Analog Reclamation via IP DTA

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Abstract

Analog Reclamation is at the forefront of most Cable Operators minds today. In a 750MHz cable plant it is likely that half or more of the available spectrum is allocated to basic or extended analog programming. Obviously this spectrum is attractive to reclaim in order to add additional tiers of programming. Internet bandwidth usage is also growing rapidly, with peak hour usage growing at an annual rate of 40-50%. Analog reclamation could provide operators with the spectrum needed to meet consumer demands. Until this point one of the only options available for analog reclamation was to use a DTA, also known as a Digital Transport Adapter.

Traditional DTAs solve the analog reclamation problem by allowing an operator to move traditional analog subscribers to QAM delivered video with a very inexpensive device. Unfortunately the DTA device is limited in that there is no two-way communication capability with the network. For the subscriber this translates into no advanced Guides, no On Demand Capability and no way to consume OTT content.

This paper will describe an alternative to the traditional DTA called the IP DTA. This alternative leverages the operator's investment in DOCSIS 3 by using Bonded DOCSIS channels as the transport for the legacy analog tiers. The concept takes advantages of cost reductions in newer IP Set Top boxes coupled with cost reductions gained by using Downloadable Conditional Access (DCAS) for security. The paper will outline the network model and will demonstrate the ability to support the entire analog tier being carried on as few as 4 EIA channels. The paper will also highlight financial benefits and operator savings that can be realized by moving straight to IP versus going through a traditional DTA deployment.

Introduction

Today's Cable Operators are challenged with a growing demand from their subscribers for more High Definition programming and increased bandwidth for Internet access.

The fundamental problem is a lack of spectrum on the HFC plant. A typical 750 MHz cable plant supports approximately 116 EIA channels. The largest single allocation is the spectrum allocated for traditional analog programming. In many cases greater than 50% of a carrier's spectrum is allocated to carrying analog programming. Due to the size, it is this portion of the spectrum that is the most appealing to convert for other purposes such as increased DOCSIS capacity for IP Video and High Speed Data. Unfortunately most carriers still have a significant percentage of their subscribers who are "Analog Only" or have televisions that use the analog service.

The top of mind question for many operators is how to reclaim and repurpose this analog spectrum while continuing to provide services to the traditional analog subscriber base? The following sections will outline the different technology alternatives available to address this challenge, detailing the pros and cons. The paper will also introduce the IP DTA as a viable solution based on recent technological innovations.

Figure 1 Typical spectral allocation

Potential Solutions

Analog Reclamation using Traditional DTAs

One option to address the bandwidth constraint is to connect a Set Top Box to the TV and get the programming from the Digital QAM. This approach works because the programming is already replicated on the QAM. The Traditional Digital Terminal Adaptor (DTA) was created to serve as an inexpensive one way digital QAM fed CPE that does not have to support more expensive Content Protection capability. Because the analog programming is not encrypted, there is not a requirement to encrypt this content when it's carried digitally. While the Traditional DTA allows for encryption, the encryption technology is usually a much lighter weight technology than the traditional Conditional Access technology that is used to protect the higher tiers of programming delivered via Digital QAM.

Traditional DTA Advantages

Analog reclamation using DTAs is not a new concept and the technology is relatively mature. The prices for DTAs themselves are relatively inexpensive. Also deployment of DTAs requires minimal to no changes to the transport network. In almost all cases DTAs can be "self-installed" by the subscriber and do not require a truck roll to be deployed.

Traditional DTA Disadvantages

One of the biggest disadvantages of the current Traditional DTA is it is a one way device. This significantly limits its capabilities going forward and potentially pushes the DTA into early obsolescence. For example, the Traditional DTA is not able to receive a next generation two-way programming guide. The lack of such two-way capability also means that the Traditional DTA cannot be used to consume On Demand services which could result in missed opportunities for additional revenue for the operator. Because the Traditional DTA does not have the capability to support high security Conditional Access (CAS) it cannot be used to receive higher programming tiers that require CAS, again limiting the revenue potential for the operator. Also the lack of capability for a Traditional DTA to support two-way OTT (Over the Top) video services severely limits the platform. Many operators are beginning to view Traditional DTAs as a short term fix for the analog reclamation problem. Many operators view purchasing Traditional DTA hardware as throw away capital because the Traditional DTA does not have the ability to support many of the next gen video features and ultimately limits up-sell opportunities.

1 GHz Expansion

Although plant expansion is not typically considered a reclamation strategy, it is a valid approach to increasing available spectrum. Additional spectrum that can then be used to expand programming and High Speed Data services. Expansions to 870 MHz and 1 GHz have been performed by many North American operators. A 750 MHz to 1 GHz plant expansion provides approximately 40 more EIA channels to be used for other purposes.

1 GHz Advantages

Spectrum expansion provides the opportunity for the additional capacity to enable more programming and higher speed data services. The technology to enable this extension is reasonably mature. This strategy also allows the operator to expand capacity without having to change the analog programming tier, such that an analog reclamation strategy becomes additive.

1 GHz Disadvantages

The major drawback to the spectrum expansion strategy is cost. A migration to a 1 GHz plant is costly per subscriber, especially if coordinated with a move to smaller node sizes. Also, most legacy CPEs – (QAM Set Top Boxes and Cable Modems) cannot take advantage of the new spectrum. This means that operators will need to introduce new CPE hardware (at additional cost) to take full advantage of the upgrade.

Switched Digital Video (SDV)

Traditional QAM based Switched Digital Video (SDV) technologies take advantage of low concurrency for long tail programming, allowing less popular content to be switched on and off the HFC plant. Only channels that are currently being viewed take up capacity. This allows an operator to offer significantly more "low viewership" programs. It is possible to deploy SDV to reclaim spectrum that could be used to increase high speed data capacity, but most of the time, SDV is deployed purely to extend the programming lineup.

SDV Advantages

The advantage to SDV is that it provides a more efficient way to support more programming choices on the same spectrum by allowing less popular programming to only traverse the HFC network when a customer is viewing it. This approach allows the operator to offer more total programming choices. SDV technology is relatively mature and well understood.

SDV Disadvantages

While the technology for SDV is mature it is also very complex and expensive. It is worth noting that SDV technology is also proprietary from vendor to vendor. While the switching function provides a significant benefit because it targets low concurrency content it typically is not bundled with other network efficiency strategies such as newer and more efficient video compression. SDV also requires an expensive CPE that requires a Cable Card for content protection in the US market.

IP Digital Terminal Adaptor (IP DTA)

It is widely accepted that a migration to an all IP Video infrastructure is the desired endpoint for most operators. The challenge lies in the migration to IP while continuing to leverage a significant portion of the legacy investment in network and CPE. One strategy is to employ IP Video over a DOCSIS network. This is not a new concept, but up until recently hasn't qualified as a valid "Leap Frog" technology.

The concept is relatively simple. It requires creating additional virtual IP paths to the home using the bonding technology provided by the migration to DOCSIS 3.0. Using traditional IP Multicast Video technology this approach takes advantage of the concurrency gain for popular or "short tail" content. It also leverages newer compression technologies such as H.264 to further increase efficiency. In addition, IP Video over DOCSIS takes advantage of newer, more powerful and cost effective CPE such as DOCSIS 3.0 Cable Modems, Gateways and IP Set Top Boxes. Finally, this approach takes advantage of new Downloadable Conditional Access (DCAS) technology which eliminates the need for proprietary hardware or a traditional Cable Card.

The focus of this paper is centered on exploring a primary use case for leveraging current Video over DOCSIS technology as an alternative to deploying Traditional DTAs for analog reclamation. The premise is to retask reclaimed analog spectrum into DOCSIS capacity that will be used to simulcast the previous "Analog Tier" as IP Video over DOCSIS. The operator will then deploy an IP STB (i.e. IP DTA) to terminate this programming in the home.

Figure 2 Spectral allocation with IP DTA

IP DTA Advantages

There are many advantages to adopting IP over DOCSIS technology as an Analog Reclamation strategy. While the IP DTA is more expensive than the Traditional DTA it is much more "future proof" and is not considered throw away capital. The IP DTA is a two-way device that allows an operator to significantly enhance the customer experience compared to a Traditional DTA. At a minimum, IP connectivity allows operators to deploy advanced two-way programming guides and enable two-way services such as VoD. It also enables the operator to open up a much wider portfolio of programming and services that haven't been available on traditional QAM Set Tops, such as OTT content or content stored and delivered by other devices in the home. Video over DOCSIS can also be deployed with dynamic IP multicast so that only the content being viewed by a subscriber is put onto the HFC plant. This approach maximizes the efficiency of the simulcasted programming.

Most believe that Traditional DTAs have a limited life span and that the total CPE cost over time is less if an operator bypasses Traditional DTA deployments and moves straight to an IP DTA.

The migration to an IP infrastructure not only enables analog reclamation, it also introduces possibilities for future growth. As the operator expands the IP migration beyond just the Analog Reclamation use case the advantages significantly increase. The ability to support very secure content protection using downloadable CAS allows the operator to offer higher tiers of programming and an opportunity for increased ARPU. The two-way capability of the service also introduces On Demand Services, again allowing for an increase in ARPU. Going forward, migrating to an IP headend will also allow for a faster migration to headend based services such as Time Shift TV and Network/Cloud DVR. Centralization of these functions supports the migration of programming storage from the home to the network, ultimately providing a significant long term CPE savings due to reduced CPE storage needs and costs. In addition the IP headend allows the provider to provide IP based Video Services directly to additional devices. In addition to supporting the IP DTA, other common devices could be supported such as Tablets, PCs, Game Consoles, Connected/Smart TVs and IP Dongles. Over time this migration further reduces the home CPE costs as BYOD (Bring Your Own Device) technology replaces STBs. Not only does a migration to an IP Headend support the introduction of additional devices but it also enables advanced services such as

Advanced/Targeted advertising, further increasing additional revenue opportunities.

IP DTA Disadvantages

The primary disadvantage to using the IP DTA in conjunction with IP Video over DOCSIS as an Analog Reclamation strategy is the upfront cost. IP Set Tops are more expensive than a traditional QAM DTA in an "apples to apples" comparison. It is only when the deployment of the IP DTA is seen as a first step towards an overall migration to IP that the benefits become clear. Many operators are in the process of deploying IP Video services to unmanaged devices such as Tablets, PCs, and mobile devices and are already putting in place the headend IP technologies necessary to support IP Video services.

IP DTA Technology Enablers

In the last several years a number of technological developments have occurred which enable the use of the IP DTA as a viable option for analog reclamation.

1) Channel Bonding

In DOCSIS 3.0 [1], channel bonding was introduced in both the Downstream and Upstream directions. With this capability a number of channels can be bonded together to create a high bandwidth pipe over the HFC. Modems with this capability can simultaneously receive 4 or more downstream channels. This is a critical capability for the delivery of IP video due to the high bandwidth nature of video. With channel bonding not only is the pipe wider, but it is more efficient due to the statistical multiplexing gains achieved when aggregating a large number of streams together.

2) Multicast Support

DOCSIS 3.0 also includes a significant enhancement in the multicast support in DOCSIS. It includes support for Source Specific Multicast, and the ability to apply Quality of Service (QoS) to multicast flows. Video remains a one-to-many application where a large number of subscribers are watching the same set of video streams simultaneously. Such concurrence makes IP multicast suited for the delivery of video over cable networks. This rings true for the Analog Tier as well, especially because time-shifted content viewing is not typically available for the Analog Tier. By using IP multicast, the efficient delivery of the Analog Tier content over DOCSIS can be achieved.

A number of options are available for the delivery of multicast. Those include static multicast, dynamic multicast and the use of narrowcast or broadcast channels.

a. Static Multicast

The streams corresponding to the analog tier could be statically forwarded on the DOCSIS network using IP Multicast. Static multicast does not mean that the streams are propagated in the home network statically; rather they are carried over the HFC statically. Static multicast has the advantage that it is easy to provision because the bandwidth required for the video streams is known and is independent of the viewing patterns and popularity of these video streams in various fiber nodes. However the disadvantage of static multicast is that bandwidth is consumed irrespective of whether a particular stream is being requested by any user or not.

b. Dynamic Multicast

The video streams can be delivered via dynamic multicast whereby the streams are forwarded on a segment of the network only when a user requests it. This approach still provides multicast gains in that multiple users (on the same segment of the network) when viewing the same content receive the same replication. Another advantage to this approach is that if no users on a segment request a stream, then it is not forwarded on that segment thereby saving bandwidth that can be used for other services. Dynamic multicast can more effectively save bandwidth when service groups are small, and the lineup includes less popular channels. Dynamic multicast generally trades off spectrum savings for higher costs (due to narrowcast DOCSIS channels) when compared to static multicast.

3) RF Spanning

RF Spanning refers to the approach where a set of DOCSIS downstream channels are split across a number of Fiber Nodes. With RF Spanning a very large virtual service group can be created when a set of DOCSIS channels are split across all (or many) Fiber Nodes served by a single CMTS.

By bonding a few RF spanned DOCSIS channels and forwarding static multicast streams over this Bonding Group, an architecture similar to the broadcast architecture for traditional QAM video can be achieved. This is very cost effective because now the cost of delivering these IP video streams is now amortized across a large number of subscribers, perhaps across all the subscribers served by a single CMTS (Cable Modem Termination System).

Overall a very efficient delivery mechanism can be built by combining all of the features of RF Spanning as described above. (A more detailed description of many of the DOCSIS features that are critical for IP video delivery can be found in [2]). The most popular streams from the Analog Tier can be delivered as static multicast over the RF spanned channels, while the less popular analog channels can be delivered via dynamic multicast over the narrowcast DOCSIS channels. Both the narrowcast and RF spanned channels themselves can be bonded together to get the statistical multiplexing gains.

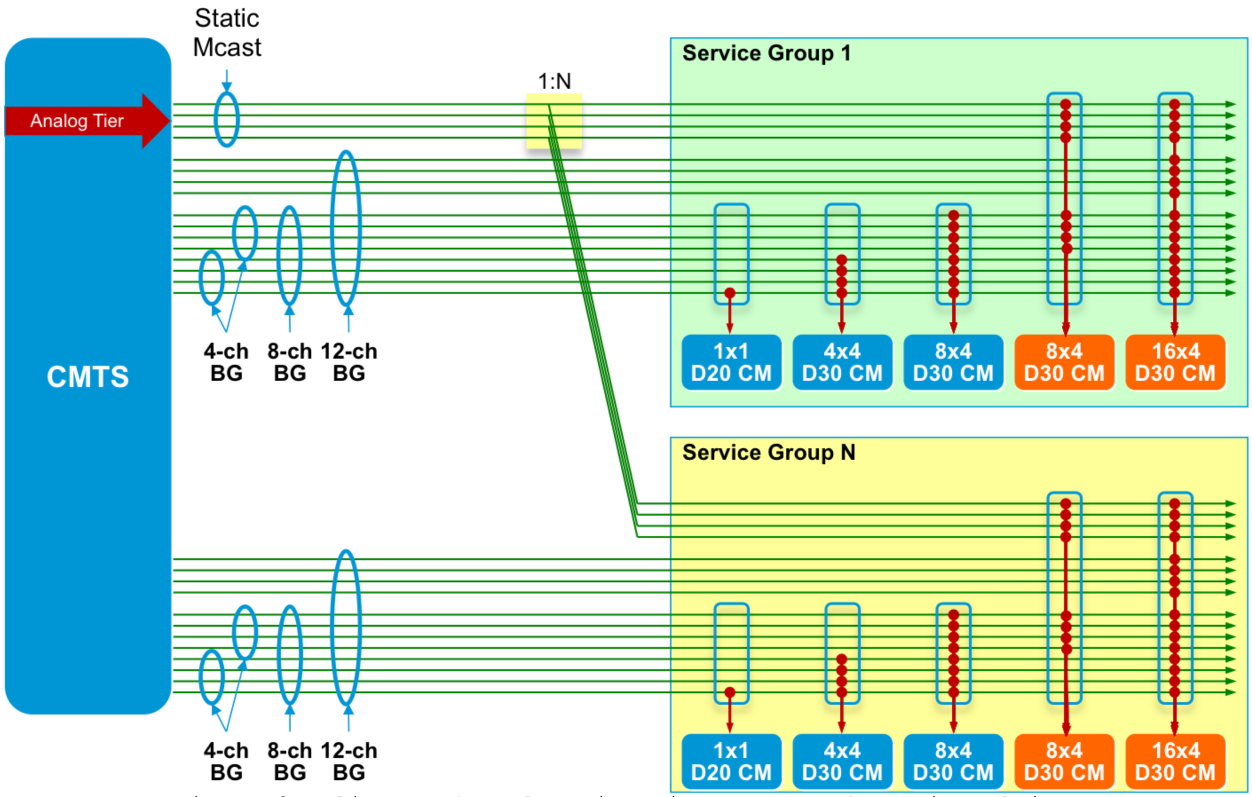

Figure 3 Delivery of Analog Tier via RF spanned static multicast

4) High Capacity Cable Modem technology

Video over DOCSIS had not been widely deployed in the past because high scalability Cable Modem technology was not available. Current 8x4 modem technology quickly becomes insufficient in a Video over DOCSIS model as higher tiers of programming and On Demand Services are added but could be used for the basic Analog Reclamation use case. Manufacturers are bringing Cable Modems to the market that support up to 24 or 32 downstream channels and up to 8 upstream channels. Operators are already evaluating and deploying this technology to offer enhanced High Speed Data offerings and this deployment of higher capacity devices will simultaneously enable managed IP Video services.

5) IP STB Technology

In addition to DOCSIS CPE technology, IP STB technology has also seen a number of recent enhancements. The next generation SOCs (Systems on a Chip) currently available from the major silicon vendors have enabled STBs with significant embedded processing capability. The addition of the new SOC allows these IP STBs to run very advanced middleware software that can process traditional linear video delivery and next generation cloud enabled services simultaneously. In addition the IP STBs also support the current and next generation 3D Electronic Programming Guides (EPGs). Other enhancements include support for advanced home networking technologies such as MoCA (Multimedia over Coax Alliance) 2.0 allowing customers to use existing home Coax to interconnect the devices. IP STBs are also beginning to support advanced Wi-Fi technologies such as 802.11n and the new

802.11ac standard. These advanced technologies also provide the potential for customer "self install" capability therefore reducing the cost of deployment.

6) Downloadable Conditional Access (DCAS) and Digital Rights Management (DRM)

Perhaps one of the most significant developments has been in the area of Content Protection or Conditional Access. Traditional Conditional Access technologies have historically relied on proprietary hardware based solutions and specifically, in the US market, has required the security to be separable which is achieved by utilizing a Cable Card in every STB. Vendors have begun publishing open standards for the hardware component of Conditional Access and silicon vendors have adopted them, making Downloadable Conditional Access a possible alternative to Cable Cards. This allows for a very strong Conditional Access system to be deployed on a generic hardware platform without the traditional Cable Card. In the US market there are examples of FCC waivers that have been granted to operators allowing for Downloadable Conditional Access to be deployed instead of Cable Cards.

For Unicast services such as Video on Demand, "long tail" linear or Time Shifted/Cloud DVR services, DRM (Digital Rights Management) technology can be applied for content protection. DRM is much better suited for Content Protection of Video services delivered via Unicast technologies. The next generation IP STBs have the capability to terminate both types of content protection mechanisms.

7) IP Error Recovery and Rapid Channel Change

Technology initially developed to support IPTV deployments in the Telco/DSL deployment markets has found a new life as well. Edge based servers can enhance the user experience and robustness of linear IP multicast delivery. By sending Unicast bursts to individual STBs, these systems allow for recovery of lost and corrupted linear IP Multicast packets. This same system can also be used to send Unicast bursts to a client enabling almost instantaneous Channel Change times. While not mandatory for an IP DTA deployment, these systems do allow for a mechanism to enhance a viewer's Quality of Experience.

8) Network Innovation

In the past, IP video migration had been harder to justify given the costs of the DOCSIS network and the scale of the CMTS products available. However in the last several years products with increasing density, scale and lower costs per DOCSIS channel have become available. The Converged Cable Access Platform (CCAP) [3] is in fact recognition by the industry of the need for high density, converged platforms that can aid in the IP video migration. The eventual goal with CCAP is to have all RF channels for a fiber node be stacked on a single spigot on the CCAP platform. The ever increasing density of the CMTS and CCAP products eliminate a major bottleneck in the IP video migration path.

IP DTA Functional Overview

Below is a diagram that outlines the high level functions for an IP DTA deployment that utilizes IP video over DOCSIS to support linear content.

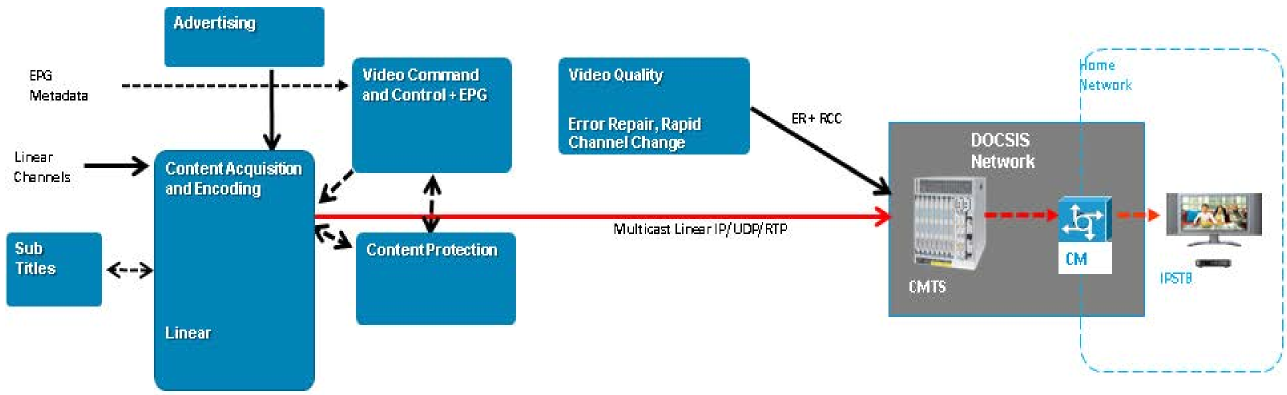

Figure 4 IP DTA Functional Diagram

The basis for linear content delivery is MPEG-2 Transport Streams delivered via IP Multicast. It is expected that most deployments would use an advanced compression technique such as H.264 as it is mature and supported widely on both the encoders and CPE. It is expected that a standard deployment would support Zoned Advertising, Sub Titles, Emergency Alerts and Closed Captioning, thereby matching current capabilities provided via Digital QAM delivery. In addition to these basic features, optional Error Recovery and Rapid Channel Change technology is available from several vendors in the market but is likely to be proprietary.

The in-home network requires a DOCSIS 3.0 Modem/Gateway to terminate the DOCSIS channels. DOCSIS 3.0 is required for most IP DTA deployment scenarios, especially for those that would eventually include offering higher tiers of programming and On Demand content. MoCA technology can be used as a wired networking technology inside the home in addition to wired Ethernet. It is expected that MoCA would be preferable as most subscribers already have coax deployed in the home. An option for Wi-Fi connectivity will also be offered to enable wireless deployment of the IP STB and eventual wireless support for other devices such as tablets, mobile phones, PCs, etc... It is expected that 802.11n technology moving to 802.11ac will be used to support Wi-Fi enabled IP DTAs.

Network Capacity Requirements

One of the important motivations for analog reclamation is to reduce the spectrum inefficiency that is a characteristic of analog video. Hence it is important to understand the spectrum requirements for the IP DTA proposal.

Given that this would require new DTAs to be deployed it is very likely that the DTAs would be H.264 capable, and hence all streams would be delivered via H.264 which is about twice as bandwidth efficient as the MPEG2 codec. Typically Standard Definition video can be encoded with good quality at about 2 to 2.5 Mbps. High Definition video will likely require about 6.5-7 Mbps with constant bit rate encoding.

The bitrates mentioned above correspond to constant bit rate (CBR) encoding, which requires more bandwidth than variable bit rate (VBR) encoding. The use of VBR streams generally provides significant bandwidth savings but comes with a corresponding challenge in managing a multitude of VBR streams in a fixed bandwidth pipe. As shown in [4] when delivering video over IP, VBR encoding can be used to reduce bandwidth consumption by about a third compared to using CBR encoding. The statistical gains from multiplexing a larger number of streams in a fat pipe (enabled by DOCSIS 3.0) make these bandwidth savings a reality.

The spectrum required for IP DTAs depends not only on the bitrate of the streams (SD vs. HD, CBR vs. VBR) but also on the architecture used for the delivery of these streams.

Static Multicast with RF Spanning

Most operators have an average of 65 analog video channels on their HFC (Hybrid Fiber Coax) plant today. Assuming that all of the video channels are carried over IP for IP DTAs, this scenario would require that the HFC plant carry 65 IP video streams. Given that analog video by nature is not high quality video, it may be sufficient to deliver these streams in the Standard definition format. If these streams are encoded in H.264 and in Standard Definition format, then they would require approximately 2.25 Mbps per stream, which translates to 146 Mbps for the entire lineup of 65 streams. The bandwidth required for statically forwarding all of the streams fits well within a 4 channel Bonding Group, assuming 256 QAM 6MHz channels.

Therefore the entire Analog Tier lineup can be transmitted in Standard Definition over IP using 4 DOCSIS downstreams on a CMTS to feed all of the Fiber Nodes on the CMTS. This is very appealing because now the spectrum requirements for the Analog Tier can be reduced from 65 RF channels to just 4 RF channels.

As discussed earlier when statically multicasting streams, the operator could RF span these DOCSIS downstreams that carry the video to many or all Fiber Nodes served by the CMTS. Hence with RF Spanning only 4 DOCSIS channels need to be provisioned for an entire CMTS. This not only reduces the cost for the operator but also helps preserve CMTS capacity for other narrowcast services.

If IP DTAs were being pursued ahead of the overall IP video migration, then it may be efficient to stream these streams in Standard Definition format, rather than High Definition format. However if IP DTAs are being launched along with an overall IP video migration initiative then it is worth considering streaming all of the Analog Tier content in a High Definition format. The reason for that approach is that many of the channels will already be sent in High Definition format, so instead of carrying both formats of content, it may be more efficient to simply carry the High Definition format and have the IP DTA downscale it to Standard Definition as needed.

Today often times the same content is carried 3 times – once as part of the analog tier, second as Standard Definition digital video, and third as High Definition video. We are proposing that when deploying the IP DTA along with an overall IP video migration for the entire lineup, it may be prudent instead to carry a single copy of the content in the High Definition format. Of course the Standard definition and High Definition digital video channels delivered via QAM video will still need to be carried to be able to support the vast number of digital STBs already deployed.

The following table shows the number of RF channels required if all 65 analog channels are delivered as a combination of all Standard Definition, an equal mix of Standard Definition and High Definition, and all High Definition.

Format	RF channels required (CBR)	RF channels required (VBR)
All SD	4	3
Half SD and Half HD	8	6
All HD	12	8

Table 1 RF channels required

As can be seen from the table above, the capacity required for delivering the Analog Tier via IP multicast is well within the scale of today's CMTS and Cable Modem products.

Combination of Static and Dynamic Multicast

Another option is to carry the lineup as a combination of static multicast and dynamic multicast. This would be more spectrum efficient than the "all static multicast" approach if several of the streams in the Analog Tier are in fact long-tail content and are not being viewed in all Service Groups at any given time.

Dynamic multicast has similar gains as Switched Digital Video since streams are not forwarded to Service Groups if no viewer is actively viewing those streams.

Depending on what percentage of the Analog Tier content is long-tail versus short-tail and what kind of over-subscription gains can be achieved on the long-tail content, the number of RF channels required for the service will vary, but will be less than the number of RF channels required in the static multicast case.

Summary

This paper has documented a fundamental problem facing most Cable Operators today. In most scenarios, Cable Operators have exhausted the HFC spectrum that is required to offer additional programming and increase High Speed Data capacity. One alternative is to expand the HFC spectrum out to 1 GHz and provide "new" spectrum. This approach is burdened with high infrastructure cost combined with a need for new CPE that would be required to use this "new" spectrum. Another option for addressing the bandwidth constraint is to deploy Switched Digital Video technology however this option is not likely to provide the significant spectrum re-allocation necessary for increased High Speed Data.

Two strategies for Analog Reclamation include the Traditional DTA and the IP DTA. The traditional DTA is a viable and mature technology for reclamation however the Traditional DTA device is one-way and does not support advanced programming guides or next generation two-way services. The Traditional DTA is considered a short term solution to the problem until operators can eventually migrate to IP delivery.

The IP DTA approach provides the benefits of Analog Reclamation coupled with a more future proof CPE instantiation. This approach begins with an Analog Reclamation strategy which allows for the deployment of a powerful and inexpensive IP STB (the IP DTA) which receives its linear programming via IP Multicast Video over DOCSIS. While the initial cost of this solution seems to be more expensive than a traditional DTA deployment, this is more than offset in the long term. Long term CPE costs are lowered by not having to deploy traditional DTAs in the short term and then replacing them several years later with a newer more capable IP STB. Moving to a device that supports IP delivery also opens up many additional revenue opportunities for the operator such as subscribers upgrading to higher programming tiers and purchasing On Demand content. In addition, the migration to an all IP headend infrastructure allows for additional services to other devices in the home such as PCs, Tablets, Smart TVs, and Game Consoles eventually reducing the need for additional IP STBs.

There is an underlying technology convergence which serves to enable the migration to an IP DTA solution. These technologies include a combination of higher capacity DOCSIS CPEs and high powered IP STBs that support downloadable Conditional Access. In addition innovations in CMTS technology have driven DOCSIS downstreams costs down significantly over recent years.

An IP DTA solution is now a viable alternative to other methodologies to help solve the HFC spectrum exhaustion issue. The IP DTA solution also provides a leapfrog approach to IP services which is the ultimate destination for most operators.

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