A Pain-Free Way to Build Live, Multi-Screen Video Delivery Networks

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Introduction

Adaptive Streaming:
The techniques used to convert a traditional video stream into a series of time-sized "segments" – 2-seconds, 4-seconds, 6-seconds – so as to "right size" the stream for the receiving display device, and as a function of available bandwidth.

Call it TV Everywhere, call it managed over-the-top (OTT) video. Call it IP-delivered video, call it Internet video. Whatever it's called, one thing is certain: The ceaseless growth in video-capable, IP-connected screens, designed to expand TV viewing options for consumers, is putting unprecedented strain on network architecture and operations.

At the same time though, live HTTP-based streaming represents a competitive opportunity that is perfectly timed for the 2011-2012 service provider marketplace. That's because it's a way to harness existing content rights for live and linear TV, and extend them to the multi-screen universe.

In other words: Think you missed it for on-demand streaming, relative to Netflix? All of the existing on-demand, OTT services have one critical flaw: Lack of current content, especially for live and linear video. This is also a crucial differentiator for service providers facing the emerging threat of satellite-based competition on mobile platforms (i.e. Dish).

The timing is thus right to construct and rely upon HTTP content distribution networks, and the necessary addition of protected, linear broadcast streams that are "adaptively-streamed" onto RF, IPTV, DSL, or fiber-rich networks.

But, the number of components required to come together, to flawlessly send a live or linear video stream

to a screen not necessarily connected to a set top box, can be unnerving at best.

First, there's the app itself, to browse and select a video stream. Then there are the content delivery network (CDN) components, to hierarchically store and stream the title. Add in digital rights management (DRM), and the trans-coding and trans-rating mechanisms necessary to "right-size" a video stream for its destination device.

The construction of HTTP-based adaptive streaming mechanisms is complex, to say the least. Adding on to that complexity are the many client-specific encapsulation and DRM formats, as well as the unicast, point-to-point nature of the HTTP protocol.

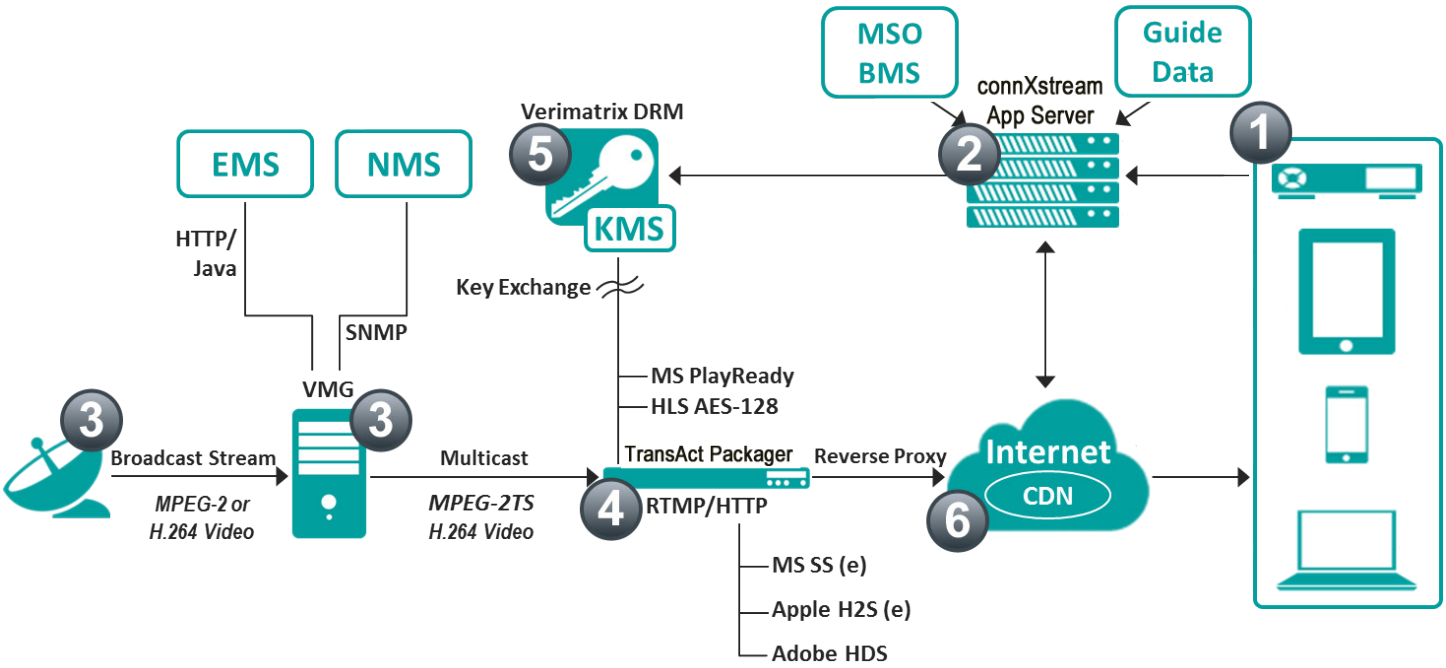
So far, few if any options exist for mid- and small-sized service providers to stream live and linear subscription video to IP-connected devices. Big systems integrators are an option, but they're expensive. A soup-to-nuts, single-source vendor is another option, but the whole point of open standards and interoperability is to widen the competitive marketplace and utilize best-of-breed products.

What's needed by service providers is an accessible, next-gen architecture to transcode, package, segment, and deliver live, linear and on-demand adaptive streams -- from the click on an app, all the way through to delivering the stream to the screen. A big part of that are integration services, to make the "new world" work with existing network components, wherever possible.

That's why a group of companies representing all major components of managed, adaptive video streaming have teamed up to provide a cost-effective, state-of-the-art HTTP overlay offering. Being engineers, we cleverly call ourselves "GOV," for "Group of Vendors." Together, the GOV represents a way to buy, install, and service products developed specifically for live HTTP-based streaming, over existing RF and IP plant.

The GOV consists of itaas, Inc., for app development and servers; RGB Networks, for next-generation multi-screen trans-coding and packaging; Verivue for CDN connectivity, and Verimatrix for DRM key management. Together, we provide all the key components needed for service providers to quickly and easily offer live and linear video streaming to IP-connected devices.

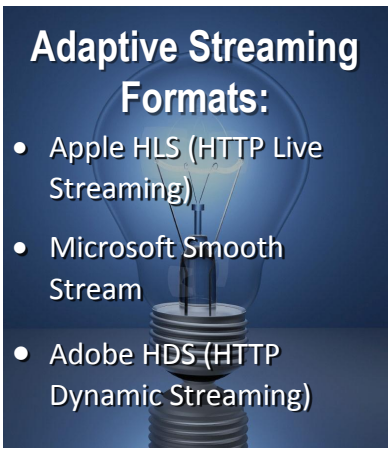
A Visual Look at the Adaptive Streaming Group of Vendors (GOV)



In order to best visualize how it all comes together, consider this entirely plausible consumer scenario, wherein Customer Bob just sat down to watch TV on his iPad. Bob could just as easily be tuning in on the "connected" side of an Internet-connected TV, or on a different tablet, or smart phone. Here's what happens in the background:

1. An app is customized to varying degrees (depending on business requirements) to represent a service provider's brand and logo, then outfitted with a Verimatrix "ViewRight" security client, developed/co-developed with itaas and Verimatrix. When Customer Bob clicks on it, and selects a show on live or linear TV, the app establishes his authenticity as a subscriber in good standing, as well as his rights to receive programming (based on subscription level), then proceeds to fetch the desired stream.
2. An application server relays Bob's request, including the display's graphics requirements and current bandwidth conditions into the Verivue-powered CDN to retrieve the stream.
3. At the headend or data center, at the output of the satellite receiver and/or terrestrial fiber network, incoming digital streams (MPEG-2 TS, H.264) are received for distribution to homes. RGB's Video Multi-Processing Gateway (VMG) decodes and re-encodes incoming video streams into multiple H.264 video resolutions and bit-rates and creates various "profile" outputs for each incoming video stream. The VMG also converts the audio associated with each video stream into a format that the receiving devices can decode (AAC).
4. The TransAct packager (or "segmenter"), made also by RGB, segments and formats the video for various devices, such as Android (Adobe HDS or Apple HLS), iPad or iPhone (Apple HLS) and PCs (Microsoft Smooth Streaming), assembles a right-sized chunk of video for Customer Bob, and applies any encryption as per DRM system rules.
5. The DRM components, provided by Verimatrix, keep Bob's stream in line with copyright conditions associated with Bob's subscription, and the contractual agreements that exist between content owners and Bob's service provider.
6. Bob's protected, segmented stream re-enters the Verivue CDN for delivery to Bob. The server hosting the stream is necessarily closest to Bob.
7. Back on Bob's couch, his iPad connects with the live stream. (Bob's using an iPad today, but the GOV also supports other tablets, IP-connected TVs, laptops, PCs, and smart phones.)

A Brief History of HTTP Adaptive Streaming



In adaptive streaming, the source video – either a file, or a live stream – is encoded into multiple bit-rate segments, sometimes called "chunks." Each chunk conforms to a delivery format for the end device, and typically contains a container, video codec, (H.264), audio codec (AAC), and encryption protocol.

Each segment typically represents between two to 10 seconds of video (so as to adapt to the display device over available bandwidth), and is sliced per video Group of Pictures (GOP) boundaries, beginning with an instantaneous decoder refresh (IDR) frame.

Unlike the B (bi-directional), P (predictive) and I (initialization) frames of MPEG-2 compression, IDR coding gives each chunk independence from prior and successive segments. Encoded segments are then hosted on a regular HTTP web server.

Client devices request segments from a web server, which are downloaded via HTTP. As each segment is downloaded, the client plays back the segments, in the order requested. Because the segments are sliced along GOP boundaries, with no gaps in between, video playback is seamless – even though it's really just a sequence of file downloads via HTTP GET requests.

Adaptive delivery enables a client device to adapt to changing network bandwidth conditions by requesting file segments encoded at different bit rates. The client constantly observes its bandwidth situation, throughout the playback period, by evaluating its buffer fill/depletion rate.

If a higher quality stream is available, and bandwidth is available to support it the client will pull in the higher-quality segment; if a lower quality stream is available, and network bandwidth indicates a need for it, a lower quality bit segment plays. Clients can typically switch between segments encoded at different bit rates every few seconds. A manifest or "playlist" file is provided to the client, which defines the location (URL) and parameters (e.g. bit rate) of each segment. For live feeds, updated "rolling window" manifest files are sent as new segments are created.

A Closer Look at the Component Pieces

The App Component

In order for an iPad, tablet, Internet-connected TV or laptop to receive subscription video streams, it needs an application: Something that knows where all the channels are, and the guide data, and how to best present the array of live and linear video content on the screen. That app, in the case of the Adaptive Streaming GOV, is developed and white-labeled for service providers by itaas Inc., with a DRM kernel made by Verimatrix.

A related application server, also from itaas, handles authentication links to service provider billing and provisioning systems, and manages how to locate available channels for streaming. In essence, the app itself asks for a playlist, of sorts, that is updated on an ongoing basis, and as specified in the Apple HLS, Android and Microsoft protocols.

The app and applications server is thus a central piece in the Adaptive Streaming GOV, to map all the pieces together. Within the GOV, itaas also serves as the central integrator – a critical role, to be sure, so that service providers have a single point of contact for adaptive streaming rollouts and management.

The Security Component

Part of the transition of adaptive streaming from free ad-based services to premium content pay-TV is the application of commercial grade content and revenue security. It is imperative to be able to provide the equivalent levels of revenue protection and delivery control on a streaming system as operators and content owners demand in traditional pay-TV delivery systems, such as DVB and IPTV.

Verimatrix's role in the Adaptive Streaming GOV is to provide secure key management, in order to protect both content and service revenue. This includes device authentication and entitlement management, to assure that client devices are attached to paying customers. This ensures that only bona fide subscribers are able to watch protected content. After a specific content is selected by the consumer, and transcoded (by RGB's components), a simultaneous transaction occurs to obtain the keys required to decrypt the video.

The Verimatrix ViewRight security kernel inside the receiver (within the white labeled itaas app) requests the key, obtains it from the VCAS headend key database upon positive entitlement verification, and unlocks the stream for viewing. The ViewRight security kernel is also capable of ensuring key aspects of the client environment are consistent with content licensing restrictions – this includes addressing issues such as output controls, content overlays and runtime OS integrity.

Additionally, the video content can be watermarked for user-specific forensic tracking as necessary, in case content has been misappropriated, e.g. via unlawful distribution over the Internet. Thus Verimatrix provides an extended security perimeter that goes beyond the traditional one-to-many broadcasting protection. The Verimatrix solution is based on a flexible layered security approach, enhancing the baseline HLS security, applying the same technology proven in more than 400 IPTV installations around the globe.

In additional to content being encrypted for live services, it also remains protected when stored on on-demand streaming servers, and in subscribers' digital video recorders. An entitlement check is always performed prior to issuing a key that enables content decryption.

Yes, It Scales

Given the enormous and growing volume of video content over IP networks – fueled by the similar trajectory in IP-connected, video-capable end displays – scale, and the ability to grow with demand, is foundational. Each of the vendors within the GOV built scalability into product designs:

- The itaas application server can support thousands of simultaneous users
- The Verimatrix VCAS security solution provides a robust DRM server array that can be architected to support arbitrarily large numbers of concurrent users
- The Verivue CDN, because of its software-clustered approach, is essentially infinitely scalable, in terms of initial and ongoing bandwidth and caching needs
- RGB's modular VMG transcoder allows for easy, license-based upgrades, allowing for cost-effective deployments of any size with future-proof growth

The CDN Component

The content delivery network (CDN) is a critical component of any adaptive streaming transition, to optimize bandwidth by caching content as close to the end display screens as possible.

Another role of a CDN in any end-to-end adaptive streaming implementation is to act as a sort of bandwidth amplifier, to support concurrency of large numbers of streams in the network. That way, all end points can display video with at the quality levels expected from a subscription video service.

CDNs also provide network proximity, to deliver video streams from the most optimal network location to the requesting screen.

In the case of the GOV, Verivue is the CDN provider, with its "OneVantage" Content Delivery Solution. OneVantage Content Delivery Solution is based on the best practices of web scale and cloud computing. At its very core, the solution is optimized around DNS and HTTP. Verivue's CDN technology is based on the guiding principles of web scale and cloud computing, providing unbounded scalability in content caching and delivery bandwidth with the resiliency inherent in state-of-the-art clustering techniques of COTS servers.

The Verivue CDN also supports URL tokenization/signing where the CDN authenticates requests from end clients to restrict access of content to only authorized end devices.

The Trans-coding and Packaging Components

Because of the many variations in client devices, an important consideration in adaptive streaming is to "transcode once, package many times." RGB's Video Multi-processing Gateway (VMG) provides this mechanism for Adaptive Streaming GOV participants. In short, the VMG handles:

- Video transcoding, to shape output video into a progressive scan format (from interlaced); shape output profiles to match the resolution and bit rate of the receiving device; perform IDR frame alignment across output profiles, so as to provide continuous and smooth playback on client devices, across different bit rate chunks; and handle IDR frame insertion for any downstream insertion points, such as those required for advertising
- Audio Transcoding into AAC, the codec used by adaptive delivery protocols from Adobe, Apple and Microsoft
- Ancillary data handling, for elements including closed captioning or

Key Interface Points Between the Group of Vendors

In any end-to-end implementation, interface points necessarily exist, between components. In an ideal deployment, each interface point is carefully constructed and maintained, so as to ensure maximum scale, up-time, and time-to-market. In the case of the GOV, key interface points exist between:

- End-point devices and the application server (itaas, Verimatrix)
- Application server and CDN (itaas, Verivue)
- CDN and Packager (Verivue, RGB)
- Packager and DRM (RGB, Verimatrix)
- Packager and VMG (RBG, RGB)

In each case, the group of vendors worked to define interfaces based on available and open standards.

subtitling, as well as in-band interactive TV signaling

- Ingest of live streams – the VMG can intake 132 signals, mixed between SD and HD (H.264 or MPEG-compressed), and convert to over 528 outputs profiles
- In addition, RGB's TransAct Packager handles:
  - Segmenting, according to the proprietary delivery protocols specified by Adobe, Apple and Microsoft
  - Encryption, on a per-delivery-protocol basis (Flash Access for Adobe HDS; file-based AES-128 for Apple HLS; AES-128 with Play Ready-compatible signaling, for Microsoft Smooth Streaming)
  - Integration with DRM components, to further protect the adaptive stream.

Now what? Putting It All Together

Participation in the Adaptive Streaming GOV is aided by the existence of a single point of contact for integration and implementation – itaas. This matters because most service providers prefer "one place to call," rather than having to isolate concerns on a per-participant basis.

Upon deciding to create an adaptive streaming overlay with the GOV, step one is a hands-on architecture session, based on business objectives. Considerations include network monitoring, anticipated generation of extra traffic, and bandwidth concerns. Also important in the architectural phase: Billing systems integration, guide metadata providers, and related back office provisioning components.

The initial discussion of requirements becomes part of the engagement and develops into a project plan and architecture.

Next is scheduling and bill of materials layouts, followed by integration, testing and launch.

A fourth phase – support – is also critical, to keep up with changes in what is a very fluid adaptive streaming marketplace.

The overall result is a group of best-in-class offerings neatly tied together in a single integrated solution.

Conclusion

The time is right – technologically and competitively – to embark on the construction of an adaptive streaming overlay, to serve the growing marketplace of IP-connected, video-capable devices. While single-source vendors are an option, the video marketplace has evolved to contain considerably more technological innovation, from a growing roster of participants. Problem is, each participant typically focuses – deeply – on one part of the end-to-end needs of an HTTP video system. Putting it all together often requires service providers to consider "big integrators" (read: expensive), or to serve themselves as general contractors.

However, though the GOV offers a unified team approach, it is also recognized that individual customers may have preferences for some of the components. This can also be accommodated to some degree. It will be possible to offer flexibility with some of the components, though this may impact the timelines and require some additional integration.

For the quickest solution, itaas, RGB Networks, Verimatrix and Verivue have joined forces to create a best-of-breed, end-to-end treatment for HTTP video distribution. This Adaptive Streaming GOV is a technologically advanced, market-ready combination of vendors and technologies, to help service providers leapfrog existing on-demand products from over-the-top providers with live and linear video offerings.

Contact connXstream@itaas.com for more technical and business details on partaking in this path to competitive superiority in an OTT world.