BROADCAST TRIGGERS INSERTION FOR DIGITAL ENVIRONMENTS

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Abstract

As deployments of interactive television gain momentum, triggers that enable enhancements to TV programs and commercials will increasingly be inserted into the broadcast stream so the enhancement is synchronized with the video programming. Enhanced broadcast and synchronization will become the norm in digital, as well as analog environments.

Delivery of enhancements poses great challenges for existing networks. Primary considerations include the traffic bursts to the network invited by triggers; upstream and downstream system bandwidth; Internet backbones access and servers; and the limitations of some set-top boxes to receive/extract triggers.

This paper provides an overview of a solution for the economical delivery of enhancements on existing networks. As this solution could be applied globally, this paper is focused on solutions for systems in North America.

ENHANCED TELEVISION

Enhanced television consists of providing additional information and interactivity (enhancements) along with the normal television programming. Viewers can access these enhancements as they watch a chosen program. Such enhancements are implemented using consumer device software, such as the Liberate TV Navigator™ along with network servers and broadcast equipment that complements the traditional video/audio broadcast network. The consumer device is a set-top box that is connected to the video distribution network (generally cable or satellite). The enhancement itself can be created offline to the TV programming, or can be created on the fly for a live enhancement (such as a sports broadcast). Content authoring and insertion is a major part of the enhanced broadcast chain.

Enhanced television covers material that is, or not (depending on the case) *synchronized* to the video and audio component of a program; synchronization can be of various degrees of accuracy, and does not often need to match the concept of *frame accuracy*. It also tends to have some form of interactivity, implemented either using features of the receiver alone (one-way broadcast) or using servers via a two-way network connection. With a two-way network connection, this interactivity can be used to enable e-commerce transactions – a combination of television and e-commerce often called *t-commerce*.

CHALLENGES FOR DELIVERY OF ENHANCEMENTS ON EXISTING NETWORKS

The end-to-end delivery of enhancements synchronized with the video programming introduces a wide variety of new services for the viewers and new business opportunities for the broadcasters and network operators. However, the delivery of such services has inherent technical challenges, which must be solved for a successful launch.

Enhanced Television synchronized content creates burst in the network

Insertion of enhancements at a very specific time in a video broadcast causes peak

subscribers demand for bandwidth on the return channel. At a given point in time, hundreds of thousands of subscribers will receive a trigger and then request the enhanced content, increasing drastically the upstream and downstream peak bandwidth requirements on the local network.

Synchronized enhancements involves multiple players in the end to end video distribution chain

Adding synchronized enhancements to video programming involves every entity from the broadcast studio all the way to the subscriber. The broadcast studio usually has responsibility for the creation and insertion of TV enhancements. Synchronization is achieved through insertion of triggers with the video signal (assuming no alterations from the video distribution network). From content authoring to synchronization to delivery, it is crucial to define the various interfaces allowing proper end-to-end integration.

The content insertion requires a proper scheduling mechanism and content caching scheme. National networks also have local affiliates and the insertion of local enhanced content brings a new level of complexity to the picture.

There are multiple network topologies and video transmission schemes

The number of players in today's video distribution chain complicates the enhanced data delivery mechanism. Broadcast studios can usually send the content to a satellite uplink in analog or digital format. Network operators receive the content from the satellite downlink, package it and distribute it to their subscribers through their specific networks. Each distribution network has its own characteristics in terms of possible downstream and upstream bandwidth configurations, terminal (set-top box) capabilities, and network management (for example, it may not be possible to extract triggers on a given digital set-top). Depending on the end-to-end network configuration, transmission can be in analog or digital, potentially altering the form of the enhancement as it is converted between transmission formats

END-TO-END SYSTEM CONSIDERATIONS

Enhanced television consists of providing additional information and interactivity (enhancements) along with the normal television programming. Viewers can access these enhancements as they watch a chosen program. Such enhancements are implemented using consumer device software (possibly running a client middleware emgine such as the Liberate TV Navigator™) along with network servers and broadcast equipment that complements the traditional video/audio broadcast network. The consumer device is a set-top box that is connected to the video distribution network (generally cable or satellite). The enhancement itself can be created offline to the TV programming, or can be created on the fly for a live enhancement (such as a sports broadcast). Content authoring and insertion is a major part of the enhanced broadcast chain.

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Enhanced television brings together divergent pieces of technology and content. An end-to-end broadcast solution has to address the issues related to developing, delivering (broadcasting) and managing the different pieces of content (or assets) that make up an enhancement, and the applications that support them (for instance, the payment systems).

From an end-to-end system standpoint, a number of key functions need to be addressed in order to assure proper delivery of enhancements. Those functions include:

- Authoring, Hosting and Archiving the content
- Management of user responses (client and server)
- Transaction fulfillment
- Security
- Branding
- Enhancement advertising
- Injecting Triggers (and enhancement)
- Receiving Triggers

This paper focuses on the last two items from this list: Injection of triggers / enhancements and receiving triggers.

Injecting Triggers (and enhancements)

Scheduling and injecting triggers associated with the enhancement into the broadcast stream; in some cases the enhancement itself may also be injected into the broadcast, to improve scalability (when bandwidth is available). Insertion in both analog and digital transport carriers is possible, but the two differ significantly.

Receiving Triggers

Functions in the receiver provided by the middleware (set-top box) to allow it to receive and appropriately handle triggers. A distinction needs to be made between triggers that *announce* the presence of enhancements that might be offered to the viewer and triggers that *cause* the enhancements to function, once selected by the viewer.

SOME BACKGROUND ON ATVEF

The Advanced Television Enhancement Forum (ATVEF)[i] is of a cross-industry group of companies[ii] representing major television programmers, technical platform providers, broadcasters, and transport providers. ATVEF, which is not a standards organization, was created to specify the design, delivery and display of enhanced and interactive TV programming that can be authored once using a variety of tools, and deployed to a variety of television, set-top, and PC-based receivers. ATVEF's creation was driven by a much-needed standardization effort at a time when broadcast TV and the Internet are converging to deliver rich, cross-platform, cross-network services and content. Older Enhanced Television systems did not have the benefit of Internet content and technology. ATVEF utilizes the Internet as the cornerstone of the specification.

The ATVEF specification defines two aspects of the enhanced television platform: the Content and the Transport. The ATVEF content defines different level of content profiles, which are designed to target different range of receiver capabilities. The ATVEF transport defines different types of transport mechanisms for carrying ATVEF triggers and content supporting different network architectures.

The following section provides a brief overview of the ATVEF transport mechanism.

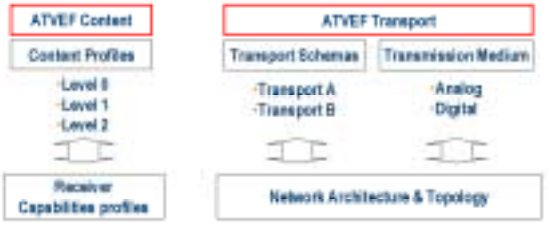

Figure 1 ATVEF Content and transport

ATVEF Transport

The display of Enhanced Television content consists of two aspects: 1) delivery of data resources and 2) display of named resources synchronized by triggers. All forms of ATVEF transport involve data delivery and triggers. The capability of networks for one-way and/or two-way communication drove the definition of two models of transport for ATVEF.

ATVEF defines two kinds of transport. Transport A is for delivery of triggers by the forward (or broadcast) path and the pulling of data by a (required) return path. Transport B is for delivery of triggers and data by the forward (or broadcast) path where the return path is optional.

ATVEF Transport A

With the Transport A delivery scheme, only the triggers are sent with the video / audio broadcast. In order to get the enhancement, the set-top must have a live network connection (two-way) via an ordinary telephony modem or cable return channel. Usually Internet protocols are used to load content in this manner.

ATVEF Transport A highlights:

- Triggers (URL) only are sent to the set-top box embedded with the video/audio stream.
- Corresponding content is accessed from the two-way network (e.g. phone, cable return)

Transport A is usually seen as a transport mechanism for analog video where triggers are carried over the VBI part of the video signal. Note that the VBI can also be carried on a digital MPEG video through the MPEG user data field.

ATVEF Transport B

In the Transport B delivery scheme, the triggers and the enhancements are both sent with the video/ audio broadcast. The enhancements are included in the video signal itself and do not require a real-time network connection for delivery of interactive content, however, this does not allow for targeting, personalization, or customization (a return channel is required for this). Transport B provides a less expensive alternative where delivery of a single enhancement to all set-top boxes is appropriate, and is particularly useful for satellite-delivered programming that lacks a real time connection.

The advantages of Transport B are that it places no additional load on the two-way network (the data is sent to all receivers), and it does not require a two-way connection (so it can run on video networks with no (or limited) return channel. As the triggers and enhancements are part of the broadcast feed, the level of interactivity provided with Transport B is limited to broadcast content (enhancements are interactive but there is no communication with the two-way network). Once a viewer selects the trigger, the set-top box retrieves the interactive content locally and displays the enhancement in real time, allowing the subscriber to see the enhanced content immediately without additional load on the two-way network.

For analog video transmission, the VBI is the only channel to carry triggers and enhancements. Since the VBI is not a high bandwidth channel, Transport B with rich enhancements is challenging on analog video. For that reason, Transport B scheme is usually seen as a transport mechanism for digital video where triggers and content are carried on MPEG transport.

ATVEF Transport B highlights:

- Triggers and Content are sent to the set-top box packaged together as insertions into the video/audio stream.

SOLUTION FOR SCALABLE DELIVERY OF ENHANCEMENTS ON EXISTING NETWORKS

In an environment where enough bandwidth is available from the broadcaster, it is possible to broadcast video, audio, triggers and enhancements from the origination point. In this scheme, the broadcaster would use a data broadcast server (such as Liberate Mediacast™) coupled with a scheduling system allowing them to add enhancements to their programming fairly easily. For end-to-end digital systems, this is possible assuming that enough bandwidth is available on the uplink.

For the case where the programming is originated in analog format, the VBI is the only channel to carry programming related information. This channel is limited and not very suitable to deliver rich content.

As the number of digital set-top boxes deployed on cable systems across North America is getting bigger and bigger, a solution for the delivery of enhancements on those existing networks is crucial in order to avoid hardware upgrade of large number of set-tops.

Model for end-to-end delivery

The remainder of this paper presents a hybrid model for end-to-end delivery of enhancements that:

a) Allows broadcasters to keep creating triggers and enhancements using the same infrastructure.

b) Allows support of triggers and enhancements of networks where the return channel and the processing capabilities of the digital set-top are limited.

This hybrid model carries timing related information (triggers) with the video programming and publishes the enhancement on a generally accessible channel (such as a proxy server). The model reduces the bandwidth requirements from the broadcaster origination point while maintaining the timing / synchronization information with the video transport. As the industry is migrating from analog to analog / digital hybrid to full digital a solution is needed to ensure the delivery of enhancements synchronized with the video.

Depending on the network capabilities either a Basic of Advanced model will allow a scalable deployment of synchronized enhancements.

The Basic model, which is the simplest, requires a stronger network infrastructure in terms of two-way connection. The Advanced model introduces data carousels (such as through the Liberate Mediacast™ server), reduces peak bandwidth requirements on the two-way network, and allows a more scalable delivery of synchronized enhancements without delivering the enhancement with the video signal from the origination point. This model also allows local enhanced content filtering and insertion.

In both models, the broadcaster inserts timing information (triggers) along with the video signal and then publishes the enhancement (usually via a web interface). As far as the broadcaster is concerned, this embodies the ATVEF Transport A model. Depending on its network topology, the network operator will either pass through the triggers to its set-tops or will extract the triggers allowing a pre-fetch and pre-caching of the enhancements.

Description of Basic and Advanced synchronization models

Basic model

For networks allowing it, the Basic model is the simplest. This is ATVEF Transport A end

to end. In this case, Liberate Connect™ servers are installed as part of the network infrastructure at the headend and Liberate TV Navigator™ is loaded onto the set-top box at the subscriber site. *Figure 2* below shows the flow diagram for the Basic model.

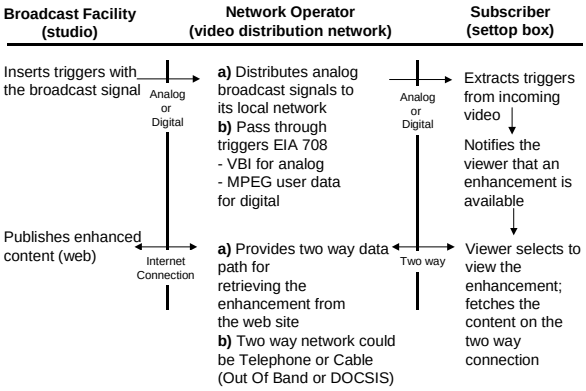

Figure 2 Basic model flow diagram

In this model, the network operator passes through the video/audio with embedded triggers to the set-top. Triggers are embedded in the VBI. For digital, the VBI is delivered through the user data field in MPEG. The software on the set-top requests enhancements over a two-way connection, typically telco or cable return. This model assumes there is enough downstream and upstream bandwidth to accommodate the bandwidth and latency demand for a large number of subscribers.

Basic model assumptions and limitations

This basic model is suitable only for networks that can sustain the peak bandwidth required by the retrieval of synchronized content.

Basic model assumptions

- The network operator infrastructure must have two-way capability with enough capacity and minimum return channel latency to support concurrent sessions for a large number of subscribers.
- The set-top must be able to extract triggers from the analog or digital video signal (Liberate TV Navigator, like other implementations, needs a minimum functionality from the set-top to achieve this).

Basic model limitations

- Limited scalability: synchronized content will introduce synchronized peaks demands from the subscribers. Requires strong 2-way network.

Advanced model

Today's network topologies with infrastructures that can support the Basic synchronization model are limited. In order to enable deployments of such synchronized services without engaging in the expense of a network upgrade, Liberate proposes an enhancement to the Basic model. The Advanced synchronization model achieves greater scalability and makes the end-to-end model feasible on today's networks.

Figure 3 below illustrates the information flow for the Advanced model.

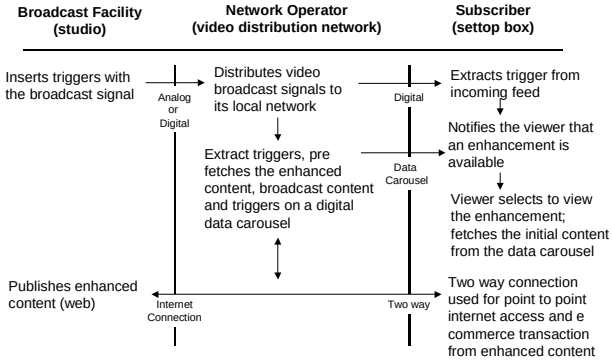

Figure 3 Advanced model flow diagram

In this model, the network operator passes through the video and audio to the subscriber in the analog or digital format. At the network operator site, the synchronization with triggers can be achieved by introducing infrastructure allowing greater scalability. The triggers are extracted at the head end, and then the enhancement can be pre-fetched and stored on an in-band carousel. This carousel is

carried on the physical layers supported by the specific network. Examples are MPEG transport , Out Of Band channel or IP Multicast in a DOCSIS environment. At this point, the enhanced content is available to all subscribers. As soon as a trigger is sent through the broadcast server (such as generated by Liberate Mediacast™), the viewer is notified and, if the viewer selects the enhancement, it is retrieved from the carousel. The two-way connection is used only when the enhanced session goes interactive (e.g. user requests a link that is not on the carousel by going to an e-commerce or secure session).

The specific deployment for the Advanced model relies on carrying the data carousel over the local network. The physical layer to carry the data carousel is determined by the set-top capabilities in terms of data delivery. Carousels can be delivered over MPEG and over a DOCSIS channel (IP Multicast).

The following section provides an end-to-end case study for the Advanced synchronization model.

Advanced Synchronization Implementation: a case study

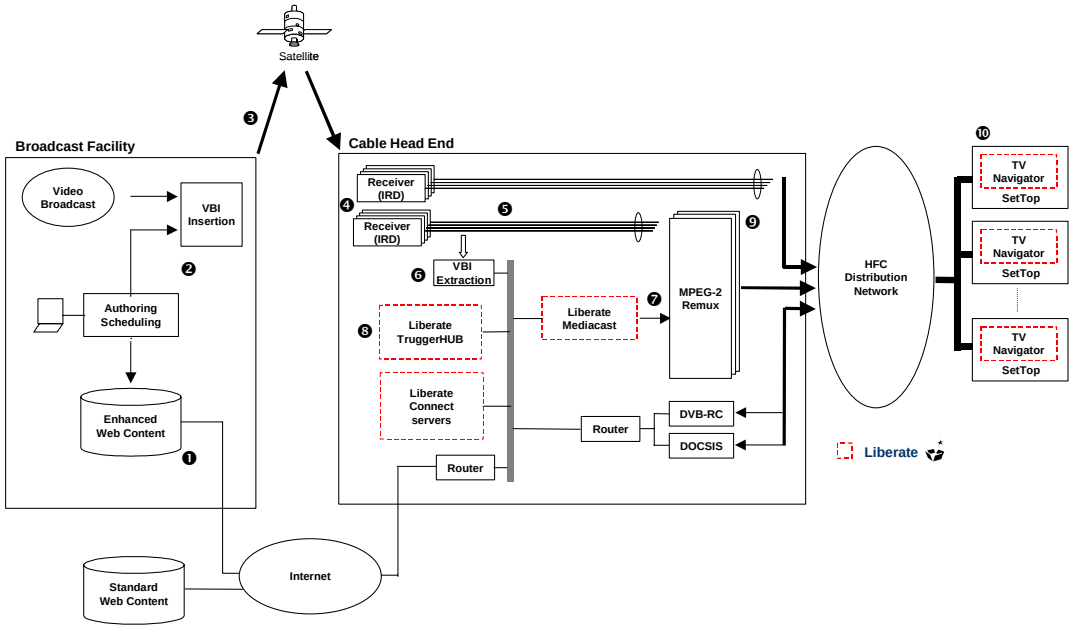

Figure 4 Advanced model end-to-end case study

This is a typical scenario of operation for the Advanced synchronization model for cable systems in North America:

❶ Content generation

The broadcaster (usually in conjunction with an ETV ASP (Application Service Provider) partner) creates the enhancement for a specific program. This enhancement is described through a play list (using XML standards) and provides location and timing characteristics (date, time, expiration) for the enhanced content. The enhancement is stored on a location accessible through the Internet backbone. It will be pulled at a later time from the Liberate infrastructure server that resides at the cable operator premises.

❷ Synchronization of information and trigger insertion

Using an authoring and scheduling system (multiple companies provide such systems), the triggers are created and inserted with the video signal, thus embedded in the broadcast feed, typically in the VBI (ATVEF Transport A). Scheduling information and enhancement (through play lists) can be made available (published) ahead of time (for the cable headend to fetch schedules and content). The broadcaster performs the insertion of triggers in the analog or digital domain. Signal transmission can be analog or digital but will preserve the embedded ATVEF triggers (ATVEF transport A, VBI, on analog or digital video).

❸ Broadcast of video content

The video is sent from the broadcaster through a network (analog or digital); typically satellite. The signal contains the ATVEF triggers embedded with the video signal. Again, the video signal could be analog or digital.

❹ Receive broadcast

The broadcast signal is received at the cable headend through a receiver (IRD). Depending on the network architecture, the network operator will either:

a) Broadcast the analog video to the network and let the set-top extract triggers from the analog video (Basic model).

b) Extract the triggers* at the headend, pre-fetch the enhanced content and send it on a data carousel through Liberate Mediacast™ (Advanced model).

* Trigger extraction can be done with external devices.

❺ Video distribution

Typically, the video programs (channels) are distributed to the subscribers in analog or digital format (some channels analog, some channels digital). The video delivery scheme (analog or digital) impacts the ATVEF support on the platform since the enhancement is transported to alternate paths. For example, for a single tuner set-top that is tuned to an analog channel, the enhanced content has to be delivered through the Out Of Band (OOB) in order to avoid tuning away and to be able to overlay the enhancement on the video programming.

❻ Triggers extraction and processing

For the specific Advanced synchronization model, the triggers are extracted at the headend. The Liberate TriggerHUB™ server is the link between the VBI extraction devices and the Mediacast carousels. Triggers are sent to the set-tops through Mediacast carousels using a notification mechanism. The Liberate TV Navigator™ allows the set-top to receive and appropriately handle triggers.

The user interface for offering enhancements to the viewer can be customized by the service operator through the TV Navigator™.

❼ Broadcast content

Liberate Mediacast™ is used to broadcast content through a data carousel scheme. The carousels are carried either in-band with the MPEG (single tuner set-tops) or through IP Multicast on the DOCSIS channel (dual tuners set-tops). The enhanced content is provisioned as part of a service that includes MPEG audio, video, and enhanced data. Mediacast™ enhances the system scalability since the enhanced content is made available to all subscribers served by the specific headend.

❽ Liberate TriggerHUB™ server

The TriggerHUB™ server resides at the cable head end and works in conjunction with Liberate Mediacast™ server. TriggerHUB™ pulls the schedule for the enhanced content associated with each video channel (from the broadcaster site). The TriggerHUB™ is the interface between the incoming triggers and the data carousel. It monitors triggers from multiple incoming sources, schedule them to the Liberate Mediacast™ server.

The first trigger of a program could include a <LINK> tag that refers to a play list. The TriggerHUB™ fetches the initial page, extracts the link, fetches the play list, creates a schedule from it, and hands it to the Mediacast™ server for carousel broadcast. This mechanism allows the system to prepare the content in advance,

hence reducing the latency on subsequent triggers.

The broadcaster can push play lists to the cable headend's TriggerHUB™ server allowing real time support of changes in the program schedule.

❾ MPEG re-multiplexing

When the target set-top is a single tuner set-top, the carousel is carried on MPEG and combined with the video and audio programs. An MPEG re-multiplexing device is used to combine the Video and Enhanced content (data carousel) on a single transport. The audio, video, and data are combined into a specific service allowing simple management and authorization through an existing Conditional Access System (CAS). The MPEG re-multiplexing device is generally part of the network for grooming video programs on specific MPEG transports.

❿ Subscriber

The set-top runs Liberate TV Navigator™ allowing it to receive, synchronize, and display the enhanced content. The set-top, when tuned to an enhancement-enabled channel, will then be able to notify the subscriber of enhanced content and retrieve it from the Mediacast™ carousel without tuning away. The carousel either resides on the same digital transport stream (MPEG) for single tuner set-top, or on the DOCSIS channel (IP Multicast) for dual tuner set-tops.

CONCLUSION

The successful deployment of Enhanced TV services requires a close coordination of Network operators, Content developers and Head End equipment vendors to overcome the many inherent problems in distributing synchronized enhanced content. Both the content and the delivery methods must accommodate the realities of the network. A platform based on standards such as ATVEF goes a long way towards ensuring a homogeneous content, allowing consistent processing. To handle the network requires a system that is capable of efficiently delivering content over networks with varied types of two-way backchannels.. Liberate facilitate this integration by offering a platform based on existing standards (such as ATVEF). From a content standpoint, the Liberate Enhanced TV platform allows common content and tools across different network topologies and set-top boxes capabilities. From a networking standpoint, the platform, through Liberate Mediacast™, ensures a delivery of enhancements which does not rely on a back channel and offers the network operator a direct control over the bandwidth allocation for the delivery of such enhancements.

FOOTNOTES

[i] ATVEF Web site: http://www.atvef.com

[ii] ATVEF was founded by a group of 14 companies: CableLabs, CNN Interactive, DIRECTV, Discovery Communications, Inc., Intel Corporation, Liberate Technologies, Microsoft and WebTV Networks, NBC Multimedia, NDTC Technology, Inc., Public Broadcasting Service (PBS), Sony Corporation, Tribune, The Walt Disney Company, Warner Bros. Over 130 companies worldwide have signed licenses to implement the ATVEF content specification.