



***Society of Cable  
Telecommunications  
Engineers***

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**ENGINEERING COMMITTEE  
Digital Video Subcommittee**

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**AMERICAN NATIONAL STANDARD**

**ANSI/SCTE 214-1 2015**

**MPEG DASH for IP-Based Cable Services  
Part 1: MPD Constraints and Extensions**

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## 1. Scope

This standard is part of a suite documenting usage of MPEG DASH in IP-based cable networks. It specifies restrictions on MPD and codecs that apply to both MPEG-2 TS and ISO-BMFF segments. Thus, DASH/TS profile is a combination of part 1 (this standard) and Part 2 (which defines aspects specific to MPEG-2 TS), and, analogously, DASH/FF profile is a combination of Part 1 and Part 3 (which defines aspects specific to ISO-BMFF). The DASH/TS profile is also very similar to the adaptive transport stream source description defined in SCTE 215.

Profile URNs for DASH/TS and DASH/FF appear in SCTE 214-2 and SCTE 214-3.

## 2. Normative References

### 2.1. SCTE References

ANSI/SCTE 35 2014, Digital Program Insertion Cueing Message for Cable

ANSI/SCTE 128-1 2013, AVC Video Constraints for Cable Television Part 1: Coding

ANSI/SCTE 128-2 2014, AVC Video Constraints for Cable Television Part 2: Transport

ANSI/SCTE 130-10, Digital Program Insertion – Advertising Systems Interfaces, Part 10 – Stream Restriction Data Model (SRDM)

ANSI/SCTE 193-1 2014, MPEG-4 AAC Family Audio System – Part 1: Coding Constraints for Cable Television

ANSI/SCTE 193-2 2014, MPEG-4 AAC Family Audio System – Part 2: Constraints for Carriage over MPEG-2 Transport

ANSI/SCTE 194-1 2013, DTS-HD Audio System – Part 1: Coding Constraints for Cable Television

ANSI/SCTE 194-2 2014, DTS-HD Audio System – Part 2: Constraints for Carriage over MPEG-2 Transport

SCTE 215-1 2015, HEVC Video Constraints for Cable Television, Part 1 – Coding

SCTE 215-2 2015, HEVC Video Constraints for Cable Television, Part 2 – Transport

### 2.2. Standards from other Organizations

ATSC A/52 Digital Audio Compression (AC-3) (E-AC-3) Standard

ATSC A/53 ATSC Digital Television Standard

ATSC A/65 ATSC Standard: Program and System Information Protocol for Terrestrial Broadcast and Cable

ISO/IEC 23009-1:2014 2<sup>nd</sup> Ed., Information technology – Dynamic adaptive streaming over HTTP (DASH) – Part 1: Media presentation description and segment formats (including Corrigendum 1 and Amendment 1).

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ISO/IEC 23009-3:2014: Information technology -- Dynamic adaptive streaming over HTTP (DASH) – Part 3: Implementation Guidelines

ITU-T Recommendation H.264 (01/2012): "Advanced video coding for generic audio-visual services" | ISO/IEC 14496-10:2010: "Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding".

ISO/IEC 14496-12:2014 Information technology – Coding of audio-visual objects – Part 12: ISO base media file format.

ISO/IEC 14496-15:2014: Information technology – Coding of audio-visual objects – Part 15: Carriage of network abstraction layer (NAL) unit structured video in ISO base media file format.

ITU-T Recommendation H.265 (07/2013): "Advanced video coding for generic audio-visual services" | ISO/IEC 23008-2:2013: " High Efficiency Coding and Media Delivery in Heterogeneous Environments – Part 2: High Efficiency Video Coding"

ISO/IEC 23001-8:2013, “Information technology – MPEG systems technologies – Part 8: Coding-independent code points”

ANSI/CEA-608-E, Line 21 Data Services, April 2008

ANSI/CEA-708-E, Digital Television (DTV) Closed Captioning, August 2013

IETD RFC 2141, URN Syntax, May 1997

IETF RFC 2326, Real Time Streaming Protocol (RTSP), April 1998

IETF RFC 2616, Hypertext Transfer Protocol – HTTP/1.1, June 1999

IETF RFC 3339, Date and Time on the Internet: Timestamps, July 2002

IETF RFC 3406, Uniform Resource Names (URN) Namespace Definition Mechanisms, October 2002

IETF RFC 5234, Augmented BNF for Syntax Specifications: ABNF, January 2008.

IETF RFC 6381, The ‘Codecs’ and ‘Profiles’ Parameters for ‘Bucket’ Media Types

DASH-IF Implementation Guidelines: Interoperability Points; Version 3.0,  
<http://dashif.org/w/2015/04/DASH-IF-IOP-v3.0.pdf>

Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation, 26 November 2008, available at <http://www.w3.org/TR/REC-xml/>

XML Linking Language (XLink) Version 1.0, W3C Recommendation 27 June 2001, available at <http://www.w3.org/TR/xlink/>

### 3. Informative References

The following documents may provide valuable information to the reader but are not required when complying with this standard.

### 3.1. SCTE References

No informative reference applicable

### 3.2. Standards from other Organizations

ETSI TS 103 285 V1.1.1 (2015-05): "MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks"

### 3.3. Published Materials

[HLS I-D] R. Pantos, W. May, HTTP Live Streaming, <https://tools.ietf.org/html/draft-pantos-http-live-streaming-17>

## 4. Compliance Notation

<i>shall</i>	This word or the adjective “ <i>required</i> ” means that the item is an absolute requirement of this specification.
<i>shall not</i>	This phrase means that the item is an absolute prohibition of this specification.
<i>forbidden</i>	This word means the value specified shall never be used.
<i>should</i>	This word or the adjective “ <i>recommended</i> ” means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
<i>should not</i>	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
<i>may</i>	This word or the adjective “ <i>optional</i> ” means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
<i>deprecated</i>	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of the standard. Implementations should avoid use of deprecated features.

## 5. Abbreviations and Definitions

### 5.1. Abbreviations

AAC	advanced audio coding
AC-3	Audio Codec 3 or Advanced Codec 3 (also Dolby Digital)
AES-CBC	Advanced Encryption Standard cipher block chaining
ANSI	American National Standards Institute
ATSC	Advanced Television Systems Committee
AVC	advanced video coding
BMFF	base media file format
BSS	bitstream switching segment
CBR	constant bit rate

CEA	Consumer Electronics Association
DASH	[MPEG] dynamic adaptive streaming over HTTP
DTS	trademark for DTS, Inc. audio (originally Digital Theater Systems, Inc.)
DTV	digital television
DVB	Digital Video Broadcasting [Project]
DVS	[SCTE] Digital Video Subcommittee
e.g.	for example ( <i>exempli gratia</i> )
ETSI	European Telecommunications Standards Institute
FF	file format
HEVC	high efficiency video coding
HLS	HTTP live streaming
HRD	hypothetical reference decoder
HTTP	hypertext transfer protocol
i.e.	that is ( <i>id est</i> )
IEC	International Electrotechnical Commission
IP	Internet protocol
ISO	International Organization for Standardization
ISO-BMFF	ISO- base media file format
MPD	media presentation description
MPEG	Moving Picture Experts Group
MPEG-2 TS	MPEG-2 transport stream
NAL	network abstraction layer
PAT	program association table
PCR	program clock reference
PID	1) program identifier; 2) packet identifier
PMT	program map table
PTS	presentation time stamp
SCTE	Society of Cable Telecommunications Engineers
TS	transport stream
URI	uniform resource identifier
URN	universal resource name
VCL	video coding layer
XLink	external link
XML	extensible markup language

## 5.2. Notation

This document uses notation similar to the one of ISO/IEC 23009-1.

XML elements are written in bold face, e.g. **Element1**.

Child XML elements are separated from parent elements by a dot ('.'), e.g. **Element2.Element1**.

XML attributes are prefixed by an at-sign ('@'), e.g. @attribute. Attributes of an element are separated from the name of the containing element by at-sign, e.g. **Element@attribute**.

ISO-BMFF boxes are written as box names enclosed in backquote ('`') signs, e.g. `box0`

Fields in ISO-BMFF boxes are separated from box names by a dot (.), e.g. ``box0`.field0`

In cases where an element has the same name as a concept it describes, when the name is written in bold face, it refers to the syntactic element. For example, **Representation** refers to an XML element named "Representation", while "representation" refers to the concept of a representation as defined in ISO/IEC 23009-1.

XML elements and attributes defined in SCTE 214 are prefixed with `scte214`:

## 6. MPD Restrictions

### 6.1. Restrictions on MPD elements

1. **MPD@minBufferTime** *shall* be present. Its value *should* be equal or larger than maximum segment (live profile) or subsegment (on demand profile) duration.
2. If the **MPD@type** is "dynamic":
  - a. **MPD@minimumUpdatePeriod** *shall* be present;
  - b. **MPD@maxSegmentDuration** *shall* be present.

**Note:** It is unsafe to base player buffer allocation on the attributes above whenever XLink is used, or MPD type is "dynamic". See sec. 8.2.3 for more details.

- c. If it is expected that at some point in the future a media segment *may* become unavailable, then the **@timeShiftBufferDepth** attribute *shall* be present, or **@timeShiftBufferDepth** *shall* be present as a part of segment information.

### 6.2. Restrictions on Period elements

1. The **Subset** element *shall not* be present.
2. The **Period.SegmentList** element *shall not* be present
3. At least one **AdaptationSet** element *shall* contain a **Role** element with **@schemeIdUri="urn:mpeg:dash:role:2011"** and **@value="main"** and each Adaptation Set containing such a **Role** element *shall* provide perceptually equivalent media components.

**Note:** Perceptually equivalent media components differing in subtitle or closed captioning language are still considered perceptually equivalent.

4. If a **Period** element represents a part of a multi-period asset, this **Period** *shall* contain an **AssetIdentifier** element.

### 6.3. Restrictions on Adaptation Set elements

1. Every adaptation set *shall* use consistent addressing. Exactly one of the following restrictions *shall* be met:

- a. Every Representation within this Adaptation Set has a **Representation.SegmentTemplate** element, and **AdaptationSet.SegmentTemplate** is not present.
  - b. **AdaptationSet.SegmentTemplate** element is present, and no **Representation.SegmentTemplate** elements are present;
  - c. The **Representation.SegmentList** element is present in every representation in this **AdaptationSet**, and all media segments are MPEG-2 TS segments
  - d. Every Representation within this Adaptation Set consists of a single segment.
2. All Representations within an Adaptation Set *shall* use the same codecs, but not necessarily the same profiles and levels. Therefore, exactly one of the following restrictions *shall* be met:
- a. The **AdaptationSet@codecs** attribute *shall be* present and equal the maximum profile and level of any Representation contained in the Adaptation Set
 

**Note:** As an example, no adaptation set *may* contain both `avc1` (AVC) and `hev1` (HEVC) video, however avc1.64Y01F (Progressive [High@L3.1](#)) and avc1.64Y028 (Progressive [High@L4.0](#)) can be in the same AVC adaptation set.
  - b. **AdaptationSet@codecs** *shall* be present, and **Representation** elements within this **AdaptationSet** *shall not* contain the @codecs attribute.
3. **AdaptationSet@segmentAlignment** attribute *shall* be present and have a value of `true` or `1`.
4. **AdaptationSet@startWithSAP** *shall* be present and its value *shall* be 1 or 2.
5. If indexing (`sidx`) is used, then
- a. @subsegmentAlignment *shall* be present and have value of `true` or `1`.
  - b. **AdaptationSet@subsegmentStartsWithSAP** *shall* be present and have a value of `1` or `2`.
6. For any adaptation set that contains video the following attributes *shall* be present:
- a. @maxWidth (or @width if all Representations have the same width)
  - b. @maxHeight (or @height if all Representations have the same height)
  - c. @maxFrameRate *shall* be an integer multiple of each @frameRate in this adaptation set. If all representations have the same frame rate, @frameRate rather than @maxFrameRate *shall* be present
  - d. @scanType *shall* be present and have value "interlaced" if at least some of the pictures are interlaced.

**Note:** This implies that if an adaptation set is interlaced, all representations in it are interlaced.

- e. `@sar` *shall* be present and, consequently, all representations within this adaptation set *shall* have the same aspect ratio.
7. There *shall* be at most one video media component in a single **AdaptationSet**.
8. If a representation contains at least one interlaced picture, this representation is considered interlaced. Interlaced and non-interlaced representations *shall not* be mixed in the same adaptation set.

**Note:** Alignment between interlaced and non-interlaced adaptation sets can be expressed by setting (sub)segment alignment attributes to '1' rather than 'true'.

9. For any adaptation set, colorimetric properties of video representations, if known, *shall* be the same. When these properties are known, they *should* be signaled as defined in sec 10.1.5.
10. For any adaptation set containing a single audio component, the following elements and attributes *shall* be present (and thus *shall* apply to all representations):
  - a. `@lang`
  - b. `@codecs`, which contains sub-parameters as defined in RFC 6381. Note implies that only the option described in 2.b above is acceptable for audio adaptation sets.
  - c. `@audioSamplingRate`
  - d. **AudioChannelConfiguration**
11. If media segments contain CEA 608/708 closed captioning carried in video elementary stream (as defined in SCTE 128-1 and SCTE SCTE 215-1), this *shall* be reflected in the MPD using **AdaptationSet.Accessibility**, as described in 7.2.

#### 6.4. Restrictions on ContentComponent elements

1. **ContentComponent** element *shall* be used if and only if the adaptation set contains multiplexed representations.

**Note:** CEA 608/708 closed captioning is not considered a separate content component if embedded in media segments.

2. **AdaptationSet** elements *shall* contain a single **ContentComponent** element per each media component in a multiplexed representation.
3. If more than one audio content component is present, each one of them *shall* be signaled using a **ContentComponent** element. `@lang` attribute *shall* be present for each audio component.
4. **ContentComponent@contentType** attribute *shall* be present in any **ContentComponent** element

## 6.5. Restrictions on Representation elements

1. The following attributes and elements *shall not* appear at Representation level within an adaptation set containing audio:
  - a. **AudioChannelConfiguration**;
  - b. @audioSamplingRate;
  - c. @lang;
  - d. @codecs, if the representation is unmultiplexed.
2. For any **Representation** element within an adaptation set containing video the following attributes *shall* be present:
  - a. @width, if and only if **AdaptationSet@width** is not present in this adaptation set
  - b. @height, if and only if **AdaptationSet@height** is not present in this adaptation set
  - c. @frameRate, if and only if **AdaptationSet@frameRate** is not present in this adaptation set
  - d. @codecs, which *shall* contain complete sub-parameter string as defined in ISO/IEC 14496-15 Annex E. Note that this means that 2.a in 6.3 applies to video adaptation sets.
3. **Representation@id** value *shall* be unique within the scope of the **Period** to which it belongs.
4. **Representation@bandwidth** value *shall* be unique within its parent **AdaptationSet** element.
5. **Representation.ContentProtection** element *shall not* be used.
6. If content protection is used, it *shall* be signaled via **AdaptationSet.ContentProtection** element(s). In case of Common Encryption (ISO/IEC 23001-7 and ISO/IEC 23001-9), `pssh` information and the default\_KID attribute *should* be present in this descriptor.

## 6.6. Use of XLink

The use of the XLink (only the subset defined in ISO/IEC 23009-1) is supported in SCTE profiles with the following restrictions:

1. The @xlink:href attribute *may* appear only in **Period** and **Representation.SegmentList** elements;
2. If **MPD@type**='dynamic' and the **Period@xlink:href** attribute is present, the value of **Period@xlink:actuate** *shall* be 'onLoad'
3. If **Representation.SegmentList@xlink:href** attribute is present, then the **Representation.SegmentList@xlink:actuate** attribute *shall* be present and have

the value "onRequest". The remote entity *shall not* contain the **SegmentList@xlink:href** attribute. This guarantees that a representation-level XLink needs to be resolved only once.

**Note:** In the use case above, the expected client behavior is to select a suitable representation, and then to do XLink resolution for that representation. This operation is conceptually identical to media playlist download in HLS.

## 6.7. Use of events

### 6.7.1. Declaring events

1. **InbandEventStream** element *shall not* be present either at Representation or at SubRepresentation level.
2. If inband events are used, their presence *shall* be signaled in **AdaptationSet.InbandEventStream** element. A client is not expected to process undeclared events, though this specification does not disallow processing them.

### 6.7.2. DASH events

Inband events *shall* be aligned.

MPD Patch and MPD Update events *shall not* be used, either inband or in MPD.

### 6.7.3. User-defined events

If processing an event (i.e. either MPD or inband event) is essential for successful presentation, **EssentialProperty** with **@schemeIdUri="urn:scte:dash:essential-event:2015"** and **EssentialProperty@value** containing the **@schemeIdUri** of the essential event stream *shall* be present in the corresponding **MPD** element.

If there are several event schemes, and processing one of them is sufficient, then the **EssentialProperty** descriptors for them *shall* have identical values of **EssentialProperty@id**.

### 6.7.4. Carriage of SCTE 35 as user-defined MPD event

**Event** elements contained in **EventStream** element with **@schemeIdUri="urn:scte:scte35:2013:xml"** *shall* contain an XML representation of an SCTE 35 cue message.

A subset of this capability is defined by **@schemeIdUri="urn:scte:scte35:2014:xml+bin"**, which implies that **Signal.Binary** element, and not the **Signal.SpliceInfoSection** element will appear as content of the **Event** element.

For both "urn:scte:scte35:2013:xml" and "urn:scte:scte35:2014:xml+bin" schemes:

1. The **Event@messageData** attribute *shall not* be used.

2. Sum of **Event**@presentationTime and **Event**@duration *shall* never exceed period duration, if known at authoring time. Event that has its **Event**@presentationTime later than the end of the period as a result of an MPD update *shall* be ignored.
3. There *should not* be more than one SCTE 35 MPD event with identical value of the **Event**@presentationTime attribute.

SCTE 35 events are considered essential, per definition of event essentiality in ISO/IEC 23009-1.

## 6.8. MPD Updates

MPD updates *may* only extend the timeline. This means that information provided in a previous version of the MPD *shall not* be invalidated in an updated MPD. Hence the only permitted change is addition or removal of **Period** elements or addition of segments in **SegmentList**.

In live scenarios MPD updates can add new MPD events but *shall not* remove existing MPD events in order to provide system consistency. As a consequence, a cancellation of a previous event *should* be done via MPD update adding a new event.

## 7. Signaling accessibility-related metadata

### 7.1. Associated audio services

#### 7.1.1. General

In many cases an audio component is not intended for a general presentation, but for a more specialized purpose (e.g., audio description for the visually impaired). Moreover, in some cases (known as “receiver mix”), two audio elementary streams need to be combined for the same service.

This section defines signaling for such services. If signaling is present both in the media segments and in MPD, the two *shall not* contradict each other.

#### 7.1.2. Roles

Associated services, such as visually impaired (VI) and hearing impaired (HI), *shall* be signaled using the **Role** descriptor with @schemeIdUri="urn:mpeg:dash:role:2011" or **Role** descriptor with @schemeIdUri="urn:scte:dash:associated-service:2015".

Let *ST* be service type signaled in an audio elementary stream.

For AC-3 and E-AC-3 elementary streams, *ST* takes the value of the bsmo field. The possible values for bsmo are defined in A/53 Part 5 (AC-3) and A/53 Part 6 (E-AC-3).

For AAC elementary streams, *ST* takes the value of AAC\_service\_type, as defined in SCTE 193-2 Table 4.

For DTS elementary streams, *ST* value is derived from component\_type bit values b3, b4 and b5, as follows:  $ST = b5 \ll 2 + b4 \ll 1 + b3$ . The values b3, b4 and b5 are defined in SCTE 194-2 Table 6.

The value of the **Role@value** attribute *shall* be derived from *ST* as described in table below.

ST	<b>Role@value</b> (MPEG)	<b>Role@value</b> (SCTE)
0	"main"	
1		"music-and-effects"
2	"descriptions"	
3	"enhanced-audio-intelligibility"	
4		"dialogue"
5	"commentary"	
6		"emergency"
7		"voice-over"
8..15		value of <i>ST</i>

The expected practice in North America is that an audio adaptation set having @contentType="audio" and **Role@value** = "main" is equivalent to the audio service "Complete Main," which is defined for audio standards such as AAC and DTS. In North America, the "Complete Main" audio service is an audio component that contains a complete audio program (which typically includes dialog, music, silence, and effects).

The expected practice in North America is that audio adaptation sets having **Role@value** = "commentary" are equivalent to the audio service "commentary", which is defined for audio standards such as AAC and DTS.

**Role** descriptors *shall* appear within **ContentComponent** element if the latter is used, otherwise they will appear at **AdaptationSet** level.

DASH role scheme "urn:mpeg:dash:role:2011" *shall* be used if there is more than one audio component a client can select (i.e., multiple audio services within a single multiplex or multiple audio adaptation sets).

In case of *ST=0* and multiple audio content components (as described above), **Role** descriptor with @schemeIdUri="urn:mpeg:dash:role:2011" and @value="main" *shall* be used.

In case of *ST > 1*, **Role** descriptor with @schemeIdUri="urn:mpeg:dash:role:2011" and @value="alternate" *shall* be used in case of full service, and "supplementary" *shall* be used otherwise.

### 7.1.3. Full and partial audio services

An audio service *may* be a full service suitable for presentation, or only a partial service which *should* be combined with another audio service before presentation ("receiver mix"). In case the partial and the full

services are in different adaptation sets, it is necessary to signal such dependence in order to indicate to the client that two adaptation sets need to be downloaded prior to the presentation.

**Note:** There is no need to signal this for a multiplex containing both – inband signaling in this multiplex is sufficient.

Let  $F$  be a boolean value, which indicates whether a service is a full service ('true'), or the client will need to combine it with a different audio service ('false').

For AC-3 and E-AC-3 elementary streams,  $F$  is true if and only if the `full_svc` bit in the `AC-3_audio_stream_descriptor` is set to '1'.

For AAC,  $F$  is true if and only if `receiver_mix_rqd` is set to '0' (see SCTE 193-2 Table 1).

For DTS,  $F$  is true if and only if `full_service_flag` bit in `component_type` field is set to '1' (see SCTE 194-2 tables 6 and 7).

If neither signaled nor known by other means,  $F$  is assumed to be true.

In case  $F$  is false for an audio service in adaptation set A, and it needs to be combined with a different audio service in a different adaptation set B, this will be signaled in adaptation set A using an **EssentialProperty** descriptor with `@schemeIdUri` attribute value of `urn:mpeg:dash:audio-receiver-mix:2015`. The `@value` attribute *shall* the value of **AdaptationSet@id** of B.

**Note 1:** this signalling is defined in sec. 5.8.5.7 of ISO/IEC 23009-1 and was introduced in ISO/IEC 23009-1:2014 AMD2.

**Note 2:** AC-3, E-AC-3 and AAC full service is signalled in PMT descriptors, hence when ISO-BMFF segments are generated from an MPEG-2 TS source, such signalling is expected to be translated into signalling defined in this section by the entity performing the container format conversion.

## 7.2. Caption service metadata

### 7.2.1. Introduction

CEA-608 and CEA-708 caption services are carried embedded in the elementary streams. Carriage of CEA-608 and CEA-708 in SEI messages is defined in SCTE 128-1 and SCTE 215-1. This section describes MPD signaling of caption service metadata for and applies to content with both MPEG-2 TS and ISO-BMFF segments.

Signaling is done using the **Accessibility** descriptors, one per each standard. The value string of each descriptor can be either list of languages or a complete map of services (or CC channels, in CEA-608 terminology).

Listing languages without service/channel information is strongly discouraged if more than one caption service is present. At any time language-channel (CEA-608) or language-service (CEA-708) is known at content generation time, it *shall* be used, as opposed to signaling mere presence or presence and language.

**Note:** Signaling described in this section is identical to DASH-IF IOP 3.0.

### 7.2.2. Signaling CEA-708 caption service metadata

If CEA-708 closed caption service is carried in the video elementary stream, the relevant metadata per CEA-708 sec. 4.5 will be expressed using **ContentComponent.Accessibility** or, if the latter is not used, **AdaptationSet.Accessibility** with @schemeIdURI set to urn:scte:dash:cc:cea-708:2015.

The @value attribute *shall* contain the Caption Service Metadata as provided in CEA-708 section 4.5, as a semicolon-separated string of service descriptions. Each service description is either a single language code or a list of colon-separated name-value pairs

```
@value           = service *15 [ ";" service ]
service          = language / ( service-number "=" param )
service-number   = (%d1 - %d63) ; decimal numbers 1 through 63
param            = language[ "," "easy-reader" ] [ "," "aspect-ratio" ]
language         = "lang" ":" 3ALPHA ; language code per ISO 639.2/B
easy-reader      = "er" ":" BIT ; default value 0
wide-aspect-ratio = "war" ":" BIT ; default value 1 (16:9), 0
indicates 4:3
```

**Note:** ALPHA and BIT are as defined by IETF RFC 5234, Appendix B.1.

Each of the service parameters (except for language) *may* be present or not present. Default values can be assumed where specified.

The CEA-708 information supplied in the **Accessibility** descriptor *shall not* contradict information supplied in the caption\_service\_descriptor in the PMT. See **7.2.5 Derivation of caption service metadata from MPEG-2 TS** for derivation.

### 7.2.3. Signaling CEA-608 caption service metadata

If CEA-608 closed caption service is carried in the video elementary stream, language metadata will be expressed using **AdaptationSet.Accessibility** with @schemeIdURI set to urn:scte:dash:cc:cea-608:2015.

The @value attribute *shall* contain description of caption service(s) provided in the stream, as either a semicolon-separated list of languages or of colon-separated channel-language pairs. The @value syntax *shall* be as described in the ABNF below.

```
@value           = channel *4 [ ";" channel ]
channel          = language | ( channel-number "=" language )
channel-number   = CC1 | CC2 | CC3 | CC4
language        = "lang" ":" 3ALPHA ; language code per ISO 639.2/B
```

### 7.2.4. Examples

```

<!-- Simple signaling of presence of CEA-608 closed caption service -->
<!-- NOTE: not signaling languages is a discouraged practice -->
<Accessibility
  schemeIdUri="urn:scte:dash:cc:cea608:2015" />

<!-- Signaling of presence of CEA-608 closed caption service -->
<!-- in English and German -->
<Accessibility
  schemeIdUri="urn:scte:dash:cc:cea608:2015" value="eng;deu" />

<!-- Signaling of presence of CEA-708 closed caption service
<!-- in English and German, with channel assignments -->
<Accessibility
  schemeIdUri="urn:scte:dash:cc:cea708:2015" value="CC1=eng;CC3=deu" />

<!-- Signaling of presence of CEA-708 closed caption service -->
<!-- in English and German -->
<Accessibility
  schemeIdUri="urn:scte:dash:cc:cea708:2015" value="eng;deu" />

<!-- Signaling of presence of CEA-708 closed caption service -->
<!-- in English and easy reader English -->
<Accessibility
  schemeIdUri="urn:scte:dash:cc:cea708:2015"
  value="1=lang:eng;2=lang:eng,war:1,er:1" />

```

### 7.2.5. Derivation of caption service metadata from MPEG-2 TS

When MPD and media segments are generated from MPEG-2 transport stream, the PMT *may* contain the `caption_service_descriptor()` descriptor, as defined in Sec. 6.9.2 of ATSC A/65. If this descriptor is present, MPD signaling of caption service *shall* be generated using the procedure described below.

If there is a service for which `cc_data.digital_cc` bit is '0', then **Accessibility** with URI `urn:scte:dash:cea-608:2015` *shall* be used to signal it. If languages or channel-language association is known (from any source), it *should* be provided, using syntax from 7.2.3.

If there is at least one service with `cc_data.digital_cc` bit set to '1', then **Accessibility** with URI `urn:scte:dash:cea-708:2015` *shall* be used to signal it. For each such service syntax defined in 7.2.2 *shall* be used, and at least service number and language *shall* be provided.

**Note 1:** Descriptors for both CEA 608 and CEA 708 often appear in the same scope.

**Note 2:** PSI, and, consequently, caption service descriptors *may* change at splice points. In case of a splice we expect a new period to be started and the process above will be applied to the new period.

## 8. Signaling Asset Identification

### 8.1. General

**AssetIdentifier** elements *may* be used to uniquely identify content in periods. This clause identifies schemes that can be used in content compliant to this specification.

**Note:** Alternative single-identifier scheme is defined in DASH-IF IOP 3.0.

### 8.2. Content Identification scheme

The value of **AssetIdentifier@schemeIdUri** for this scheme *shall* have the value "urn:scte:dash:asset-id:upid:2015". The content of this **AssetIdentifier** descriptor *shall* contain one or more **ContentIdentifier** elements defined below.

Note that same scheme can be applied to

#### 8.2.1. ContentIdentifier element semantics

Element or Attribute Name	Use	Description
<b>ContentIdentifier</b>		Represents a textual value
@type	M	Type corresponding to SCTE 35 UPID type as specified in table 9-7. The value of this attribute <i>shall</i> be same as the value of <code>segmentation_upid()</code> (i.e., 3 <sup>rd</sup> column of the table).  MID <i>shall not</i> be used – the structure shall be translated into multiple UPID elements.
@value	M	Textual representation of the UPID value. It <i>shall</i> correspond to the description in the Description column (i.e., 4 <sup>th</sup> column) of table 9-7 in SCTE 35.  In case of the UPID contains binary encoding (e.g., EIDR and ISAN), and a full textual representation is specified by the applicable standard, this textual representation <i>shall</i> be used. Otherwise binary encoding is represented as a byte string in hexadecimal format.
<b>Legend:</b> For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>...<maxOccurs> (N=unbounded) Elements are <b>bold</b> ; attributes are non-bold and preceded with an @.		

It *may* happen (e.g., when XLink-based ad insertion is used) that the same content (e.g., with same Ad-ID) will be used in the same MPD and the authors' intent is not to use the second occurrence of the previously displayed content. In this case the authors *should* insert a unique value (such as UUID) into the @value attribute. This specification leaves the interpretation of this value to implementations.

### 8.2.2. XML syntax

```
<xs:complexType name="UPID">
  <xs:sequence>
    <xs:any namespace="##other" processContents="lax"
      minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="type" type="xs:string" use="required"/>
  <xs:attribute name="value" type="xs:string" use="required"/>
  <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
```

### 8.2.3. Example

```
<AssetIdentifier schemeIDUri="urn:scte:dash:asset-id:upid:2015">
  <!-- EIDR of the asset -->
  <scte214:ContentIdentifier type="EIDR" value="10.5240/EA73-79D7-1B2B-B378-3A73-M"/>
  <!-- Alternative ID using an opaque provider-specific scheme -->
  <scte214:ContentIdentifier type="MPU" value="CSP1DE12AB327FE312AF"/>
</AssetIdentifier>
```

## 9. Generic restrictions on media segments

### 9.1. Terminology

For the purpose of this section the following variables are defined for any segment  $S(n)$  and its  $k^{\text{th}}$  subsegment  $n[k]$ :

$EPT(n)$  := earliest presentation time of segment  $n$ .  $EPT(0) = 0$ ;

$EPT(n[k])$  := earliest presentation time of its subsegment  $n[k]$ .  $EPT(n[0]) = EPT(n)$ .

$SD(R)$  := signaled segment duration for representation  $R$ , as expressed e.g. in the `@duration` attribute or the `S@d` in the **SegmentTimeline**. While this applies to a specific representation  $R$ , segment alignment requirement in this specification requires this value to be identical for all representations in an adaptation set.

$MSD$  := maximum segment duration, as indicated in **MPD@maximumSegmentDuration**

$MSSD$  := maximum subsegment duration, as indicated in **MPD@maximumSubsegmentDuration**

$D(n)$  := "real" presentation duration of segment  $n$ , i.e.  $EPT(n+1) - EPT(n)$ .

$SD(n[k])$ , the signaled subsegment duration, is same as  $D(n[k])$ , presentation duration of segment  $k$ , and is provided in ``sidx`.subsegment_duration[k]` of the ``sidx`` box indexing segment  $n$ .

$BW[R]$  := value of **Representation@bandwidth** of a representation  $R$  to which segment  $n$  belongs.

$MBT$  := value of **MPD@minBufferTime**

All durations are in seconds, and bandwidth is given in bits per second.

### 9.2. Duration

#### 9.2.1. Segments

If representation contains more than one segment and is used for normal playback, the following restrictions **shall** be met:

1. Segments **shall** have almost equal "real" duration. The maximum tolerance of "real" segment duration  $D(n)$  **shall** be  $\pm 50\%$  of the stated segment duration, and the accumulated drift **shall not** exceed  $50\%$  of the stated segment duration  $SD$ .

$$\text{abs} \left( \sum_{i=0}^{n-1} D(i) - (n+1) * SD(R) \right) \leq 0.5 * SD(R)$$

**Note 1:** This is done so that if seeking is done using stated duration, correct segment will be identified despite the accumulating drift.

**Note 2:** drift *may* develop due to mismatch between  $D$  and  $SD$  due to imprecision of the clock used to state  $SD$ . For example, if  $SD=2$  sec and segments are 2002 ms each,  $\pm 50\%$  drift will be exceeded in less than 10 minutes.

2. The "real" segment duration for representations containing more than one segment *shall* be between 0.97 and 30.03 seconds.

$$0.97 \leq D(n) \leq \min(MSD, 30.03);$$

**Note:** This is done in order to simplify client implementation when segment durations are unknown at MPD parse time. This can happen due to use of XLink in the "OnRequest" mode or/and in case of MPD updates.

### 9.2.2. Subsegments

For representation used for normal playback and containing subsegments, the "real" subsegment duration *shall* be less than 30.03 seconds.

$$D(n[k]) \leq SSD_{max} = \min(MSSD, 30.03);$$

### 9.2.3. Segment duration patterns

#### 9.2.3.1. Syntax and Semantics

If segment durations follow a well-defined pattern, the segment duration specified in the MPD *should* be the average duration. In case of number-based addressing this *should* be average over the duration of the period, while in case of **SegmentTimeline** it *should* apply only to segments described in an **S** element.

**Note:** There is no requirement to specify a precise segment duration – an approximation is good enough as long as the restrictions in 9.2.1 are maintained.

If there is a requirement for higher precision for precise lookup purposes, the following attributes are defined in the SCTE DASH namespace:

Element or Attribute Name	Use	Description
@offsetTimescale	OD	specifies the timescale in units per seconds to be used for the derivation of precise duration values in the Segment Information.  Default value 1.
@offsetPattern	M	specifies a repeating pattern of offsets.  Each offset is a signed integer in units specified by @offsetTimescale.  For a pattern with $N$ offsets, segment $i$ has offset $O(i) = \text{offsetPattern}[i\%N]$  The relation between real and stated duration of the segment is given by $D(n) = SD + O(n)$
<b>Legend:</b> For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>...<maxOccurs> (N=unbounded) Note that the conditions only holds without using xlink:href. If linking is used, then all attributes are "optional" and <minOccurs=0> Elements are <b>bold</b> ; attributes are non-bold and preceded with an @.		

The attributes *may* be used in **S** element or in **SegmentBase** and elements derived from it.

**Note:** Offsets are intended for precision purposes and are purely informational. In particular they do not affect URL construction.

### 9.2.3.2. Example

Let us assume **SegmentBase**@timescale = 1000 and @scte214:offsetTimescale = 90000

Let us further assume 2-sec segments with a pattern of 12 segments of 180480 90KHz clock ticks followed by a shorter 176640-tick segment, and  $SD = 2002$ .

In this case @scte214:offsetPattern = "300 300 300 300 300 300 300 300 300 300 300 300 -3540".

In our case the number of offsets (i.e., number of elements in the @scte214:offsetPattern list) is 12. Therefore segment  $i$  has duration (in 90KHz clock ticks) of  $D(n) = 2002 \times 90 + \text{offsetPattern}[i\%N]$ . For  $i=0..11$  the result will be  $2002 \times 90 + 300 = 180480$ .

### 9.3. Bandwidth, size, and buffering

#### 9.3.1. Introduction

This section formalizes the relationship between the declared bandwidth  $BW[R]$ ,  $MBT$ , and segment sizes.

The derivations below are a straightforward, albeit lengthy, translation of the requirement in ISO/IEC 23009-1 that if segments of representation  $R$  are delivered over a constant bitrate channel with bitrate equal to  $BW[R]$  attribute, then each sample with decoding time  $DT$  is available for decoding at the media engine by time  $DT + MBT$ .

**Note:** In many cases the latter *may* be a stricter limitation than the ones stated in the sections below, as the discussion below applies to complete (sub)segments, rather than samples.

While  $MBT$  does specify minimum time sufficient for ensuring continuous playout of a representation, it describes content encoding properties, rather than expected network behavior. Hence a player implementation has to account for realistic network conditions, and this specification provides neither restrictions nor any guidance on these issues.

#### 9.3.2. Segments

Let  $SD_{max}$  be the maximum segment duration. For representations containing more than one segment it is defined as follows:

$$SD_{max} = \min(1.5 * SD(R), MSD, 30.03)$$

Let  $SZ_R(n)$  be the size (in bits) of segment  $n$  from representation  $R$ .

**Note:**  $SZ_R(n)$  is the size of the complete segment including all headers, 'sidx' and 'ssix' boxes (for ISO-BMFF) and inband events.

Let  $MBT_s$  be the minimum buffer time in units of segments, defined as  $MBT_s = \text{ceil}\left(\frac{MBT}{SD_{max}}\right)$

**Note:** Buffer size of  $BW[R] * SD_{max} * MBT_s$  is sufficient for playback of representation  $R$  under idealized network conditions (i.e., assuming constant download rate).

For any representation that contains  $N > 1$  segments and is used for normal playback, the following restrictions **shall** be met:

1. Any segment  $n$  **shall not** exceed the buffer size, hence the following **shall** hold:

$$SZ_R(n) \leq BW[R] * SD_{max} * MBT_s$$

2. Combined size of any  $MBT_s$  consecutive segments **shall not** exceed the buffer size, hence for any  $0 \leq k \leq N - MBT_s$ , the following **shall** hold:

$$\sum_{i=k}^{MBT_s} SZ_R(i) \leq BW[R] * \sum_{i=k}^{MBT_s} D(i)$$

**Note 1:** In case of inband events care *should* be taken to keep events small enough in order not to break the model above.

**Note 2:** For representations without subsegments it is often useful to set *MBT* to  $SD_{max}$ . For representations containing subsegments  $SSD_{max}$  may be a better alternative. This agrees with the recommendation in DASH-IF IOP 3.0.

### **9.3.3. Video aspects**

*MBT* should not be less than CPB removal delay.

$MBT \cdot BW[R]$  should not exceed the size of CPB.

## **10. Codec-Specific Aspects**

### **10.1. Video**

#### **10.1.1. Supported video codecs**

The following video codecs are supported in SCTE DASH profiles:

1. AVC (ISO/IEC 14496-10, restrictions in SCTE 128-1 )
2. HEVC (ISO/IEC 23008-2, restrictions in SCTE 215-1)

#### **10.1.2. Resolutions and frame rates**

This specification neither specifies nor requires support for specific operating points (i.e., combination of resolution, frame rate and aspect ratio).

The input to encoding process is expected to be in one of the production formats specified in SCTE 215-1 sec. 6.0. At least one representation *should* have the resolution, frame rate, and aspect ratio listed in SCTE 215-1 Appendix A.

**Note:** Some of the possible derived operating points are specified in ETSI TS 103 285. The latter does not cover some of US-specific operating points.

#### **10.1.3. SAP values**

##### **10.1.3.1. AVC video**

Segments starting from an IDR picture in decoding order have SAP value of 1, unless this IDR picture is followed by a picture which precedes it in presentation order. In the latter case the segment has SAP value of 2.

##### **10.1.3.2. HEVC video**

Segments starting from pictures with `nal_unit_type` equal to `IDR_N_LP` or `BLA_N_LP` have SAP value of 1.

Segments starting from `IDR_W_RADL` or `BLA_W_RADL` have SAP value of 2.

### 10.1.4. Multiplexed segments

When a segment contains video and one or more audio elementary streams, its SAP value is the SAP value of the video elementary stream.

### 10.1.5. Colorimetry

**AdaptationSet.SupplementalProperty** descriptors *shall* be used to signal source signal information such as color primaries, optoelectronic transfer characteristics, as well as matrix coefficients for derivation of luma and chroma signals.

The URNs and corresponding values are defined in ISO/IEC 23001-8, and are informatively provided in the table below.

@schemeIdUri	@value
urn:mpeg:mpegB:cicp:ColourPrimaries	See ISO/IEC 23001-8 sec. 7.1
urn:mpeg:mpegB:cicp:TransferCharacteristics	See ISO/IEC 23001-8 sec. 7.2
urn:mpeg:mpegB:cicp:MatrixCoefficients	See ISO/IEC 23001-8 sec. 7.3

**Note:** This definition is a subset of the definition appearing in DASH-IF IOP 3.0

## 10.2. Audio

### 10.2.1. Supported codecs

The following audio codecs are supported in SCTE DASH profiles:

1. (E-)AC-3 (ATSC A/52, restrictions in A/53 Parts 5-6)
2. AAC (ISO/IEC 14496-3, restrictions in SCTE 193-1)
3. DTS-HD (ETSI TS 102 114, restrictions in SCTE 194-1)

### 10.2.2. SAP values

For AC-3, E-AC-3, DTS and AAC, all segments *shall* have SAP value of 1.

AAC segments *shall* be start with a RAP AU (as defined in SCTE 193-1) and *should* be encoded according to the MPEG DASH Implementation Guidelines sec. 5.1.2 in order to ensure seamless bitstream switching.

## 10.3. Trick Modes

### 10.3.1. Introduction

Playback of media content at speed and / or direction other than the ones intended for normal playback of this asset is referred to as *trick modes*. Trick modes include modes like fast forward, slow motion, and rewind; and are used to emulate visual experience of rewinding analog videotapes.

Trick modes can be implemented in multiple ways, starting from fetching segments at a different speed, to maintaining special trick mode representations, to bringing only specific frames from the segment. This standard does not prescribe a particular implementation strategy or combination of strategies. ETSI TS

103 285 sec. 6.2 provides a long discussion about ways of implementing trick modes in DASH, while encoding techniques discussed in SCTE 128 provide a content preparation perspective.

**Note:** SCTE 128 and SCTE 215 discuss trick modes based on extraction of identifiable pictures that result in respective decodable sub-bitstreams, or conversely, on discarding identifiable pictures to obtain respective decodable sub-bitstreams. This functionality can be implemented using Subsegment Index ('ssix') boxes

Trick modes are not necessarily permitted in all content – sometimes certain modes will be disallowed. This restriction model is described in SCTE 130-10, and sec. 11.3 defines its integration into DASH MPD.

### **10.3.2. Trick mode representations**

Periods *may* contain adaptation sets with representations intended for use in trick modes (e.g., representations with low frame rate). Such adaptation sets *shall* employ signaling as defined in DASH-IF IOP 3.0.

In particular this implies that the trick mode adaptation sets will be marked with a **SupplementalProperty** or **EssentialProperty** element with @schemeIdUri value of "http://dashif.org/guidelines/trickmode" and the @value the value of **AdaptationSet@id** attribute of the adaptation set to containing “normal” (non-trick-mode) representations of the same content.

## **11. Multi-period assets**

### **11.1. Period continuity**

If multi-period content is offered (e.g., when some of the periods represent placement opportunities), periods with identical **AssetIdentifier** elements are considered as contiguous parts of the same asset.

If an asset spans over more than one period, **Period.AssetIdentifier** element *shall* be present in each such period.

**Note:** Not all **Period** elements in the MPD need to contain asset identifiers – only the ones that contain parts of the same asset.

Periods with identical asset identifiers *shall* be *period-continuous* as specified in DASH-IF IOP v3.0.

### **11.2. Asset boundaries**

If multi-period content is offered in a dynamic MPD, periods can be removed and/or added during the presentation. In these cases the author *may* want to preserve the information regarding the playback location in time in order to allow e.g. correct display of time in UI.

If a period is the last period of a given asset, this *may* be signaled using **Period.SupplementalProperty** with @schemeIdUri="urn:scte:dash:asset-end" .

Correspondence of *PeriodStart* to the time of the asset *may* be signaled using **Period.SupplementalProperty** with @schemeIdUri="urn:scte:dash:asset-

time". The value of @value attribute *shall* be the timestamp corresponding to *PeriodStart*, as NPT or SMPTE relative timestamp, as defined in RFC 2326.

Correspondence of *PeriodStart* to UTC time *may* be signaled using **Period.SupplementalProperty** with @schemeIdUri="urn:scte:dash:utc-time". The value of @value attribute *shall* be the timestamp corresponding to *PeriodStart*, in format defined in RFC 3339.

**Note:** The difference between the asset time and UTC time is that asset time is relative to the asset start, while UTC time is the UTC time corresponding to the acquisition time of the first sample of the period. Thus, asset time will show that a period starts at 42<sup>nd</sup> minute of an asset, while UTC time will show that the period starts with content captured on October 21, 2015 at 4:29am.

### 11.3. Stream restrictions

Period elements *may* contain a **SupplementalProperty** element with **SupplementalProperty@schemeIdUri** value of "urn:scte:scte130-10:2014". The content of the descriptor is the SCTE 130-10 **StreamRestrictionList** element.

**NptRange** in this descriptor *shall* be relative to *PeriodStart* and the restrictions *shall* be valid only for the duration of the period in which the **SupplementalProperty** element appears.

**Note:** Given @nptstart value of  $N_s$ , @nptend value of  $N_e$ , and period duration  $D$ , the restrictions in the **StreamRestrictionList** element are valid in the range  $[\max(0:00.00, N_s), \min(D, N_e)]$ .

## Annex A URNs

The following URNs are defined in this specification:

**urn:scte:dash:2015**

XML namespace for this specification.

**urn:scte:dash:essential-event:2015**

Event essentiality, see 6.7.3

**urn:scte:scte35:2013:xml**

XML representation of SCTE 35, see 6.7.4

**urn:scte:scte35:2014:xml+bin**

base64-coded representation of SCTE 35 wrapped in XML, see 6.7.4

**urn:scte:dash:associated-service:2015**

Roles for non-accessibility associated audio services, see 7.1

**urn:scte:dash:cc:cea-608:2015**

Signaling of CEA-608 closed captions, see 7.2.3

**urn:scte:dash:cc:cea-708:2015**

Signaling of CEA-608 closed captions, see 7.2.2

**urn:scte:dash:asset-id:upid:2015**

Asset identifier scheme based on SCTE 35 UPIDs, see 8.2

**urn:scte:dash:asset-end**

End of last period of an asset, see 11.2

**urn:scte:dash:asset-time**

NPT corresponding to asset time, see 11.2

**urn:scte:dash:utc-time**

UTC time corresponding to asset time, see 11.2

**urn:scte:scte130-10:2014**

Carriage of SCTE 130-10, see 11.3