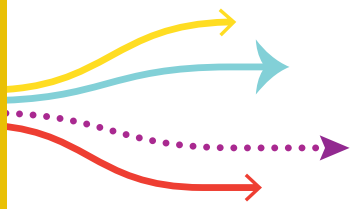
DECEMBER 2013



A New Architecture for Multiscreen Service Distribution, Rights Management and Monetization

As IP networks emerged for data applications in the 1990s, broadband operators were first to understand the value of new services that could be delivered to consumers over these networks. These trailblazers invested in network infrastructure as well as set-top boxes (STBs) and home gateways to provide the managed platforms that were then essential for delivering real-time services such as video with adequate Quality of Service (QoS).

Operators generated extra revenue through value-added packages incorporating the new services, while customer relationship departments were overhauled to manage the ever more demanding relationships with subscribers. By launching voice over IP (VoIP) and video over IP services a decade ago along with broadband data, the first triple play offerings were created.

More recently, the emergence of adaptive streaming technologies such as HTTP Live Streaming (HLS) and Smooth Streaming, along with the wider uptake of powerful new video-enabled retail devices like tablets, game consoles and smartphones, led to the current mass deployment of HTTP adaptive bit rate streaming (ABR).

This technology is now enabling many new services to be delivered over the open Internet. A new world of “virtual” pay TV operators, over-the-top (OTT) providers, has emerged, using content delivery network (CDN) service providers as technology partners to cut out the distribution platform in the middle.

envivio®

The increasing consumption of TV services on portable devices, the share of Internet traffic taken by video streaming services such as Netflix, the emergence and success of premium content delivered first and only on the Internet (such as the series House of Cards), and the general availability of IP connectivity across all multimedia devices are all positive indicators that "anywhere, anytime" media consumption is not just a fashionable trend, but a real disruptive change in viewing habits.

Opportunity for broadband operators

Pay TV operators initially responded by developing multiscreen services themselves and, when possible, utilizing their premium content offerings to reduce the erosion in TV package subscription against pure-play OTT providers. What started as a defensive move and an initiative to reduce TV subscription erosion could turn into a major strategy shift, leveraging multiple benefits brought by the initial multiscreen approach:

- Give consumers the freedom to watch what they want, when and where they want.
- Address not only the subscribers on their networks, but also tap into customers outside their current reach and become more global service providers.
- Leverage all multimedia devices as a potential STB replacement. Game consoles, Connect-edTV, Roku/AppleTV boxes, TV dongles, can all be served directly using Wi-Fi technology and thus contribute to saving hundreds of millions of dollars in STB investment and support.

Adaptive bitrate: the technology behind today's efficient video streaming

Available in multiple flavors with various acronyms (HLS, HDS, HSS, MPEG-DASH, etc.) adaptive bitrate technologies have become the main video streaming methods across the Internet and wireless networks thanks to their capacity to cope with variable bandwidth and ability to cross firewalls.

With this technology, the source content is encoded at multiple bitrates, then each of the different bitrate streams is segmented into small multi-second parts (Figure 1). The streaming client is made aware of the available streams at various bitrates and segments of the streams by a manifest file. When starting, the client requests the segments from the lowest bitrate stream. If the client finds the download speed is greater than the bitrate of the segment downloaded, then it will request the next higher bitrate segment. Later, if the client finds the download speed for a segment is lower than the bit rate for the segment, and therefore the network throughput has deteriorated, it will request a lower bit rate segment. The segment size can vary depending on the particular implementation, but they are typically between one and ten seconds (Figure 2).

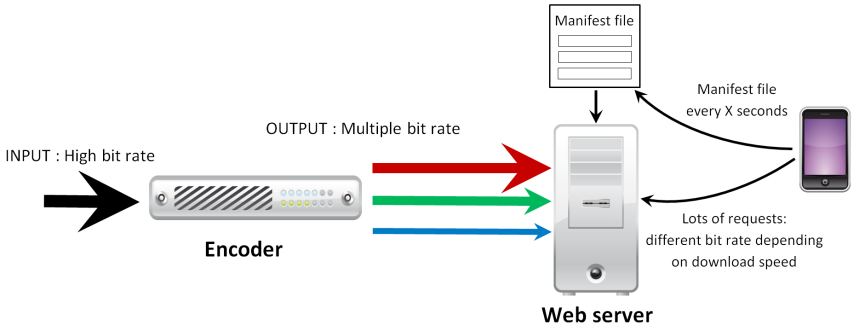


Figure 1: Adaptative streaming overview

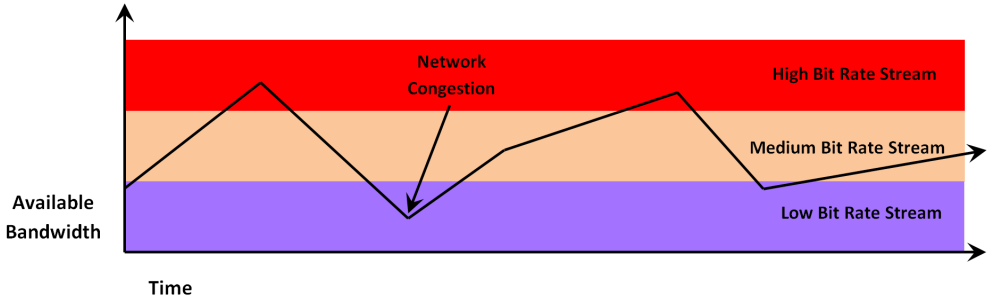


Figure 2: Progressive bitrate calibration

As mentioned previously, several adaptive bitrate streaming formats currently coexist:

- HTTP Live Streaming (HLS) initially developed by Apple for its iDevices and now widely used in other tablets, smartphones and some STBs
- HTTP Smooth Streaming (HSS), developed by Microsoft with very broad adoption
- HTTP Dynamic Streaming (HDS), developed by Adobe
- MPEG-DASH, the MPEG standard

These standards differ primarily due to the format of the manifest that references the available fragments, the number of files per asset, the presence of a server manifest, and the support of multiple digital rights management (DRM) systems (available for MPEG-DASH). Each has its own compliant players. HLS and Smooth Streaming are commonplace today, but MPEG-DASH as an industry standard should replace both in the foreseeable future.

In some specific cases, all of these formats can provide better results in terms of video quality than traditional IPTV. Indeed for the latter, bandwidth is fixed whereas ABR streaming enables this limit to be exceeded when the network allows, delivering higher video quality and a better user experience. It would be incongruous for a quality-assured pay TV viewing experience, delivered by a given operator, to be worse than the content watched for free over the same operator's open Internet service. But as we will see, IPTV can now also benefit from ABR to deliver an improved quality of experience while containing costs for operators.

Some challenges remain...

Adaptive bitrate technologies are the main engines behind the deployment of new services, but some business and technical issues still need to be solved in order to deploy ABR in massive scale and consider it a potential replacement for the more "traditional" video distribution.

- HTTP/unicast video distribution is good for networks with no guaranteed QoS. Now, every user requesting an individual stream potentially creates massive network traffic which grows proportionally to the audience size. This is the reason why Netflix generates the biggest Internet traffic in US.
- For premium content, security and anti-piracy is a must. However, this must be put in balance with user expectations: they would like to view the content they purchase across any of their devices, regardless of its brand. Designing digital rights management in a secure yet simple manner and making content available across a large variety of platforms is a real technology challenge.
- Finally, multiscreen monetization and service personalization are still in their infancy. While some commercial trials show very promising results, scale and the right infrastructure are needed to develop a viable, standalone and long-term business model.

In the following sections Broadpeak, Microsoft and Envivio discuss how each problem can be addressed.

Efficient video distribution

Adaptive bitrate: the impact of one-to-one delivery

Scale is paramount for TV services. One-to-one unicast works well for delivery of niche content, or for services with a small number of users. But since bandwidth demand grows in a linear fashion with the number of users, the network can collapse under the traffic load generated by popular content, and more specifically, by live channels consumed by large numbers of subscribers running into the hundreds of thousands or millions.

As a result, OTT is very hard to scale for linear TV. IPTV avoids this problem through multicast delivery, ensuring that every link of an IP network carries just one copy of a given IP video packet. This allows operators to contain the number of cache servers they need to deploy in their infrastructure for ensuring the service, but only applies for STBs available in managed networks.

It is with these observations in mind that Broadpeak has developed its nanoCDN™ technology.

envivio®

Broadpeak nanoCDN: leverage multicast all the way to the home gateway

First demonstrated at IBC 2012, the nanoCDN concept pioneered by Broadpeak extends CDN performance and scalability right to the end device by recruiting CPE equipment such as gateways that have storage in the customer's home. Effectively, the access circuit becomes part of the CDN network, which means that end-to-end bandwidth consumption as far as the home remains constant irrespective of usage, even at peak times, and no matter how many devices are accessing the streams within the home. To make this work, Broadpeak modifies the streams at the point of ingest into the nanoCDN, and then within the home network a small piece of software undoes those changes so that the video can be viewed. The concept is easy to try by putting just a single channel on a nanoCDN to leverage the multicast capacity. Then, a single server transforms the stream from unicast to multicast.

A portal accessed by home devices lets subscribers choose content, pointing to a central server that, in turn, routes requests to the right streams. If a live stream becomes one of the most popular channels, it automatically gets switched to multicast.

An application on the home gateway then transforms multicast back to unicast so as to keep the final device (say an iPad or an Xbox One) unchanged. This solution can mix unicast delivery for on-demand and PVR in the cloud. Time-shifting solutions are based partly on storage on the home gateway and partly on storage on servers can also be integrated.

Broadpeak nanoCDN's main benefit to operators comes from the large savings it provides in terms of infrastructure costs.

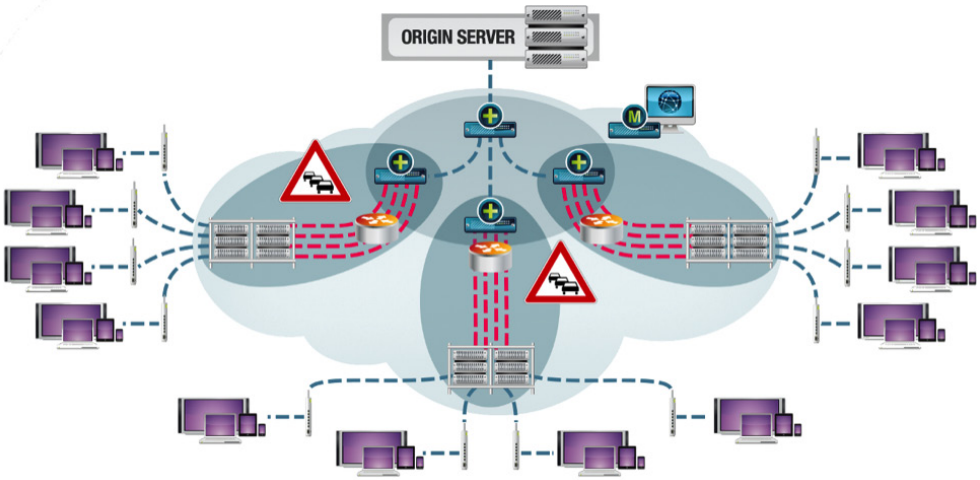


Figure 3: With traditional CDN: contention points in the edge network, 1M requests with 3 POP → 330,000 streams per POP

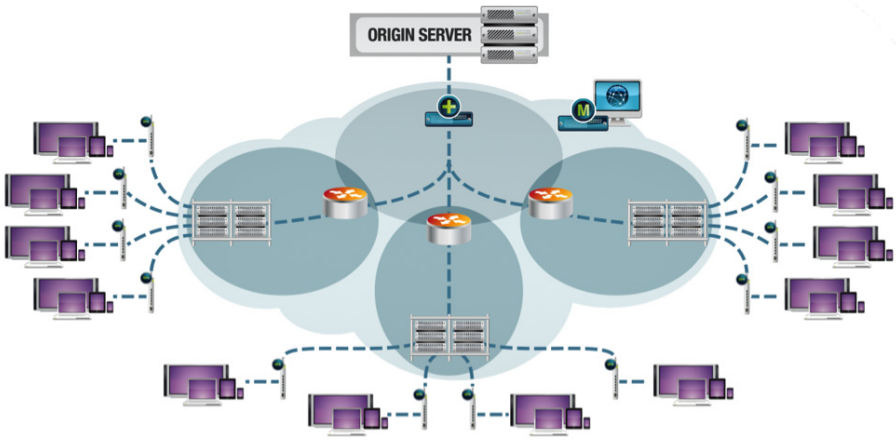


Figure 4: With nanoCDN: no contention points, 1 million requests → 1 multicast per layer in the network

If we consider a live multiscreen project with the following assumptions:

- Usage
  - One million concurrent sessions
  - Average video bitrate at 3Mbps
  - → 3 Tbps load in the network
  - 50 live channels with 3 layers and a cumulative bitrate of 6 Mbps
  - If the traffic is distributed between 3 points of presence (POP) → 1 Tbps per POP
- Equipment capacity
  - Router capacity: 1Tbps
  - Streaming servers capacity: 30 Gbps
  - CMTS downlink capacity: 40 Gbps

The equipment required with and without the nanoCDN is shown in this scenario:

	Without nanoCDN	With nanoCDN
Routers	8	8
Streaming servers	105	2
CDN management server	5	5
CMTS	75	3

This translates in terms of cost into a 10x reduction when the nanoCDN is used. If the number of users grows to 10 million instead of one million, the cost savings is 20x.

Broadpeak's nanoCDN solution also improves the quality of service for live content coming from OTT platforms. By removing contention points and adapting the content closer to the end-user, nanoCDN allows operators to deliver a layer that is always higher than the one that would have been streamed from a standard unicast server.

By putting every last bit of bandwidth to work, nanoCDN helps operators deliver the best possible service from their network and therefore plays a vital role in extending the eligibility of the IPTV package.

Efficient digital rights management

The opportunity

Pay TV customers expect to watch their content across the full breadth of devices inside and outside of the home.

Broadcasters need to manage secure premium content delivery to consumers in-home through managed networks to in-home set top boxes (STBs), as well as through unmanaged networks that allow OTT content to flow to connected devices. Both content delivery methods are illustrated in Figure 5 below.

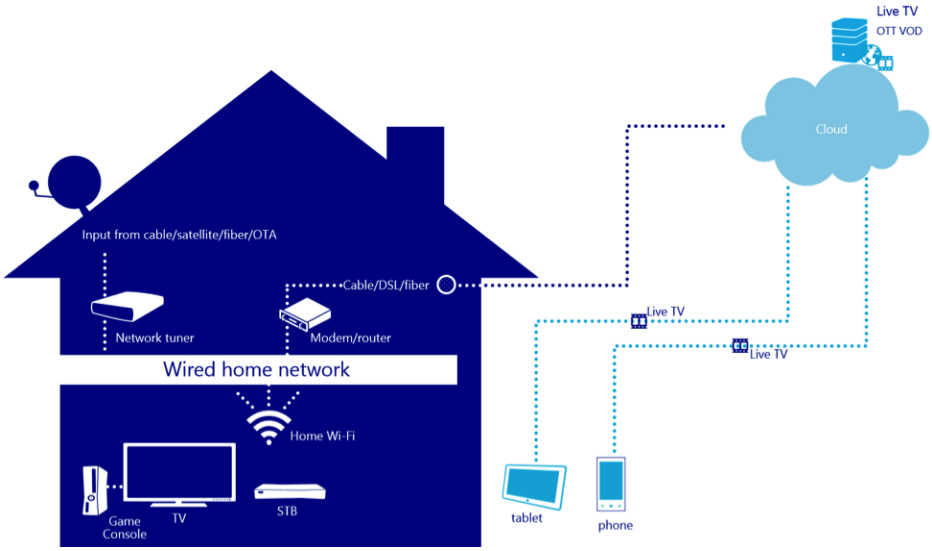


Figure 5: Typical content delivery networks (image courtesy of Microsoft)

Broadcasters want to utilize the quality of service and data bandwidth of the managed network to deliver their content to connected devices within the home network. This can be achieved by implementing in-home content sharing architectures, provided that adequate rights have been obtained from the content owners. This can be accomplished with basic link protection such as DTCP-IP. However, this approach is limited in its support of mobile platforms, and does not meet most premium content security requirements, nor offer the rights expression of a modern DRM technology.

Microsoft PlayReady for Network Devices (ND)

Microsoft PlayReady for Network Devices (ND) provides a solution to extend the reach of live TV and VOD content to connected devices in the home. PlayReady ND was designed to accomplish the following:

- For OTT services, a PlayReady ND enabled device can stream to in-home clients while also extending to the client the rich rights policies of a managed DRM.
- For conditional access, PlayReady ND enables broadcasters to bridge the content protection scheme from the cable/satellite source to managed DRM clients within the home. With support for MPEG-2 TS built in, in-home clients can consume the client without the need to re-encode the source.

By using PlayReady ND, a service provider is ensured that the robustness and compliance of the clients is actively managed. Some of the other benefits include:

- The content always remains encrypted for both streaming and offline playback scenarios.
- The client can only consume the content using a DRM technology that is industry approved.
- The client can leverage standard technologies such as MPEG2-TS, Smooth Streaming, and MPEG-DASH.
- An OTT service can support common broadcaster requirements such as frequent key rotation, regional blackouts, and ad insertion.

Figure 6 below illustrates a typical use case where:

- A PlayReady ND Transmitter (ND-T) receives content into the home. The content could be either from an OTT service or cable or satellite.
- If the content is coming from a Conditional Access System (CAS), the PlayReady ND Transmitter on the STB would apply PlayReady encryption to the stream. For an OTT service the Transmitter will just retransmit the stream.
- A PlayReady ND Receiver (ND-R) on the device will use the discovery service to find the Transmitter. The Transmitter can display live channels as well as VoD content.
- A PlayReady ND Transmitter will authenticate the PlayReady ND Receiver and then broadcast the channels or other authorized content.

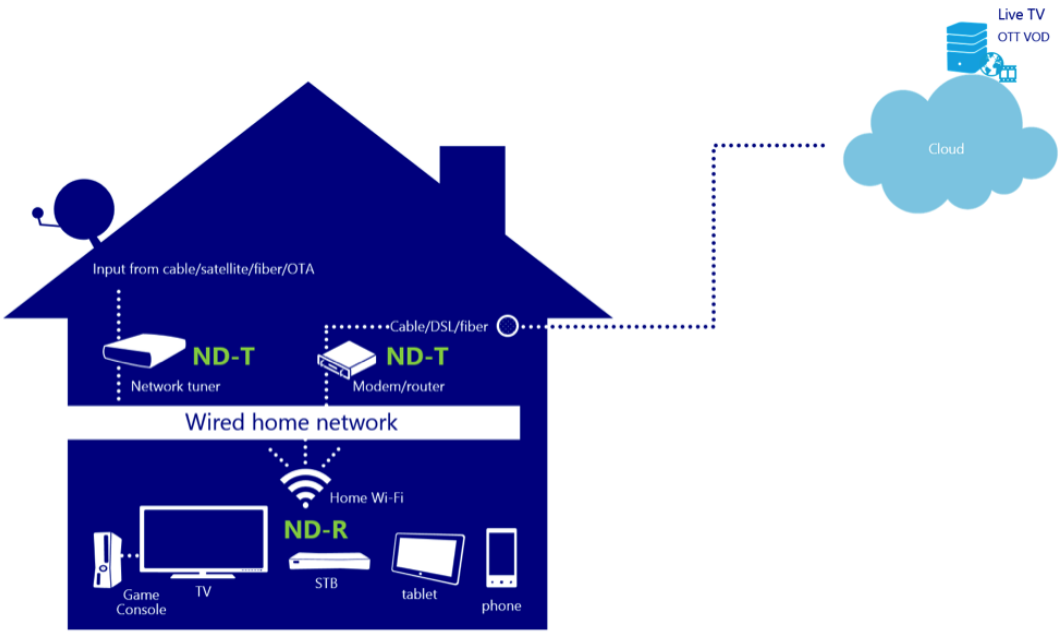


Figure 6: PlayReady ND home network (image courtesy of Microsoft)

Microsoft PlayReady ND offers a secure content distribution for in-home streaming by leveraging the capabilities of a managed DRM. Conditional Access providers also see value in PlayReady ND as it securely bridges CAS protected content to PlayReady enabled devices.

This solution not only helps broadcasters capture the opportunity of in-home streaming but also allows them to distribute as well as monetize premium content, while still adhering to the policies and requirements of the content owners. Thereby operators can extend the reach of their content and services and increase value delivered to customers.

envivio.

Service monetization

In a world where consumers are used to freely consuming content from the Internet—sometimes illegally—monetizing content or live channels may seem challenging. However, with the emergence of connected devices with improved user interfaces, the increased broadband speeds allowing HD streaming, and the quality and choice of content proposed for consumption, these services now offer an excellent user experience, and their audience keeps increasing. The question is no longer "if" the service can be monetized, but finding the right mix of options to monetize the service across a wide range of users.

Multiscreen business models

While most operators are still making adjustments to their various business and sales models for their multiscreen offering, a few models have been deployed successfully:

- Paid subscription: access to content is offered through monthly subscription or "a la carte".
- Packaged offering: bundled with other services, the multiscreen offering is usually part of a "Premium" offering along with another pay TV, broadband, or wireless subscription.
- Paid by advertisement: TV services, available as catch-up assets, are financed by targeted advertisement.

These models are not unique, and more sophisticated blended models are also appearing, mixing free/ad-based long tail content with paid subscriptions for premium content and experience. In this landscape, there is still a lot of room for innovation and new business models. Two models seem particularly promising: personal advertisement on TV channels and cloud PVR.

Personal advertising for linear channels

While today "local ad insertion" is a healthy business for cable, it only exists for the main screen and ads can only be tailored per subscriber area. What if the ad breaks could now be tailored seamlessly for each and every viewer based on his/her profile? With personal advertising, the ad can be tailored to various segments of population, taking into account not only the location, but also the demographics and the user preferences down to the individual level. This approach has the benefit of leveraging the power of profiling and analytics technologies from the Internet and the large audience of linear broadcast TV.

By putting in place an architecture allowing seamless targeted advertising on TV channels, operators can leverage a larger audience and higher CPM, offering a new and creative way to monetize the service while improving its perceived value to the subscriber.

Increased subscription for advanced services

Offering a better user experience and the convenience of watching favorite TV shows at the most convenient time is also an important avenue to monetize multiscreen services. New business models are arising, where access to basic functionalities (such as access to TV channels) is provided as part of a bundled service or sponsored by ads, while advanced functionalities (such

as network PVR, program replay, etc.) require a subscription.

Operators can now leverage the cloud storage infrastructure to efficiently replace digital video recorders (DVRs), lowering their investment and cost of support, while gaining incremental revenues by proposing a cloud-based PVR capable of addressing all viewers' screens.

Envivio Halo™ Experience Server

Envivio Halo Experience Server is a multiscreen application server designed to allow operators to further personalize the user experience based on individual viewer requests. It facilitates advanced applications including time-shifted TV and network DVR, targeted advertisement insertion, social and personalized TV—without requiring significant changes in the existing multiscreen infrastructure.

Implementation is simple and cost-effective—no multi-platform or specific client development is required, no change is needed in the CDN, and content switching using Halo Experience is seamless. The Experience Server keeps track of all video chunks delivered in the network and leverages the native caching capabilities of the CDN to create new services by performing virtual content extraction (for network PVR) or replacement (for ad insertion) on a per user basis.

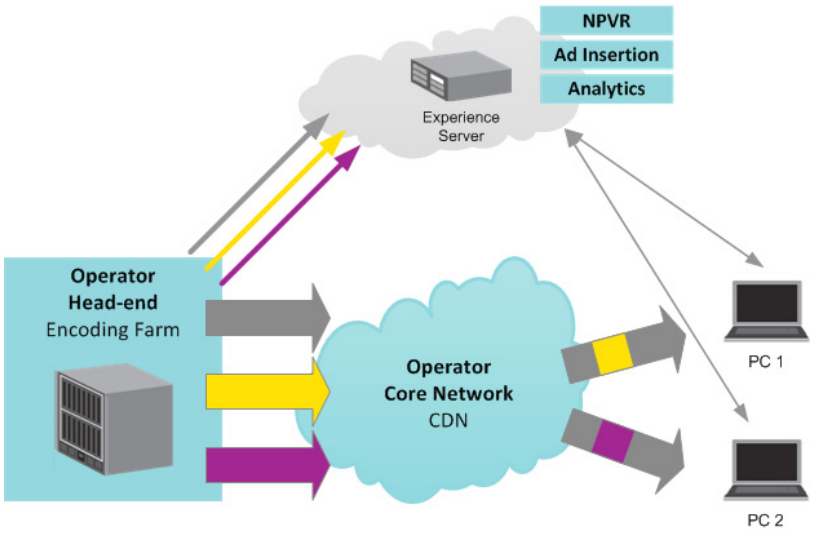


Figure 7: Halo Experience Server overview

The main video traffic is cached and distributed by the CDN, while the Experience Server keeps track of all the video chunks created by the headend. The client connects to the Experience Server, and based on the player request, the Experience Server dynamically directs the client to the proper chunks inside the network. By matching the client profile and request to the application control (ad, NPVR, etc.) the Experience Server can then virtually recompose a new and unique user experience.

Halo Experience also offers audience measurement capabilities to better track connected user viewing patterns, and supports the full range of streaming formats, including Apple HTTP Live Streaming (HLS), Microsoft Smooth Streaming, Adobe HTTP Dynamic Streaming (HDS) and MPEG-DASH.

This approach offers significant advantages:

- It provides seamless content insertion, replacement and extraction, with no impact on the Quality of Experience (QoE) for the end user.
- It remains independent from the device: no custom application is required; it leverages its built-in ABR playback capability, simplifying maintenance and the addition of new devices.
- It is also independent from the CDN: whether the operator uses in-house, external or a mix of various CDNs, the Experience Server can be deployed as an "overlay" for existing content delivery methods.
- Finally, it establishes a unique low-bandwidth connection with each player and can perform real-time content targeting and collect analytics about user behavior.

Putting all the pieces together

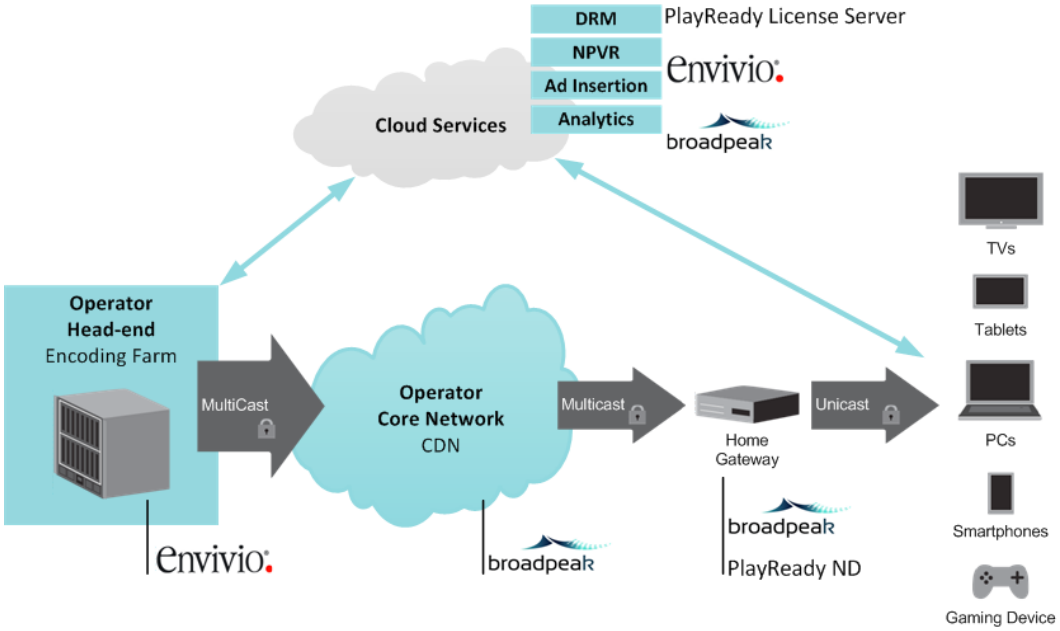


Figure 8: New architecture for enhanced multiscreen distribution

The end-to-end architecture incorporates the following components:

- Headend:
  - Content production: Envivio Muse Live and Muse On-Demand encoders/transcoders
  - Content protection, storage and origin server: Envivio Halo network media processor
- Cloud Applications:
  - Content personalization (ad, nPVR, etc.): Envivio Halo Experience Server
  - Digital rights management: Microsoft PlayReady DRM server
  - CDN management and analytics: Broadpeak BkM
- Network optimization
  - Broadpeak CDN
  - Broadpeak nanoCDN
- Gateway
  - Broadpeak nanoCDN
  - Microsoft PlayReady Network Device

The entire solution is based on software: the main network components (headend and CDN) can be deployed on standard IT infrastructure, while application controls can be deployed in the cloud (public or private) and scale with the number of users.

Thanks to the combination of best-of-breed technologies for DRM, content personalization and efficient network distribution, this new approach allows operators to deploy disruptive services with high value-add to the end user while lowering the costs of device development and network traffic.

With contribution by:

For more information:
http://www.envivio.com
http://www.microsoft.com/playready/
http://www.broadpeak.tv/en/contacts/

Envivio Corporate Headquarters
400 Oyster Point Boulevard, Suite 325
South San Francisco, CA 94080 USA
Tel: +1 650 243 2700
Tel: +1 866 ENVIVIO (368 4846)

info@envivio.com

Envivio - France
5 Rue Louis Jacques Daguerre
35136 Saint Jacque de La Lande
France
Tel: +33 2 23 35 52 60

Envivio - China
Suite 800, Beijing Sunflower Tower
No. 37 Maizidian Street
Chaoyang District
Beijing, 100026, China
Tel: +86 10 8451 1231 / 1232

Envivio JBO - Japan
15F Cerulean Tower
26-1 Sakuragaoka-cho
Shibuya-ku, Tokyo 150-8512, Japan
Tel: +81 3 5456 5785

Envivio - Singapore
Prudential Tower #27-09
30 Cecil Street
049712 Singapore
Singapore
Tel: +65 6232 2754