# INVENTION DISCLOSURE

1. **Invention Title.**

## Feedback control measurements for Digital Program Insertion timing

2. **Invention Summary.**
MPEG streams containing advertisements to be inserted at the client (STB) during commercial breaks must be carefully aligned in time with the breaks. This invention provides a mechanism to measure alignment errors so corrections can be made.

3. **Invention Description**.

**a. Describe the invention in detail and/or attach a description, drawing(s) and/or diagram(s), if available. Please include flow charts for descriptions of software processes, and block diagrams for descriptions of hardware systems. Include the description/attachments in electronic form if possible.**

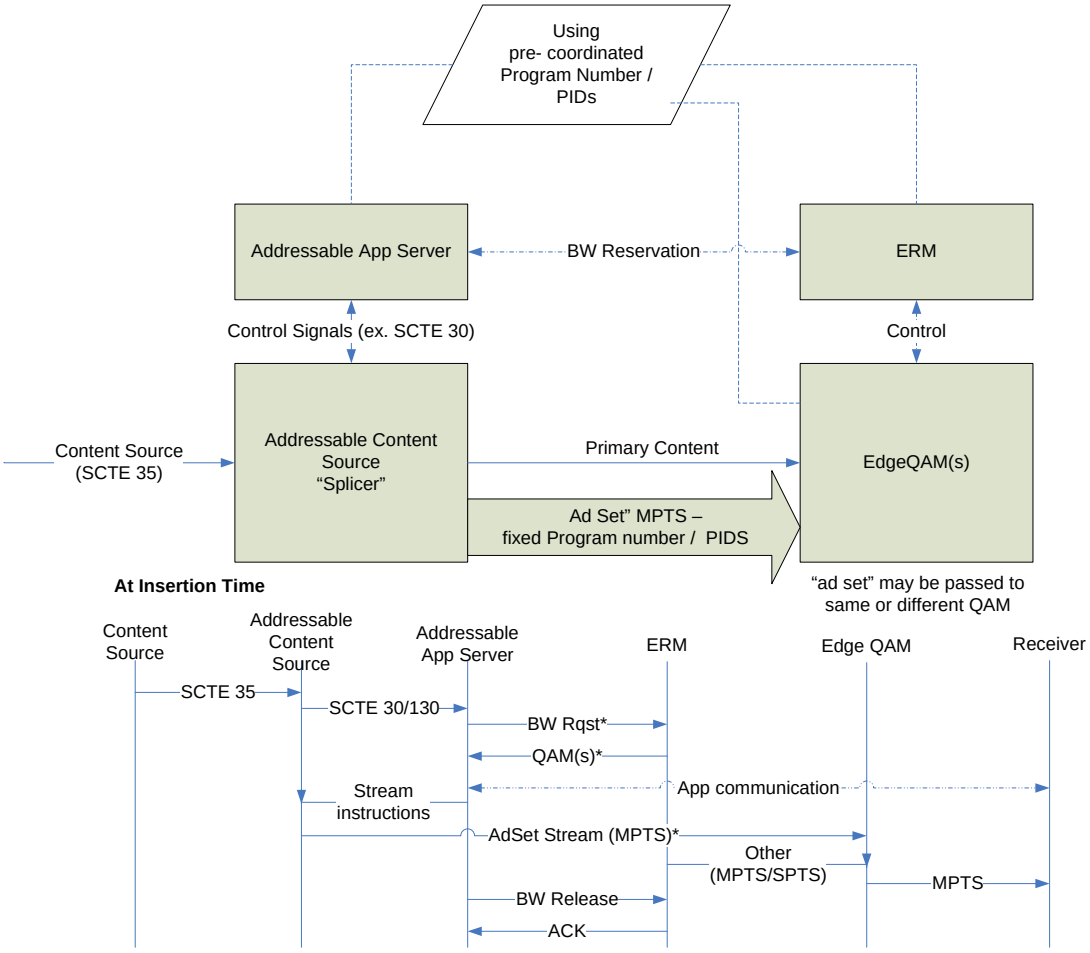
1. Public information (background).
The following text is taken from the ERMI draft specification and is already known to the focus team. It is included herein to set the background describing ad insertion.

# Digital Program Insertion

This section contains requirements germane to the insertion of digital programs used for ad insertion.

## Background

Ad insertion functionality, described by (draft) SCTE DVS 766 and other specifications, provides the ability to insert video ads ("Ads") into an existing program video stream ("Prog") on a per-subscriber STB basis. All the elements in the video delivery system must interact to make this possible including the Addressable App Server, the ERM, the EQAM, and each participating subscriber STB. The overall architecture is shown in the following diagram.




* Request specific bandwidth within one or more of the pre-coordinated Program Numbers/PIDs
1. Will be requesting for multiple qam groups
2. options:
A) ad set sources as a multi-cast that each QAM stream input joins
B) ad set sources as a uni-cast to a specific QAM stream input

***Figure 0 -8 -Digital Program Insertion Diagram***

The Addressable App Server will request the ERM to set up sessions for Ads. The ERM in turn will send a session setup request to the EQAM.

The sessions containing these Ads may be only be set up seconds before an ad insertion. The tight timing requirements engender the need for pipelining of Prog and Ad video data, minimal signaling overhead, and pre-arranged coordination of Program numbers and PIDs.. This in turn gives rise to the informative text detailed in the next section implement ad insertion functionality. Requirements for Addressable App Server and STBs are out of scope.

**Treatment of Program numbers and PIDs**

The Application governing addressable advertising needs to tell (by methods out of scope) each STB the Program number and PIDs of the ad to tune to. It would not be enough to rely on the STB to parse the PMT to determine the PIDs, due to the additional latency introduced by PMT acquisition and parsing. Therefore, Program numbers/PID data is reserved so that the Program numbers/PID mapping can be performed in advanced by the Addressable App Server and communicated to the STB for loading into the MCARD CA_PMT. The method for accomplishing this is as follows:

- The provisioning confg file provides reserved PIDs.for EQAMs. Also, in the config there is enough information so the **Error! Reference source not found.** knows which PIDs to use for CA. Note: There may be other applications beyond Ad Insertion that will also need reserved PIDs. The method for sharing this reserved PID space is out of scope. Program numbers are coordinated by means out of scope between the Addressable App Server and the ERM.
- During a session setup, the Ad insertion sessions should be set up with no PID or program remap.
- **Error! Reference source not found.** behavior

For sessions carrying Ad insertion video streams, the **Error! Reference source not found.** should use the async mode..

2. Public information (background).

3. Public information (background). The following text is taken from an email Charlie Bergren sent to the ERMI focus team. The email describes the timing problem and is included herein to further set the background describing ad insertion

**From:** Charles Bergren
**Sent:** Friday, September 26, 2008 10:31 AM
**To:** 'Michel, Walt'; Greg White; V-EQAM Data-plane FT Majordomo List
**Cc:** Mark Dulapa
**Subject:** ERMI - ad insertion timing budget

Walt,

I think we have squared away the informative requirements within ERMI that will help support ad insertion. This includes some guidance for ERM behavior and the PMT/PID considerations. I hope to have that text incorporated later today and out to the ERMI team for review.

I've been reviewing the SCTE and other formative specs on ad insertion (with particular attention to the timing requirements) and I'm wondering if we have our bases covered. I've copied Mark Dulapa on this since he's working on similar issues

at CableLabs in the STB / OCAP arena. Please correct me if I'm wrong summarizing these other specs or flagging this problem.

The formative spec outlines the need for a 33 msec alignment at the RF input of the STB between the respective video data for the 'normal viewer video' ("Prog") and the 'inserted ad video' ("Ad"). This alignment is required whether the Prog and Ad are within one mux (on one QAM channel), or on separate frequencies (different QAM channels).

This requirement allows the specifications governing Ad insertion on the STB to function in a nominal manner to provide seamless Ad insertion. However, this also establishes a budget for the performance of all the video carriage gear north of the STB. It's this budget that I'm worried about.

Scenario - In this email discussion, we can explore backing off the worst cast scenario, but let's assume worst case for now. Let's first assume that the Prog and Ad video streams are both aligned at the "Sources" somewhere north of the EQAM. But let's assume the ERM simply selects a separate QAM (without consideration of this issue) for the Ad video stream. The data for each stream could travel through a multi-cast path (with delay "Tmc") then through a different QAM channel (with delay "Tqc"). Thus, the "alignment" could be thrown off by the differential timing of the two paths. I'm assuming the HFC path is inelastic and any differential delay there will be small.

Alignment (at RF input) = (TmcProg + TqcProg) - (TmcAd + TqcAd)
This is the figure that must be kept below 33 msec. My instinct tells me this budget could be a problem.

Right now, we have no control over Tmc for either path. Perhaps MSOs can control that number, or it's low to start with?
Right now, we have no normative requirement within our developing stream spec for Tqc other than to minimize it.

The particular scenario I worry about is that Tqc will be different for different EQAM vendors and that the ad insertion control systems doesn't have enough control over how QAMs are assigned to video streams.

Suggestions for moving foward –
1. Let's review my assumptions that a problem could exist. Maybe we can drop item 2 below!
2. Let's discuss methods to back off the worst case scenario. Perhaps we can suggest requirements for operators or ERMs to handle this.
3. We should estimate where we are with this budget.
4. We could work through what happens if the budget is not met. This would involve working out what happens if the Ad video stream is slipped forward or back in time relative to the Prog stream. These bad effects could include: video blocking, audio pops, missed ads, shortened ads, etc. I suspect the SCTE 766 team already has these scenarios worked out, but I haven't seen a report on that. But before I do that analysis, let's work through items 1-3 above.

CB

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Best Regards
Charles Bergren

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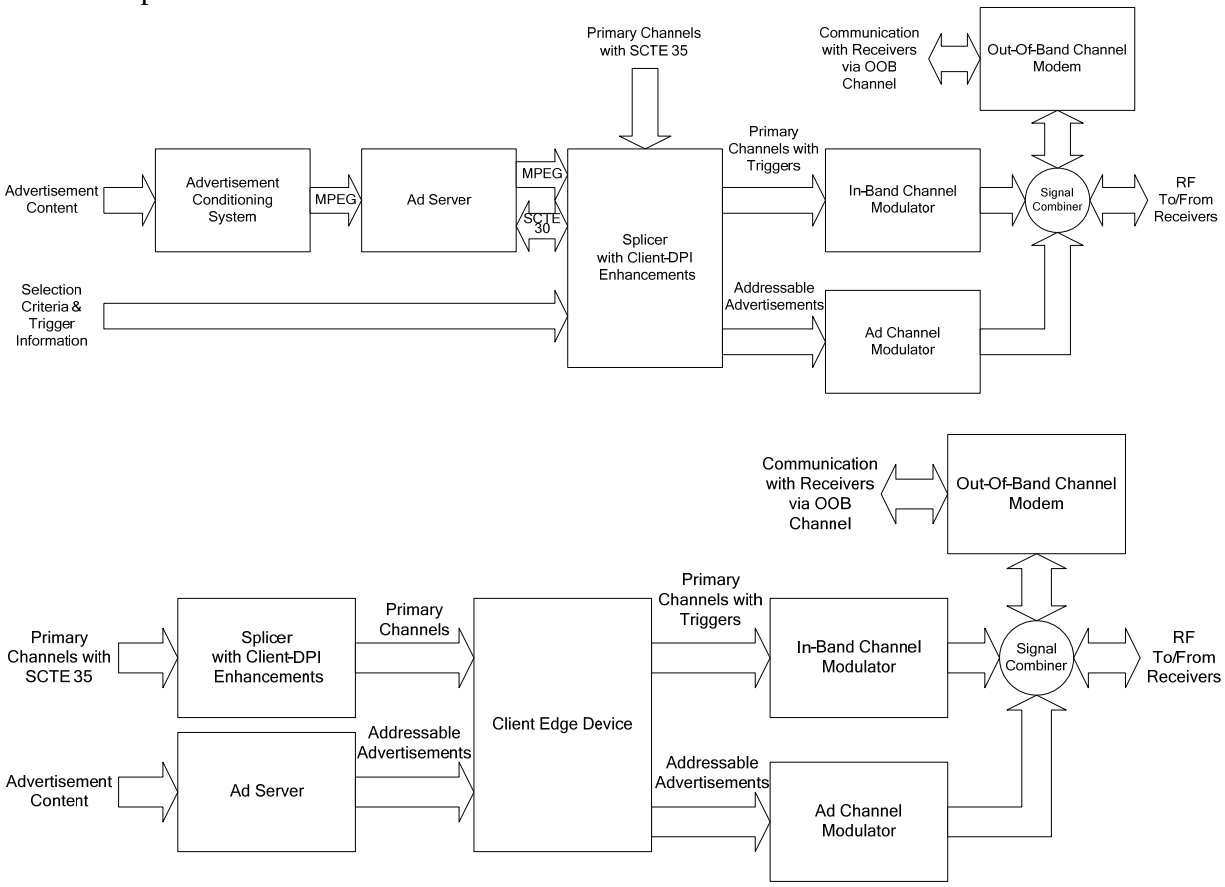
AIM CharlieCLabs

4. Documentation of the invention

Shown below are two head-end architectures for Level0 client DPI. These two diagrams are reproduced from the current draft of DVS766.




In these architectures, the Primary Channel with Triggers and the Addressable Advertisements need to arrive at the RF Receiver in the STB with a precise time alignment (33ms in the current DVS766 draft). For purposes of the discussion going forward, the term "Conditioner" is used to represent the "Splicer with Client-DPI Enhancements" in the first figure, and the "Client Edge Device" in the second figure. The Conditioner is the device that is responsible for assuring that the necessary time alignment is achieved. The term "EQAM" is used in the foregoing as a replacement for "Modulator".

Since there may be a considerable latency difference between the Primary Channel path and the Addressable Advertisements path from the Conditioner to the STB it is necessary to have a mechanism to measure that latency difference such that the desired time alignment of the streams can be assured.

A further complication of this architecture, which is not shown in the figures above, is that the Primary Channels stream is likely not delivered to a single modulator, but is in fact IP multicast to a number of modulators, with each copy having an independent latency.

This invention assumes that the Primary Channels stream can be IP multicast or IP unicast, but that the Addressable Advertisements streams are IP unicast only.

The invention:

1) Each EQAM and the Conditioner needs to have a common timebase with millisecond accuracy, this can be achieved by use of DTI or another system clock mechanism, perhaps even NTP.
2) The EQAM needs to monitor the program streams for trigger signals
3) Upon seeing a trigger signal, the EQAM needs to send a report to the Conditioner containing some identifiable information from the trigger signal, as well as a timestamp that indicates when the trigger signal will be produced on the output of the EQAM, with the addition of pre-compensation for the interleaver / de-interleaver latency.
4) Once session setup completes for the Ad Channel EQAM, the Conditioner can begin streaming black frames along with "dummy" trigger signals to the Ad Channel EQAM
5) Conditioner receives reports from the Ad Channel EQAM(s) based on the dummy trigger signals, allowing it to calculate latency from it to the output of each Ad Channel EQAM.
6) Conditioner monitors the Primary Channel streams for trigger signals, and notes when a trigger signal has been sent
7) Conditioner receives report(s) from the In-Band Channel EQAM(s) based on each trigger signal in the Primary Channels
8) Conditioner can then calculate latency between it and the output of the In-Band Channel EQAM(s)
9) Conditioner can time the transmission of the initial I frames of the ad content based on the latency difference between the Primary Channel and the Ad Channel paths.

b. Why was the invention developed? What problem(s) does the invention solve? How is it better?

Digital Program Insertion (DPI) technology stems from several specifications, including SCTE draft Document SCTEXXXDVS766, "Stream Conditioning For Switching Of Addressable Content In Digital Television Receivers". This specification was drafted starting from an assumption that the MPEG stream containing the commercial break ("Program") and the MPEG stream carrying the ad to be inserted ("Ad") arrive within 33 milliseconds of each other at the input of the Set Top Box (STB). This assumption made it easier to draft the 766 specification by putting the onus on the video source transport systems to provide the Program and Ad streams so aligned in time. However, the Program and Ad streams may be subject to different delays depending on their respective paths through video source transport systems to the STB input. Each video source transport path may have different switching gear and video processing equipment (including Edge Quadrature Amplitude Modulators (EQAMs) and STB MPEG processing). Means must be developed to control the time alignment of these two streams as

they travel through these two paths. This invention provides innovative means to measure the time alignment so it may be subsequently controlled. This invention does not specify the control methods other than to cite examples of potential methods.

This method provides feedback data for control purposes. This data is captured from EQAMs proximate to the head-end, video source equipment. Other methods may require data capture from STBs. This method is thus better in several ways:

- Saleable network bandwidth is not consumed by feedback data.
- Feedback data is confined to a smaller, well-controlled, head-end administrative network. The assumption is that the feedback data will be available in a more timely fashion and perhaps more accurate.
- Fewer vendors are involved since STBs do not have to support this measurement method. If only the EQAM vendors and the vendors of Addressable App Servers need to support the invention, then it is more likely to be implemented and implemented correctly.

c. Briefly outline the potential commercial value and customers of the invention.
*Ignoring the potential value of facilitating the insertion of Ads, this method helps to prevent losses should ad insertion fail to take place properly. These losses could include:*

- *Loss of ad revenue if Ads are not successfully inserted.*
- *Losses due to decreased quality of viewer experience if video artifacts occur during a faulty Ad insertion. These losses could include*
    - *Increase truck rolls*
    - *Increased customer service calls*
    - *Increased network debugging costs.*

**4. HOW is your invention different from existing products, processes, systems? Please list the closest publication(s), product(s), method(s), patent(s), etc. to your invention. <u>For each item, how is your invention different?</u>**

No other existing products, processes, or systems are known at this time.