White Paper

Carving the Path to Video Convergence

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Introduction

The TV service market is undergoing substantial changes. Growing penetration of HDTV sets along with increased competition between Cable, Telecommunications, and Satellite have resulted in an increased demand for more HD content, as well as new services. Viewership is slowly migrating from real-time broadcast to time-shift and on-demand.

In addition, as more households are connected to broadband Internet and access rates offered by service providers increase from a few Megs all the way to 50 Megs for residential broadband access, web-based video services, also known as "over-the-top" become a viable alternative to traditional video service providers.

Web-based video is getting the attention of new service providers, existing content providers as well as traditional video service providers. New consumer-electronic devices such as TV sets, DVRs and mobile video devices all use IP as the infrastructure to carry video services and fuel the need to migrate to IPTV. Delivery of video services across the three screens – TV, PC and mobile devices, as well as personalizing the video experience are on every service provider's radar screen, and migration to IPTV within the cable industry seems inevitable.

Introducing and monetizing new services – On top of the challenges of creating, testing and integrating new applications with existing set-top-boxes (STBs) and devices, new applications consume HFC spectrum – a valuable resource in cable networks. Since new applications take time to ramp up viewership, it is necessary to allocate them sufficient network resources, but at the same time avoid over-allocating resources before these applications have been proven and become popular. Allocating complete 6MHz channels to new applications is practically impossible in many cases due to the already tight budgeting of spectrum between broadcast, VOD, SDV and data services.

New applications often cannot justify charging subscribers for additional fees, and therefore rely on advertising as the monetization mechanism. Putting together an advertising back-office for each of the different applications is impractical, and as a result many of these new applications are launched for months and sometimes years without a sound business model and in some cases even taking viewership (and dollars) away from existing revenue-driving services such as linear TV.

Viewership and resource migration – As TV viewership migrates from traditional broadcast services of popular channels to more niche content, non-linear VOD or time-shift TV, and from the RF TV to IPTV, there is a need for the

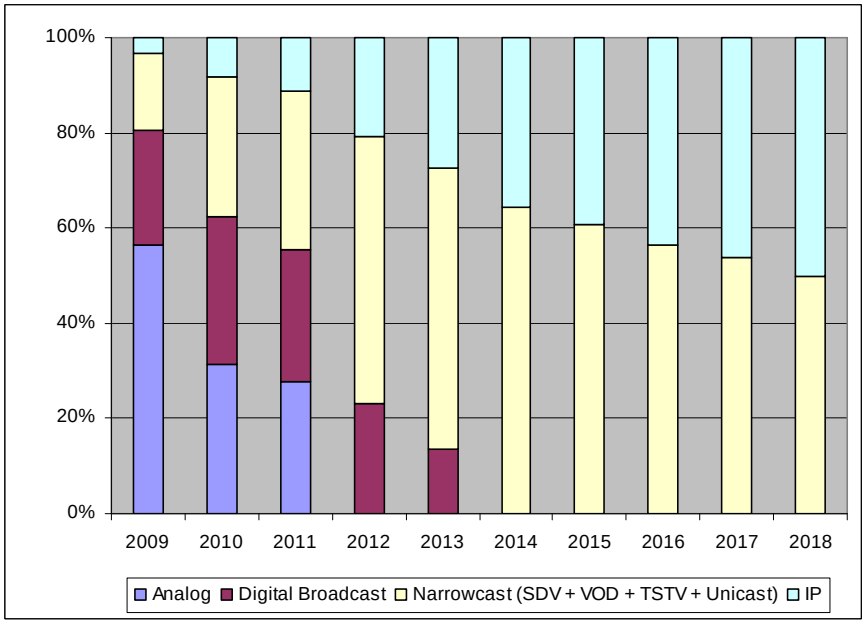

Figure 1: Projected allocation of HFC resources (Source: BigBand Networks)

network edge resources and spectrum allocation to follow the viewership pattern. The result is a constant reallocation of spectrum between analog, digital broadcast, SDV, VOD and IP edge devices. Figure 1 shows a typical projected reallocation of HFC spectrum between different applications over time.

While there is no single path for spectrum evolution that fits all, several patterns are common among most MSOs:

• Analog tier is being reduced, either gradually (removing a few channels each year) or as a step function by transitioning to all digital using digital STB or Digital-to-Analog Adaptors.

• Narrowcast spectrum is increasing due to introduction and ramp up of services such as SDV, VOD, Time-shift TV as well as new applications.

• The IP tier is going to increase significantly, driven mostly by the increased transport of video over time.

Migration from service "push" to "pull" - Originally, video services were mostly "pushed" by the network to the STB, where the STB would select the appropriate service (channel) for the subscriber. VOD was the first service to introduce a "pull" concept where the STB requested a specific service and the network responded to that specific request. While this concept was first used for non-linear video service, it was then adapted also for linear video services by Switched Digital Video (SDV). In order to avoid sending all the channels to all STBs and overloading the limited HFC capacity, SDV uses the pull concept, where a STB requests a specific channel, and the SDV server makes that channel available to the STB on a specific narrowcast QAM. SDV further pushed the envelope on network-based pull technology to have lower latency and very high scale, hence extending its capabilities beyond the characteristics required by VOD. As more applications, contents, formats and personalization are used, the importance of "pulling" content from the network, and the network ability to quickly fulfill the service requests will become more important.

Cable IPTV migration strategies

Cable IPTV holds several promises that draw the attention of most MSOs, including:

Lower cost STBs – IPTV STBs are mostly based on new technology and devices, offer economies of scale and a breadth of equipment suppliers. The ability to get around the STB duopoly, introduce new encryption schemes and save on one of the most CAPEX intensive components is appealing to cable operators.

IP-based Consumer-Electronic devices – As more TV sets offer inherent IP capabilities, more Wi-Fi enabled portable video devices get into the household and subscribers spend more time watching videos over PCs, there's a growing need to deliver video services over IP to all of these devices, allow device shifting and time-shifting, rather than just feed STBs. The ability to provide service to other video consumption devices is an important differentiator for MSOs.

Unified transport across access technologies – Some operators deploy additional last-mile technologies in addition to HFC; others are looking at new technologies such as GPON or RF Over Glass (RFoG) and even wireless for augmenting their current installed base. IPTV provides the promise of a converged transport layer for all of these different access technologies.

The problems of extending IP infrastructure to IPTV – MSOs may choose to extend their CMTS-based infrastructure to support IPTV. Today, most systems are using one QAM carrier for downstream IP and one for upstream. With the introduction of DOCSIS 3.0, this is extended to 3 downstream QAM carriers, and one upstream carrier which is still less than 4% of the available spectrum of a typical 750MHz or 860MHz cable plant.

But as video viewership shifts to IP, MSOs will find themselves allocating 20, 30 and more QAM carriers to IPTV, hence increasing their CMTS infrastructure by a factor of 10! At that level the CMTS infrastructure becomes a great cost liability on video services. In addition, the viewership migration does not occur overnight. As viewership migrates from traditional MPEG-2 transport to IP, MSOs will have to replace video

EQAM ports with CMTS ports, rewire service groups and constantly fine tune their network to adjust to the changing viewership behavior. Any service or application that applies to both traditional and IP devices needs to be implemented and integrated with both MPEG-2 transport (RF) and CMTS policy servers (IP), hence making the introduction of new applications even more troublesome.

Video convergence is the key to successful migration to IPTV – An alternative approach is to consolidate both RF and IP video services over a converged control plane and use a single pool of network resources for delivering video whether over RF or IP. IPTV is really more about video than IP. Some EQAM devices are capable of delivering video over MPEG-2 transport or encapsulating it in DOCSIS headers for carriage over HFC as IP.

In that case, the question of RF vs. IP becomes a simple service attribute or encapsulation option, while the video service along with its associated Quality of Service, processing, ad insertion etc. is handled in the same manner whether destined to an IP or traditional video device. This approach really provides a seamless migration path from RF to IP since both applications and edge resources do not need to change as viewership migrates from RF to IP.

Traditional Edge Resource Managers do not address IPTV migration – The concept of sharing edge resources between multiple applications, while not widely deployed as of yet, has led to the introduction of control plane entities such as an Edge Resource Manager (ERM) or a Global Session Resource Manager (GSRM), which allocate edge device resources to multiple video applications, both embedded and external.

The ERM entity as defined by Comcast Next generation On Demand (NGOD) architecture uses S6 protocol to communicate with Session Managers for RF resources. The GSRM entity as defined by Time Warner Cable Integrated Services Architecture (ISA) uses SSP-SIS as the protocol for a similar task. Both entities focus on the sharing of resources between On-Demand applications and SDV, but limit their scope to the RF spectrum.

The fact that these traditional ERMs do not address the IP spectrum or the migration from RF to IP prevents them from being used for converged video delivery and therefore significantly limits their applicability in solving the real resource sharing issues that face MSOs.

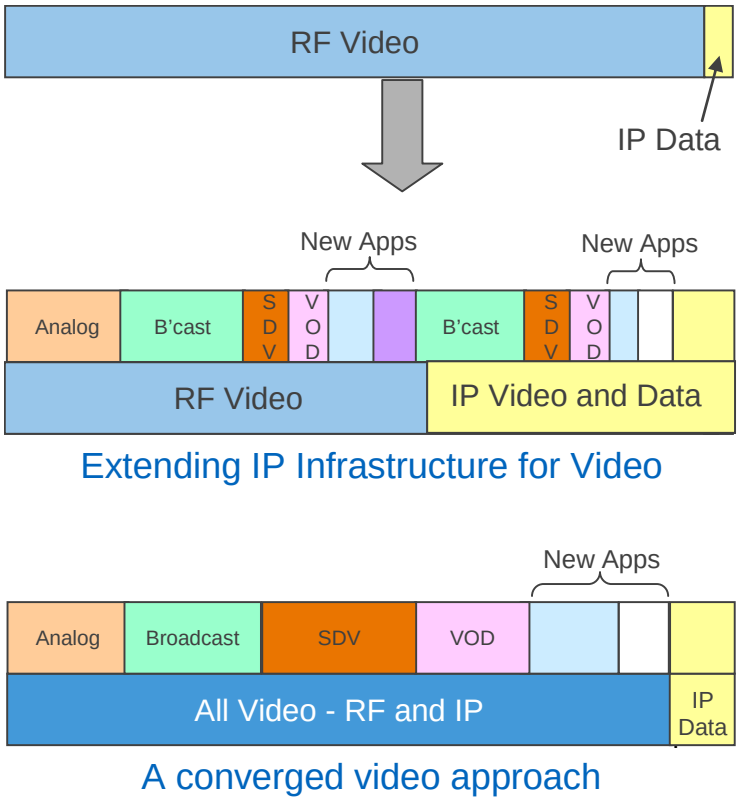

Figure 2: IPTV Migration Strategies

CVEx™ - The converged video service delivery platform

BigBand Networks CVEx™ (Converged Video Exchange) addresses the important need for video convergence by providing a unified control plane that cuts across multiple applications as well as RF and IP spectrum, and provides a single context for the delivery of all video services.

Rapid service introduction and monetization **–** CVEx is a control-plane, software-based infrastructure that logically sits in the heart of the video network and controls the creation and delivery of all video sessions and services. CVEx may provide resources to internal (embedded) or external session managers.

As video services are "pulled" from the network, rather than automatically "pushed" or flooded, different video consumption devices issue requests for video sessions. These requests go directly to CVEx in the case of embedded session managers such as linear SDV, IP (using vIP PASS™) or may go to external session managers for applications which are not embedded within CVEx. The external session managers then issue a resource request to CVEx for setting up the required video session, along with description of that application, the required processing, encryption, etc. The outcome is that all video service requests come into CVEx either directly or indirectly, making CVEx the control center for video service fulfillment.

CVEx allocates the necessary network resources – QAM carriers, encryption resources, personalized splicing resources, etc. and communicates with the edge resources for the creation of the video session. CVEx also provides a unified interface to an advanced advertising system using an SCTE 130 interface allowing a consolidated advertising back-office and campaigns.

By presenting all session managers a unified interface for the creation of a video session along with its resource, encryption, advertising regardless of the end device, CVEx simplifies the introduction and monetization of new video services.

Standards-based approach **–** CVEx does not modify the architecture or protocols used today for specific applications. It supports the existing ISA SSP-SIS, and NGOD S6 protocols to external session managers, and the ISA RPC or NGOD R6 & D6 or CableLabs® protocols to an edge device. It further supports standard protocols to STBs and other video consumption devices based on the required application. The usage of SCTE 130 Ad Manager (ADM) to Ad

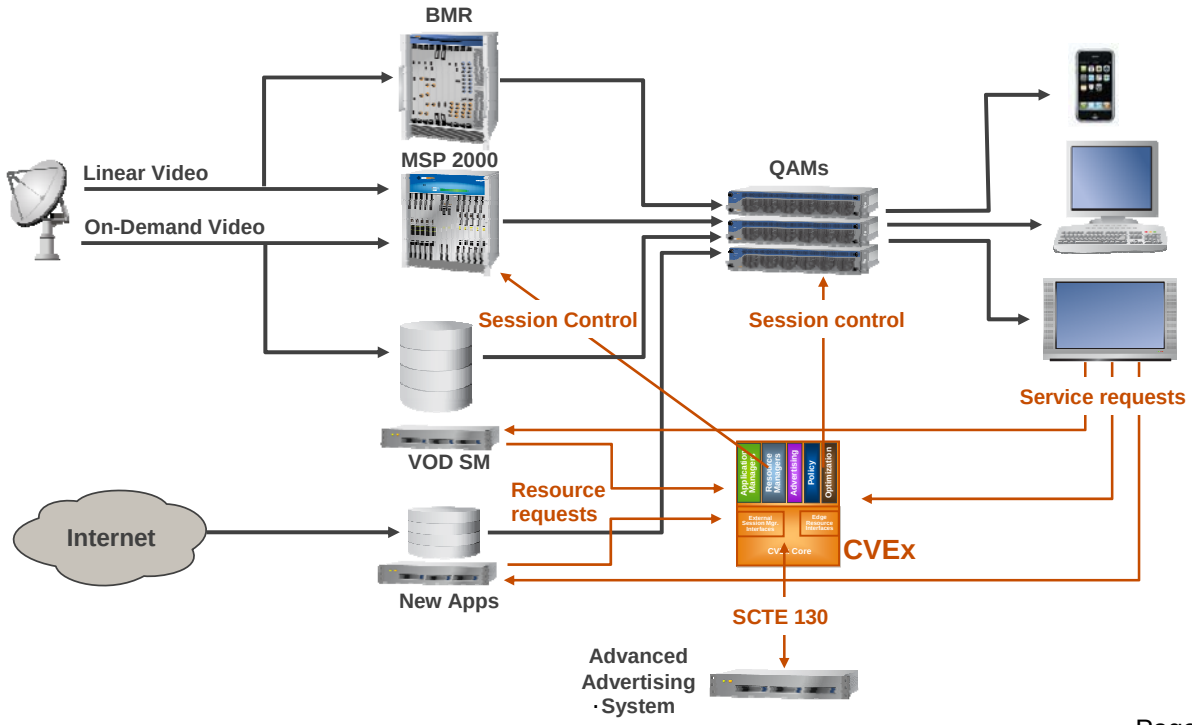

Figure 3: CVEx provides a unified control plane to all video services

Decision Service (ADS) interface allows for integration with a variety of next generation advertising components and for consolidated campaigns to be applied to different video services.

Supporting a smooth migration to IPTV – As discussed earlier, video convergence is a crucial piece in successful migration to cable IPTV. CVEx treats all narrowcast QAM resources as a single pool of edge resources and applies them to both RF and IP video sessions based on the edge device capabilities and the requests of the session manager.

As viewership within a service group migrates from RF to IP there is no need to replace, rewire or reconfigure devices. CVEx will automatically create sessions with the appropriate attributes on the edge devices, and share the sessions on edge devices and QAMs based on each edge device capabilities.

Robust policies and business rules – As MSOs introduce new services, offer more content and look for non-subscription based revenues sources through advanced advertising, there is constant competition between session mangers over edge resources.

CVEx enables MSOs to optimize their resource allocation by applying policies to session creation, and allowing operators to configure and update business rules that correspond to application's resource requirements and revenue creation.

For example, operators may want to define specific rules when to prioritize the fulfillment of time-shift TV session over the ability to use remaining resources to provide additional ad versions on live TV for better addressability and advertising premium.

Enabling the introduction of next generation edge devices – Pooling of all narrowcast QAM resources basically creates a narrowcast Super-Group. New EQAM technologies and the need to reduce the cost of a single QAM carrier push for QAM up-conversion to increase from 8:1 to 16:1, 32:1 and beyond in next generation EQAM devices. However, it becomes impossible to allocate so many QAM carriers to a single application, or even just assign them only to RF or only to IP.

The introduction of a SuperGroup for all video services, and the ability to share that SuperGroup among RF and IP is an important part in making it possible for cable operators to leverage these next generation edge devices, which promise to reduce the CAPEX and OPEX associated with capacity expansion.

Insight into viewership across applications and devices – An important part of application introduction is the ability to measure new applications' success and use that information when considering their business justification.

As more applications are introduced and different video consumption devices are used, it becomes more challenging to get a comprehensive view on viewership and how it breaks down. For example, how many subscribers are watching a specific program live vs. time-shifted? How many are watching that episode on their TVs vs. PCs vs. mobile devices? The answers to these questions and a lot more can be provided by looking at the viewership information as aggregated by CVEx, and complementing it with analysis and reporting capabilities.

BigBand Networks SDV systems have been providing information on linear SDV as well as broadcast viewership as a byproduct of SDV deployments. Several MSOs have been using these offline tools to plan their SDV network, capacity growth and introduction of niche and HD content. CVEx extends these offline tool capabilities by applying them not just to linear channels but to all video services and across the RF and IP planes.

Leveraging BigBand's control plane expertise – As the leading provider for Switched Digital Video (SDV), BigBand's technology is focused on reliable, scalable and immediate response-time systems that enable operators to introduce SDV into their linear lineup in a seamless manner, completely transparently to their subscribers. BigBand's solutions currently execute billions of real-time transactions per year across more than 24 million households passed. The same technology is being used in CVEx for the scalable and reliable delivery of additional video services. CVEx also draws on

BigBand Networks' SDV resource management algorithms to optimize the allocation of sessions to QAM carriers and applying sophisticated mechanisms for sharing between different applications, supporting a mix of SD and HD services as well as RF and IP.

Future migration to network-based navigation – The introduction the Electronic Program Guide (EPG) as a feature of digital STBs was an important step to help subscribers navigate through an increasing number of channels, getting more relevant information on available content and improving overall user experience. But the navigation capabilities of STBs lag behind those offered by web browsing and Internet-based video providers.

As video services become more personalized there will be an increasing need for the navigation to become more personalized as well, offering community groups, recommendation engines similar to those provided by web-stores and web-based libraries, as well as personalized skins.

It therefore becomes more logical and cost-effective to have the navigation functionality move from the STB into the network, where more information, personalization and advanced graphic capabilities can be applied, beyond what can be provided by the CPU power and memory capabilities of the current STB installed base.

CVEx provides a platform that can be used not just to service the session requests coming from the STB, but to actually enable the migration to a network-based navigation where the guide will run as a personalized application inside the network, providing a unicast stream to the subscriber, and session initiation will be generated from within CVEx and interface with the session managers and edge resources.

Summary

Cable operators are faced with business, technical and operational challenges as they look to introduce new services while protecting their current infrastructure investments. Cable IPTV is a key initiative with most MSOs, and its success will greatly rely on the ability of cable operators to smoothly migrate to IPTV and follow viewership patterns.

A converged video architecture allows operators to unify their video services under one control-plane umbrella and treat video applications in the same manner whether they feed TVs or PCs or run over MPEG-2 transport or IP. A converged video architecture requires more than simple QAM sharing within the RF spectrum, as provided by "vanilla" ERM and GSRM products. It requires pooling all narrowcast spectrum and using that one pool to deliver video services as they shift from RF to IP.

BigBand's Converged Video Exchange platform enables true video convergence by treating all video services whether linear or non-linear, RF or IP in the same manner, allocates resources to all applications, and applies policies when allocating resources to applications. It further provides a unified interface for an SCTE 130 advanced advertising system to allow for advertising revenues for new applications.

CVEx introduces the concept of QAM SuperGroups, and the notion of managing the entire narrowcast spectrum for all applications, hence also paving the way for next generation edge QAM devices and higher up-conversion ratios, which provide higher densities and lower CAPEX, OPEX for QAMs.

CVEx also provides unprecedented insight into viewership across applications and devices by leveraging the fact that all applications setup sessions through CVEX, and the usage of offline analysis tools to slice and dice the raw data and provide valuable reports and feedback to network operations, media buyers and advertisers.

CVEx is an evolution of BigBand's robust SDV system that has a proven track record serving over 24 million households with linear services transparently and with high availability. It provides cable operators with the ability of supporting SDV sharing resources with VOD and time-shift TV applications, while introducing IPTV services in a cost-effective and non-disruptive manner. Bottom line: CVEx future-proofs the network for the gradual, yet inevitable migration to IPTV, while supporting economies for both today and tomorrow.