick files, managing cache policy and stream through to cache servers.

- Open Streaming Service (OSTR) Server Pair is a managing tool for XOR edge streamers such as the Flash Memory Streamers. It functions as a gateway server that connects the CDN system to the NGOD compatible backoffice.

Summary

XOR has been at the forefront of content delivery, helping Video on Demand customers leverage newer technologies to improve the way they deliver content to their subscribers. With a new CDN architecture that employs sophisticated SSD management, intelligent video-centric cache management, and load-balancing and redundancy, XOR brings new innovative technologies to the table, helping VOD operators lower their cost and improve the eciency of content delivery, ultimately providing a better user experience to their subscribers.