# SYSTEM MANAGEMENT IN AN EBIF WORLD

Kevin Taylor, Joshua Seiden, Jeff Calkins
Comcast Cable

*Abstract*

*In this paper we will examine the challenges that face the MSO community in deploying and managing an end-to-end EBIF system. The EBIF system architecture and its challenges will be reviewed. The issues related to the EBIF Video Data Path and the Data Signaling Path will be examined. Also, guidelines for EBIF application developers will be presented for an application to be well-behaved on a MSOs network. Finally, EBIF diagnostic applications will be proposed to aid in the monitoring and management of the EBIF Video Data Path and Data Signaling Path.*

## INTRODUCTION

The cable industry and their programming partners have a unique opportunity to enhance the video product offered the consumer with EBIF applications. For these enhancements to be successful there needs to be a focused effort to prepare the MSO video path and data signaling path to support the requirements of the EBIF delivery and data return infrastructure. Without careful management of the cable operator's system resources, the customer experience will not be acceptable and the end-to-end system will exhibit instability. In this paper, we will examine the challenges of enabling the MSO EBIF video delivery path, managing the data signaling path in an EBIF enabled system, and propose EBIF applications that will be useful in diagnosing end-to-end system problems.

In discussing this topic, there are two primary areas of the cable operator's infrastructure that will be discussed.

**EBIF Enhanced Video Path** – The EBIF Enhanced Video Path includes the origination of the EBIF application and its data, the delivery of the EBIF application to MSOs headend and hubs, and the final delivery to the consumer premise equipment (CPE). This path includes all encoders, groomers, multiplexers, ad splicers, encryption devices, QAM modulators, and transmission channels.

**Data Signaling Path** – The Data Signaling Path includes both the out-of-band (OOB) forward data channel (FDC) and the return data channel (RDC). There are primarily three classes of technology used in the Data Signaling Path: ANSI/SCTE-55-1, ANSI/SCTE-55-2, and DSG/DOCSIS.

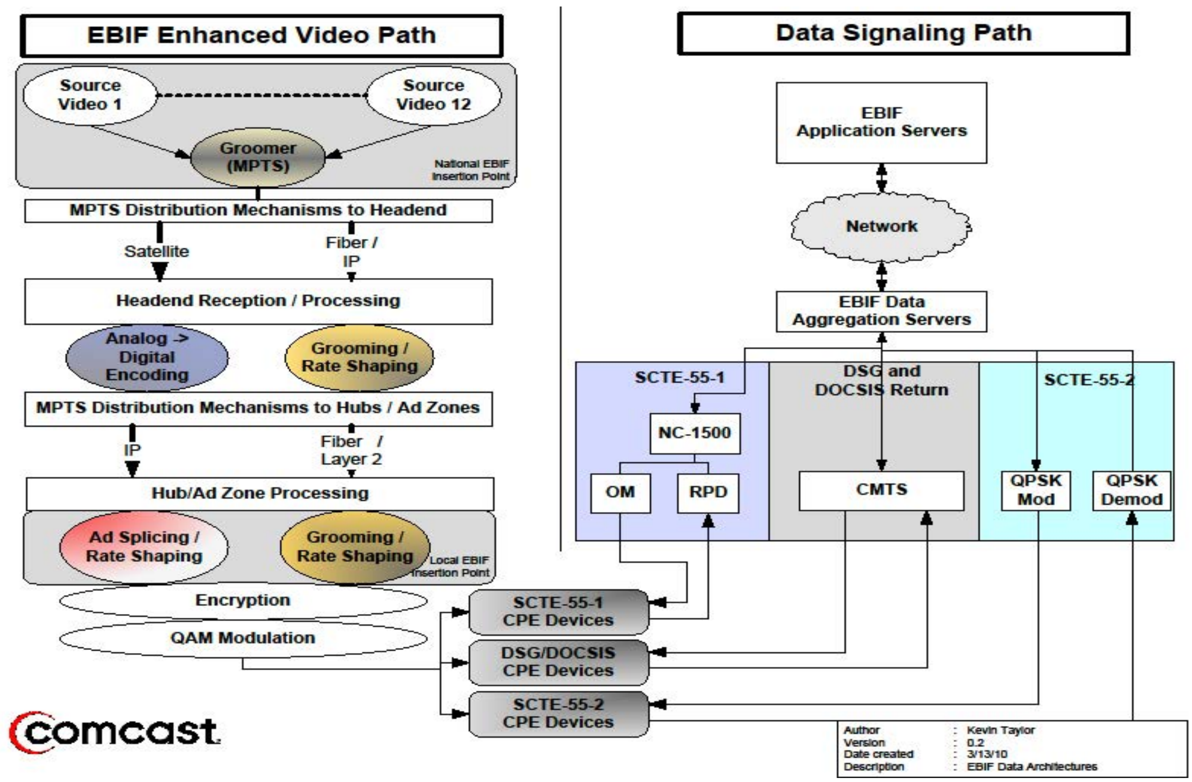


**Figure 1 – End-to-End System**

## EBIF ENHANCED VIDEO DELIVERY SYSTEM ARCHITECTURE AND CHALLENGES

The delivery of EBIF enhanced video can be done by one of two originators – a broadcaster or an MSO. Broadcasters may choose to enhance their national broadcast with EBIF and deliver it with the largest possible footprint, or they may choose to deliver EBIF applications and data separate of the video to achieve a localized feed. MSOs will also originate their own applications by multiplexing EBIF applications and data at the headend to enhance their services. MSOs may choose to use bound applications for content they own, but they may also deploy unbound applications that enhance their products, i.e. Caller ID to the TV.

Challenges exist that may force a broadcaster or MSO to localize the delivery of EBIF applications and data. Current EBIF deployments face the fact that different EBIF User Agents may present EBIF applications differently. This issue has been addressed to some degree by the adoption of EBIF I05 across MSOs, particularly for those MSOs involved in the Canoe project. EBIF I05 does ensure a baseline of functionality that works across all user agents, but beyond that baseline the concept of localizing the EBIF application and data helps to address variances.

One specific concern is that for VOD Telescoping applications, VOD asset IDs are not consistent across servers. This complicates the VOD Telescoping application by forcing the application developers to validate that the asset ID in the application is the correct asset on the VOD server. Both of these issues will be addressed in the upcoming I06 version of the EBIF specification, however, until I06 User Agents are deployed widely, these are issues that must be manually managed by the broadcaster and the MSOs. The best way to manage these issues prior to I06 being available ubiquitously will be to localize the delivery of EBIF applications and data.

National vs. Local Delivery

The delivery of EBIF applications and data across a large footprint can take two forms – national or localized. A broadcaster who is trying to reach maximum footprint on their delivery may choose to insert the application and data at the origination site or uplink. The architecture to do this is seen in Figure 2.

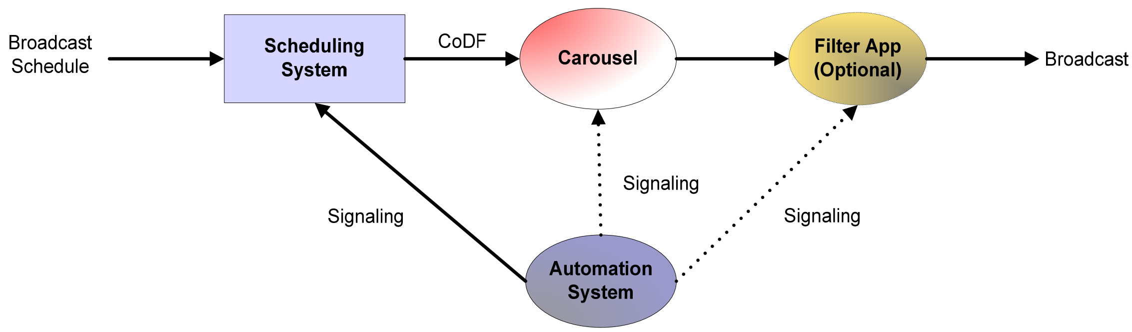


**Figure 2 - EBIF Broadcast Center Architecture**

Broadcasters need to accomplish two primary objectives when enhancing their feeds with EBIF. First, they must make sure that any applications inserted in the broadcast are not shown during advertisements. While unbound applications may be allowed to overlay any video source, bound applications cannot overlay a third-party's ad spot. To do this, one can take two different approaches. A filter application can be deployed to take signaling from the automation systems and block an application coming from a carousel. Also an interface into the existing scheduling system can be implemented from the automation system to the scheduling system, which in turn can shut off the EBIF application in the carousel.

All broadcasters must also be aware that their control of the signal ends when the broadcast leaves the uplink or origination site. At the headend, MSOs may groom services in a multiplex for more efficient transmission on the cable plant. An MSO may be throttling bandwidth of a service without the broadcaster's knowledge. For example – it is likely that an MSO would take an SPTS from a broadcaster and then groom it into an MPTS for distribution on their network. In this case, a service has the potential to have its overall bandwidth reallocated to achieve the MSOs most efficient use of bandwidth. When this happens, any service with extra bandwidth, EBIF PIDs, other data PIDs, alternative audio, etc. may be subject to this bandwidth reallocation. At this time, the only means to save bandwidth on a service is to take away from the video. Therefore, MSOs may choose to lower the video quality in order to fit the service into an MPTS or channel. For example, EBIF bandwidth is typically limited to less than 200kbs. Lowering the bandwidth on the EBIF application increases the application's launch latency, but currently the bandwidth allocated for the EBIF data cannot be modified. No tools exist today to throttle EBIF data or application PIDS in an MPEG stream while leaving others unchanged. In addition, many EBIF data streams are synchronous to be frame-accurate with the video stream – in this event, even if the data PID could be throttled; doing so would harm the context of the application.

The 200kbs limit may not sound like much, but as more and more services become enhanced with EBIF, multiplexes will have to adjust to carry the additional data. If an MSO is carrying 12 services in a multiplex, and all services are enhanced with EBIF, a potential 2.4Mbps of EBIF data overhead exists. This additional bandwidth may force the cable operator to lower the bandwidth allocated in the video in order to make room, thus degrading picture quality.

As more and more applications are deployed, content providers will begin to see the need to localize their application data on national broadcasts. Differences in EBIF User Agents, VOD systems, and the desire to localize data being presented to the user will cause the content providers to rethink their EBIF distribution model. Implementing different versions of an application or sending localized packages of data over satellite will quickly become unscalable. The only option in this case is to separately deliver the EBIF component of a service terrestrially and then multiplex it back into the video locally. This will not only allow for more efficient utilization of satellite bandwidth, but will also enable EBIF applications to be localized directly to the settop box population.

<u>National Delivery of Localized Data</u>

As EBIF applications become more prevalent, broadcasters and MSOs will need to localize the delivery of applications and data. This will not only lessen the impact of some of EBIF's current limitations, but will also allow the application to become localized. With localized delivery, an application can present data that is meaningful to the consumer at a much granular level. For example, News/Weather/Sports ticker applications can provide local data, advertisements can link or click-to-call to the consumers local store, etc. To accomplish this, it becomes necessary to delivery the EBIF application and data separately from the video and audio. The Broadcaster can continue to deliver the video content via satellite (or terrestrially), but the carouselled EBIF data is sent terrestrially to a remote groomer at the headend. At the headend, the EBIF PID is groomed back into the video source and the interactive service is modulated for the plant. (See Figure 3)

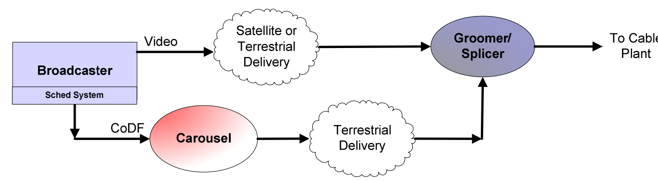


**Figure 3 –EBIF Local Data Delivery for National Broadcast**

<u>Local Delivery of EBIF</u>

MSOs are increasingly deploying EBIF applications to enhance their service offerings to customers. EBIF can be leveraged to provide unbound applications such as guides, caller ID, news and weather tickers, etc., or can be used to enhance local programming (vote and poll during the local news, etc.). (See Figure 4)

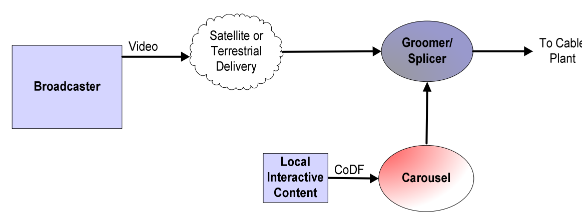


**Figure 4 – MSO EBIF Insertion**

In this case, the distribution of the EBIF application is more complicated depending on the content that the app is overlaying. The MSO may have a local carousel or may receive an EBIF stream from an aggregator. Content will usually be sent to the carousel via the CoDF format. The carousel will then send the EBIF data to a groomer based on either a manual schedule or schedules received via CoDF. The data can then be groomed into an existing video feed or the out-of-band channel at the edge.

Many challenges exist when inserting an application locally. The largest challenge that has yet to have been solved is scheduling an application so that it does not overlay on National Ad spots. In a case where local spots are being inserted, Q-tones or digital ad insertion signals (SCTE-35) can signal a carousel to suspend an application. However, from the perspective of a local broadcast, a national spot looks as if it is part of the video, i.e. there is no signaling to determine when the national ad starts and stops. This challenge will have to be solved to automatically prevent the overlay of national spots, but until then, MSOs must schedule their carousels appropriately to prevent this from occurring.

The issue of a MSOs rights to overlay existing content with a third-party application is in a nascent stage. Content providers, MSOs, and Application Developers will have to solve these issues in the near future.

## DATA SIGNALING IN AN EBIF ENABLED SYSTEM

### Description of the OOB and Return Channel

In the North American MSOs cable systems, there are three main types of out-of-band (OOB) signaling and return path. These three types are SCTE-55-1, SCTE-55-2, and DSG/DOCSIS. In preparation for our discussion of the data signaling problems in an EBIF enabled environment, we will do a quick summary of these technologies and a review of the main characteristics of these OOB and Return Path Signaling technologies.

**ANSI/SCTE-55-1** – SCTE-55-1 is used in cable systems supporting the DigiCipher settops and host devices. This approach uses an out-of-band (OOB) channel that has a data rate of 2.048 and return path employing Aloha. It is based on technology developed by General Instruments (Motorola).

**ANSI/SCTE-55 -2** – SCTE-55-2 is used in cable system supporting the PowerKey settops and host devices. This approach uses a DAVIC OOB and return. It is based on technology developed by Scientific Atlanta (Cisco).

**DSG and DOCSIS** – Data Signaling Gateway (DSG) is a protocol for sending one-way message through the DOCSIS channel. DSG/DOCSIS is increasingly used for CPE device signaling and the footprint of this technology is expected to continue to grow.

Another of the primary challenges of launching EBIF in the existing legacy systems is the use of the legacy data signaling paths for the EBIF data return. The current data signaling paths carry guide data, VOD data, polling, code download, and other application data. The downstream signaling paths are already run near capacity, and the return signaling paths are also reaching their saturation point with the addition of new interactive applications. This is the environment into which the EBIF applications are being introduced. This requires a careful engineering and management of the data signaling path to enable successful launch of EBIF applications.

EBIF applications bring with them a set of network loading characteristics that have not been seen previously in cable operator networks. These network loading models include time synchronized events and channel synchronized events, as well as the existing network loading models. The large scale of planned EBIF deployment and the ability to create highly synchronized events has the ability to create very large scale network events that can overwhelm the MSOs network without careful engineering of both the EBIF applications as well as careful engineering of the MSO network. Another important fact is that the same EBIF application may be running on devices that are part of each of the three types of data signaling path simultaneously requireing engineering to the lowest common dominator network characteristics. This implies that these EBIF applications need to be designed to work on the most constrained of the networks. It should be remembered that the two legacy networks (SCTE-55-1 and SCTE-55-2) have been deployed for more than 12 years. The process of laying down the EBIF infrastructure on top of the existing legacy data signaling path should be viewed as a retrofitting of the legacy data signaling path requiring a disciplined engineering approach to layering EBIF applications onto the existing data signaling paths. This retrofitting should include the two following areas of focus:

- EBIF Application Developers Guidelines
- Signaling Path Management and Monitoring

<u>EBIF Application Developers Guidelines</u>

There are several guidelines that application developers should follow in their design of applications that are destined to run on the MSO Data Signaling network.

*Data Signaling Path Capacity Constraints* - EBIF Applications are run on MSO networks that are constrained in capacity and already carry a significant network load. Therefore the EBIF developer needs to take great care in designing the data signaling path loading characteristics of the EBIF application to carefully use the data signaling path resources.

*Data Signaling Path is a Shared Resource* – The MSOs data signaling path is shared amongst several applications that need low latency responses. These applications include VOD and SDV. It is important to the customer experience that there is always capacity to service these types of requests.

*Event Timing* - One of the most important design points of the EBIF application will be what kind of synchronization is created as EBIF applications respond. MSO data signaling paths are engineered expecting randomized return events from individual devices. If large numbers of CPE devices are synchronized to respond at the same time due to either application characteristic or synchronization with the EBIF enhanced programming, the data peak will be more than the MSO network can accommodate. Therefore the designers of EBIF applications need to take into account the network characteristics of the MSO network to create EBIF applications that are well behaved. EBIF applications need to be designed to randomize the response timing as much as possible to smooth peaks.

*Protocol Design* - The legacy signaling paths are well-behaved when the offered load consists of smaller return messages spread over time. The EBIF application provider needs to keep the return message size as small as possible and randomized over time.

*Network Cell Boundaries* - EBIF application developers need to be aware of the underlying data cell size for the networks that the EBIF application will be running on. The EBIF developer should take cell boundaries into account to minimize the number of upstream cells required to deliver return data back to the application server. In the SCTE-55-1 protocol, each upstream cell requires a downstream acknowledgement. For example, an application going from requiring one cell upstream to requiring two cell upstream not only doubles the amount of upstream bandwidth, but it also doubles the downstream bandwidth to acknowledge the upstream cells. There are step functions in how the application uses network resources, and application developers need to know where these step functions are and work to minimize resource utilization and not cross the step boundaries unless necessary.

To some developers, these recommendations may seem extreme. However, a single poorly design EBIF application can significantly impact customer experience and MSO revenue associated with VOD, Caller Id, Guide response times, and other applications running on the subscriber's CPE. A suite of well-behaved EBIF applications can greatly extend the data signaling path to handle additional applications adding greater value to the cable product offering.

<u>Signaling Path Management and Monitoring</u>

The current SCTE-55-1 and SCTE-55-2 signaling paths are now more than 12 years old which is a lifetime in terms of technology lifecycles. Also, these channels are significantly constrained as compared to the DSG/DOCSIS channels. The legacy signaling paths require greater care and management. However, the majority of cable CPE devices are managed from these legacy signaling paths. Therefore it is imperative that the cable operator carefully manage these signaling paths to allow a positive customer experience for the new EBIF applications that need to use these communications channels.

*Forward Data Channel Bandwidth Management*

Over the past two years there has been on-going work in Comcast markets to better understand and manage the data signaling path. One of the most surprising results of this work was the discovery of the importance of management of the forward data channel and the fact that the forward data channel was one of the first bottlenecks that needed to be remediated. The results of the changes were quite surprising.

- Code down load time was cut in a third due to eliminating the data peaks that were overrunning the network
- Warehouse staging time was significantly cut. Prior to the network changes about 20% of the settops needed to be re-hit from the billing system. After the network change, the number of re-hits was less than 2%.

From the work done in the Comcast markets, several guidelines have been developed to guide the management of the forward data signaling path. The cable operator needs to manage their forward signaling path by:

- Have a forward signaling path bandwidth budget and manage to the budget. The bandwidth budget needs to take into account both average and peak values. In the Comcast example from above the significant improvements were generated by improved management of the data peaks.
- Work with equipment and application vendors to make sure data sources conform to average and peak data budgets. Prior to the advent of EBIF applications there was enough head room in the data stream to absorb data peaks. However, with the increased load on the network this head room is no longer present and these peaks cause data loss impacting the customer experience.
- Data packing on the Ethernet interfaces needs to be as efficient as it can be. Another problem that was discovered was that when many UDP packets containing a single MPEG packet are processed, the network processing equipment can be overrun. The downstream QPSK runs much more efficiently when the UDP packets are full of MPEG transport packets.

- Monitor the forward path for data loss on both the network and cable interfaces. Much of the data delivered to the data signaling path is delivered in UDP packets which do not guarantee delivery. Also, any network design issues, network changes, or increased traffic can result in data loss on the network feeding the forward data signaling path causing customer impacting events. There are many events that can impact the data signaling path and the only way for the cable operator to pro-actively address these issues is to invest in the appropriate monitoring infrastructure.

The following graphs represent data captures from a Comcast market on the forward data signaling path. In this example, the forward data signaling path bandwidth budget is currently allocated to the ALOHA network proxy (1000kbps), the controller (750kbps) and the guide stream (150kbps). The system streams are dynamic and peak usage can exceed the QPSK downstream modulator's capacity, causing it to drop packets. Because the three systems share the downstream QPSK bandwidth, budget exceeding transients by any of the systems can be operationally or customer affecting. Managing the ALOHA downstream bandwidth is critical for EBIF applications that primarily send upstream messaging; because each upstream cell has a downstream bandwidth cost tied to "acking" each upstream cell.

A mid-week downstream graph of the interactive network proxy that is allocated 1000kbps is captured below. (See Figure 5)

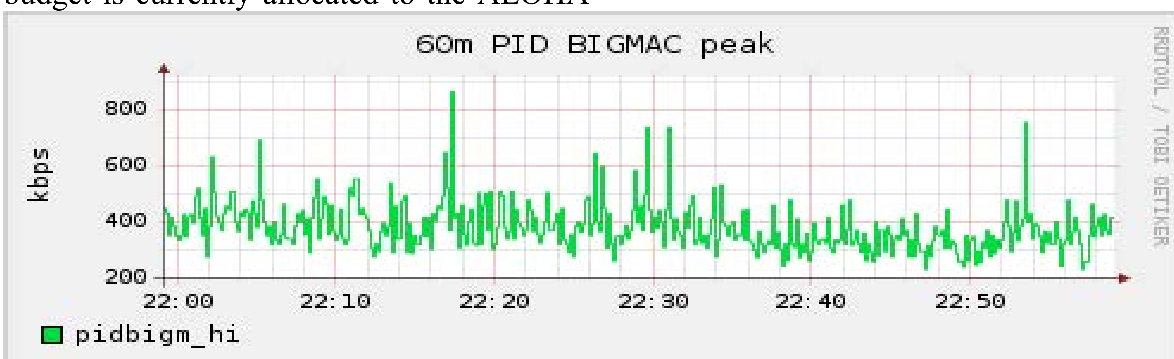


**Figure 5 – ALOHA Network Proxy Downstream Data**

The controller bandwidth is currently allocated 750kbps of the downstream QPSK bandwidth. The controller streams are moderately bursty. The green waveform (upper waveform) identifies transient 100msec peaks whereas the black waveform (lower waveform) shows an average one second load. (See Figure 6)

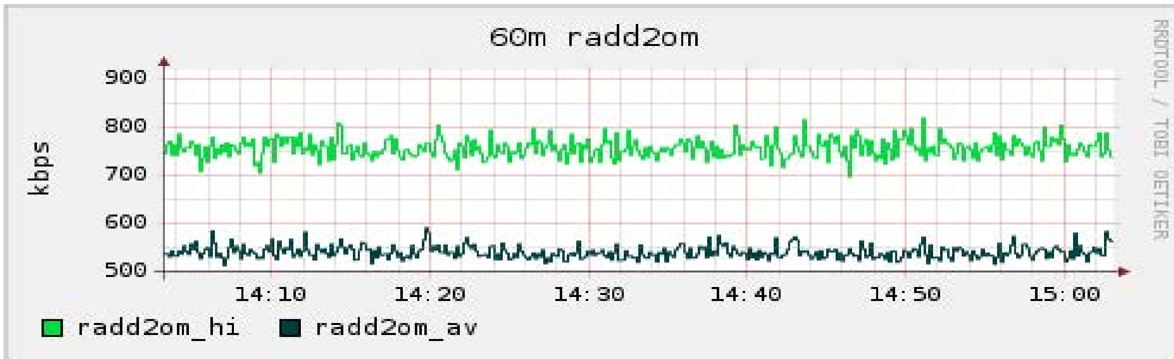


**Figure 6 – Control System Downstream Traffic**

The controller bandwidth consists of the system control PIDS and code download (CDL) object carousels. The system control PIDS are made up of PAT (PID 0), CAT (PID 1), the NETWORK PID (PID 777) carousel for transmitting channel maps and EMM (PID 1503 and 1504) used to transmit settop control messaging. The following 60 minute production graphs the controller system PID peak transients. (See Figure 7)

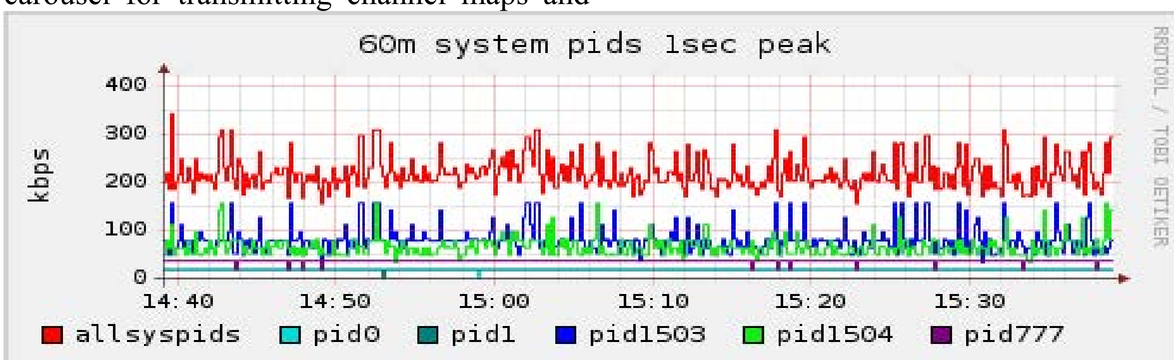


**Figure 7 - Downstream Traffic on all System PID's**

The largest downstream QPSK bandwidth component of the controller is the OOB settop CDL settop objects and their associated PMT's. (See Figure 8) Management of the OOB CDL carousels provides the greatest opportunity to re-allocate downstream bandwidth to EBIF applications and other ALOHA interactive applications. In some production environments the CDL carousels can be turned-down or turned-off during peak usage times.

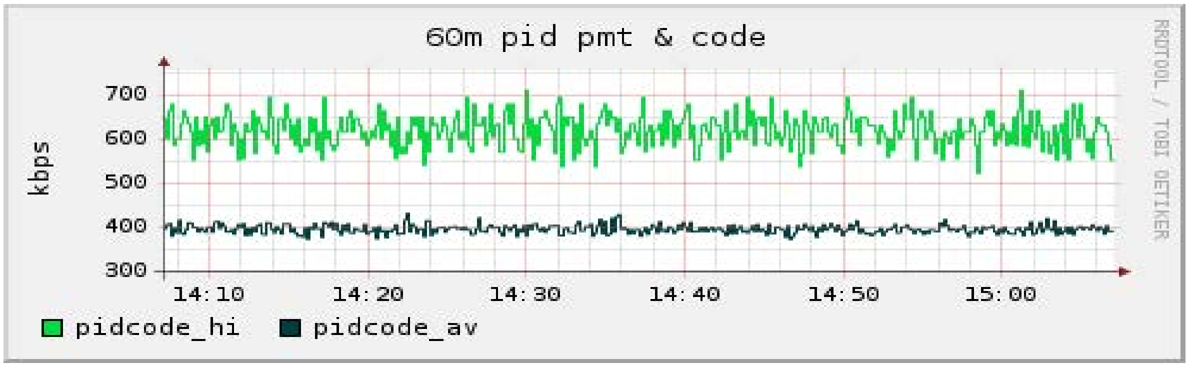


**Figure 8 – Code Download Downstream Data**

The guide stream presents another opportunity to manage the transient downstream QPSK OOB usage in favor of interactive applications. The guide stream does not transmit a significant amount of data, but the guide stream has a tendency to generate large bandwidth transients considerably larger than the steady state bandwidth. The following graphs shows the average bandwidth load in black and the transient bursts that hit the downstream QPSK and compete for limited downstream QPSK resources. (See Figure 9)

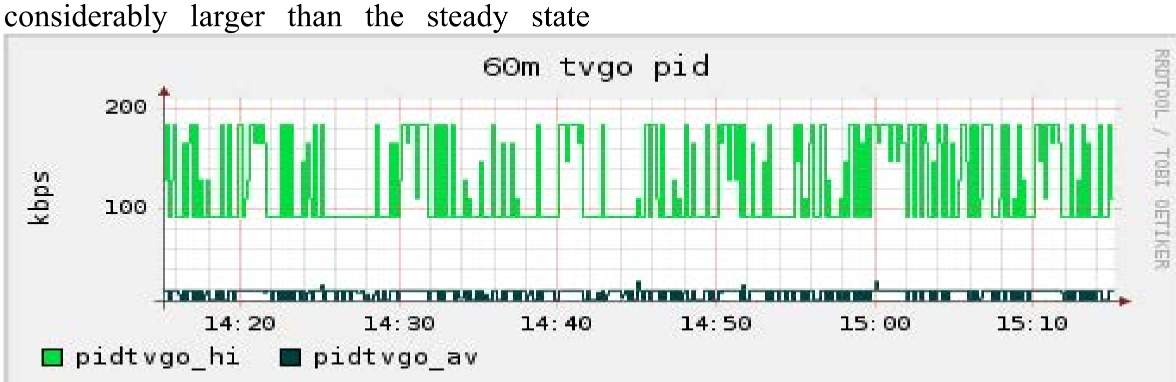


**Figure 9 – Guide Stream Downstream Data**

The instantaneous sum of all of the data sources on the network feeding the down stream signaling path need to be less than or equal to the capacity of the forward data channel. If this limit is not enforced then simultaneous peak usage can exceed the downstream QPSK's capacity causing data loss, network instability, and customer impacting events.

*Return Data Channel Bandwidth Management*

The management of the Return Data Channel is always a challenge. To help understand some of the complexities of the return path, we will examine some of the characteristics of the ANSI/SCTE-55-1 return path. The ANSI/SCTE-55-1 return uses the Aloha protocol.

The ALOHA protocol requires an ALOHA network proxy device to acknowledge (ack) upstream cells and the settop interprets a missing acknowledgement as a collision, requiring the settop to "retry" the cell retransmission. In the absence of receiving an "ack" the settop client will retry sending the cell as many as six times (6x). It is important to note every upstream cell has an associated downstream "ack" bandwidth cost. If the ALOHA network is running properly, the odds of a settop successfully transmitting a cell upstream is approximately 99.9%. The ALOHA network proxy accounts for "successful" and an estimate of "retry" cells. The following graph from a production upstream path hosting approximately 1000 settops shows 24 hours of "good" (acknowledged cells) and "retry" cells, providing an opportunity to monitor the efficiency of each upstream path or each settop. (See Figure 10)

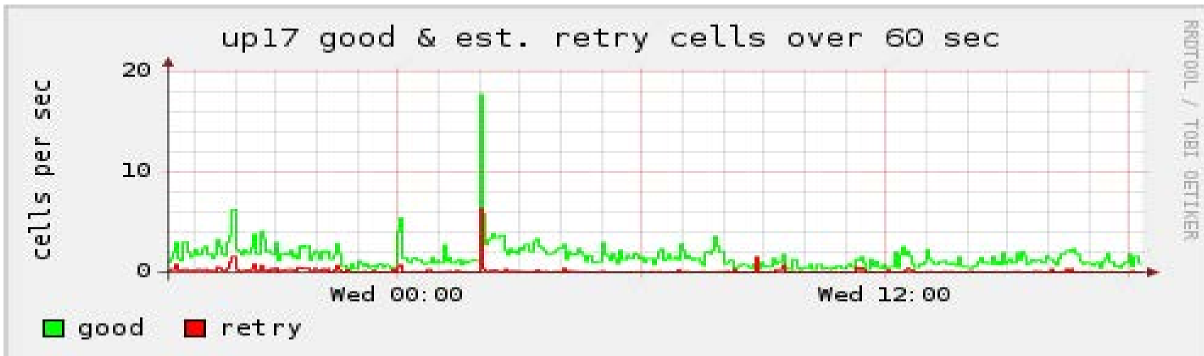


**Figure 10 – Upstream Traffic Retries**

The SCTE-55-1 return path demodulator is capable of demodulating approximately 92 cells per second (cps) whereas an ALOHA network reaching 50 cps begins to spend more time sending "retry" cells than transmitting successful cells in a timely manner. Operating the ALOHA network above 50 cps equates to operating the network inefficiently or delaying the successful transmission of settop messaging.

The following graphs each 1 second peak identified in each 60 second window. (See Figure 11)

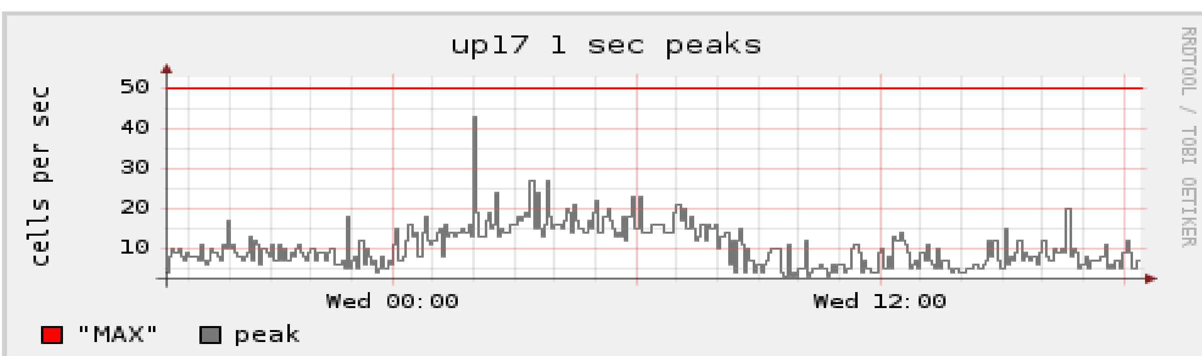


**Figure 11 – Upstream Traffic Peaks**

ALOHA capacity on the Comcast networks is currently constrained by the downstream QPSK pipe. The following section identifies opportunities to manage and reallocate downstream bandwidth resources towards for EBIF and interactive application usage.

ALOHA Traffic Models

The initial ALOHA traffic model was based upon randomly arriving single cell messages. Early VOD ALOHA traffic patterns were well represented by modeling this behavior and the resulting upstream settop capacities have worked adequately. However, new feature rich VOD applications and EBIF application driven traffic loads doesn't conform to the original basic ALOHA model assumptions with synchronized messages and longer settop messages which tend to collide. The new network bandwidth loading model that includes EBIF applications and other enhanced application needs to be developed to help predict network performance, settop capacity constraints, and application limitations.

The forward data channel traffic has to be managed as the peak loads are a function of the applications and three independent systems using the downstream (controller, ALOHA network proxy, and guide stream). Maximum node settop counts and downstream settop counts are a function of peak application usage.

The ALOHA network is a scarce resource and all aspects of the network will need to be carefully engineered and managed to support all of the applications that need to use its resources. It will be necessary to compare ALOHA interactive applications and determine the best use of scarce ALOHA bandwidth. As new applications use the ALOHA network, it will be necessary to manage both ALOHA network efficiency and usage as well as to manage node / upstream settop counts.

## EBIF ENHANCED VIDEO PATH SYSTEM MONITORING AND DIAGNOSTICS APPLICATION

The MSO digital video infrastructure has grown organically over the past 12 years. This growth has been driven by the following factors:

*Individual cable operator priorities* - Each cable operator manages their business and operation according to their priorities. This causes a significant difference in timing of technology deployments and how they are implemented.
*Individual market and headend sizes* – The size and scale of a market and its associated headends has a significant influence on the types of technologies and the timing of those technologies.
*Technology Timing* – Technology is always in a state of evolution. So the timing of a technology deployment into a market has a significant impact on its current and latent capabilities.
*Configuration Options* – The technology that is deployed is always optimize for the current set of priorities. A good example of this is in the quest for optimum picture quality, operators will remove unused data from a multiplex. When EBIF data is added in the multiplex at the programmers' uplink, the EBIF data may not pass onto the cable operator's plant due to configuration choices made in the headend.

These four factors greatly influence the capabilities of any particular market and headend deployment. As the EBIF infrastructure and EBIF applications are rolled out, each of the existing markets will have a unique combination of technologies that may or may not be compatible with the EBIF deployment.

One of the primary challenges of fully enabling the EBIF ecosystem will be proving out that each headend and EBIF enable service is actually passing the required data.

As noted above, there are several reasons that a particular headend can be configured in ways that prevent the EBIF data to be passed. In the current MSO community there are many services, in many QAM's, in many ad zones, in many markets. Just as an example of the sheer number "pipes" (an individual service on a QAM located on the edge of the MSO network), if we assume a 1000 ad zones, 70 QAM's in each ad zone, and 10 services per multiplex. This would equate to 700,000 individual "pipes" between the EBIF application provider and the CPE population.

There is a very large number of "pipes" between the EBIF application source and the CPE equipment spread across the North American cable footprint. The only way to build confidence that this many "pipes" actually pass EBIF data is to create an EBIF application and data server that will function as an aggregation point for diagnostics information on the proper passage of EBIF signaling through the many "pipes" of the MSO networks. There are two variations of the approach that should be taken. One approach is from the MSO view of the network, and the second approach is from the programmer's view of the network.

MSO EBIF Diagnostics Application

**Goal:** The MSO EBIF Diagnostic Application will be used by the MSO to prove out the delivery of EBIF applications from the local EBIF insertion point to the User Agent on the CPE's across all of the headends in the cable operator's markets.

**Insertion Point:** The MSO EBIF Diagnostic Application will be inserted at the local EBIF insertion point.

**Scope:** The MSO EBIF Application will be used to prove that EBIF application and data will pass from the local insertion point through the operator's network and all the associated headend equipment to the User Agent running on the CPE.

**EBIF Application Functionality:** When the subscriber tunes to a service with the MSO EBIF Diagnostics Application, it will signal the diagnostic server that the settop has run the EBIF application. Service and CPE data will be returned to the diagnostics server. The EBIF diagnostics application will have neither a user interface nor any interaction with the user.

**Data Collection:** The EBIF Diagnostics Server will schedule the insertion of the EBIF Diagnostic Application and gather the response data. The diagnostics server will map the response to the services and nodes within the cable operator infrastructure to build a map of services in nodes that are not responding to EBIF applications.

Programmer EBIF Diagnostics Application

**Goal:** The Programmer EBIF Diagnostics Application will be used to confirm proper delivery of the EBIF applications from the programmer's insertion point to the participating MSOs CPE's.

**Insertion Point:** The Programmer EBIF Diagnostics will be inserted at the programmer's EBIF insertion point.

**Scope:** The Programmer EBIF Diagnostics Application will be used to prove proper delivery of the programmer's EBIF applications to the target population on the MSOs network. It will be used to help identify "pipes" that are not properly configured to pass EBIF applications and data from the programmer. This will need to be a collaborative activity between the programmer and MSO for this activity to be successful.

**EBIF Application Functionality:** When the subscriber tunes to a service with the Programmer EBIF Diagnostics Application, it will signal the diagnostic server that the settop has run the EBIF application. Service and CPE data will be returned to the diagnostics server. The EBIF diagnostics application will have neither a user interface nor any interaction with the user.

**Data Collection:** The EBIF Diagnostics Server will schedule the insertion of the EBIF Diagnostic Application and gather the response data. The diagnostics server will map the response to the services and nodes within the cable operator infrastructure to build a map of services in nodes that are not responding to EBIF applications.

## CONCLUSIONS

The advent of EBIF enable networks is an exciting opportunity for cable operators to add a richer customer experience and enable greater advertising revenue. However, there is a cost that comes with this opportunity which is the cost of re-engineering and enabling the EBIF Video Data Path and actively managing the Data Signaling Path.

### Areas for more research

- SCTE-55-1 - Current underlying assumption around random data distribution is changing. The data distribution is not random and, even worse, is moving towards higher level of synchronization. New models need to be put together that predict network performance and capacities.
- How do SCTE-55-2 and DSG/DOCSIS stand up under the changing network loads which are moving towards highly synchronized events and non-random distributions.