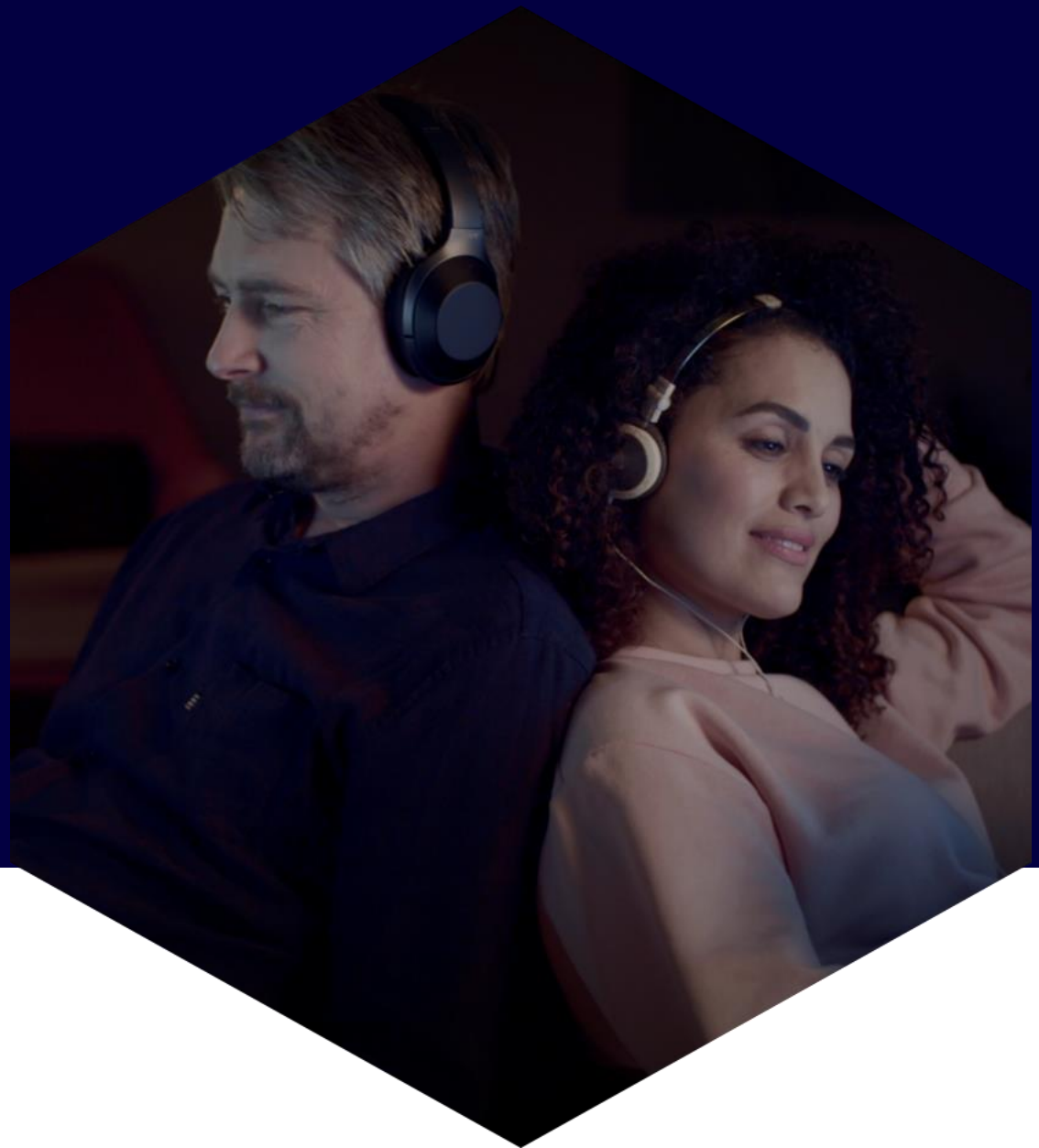
Interoperable ad slot signaling for DASH according to DVB and SCTE

Dr. Yasser Syed (Comcast, representing SCTE)
Dr. Rufael Mekuria (Unified Streaming, representing DVB)



DVB

SCTE Society of Cable Telecommunications Engineers

Outline

- Introduction to SCTE WG5 and WG7 and DASH-IF related work
- Introduction to DVB
- Overview of topics discussed in joint effort of DVB and SCTE on ad slot signaling in DASH
- Constraints introduced in SCTE 214-1
- Constraints introduced in DVB-TA and DVB-DASH
- Example use cases
- Demo streams
- Future work

SCTE WG5- Intro

Purpose: The Digital Program Insertion Working Group is focused on the development of standards and practices that support an important revenue stream for the cable industry: advertising insertion into programs.

Affecting both the content providers and the operators themselves, advertising revenue continues to grow in importance and the variety of programming vehicles expands beyond traditional QAM-based "linear television" to include IP distribution, On Demand, and TV Everywhere.

The variety of transport, compression, and related technology changes make the aspect of digital program insertion of advertising a challenging and exciting area. The end-to-end infrastructure diagram, which is shown below provides an overview of the areas that WG5/DPI impacts.

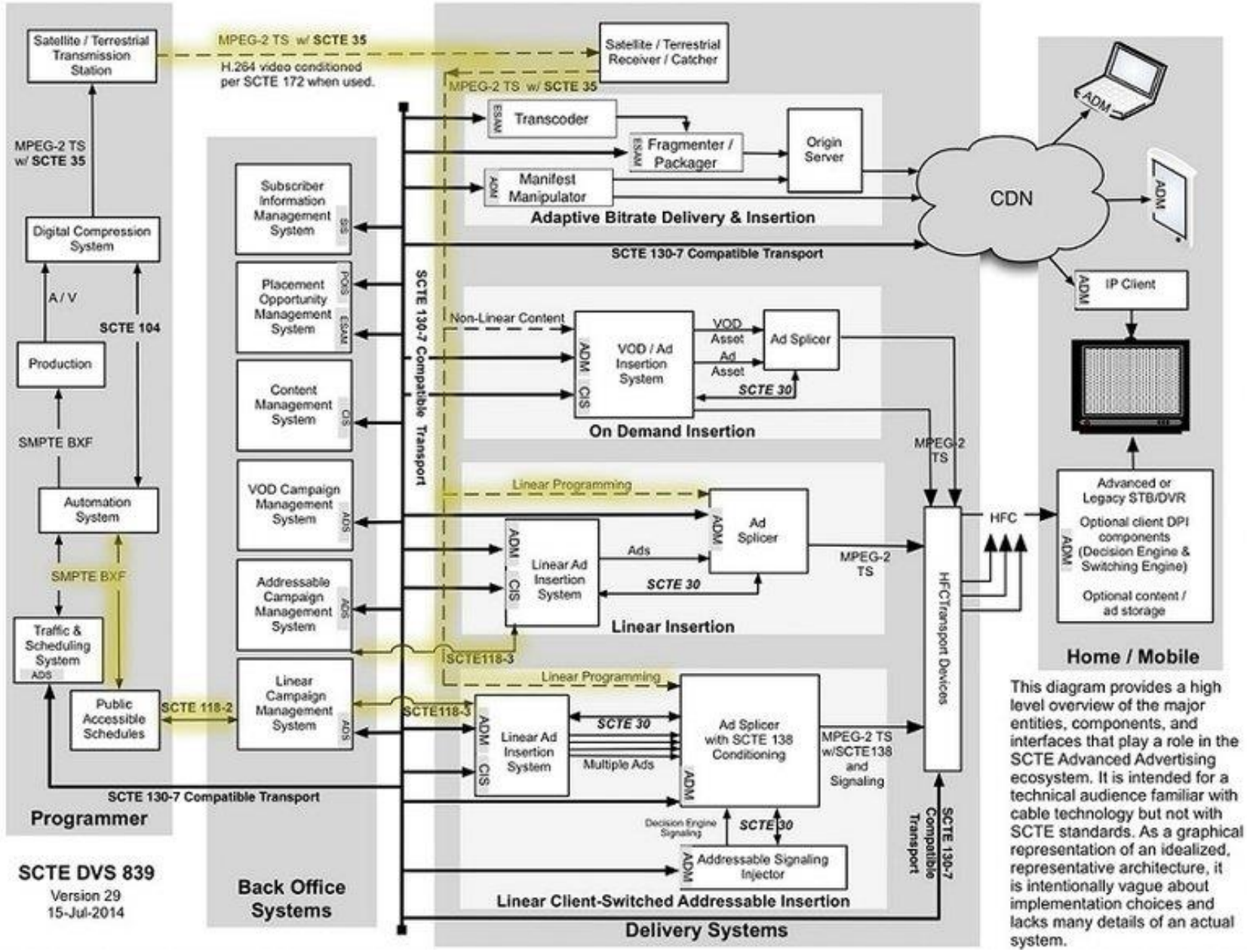
- Advanced advertising technology: Addressable ad insertion, linear and on-demand ad insertion interfaces, digital cueing and splicing, alternate content/blackout, and metadata.

SCTE WG5 -Intro

Standards:

- Transport Splice Signaling/Insertion (SCTE 35- Cueing Message/ SCTE 67 Guidelines/ SCTE 172 – Stream Conditioning)
  - https://www.scte.org/standards/library/catalog/scte-35-digital-program-insertion-cueing-message/
  - https://www.scte.org/standards/library/catalog/scte-67-digital-program-insertion-for-cable/
  - https://www.scte.org/standards/library/catalog/scte-172-constraints-on-avc-and-hevc-structured-video-coding-for-digital-program-insertion/
- Baseband Signaling (SCTE 104-Automation to Compression Systems)
  - https://www.scte.org/standards/library/catalog/scte-104-automation-system-to-compression-system-communications-api/
- Ad Decisioning (SCTE 130-X Advertising Systems Interfaces)
  - https://www.scte.org/standards/library/catalog/scte-130-1-dpi-advertising-systems-interfaces-part1-advertising-systems-overview/
- Alternate Content Event Signaling ESAM/ESNI (SCTE 224- Event Scheduling & Notification/ SCTE 250- Real-time Event Signaling and Management)
  - https://www.scte.org/standards/library/catalog/scte-224-event-scheduling-and-notification-interface/
  - https://www.scte.org/standards/library/catalog/scte-250-real-time-event-signaling-and-management-api/

SCTE Interfaces for Advanced Advertising



This diagram provides a high level overview of the major entities, components, and interfaces that play a role in the SCTE Advanced Advertising ecosystem. It is intended for a technical audience familiar with cable technology but not with SCTE standards. As a graphical representation of an idealized, representative architecture, it is intentionally vague about implementation choices and lacks many details of an actual system.

SCTE WG7 Intro

Purpose:

Adapt cable network distributions to streaming technologies. First from repurposing MPEG-2 TS Distribution stream. Then using ISOBMFF segments.

Standards:

- MPD Constraints for MPEG-TS, ISOBMFF, CIF (SCTE 214-X)
  - 214-1 will contain a guideline for SCTE 35 messages to DASH Events
  - https://www.scte.org/standards/library/catalog/scte-214-1-mpeg-dash-for-ip-based-cable-services-part1-mpd-constraints-and-extensions/
- Marked up MPEG-2 for Segmentation (SCTE 223)
  - https://www.scte.org/standards/library/catalog/scte-223-adaptive-transport-stream/

Intro DVB (https://dvb.org/)

- Founded in 1993 industry led consortium designing open technical media specification
- Key and pioneer standard for digital TV over terrestrial, satellite, cable and IP
- Commercial standards, it works via a commercial requirements module
- Internationally deployed, but mostly in Europe centric
- DVB-AVC TS 101 154 https://www.etsi.org/deliver/etsi_ts/101100_101199 /101154/02.06.01_60/ts_101154v020601p.pdf
- DVB-DASH in TS 103 285
- Work on channel discovery and signalling (DVB-I) TS 103 770
- DVB-TA published in 2020 signalling ad breaks in MPEG-2 TS

  https://dvb.org/?standard=dynamic-substitution-of-content-in-linear-broadcast-part-1-carriage-and-signalling-of-placement-opportunity-information-in-dvb-transport-streams

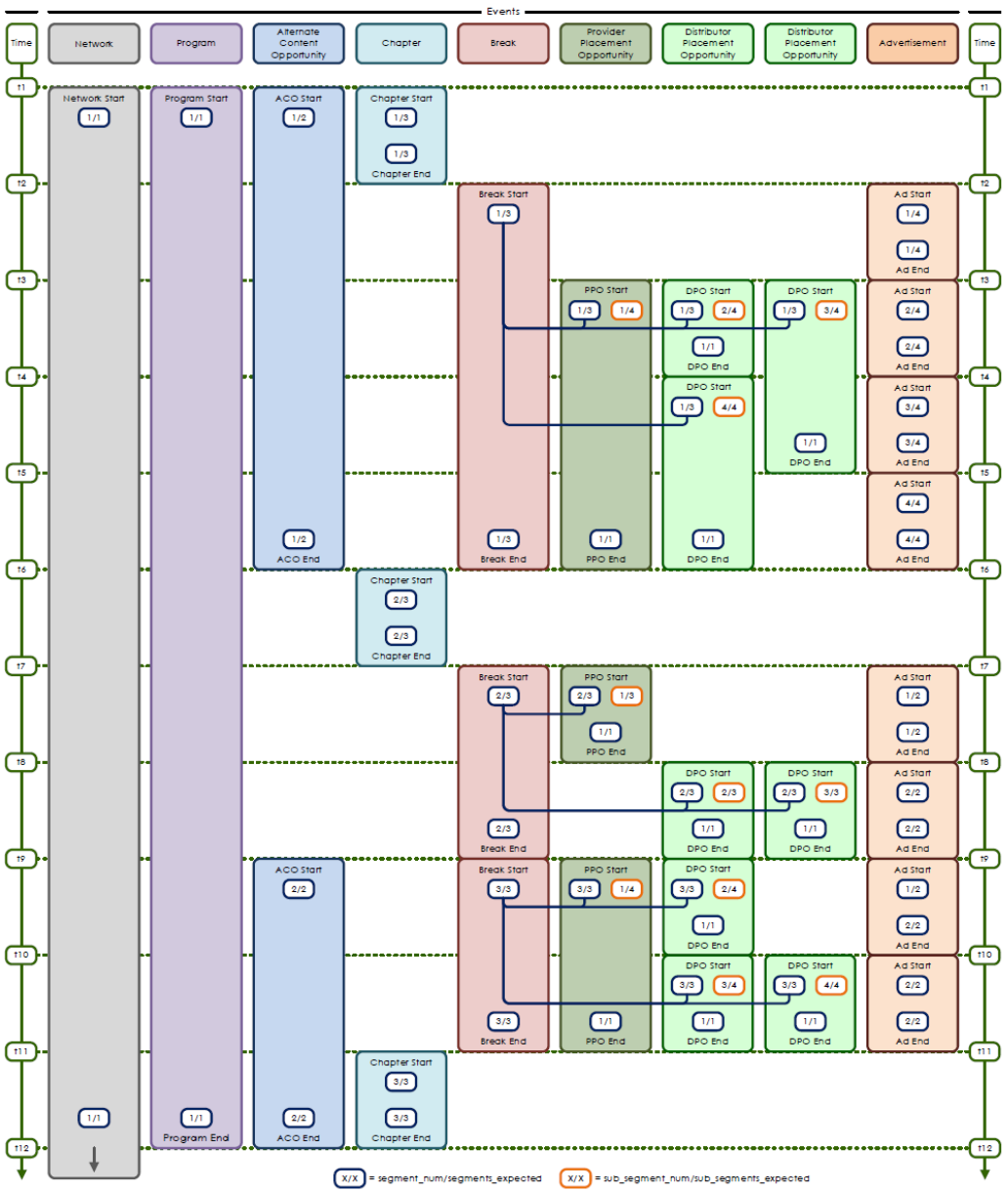
Commercial Requirements CM-TA

- Content conditioning at boundaries
- Content and device identification in DASH and HLS for TA
- Reporting of viewer impressions for DASH and HLS for TA
- Ad slot signalling for targetted advertising
- Integration with DVB-I, use cases in ad supported TV channels (FAST)

Ad slot signalling in DASH

- Ad slot signalling in DASH is an important (but not the only) piece of the puzzle
- Impression Reporting, Ad identification, content conditioning are important areas not covered in this talk but key for implementing TA for FAST TC
- Rest of this talk will focus on the technical details of signalling ad slots with SCTE-35 in MPEG-2 TS and DASH based on recommendations from DVB and SCTE
- DVB and SCTE joined forces on this topic
  - SCTE developed the core specification SCTE 214 and 35
  - DVB provided commercial requirements and input on DASH/MP4 usage, and a list of questions/topics, looking to profile the SCTE base specification for their needs

Ad Slot Signalling in SCTE-35



SCTE/DVB Joint Discussion Group Topics
(resulted in several liaisons with MPEG)

Discussions:

- On- receive / On-start mode
- Duration/ early termination/ start & end pairs
- Repeats & Updates of SCTE 35 messages
- Use of IDs for correlation
- Advanced warning
- ESNI/ESAM roles
- Zero Duration Splice Insert
- Crossing period boundaries
- VOD Content- Ad Insertion
- Anchoring of timeline
- SCTE 35 ID/ DASH Event IDs
- Binary/ XML
- Splice Immediate function in DASH
- Breakaways (suspended program)
- Time synchronization and PTS
- Events continuing across periods
- Conversion back to SCTE 35 from DASH Event
- DASH Client Model
- Feedback on DASH-IF IOP-part 10

214-1 2022 MPD Period Level EventStream/Event Constraints for SCTE Events

Eventstream

- @timescale granular enough to accommodate frame accurate access (240 KHz)
- @presentationTimeOffset should be present and allow for events starting in the past of the current period (Epoch-Locking/ No past period retentions needed)
- Operate On-Receive Mode
- One EventStream for a PID

Events

- Contain only 1 Splice_info_section
- Event@duration should be expected duration/Can be closed by 0 duration event
- Event retained as long as media segments under event is there
- No two events with same ID and same presentation time exists in the same EventStream
- @messageData not used

DVB-DASH and DVB-TA part 3 (2022)

- DVB-DASH Bluebook (2022):
  - Bluebook is early publication by DVB
  - Support for XML based Event
  - Processing reading SCTE 35 Events
  - Reference SCTE 214-1
  - Some restrictions on how Event structure is used
- DVB-TA part 3 (2022):
  - Restrictions on using SCTE-35 in DVB-DASH
  - Using Events and use cases in OTT such as insertion, early termination
  - Time_signal and splice insert support
  - Interoperable with common server side (Google, AWS MT, Yospace and others)
  - Steer for adoption in HbbTV

SCTE-35 restrictions in DVB-TA

Splice_info_section

Syntax	Bits	Restrictions	Same as TS 103 752-1
table_id	8	N/A	YES
Section_syntax_indicator	1	N/A	YES
private_indicator	1	N/A	YES
reserved	2	N/A	YES
section_length	12	N/A	NO, this field is limited to a maximum value of 4093.
protocol_version	8	N/A	YES
encrypted_packet	1	Shall be 1 or 0 see TS 103 752-1 5.3.4.1	YES
encryption_algorithm	6	N/A	YES
pts adjustment	33	May be set, but shall be ignored.	NO
tier	12	N/A	YES
splice_command_length	12	N/A	YES
splice_command_type	8	Shall be 0x05 or 0x06 splice_insert() or time_signal()	YES
E_CRC_32	32	N/A	YES
CRC_32	32	N/A	YES

SCTE-35 restrictions in DVB Splice_insert

Syntax	Bits	Mnemonic	Restrictions	Same as TS 103 752-1
splice_event_id	32	uimsbf	(pseudo-)Unique. This field is not used to correlate in and out messages (start and end of a break), but instead to identify individual splices.	YES
splice_event_cancel_indicator	1	bslbf	Shall be 0	YES
reserved	7	bslbf	N/A	YES
out_of_network_indicator	1	bslbf	Shall be 1 for a start (OUT) of a break, 0 for an end (IN). It is recommended that the 0 (IN) is only used for an early return see clause 4.4.8.1.	NO
program_splice_flag	1	bslbf	Shall be 1	YES
duration_flag	1	bslbf	Shall be 1	YES
Splice_immediate	1	bslbf	Should be 0, but should be ignored in DVB-DASH the event presentation time is used as the splice time.	NO
reserved	4	bslbf	N/A	YES
splice_time()				NO
time_specified_flag	1	bslbf	May be set, but should be ignored as this has no meaning in DVB-DASH. Should be 1 in case marker originated from a MPEG-2 transport stream to keep this information, otherwise it should be set to 0.	NO
reserved	6	bslbf	N/A	YES
pts_time	33	bslbf	N/A	YES
Auto_return	1	bslbf	Shall be 1 for OUT, shall be 0 for IN.	YES

Duration	33	Uimsbf	Shall equal the expected break duration when out_of_network_indicator is 1. Shall be 0 or the expected break duration when out_of_network_indicator is 0.	YES
Unique_program_id	16	uimsbf	N/A	YES
Avail_num	8	uimsbf	N/A	YES
avails_expected	8	uimsbf	N/A	YES

SCTE-35 restrictions in DVB

Time_signal And Segmentation descriptor

Syntax	Bits	Mnemonic	Restrictions	Same as TS 103 752-1
splice_time()				NO
time_specified_flag	1	bslbf	May be set, but should be ignored as this has no meaning in DVB-DASH. Should be 1 in case marker originated from a MPEG-2 transport stream to keep this information, otherwise it should be set to 0.	NO
reserved	6	bslbf	N/A	YES
pts_time	33	bslbf	N/A	YES
splice_descriptor_tag	8	uimsbf	0x02	YES
Descriptor_length	8	uimsbf	N/A	YES
Identifier	32	bslbf	0x43554549	YES
segmentation_event_id	32	bslbf	It shall be the same for corresponding start and end descriptors that signal an ad slot.	YES
segmentation_event_cancel_indicator	1	bslbf	Shall be 0	YES
reserved	7	bslbf	N/A	YES
program_segmentation_flag	1	bslbf	Shall be 1	YES
segmentation_duration_flag	1	bslbf	Shall be 1	YES
delivery_not_restricted_flag	1	bslbf	1	YES
segmentation_duration	40	uimsbf	Shall match the expected duration for Dynamic Ad Substitution. Shall be zero for Dynamic Ad Insertion.	YES, except for Dynamic Ad Insertion that was not defined.
segmentation_upid_type	8	uimsbf	N/A	NO (0x0F)
segmentation_upid_length	8	uimsbf	N/A	YES
segmentation_upid()			N/A	NO
segmentation_type_id	8	uimsbf	For PO: 0x34, 0x35, 0x36, and 0x37, may be different for other descriptor types	YES
segment_num	8	uimsbf	Optional, N/A	YES
Segments_expected	8	uimsbf	Optional, N/A	YES
Sub_segment_num	8	uimsbf	N/A	YES
Sub_segments_expected	8	uimsbf	N/A	YES

Restrictions on using SCTE-35 Events in DVB-DASH (DVB-TA part 3)

- EventStream element
- Scheme id uri: *urn:scte:scte35:2014:xml+bin* or *urn:scte:scte35:2013:xml*
- @presentationTime shall match the splice time
- Use EventStream@presentationTimeOffset to enable global timeline for events
- Frame accuracy of timing for video, audio within 100 ms bounds
- Don’t use indefinete duration: 0xFFFFFFFF
- Guidance on when an Event may be added or removed from the manifest, including guidelines for 4s+ advance notice

Use Case: ad substitution/replacement

- Splice_insert or time_signal in splice_info section
- Frame accuracy to sap 1 or sap 2 at splice point
- Auto_return=1 for splice_insert
- Matching start and end of DPO/PPO
- Event@duration shall match (expected) break duration
- Unique Event@id shall be used

```
<Period id="1519" start="PT451209H39M31.000S">

<EventStream schemeIdUri="urn:scte:scte35:2014:xml+bin" timescale="1"
presentationTimeOffset="1624354771">

    <Event presentationTime="1624354848" duration="19" id="760">

     <Signal xmlns="http://www.scte.org/schemas/35/2016">

    <Binary>

/DAgAAAAAAAAAP/wDwUAAAL4f//+ABoXsMAAAAAAAPF20V0=

</Binary>

     </Signal>

   </Event>

 </EventStream>

<!– rest ommitted for simplicity>
```

Use Case: ad insertion (VoD/Live2VoD)

- New and only applies to VoD
- Event@duration=0 and SCTE-35 duration = 0
- Auto_return=1 for splice_insert
- Matching start and end of DPO/PPO in same splice info section
- Event@duration shall match (expected) break duration
- Unique Event@id shall be used
- Optional segmentation descriptor for insertion may be defined (TBD), also to support insertion of multiple ads

```
<Period id="1" start="PT0S">

<EventStream schemeIdUri="urn:scte:scte35:2014:xml+bin"
timescale="1">

      <Event presentationTime=“0" duration=“0" id="760">

       <Signal xmlns="http://www.scte.org/schemas/35/2016">

      <Binary>

/DAgAAAAAAAAAP/wDwUAAAL4f//+AAAAAMAAAAAAAK9Lx0I
=       </Binary>

       </Signal>

     </Event>

 </EventStream>

<!– rest ommitted for simplicity>
```

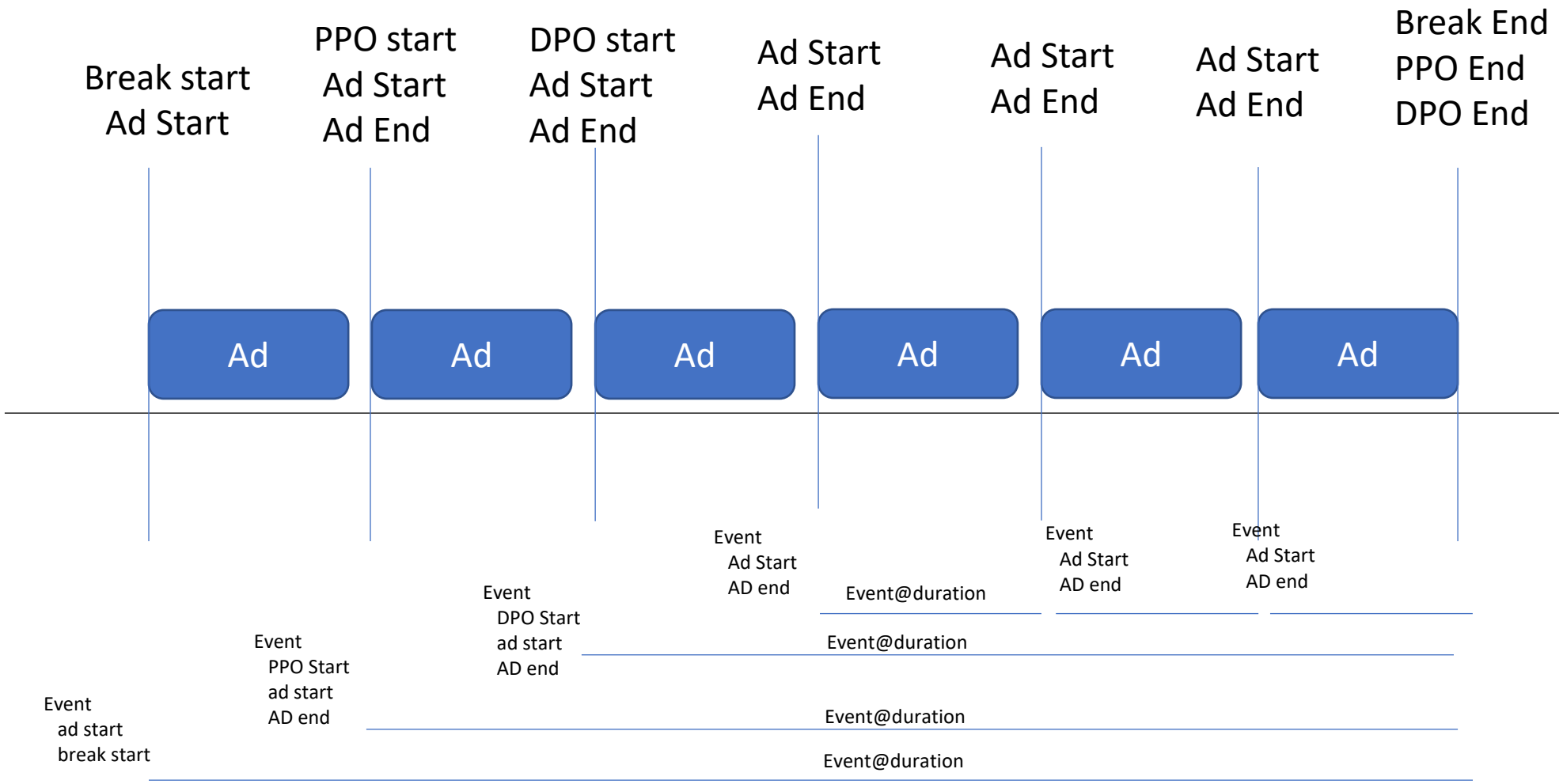
Use Case: early termination

- Terminate the ad break earlier than expected
- Requires gradual publishing of the ad segments at the rate of the live content @maxSegmentDuration is typically used for this.
- Splice_insert with out_of_network_indicator=0 before end of the break
- Ad insertion system may need to correct to the actual break away point
- time_signal with end descriptor before the expected segmentation duration
- Should be signalled well enough in advance (+- 4 seconds)

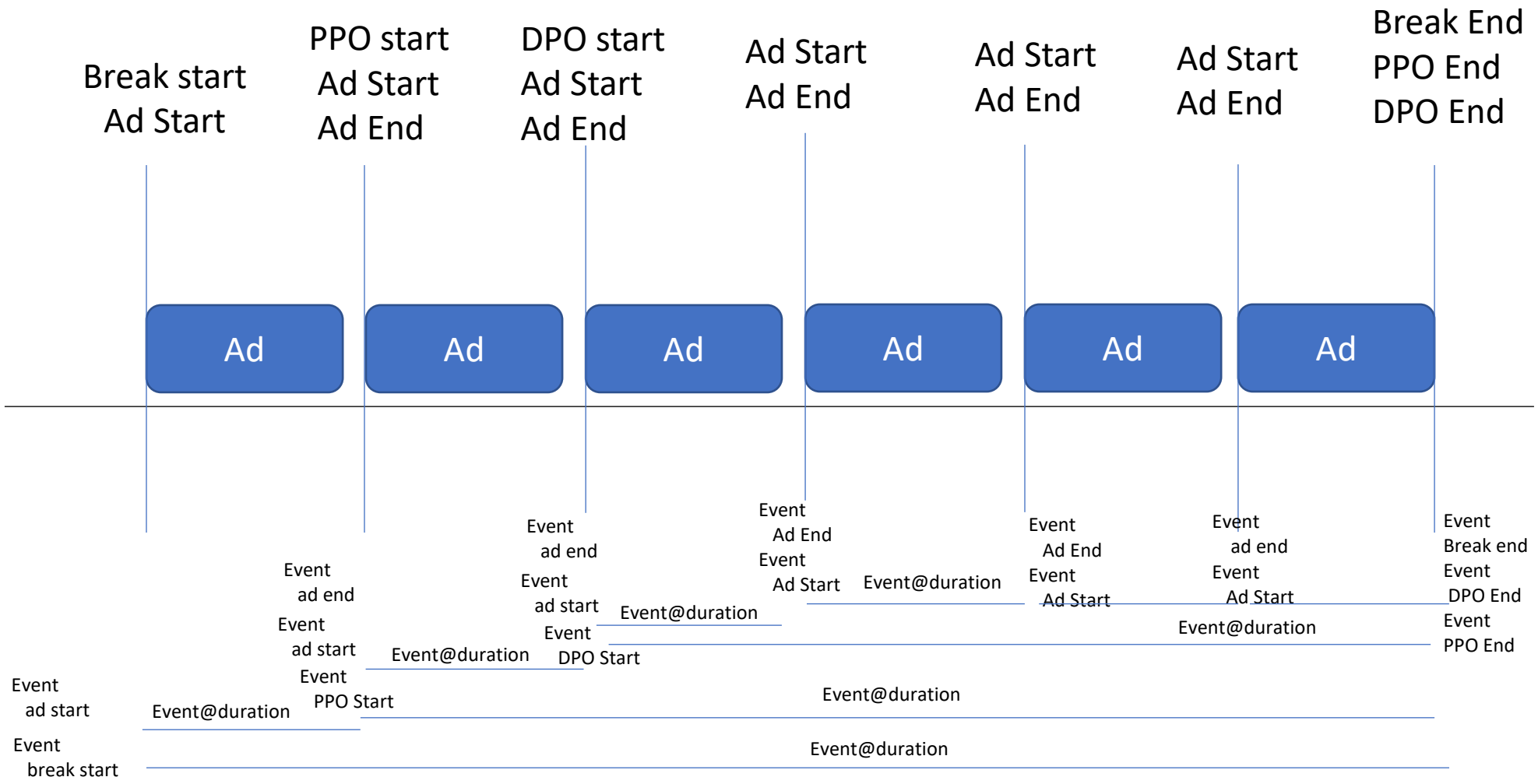
```
<Period id="1" start="PT0S">
<BaseURL>dash/</BaseURL>
<EventStream schemeIdUri="urn:scte:scte35:2014:xml+bin" timescale="600" presentationTimeOffset="999815323200">
        <!-- 2022-10-21T14:25:58.381666Z -->
         <Event presentationTime="999817415029" duration="27059" id="1394358337">
              <Signal xmlns="http://www.scte.org/schemas/35/2016">
                   <Binary>/DAbAAAAAAAAAP/wCgUAAAAAf18AAAAAAAAqqkN1</Binary>
              </Signal>
          </Event>  <!-- 2022-10-21T14:26:43.480000Z -->
          <Event presentationTime="999817440888" id="102481674">  <!– closes 2 seconds earlier -- >
           <Signal xmlns="http://www.scte.org/schemas/35/2016">
                   <Binary>/DAbAAAAAAAAAP/wCgUAAAAAf18AAAAAAAAqqkN1</Binary>
           </Signal>
          </Event>
```

Mapping time_signal with segmentation descriptors to events

Option A Multiple segmentation descriptors
event duration = longest duration



Option B Single segmentation descriptors



What about period creation ?

- Both single and multi period are supported for packager/encoder (as in DASH-IF IOP)
- Trick is that there is timing info in the segments (ISOBMFF) and in the manifest (Period@start, availabilityStart time etc.)
- For sufficiently large DVR window and sufficient SCTE 35 markers direct convertion from single to multi period is possible
- Document provides guidelines for conversion from single to multi-period manifest
- Conversion is only based on manifest manipulation, no changes to segments are needed or required (when using the live profile and segment timeline!)
- Implemented by various DAI vendors (AWS MT, Google DAI, YoSPace and others), state or per client manifest even better for the DAI vendor maintaining a per client connection that can also be used for viewer tracking.

Demo test streams

Name	Ingest url
Learning Channel	https://demo.unified-streaming.com/k8s/vod2live/stable/unified-learning.isml/.mpd
Live Trunk	https://demo.unified-streaming.com/k8s/live/trunk/scte35.isml/.mpd
Live Stable	https://demo.unified-streaming.com/k8s/live/stable/scte35.isml/.mpd

Future Work (ad slot signalling)

- New future annex in 214-1 will indicate guidelines for SCTE 35 message translations to SCTE DASH Event, but still should fit within these constraints
- Contributions on HLS front, probably HLS-DASH interop task force CTA
- We would like to work with DASH-IF (e.g. Comments IOPv5 part 5 5.5.2)
- Test content creation

Potential collaboration with DASH-IF

- Ad content conditioning/formatting
- Ad reporting
- Identification
- Test content creation
- A lot of synergy on IOP v5 part 5