INFRASTRUCTURE CAPABILTIES SUPPORTING CABLE'S NATIONAL PLATFORM

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Abstract

One of the major initiatives for the cable industry is the introduction of functionality giving subscribers opportunities to interact with applications and services through their televisions. Doing so will enhance viewing experiences, usher in new revenue opportunities and provide competitive differentiation to satellite broadcasters and the telephone companies.

The ETV and the tru2way family of specifications available at CableLabs describe how applications can be bound to programming allowing cable to deliver a national platform for advertising and other services. While there are industry specifications for delivering bound applications to a set-top box, there are no specifications defined on the infrastructure capabilities needed to manage these bound applications. This paper proposes a technical architecture and capabilities that can be used to manage and deliver bound applications (in both ETV and OCAP formats) capable of providing operators with a flexible platform for advanced services delivery.

ETV and OCAP applications are bound to individual programs by carrying those applications on MPEG-2 PIDs (Program Identifiers) that are included along with the programming. There can be multiple PIDs associated with a bound program and the paper proposes a flexible architecture to manage them. These include:

- *Passing bound applications, which include extra PIDs, through headend equipment;*
- *Capability to dynamically add or drop individual PIDs associated with bound programs;*
- *Protocol interfaces to manage the manipulations of identifiers associated with bound programs;*
- *Interoperability between the HFC resource management system and the PID insertion function to account for the additional bandwidth used on a QAM as bound applications are managed;*
- *An overall control mechanism to coordinate the management of bound applications with programmers, both national and local.*

With a proper management framework bound applications will provide both a platform for national services as well as personalized services. The ETV and OCAP toolset provides for a plethora of services, but the management and control architecture needs to be designed in order to achieve the full potential for innovation of which it is capable. The authors examine the requirements associated with management and control and explain how present capabilities can evolve to satisfy them.

THE NATIONAL PLATFORM

Until recently, implementing interactive subscriber services on a national basis was not feasible due to the lack of implementation standards in the cable industry. The splintered approach of proprietary technologies was cost prohibitive for content providers and distributors. Today, with new and emerging specifications such as ETV, which includes the Enhanced TV Binary Interchange Format (EBIF) and the tru2way, which includes the Open Cable Application Platform (OCAP),

specifications developed by CableLabs, the proliferation of interactive TV in North America is closer to becoming reality. However deployment challenges still remain for cable operators.

The benefits of interactive TV to subscribers, programmers, advertisers and cable operators is mutual, as figure 1 shows. The shared benefits that interactive TV offers each of these key stakeholders provides fertile ground for a nascent ecosystem, with the potential to improve the viewing experience, while driving new corporate revenue streams.

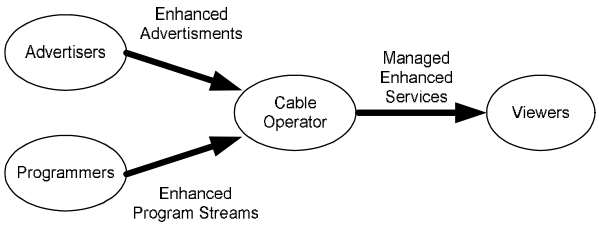

Figure 1 – Enhanced Programming Flow

Interactive TV application will come in two forms:

- Synchronous, or bound to the programming;
- Non-synchronous, or unbound to programming.

Bound applications are associated with specific programming. While a subscriber is watching a program, the ETV application will run, resulting in an enhanced viewing experience. A bound application provides the ability to interact with a program or with advertising. For example, a subscriber would be enabled to vote during a reality TV programming directly through the use of the remote control rather than through a secondary device such as a phone or PC. In another scenario a subscriber can request more information about a product or service promoted during an advertisement. While clearly enhancing the subscriber experience, bound applications garner the most interest from content providers because of the economic potential. Currently bound applications can be supported in linear and VOD content and will be supported in time-shifted content in the near future.

Unbound applications are not associated with specific programming and are not implemented as part of a programming service; they are, instead, resident in the set-top box and can be run regardless of the programming being watched. Examples of unbound applications include the standard guide or CallerID to the TV, both of which can be rendered on the TV regardless of the currently tuned linear broadcast.

The delivery of applications, specifically bound applications, remains in its infancy. The CableLabs' specifications define how the bound applications should be interpreted at the set-top box but stops short of governing supporting infrastructure components; justifiably so, since this area needs to evolve to ensure the most efficient and innovative ways to manage bound applications.

The focus of this paper is a suite of capabilities that will support the national deployment of interactive TV by streamlining specific components that enable the localization and personalization of bound interactive TV applications.

BUSINESS DRIVERS OF INTERACTIVE TV

Interactive TV offers advantages to key stakeholders including subscribers, content providers, programmers, advertisers, and cable operators through interaction, personalization and localization of content.

Subscribers

One does not need to look far to find evidence of subscribers' interest in

participating, shaping and enhancing content. Personalized websites, video outlets such as youtube.com and facebook, and the popularity of reality TV in which subscribers can determine the outcome of the programming align with the principles that interactive TV will enable. The adoption of these, and similar, phenomena indicate that subscribers should quickly embrace interactive TV as well.

Programmers

With increasing alternatives to broadcast TV, programmers continue to vie for 'eyeballs' of live programming. Interactive TV differentiates their programming and strengthens their brand with enhancements. Straightforward opportunities to enhance the programming with bound applications include the capability for voting and trivia questions while providing near real-time feedback about how other subscribers responded at either the national or local level, thereby creating a sense of community.

Additionally, programmers can use interactive TV to keep subscribers 'on brand' before tuning away to alternative networks by offerings opportunities to view their VOD content, perhaps at the conclusion of program, or even offer content provided by sister networks (i.e., NBC, Bravo, USA). The programming community is well-positioned to provider subscribers with personalized and localized experiences that are compelling and difficult for the competitors to mimic.

Advertisers

As broadcast and cable advertising continue to be threatened by internet or mobile device alternatives, interactive TV provides advertisers with an effective response. Advertisers can enhance ads to fulfill requests for information about products or by using interactivity to telescope directly to VOD clips about their products to provide additional information to the subscriber. Consider the local car dealership that can promote its latest campaign during a national advertisement for the car chain by 'piggy-backing' onto that national advertisement. Interactive TV also provides incentive to subscribers to watch time-shifted advertisements once this functionality is supported.

As the CableLabs specifications are adopted and implemented among MSOs, an unrivaled national platform will emerge, providing advertisers and cable operators alike with a robust opportunity.

Cable Operators

Since subscribers, programmers and advertisers can all be counted as customers or partners, cable operators will benefit as the enabler of interactive TV. They can capitalize on their scale versus that of DBS and/or telco providers as well as their established relationships with programmers and advertisers. In addition, operators can use enhanced advertisements to promote their own offers and services. For example, a cable operator could enhance a linear promotion to telescope to a VOD clips to learn more about the available On Demand services, how to interpret their cable bill, or even sign up for a service offering directly from their TV.

Each of these key stakeholders shares a common ecosystem that powers the television business today. The benefits afforded by interactive TV across these key stakeholders provide a recipe for the broad adoption and consequent success of interactive TV that will introduce a new era in the TV viewing experience.

UNDERSTANDING THE SPECIFICATIONS

Within a proper framework, bound applications can provide both a platform for

national services as well as individually addressed services. But in order to architect the right framework one must first fully understand the applications, the available specifications and how they affect the existing architectures.

The industry specifications for ETV and tru2way are developed by CableLabs. This set of specifications provides a basis for product interoperability. The specifications were designed to be non-proprietary and open in order to support the national reach for the platform. The guiding principle varies little from the 'write once, run everywhere' model common in computer programming today.

Enhanced TV

ETV provides a way in which interactive TV applications may be deployed to legacy set-top-boxes (STBs), such as the Motorola DCT-2000 and Scientific-Atlanta Explorer 2000. Since it is estimated there are millions of deployed legacy STBs, ETV was created to allow operators to deploy interactive applications across this large footprint of STBs. ETV applications will also run on tru2way host devices.

It is important to note that ETV is supplemental to tru2way. In fact, an ETV User Agent could be implemented as a tru2way application to support ETV applications on tru2way hosts.

ETV applications are set-out in an EBIF, for use in decoding and rendering ETV constructs on the TV screen. Applications consist of a collection of one or more partitions containing resources and programmatic data. ETV applications are interpreted by a User Agent resident in the set-top box. On a tru2way host, the ETV User Agent is a bound application.

In terms of transmission from the headend, ETV requires a number of additions to a standard MPEG-2 transport stream. These include two new descriptors in the MPEG-2 Program Map Table (PMT), an EISS Table (ETV Integrated Signaling Stream) containing applications signaling and timing information and a Data Carousel for carriage of the application itself. When the receiver tunes to the transport stream that contains the ETV application, the receiver reads the PMT and determines there is an ETV application present and alerts the ETV User Agent to run the application.

ETV is well beyond lab testing and has entered field trials that are important to validate the technologies in use. ETV is generally recognized as a "fast track" item, garnering deployment priority as soon as feasibly possible.

tru2way

tru2way has several components, including a host specification, CableCard interface specification and the OCAP middleware specification. Middleware is software that provides an interface between applications and whatever system software a manufacturer chooses for a host device. The middleware is based on the widely accepted Java™ technology. By abstracting away the various consumer electronics device operating systems to a common set of middleware APIs, application developers can write an application only once and it will run on all models of tru2way devices. Cable subscribers with tru2way-enabled digital televisions, retail set-top boxes, and other interactive digital cable products will be able to receive all of the cable operator's services just as if the subscriber was leasing a comparable set-top box from the operator.

In terms of transmission from the headend, tru2way bound applications require similar additions to a standard MPEG-2 transport stream as does ETV. The application and the data files that it accesses are packaged into an

Object Carousel (OC) format, which is an extension of the MPEG-2 transport environment that exposes a file system to the device at the other end of the network. In addition, an Application Information Table (AIT) is required to tell the tru2way host both that there is an application present and where to find it. This collection of files is then multiplexed into the MPEG program stream. When the receiver tunes to the transport stream that contains the application, the tru2way system reads the AIT and launches the application; if the receiver tunes away from the service, the application is terminated.

OVERVIEW OF THE NATIONAL PLATFORM

While specifications exist for the client (i.e., how the set-top box is supposed to receive and handle bound applications), the server-side infrastructure requirements are more loosely defined. This is analogous to the VOD infrastructure in which there are numerous variations on how the service can be deployed and managed. Like VOD, this scenario presents opportunities and challenges to the broad deployment of a national interactive TV platform. The goal is to create an infrastructure framework that supports the national platform using industry specifications for defined interfaces.

In creating this framework, there are at least five different technical components of the National Platform that must be considered, as shown in Figure 2.

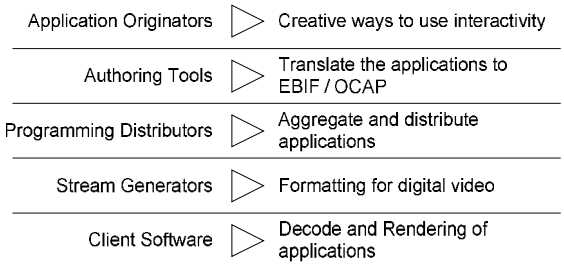

Figure 2 – Enhanced Programming Ecosystem

The applications originators are the programmers and advertisers who choose to enhance their programming. These groups may create the application in-house or outsource the application development to third-party developers.

Third-party developers often provide authoring software tools to create the enhancements for the bound applications. For the purposes of this paper, the word "enhancement" refers to an MPEG-2 program that contains an ETV or OCAP application. The authoring tools generally include easy-to-use interfaces and simulation tools to aid in the design and development process. Ultimately, these tools are used to put the applications in the correct format to be considered compliant to the industry specifications.

With bound applications there will be variations on how the enhancements will be passed from a programmer to the headend and on down to the market level. In addition to enhancements being originated directly from the programming studio, the ecosystem includes programming distributors such as the Comcast Media Center (CMC), TVN Entertainment, Headend In The Sky (HITS) and others. Additionally, there is always the possibility to swap enhancements at the local level either in the headend or deeper in the network, closer to the consumer.

Another component of the National Platform is the stream generators which put the applications into the proper format to be included with a digital program stream and the devices which actually place that enhancement into the program stream so it can be delivered to a digital set-top box. These stream generators will need to develop the capabilities to add and drop different enhancements based on the needs for localization. These stream generators need to adhere to a number of industry specifications (e.g., SCTE-130) to ensure the digital

program streams are of the proper type and format to be decoded by a set-top box.

Finally there are the digital set-top boxes which need User Agent to read the interactive signals in the broadcast stream. The User Agent is the software programs in the set-top box that interprets the interactive applications.

CHALLENGES OF THE NATIONAL PLATFORM

Broad deployment of the National Platform faces many challenges surrounding the management and control of interactive TV applications. Some of the issues to be considered are listed below.

Data PID Integrity

Data PID integrity includes successfully passing and maintaining bound applications through the National Platform without adverse impacts. The bound applications create additions to the PMT associated with that program which needs to be handled by a number of pieces of equipment in the infrastructure.

Data PID Control

The capability to dynamically manage individual or multiple PIDs, including the ability to administer and manipulate identifiers associated with the bound application, is key. If there is no business agreement between the programmer and the operator, the infrastructure needs the capability to recognize and remove the enhanced PIDs from the programming. The infrastructure needs the ability to insert non-enhanced ads into enhanced programming to support regular advertising capabilities.

Localized Operations

To support enhanced advertising, the infrastructure needs the capability to insert enhanced ads into either enhanced or non-enhanced programming. In addition, the coordination of the control of bound applications and local enhancements needs to be coordinated between the programmer / advertiser and the infrastructure. These additional control interfaces need to be developed to support more sophisticated use of the tools. This includes a general operational readiness from a business and technical level between the operator and programmer or advertiser.

Bandwidth Management

Adding enhancements to the programming has the effect of increasing the amount of bandwidth needed for that program. Since those extra PIDs associated with the PMT carry data, those extra bits and bytes need to be accounted for by the infrastructure to ensure the complete bit rate through a QAM modulator does not exceed the capacity.

Return Path Capacity

Since the programming enhancements rely on interactivity, the capacity of the return path needs to be managed. If the enhanced program is widely viewed there can be bursts of activity when all those subscribers respond to an enhancement. The goal here is to not overwhelm the return path. Legacy boxes will use the existing back-channel which is relatively low capacity compared to newer technologies such as DOCSIS®/DSG. Since there are different tiers of set-top boxes, the enhancements can be different and look better with more advanced boxes with a higher capacity back-channel.

Data Collection & Reporting

Since interactivity is managed across a national platform, there has to be a method for that interactivity to be aggregated on a massive scale. For example, some popular programs can garner tens of millions of

concurrent subscribers and if a significant portion of the subscribers vote simultaneously, the ensuing avalanche of data needs to be handled, aggregated and acted upon in a scaleable and quick fashion.

A PROPOSED ARCHITECTURE

Bound applications can be inserted into programming at either the national or local level, including personalizing the bound application at the local level. Therefore, a dynamic and flexible architecture is required to manage, control and deliver these services while accounting for national and local footprints.

Figure 3 shows an architecture which supports the National Platform including personalization at a local level. National programming originates on the left side of the figure, including the insertion of national advertising. At this point both the programming and the advertising can include enhancements. When the programming reaches the local cable operator (on the right side of the diagram), local personalization systems can further modify the enhancements and direct the programming to groups of subscribers and potentially even individual subscribers. The local personalization is implemented in conjunction with the programmer or advertiser who wants to craft a custom experience for their subscribers which otherwise would not be possible with just nationally originated programming.

Figure 3 proposes several new components to the local cable infrastructure including a new category of edge, video processing platform, known as a media services platform. This platform interfaces to the personalization engine.

Media service platforms are responsible for personalizing streams for subscribers and can selectively insert specific ads into the programming, and specific bound applications into both the programming and advertising. The media services platform will offer the data PID control interfaces as well as ensure data PID integrity for the program streams. Since personalization is done based on specific subscribers of the programming, it is best done toward the edge of the local cable network, as close to those subscribers as possible.

The bandwidth management function will be handled by the "last mile" network. The assumption for cable is that this last mile is an HFC network hence the Edge QAM plays a significant role in bandwidth management, ensuring that the enhanced programming does not overrun the capacity of the QAM channel. There are other last miles networks, including wireless, where the wireless access point would have the responsibility to ensure the wireless channel is not overrun.

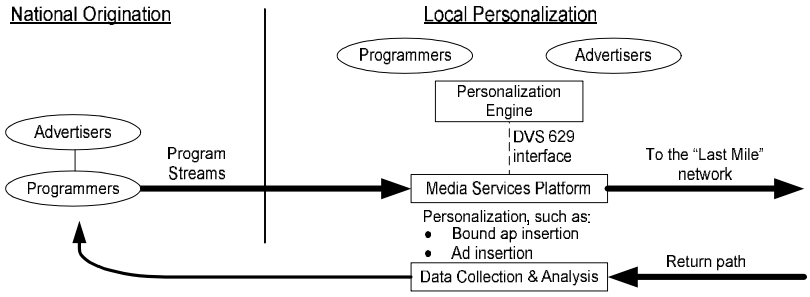

Figure 3 – Proposed Architecture

The personalization engine makes decisions about what personalizations should occur in the programming. The personalization engine has separate interfaces to both the programmers and advertisers to make close to real-time decisions about how to personalize programming based on available campaigns, operator business agreements and viewership.

These personalization decisions are passed to the media service platform over the DVS 629 interface. DVS 629 has recently been developed by the Society of Cable Telecommunications Engineers Digital Video Subcommittee (DVS) specifically for the purpose of personalizing programming. It is expected that DVS 629 will be ratified into an SCTE standard later this year and then be known as SCTE 130.

Finally, the figure shows the data collection and analysis function. Since the programming is interactive, the user responses need to be collected, aggregated and passed back to the programmers and advertisers. The analysis can be either real-time, such as voting which can be provided as feedback during the programming, or non real-time if there is no impact on the current programming.

The cable industry has been working toward personalization and the DVS 629 interface allows separation of the personalization engine and the media services platform to allow innovation to occur around that interface. Figure 4 shows additional detail around the insertion of enhancements to programming.

This figure represents how a program delivered to a customer can have both local and national enhancements for both the program itself and advertisements associated with that program. Note that the enhancements associated with the program are available during the program, but not during the advertisement where different enhancements can be available. The media services platform must not only be able to insert the correct enhancements, but must enforce the boundaries between the program and advertisements to ensure that the proper enhancement is presented to the proper subscriber, with the proper enhancement at the proper time during the program or advertisement.

Considerations

Bound applications are actual software programs and data associated with a TV program or advertisement. The bound application is inserted either at the national origination of locally, and that application is run in the set-top box. Technically the bound applications are inserted into the MPEG-2 program stream which represents that program. The bound applications are inserted as additional data on specific PIDS associated with the digital programming.

Since these bound applications represent real data, the media services platform must account for them as they are multiplexed onto the last-mile network, which for this paper could be considered a 256 QAM modulator able to carry approximately 38.8 mbps of data. Traditionally the programming is statistically multiplexed to best fit within the

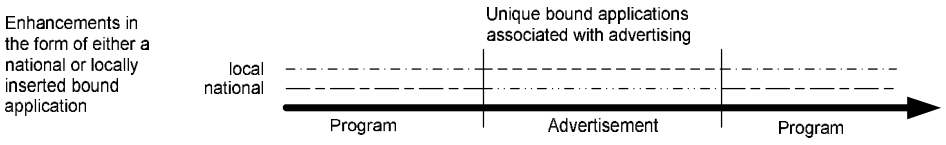

Figure 4 – Enhancements to Programming

38.8 mbps; the bound applications, however, represent additional bit rate overhead which must also be carried by that QAM but which cannot be statistically multiplexed. Clearly inserting bound applications will impact the amount of bits through the QAM and this information will need to be signaled back to the edge resource manager associated with the QAM resources in order to accurately account for QAM usage. This information will allow the edge resource manager to efficiently utilize the resources in that QAM.

Additionally, media services platforms should be able to manipulate the Program Map Table associated with the program such that the additional PIDs associated with the enhancements (both national and local) are accurately represented such that the set-top box is presented with a valid MPEG-2 bit stream to decode. The integrity of the PMT and the MPEG-2 bit stream has to be maintained even though locally the enhancements can be added or dropped in near real-time based on instructions from the personalization engine.

The personalization engine will require interfaces back to the programmers and advertisers in order to manage the personalization. These interfaces are yet to be defined but could be considered a next phase to the work being done to create DVS 629.

CONCLUSION

Interactive television offers the cable industry opportunities to improve subscribers' viewing experiences, reduce churn and enhance advertising revenues. By providing distinctive benefits to subscribers and content partners, each stakeholder will gain a significant advantage as the 'handshake' among them is redefined.

Cable operators can address the infrastructure challenges described in this paper by leveraging the architecture proposed by the authors. This can also provide the potential to launch a migration towards a more flexible national platform for personalized services and advertising.

The necessary standard interfaces are becoming available, as is the equipment needed to implement the required services and functionality. At that point, the programming experience will increasingly become limited only by the creativity of the application developers. Such an evolution will usher-in new viewing experience for cable subscribers.