



White Paper

**Rapid And Seamless  
Delivery Of Managed  
Internet Protocol (IP)  
Video Services In  
Cable Networks**

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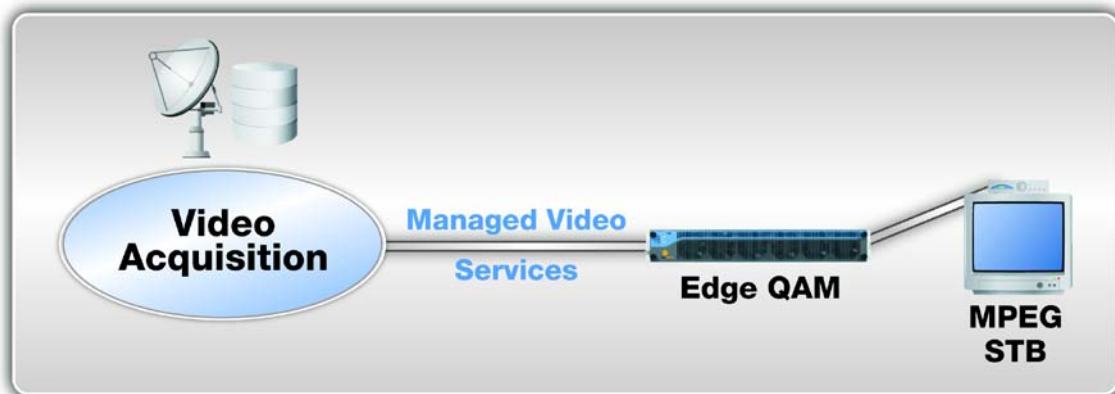
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# Rapid And Seamless Delivery Of Managed Internet Protocol (IP) Video Services In Cable Networks

## Overview

IP Video continues to proliferate worldwide as the number of broadband connections grows, bandwidth speeds are getting faster, and mobile connectivity drives towards ubiquity. Consumers, especially younger generations, are experiencing what is possible with the rapidly expanding list of consumer electronics devices which are IP Video enabled "out of the box". These consumer electronics devices are also being supported by a growing array of service offerings from players like Apple, Netflix, Microsoft, and Google, in addition to the traditional content providers. MSOs are faced with how to extend traditional video distribution (Figure 1) to respond to these market dynamics.



**Figure 1: Traditional Multi-channel video distribution to TVs**

As customers demand the flexibility of viewing video on an expanding set of IP devices, Cable MSOs have both a set of challenges and a unique opportunity. Distribution of video using IP has been done for many years in the service provider network, but extending to customer end-points introduces complexities in maintaining quality of service, management, billing and rights management. While standards exist for key technologies, there will be challenges when dealing with a growing array of unmanaged consumer devices from many vendors. Additionally service providers have a real problem if consumers source IP Video from the Internet over broadband connections as noted in Figure 2 because it only results in significant costs with no commercial benefit to the MSO whose network is being used to deliver the content.



**Figure 2: Over-the-top Internet Video over DOCSIS<sup>®</sup>**

As trusted and experienced video providers, MSOs are uniquely positioned to serve subscribers to a growing number of consumer devices both inside and outside the home, beyond traditional set-top boxes. This is a logical extension of video services and, with ownership of the distribution network to homes and businesses, cable operators can excel at delivering a high performance video experience, including HD/ 3D and beyond, across the broadcast lineup plus growing libraries of non-linear on-demand content.

Given the IP Video growth rates and the rapid pace of innovation occurring, it is vital that MSOs serve customer needs quickly to retain ownership and to capture the opportunity. BigBand Networks invented Switched Digital Video (SDV) and leads the market with over 35M households passed today. BigBand recently extended their proven SDV platform to enable cost-effective and large scale delivery of IP Video using the vIP PASS<sup>™</sup> solution. BigBand's vIP PASS solution allows operators to use the proven performance of SDV to distribute IP content to the home or business to a standard DOCSIS<sup>®</sup> 3.0 cable modem. Inside the customer premises the cable modem can then serve as the IP Video source to any number of IP devices using open standards.

BigBand's vIP PASS solution is proven in large scale production environments and offers MSOs an opportunity to quickly offer IP Video services with an outstanding return on investment. For example, vIP PASS enables an MSO to deliver an IP Video offering that replicates the linear broadcast channel line-up to customer PCs in less than 120 days. This solution would use multicast switched digital techniques in the network to a standard DOCSIS<sup>®</sup> 3.0 cable modem serving as the content source in the home.

## Implementation Options

The key challenges in ramping IP services is supporting a rapidly growing list of unmanaged consumer electronics devices and finding the bandwidth to source the growing services.

Devices:

Implementing IP Video across cable networks promises the benefits of increased flexibility, new services velocity, and network efficiency. However this requires supporting new consumer electronics devices that historically are not native to the cable network.

Traditional RF video only requires delivery to a limited number of customer premise devices (RF Set-Tops and Cable Cards) which present a highly controlled and predictable environment. In contrast, for ubiquitous IP Video deployment, IP Video needs to be delivered and supported across a wide and growing array of consumer electronic devices consisting of PCs, game consoles, mobile tablets,, Blu-ray players, Internet-enabled televisions (IETVs), phones, and a continually growing variety of consumer IP Video equipment. The diversity of IP Video consumer devices will only continue to grow.

Transport:

IP Video constitutes a new service, and the transport layer and bandwidth/ spectrum considerations are key elements of the end-to-end solution. Choosing the transport layer to launch and support this service requires careful consideration. In large systems, especially those under 860MHz, the available spectrum is limited.

Today, three major transport solutions are proposed for IP Video deployment:

1. *DOCSIS® 3.0 CMTS*  
IP Video transport of MPEG2, H.264 or other video formats via a DOCSIS® 3.0 CMTS with dedicated IP Video downstream channels to a modem.
2. *CMTS Offload Solutions like BigBand's vIP PASS™*  
Transport of video utilizing either existing MPEG2 or IP transport encapsulated with a DOCSIS® header and transported over the RF switched QAM tier to terminate on a standard modem. Encapsulation can also occur directly in the DOCSIS 3.0 cable modem. Modems are also simultaneously connected to a CMTS for upstream control plane communications.
3. *Transport Gateways*  
Traditional distribution of MPEG2 video over RF QAMs to a gateway in the home. A transport gateway has transcoding capabilities to provide in- home video conversion to IP over Ethernet and other CPE connections.

## Comparing Transport Alternatives

### 1. DOCSIS® 3.0 CMTS

A CMTS is highly effective for delivering high speed data and IP voice services. Typically, three to four downstream channels are bonded together to support speeds ranging from 50 Mbps to 100 Mbps (depending upon the number of cable modems per service group). Some MSOs combine IP voice and data in the same channels, while others prefer to dedicate a separate dedicated downstream channel for voice services.

Video is highly persistent and bandwidth intensive, in direct contrast to high speed data services that are “bursty” in nature. A managed IP Video service requires significant bandwidth with little tolerance for packet loss, especially for linear broadcast programming that is multicast. As the number of active IP Video viewers in a service group grows, the amount of bandwidth required can easily consume the majority of the CMTS capacity, leaving little bandwidth for other services like high speed data. A managed video service must also be careful to not run afoul of regulators and network neutrality versus unmanaged over the top (OTT) video from the Internet. Any design of a managed IP Video service for large scale deployment also likely requires a dedicated bonded channel group, separate of the channels dedicated for high speed data and IP voice services.

The CMTS uses Packet Cable mechanisms to authenticate modems and to provision bandwidth. Unfortunately a CMTS does not have a control plane mechanism that understands sessions, authenticates at the video service level, nor does it have the ability to combine multiple functions to create and deliver a service to the subscriber. Therefore, any IP Video service through a CMTS requires a separate session control layer in addition to Packet Cable. Additionally, most new customer IP Video devices require a DHCP server in order to establish a connection which is not available from the CMTS.

A CMTS operates strictly at the data transport layer and does not do any video translation or optimization based on the specific device requesting a service. It can work with standard IP Video Digital Rights

Management (DRM) Systems, including supporting multiple DRMs simultaneously. However, no CMTS supplier has put together an integrated end-to-end IP Video solution. Responsibility falls to the MSO to select the appropriate ecosystem including the program guide and digital rights management required to support a video service.

CMTS's have robust tools for measuring packet loss, jitter and delay. However, a CMTS is not "video aware" and has no concept of a program or session and no standard tools exist for measuring customer viewership of programs. As viewers move from watching programming on traditional TVs to IP Video devices, TV ratings must be measured differently. Broadcasters have indicated that in order to allow program distribution to these devices in the home they must measure viewership across all customer IP devices to more accurately measure program ratings.

Finally distributing video over a CMTS requires new monitoring and troubleshooting tools to ensure high quality video performance versus proven processes when going over traditional RF QAMs.

Other Considerations:

Many legacy CMTS equipment suffer performance degradation when enabling multicast video processing required to support a broadcast IP Video service.

A CMTS today lacks the ability to do media processing, such as transcoding or targeted advertising.

Bonded channels dedicated to IP Video services are fixed, and once a cable modem has tuned to a bonded channel group and is receiving a program in the group, it cannot simultaneously tune to other bonded channel groups. Therefore, the IP Video service group size may be significantly smaller than the service group size for high speed data and video offerings such as VOD or SDV.

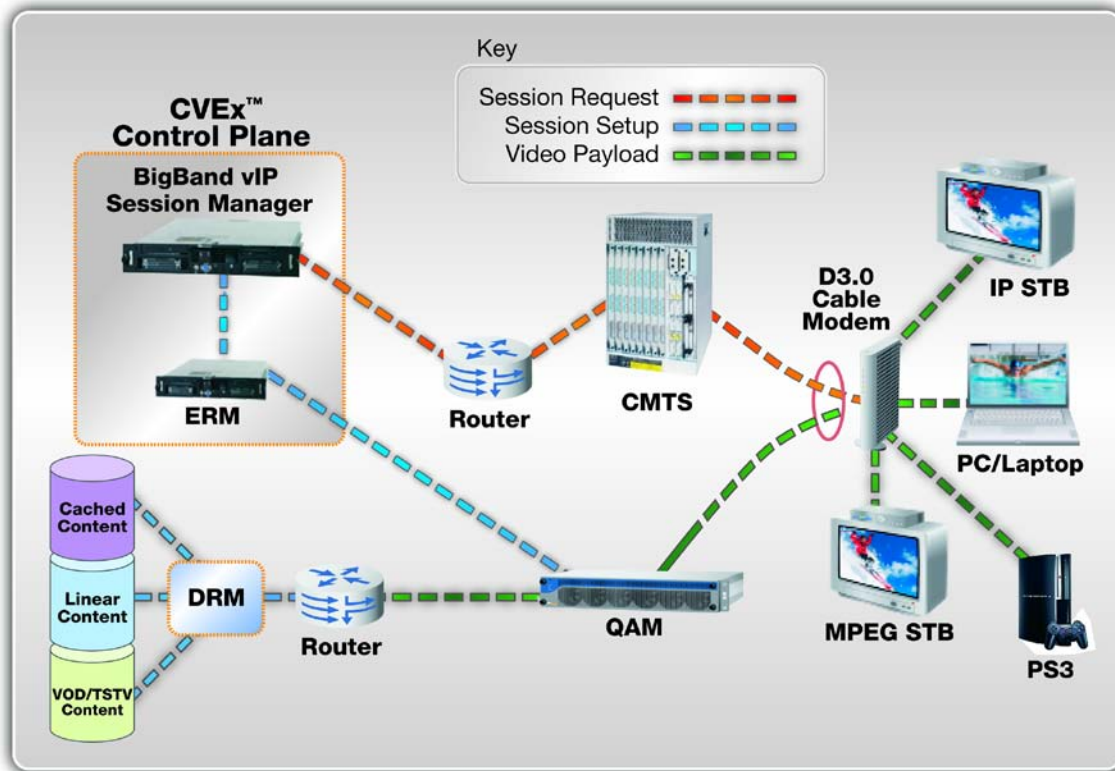
## **2. CMTS Offload Solutions (vIP PASS™)**

These solutions leverage existing infrastructure and complement the CMTS by offloading managed video and freeing the CMTS to support high speed data (including OTT video and IP Voice). This is achieved by employing a control plane to manage video and delivering it to the cable modem via proven and cost effective RF QAMs. DOCSIS® 3.0 cable modems (a.k.a. home gateways) have multiple independent tuners. Only one of these tuners must be connected to the CMTS to establish timing and modem authentication via Packet Cable standards. The remaining tuners can be divided between high speed data over the CMTS and managed video services over the RF QAMs.

As detailed in Figure 3, BigBand's vIP PASS™ uses the CVEx™ control plane as an extension to the SDV session manager to establish IP sessions. IP Video is then encapsulated in either the QAM and sent with a DOCSIS® header to the cable modem or directly in the DOCSIS 3.0 modem. Standard DOCSIS® 3.0 cable modems are loaded with a thin vIP client configuration that supports the vIP control plane communications via the CMTS. The cable modem also is responsible for acting as the content server in the home and converting the network based multicast traffic to unicast for distribution to standard IP consumer devices (most of which do not support multicast today).

The MPEG2 transport layer supports any underlying video format including MPEG2, MPEG4 and others. Another advantage is that IP Video and traditional RF video can be combined in the same service groups and even in the same QAMs. This is extremely advantageous as cable operators consider the migration of their network from RF MPEG2 to IP and MPEG4. Unlike a CMTS only solution, the operator does not need to manage multiple silos of spectrum and then constantly readjust service groups and spectrum as more customers move from MPEG2 to MPEG4 and IP. Additionally, any household can have any mix of IP Video CPE and traditional MPEG2 set tops for any combination of services, thus preserving prior MPEG2 capital expenditures while immediately enabling more cost effective IP and MPEG4 investment. Given that the

control plane is session aware it is also possible to conserve considerable bandwidth and only source the required IP content when specifically requested by a device. Once requested by a single device in a service area, the content is then also available for other devices on the network allowing the MSO to leverage significant multicast benefits.



**Figure 3: BigBand vIP PASS™ Solution**

This solution does not require any additional device authentication other than authentication of the cable modem which is already done by the CMTS via Packet Cable standards. Customers who are authorized for IP Video services would simply have their cable modems populated with the appropriate provisioning configuration (Data/ Voice and Video). This provides the benefit of supporting emerging business models and addressing the rights management required by content providers.

All session control is done via BigBand's CVEx control plane where service authentication is required and this is done by linking the navigation system into the existing back office system. This is highly similar to the way that premium RF services are authenticated today. vIP PASS has already been integrated with a number of such navigation systems.

IP Video requires protection at the content level. In contrast, traditional RF video is protected only at the transport stream level (Conditional Access - CA). CA does not work for IP Video because many IP devices can store content and proxy it on to other devices. Therefore, the content itself must be protected via a Digital Rights Management (DRM) system. vIP PASS has been integrated to work with many popular DRMs including Widevine, and Verimatrix.

Content Navigation and the guide will be key to the customer experience and a great challenge because of the number and diversity of IP Video devices that must be supported. The traditional approach using a set-top based guide is not practical. Rather, a network based or flash based guide with skinnable graphics allows IP devices to have the same look and feel as the operator's existing set-top guide while also supporting rapid

development of IP capabilities not found on RF set-tops. vIP PASS supports guides from a variety of companies.

BigBand's vIP PASS builds on BigBand's SDV architecture and is a plug-in to the CVEx solution so it includes a comprehensive set of tools to measure and report viewership, video service delivery, and video performance and service consumption across each service group. No other solution offers as comprehensive a set of existing proven video service and network service tools for both legacy and IP devices.

Other Considerations:

A significant advantage of the vIP PASS solution is also the ability to deliver IP Video to the growing multitude of CE devices in the home without requiring constant development or modifications by the MSO. BigBand has developed a Digital Media Server that implements the Digital Living Network Alliance (DLNA) capabilities in the cable modem/home gateway as part of the vIP client. This feature enables streamed content served from the network via vIP to be played out from the cable modem server to any IP Video device in the home or business. This means standard consumer IP devices such as mobile tablets/Apple iPads, gaming consoles, TVs and other devices that have implemented DLNA can access the IP Video services via open standards. All vIP PASS software that operates on the cable modem is DOCSIS® 3.0 conforming and has been tested and approved by the major DOCSIS® 3.0 chipset manufacturers. vIP PASS™ utilizes that standard DOCSIS® software upgrade mechanism for automatically installing software upgrades in the field.



IP Video presents additional challenges when it comes to addressable advertising. For Ad Insertion to work properly, IP Video must be decrypted, spliced and then re-encrypted, because IP Video content is pre encrypted via DRM. This is very expensive. However, vIP PASS has been integrated with the BigBand MSP2000, a multimedia system that is capable of splicing directly upon DRM encrypted content, thus making addressable advertising highly viable.

BigBand's vIP PASS also offers network and device aware switching. With the intelligence of which device is actually making a service request, it is possible to modify the service from the network to ensure that the proper stream reaches the end user. This could be basic manipulation such as DRM or more advanced such as transcoding or bitrate modulation.

### **3. Residential Gateways (Transport Gateways/ Hybrid Gateways)**

These devices are in development with the goal of eliminating the need for dedicating RF spectrum specifically to deliver managed IP Video services. They propose to convert standard MPEG2 video into IP Video at the home. The argument for residential gateways is that IP services can be immediately offered to customers without any changes to the cable infrastructure, but obviously a new device must be deployed and managed in the home.

Most of these devices are at the concept stage with pricing expected to be high on order of \$200-\$350 for a new device/ home (vs. \$50/ DOCSIS® 3.0 cable modems already widely deployed). Pricing and availability is obviously highly dependent on the final feature set and capabilities.

**Transport Gateways** consist of a DOCSIS® cable modem which can tune MPEG2 video channels and convert this to IP Video on an Ethernet output. They are traditionally limited to translating only MPEG2 channels that are transmitted in the clear. Therefore, only basic broadcast channels can be supported – no premium channels or VOD can be supported using this method.

**Transport Gateway Plus** include a multi-set cable card that is capable of decoding up to four simultaneous MPEG2 videos protected by conditional access. Premium videos can be decoded and then translated to IP Video on Ethernet output to multiple IP devices. However, the only protection to IP Video is via DTCP which is a transport layer protection, versus a content layer (DRM) protection. For first run movies that are available simultaneously on DVD and VOD, and for other premium content like sports events, programmers are likely to find the lack of DRM protection to be unacceptable. The cost of these devices is significantly more than Transport Gateways based on the additional cost of the cable card.

**Hybrid Gateways** are Transport Gateways that include a next generation set top chipset in place of a cable card. These proposed gateways, include next generation set top chip sets that are capable of transcoding so that IP devices with requirements for different bandwidths and aspect ratios can be supported. Unlike other transport gateways, they also include the capability to support one DRM system so that IP content can be protected. However, they are designed for video only and do not support high speed data and voice services. So the operator must also support a cable modem in addition to the gateway.

Proposed Hybrid Gateways include transcoding and the ability to support a single digital rights management protection system. Putting the DRM in the home has its own challenges. The IP Video world has not settled on a single content protection scheme and it is highly unlikely to do so for a number of years. For example, multiple device manufacturers support Adobe Flash® but Apple decidedly does not. MSOs will have to support multiple DRMs if they are to be perceived as customer device friendly. As proposed, an MSO that chooses Hybrid Gateways will not be able to support many customer IP devices because they will be limited to a single DRM.

The MSO will also be faced either with the prospect of a custom program guide which runs on the gateway and must be maintained specifically for that device, or alternatively, with integrating these devices to a network based guide. Neither of these is available today. Also none of the Gateways proposed include the ability to measure viewership. The problem becomes more complex when multiple consumer IP Video devices are connected to the gateway.

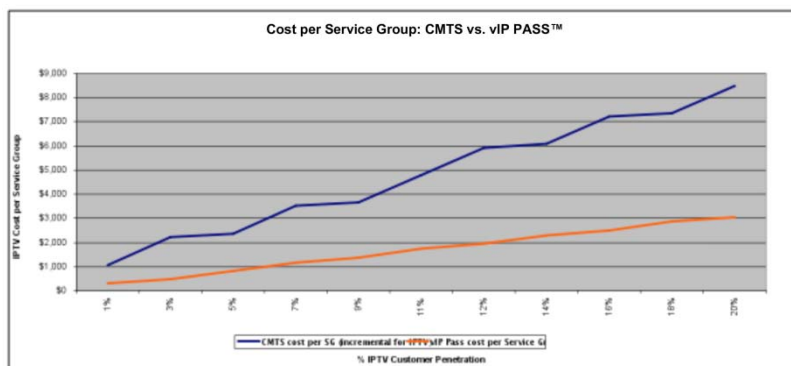
## IP Video Economics

BigBand Networks has built an IP Video deployment model that compares the costs and bandwidth required to deploy IP Video using the three transport alternatives discussed above. See Table #1.

	vIP PASS™	CMTS	Transport Gateway
<b>Cost per Channel</b>	Lowest	High	Highest
<b>Time to Market</b>	Now	Now	Prototype Only
<b>Investment Protection</b>	Software Only/ Upgradeable	Next Gen Being Developed	3 to 5 Year Life with Truck Roll to Upgrade
<b>Flexibility</b>	Standard IPTV Eco-system	Some Integration Required	Customization Required per Device/ Application

**Table 1: BigBand vIP PASS™ Solution**

The model was run using an aggressive CMTS downstream price per channel of \$1,000. At this price, using a CMTS to deploy IP Video is typically three to four times the cost of implementing the vIP PASS™ solution. Some claim that the price of a CMTS downstream will rapidly decline to \$500 or less. The model was run a second time at \$500 per channel, simultaneously projecting current pricing models for edge QAMS and servers which are used by the COS solution. Importantly, while this assumes very aggressive price declines on CMTS technology, the gap only narrows modestly. At \$500 per CMTS downstream, the vIP PASS solution still provides a 2½ times cost advantage. See Figure 4 below.

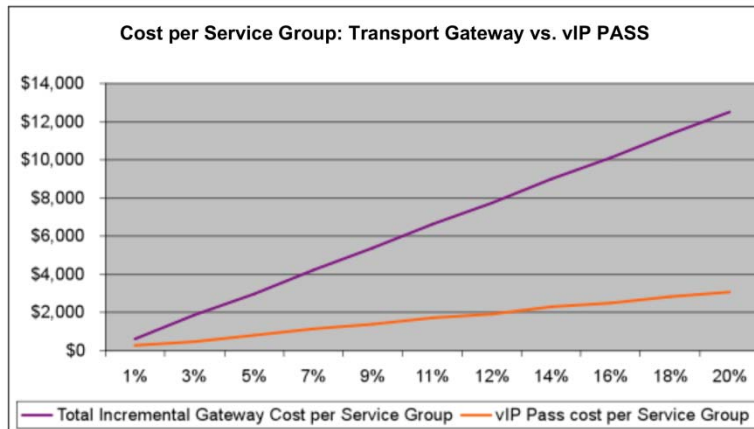


**Figure 4: Cost per Service Group (CMTS vs. vIP PASS™)**

At very high subscriber penetrations, it is also anticipated that the cost of the CMTS solution becomes significantly greater because it comes upon the limitation of service group size imposed by the maximum number of channels that can be supported in one bonding group. This limitation imposes additional costs and duplication of programming in the cable spectrum. The only alternative is to change out all cable modems in the future to those supporting more than 8 channels.

## Transport Gateways

Since delivery of only clear channel, unprotected program content was not deemed to be a commercially viable IP Video Service the model was run for Gateway variants that support premium MPEG2 channel delivery.



**Figure 5: Cost per Service Group (Transport Gateway vs. vIP PASS™)**

Over the long term, the economic claims of Transport Gateways do not bear out. Even with zeroing out integration costs, Gateways are an expensive alternative, much higher than the CMTS alternative. See Figure 5. Gateways become more expensive than vIP PASS even with conservative IP Video subscriber penetrations of 2% or less. Clearly, IP Video is expected to rise beyond this meager penetration in the first year of deployment. Transport Gateways are limited in that they do not support 1080p/3DHD channels nor narrowband IP Video channels without adding significant bandwidth to simulcast these formats on the cable plant. This negates the argument of bandwidth savings. Hybrid Gateways could conceivably support these channels, but at a very high cost per subscriber.

## Conclusion

Of the three alternatives, only BigBand's vIP PASS solution enables MSOs to take advantage of the IP Video opportunity today. It provides an evolutionary path that leverages the existing infrastructure with powerful economics and a fast return on investment (ROI). Not only is it the most costs effective by a factor of three to one, but it also offers MSOs a proven path to IP Video services very quickly (<120 days) using the proven SDV platform. From a commercial deployment standpoint, it is the only solution that is proven in large scale deployments and integrated with the required end-to-end solution elements of an IP Video ecosystem required for delivering a high quality managed IP Video service to subscribers.

Other alternatives such as Transport Gateways or CMTS only solutions have various limitations; whether they be issues related to scale, economics, quality of service, DRM, measurement and so forth that will hinder operators from rapidly, efficiently, and cost-effectively meet subscriber demand for IP Video services today.

Cable's Telco and Internet competitors are deploying IP Video today, and moving towards the vision of "Any Service at Any Time to Any Customer Device". For MSOs to maintain their subscriber base, they must respond quickly. They must begin immediately to launch managed IP Video services to the tens of millions of unmanaged customer premise IP Video devices that are already in subscriber's homes. Fortunately, vIP PASS is a commercially mature solution capable of providing this capability including all the tools necessary to measure and monetize these services. It is also the most economic solution for implementing managed IP Video services into the network with the highest quality video experience.

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