

VELOCIX ENHANCED VIDEO EXPERIENCE

ACCELERATE THE ADOPTION AND MONETIZATION OF PERSONALIZED STREAMING VIDEO SERVICES

STRATEGIC WHITE PAPER

Smartphones and tablets offer consumers compelling new ways to watch TV and video content. As these devices become ubiquitous, service providers are facing growing consumer demand for multiscreen services and increasing competition from over-the-top (OTT) content providers. Service providers want to secure market share and explore new monetization opportunities by extending their premium TV offers to connected devices. To succeed, they need cost-effective solutions that enable them to deliver a consistently superior streaming TV and video experience to every screen.

Alcatel-Lucent addresses the needs of service providers with the Velocix Enhanced Video Experience (EVE), a foundation for delivering next-generation multiscreen video streaming services over IP-based content delivery networks (CDNs). Velocix EVE offers service providers a means to enhance and extend the pay TV delivery infrastructure by combining the best of IP streaming innovation with increased awareness of network conditions and customer context. Built on the Velocix CDN, it enables service providers to differentiate from competitors and captivate customers by offering a more personalized, dynamic and equitable TV and video service experience on every screen.

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INTRODUCTION

The TV experience has been stuck in a 40-year-long holding pattern. Television technology has continued to evolve, from black-and-white to color, and then to high definition (HD) and 3D. But the TV experience has largely remained the same: a passive, lean-back experience that involves watching broadcast TV from the living room couch.

Smartphones and tablets have changed the game by giving consumers compelling new ways to consume content. Quick to recognize the opportunity, web-based providers jumped at the chance to offer video services for connected devices. With initial offers oriented toward short video clips and user-generated content, they pointed the way toward a more interactive, lean-forward viewing experience. Today, web-based providers are extending their offers to include long-form TV content. They have the living room couch squarely in their sights.

Service providers reacted to this new threat by extending their own TV and video services to connected devices. In the U.S., for example, cable operators created the TV Everywhere concept to allow subscribers to access their favorite TV shows on connected devices. The intent was to compete with popular web-based providers like Netflix and Hulu and remain the preferred distributors of premium video content. In reaching out to connected devices, operators married their extensive networks and content rights with technologies used in the Internet world, such as adaptive bit-rate streaming and CDNs.

The continued development of concepts like TV Everywhere represents an important first step for service providers seeking to deliver advanced video services and extend their influence across the connected device world. Service providers are leveraging web-based technologies that were meant for best-effort delivery, but they still have work to do to deliver a fully consistent TV experience across all connected devices. On some screens, for example, providers can only support a subset of their services. On others, they have trouble delivering the superior quality that customers expect, or at least matching the quality customers get with content broadcast to their TVs.

To take the next step, service providers need solutions that can replicate the full pay TV experience — the one available today through traditional networks and set-top boxes — on IP connected devices and enhance this experience with new capabilities. These solutions must help providers address the challenges inherent in extending a consistently superior and personalized TV experience across a fragmented delivery chain that includes a multitude of devices, platforms, applications and vendors. These solutions must also provide the basis for adding capabilities to manage pay TV functions such as sports blackouts, ad insertion and emergency alerts on all screens, and to introduce new seamless services like network PVR (n-PVR). By deploying IP video solutions that leverage their network and subscriber knowledge, service providers can deliver more service value across more screens while reducing overall delivery costs.

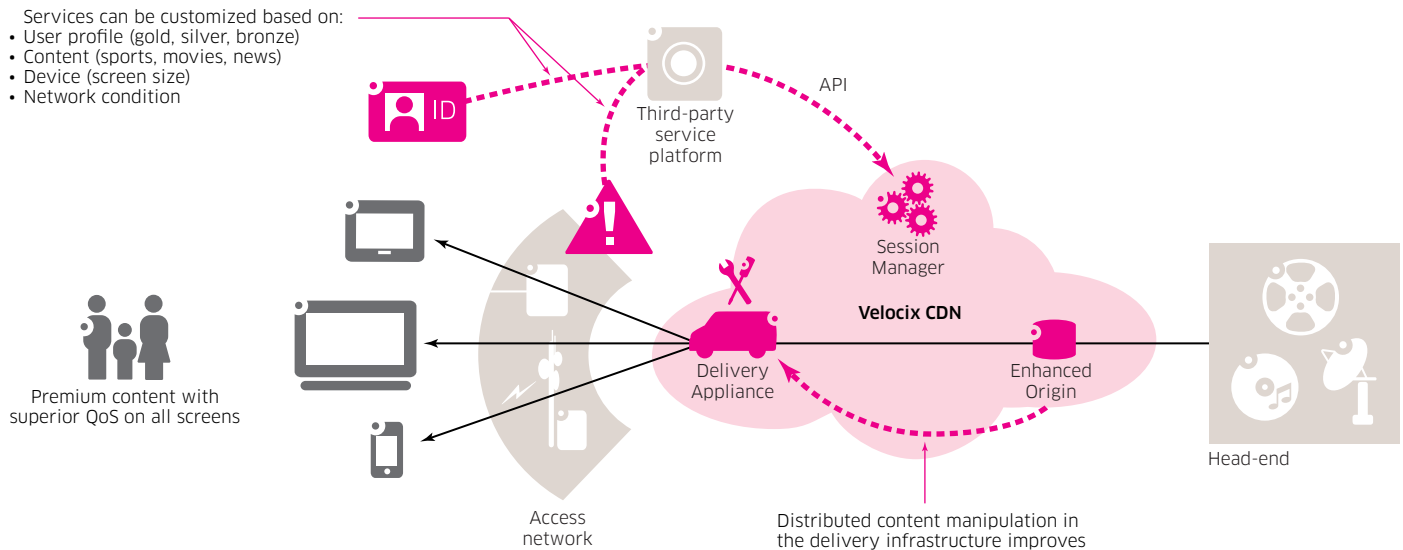
CHARLES HASEK,
PRINCIPAL ARCHITECT
OF VIDEO SYSTEMS,
TIME WARNER CABLE:

“The goal is to provide traditional cable services to IP connected devices within our customers’ households. [Our] CDN is a foundation to continue to offer advanced video services to our customers and a platform for enabling IP video.”

ENHANCING THE VIDEO EXPERIENCE

The Velocix Enhanced Video Experience (EVE), shown in Figure 1, creates a foundation for next-generation multiscreen video streaming by adding session awareness to video delivered over IP-based CDNs and embedding video processing into and across the delivery infrastructure. This combination of capabilities increases awareness of subscriber context and network intelligence and allows service providers to deliver a more personalized, dynamic and equitable video service experience to subscribers on every screen.

Figure 1. Velocix Enhanced Video Experience



Velocix EVE adds several key elements and enhancements to the advanced on-net capabilities provided by the Velocix CDN. Important additions include:

- The Velocix Session Manager, which can adapt the video experience in real time based on contextual factors such as network conditions, content types, consumer profiles and device characteristics.
- The Velocix Enhanced Origin, which records, stores and originates media content. It prepares this content so that it can be manipulated in an appropriate manner before being delivered to end users. The Enhanced Origin supports industry-leading protocols for publishing live and on-demand media, common container formats (MPEG-2 TS, ISOFF), and several leading delivery formats (HLS, Smooth Streaming, HDS, MPEG-DASH).
- Enhancements to the Velocix Delivery Appliance, which manipulates content on the edge of the network to support transformation, personalization and delivery to end users.

With Velocix EVE, service providers gain a greater awareness of individual user content requests and video streaming sessions. This heightened awareness enables service providers to manipulate and personalize the flow of each video stream while accounting for multiple inputs. These inputs can include current network conditions, the subscriber's profile, the type of content being viewed and the device being used for viewing.

Unlocking profitable video use cases

Velocix EVE supports numerous use cases that can benefit service providers and their subscribers. It also offers service providers the basis for developing new use cases that can target and yield benefits in key areas. For example:

- Velocix EVE improves subscriber quality of experience (QoE) by supporting a fast channel start function. It can also improve QoE by using knowledge of network congestion, subscriber context and subscriber preferences to manage and optimize video streams in environments and at times where bandwidth resources are scarce.
- Velocix EVE creates monetization opportunities by supplying building blocks that enable service providers to build targeted advertising offers and time-shifted TV services such as pause live TV, start-over TV, catch-up TV and n-PVR.
- Velocix EVE minimizes storage and transport costs with a unique mechanism that manipulates content at the edge of the network. This mechanism enables service providers to store and propagate one video format across the CDN to support any device or piece of customized content. Velocix EVE can also reduce cost by using multicast to deliver linear TV to connected devices. These cost savings will be essential for helping service providers remain profitable as IP video streaming scales to the mass market.
- Velocix EVE increases the security of content delivered to connected devices by supporting per-session encryption, watermarking and content blackout capabilities. It provides added security for end users by supporting notifications from emergency alert systems.

PROMOTING ADVANCED CONTENT DELIVERY

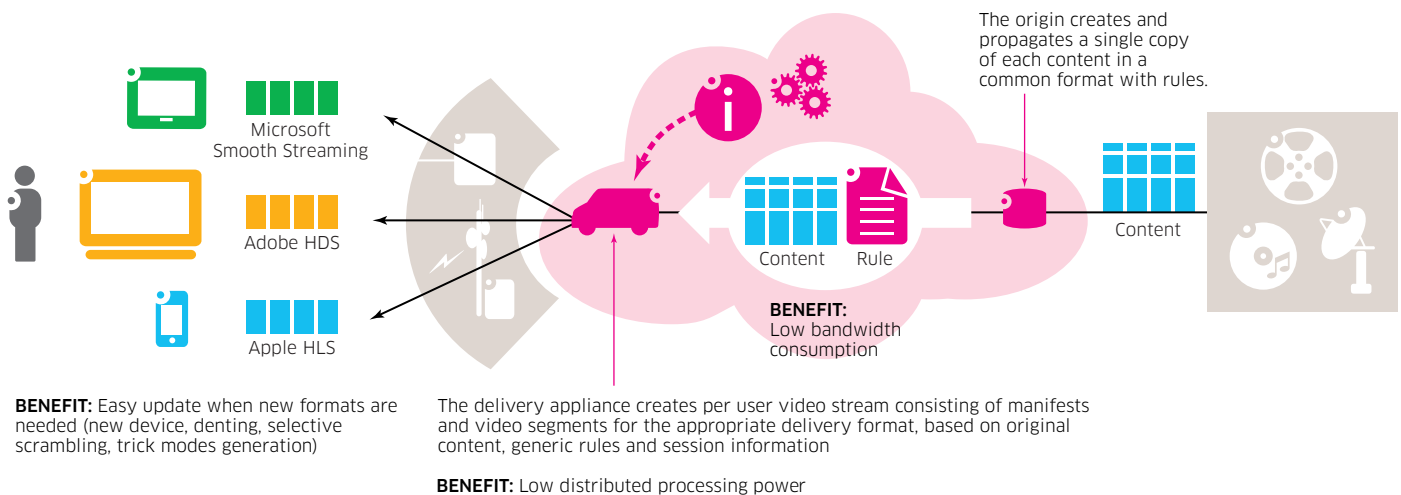
Velocix EVE uses advanced content transformation and personalization capabilities to enable service providers to adapt and improve the IP video experience. It complements these capabilities with optimization functions that allow service providers to control video quality in cases where bandwidth is scarce or potentially unreliable.

Content transformation

The rapid proliferation of connected devices is compelling service providers to manage an increasingly diverse collection of multimedia delivery formats. While HTTP Adaptive Streaming has become the standard streaming technology, the relative success of technology variants such as Apple HTTP Live Streaming (HLS), Adobe HTTP Dynamic Streaming (HDS) and Microsoft Smooth Streaming is creating challenges for service providers. For example, service providers need extra storage and transport capacity because they have to ingest, encapsulate, and deliver media in many different formats. At the same time, they need to find quick and inexpensive ways to support new and emerging formats like MPEG DASH.

With a patent-pending technology called rule-based transformation (RBT), Velocix EVE enables service providers to repackage and manipulate content dynamically, at the edge of the network. Shown in Figure 2, RBT offers an efficient and effective means for service providers to store and distribute personalized content inside the CDN.

Figure 2. RBT provides scalable and cost-effective content storage and distribution



Rule-based transformation uses a unique approach to spread the repackaging workload across the CDN. Instead of propagating all formats of a given piece of content into the CDN, the Enhanced Origin sends one copy of the content to the Delivery Appliance using a common format, along with a rule. This rule describes how to process the original content to produce the desired output formats; for example, how to transform a file in HLS format to Smooth Streaming or HDS format. At the edge of the network, the Delivery Appliance applies the rule and creates a video stream in the target format. If required, the Delivery Appliance can cache the rule for future use.

RBT can be applied by the enhanced origin in a centralized scenario or by the Delivery Appliances in a distributed scenario. Both approaches reduce storage needs. In addition, the distributed scenario can minimize bandwidth needs by propagating one video format across the CDN to support any device. This scenario requires less processing power in the Delivery Appliance compared to alternative “just in time” packaging techniques that need to analyze the incoming format before converting it to the target output formats. This added efficiency makes RBT a highly scalable technology.

Velocix EVE uses RBT to exploit evolving device realities and adapt quickly to changing consumer usage behavior. For instance, when new devices and formats are introduced, Delivery Appliances can use simple rule updates to learn how to manage them. Only license activation is required.

In addition to supporting more efficient and effective distribution of multiscreen content, RBT enables a broad and dynamic set of new capabilities that extend far beyond repackaging content into other formats. For example, RBT can help Delivery Appliances perform a variety of subtle transformations, including:

- Trick modes generation, which offers users traditional video recorder functions such as pause, fast forward, fast rewind, slow forward, slow rewind and the ability to jump to a previous or upcoming frame. Trick modes generation supports these functions by creating video flows that consist of subsets of the original video frames and adding these flows to the original stream. With RBT, Delivery Appliances can generate trick modes on the fly by executing rules on the original content. This process provides savings in storage and transport of these additional video flows.

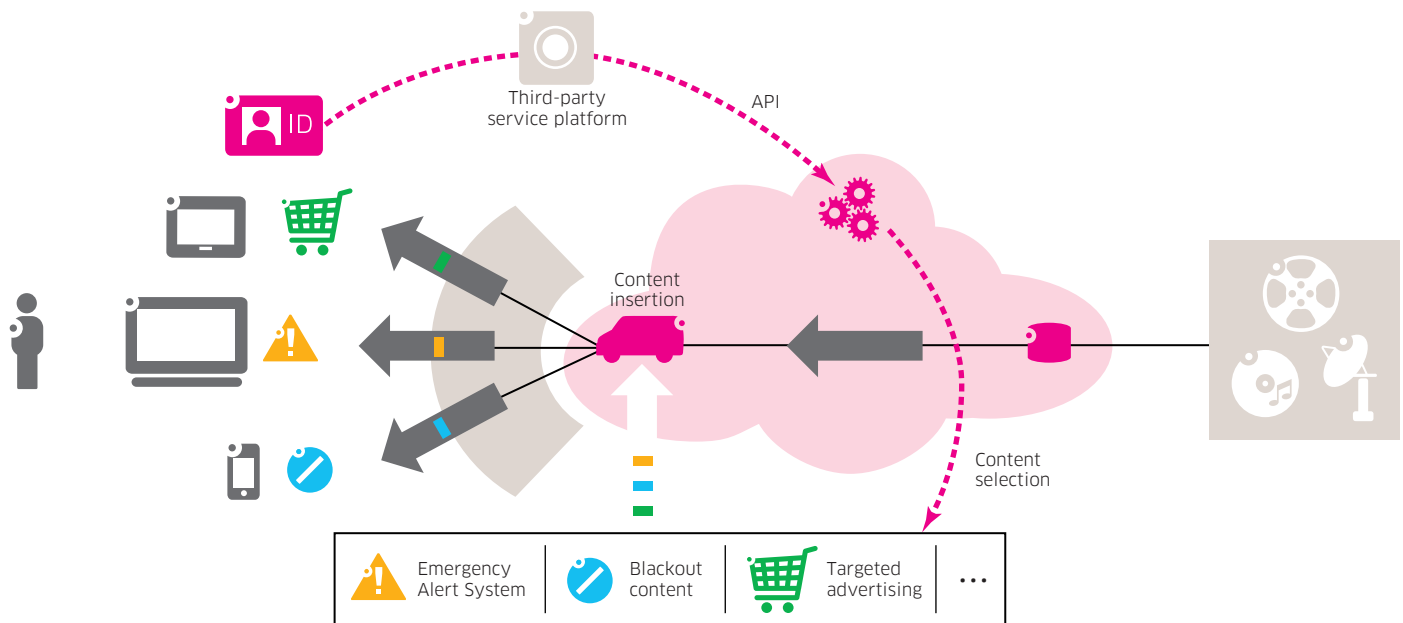
- Denting, which dynamically reduces the bit rate by removing video frames from segments. The bit rate is reduced through a lower frame rate instead of a lower encoding quality or resolution. Denting is typically used to dynamically create customized streams at lower bit rates. For example, denting can reduce the bit rate to support trick modes generation or fast channel start capabilities (described in the “Reduced startup time and latency” section below). In each case, RBT instructs the Delivery Appliance on what portions of the stream to remove to produce the dented stream.
- Selective scrambling, which encrypts content using a standard algorithm but leaves some strategic video portions unencrypted. Selective scrambling enables downstream servers to understand the internal structure of protected streams. For instance, selective scrambling can offer a view of where video frames start and end or what types of video frames are included in a given stream. This visibility allows the downstream servers to process the stream; for example, to generate trick modes. The challenge in implementing selective scrambling is that the scrambler must be video aware to know which parts of the stream to scramble and which parts to leave clear. RBT can perform complex scrambling at the edge without needing to make the Delivery Appliance aware of the video. It does this by informing the Delivery Appliance about exactly which portions of the content should be scrambled and how.

Content personalization

The industry has adopted HTTP-based adaptive delivery protocols for streaming video to connected devices. Because HTTP is a stateless protocol, the streaming server does not manage the state of the client. The client is solely responsible for maintaining its own state. To the server, all client requests are equal, regardless of whether they come from the same client or multiple clients, which bit rate they are trying to play, or whether they are trying to switch bit rates. As a result, service providers have little control over what is being delivered to the client. This makes it difficult for them to scale delivery cost effectively and impossible for them to tailor it to individual users or devices.

Velocix EVE integrates session awareness into the network. This integration allows service providers to personalize content at the edge of the network based on user, device or content information, as shown in Figure 3. For example, a Delivery Appliance can manipulate content by inserting an ad, an emergency alert or alternative content for users in blackout zones. The ability to personalize content at the edge of the network allows Velocix EVE to support scalable delivery. The same content is distributed to all users across the CDN, and all content personalization occurs at the edge, close to the user. By contrast, solutions that personalize content in a central location dramatically increase traffic volume and storage requirements because they have to support an individual unicast stream for each user request, making these solutions harder to scale.

Figure 3. Personalizing content at the edge based on user and device context



Velocix EVE personalizes content by leveraging the content manipulation capabilities of RBT in combination with a new, separate control plane that brings session awareness to HTTP Adaptive Streaming. The Delivery Appliance receives the original content and rule from the Enhanced Origin and then interacts with the Session Manager to get information on how to personalize each user's content.

The information provided by the Session Manager may specify how to segment, substitute, modify or encrypt the content. It may also specify how the original rule should be applied to a given piece of content for a particular request (session) and application. The Delivery Appliance uses all of this information with the rule to manipulate the content.

To help personalize the video stream, Velocix EVE uses third-party systems to deliver information to the Session Manager. For example, Velocix EVE can work with an ad campaign manager, a subscriber or broadcaster management system, a conditional access control server, a key management system, or an emergency alert center. The choice depends on what type of personalization is required. The Velocix Session Manager provides application programming interfaces (APIs) that support easy interaction with third-party systems. These APIs support a broad range of industry-standard interfaces, including XML REST, SCTE-130, Diameter and RADIUS.

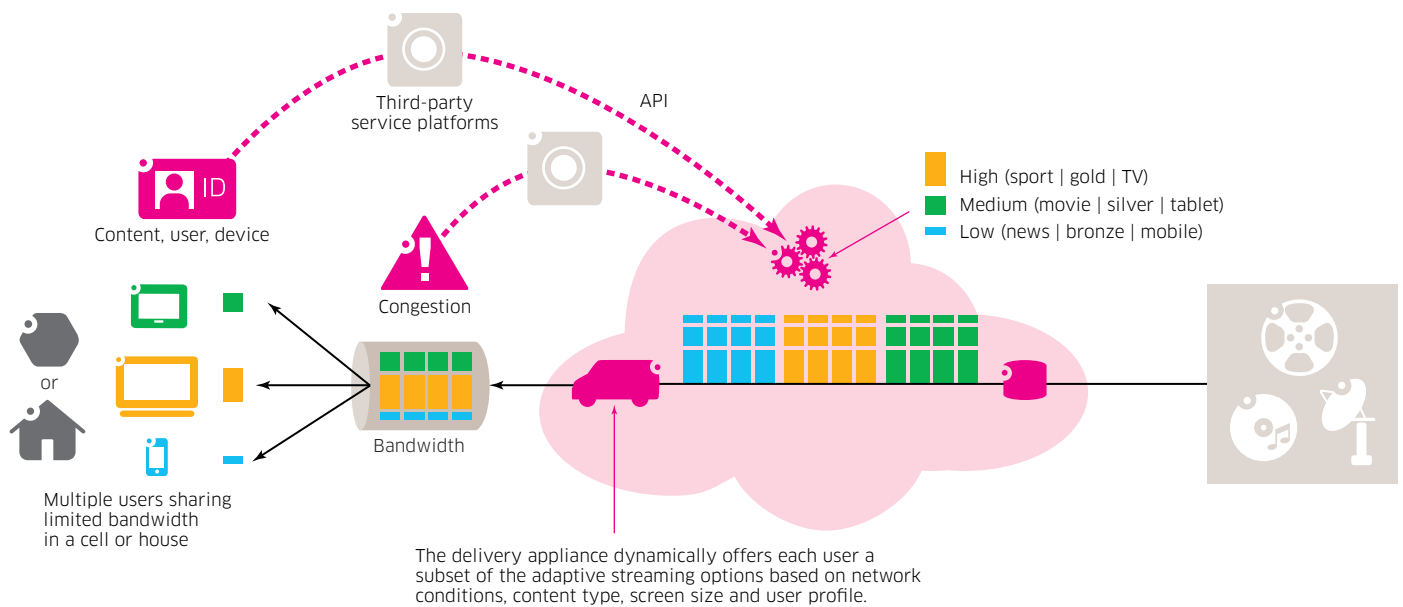
Experience management

With HTTP Adaptive Streaming, the default behavior of connected devices is to try to access the maximum bit rate. This approach is reasonable in cases where devices request content that will be delivered to them over an unmanaged distribution network such as the Internet. However, it has some limitations because the devices lack insights into the content they are displaying and the minimum bit rate they need to ensure that users perceive good quality. They are compounded by the fact that devices have no visibility into the actions and behavior of other devices that share the same available bandwidth.

This absence of insights and visibility creates an imbalance in the way available bandwidth is allocated. In a home network, for example, devices like smartphones and connected HDTVs often battle over available bandwidth. Some devices get more bandwidth than is needed for a good viewing experience; others get less, with their users experiencing buffering and pixelation. The situation worsens as more devices request streams within the home network.

Velocix EVE addresses these problems by enabling service providers to retake control of the quality delivered to end users over their network in environments with scarce bandwidth resources (Figure 4). For example, in home networks and mobile cells, the access technology (DSL line or radio access network) typically limits bandwidth to a few megabits per second, to be shared across all devices. With Velocix EVE, service providers can define and determine exactly how bandwidth is shared among the devices in these environments.

Figure 4. Using experience management to control delivery speed and quality



The Session Manager supports these activities by collecting data about usage context and potential network congestion from a variety of sources. For example:

- Information about devices is retrieved from GET requests sent by the devices themselves.
- Information about subscriber types can be retrieved from a subscriber management system based on attributes such as device IDs and IP addresses.
- Information about the content being watched can be retrieved from the Enhanced Origin.
- Information about network conditions can be retrieved from a system that provides real-time network analytics; for example, the Alcatel-Lucent 9900 Wireless Network Guardian.
- Information about business rules can be retrieved from a system that supports a Policy and Charging Rules Function (PCRF); for example, the Alcatel-Lucent 5780 Dynamic Services Controller (DSC).

The Session Manager processes this information and passes on specific recommendations to the Delivery Appliance. Based on these recommendations, the Delivery Appliance dynamically offers a limited set of adaptive streaming options to each user or device. For example:

- Users can be offered higher maximum available bit rates for video streamed to connected TVs or game consoles and lower maximum bit rates for smaller screens, such as tablets or smartphones.
- Premium subscribers can be offered higher bit rates; basic subscribers can be offered lower bit rates.
- Users can be offered higher bit rates for dynamic content, such as sports programs, and lower bit rates for more static content, such as news programs.

These offers ensure that bandwidth is shared fairly and that each device receives the appropriate quality.

In creating these offers, Velocix EVE also considers how bit rate influences users' perceptions of quality for different types of content. This content awareness can be used to reduce bit rates and free up bandwidth while ensuring that users continue to perceive a good QoE. It can use mean opinion scores (MOS)¹ to determine how much the bit rate can be reduced without lowering quality perceptions. For example, a sporting event requires a much higher bit rate than a news program to sustain users' perception of quality. Within a movie, a fast-moving chase scene may require a higher bit rate than a slow-moving close-up scene to deliver the same perceived quality.

If appropriate, the service provider can give subscribers more control over the viewing experience; for example, by offering them the ability to specify their streaming preferences using a simple portal. In cases where their data consumption is capped, users may wish to set up a policy that ensures that they stream only at lower bit rates as they approach their data limit.

BUILDING A BETTER TV EXPERIENCE

Video consumption no longer centers on traditional broadcast models with schedules defined by service providers and broadcasters. It has evolved to become an on-demand experience where the user decides what to watch and when to watch it.

Advanced recording functions

Velocix EVE supports and promotes this new model by offering advanced recording functions inside the Enhanced Origin. These functions provide a foundation for building video offers around a broad range of popular services, including:

- **Pause live TV:** Users can pause a channel and resume viewing from the same point later. After resuming, they can fast forward to catch up with the live broadcast.
- **Restart TV (or start-over TV):** Users that tune in late can watch a program from the beginning.
- **Rewind TV:** Users can replay part of a live broadcast; for example, to get a second look at a key play in a sporting event or an important part of the plot in a TV show.

¹Mean opinion score (MOS) is a subjective measurement that indicates the human user's view of the quality of a multimedia asset. The MOS is expressed as a single number in the range 1 to 5, where 1 is the lowest perceived quality and 5 is the highest perceived quality.

- Catch-up TV: Users can view previously aired programs on demand, without having to initiate a recording. Catch-up TV supports flexible schedules and supports traditional pause, fast forward and rewind functions.
- n-PVR: Users can record their favorite programs and watch them on their own schedule, anywhere, on any device. Recordings are stored in the network rather than on a device in the user's home.

Reduced startup time and latency

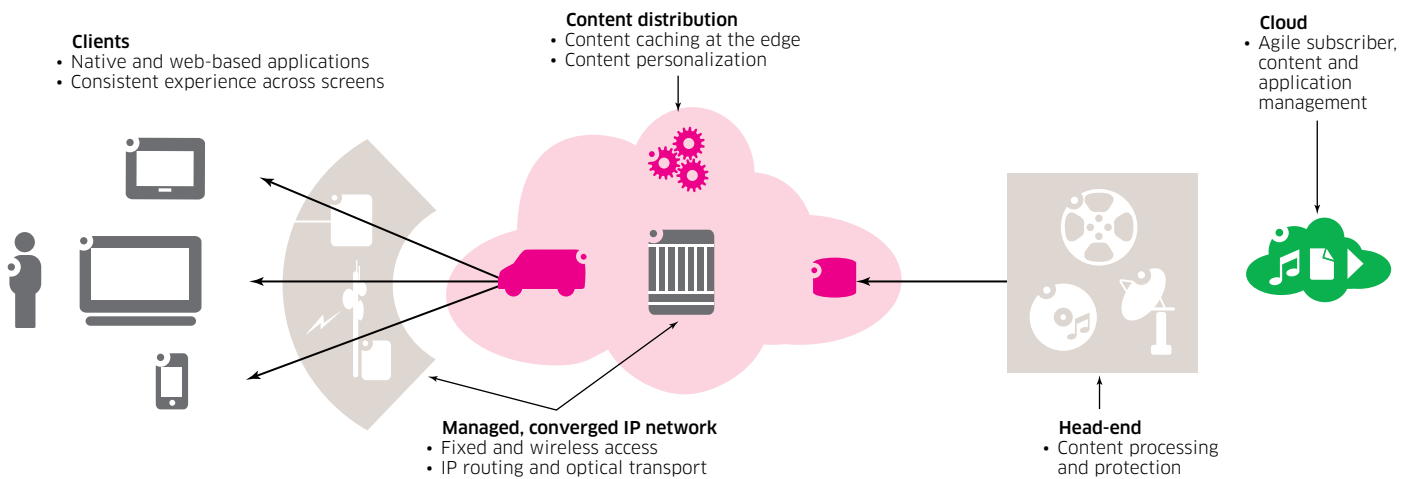
When consumers watch video on high-resolution smartphones and tablets, they expect video quality and functions that are comparable to TV services delivered over broadcast networks. Consumers may be prepared to wait several seconds for on-demand content to start up. But they are less tolerant of delays when they change between live streams or use skip and seek operations. The Velocix EVE fast channel start feature improves QoE with optimizations that significantly reduce startup time and latency on connected devices — to less than 1 second, typically.

The deep manifest and content manipulation techniques supported by Velocix EVE open up new opportunities to adapt and optimize client behavior for Internet-based content distribution. For example, HTTP Live Streaming devices typically need to buffer 3 segments before startup. To reduce startup time, the Delivery Appliance creates smaller segments and specialized manifests, and dynamically divides the first segment into 3 subsegments that can be buffered faster. The Delivery Appliance further reduces startup time by removing unused data to condition the first few segments (denting), and by ordering audio and video.

THE NEXT GENERATION OF IP VIDEO DELIVERY

Velocix EVE forms the foundation for the next generation of IP video delivery. It is an integral component of the Alcatel-Lucent video strategy, which is embodied by the Multiscreen Video Platform (Figure 5). Its aim is to help service providers leverage their IP-based CDNs in combination with emerging web-based innovations such as adaptive streaming and cloud-based video publishing platforms to offer subscribers a superior QoE on every screen.

Figure 5. Alcatel-Lucent Multiscreen Video Platform



Alcatel-Lucent recognizes that every service provider faces different challenges and strives to get maximum value from its investments in networks and services. With the Multiscreen Video Platform, Alcatel-Lucent offers a modular approach that gives service providers flexibility and options instead of one-size-fits-all solutions. In addition to content distribution (CDN), the Multiscreen Video Platform includes:

- Subscriber, content and service management capabilities backed by service-oriented architectures and agile development processes that speed time to market
- A head-end that supports comprehensive content processing capabilities, including encoding, transcoding, protection and storage
- Device clients with web-based or native applications that enable a consistent and seamless experience across all screens
- A managed and converged IP network that covers IP and optical transport as well as fixed and wireless access

Alcatel-Lucent also recognizes that innovation comes from many different sources within the industry. The company has built a partner ecosystem that includes key industry leaders. The Multiscreen Video Platform uses these partnerships — including a key strategic alliance with thePlatform, the leading online video management and publishing company — to enable service providers to reach more subscribers, devices and locations with cost-effective online TV and video services. In addition, Alcatel-Lucent leverages a longstanding relationship with Microsoft Mediaroom to provide a platform of pre-integrated hardware and software that helps IPTV providers create and deliver new digital TV and entertainment services across all connected devices.

To deliver cost savings and content monetization opportunities, a CDN must be fully integrated into the service provider environment. Integration must ensure that the CDN can work with other components to facilitate quick service rollouts, promote network performance, simplify integration with third-party platforms, and control end-user QoE. Alcatel-Lucent can design, validate, integrate and deploy innovative technologies across a proven multivendor ecosystem of network products and devices to help service providers build best-of-breed, end-to-end pay TV platforms. Alcatel-Lucent uses its expertise in software customization to ensure that new IP components such as CDNs are integrated into existing infrastructure in an appropriate and timely manner.

CONCLUSION

Velocix EVE extends the Alcatel-Lucent Velocix CDN technology to support the efficient delivery of personalized video streams to vast numbers of viewers across all connected devices. Velocix EVE is the first solution to integrate two important innovations for customized video delivery — session awareness and rule-based transformation — within the same IP streaming delivery infrastructure.

By combining the best of IP streaming innovation with increased awareness of network conditions and customer context, Velocix EVE dramatically enhances the pay TV delivery infrastructure. These enhancements offer service providers a cost-effective means to extend their premium pay TV offers to IP connected devices. They also provide a platform for adding multiscreen support for important pay TV functions such as ad insertion, blackouts and emergency alerts. With Velocix EVE, service providers can differentiate from competitors by offering a more compelling, consistent and personalized pay TV experience on every screen. This differentiation can help providers accelerate the adoption and monetization of personalized video streaming services.

ACRONYMS

API	application programming interface
CDN	content delivery network
DASH	Dynamic Adaptive Streaming over HTTP
DSL	digital subscriber line
EVE	Enhanced Video Experience
HD	high definition
HDS	HTTP Dynamic Streaming
HDTV	high-definition television
HLS	HTTP Live Streaming
HTTP	hypertext transfer protocol
IP	Internet Protocol
IPTV	Internet Protocol television
ISOFF	ISO file format
MOS	mean opinion score
MPEG	Moving Picture Experts Group
MPEG-2 TS	MPEG-2 Transport Stream
n-PVR	network-based personal video recorder
OTT	over the top
PCRF	Policy Charging and Rules Function
QoE	quality of experience
RADIUS	Remote Authentication Dial In User Service
RBT	rule-based transformation
REST	Representational State Transfer
SCTE	Society of Cable Television Engineers
XML	extensible markup language

