Converging IMS and Switched Broadcast to Deliver Any Media to Anyone, Anywhere

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1.0 Television is Changing !

In just a few years the networks that are used to provide video to subscribers have changed dramatically, and continue to evolve at a rapid pace. Early networks were capable only of broadcasting a pre-selected range of programs to each user, which were viewed on immobile television sets. The majority of programming had to be “enjoyed” at pre-arranged times while on-demand choices were limited. Telephony services were accessed on entirely separate devices, as were data services such as emailing and web surfing.

A rich variety of technologies are dramatically changing the television viewing experience. Indeed, the pace of change is so rapid that, within our own lifetimes, the description provided in the previous paragraph will become a laughable, archaic memory.

The next step in television’s evolution requires convergence across multiple service domains. Subscriber demand for mobility means that video is no longer considered a standalone service, delivered to a stationary device or fixed location. Soon a television will no longer be considered just a video display device, and a mobile phone will no longer simply be used for voice calls. Integration and coordination of services, such as telephony, instant messaging, buddy lists, social networks and presence delivered to devices which are not fixed by network access, will generate consumer interest and exciting opportunities for revenue growth.

The convergence of SWB (switched broadcast) and IMS (IP multimedia subsystem) will offer service operators the ability to leverage open platforms characterized by scalability, versatility, high availability and low cost. These platforms will enable the delivery of video content to any device, at any location, through multiple access network types. Additionally, simpler network operations are achieved by single application environments, and single subscriber profiles. Handoff of video sessions to moving handheld devices will become much easier and faster to implement.

2.0 Switched Broadcast: Broader Choices, More Personalization

Switched broadcast has moved from being an engineering concept to a field-proven solution, with large-scale deployments by cable operators, supporting several million homes passed. All of the major North American cable companies are currently examining the benefits and applications of switched video networks, and next year is likely to see widespread deployments.

Sometimes referred to as switched digital broadcast and switched digital video, switched broadcast enables service providers to dramatically expand the amount of programming offered to subscribers. Instead of a few hundred programs, subscribers can potentially access thousands of choices, ranging from popular sitcoms and blockbuster movies, to long-tail content that appeals to smaller audiences. The long-tail effect, a concept embraced with great success by companies like Netflix, demonstrates that niche programming can represent significant sources of revenue for service providers that are able to deliver it economically to large numbers of subscribers.

Switched broadcast enables an expansion of programming by reducing the amount of network capacity required to provide subscribers with all the programs they want to watch. In switched networks, programs are delivered only when and where requested by viewers, unlike legacy broadcast systems that deliver all programming to all subscribers, all the time. This is accomplished by providing the subscriber's STB (set-top box) with the ability to communicate in real-time with a network-side video platform and select which program the subscriber wants to watch. The switched broadcast system responds by delivering to the viewer's service group, only those programs being watched by subscribers within that group. Each STB then tunes to the appropriate program.

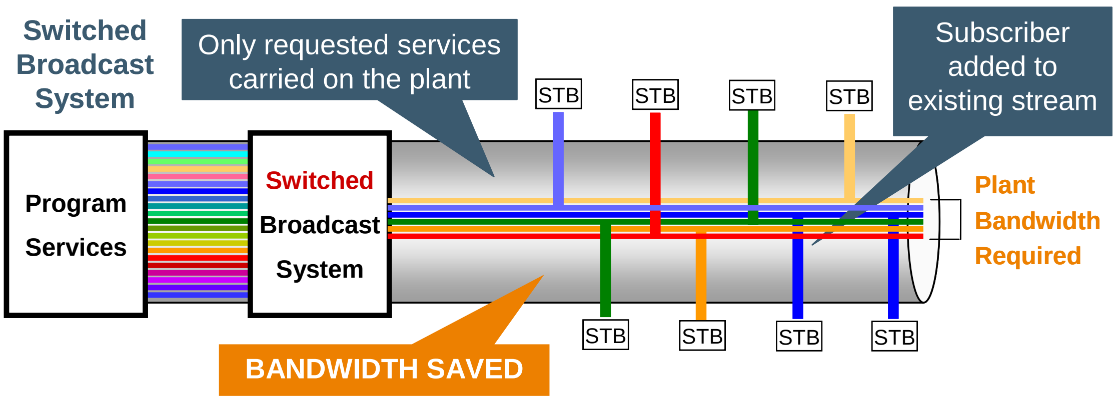

Figure 1: Switched broadcast expands programming choices by saving network capacity

However, switched broadcast is about much more than bandwidth reclamation. By adopting switched unicast, a type of switched broadcast in which each subscriber receives a unique program stream, service providers can allow their subscribers to enjoy greater personalization of programming. Switched unicast consumes less bandwidth than traditional broadcast programming and, though it doesn't have the same bandwidth reclamation potential as switched multicast, it still enables a significant increase in the amount of programming offered.

Personalized news is one example of how programming can be chosen to reflect the interests of individual subscribers. Switched unicast systems enable content and subscriber interests to be correlated. As an example, news summaries can be created that are more likely to retain the attention of viewers than traditional broadcast TV news programs. Enterprising newsrooms could record a series of short news stories on a wide range of topics, allowing cable operators to combine them into personalized bulletins that address a subscriber's specific interests. A personalized version of a radio station is another example of how switched unicast provides operators the opportunity to offer increasingly customized content.

Addressable advertising is another form of content personalization enabled by switched broadcast. Empowered by insights into subscribers' interests, achieved through the communication between subscribers' STBs and switched broadcast systems described above, service providers can deliver promotional messages that more closely match the interests of viewers. Since marketers are willing to pay premium rates to achieve higher response rates among their target audiences, addressable advertising offers service providers a way to dramatically increase advertising revenues.

3.0 IMS: An Architecture for rapid service deployment and converged multi-media service delivery

IMS means convenient, converged communications - one-stop, finger-tip access to a plethora of multimedia services. There once was a time when technology allowed for a number of means of communication, but there was no synergy between them. A multitude of devices and several providers were required for different services, and no roaming was permitted. Consequently, networks have essentially been individual islands (video, voice, data, e-mail, IM, etc.) and traveling from one to the next meant signing-in and authenticating with each. Provisioning each new network has been capital intensive, operationally inefficient and time-consuming.

Figure 2a: Without IMS, network functionality exists in silos, slowing deployment of services

Today, IP and IMS are changing all that. It is, after all, an "always-on" world in which we now live and IMS promises to meet that demand. Consumers want intelligent services that can be personalized across multiple devices and that can be easily accessed anywhere, anytime with a single password.

Converged multimedia services rich in voice and data capabilities, and expansive in entertainment options, have entered the mainstream, and are evidence of broadband's emerging potential. These multimedia services are moving the cable and telecommunications industries into an environment where video, voice and data are harmonized, and efficiently delivered across a common IP-based service delivery architecture. IMS is the means of delivery.

IMS allows personalized services to be delivered independent of the type of network and device being used. IMS offers a network framework with common identity/policy management and common session control, and thus the opportunity to deploy a seamless, simpler, richer set of multimedia services to your customers. A converged network makes efficient use of transport and access media and greatly simplifies the challenges of OSS integration by moving all management systems under a single, common network umbrella.

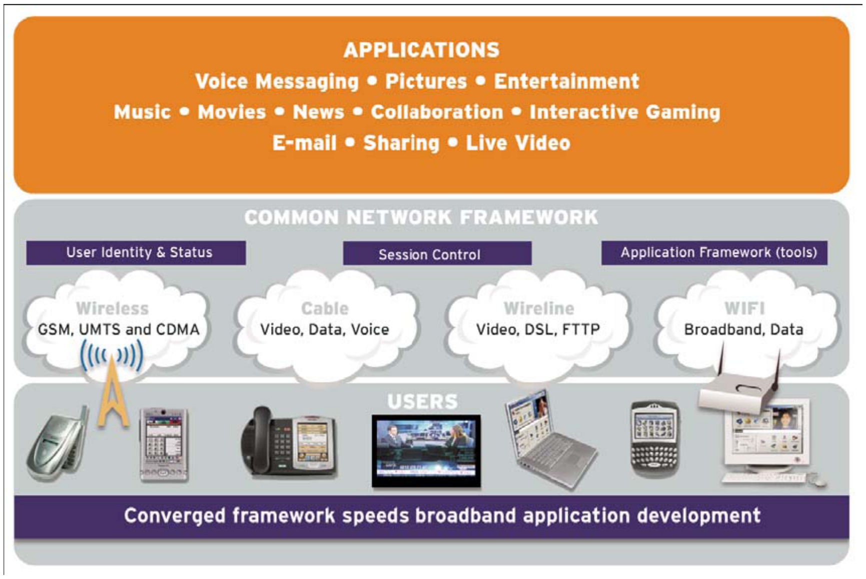

Figure 2b: A common network framework that leverages IMS speeds development of broadband applications

Here's a high-level view of the IMS core capabilities in delivering what we call the "converged quad-play":

- *Single subscriber identity and authentication* - enables a user to log onto a service using one device and continue the session on another device, without having to sign in again. This capability is made possible by a master database managed through a HSS (home subscriber server) element in the IMS core network.
- *Unified session control* - enables sessions to be handed off between devices, such as when a VIDEO viewing session is started on a TV and then continued on a mobile device. This function is accomplished from a CSC (call session controller) element in the IMS core network.
- *Service enablers* - such as Presence and Network Buddy List, can be extended to any network device and to any application server via the IMS core network, enabling features to be delivered in the same manner to a PC, mobile device or video set-top box.
- *Application ubiquity* - refers to the way the IMS application layer applies to multiple access networks. New applications and services can be extended from one access/device type to another with relative ease.
- *Resource control* - ensures that the required resources for a service are established among different access types. This IMS capability manages policies for service by access type, and makes sure the specific access network can deliver the required attributes based upon the nature of the user's subscription and the services requested to be delivered. IMS provides a core network foundation allowing a service provider to deliver a personalized multimedia experience beyond basic video.

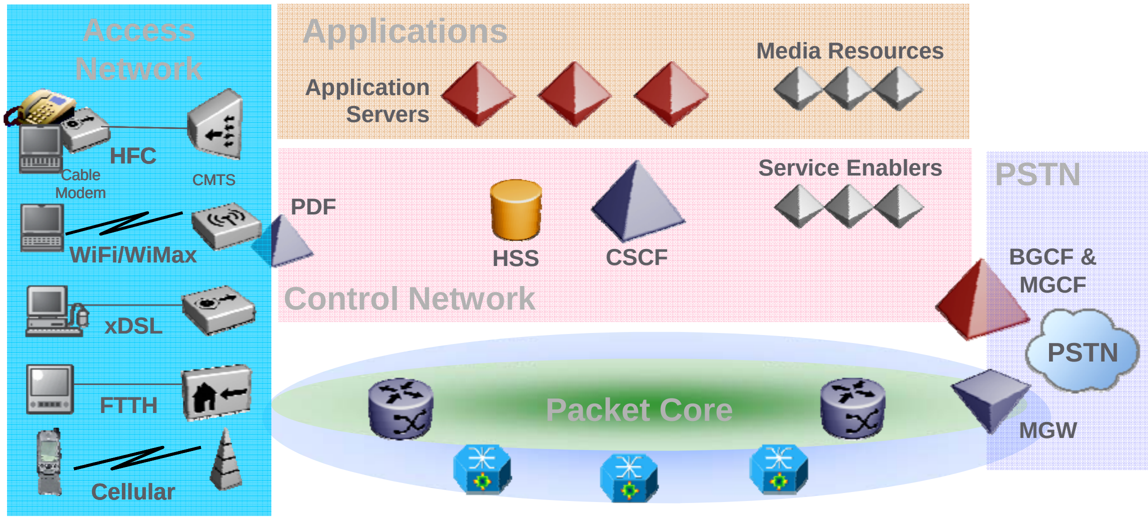

Figure 2c: IMS Reference Network

4.0 Synergistic Benefits of IMS and Switched Broadcast

As service providers combine interactive video with voice, data and mobility services to form quad-play bundles, will their subscribers be just watching video or engaging in a new multimedia experience? There is an elegant and cost-effective way to not just deliver a video, voice, data and mobility bundle but to seamlessly integrate them into a richly interactive and personalized experience. The quad-play bundles video, voice, data and mobility into one service package, with one monthly bill. The immediate goals of offering a quad-play bundle are two-fold:

- Win a greater share of the consumer spend;
- Reduce churn.

Cable operators are pursuing quad-play offerings to maintain a competitive edge. They are enhancing their VOD (video-on-demand) services and pursuing partnerships to add wireless mobility to their existing video, data and emerging voice services. Local telephone companies are bundling wireless mobility and high-definition video services to their established voice and Internet data services. All types of operators are hoping to win over customers by offering the convenience of a single monthly bill from a single provider and an attractive bundled price compared to buying the same services individually. The challenge is that the services are still separate everywhere except on the bill in the customer's mailbox.

With all this duplication of infrastructure, operating expenses are high. It is complex and costly to introduce new services. Even if you could create a consistent user experience for a service across multiple media, the application would have to be developed separately on each platform. For users, there is little benefit in moving all of their services to one provider except for the promise of a better price. Worse yet, this quad-play offering is easy to duplicate. A competitor can come along and bundle exactly the same services at a lower price. If you're a service provider, what's your edge?

The solution? Convergence of SWB with other forms of service by leveraging IMS as the common control plane for establishment and control of the session aspects of the video session. This allows the establishment of video media sessions within the context of single subscriber profiles and allows for the continuity and availability of media sessions across access and network domains. Further, the interaction between different communication services is easily enabled without inter-application coordination.

In a converged network:

- *Networks are common* - voice was traditionally delivered on a wireline network, data on a broadband network and video on cable or satellite. Mobility services had been restricted to voice, only recently expanding to include data service. A provider may be maintaining or leasing bandwidth on two or three separate network infrastructures to deliver all of these services. The converged network is “all-IP” to provide the most cost effective way to combine video, voice, and data onto a single unified network.
- *The User experience is singular and consistent* - content and devices are no longer tied to access. The user may use the same device on different access networks or different devices on the same access network. The user has one identity, one authentication mechanism, one address book, one buddy list, one list of favorites, and at the end of the month, one bill. Further, the user maintains this consistent view of service invocation whether at home or roaming to another access network somewhere else in the world.

The converged service provider is not competing solely on price, but with an integrated offering that offers a richer user experience. By increasing the value of their service offer, the provider can gain significantly higher ARPU (average revenue per user) and increase user loyalty.

4.1 Cool New Services

With a converged network, the provider may offer a service that allows you to keep all your current TV channels but also watch them anywhere - on your cell phone, PC, laptop or car device. Recent surveys have indicated significant interest in this service with significant potential pull of new subscribers onto the converged network with a resultant gain in wallet share.

The initial opportunities for service convergence include combining voice and video functionality and extending video functionality to mobile devices. Beyond this, you can extend core service enablers to create a unified user experience across devices. Here are service examples that are possible with currently available IP and IMS technologies:

- *While watching TV, the user receives an online prompt displaying the caller ID of an incoming call* - the phone doesn’t ring (a user-selectable setting), so nobody else in the household is disturbed. The subscriber can choose to either:
  - *Accept the call* — the phone rings and the call can be answered on the home phone or a speakerphone associated with the TV.
  - *Reject the call using the TV remote control* — the phone never rings and the call is discarded.
  - *Forward the call to voice mail using the TV remote control* — the caller can leave a voice mail message, and the subscriber sees a message-waiting indicator on the TV screen.

  The subscriber does not have to get up to see who is calling, which is particularly welcome if the calling party is not of interest. Who wants to interrupt a favorite TV show to take a message for another household member, when voice mail can do just as well or better? The service also supports click-to-call capability, whereby a subscriber can place a call using the remote control, either from an address book or a list of received calls. In the future, subscribers will also be able to place and receive video calls using a TV-mounted webcam.

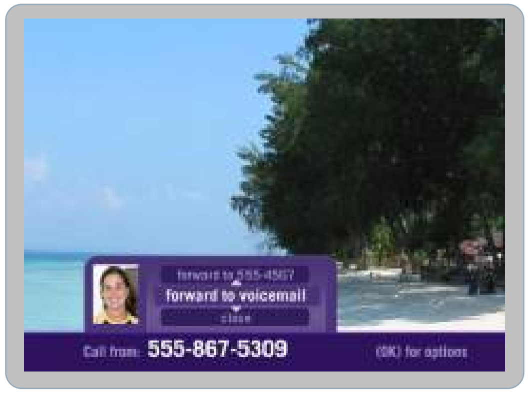

Figure 3a: Call ID and Control on TV

- *Extend data services into the TV environment* - for example, subscribers could exchange IMs (instant messages) with others on their personal buddy lists, while watching a TV show. Thanks to “presence” capabilities, the system knows whether the subscriber’s buddy is watching the same video stream, and if so, sets up the IM connection for them to share a back-and-forth chat while watching TV. The two subscribers can then share the viewing experience, trading comments about what they’re watching, even though they’re in different places. SWB technology is a key enabler of this service as it tracks channel usage and displays that information to the user’s buddies. This feature would not be possible with legacy STBs as channel usage information is not a parameter that is monitored or transmitted back into the network.

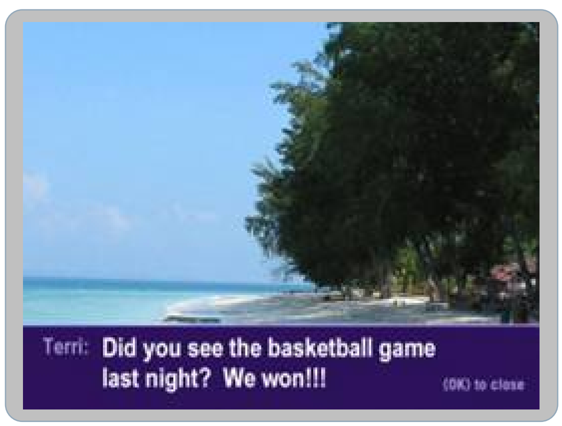

Figure 3b: IM to the TV

- *Picture-sharing is another popular option* - suppose you want to share digital photos with a distant family member who doesn’t have a PC or Internet connection. You could send the photos to the service provider’s photo exchange service, which in turn uploads them to the recipient’s set-top box. That person receives a notification that pictures are available for viewing, and selects “slideshow” on the TV remote control to view the photographs on the TV screen.

- *Extend TV services into the wireless environment* - a mobile device can become an extension of the VIDEO service - both to control and to view video content. For example, suppose a change in your flight schedule will cause you to miss tonight's episode of your favorite TV show. You can use your PC, PDA, cell phone or other wireless device to pull up the TV schedule, select the episode and send a command to the digital video recording service to record this episode. Later, you can use your video-enabled mobile device to call up the DVR menu, select the pre-recorded program and watch it wherever you are. Conversely, you could begin watching the TV show at home and then switch seamlessly to the mobile video device to watch the rest of the program on your trip. The user interface will be the same on the mobile device as on the home VIDEO set, making navigation familiar and convenient.

Figure 3c: TV on Mobile Clients, TV and PC

For service providers, video over IMS offers a number of benefits:

- *Win new subscribers* (and keep the ones you've got) by offering a richer home entertainment experience than can be achieved with competitors' standard triple or quad-play offerings.
- *Gain new revenues* by delivering a differentiated, value-added service — personalized and interactive — supplemented with revenues from carefully targeted advertisements.
- *Reduce operating expenses* by reusing a variety of functions across the quadruple play environment, such as subscriber, service and user profile data, authentication, authorization, Digital Rights Management (DRM), charging support, and the media and data servers that optimize delivery to various device types.
- *Deploy new services faster* since an application can be created in one place and deployed across all access networks and devices, with a core billing system that aggregates billing data.

For end users, video over IMS enhances the communication and entertainment experience with value-added capabilities. The traditional TV viewing experience can be combined with diverse types of person-to-person or group communications such as chat, instant messaging, caller ID, videoconferencing or video mailbox to enrich the experience. Subscribers can create, manage and share their unique libraries of content both commercial and personal. For instance, they can establish video surveillance for home security, share photographs and video blogs with friends, push Web pages or send a favorite, pre-recorded TV show to a fellow subscriber. In spite of the diversity of service opportunities, the user experience is simpler and familiar from one device to another and services can be personalized to meet users' needs across devices.

5.0 Architecture for Switched Broadcast and IMS Convergence

Prior to IMS, a typical deployment used proprietary interfaces, separate service and subscriber processors and databases by access type, and separate networks. With IMS, the in-home television (set-top box) becomes another class of IMS enabled device, much like mobile phones, PDAs and laptop computers. Service providers can extend advanced, multimedia VIDEO services to IMS enabled devices converging voice, data and video services into a differentiated service offer.

The IMS open-standard solution uses a single approach for authentication, quality of service, content management and security for telephony, multimedia and VIDEO. It enables users to sign on only once to access services across multiple access types, and it supports personalized libraries of content to be delivered to the subscriber’s TV, PC, PDA or other video-enabled mobile device.

Currently, the SRM (session and resource manager), SWB server and SWB manager perform as the control plane of a video network. Utilizing standards such as DSM-CC or RTSP, a control plane emerges to manage the resources and sessions required to deliver VOD and SWB applications through the existing HFC access network. In a telco IPTV environment, this function is commonly referred to as “middleware” and uses mostly proprietary solutions. In an IMS network, IMS is the control plane enabling architectural functions including:

- Subscriber roaming:
    - Decoupling the subscriber from specific access and specific terminal equipment.
- Application ubiquity:
    - Application availability to / from any access network;
    - Content ‘tuning’ to match access & terminal capabilities.
- Resource control:
    - Authorization & availability;
    - Accounting - measuring resource usage, revenue assurance;
    - Policing resource usage and fraud prevention;
- Subscriber authentication:
    - Common Model for all devices, access & applications.
- Content protection:
    - Subscriber Oriented CA & DRM across a wide class of devices
- Session hand-off.

One of the major challenges of this convergence is the evolution of the existing (or under deployment) video network. A generic reference architecture of today’s video network is shown in figure 4a.

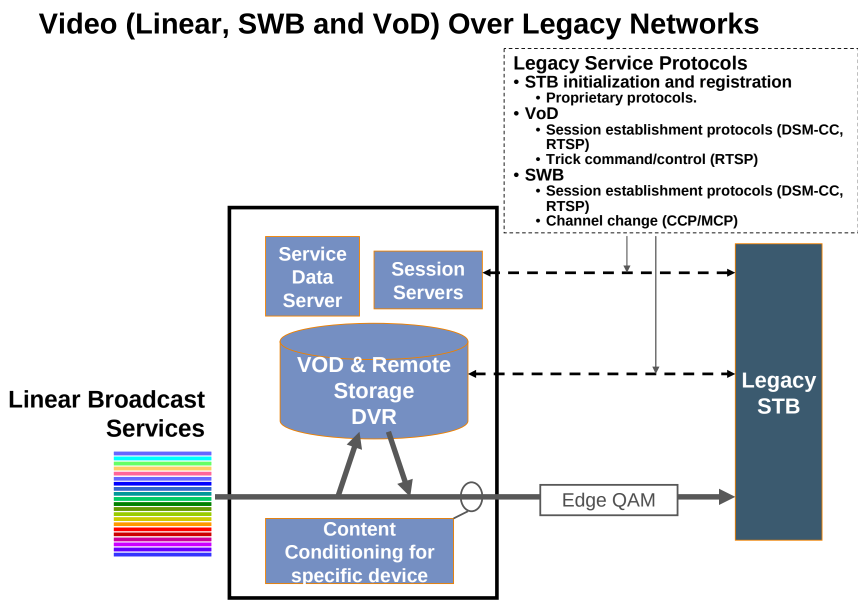

Figure 4a: Reference architecture showing a typical video network today

In this model, the network uses a combination of standardized and proprietary protocols to initiate communication with the STB and establish video streaming sessions. There has been considerable investment to develop and implement these protocols; however, the model does not promote the convergence of network functions and services.

In today's model, the following functional components are used: Service data center, session servers, VOD and remote storage, network-DVR, content conditioning, edge QAM and STBs. Other components such as the ERM (edge resource manager) are not included here for sake of clarity.

Video is streamed to the legacy STB in linear and non-linear modes, meaning broadcast, switched broadcast (multicast) and on-demand (unicast).

Initialization and signaling to the STB is a proprietary mechanism specific to the manufacturer. Video is streamed using standard MPEG-2 digitization and compressing techniques. When switched broadcast is employed, DSM-CC and RTSP protocols are employed to establish and tear down sessions while channel changes are accomplished through the CCP (channel change protocol) and MCP (mini-carousel protocol). VOD sessions also employ DSM-CC and RTSP while "trick commands" such as pause and rewind are enabled through RTSP.

In the IMS model shown in figure 4b, the IMS-enabled STB or end device is SIP-enabled and therefore, initialization and session control are accomplished through SIP / SDP. The usage of SIP / SDP allows video sessions to be setup, taken down, re-setup or transferred. Session requirements, based upon capabilities of the device and the current access network, are determined via the SDP (session description protocol). Further, session types (broadcast, multi-cast, unicast) may be transmitted in the SDP to enable the video application server to control the media plane resources to condition the stream for the requesting device. EPGs (electronic program guides) would be distributed to the device via the SIP subscribe / notify functionality.

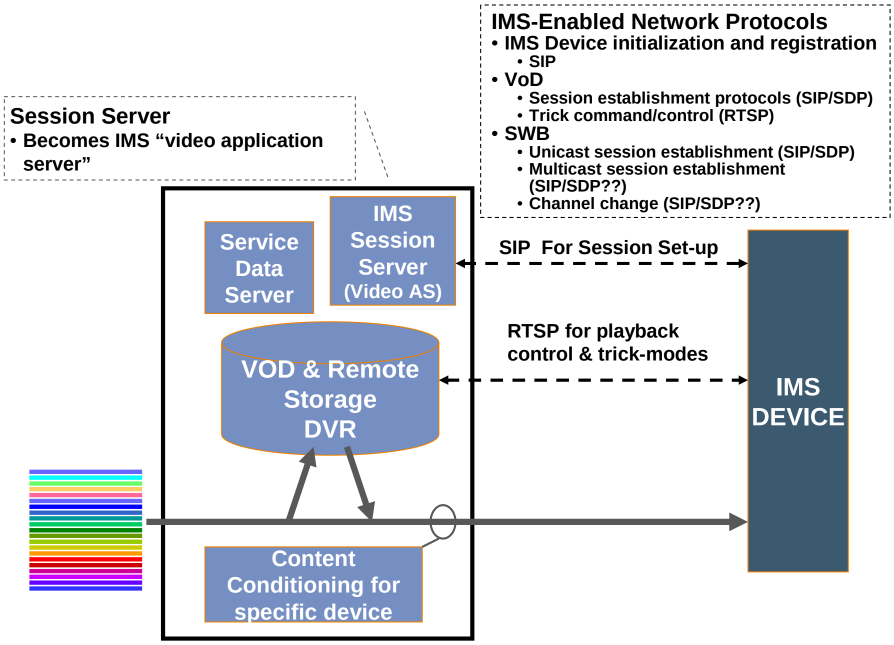

Figure 4b: IMS architecture using SIP / SDP to initiate and control video sessions

Since SIP is not suitable for trick commands, RTSP is retained. The core of the network also becomes transformed as the session servers become IMS enabled Video Application Servers. This results in the ability to leverage IMS core features such as single identity, subscription, privilege profile, NAT / FW traversal, routing, and feature interactions. Further, the IMS “enablers” such as presence and group list management (buddy lists) allow all application servers to use a common user specific set of data.

The drawback to this model is the inability to support the millions of STBs already deployed. Figure 4c shows a network utilizing an IMS core while retaining legacy STBs or end-devices. This is accomplished through a SIP / IMS proxy device which performs the necessary translation between IMS protocols such as SIP and the legacy protocols of existing STBs. It is completely possible to support broadcast, multicast, and unicast video “sessions” in this fashion. This model eliminates the requirement for forklift upgrades while enjoying the features of IMS.

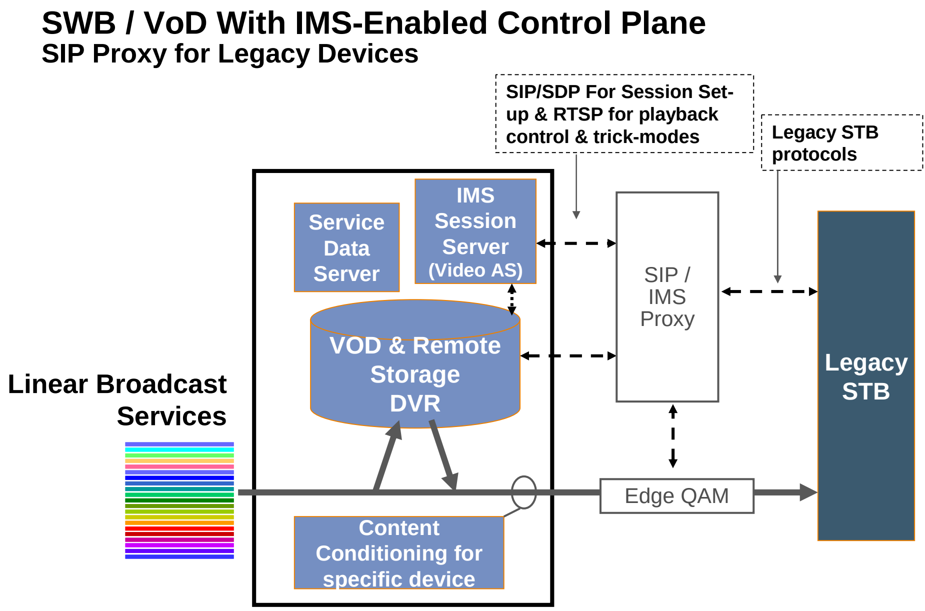

Figure 4c: Network leveraging IMS core while retaining legacy STBs or other CPE

While the previous model starts to introduce IMS into the video control plane, some real benefits occur when the operator is able to leverage common video sources for a multitude of end-viewing devices such as wireless phones or PDAs. Referring to figure 4d, the common IMS control plane is able to initialize and control video sessions to legacy STBs and newer SIP-enabled devices. A new component is added to condition the video for the appropriate end point device. This conditioning could include transcoding, transrating, resizing, clamping, etc

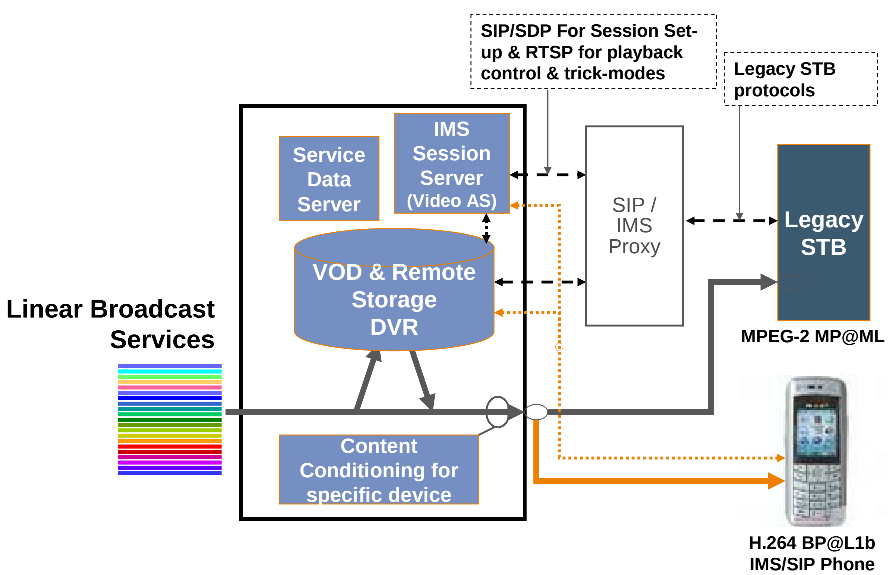

Figure 4d: Network comprising of legacy STBs and SIP-enabled CPE with IMS core

Some of IMS's premiere applications include buddy lists, presence indicators and shared application control. This "sharing of experience" greatly enhances the TV viewing experience. TV is no longer an event shared only in the home but rather, it can be shared anywhere as long as the subscribers can reach the operators network. It becomes "TV without boundaries".

Users can see who is online and invite others to watch similar programs even if the other user decides to use a different viewing medium, such as a wireless phone. Once these users are viewing the same show, either one can pause, play or affect the experience through the common IMS control plane. With iTV applications such as IM to the STB, users can trade messages and satisfy the "multi-tasking" mode, typical of the current generation.

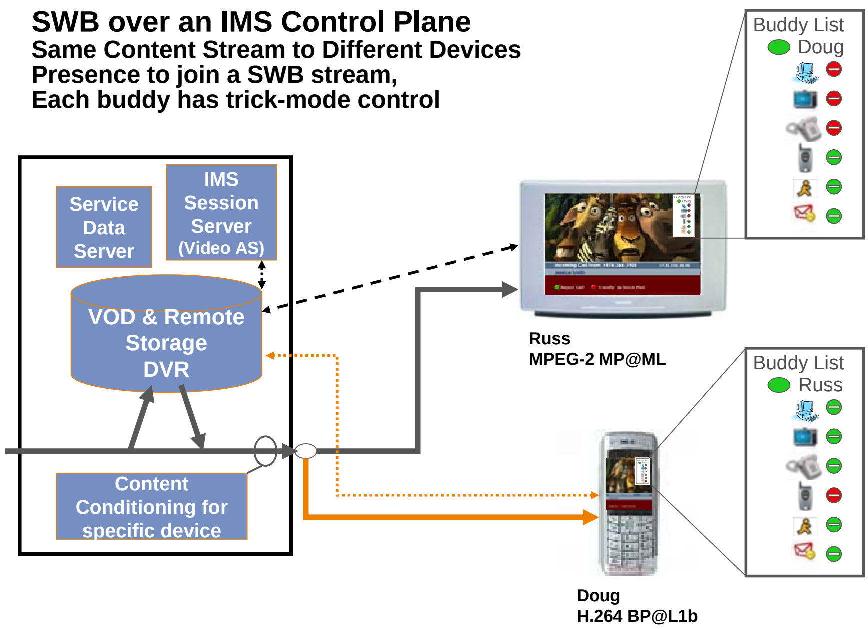

Figure 4e: SWB over IMS results in "TV without boundaries"

Figure 5 conceptually shows the functional elements of the SWB / VOD and broadcast networks being controlled in an IMS environment.

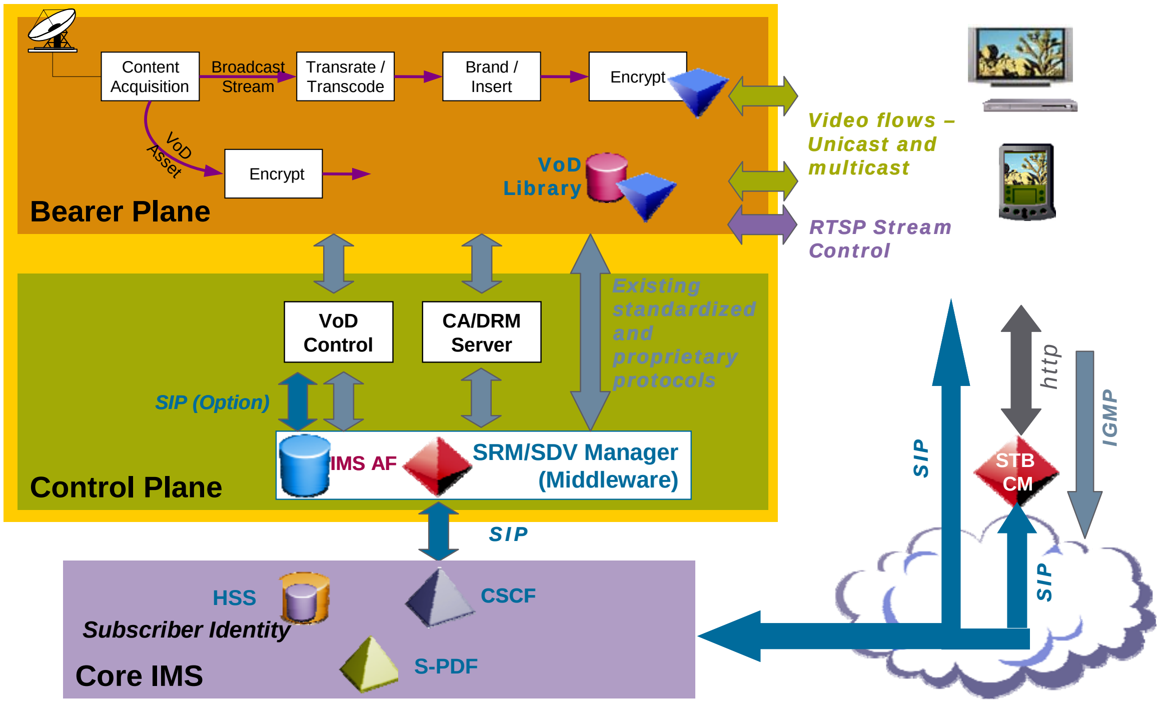

Figure 5: Functional elements of SWB / VOD and broadcast networks in an IMS environment

6.0 Conclusions

This paper provides a viable approach to the convergence of SWB, VOD, and IMS. It has been shown that high interest features can be delivered to the end user on any device via any access network in a consistent fashion yet with full control by the service provider. Further, this network convergence can be fully evolutionary exclusive of existing video network infrastructures and current IMS specifications.

While much detailed work is required to define a complete suite of specifications and drive towards open, multi-vendor standards, the realization of this converged network is possible in very short timeframes. This rapid time-to-market is practical due to the installed base and experience of SWB deployments and the very nature of IMS to provide the common core whilst the application servers do their own thing.

For the end customer, the new service experience will be profound. While we have described a few examples of what could be done, the openness of the architecture will allow significant innovation with the presentation of services to the end user. Further, the openness of the architecture allows for many different flavors of the service to run concurrently in the network allowing the end user to choose their preferred implementation.

And for the cable operator, it allows the richest possible bundle at the lowest possible cost points whilst gracefully evolving their network infrastructure and content repositories. This capability will continue the leadership of the cable companies in quad-play bundled service offerings and will enable effective competitive functionality with the emerging "over-the-top" video service providers. Further extensions to this architecture will allow new revenue generating services such as personalized ad insertion which is not only characterized by the video stream but also by the location and context of the end consumer.

Acronyms and Definitions

AF	Abstract Framework
ARPU	Average Revenue Per User
AS	Application Server
BP@L1b	Baseline Protocol at Level 1b
Buddy List	A list of colleagues, workgroup members, friends, etc., that you might wish to communicate with.
CA	Conditional Access
Caller ID	Identity of the calling party (historically a telephone number)
CCP	Channel Change Protocol
CDMA	Code Division Multiple Access – usage in this paper refers to Cellular applications
CM	Cable Modem
CPE	Customer Premises Equipment
CSC	Call Session Controller
CSCF	Call Session Control Function
DRM	Digital Rights Management
DSL	Digital Subscriber Line
DSM-CC	Digital Storage Media - Command and Control
DVR	Digital Video Recorder
Edge QAM	Quadrature Amplitude Modulation
EPG	Electronic Program Guides
ERM	Edge Resource Manager
FTTP	Fiber To The Premises
FW	Firewall
GSM	Global System for Mobile Communications (cellular phone technology)
H.264	An ITU standard for compressing a videoconferencing transmission based on MPEG-4.
HFC	Hybrid Fiber Coax
HSS	Home Subscriber Server
HTTP	Hypertext Transfert Protocol
IGMP	Internet Group Multicast Protocol
IM	Instant Message
IMS	IP multimedia subsystem
IP	Internet Protocol
IPTV	Internet Protocol Television
iTV	Interactive Television
MCP	Mini-Carousel Protocol
MP@ML	Main Profile at Main Level
MPEG-2	Moving Picture Experts Group - An ISO/ITU standard for compressing video
MPEG-4	Moving Picture Experts Group - An ISO/ITU standard for compressing video
Multicast	Multicast is a one-to-many transmission similar to broadcasting, except that multicasting means sending to specific groups, whereas broadcasting implies sending to everybody.
NAT	Network Address Translation
OSS	Operations Support System
PC	Personal Computer
PDA	Personal Digital Assistant
PDF	Policy Decision Function
Presence	The state of knowing that another person is currently online and available.
QAM	Quadrature Amplitude Modulation
RTSP	RealTime Streaming Protocol (IETF RFC 2326)
SDP	Session Description Protocol
SDV	Switched Digital Video

SIP	Session Initiation Protocol
SMS	Short Message Service
S-PDF	Service-based - Policy Decision Function
SRM	Session Resource Manager
STB	Set-Top Box
SWB	Switched Broadcast
UMTS	Universal Mobile Telecommunications System - The European implementation of the 3G wireless phone system.
Unicast	In unicast, even though multiple users might request the same data from the same server at the same time, duplicate data streams are transmitted, one to each user.
Video AS	Video Application Server
VOD	Video On Demand
WiFi	Wireless-Fidelity - A logo from the Wi-Fi Alliance that certifies that Ethernet devices comply with the IEEE 802.11 wireless standard.