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MPEG DASH for IP-Based Cable Services Part 4: SCTE Common Intermediate Format (CIF/TS) Manifest for ATS Streams

SCTE-CIF-TS-I01.0

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140 Philips Road
Exton, PA 19341

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1. Introduction

The purpose of this document is to describe the Common Intermediate Format MPD including its elements, attributes, and values. The CIF MPD or CIF manifest is created from the parsing of an MPEG Transport Stream that is marked up and conditioned for virtual segmentation. A downstream device such as a packager can then use the CIF MPD to request and extract segments that can be modified to support various types of adaptive streaming technologies in the client.

The CIF MPD is used for processing of virtual segmented content streamed for linear services or stored for cDVR and VoD services. The CIF MPD is the DASH-like manifest as described in the reference architecture in Section 7 of SCTE 217 [16]. This document is an extension of DASH as constrained by SCTE 214-1 [2], 214-2 [3], and 214-3 [4]. The scope of this document is to describe the structure of the CIF MPD. The CIF MPD contains enough information to create client manifest and segment conditioning for the supporting end-client player adaptive streaming technologies.

The Common Intermediate Format (CIF) is based on DASH's Manifest Presentation Description (MPD) for MPEG-TS profiles, but with some extensions. The CIF MPD is created from parsing ATS or DASH-TS conditioned streams or generated while encoding video files as specified in SCTE 223 [6].

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

[1] ANSI/SCTE 128 2013-2, AVC Video Systems and Transport Constraints for Cable Television

[2] ANSI/SCTE 214-1 2016, MPEG DASH for IP-Based Cable Services, Part 1: MPD Constraints and Extensions

[3] ANSI/SCTE 214-2 2016, MPEG DASH for IP-Based Cable Services, Part 2: DASH/TS Profile

[4] ANSI/SCTE 214-3 2015, MPEG DASH for IP-Based Cable Services, Part 3: DASH ISO BMFF Profile

[5] ANSI/SCTE 215-2 2015, HEVC Video Constraints for Cable Television Part 2- Transport

[6] ANSI/SCTE 223 2017, Adaptive Transport Stream.

2.2. Standards from Other Organizations

[7] ANSI/CEA-708-E, Digital Television (DTV) Closed Captioning, August 23 2013

[8] ISO/IEC 23009-1:2014 2nd edition, Dynamic adaptive streaming over HTTP (DASH), Part 1: Media presentation description and segment formats

[9] W3C Sourcing In-band Media Resource Tracks from Media Containers into HTML; http://dev.w3.org/html5/html-sourcing-inband-tracks

Note: It is likely this link will change as the specification advances in the W3C process.

[10] W3C Media Source Extensions; http://www.w3.org/TR/media-source/

[11] ISO/IEC 23009-4:2013, Segment encryption and authentication.

[12] IETF RFC 2045:1996 Multipurpose Internet Mail Extensions (MIME) Part one: Format of Internet Message Bodies

2.3. Published Materials

- No normative references are applicable.

3. Informative References

3.1. SCTE References

[13] ANSI/SCTE 35, Digital Program Insertion Cueing Message for Cable.

[14] ANSI/SCTE 104, Automation System to Compression System Communications Applications Program Interface (API)

[15] ANSI/SCTE 215-1, HEVC Coding Constraints for Cable Television Part 1- Coding

[16] ANSI/SCTE 217, MPEG DASH Reference Architecture for IP-based Cable services.

3.2. Standards from Other Organizations

[17] Digital living network alliance (DLNA) home networked device interoperability guidelines – Part 5: Device Profiles; https://spirespark.com/dlna/guidelines/ : June 2016

[18] Guidelines for Implementation: DASH-IF Interoperability Points DASH V4.1, http://dashif.org/wp-content/uploads/2017/09/DASH-IF-IOP-v4.1-clean.pdf

[19] Real-time Event Signaling and Management API, OC-SP-ESAM-API-I03-131025, October 25, 2013, Cable Television Laboratories, Inc.

[20] ADOBE HTTP Dynamic Streaming, http://www.adobe.com/products/hds-dynamic-streaming.html

[21] IETF RFC 8216: HTTP Live Streaming, https://tools.ietf.org/html/rfc8216.

[22] Smooth Streaming Transport Protocol, http://learn.iis.net/page.aspx/684/smooth-streaming-transport-protocol

[23] IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing.

[24] IETF RFC 7231: Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content.

[25] IETF RFC 7232: Hypertext Transfer Protocol (HTTP/1.1): Conditional Requests.

[26] IETF RFC 7233: Hypertext Transfer Protocol (HTTP/1.1): Range Requests.

[27] IETF RFC 7234: Hypertext Transfer Protocol (HTTP/1.1): Caching.

[28] IETF RFC 7235: Hypertext Transfer Protocol (HTTP/1.1): Authentication.

[29] ISO/IEC 13818-1, (2015), "Information Technology – Generic coding of moving pictures and associated audio – Part 1: Systems"

[30] IETF RFC 4151: The 'tag' URI Scheme.

[31] ETSI TS 102 366 V1.4.1, (2017-09), Digital Audio Compression (AC-3, Enhanced AC-3) Standard.

[32] ISO/IEC 23091-3:2017, (2016), "Information Technology – MPEG Systems Technologies – Coding independent code-points Part3:Audio"

3.3. Published Materials

- No informative references are applicable.

4. Compliance Notation

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
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should	This word or the adjective "*recommended*" 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.
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deprecated	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5. Abbreviations and Definitions

5.1. Abbreviations

ABR	adaptive bitrate video
Ads	ad service
API	Application Program Interface
ATS	adaptive transport stream

AVC	advanced video coding
C2G	Cloud to Ground Service
CC	closed captioning
CDN	content delivery network
cDVR	Cloud Digital Video Recorder
CIF	common intermediate format
CKM	cryptographic key management
DASH	dynamic adaptive streaming over HTTP
DASH-IF	DASH Industry Forum
DLNA	Digital Living Network Alliance
DRM	digital rights management
DVR	digital video recorder
DTV	digital television
EBP	encoder boundary point
EIDR	entertainment ID registry
ESAM	event signaling and messaging
GOP	group of pictures
GUID	globally unique identifier
HDS	HTTP dynamic streaming (Adobe)
HEVC	High Efficiency Video Coding
HI	hearing impaired
HLS	HTTP live streaming (Apple)
HSS	HTTP smooth streaming (Microsoft)
HTML	HyperText Markup Language
HTTP	Hypertext Transfer Protocol
IETF	Internet Engineering Task Force
IP	Internet protocol
ISO-BMFF	ISO based media file format
MPD	media presentation description
MPEG	moving pictures experts group
nDVR	network digital video recorder
NPT	normal playback time
NTP	network time protocol
NSfCM	not set for client manifests
PAT	program association table
PES	packetized elementary stream
PID	packet identifier
PMT	program map table
PPS	picture parameter set
PSI	program specific information
PTS	presentation time stamp
QAM	quadrature amplitude modulation
RAP	random access point
RFC	request for comments
SAP	stream access point
SCTE	Society of Cable Telecommunications Engineers
SPS	sequence parameter set
SPTS	single program transport stream
TKHD	track header

URI	uniform resource identifier
URL	uniform resource locator
UTC	universal time coordinated
VI	visually impaired
VoD	video on demand
XML	extensible markup language

5.2. Definitions

Accessibility	The degree to which a media content or certain media content components are available to as many people as possible.
Adaptation Set	A set of interchangeable encoded versions of one or several media content components as defined in the DASH specification [8].
ATS	Adaptive transport stream. A conditioned MPEG-TS that is suitable for segmentation by a Packager.
Bitstream Switching Segment	Segment that if present contains essential data to switch to the Representation to which it is assigned as defined in the DASH specification [8].
Segment	A discrete section of content that can be independently decoded, possibly given additional initialization information. A packager can take virtual segments in the streams and create segments.
CIF Client	Software consumer of a CIF MPD. Primarily this is a Packager. Alternatively, a CIF client can be a dynamic ad insertion system, a blackout manager, a digital video recorder, or a video monitoring system.
CIF MPD	Formalized description for a media presentation for the purpose of providing segmentation of MPEG-TS file in a common intermediate format to a CIF client. Can also be know as a CIF manifest.
Client Manifest	Formalized description for a media presentation for the purpose of providing a streaming service to a client player.
Client Player	Media player using a specific adaptive streaming delivery (such as HLS, DASH, HDS, HSS) for content viewing purposes. The client player consumes a client manifest converted from the CIF MPD.
Cold cDVR	A completed cloud recording that can be viewed of a linear asset that has finished streaming.
Content Component Type	A single type of media content such as audio, video, or text as defined in the DASH specification [8] as media content component type.
DASH	Dynamic Adaptive Streaming over HTTP. In the CIF Specification, DASH is used to refer to concepts that are created in the 23009-1 specification [8] in MPEG-DASH group.
DASH Client	Client that consumes a DASH manifest. A CIF client consumes a CIF MPD, which uses DASH constructs.
DOM	W3C Document Object Model.
EPOCH	1-Jan-1900 00:00:00 and a 32-bit fraction field. Post EPOCH is 25-05-1977 18:00:00Z.
Early Terminated Period	A period that ends earlier than anticipated. This can happen when an inserted Ad is too short for the intended period.
Functionally Identical	Manifests index a collection of media segments. It can index the same collection of media segments more than one time in the manifest. For

	instance, the same representation could be listed in two different AdaptationSets. If their point to the same collection of segments, then it is known as being functionally identical.
Hot cDVR	An in-progress cloud recording that can be viewed of a linear asset that is still being streamed.
Initialization segment	Segment containing metadata that is necessary to present the media streams encapsulated in Media segments as defined in the DASH specification [8].
MBR Set	Set of representations that belong to the same AdaptationSet. Each representation is comprised of a group of segments that represents the encapsulated media stream.
MPD	Collection of data that establishes a bounded or unbounded presentation of media content as defined in the DASH specification [8]. An MPD is represented as an XML document.
MSE	W3C Media Source Extensions.
Muxed or Multiplexed	In the transport stream, this generally refers to a single program transport (SPTS) unless otherwise specified. In the segment case, this would refer to a section of the muxed transport stream containing both the video, audio, and data for that point in time.
Packager	A packager processes a conditioned continuous group of elementary streams to create specific ABR-format segments of mixed or separated elementary streams that are stored in a file or transmitted. A packager does not normally perform any transcoding functions but depends on the conditioned stream to create those independently decodable sections. A packager can also be known as a fragmenter, encapsulator, or segmentor.
Period	Time-based interval of the media presentation, where a contiguous sequence of all periods constitutes the media presentation as defined in the DASH specification [8].
Recorder	Device that stores ABR playback of content collected from a linear stream in a real-time or non real-time fashion. The recorder processes the content and creates an in-sequence number or stream byte offset record of the stream. Recordings can be played back after the entirety of the recording is complete (cold) or while it is being recorded (hot).
Representation	Collection and encapsulation of one or more media streams in a delivery format and associated with the descriptive metadata as defined in the DASH specification [8]
RUI-H	DLNA Remote User Interface – HTML5.
SubRepresentation	Part of a representation described in the MPD that is present in the entire period as defined in the DASH specification [8].
Virtual Content Component	One continuous component of the media content with an assigned media component type that can be encoded individually into a media stream as defined in the DASH specification [8] as media content component

6. CIF Architecture

6.1. High level Architecture

The CIF Specification describes the manifest presentation description for an MPEG-TS linear stream or stored file. Through the manifest, a CIF Client (e.g. a Packager or Transcoder) can request one or more particular section(s) of the MPEG-TS file or stream. To standardize the details in the manifest, the DASH standard [8] is used as it describes a rich and precise vocabulary for manifest description. In the DASH taxonomy, *representation* conceptually means single media (one or more elementary streams), comprised of multiple short *segments* . An *adaptation set* is a set of seamlessly switchable representations, and a *period* is a time box within which representations exist. Each period can be viewed as an independent playlist (similar to a master m3u8 in HLS) or a completely different program, and a period border can be seen as a splice point.

Using CIF MPDs does not require end-customer DASH clients. Packagers will retrieve content based on CIF MPD, and create client manifests of appropriate technology (HLS, DASH, HDS, HSS) as shown in Figure 3. A linear packager may ingest an ATS stream [6] and output a segmented DASH-TS stream, while parsing the stream to create a CIF MPD for the stream. A downstream packaging device may be used to retrieve specific segments from a content asset based upon cache miss request from a CDN or a client request for cDVR material.

6.1.1. DASH Overview and Attribute Descriptions

The DASH standard provides a method for retrieving media segments [8]. The authors of DASH included participation from Apple and Microsoft, who contributed the MPEG2-TS Live and ISO-BMFF Live Profiles respectively. These two profiles are used as examples by which the HLS and HSS ABR Fragments/Segments are indexed.

In current applications, the DASH standard [8] is used for server (an HTTP server) – client distribution of media to an end customer. A DASH MPD [8] describes the construction of a URL for each DASH segment. DASH segments are indexed by time or segment number and described by a number of properties including bitrate, codec, and resolution. A DASH client [8] is capable of processing an MPD and performing HTTP GET requests to retrieve a media asset. MPDs should be compressed during transfer using the gzip transfer encoding toolset that is part of the HTTP 1.1 server. Use of other compression tools for MPD transfer other than those specified in HTTP 1.1 is strongly discouraged to avoid complexities in maintaining toolset updates across servers.

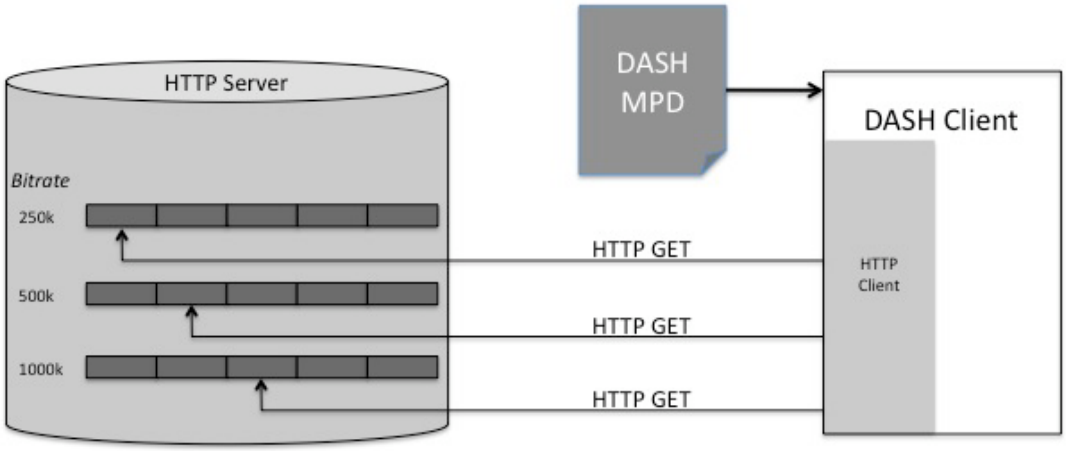


Figure 1 - DASH Client Side MPD and Segment Retrieval

In the CIF architecture case, the current application is expanded to include the use of DASH-like structures to deliver media segments to downstream devices in the network. The JIT packager or other intra-network downstream CIF client uses a DASH-like MPD to find and request segments from the file or linear stream for further segment and manifest processing. Modifications to the CIF MPD are needed so that relevant information contained in the CIF MPD can be converted to a compliant client manifest used by a DASH or HLS client. The CIF client packager creates a client manifest from the CIF MPD for the client player in one or more formats: HLS, HDS, HSS, ISO-BMFF DASH, or less commonly MPEG-TS DASH. The CIF MPD is used by the packager to retrieve DASH segments from an internal facing network storage system and to create the appropriate client manifest for the specific type of end client player.

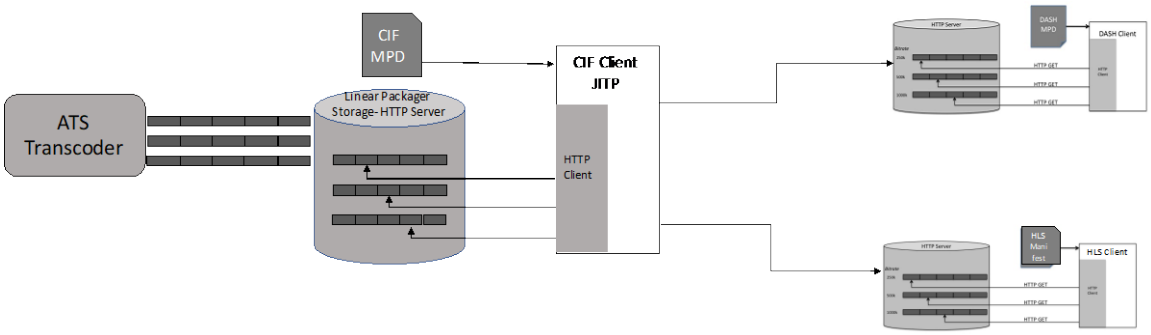


Figure 2 - CIF Architecture using DASH-like Structures

Since the creation of the CIF MPD for packager purposes is not a traditional use of the DASH specification there are some additional constructs detailed in this document that are extensions to the DASH specification. The intent is to keep the CIF MPD as closely aligned with the DASH specification but to allow for extensions such that different types of client manifests can be created to support different type of end-client adaptive streaming delivery technologies.This allows for storage/retrieval in the network in one format while still supporting several end-client delivery technologies. For the purposes of packager encapsulation, these DASH MPD constructs are used as described below. Refer to the example MPDs in the appendices while reading this text.

6.1.2. DASH CIF Level Architecture

The packager will retrieve assets from a distributed service network storage systems. Storage systems may be distributed based on services: linear program storage for linear channel services, recorder storage for cDVR services, and VoD file storage for VoD services. The packager system (linear packager in combination with a JITP) transforms assets from ATS format into an end-client supported format (e.g., HLS, HSS), and generates an appropriate end-client-specific manifest. To retrieve the requested segments from the embedded ATS file, the packager can retrieve sections of the ATS file (sections of a muxed transport stream or specific audio or video segments) using the CIF MPD [6]. The packager has a choice of several AdaptationSet elements within the manifest to retrieve the essential media components for the client or CDN request in a compact manner.

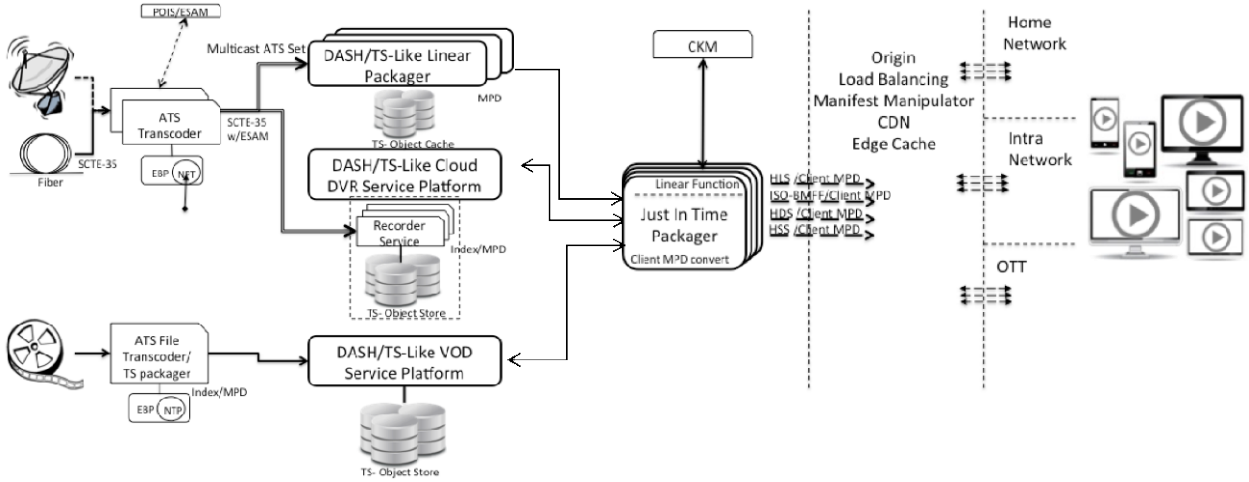


Figure 3 - Linear/ cDVR/ VoD Content Workflows and Delivery Chain

The JITP SHOULD communicate with a network facing DASH CDN on the upstream side to retrieve sections of the ATS as needed for JIT re-encapsulation into client formats, as well as a CIF MPD that indexes DASH, HSS, HLS, and HDS timelines within the ATS assets [6].

The CIF MPD is based upon the DASH standard but with extensions. Both HLS and HSS proprietary formats can be easily described in a common manifest format. HDS can also be described by a manifest as well. Requests made from the JITP to the DASH origin/CDN happen through HTTP GET requests for DASH segments. The CIF MPD can be "static" or "dynamic" and SHALL be updateable to a new content manifest as content segments are added to the asset. Versioning of content manifests is managed through clock based indexing approaches. The packager can use URL requests to make these requests.

6.2. CIF MPD Creation

The CIF MPD is created either by a linear packager or by VoD file preparation for linear, cDVR, or VoD services as described in reference architecture in Section 7 of SCTE 217 [16]. In the linear service workstream, the linear packager tunes into a UDP multicast session containing an ATS set of SPTS streams [6]. It then writes a CIF MPD in a live rolling window format (*e.g.,* a 30-second rolling window) with the segmentation determined by received EBP fields, parsed information in the stream (*e.g.,* SCTE-35 tags), or out-of-band information (e.g., a configuration file or just hardcoded). In the cDVR or VoD file-based workstreams, the CIF MPD is created by sectioning out the linear CIF or made during the file transcoding process. Where possible, the CIF MPD will adhere to the DASH MPD constructs and SCTE

214-1 [2] and 214-2[3] constraints, though it may carry additional information as defined in this specification that needs to be passed to downstream devices (e.g., user agents and browsers).

6.3. Conventions of Use for CIF MPD

Elements and attributes that are part of the CIF MPD contain information necessary for a CIF client to select a specific segment. Examples of this are fetching segments based on time, format, or bandwidth. However, additional elements and attributes are added to the manifest to enhance the operation of the client player. It is important though to minimize the amount of data being carried through the manifest. The following are guidelines for when it is acceptable to add data to the CIF MPD.

- Information needed for creation of client manifests (*e.g.,* specific information to enable HLS, HDS, HSS or DASH ISO-BMFF clients)
- Information needed for subsequent manifest conditioning or remote period operations that may alter the client manifest (*e.g.,* identifiers or relative path URLs)
- Parameter information needed by clients players to interface with other systems (e.g., browsers, side program insertion)
- Information whose retrieval/extraction would result in a noticeable delay to the end customer client (e.g., identification of CC language, descriptive video, DRM info). Note that the sum of additional payload size in the MPD SHOULD have a restriction in the size of 10% (within a tolerance) of the MPD size at the period level.

6.4. CIF Conversions for Cloud-to-Ground Client Player Applications

At the packager, the CIF MPD needs to be converted to a client manifest suitable for cloud-to-ground client applications using an ISO-BMFF format [17]. The CIF MPD may need to carry additional information intended to be passed to the client player/application or constrain its format according to SCTE 214-3 [4] to allow for simple conversions to this client manifest format.

Client player applications will vary based on the client type being an MVPD client (*e.g.,* Xi3) or VidiPath[tm] client, which may be an MVPD conformant client [17]. A VidiPath[tm] client device conforms to all the mandatory guidelines in a DVR architecture and can download and run an RUI-H service provider application that is constrained to the APIs mandated in a DVR architecture.

6.5. CIF Carriage of User Agent Information

A VidiPath[tm] client device includes a user agent that is similar to most browsers in that it supports HTML5 [17] and may have been developed from an open source browser. The user agent also supports media formats that browsers may not including MPEG-2 TS container with AVC video, and MP4 (ISO-BMFF) container with an AVC video. These formats are typically used for streaming within the home. The user agent will also support DASH MPEG-2 Simple and ISO-BMFF Live and On-demand profiles. The user agent will process the metadata from the video stream and the manifest and map it to API (DOM) structures that an RUI-H application can access. Respective to media format type, the W3C in-band sourcing specification [9] defines how the metadata in the manifest, container metadata, or video metadata is mapped to an HTML MediaElement API.

The CIF MPD may need to carry additional information not found in DASH manifest that may in turn may be passed onto other carriage mechanisms to reach the user agent. Some information carried in this manner is to avoid presentation data problems due to delay of parsing the stream.

6.6. Source Origins of Timing Elements and Attributes

The CIF MPD for linear services is created by the linear packager which processes information ingested from an MBR set of ATS streams. A transcoder ingests a source linear stream and transcodes the source stream to an MBR set of ATS conditioned streams [6]. These ATS streams are then processed by a linear packager and the CIF MPD is created. For VoD services, the CIF MPD is created at the time of transcode of the source file.

Each ATS stream contains timing, boundary point, and labeling information for each segment as well as SCTE 35 messages and PTS stream times [6]. This information along with its own clock time is what the manifest creator (either linear packager or VoD transcoder) uses to create the CIF MPD.

The source stream into the transcoder can contain two timing mechanisms. One is the SCTE 35 Time Descriptor element that originates from the content provider and is a wall clock time that is inserted at least once every five seconds using an SCTE 104 mechanism [14]. The transcoder can use this time descriptor as a basis for the wall-clock time to create the EBP time for each virtual segment in the stream or if not present it can create the wall-clock time from the transcoder device network time clock. This wall-clock information is then processed by the manifest creator and becomes a source for the period level start attribute and supplemental property UTC-time, and AdaptationSet level S@d and S@r attributes.

The second timing mechanism in the source stream is PTS. This can be passed through or reclocked at the transcoder. The PTS information is then processed by the manifest creator and becomes a source for period level presentationTimeOffset element and AdaptationSet level S@t attribute.

The transcoder itself initializes the sequence number at the startup of the ATS stream using the wall-clock time set to the EPOCH time divided by the regular segment duration (SD) (e.g., two seconds) as defined for the period [6]. This number is used as the startNumber attribute of the segment template and sources the adaptationSet S@n attribute.

For linear services, there is also a clock signal at the linear packager which can also be used as a potential time source that can be used for determining the availability time of the first available segment since the linear packager does create the CIF MPD. In linear services, a rolling window is used to maintain a cached pool of segments that represents live linear streaming. In this approach, segments may fall off the manifest as well be added on without changing the period structure which means the first available segment will also change.

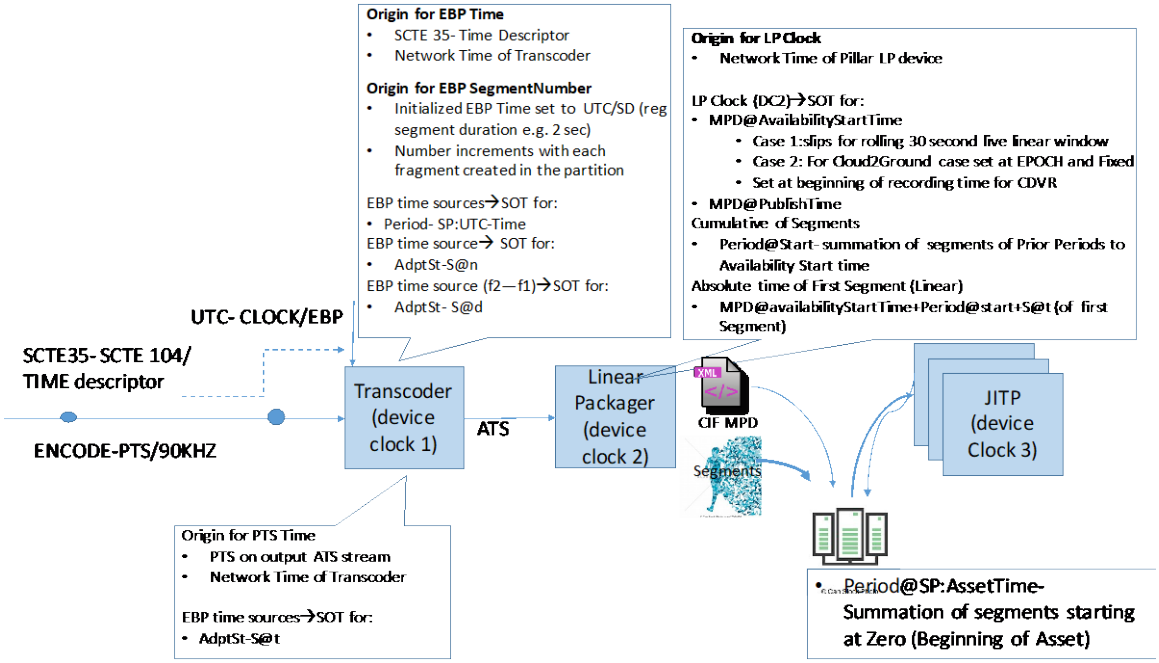


Figure 4 - Time Signals in Network Segmented Content Workflows

Once the CIF MPD and the segments are stored, the JITP fetches content segments based on a client request that comes through by CDNs or directly through the client itself. This initializes the client workflow (Figure 4), where the CIF MPD is read by the JITP to fetch content segments and JITP also creates the client manifest derived from the CIF MPD into a format that the client player accepts. Time signals in this case are carried over from the CIF MPD with things like PTS overflow handled in the client manifest according to the type of adaptive streaming format used the client. Additionally, the player is operating using a clock on its device platform. Sometimes this clock can be misaligned from the clock of the manifest creator. This can create complexities in linear services if the client clock is ahead of the manifest creator clock. The client can avoid these complexities through some behavior strategies such as not taking the current available segment in the manifest, but taking a segment a few segments back from the current segment.

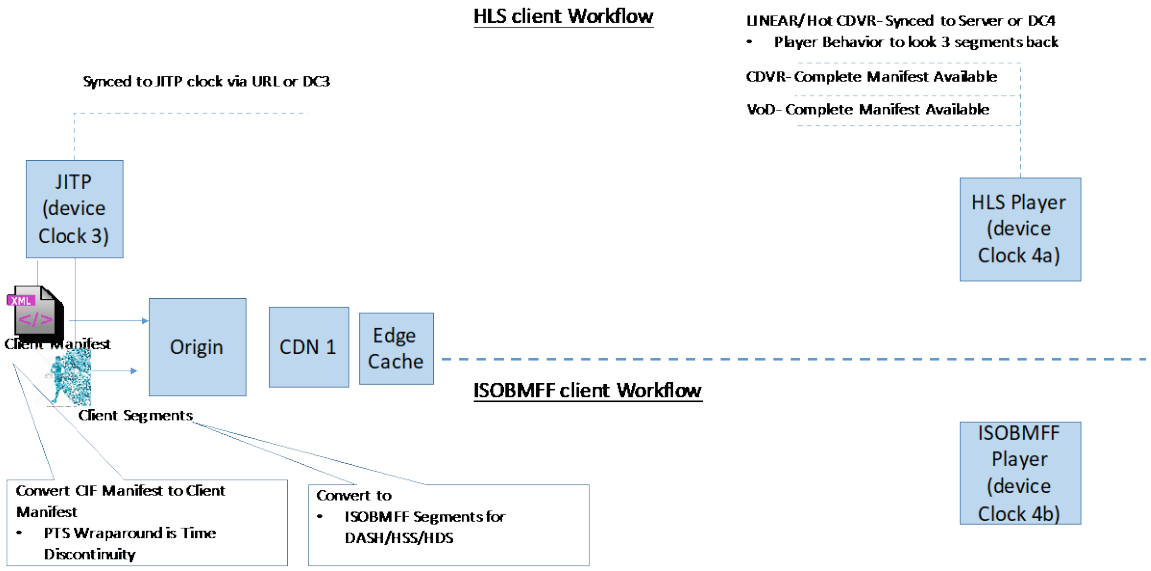


Figure 5 - Time Signals in Client Segmented Content Workflows

6.7. Identifiers in CIF

Identifiers (@id) exists at the MPD, Period, AdaptationSet, and Representation levels of the CIF MPD. These @ids attributes have constraints which are listed in the description of the table row entry which are helpful to JITP conversions to client manifests. Many of these values for the attributes assist in uniquely identifying different hierarchy levels in the manifest which can be specific to asset and/or service. Value assignments for this identifier attributes can be specific to the implementation of the specification. In these cases, the value entries will be identified as "TBA-MVPD" (To Be Assigned by the MVPD) and the actual values for these entries will be decided upon by the MVPD implementing the CIF specification.

6.8. Handling of Errors

If an outage occurs due to a recording error or an actual error on the ATS stream, the transcoder or recorder creates an outage in time that can differ across the ATS set of streams [6]. The packager handles this in the CIF MPD in two approaches: (1) the MPD does not index for that missing period of time, or (2) the MPD creates a new period but without the missing representation and updates this through an event message. For approach one, when a request for the DASH segment cannot be successfully completed by a packager or origin server, it SHALL return an appropriate error code (e.g., 404, 410, 503; see HTTP error codes in the appendix). CIF client behaviors SHOULD accommodate for this by requesting an alternate segment representation for that period. For approach two, the resulting conditioned output client manifest format created by the JIT packager SHOULD accommodate for the missing representation by creating a new period with an event message. Approach one is to be used for initial outages (in the seconds range). Approach two is for longer outages where a decision is made to create a new period or the MPD is updated to reflect this. The decision to use approach two instead of approach one depends on the duration of outage and the configurable threshold criteria determined for this.

7. CIF MPD Specification

Tables for MPD, Period, AdaptationSet, and Representation are based off of tables in the DASH specification [8], but add constraints or additional information that is needed to create the MPD instance that is the CIF MPD. If an attribute is described and it is optionally defined in a second location, then the location in the lowest level in the MPD hierarchy takes precedence.

7.1. Table Format

This section defines the general Table format layout for Attributes and Elements in the manifest as described in Table 1.

Table 1 - Table General Format

Element or Attribute Name **<Hierarchical Level of Table in Manifest>** **<DASH Table Reference [8] >**	**CIF Use** **<M,O,CM>** **<CIF Use of Attributes/Elements>**	**Description**
<Attribute-left justified> [DASH Defined Use [8]] <additional information>	**<Conditions of Use>** "__ "<Not used>	< Additional descriptions and constraints of Attributes and Elements in this CIF document. Definitions of attributes and Elements that are listed in DASH Document [8] are not repeated here>
<Element-left justified> [# of Instances]		
<Sub Attribute>		
<Sub Element>		
	General Constraints Default	
	Components Constraints ONLY or EXCEPT	
	Service Constraints ONLY or EXCEPT	
Essential or Supplemental Property	Property 1 Use	Property 1 Description
	Property 2 Use	Property 2 Description
	Property 3 Use	Property 3 Description

7.2. DASH MPD Element

This section describes MPD level related information for usage in the CIF MPD.

Note: MPDs should be compressed during transfer using the gzip tranfer encoding that is part of the HTTP server. Use of other compression tools for MPD transfer is discouraged since it is not part of the HTTP toolset.

7.2.1. DASH MPD Semantics

CIF MPD level semantics shall be as specified in Table 2.

Table 2 - CIF MPD Semantics

Element or Attribute Name <MPD> Table 3 in section 5.3.1.2 [8]	CIF Use	Description
MPD		The root element that carries the Media Presentation Description for a media presentation.
@id [O]	M	The ID of the asset. A URI qualified ID can be used to identify the type of service the MPD represents. (e.g., "urn.xxx.linear.stream:xxxx") • Linear: TBA-MVPD • cDVR: TBA-MVPD • VoD: TBA-MVPD
@profiles [M]	M	see Section 6.1 of SCTE 214-2 [4]
@type [OD] Default = "static"	M	If set to "dynamic", it means the MPD is expected to be updated periodically. • Linear – "dynamic" • CDVR (hot recording) – "dynamic" • CDVR (completed) – "static" with dynamic attributes removed • VoD – "static"
@availabilityStartTime [CM for type= "dynamic"]	M C2G Default Value set to POST EPOCH Time (1977-05-25T18:00:00.000000Z) ANY	Expressed in the time frame of the system clock on the packager, this attribute contributes to the calculation of when the first listed segment in the MPD is available for download by a CIF client. For @type='dynamic' this attribute SHALL be present. In this case it specifies the anchor for the computation of the earliest availability time (in UTC) for any segment in the media presentation. For @type="static" if present, it specifies the segment availability start time for all segments referred to in this MPD. If not present, all segments described in the MPD SHALL become available at the time the MPD becomes available. For linear channel applications, the availabilityStartTime on MPD updates may change according to a sliding window of time that is based on the timestamp of the system that generated the MPD.

Element or Attribute Name <MPD> Table 3 in section 5.3.1.2 [8]	CIF Use	Description
	EXCEPT For cDVR Cold and VOD use DEFAULT NSfCM	For cDVR recordings, the periods that were in the MPD at recording start remain in the recording. When a recording starts, the CIF MPD@availabilityStartTime is set to the value of the calculated availabilityStartTime of the first segment in the recording. Thereafter the value of the attribute does not change, but segments are added to those indexed in the MPD. To handle cloud-to-ground delivery, the availabilityStartTime should be fixed. In these cases, the availabilityStartTime starts at the POST EPOCH time.
@publishTime [OD] Must be present for type = “Dynamic”	M	The publishTime indicates the timestamp of the system that generated the MPD when member segments are written to storage and accessible to consumers of the MPD. If at the CIF client the publishTime between two retrievals is the same, then the MPD is considered “not updated”. When converting to a static MPD, use the last dynamic MPD publishTime.
@availabilityEndTime [O]	—	Not used.
@mediaPresentationDuration [O]	M DEFAULT Set to PT1S	Provides the total duration of the media presentation. It can determine how much period time that has elapsed for the entire media presentation. This can be used in a dynamic mode for linear content that can append new periods and thereby track increasing time for the entire presentation duration. This handles the live case where one does not know the end of the current period duration but can keep increasing it during each MPD update as it grows. This can be useful for ad splicing, so that players joining mid-break can splice an ad for the remainder of the break.
	ANY	
	Linear Use DEFAULT NSfCM	
@minimumUpdatePeriod [O]	M DEFAULT Set to P420Y	The creator of the MPD chooses the minimum update period. The MPD@minimumUpdatePeriod specifies the smallest period between potential changes to the MPD. Once an asset is complete, the *mimimumUpdatePeriod* field uses the default value.

Element or Attribute Name **<MPD>** **Table 3 in section 5.3.1.2 [8]**	**CIF Use**	**Description**
	ANY	In regards to MPD update restrictions, see Section 6.8 of SCTE 214-1[2]. 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.
	cDVR Cold or VOD use DEFAULT NSfCM	
@minBufferTime [M]	M	The minimum amount of time a client player SHOULD buffer content before beginning playout. See Section 6.1 bullet 1 of SCTE 214-1 [2]. Note: This merely suggests to downstream systems how big the regular duration segments could be. It may be possible that multiple irregular segment duration could fit in minbuffertime duration, but that is not the usual case.
@timeShiftBufferDepth [O]	M DEFAULT Set to P420Y	The duration of the time shift buffer that is guaranteed to be available for this asset. The creator of the MPD assigns this value as well. See Section 6.1 of SCTE 214-1 [2]. Once an asset is complete, the *mimimumUpdatePeriod* and *timeShiftBufferDepth* field uses default value.
	ANY	
	cDVR cold and VoD use DEFAULT NSfCM	
@suggestedPresentationDelay [O]	—	Not used.
@maxSegmentDuration [O]	M DEFAULT 30.03	The maximum duration of any segment in the MPD. See Section 9.2.1 of SCTE 214-1 [2].
	ANY	
	EXCEPT for VOD with SIDX	
@maxSubsegmentDuration [O]	—	The maximum duration of any subsegment in the MPD.
	ANY	

Element or Attribute Name <MPD> Table 3 in section 5.3.1.2 [8]	CIF Use	Description
	ONLY for VOD with SIDX	
ProgramInformation [0..N]	[1]	Carries the Segmentation UPID identifiers at the MPD level through ContentIdentifier element, see Section 8.2 of SCTE 214-1 [2] schemeIdUri "urn:scte:dash:asset-id:upid:2018" At the period level, this identifier will be carried in the Period AssetIdentifier element and extracted thru payload schema. Applications reading the MPD MAY need to be aware of identifiers at both the MPD and period level.
	ANY	
	EXCEPT for VOD = [0..1]	
scte214:ContentIdentifier	[1..N]	Each element carries a separate segmentation UPID in textual format For Linear/cDVR: **TBA-MVPD** For VoD (Optional): **TBA-MVPD** For Ads: (Optional): **AdId**
BaseURL [0..1]	—	Not used. Note: This element at this manifest level is reserved for future use.
Location [0..N]	—	Not used.
Period [1..N]	[1 ..N]	Specifies the information of a period.
Metrics [0..N]	—	Not used.
EssentialProperty [0..N]	—	Not used.
SupplementalProperty [0..N]	[1]	**powered-by** See Section 13.1 of SCTE 214-1 [2].

Element or Attribute Name **<MPD>** **Table 3 in section 5.3.1.2 [8]**	**CIF Use**	**Description**
Specifies supplemental information about the containing element that MAY be used by the CIF client optimizing the processing.	[1]	**built-with** schemeIdUri= “urn:scte:dash:built-with:2018” value = **TBA-MVPD** To signal to downstream consumers of the CIF MPD manifest what version of the CIF MPD specification was used to generate the manifest so they can parse and utilize it separately from the powered-by information. **e.g.** <SupplementalProperty schemeIdUri= “urn:scte:dash:built-with:2018” value="SCTE-CIF-TS-I01.0"/>
	[0..1]	**generation-info** See Section 13.1 of SCTE 214-1 [2] [Not Used - defer to @publishTime for now]. Indicates the software version of the MPD creator.

	[0..1]	**DRMData** @schemeIdUri= “urn:scte:cif-ts:drmdata:2018” @value = base64 value This supplemental property defines how to encrypt segments and modify MPDs to convert to customer-side adaptive streaming DRM technologies. Multiple occurrences of this supplemental property in the MPD are allowed with values at lower levels taking precedence for that time period. DRMData information is used to inform downstream CIF client devices (*e.g.,* packagers) how to encrypt segments for further downstream distribution. CIF client devices (*e.g.,* Packagers) MAY need to initially decrypt stored “at rest encrypted” segments while fetching segments in storage before encrypting these segments for DRM-specific customer client player technologies and addressing this in client manifests. The @value is the payload data that needs to be transmitted to the DRM key manager in order to retrieve the necessary keys for encrypting segments. DRMData is supported by an in-line scheme where the payload is embedded as the value in a base64 encoded format [12]. [1] Note: in the ISOBMFF client manifest this information will be put in the ContentProtectection element in the AdaptationSet PSSH box initialization segment. Example: <SupplementalProperty schemeIdURI = "urn:scte:cif-ts:drmdata:2018" value= "Pz48UmVjb3JkaW5nSW5mb1Jlc3VsdCB4bWxuc z0idXJuOmNvbTpjb21jYXN0Om5kdnI6YzMiIHJl Y29yZGluZ0lkPSIxMTExMTExMzY3OTI0MjM2 MDk4IiBUVEw9IjM2MDAiIGFjY291bnRJZD0iM jEwNCI+PFJlY29yZGluZ0luZm8gc3RhdGlvbklkP SI3OTU5MzUwMDY4NzM4ODExMTE3IiBzdHJl YW1JZD0iNzk1OTM1MDA2ODczODgxMTExNy IgcmVjb3JkaW5nQWR6b25lPSIwIi8+PC9SZWNv cmRpbmdJbmZvUmVzdWx0Pg==”/>

Element or Attribute Name <MPD> Table 3 in section 5.3.1.2 [8]	CIF Use	Description
	[0..1]	**Syscode** See Section 13.1 of SCTE 214-1 [2] Adzone information that is attached to the recording. This is a value that is of interest to the alternate content router. Note: It is a string of non-limited length that is expected to contain a maximum number of 10 digits. @schemeIdUri= "urn:scte:dash:cif-ts:syscode:2018",@value= "123456789".
	[0..1]	**QamDelivery** @schemeIdUri="urn:scte:dash:cif-ts:qamdelivery:2018" Indicates information that aids in presenting this program via QAM. Properties of this type are grouped and identified by the URI "urn:scte:dash:cif-ts:xxx:2018". The supplemental property will contain separate elements for each file ex: <SupplementalProperty schemeIdUri= "urn:scte:dash:cif-ts:qamdelivery:2018" > <cif:Trick Speed=8>eiwoe/28334ou.ts</cif:Trick> <cif:Trick Speed=-8>eiwoe/28c334ou.ts</cif:Trick> <cif:Trick Speed=16>eiwoe/283ec34ou.ts</cif:Trick> <cif:Trick Speed=-16>eiwoe/2er8334ou.ts</cif:Trick> <cif:Trick Speed=32>eiwoe/2je8334ou.ts</cif:Trick> <cif:Trick Speed=-32>eiwoe/28uy334ou.ts</cif:Trick> <cif:Trick Speed=64>eiwoe/283eees34ou.ts</cif:Trick> <cif:Trick Speed=-64>eiwoe/283o8034ou.ts</cif:Trick> <cif:Index>eiwoe/283index.ts</cif:Index> </SupplementalProperty>
UTCTiming [0..N]	__	Not Used. Note: This is an element that may be used in DASH client MPDs.
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>…<maxOccurs> (N=unbounded) Elements are **bold**; attributes are non-bold and preceded with an @		

7.3. DASH Period Element

This section describes period-level related information for use in the CIF MPD.

7.3.1. DASH Period Semantics

CIF period level semantics shall be as specified in Table 3.

[1] In future revisions, an external scheme MAY be developed where the payload needs to be fetched from an external resource as defined in the value attribute.

Table 3 - CIF Period Semantics

Element or Attribute Name <Period> Table 4 in section 5.3.2.2 [8]	CIF Use	Description
Period		Specifies the information of a period.
@xlink:href [O]	__	Not used.
@xlink:actuate default: “onRequest”'	__	Not used.
@id [O]	M (string)	An identifier (guide) for this period. The identifier SHALL be unique within the scope of the media presentation. If the **MPD**@type is "dynamic", then this attribute SHALL NOT change when the MPD is updated. This attribute SHOULD NOT be confused with the AssetIdentifier element, which is used to identify multiple periods belonging to the same asset. Cardinal numbers are to be used. Each service to be defined as: VoD- **TBA-MVPD** cDVR- **TBA-MVPD** Linear- **TBA-MVPD**
@start [O]	O First Period Default = 0	Used to show period start time relative to the start of the MPD or previous period. Omit for an early terminated period.
@duration [O]	__	Not used.
@bitstreamSwitching [OD] Default: false	__	Not used.
BaseURL [0..N]	[0..1]	Used when manipulating CIF MPDs for applications such as stream switching.
SegmentBase [0..1]	__	Not used.
SegmentList	__	Not used- See section 6.2 of SCTE 214-1 [2].
SegmentTemplate	__	Not used. See AdaptationSet.
AssetIdentifier [0..1]	[1]	Used to identify multiple periods that belong to the same content asset. Carries the Segmentation UPID identifiers at the period level through ContentIdentifier element, see Section 8.2 of SCTE 214-1 [2]. Use of UPID MIDs in MPDs should be discouraged since the MID can be broken up into multiple contentIdentifier elements. As an Input, AdID may carry MIDs in the SCTE 35 message UPID structure, but processing to get this information on the MPD may require breaking the MID to separate contentIdentifier elements. schemeIdUri “urn:scte:dash:asset-id:upid:2018”

Element or Attribute Name <Period> Table 4 in section 5.3.2.2 [8]	CIF Use	Description
		At the MPD level, the Segmentation UPID will be carried in the MPD@ProgramInformation attribute and extracted through the payload schema. Applications reading the MPD MAY need to be aware of identifiers at both the MPD and period level.
scte214:ContentIdentifier	[1..N]	Each element carries a separate segmentation UPID in textual format For Linear: • **TBA-MVPD** • ProgramID – Most likely an EIDR or AdID for a commercial (Higher Priority if exists). • ShowID or AirID (Highest priority if exists). For File: • **TBA-MVPD** • ProgramID – Most likely an EIDR or AdID for a commercial (Higher Priority if exists). • ShowID or AirID (Highest priority if exists).
EventStream [0..N]	[0..N] ANY EXCEPT for Ads = [1]	Specifies an event stream. An event stream can contain multiple events. We use events for: • SCTE 35 splice_info_section() in base 64 [12]. The SCTE PIDs in the stream will be dropped at the point where the EventStream is created in the MPD. See Section 6.7
AdaptationSet [0..N]	[0..N]	The *AdaptationSetType* indicates if the AdaptationSet Element is "root". "root" indicates an AdaptationSet Element, which sends segments according to segment durations as aligned with consecutive EBPs of the same partition_id. Other types of AdaptationSet Elements can be created from a "root" AdaptationSet Element. See Section 6.2 point 3 of SCTE 214-1 [2]. See the note in Section 6.2 point 3 of SCTE 214-1 [2].
Subset [0..N]	—	Not used.
SupplementalProperty [0..N] Specifies supplemental information about the containing element that MAY be used by the CIF client optimizing the processing.	[0..1] ANY EXCEPT for cDVR Cold, VOD, Ads = [1]	**Asset-time**: see section 11.2 of SCTE 214-1 [2] The value of @value attribute ***shall*** be the timestamp corresponding to *PeriodStart*, as NPT or SMPTE relative timestamp, as defined in RFC 2326.

Element or Attribute Name <Period> Table 4 in section 5.3.2.2 [8]	CIF Use	Description
	[0..1] For Lin [1] ANY EXCEPT for Lin= [1]	**UTC-time**: see Section 11.2 of SCTE 214-1 [2] for use with linear. 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. E.g., asset time will show that a period starts at 42nd minute of an asset, while UTC time will show that the period starts with content captured on October 21, 2015 at 4:29am. UTC time should also account for leap seconds.
	[0..1]	**Asset-end**: see Section 11.2 of SCTE 214-1 [2]. This can be used to indicate the last period of a multi-period asset.

Element or Attribute Name <Period> Table 4 in section 5.3.2.2 [8]	CIF Use	Description
	[0..1]	**DRMData** @schemeIdUri= “urn:scte:dash:cif-ts:drmdata:2018” @value = base64 value This supplemental property defines how to encrypt segments and modify MPDs to convert to customer-side adaptive streaming DRM technologies. Multiple occurrences of this supplemental property in the MPD are allowed with values at lower levels taking precedence for that time period. DRMData information is used to inform downstream CIF client devices (*e.g.,* Packagers) how to encrypt segments for further downstream distribution. CIF client devices (*e.g.,* Packagers) MAY need to initially decrypt stored “at rest encrypted” segments while fetching segments in storage before encrypting these segments for DRM-specific customer client player technologies and addressing this in client manifests. The @value is the payload data that needs to be transmitted to the DRM key manager in order to retrieve the necessary keys for encrypting segments. DRMData is supported by an in-line scheme where the payload is embedded as the value in a base64 encoded format [12]. [2] Note: in the ISOBMFF client manifest this information will be put in the ContentProtectection element in the AdaptationSet PSSH box initialization segment. Example: <SupplementalProperty schemeIdUri = "urn:scte:dash:cif-ts:drmdata:2018" value= "Pz48UmVjb3JkaW5nSW5mb1Jlc3VsdCB4bWxucz0idXJuOmNvbTpjb21jYXN0Om5kdnI6YzMiIHJlY29yZGluZ0lkPSIxMTExMTExMzY3OTI0MjM2MDk4IiBUVEw9IjM2MDAiIGFjY291bnRJZD0iMjEwNCI+PFJlY29yZGluZ0luZm8gc3RhdGlvbklkPSI3OTU5MzUwMDY4NzM4ODExMTE3IiBzdHJlYW1JZD0iNzk1OTM1MDA2ODczODgxMTExNyIgcmVjb3JkaW5nQWR6b25lPSIwIi8+PC9SZWNvcmRpbmdJbmZvUmVzdWx0Pg==”/>

[2] In future revisions, an external scheme MAY be developed where the payload needs to be fetched from an external resource as defined in the value attribute.

Element or Attribute Name <Period> Table 4 in section 5.3.2.2 [8]	CIF Use	Description
	[0..N]	**AlternateID** Group of supplemental properties using a single identifier. The @schemeIdUri is a URN derived but source is still "urn:scte:dash:asset-id:id-list:2018". See Section 8.1 of SCTE 214-1 [2]. AD-ID: @schemeIdUri= "urn:scte:dash:asset-id:id-list:2018", Value= "ABCD0001000H" ADI : @schemeIdUri= "urn:scte:dash:asset-id:id-list:2018", Value= "vodcompany.com UNVA2001081701004001"
Legend: 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 **bold**; attributes are non-bold and preceded with an @.		

7.4. DASH AdaptationSet

This section describes AdaptationSet-level related information for use in the CIF MPD.

7.4.1. AdaptationSet Semantics

CIF AdaptationSet-level semantics shall be as specified in Table 4.

Table 4 - CIF AdaptationSet Semantics

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	CIF Use	Description
AdaptationSet		AdaptationSet description.
@xlink:href [O]	__	Not used.
@xlink:actuate [OD] default: "onRequest"'	__	Not used.
@id [O]	M	This value is an unsigned integer value. Where the *id* token is used to identify the particular AdaptationSet element. The following restrictions SHALL apply: • See Section 6.2 point 1 of SCTE 214-2 [3]. • AdaptationSets that are the same across periods need to have the same AdapationSet@id value. • AdaptationSet@id is not equal to "0". For AdaptationSets which will be mapped to client player ISOBMFF profiles, AdaptationSet@id SHALL allow the 'tkhd' box track_ID field to be deterministically mapped. When converting from transport stream, the track_ID field and consequently Adaptation@id SHOULD be uniquely mapped. Value = **TBA-MVPD**

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	**CIF Use**	**Description**
@group [O]	__	Not used.
CommonAttributesElements	-	Specifies the common attributes and elements (attributes and elements from base type ***RepresentationBaseType***).
@lang [O]	___	Declares the language code for this AdaptationSet. The syntax and semantics according to ISO 639-2 SHALL be used as indicated in SCTE 214-1 [2]. The *lang* attribute indicates the language of the AdaptationSet element. This attribute can be sourced from the PMT in the MPEG SPTS. In the PMT case, the *language* is indicated by a 3-letter code. For placement in the MPD, the MPD creation SHOULD convert the PMT three-letter code to an @lang attribute with a two-letter code according to RFC 5646.
	M For single component Audio ContentType AdaptationSets	
	ANY	
@contentType [O]	___	Values are : • "video" – Indicates an AdaptationSet element that returns video segments. See Section 6.3 point 7 of SCTE 214-1 [2]. If additional video feeds using the same audio choices are needed (*e.g.,* alternate camera angles) then another AdaptationSet in the same period SHOULD be constructed. • "audio" – Indicates an AdaptationSet element that returns audio segments. The Iframe case is represented as a Trickmode Representation. See Section 7.4.4. Note: The MVPD determines if the media segments being sent to the packager is in the "muxed" mode or "demuxed" mode. The muxed mode will send both the video/audio in one segment which may aid in synchronizing the video and audio. The demuxed mode, the video and audio are sent as two separate segments and may be more efficient for audio late binding scenarios. Note: In the muxed case, Adaptation@contentType is not used instead contentComponent@contentType is used to indicate this for each media component. Note: The muxed case can be determined by the AdaptationSet@codecs attribute, defined as a comma separated list, and the presence of multiple ContentComponents in the same AdaptationSet.
	M For single media component AdaptationSets	
	ANY	
@par [O]	__	Not used.
@minBandwidth [O]	__	Not used.
@maxBandwidth [O]	__	Not used.

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	**CIF Use**	**Description**
@minWidth [O]	—	Not used.
@maxWidth [O]	— M For Video contentType and MUX ANY	See Section 6.3 point 6a of SCTE 214-1 [2]: Used.
@minHeight [O]	O	Not used.
@maxHeight [O]	— M For Video contentType and MUX ANY	See SCTE 214-1 [2]: Used.
@minFrameRate [O]	—	Not used.
@maxFrameRate [O]	— M For Video contentType and MUX ANY	See Section 6.3 point 6b of SCTE 214-1 [2]: Used. To express framerate values, use Table 13 in SCTE 215-1 [15].
@segmentAlignment [OD] default: false	M default: "true" in SCTE DASH Constraints ANY EXCEPT for VOD with SIDX	For segmentation (HLS): "false" indicates that segments are overlapping. If the helper can demux unnecessary packets before sending them out, then *segmentAlignment* can be set to "true". For segmentation (HSS, HDS): "true" For video AdaptationSet element: this indicates that HSS client players need non-overlapping segments. See Section 6.3 point 3 of SCTE 214-1 [2]. In the CIF implementation, segmentAlignment is "true" if representations within an AdaptationSet are to be segment aligned. If representations across AdaptationSets are to be aligned at each segment across AdaptationSets, the @segmentAlignment is set to "1".
@bitstreamSwitching [O]	M Default: "true"	See Section 6.2 point 2 of SCTE 214-2 [3]. Indicates that a concatenation of segments from different representations can be played back without an artifact.
@subsegmentAlignment [OD] default: false	— ANY M ONLY for VOD with SIDX	See Section 6.3 point 5a of SCTE 214-1 [2]. In the CIF implementation, subsegmentAlignment is "true" if representations within an AdaptationSet are to be subsegment aligned. If representations across AdaptationSets are to be aligned at each subsegment across AdaptationSets, the @subsegmentAlignment is set to "1".

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	**CIF Use**	**Description**
@subsegmentStartsWithSAP [OD] default: 1	— ANY M ONLY for VOD with SIDX	See Section 6.3 point 5b of SCTE 214-1 [2]. Attribute indicates the subsegment begins with a closed GOP (SAP=1) or subsegment begins with an IDR frame (SAP=2). Random access point, where the RAP is the first picture in the subsegment in both decoding and presentation order.
Accessibility [0..N]	[0..N] EXCEPT for MUXed Components ANY	See Section 7.2 of SCTE 214-1 [2].
Role [0..N]	[0..N] EXCEPT for MUXed Components ANY	See Section 6.2 point 3 of SCTE 214-1 [2]. • Video: Main SCTE 214-1 [2] • Audio: Main, commentary, emergency see Section 7.1 of SCTE 214-1 [2]. • Associated audio services (VI & HI) @schemeIdUri= “urn:scte:dash:associated-service:2018” see Section 7.1 of SCTE 214-1 [2]. • Use of role in AdaptationSets, see Section 6.2 part 3 of SCTE 214-1 [2].
Rating [0..N]	—	Not used.
Viewpoint [0..N]	—	Not used.
ContentComponent [0..N]	— ONLY for MUXed Components = [2..N] ANY	Each media source in a MUX is described in a ContentComponent. See Section 6.4 of SCTE 214-1 [2]. See Section 6.3 of SCTE 214-2 [3]. e.g. <ContentComponent contentType= “video” id=”481”> If ContentComponent is an element of an AdaptationSet, elements that describe media components (e.g., role or accessibility) should be placed inside the ContentComponent element.
@id [O]	M	This is the PID of the source elementary stream.
@lang [O]	— M ONLY for Audio ContentType	Same semantics as higher level @lang attribute.

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	**CIF Use**	**Description**
	ANY	
@contentType [O]	M	Same semantics as higher level @contentType attribute.
@par [O]	__	Not used.
@tag [O]	__	Not used.
Accessibility [0..N]	O	Same semantics as higher level **Accessibility** element.
Role [0..N]	O	Same semantics as higher level **Role** element.
Rating [0..N]	__	Not used.
Viewpoint [0..N]	__	Not used.
BaseURL [0..N]	[1]	The BaseURL at the AdaptationSet Element level represents the URL used for MPD requests of a specific AdaptationSet element. The request can append values to the URL to indicate a segment of a particular bandwidth and time or other choices within the AdaptationSet element. BaseURLs for AdaptationSet elements contained within the same packager MPD SHALL be unique within the period, but can remain the same for the same BaseURL at the same level across periods of the same asset. The BaseURL can be formatted to be descriptive enough to indicate the nature of an AdaptationSet element.
SegmentBase [0..1]	__	Not used.
SegmentList [0..1]	__	Not used.
SegmentTemplate [0..1] <SegmentTemplate startNumber= "12568909" presentationTimeOffset="4313395748" timescale= "90000" media= "$RepresentationID$/$Number$.ts" > <SegmentTimeline> <S t="4313395748" n="12568909" d="180180" r="7"/> <S d="176640" /> <S d="180480" r="2"/> <S t="4315555268" n="12568921" d="176640" /> </SegmentTimeline> For VOD with SIDX: <SegmentTemplate timescale="90000" presentationTimeOffset="187680" media="$RepresentationID$.ts" index="$RepresentationID$.sidx"/>	[1]	This element identifies resource names for the media and index files. SegmentTemplate inherits the properties of the SegmentBase element and the SegmentBaseInformationType. Segments S elements are described by startNumber, duration, the number of repeats , and sometimes time/segment number. Media segments initialization is described in Section 7.2 of SCTE 214-2 [3].
SegmentBase @timescale [O]	M	@timescale is set at 90,000 ticks per second.
SegmentBase @presentationTimeoffset [O]	M Default is 0	See Section 6.4 of SCTE 214-2 [3].

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	CIF Use	Description
	ANY	
	EXCEPT for VOD = 0	
MultipleSegmentBaseInformation @startNumber [0..1]	0…1 Default to 1	@startNumber SHOULD start from the segment number of the first segment in each AdaptationSet in the period. The segment number, which will determine the startNumber is either initialized by the transcoder system or for linear is embedded in the EBP structure. For linear the start number is determined by UTC time of the first segment in the period (EBP Time) divided by the regular segment duration of the period (UTC/SD) truncated to nearest integer. The startNumber initialized for later periods in a linear asset do not have to be continuous but just increasing. For VoD, the startNumber is set to one at the beginning of the asset.
	ANY	
	EXCEPT for VOD with SIDX	
@media [O]	M	Creates the media segment list using sequence numbers i.e. "$RepresentationID$/$Number$.ts" The sequence number for each segment can be calculated as follows: 1) the sequence of the first segment number of the period is the startNumber assigned as an attribute of the SegmentTemplate element, and 2) successive segment is incremented by one from the preceding segment sequence number. To understand the associated wall clock time associated with this, the start of each period will have an indicator of associated wall clock time or NPT through the UTC-time or asset-time period supplemental properties.
@index [O]	—	Indicate template name of the SIDX file. Representation@id would indicate exact name.
	ANY	
	M ONLY For VoD with SIDX	
@initialization [O]	—	Specifies the template to create the Initialization segment. If file pointed to by the @media does not start with PAT and PMT then the @initialization segment would be required for playback.
	ANY	
	O ONLY For VoD with SIDX	

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	CIF Use	Description
SegmentTimeline:S [1..N]	[1..N]	If there is a segment of a new duration, a new <S> element SHALL be added to the manifest. This new <S> and any subsequent <S> SHALL define a duration via the *d* attribute and optionally a number of repeats via *r*, if needed. For example, "*<S n=”12568909” d="180180" r="7">*" communicates that the first segment has the indicated startNumber at the beginning of the period and is 180180 timescale ticks long. As the timescale is 90000 ticks per second, this results in a 2.002 second long segment. Following this first segment, are seven more segments of exactly the same duration, for a total of eight 2.002 second segments. S elements should be contiguous so gaps and overlaps should be discouraged such that “n” and “t” are predictable. “n” and “t” elements can be repeated if S elements needs to be realigned.
	ANY	
	EXCEPT for VOD with SIDX	
S@t [O]	O Except for First S element = M	Set to the PTS value in the stream. 90 Khz clock should be used for timescale. Uint64 value is to be used in order to handle pts PTS rollover in CIF MPD. Generated client manifests can then indicate rollover by a discontinuity value. The “t” attribute is only mandated for the first S element of the period. It can be repeated in other successive S elements if calculations of the “t” element becomes misaligned due to a discontinuity or gap in timeline.
S@n [O]	O Except for First S element = M	Specifies the segment number sequence that is initialized at the start of the period. Refer to @startNumber field on how to initialize. The “n” attribute is only mandated for the first S element of the period. It can be repeated in other successive S elements if calculations of the “n” element becomes misaligned.
S@d [M]	M	A new DASH segment is created in the appropriate AdaptationSet element for every EBP marker. The duration of the DASH segment is the amount of time between the current and the next EBP marker. • For segment duration patterns, see Section 9.2.3 of SCTE 214-1 [2].
S@r [M]	O Default implies r= 0	A single segment S element occurrence will not require this attribute. When @r is not present, it implies “r=0”
S@var	O NSfCM	A white space separated list of value and have Arg variable address individual strings within that list, such as $Arg[0]$. An essential property is defined to indicate that variable variants are used.

Element or Attribute Name <AdaptationSet> Table 5 in section 5.3.3.2 [8]	CIF Use	Description
Representation [0..N]	[0 .. N]	There is one for every profile. The representation is identified by its bandwidth, width, or height.
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory, F=Fixed. 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 **bold**; attributes are non-bold and preceded with an @, List of elements and attributes is in ***italics bold*** referring to those taken from the Base type that has been extended by this type.		

7.4.2. AdaptationSet- Common Attributes and Elements

This section captures the common attributes and elements for constraints or additions on usage at the AdaptationSet level. CIF AdaptationSet Common level semantics shall be as specified in Table 5.

Table 5 - CIF AdaptationSet Common-Level Semantics

Element or Attribute Name <AdaptationSet- Common> Table 9 in section 5.3.7.2 [8]	CIF Use	Description
Common attributes and elements		
@profiles [O]	__	Not used.
@width [O]	__	Not used.
@height [O]	__	Not used.
@sar [O]	___	See Section 6.3 point 6e of SCTE 214-1 [2].
	M ONLY For Video contentType	
	ANY	
@frameRate [O]	__	Not used.
@audioSamplingRate [O]	___	See Section 6.3 point 10c of SCTE 214-1 [2]. In cases of advanced AAC formats, the audioSamplingRate follows the pre-SBR (AAC core) rate. Note: (as a guideline) The @codecs value can determine if an audio stream is SBR-enabled or not. When the pre-SBR rate is 32, 44.1, 48 KHz, then the SBR sampling rate= pre-SBR sampling rate.
	M ONLY For single component Audio contentType	

Element or Attribute Name <AdaptationSet- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
	ANY	When pre-SBR sampling rate is <32KHz, then SBR sampling rate = 2* pre-SBR sampling rate. This will not hold for ARIB originated audio files. Note: If CIF MPD is intended to be modified for a downstream DASH client player then this attribute needs to be changed to the SBR sampling rate.
@mimeType [M]	M	Specifies the MIME type of the concatenation of the initialization segment, if present, and all consecutive media segments in the representation.[8] "*video/mp2t*" indicates the media is available in MPEG2-TS format. See DASH spec [8]: refer to RFC 6381.
@segmentProfiles [O]	__	Not used.

Element or Attribute Name <AdaptationSet- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
@codecs [O]	M	See Section 6.3 point 2 of SCTE 214-1 [2]. Video: AVC The @codecs attribute indicates that the AdaptationSet element indexes the AVC (H.264) video (“avc1”). The "*4D401F*" token (Main Level 3.1) gives extended information about the level and profile of the H.264 encoding. This SHOULD be the full version of the codec attribute. Note: in stream format, the stream contains SPS/PPS information which allows the packager to pass this information onto segment outputs. HEVC The @codecs attribute indicates that the AdaptationSet element indexes the HEVC (H.265) video (“hev1”-carries SPS/PPS). The “2.4.L123.B0” token (main10, level 4.1, main tier) gives extended information about the level and profile of the HEVC encoding. This SHOULD be the full version of the codecs attribute. MPEG-2 The @codecs attribute indicates that the AdaptationSet Element indexes the MPEG-2 (H.222) video (“mp2v”). The “61” token (main profile) gives extended information about the profile of the MPEG-2 video encoding as described in Annex T of 13818-1[29]. This SHOULD be the full version of the codecs attribute. Audio: See Section 6.3 point 10b of SCTE 214-1 [2]. This SHOULD include granularity to determine the SBR-enabled audio streams. For Muxed: A comma-separated list of the video codec type and then of the audio codec type(s).
@maximumSAPPeriod [O]	__	Not used.
@startWithSAP [O]	M ANY EXCEPT for VOD with SIDX	See Section 6.3 point 4 of SCTE 214-1[2]. This attribute indicates the segment begins with a closed GOP (SAP=1) or the segment beings with an IDR frame (SAP=2). These values indicate a random access point, where the RAP is the first picture in the segment in both decoding and presentation order.
@maxPlayoutRate [O]	__	Not used.
@codingDependency [O]	__	Not used
@scanType [O]	__	Not used.

Element or Attribute Name <AdaptationSet- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
FramePacking [0..N]	—	Not used.
AudioChannelConfiguration [0..N]	—	See SCTE 214-1 [2]: Used for audio media components. Note: MPEG-Audio uses Channel Configuration Table 9 in CICP [32] to define this element. Use schemeIdUri = "urn:mpeg:mpegB:cicp:ChannelConfiguration". Note: Dolby Audio uses Channel Map Locations Table E5 in ETSI TS 102 366 [31] to define this element use schemeIdUri = "urn:mpeg:mpegB:cicp:ChannelConfiguration".
	[1..N] ONLY for audio component contentType	
	ANY	
ContentProtection [0..N]	[0..1] for all Services = NSfCM unless usage of E2E Common Encryption	Used. See Section 7.7.
EssentialProperty [0..N]	[1] Trickmode	Trickmode – see DASH-IF-IOP [17].
	[1] Slate	Identifies use of alternative URL for use in Slates schemeIdUri= "urn:scte:dash:cif-ts:urlAlternative:2018"
	[1] SegmentLossTimeline	Identifies use of SegmentLossTimeline at Representation level schemeIdUri= "urn:scte:dash:cif-ts:SegmentLossTimeline:2018" value= TBA-MVPD e.g. "https://channelxx.slate.scte.org"
	[1] Variants	Identifies use of variable variants for S elements schemeUdUri= "urn:scte:dash:cif-ts:variants:2018"

Element or Attribute Name <AdaptationSet- Common> Table 9 in section 5.3.7.2 [8]	CIF Use	Description
SupplementalProperty [0..N] Specifies supplemental information about the containing element that MAY be used by the CIF client optimizing the processing.	[0..1]	**DRMData** @schemeIdUri= “urn:scte:dash:cif-ts:drmdata:2018” @value = base64 value This supplemental property defines how to encrypt segments and modify MPDs to convert to customer-side adaptive streaming DRM technologies. Multiple occurrences of this supplemental property in the MPD is allowed with values at lower levels taking precedence for that time period. DRMData information is used to inform downstream CIF client devices (*e.g.,* Packagers) how to encrypt segments for further downstream distribution. CIF client devices (*e.g.,* Packagers) MAY need to initially decrypt stored “at rest encrypted” segments while fetching segments in storage before encrypting these segments for DRM-specific customer client player technologies and addressing this in client manifests. The @value is the payload data that needs to be transmitted to the DRM key manager in order to retrieve the necessary keys for encrypting segments. DRMData is supported by an in-line scheme where the payload is embedded as the value in a base64 encoded format [12]. [3] Note: in the ISOBMFF client manifest this information will be put in the ContentProtectection element in the AdaptationSet PSSH box initialization segment. Example: <SupplementalProperty schemeIdUri = "urn:scte:dash:cif-ts:drmdata:2018" value= "Pz48UmVjb3JkaW5nSW5mb1Jlc3VsdCB4bWxuc z0idXJuOmNvbTpjb21jYXN0Om5kdnI6YzMiIHJl Y29yZGluZ0lkPSIxMTExMTExMzY3OTI0MjM2 MDk4IiBUVEw9IjM2MDAiIGFjY291bnRJZD0iMj EwNCI+PFJlY29yZGluZ0luZm8gc3RhdGlvbklkPS I3OTU5MzUwMDY4NzM4ODExMTE3IiBzdHJlY W1JZD0iNzk1OTM1MDA2ODczODgxMTExNyIg cmVjb3JkaW5nQWR6b25lPSIwIi8+PC9SZWNvcm RpbmdJbmZvUmVzdWx0Pg==”/>

[3] In future revisions, an external scheme MAY be developed where the payload needs to be fetched from an external resource as defined in the value attribute.

Element or Attribute Name <AdaptationSet- Common> Table 9 in section 5.3.7.2 [8]	CIF Use	Description
InbandEventStream [0..N]	[0 .. N]	Specifies the presence of an in-band event stream in the associated representations.
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>..<maxOccurs> (N=unbounded) Elements are **bold**; attributes are non-bold and preceded with an @.		

7.4.3. Multiple Video Codecs in AdaptationSets

Video content can be carried with different codecs, but each codec type SHALL be carried in a separate AdaptationSet. Each AdaptationSet SHOULD use the segmentAlignment attribute equal to an integer (preferably "1") when the segments of each codec are bitstream switchable. Each AdaptationSet codec variation can have a role as "main" within the period.

7.4.4. Trickmode Representation AdaptationSet

Trickmodes can be implemented in multiple ways from fetching segments at different speeds, to bringing specific frames from the segment, or maintaining special trickmode representations. This section describes an implementation of the third option of using representations and grouping them into a separate AdaptationSet as described in Section 10.3.2 of SCTE 214-1[2] and in the DASH-IF –IOP [17].

A separate AdaptationSet for trickmode can be created. An *EssentialProperty* is used for trickmode where EssentialProperty@value = AdaptationSet@id will indicate the AdaptationSet to which the trickmode applies.

An "I" frame-only version of the stream ("iframe") can be generated by a trickmode representation.

Trickmode AdaptationSets can be encrypted using the ContentProtection element.

7.5. DASH Representation Element

This section describes representation level related information for use in the CIF MPD. Representation elements determine the range of bitrates, resolution, and quality for the AdaptationSet contentType whether it is video or audio. These representations contained in the AadaptationSets are defined by content encoding profiles. Content encoding profiles are expected to be TBA-MVPD and defined by the provider. A stream label is defined and assigned to each of the representation stream variants found in AdaptationSets.

7.5.1. Representation Elements Semantics

CIF representation level semantics shall be as specified in Table 6.

Table 6- CIF Representation Semantics

Element or Attribute Name <Representation> Table 7 in section 5.3.5.2 [8]	CIF Use	Description
Representation		This element contains a description of a representation.

Element or Attribute Name <Representation> Table 7 in section 5.3.5.2 [8]	**CIF Use**	**Description**
@id [M]	M	See Section 6.5 point 3 of SCTE 214-1 [2]. Note: Representation@id is to be a unique value within the period that contains it . It allows to have dependencies between Representations in different adaptation sets (*i.e.,* this is what the implementation of HI / VI does – the VI track depends on a specific main audio representation [17]). The exception to this is when the representation is functionally identical with another representation in the period. @id attribute is set to contain a string identifier for the representation. Value = **TBA-MVPD**
@bandwidth [M]	M	Bandwidth represents the section of the TS stream being pulled. If you are pulling from a section of a multiplexed TS stream (deprecated), this bandwidth may be greater than the bandwidth of the media segment that SHALL be indicated in the client manifest. The bandwidth of the media segment would be indicated in the SubRepresentation. A SubRepresentation bandwidth to indicate the media component segment bandwidth will not be needed if the representation bandwidth is a close approximation. In the case extraneous PIDs are used, for things such as null byte stuffing, it SHALL be filtered out. The *bandwidth* attribute (in bits per second) describes the bandwidth required to deliver media segments of the representation to the downstream packaging device. This MAY include the overhead of other components in the stream. Note: if two representations are the same bandwidth but differ by resolution in the same AdaptationSet, then the bandwidth value with the higher resolution representation can be larger by the addition of one unit.
@qualityRanking [O]	__	Not used.
@dependencyId [O]	__	Not used.
@associationId [O]	__	Not used.
@associationType [O]	__	Not used.
@mediaStreamStructureId [O]	__	Not used.
CommonAttributesElements	-	Used.
BaseURL [0..1]	__	Not used. Note: This element at this manifest level is reserved for future use.
SegmentBase [0..1]	__	Not used.

Element or Attribute Name <Representation> Table 7 in section 5.3.5.2 [8]	**CIF Use**	**Description**
SegmentList [0..1]	—	Not used.
SubRepresentation [0..N]	— [2..N] ONLY for MUXed Components ANY	Used for multiplexed case.
SegmentTemplate [0..1]	—	Not used.
SegmentLossTimeline	— [0..1] ONLY for Representations with missing segments ANY	Indexes missing segments of a specific representations in an MBR set and identifies a slate through an AlternateURL.
SegmentLossTimeline:S [1..N]	[1..N]	An <S> element is used to indicate missing segments in the specific representation. Subsequent missing S representational elements can be indicated by repeats through the r attributes.
S@t [O]	O	Set to the PTS value in the stream. 90 Khz clock should be used for timescale. Uint64 value is to be used in order to handle pts rollover in CIF MPD. Generated client manifests can then indicate rollover by a discontinuity value. The "t" attribute is only mandated for the first S element of the period. It can be repeated in other successive S elements if prediction of the "t" element becomes misaligned due to a discontinuity or gap in timeline.
S@n [O]	O	Specifies the segment number sequence that is initialized at the start of the period. Refer to @startNumber field on how to initialize. The "n" attribute is only mandated for the first S element of the period. It can be repeated in other successive S elements if prediction of the "n" element becomes misaligned.
S@r [OD]	O Default implies r=0	A single segment S element occurrence will not require this attribute. When @r is not present, it implies "r=0"
S@var[O]	O w/ S@arg NSfCM	Appended to URLs described in the EssentialProperty AlternateURL.

Element or Attribute Name <Representation> Table 7 in section 5.3.5.2 [8]	CIF Use	Description
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>...<maxOccurs> (N=unbounded) Elements are **bold**; attributes are non-bold and preceded with an @, List of elements and attributes is in ***italics bold*** referring to those taken from the Base type that has been extended by this type.		

7.5.2. Representation- Common Attributes and Elements

This section captures the common attributes and elements for constraints or additions on usage at the Representation level. CIF Representation- Common level semantics shall be as specified in Table 7.

Table 7- CIF Representation Common-Level Semantics

Element or Attribute Name <Representation- Common> Table 9 in section 5.3.7.2 [8]	CIF Use	Description
Common attributes and elements		
@profiles [O]	__	Not used.
@width [O]	___ M For Video ContentType ANY	See Section 6.5 point 2a of SCTE 214-1 [2].
@height [O]	___ M For Video ContentType ANY	See Section 6.5 point 2b of SCTE 214-1 [2]: Video – set to reflect the height resolution of the representation.
@sar [O]	__	See Section 6.3 point 6e of SCTE 214-1 [2].
@frameRate [O]	___ M For Video ContentType ANY	Gives the frame rate of the content, in this case: 30,000/1001 fps, 30 fps, 60,000/1001 fps, 60 fps [15]. To express framerate values use Table 13 in SCTE 215-1 [15].
@audioSamplingRate [O]	__	Not used – see SCTE 214-1 [2].
@mimeType [M]	__	Not used.
@segmentProfiles [O]	__	Not used.
@codecs [O]	M	See Section 6.5 point 2d of SCTE 214-1 [2]. For muxed: A comma-separated list of video codec type, and then audio codec type.
@maximumSAPPeriod [O]	__	Not used.
@startWithSAP [O]	__	Not used.

Element or Attribute Name <Representation- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
@maxPlayoutRate [O]	__	Not used.
@codingDependency [O]	__	For Trickmode representations, if codingDependency is "false" this indicates the representation is bi-directional. Mandatory at representation level for trickmode AdaptationSet. Note: Simple IDR tracks are bi-directional. Tracks with a more complex GOP structure may not be so.
	M For Video ContentType for Trickmode AdaptationSets	
	ANY	
@scanType [O]	__	Not used.
FramePacking [0..N]	__	Not used.
AudioChannelConfiguration [0..N]	__	Not used See Section 6.5 point 1a of SCTE 214-1 [2].
ContentProtection [0..N]	__	Not used- See Section 6.5 point 5 of SCTE 214-1 [2].
EssentialProperty [0..N]	__	Not used.
SupplementalProperty [0..N] Specifies supplemental information about the containing element that MAY be used by the CIF client optimizing the processing.	__	AVC contentType- **avc-sps**, **avc-pps** @value= unformatted string @schemeIdUri=urn:scte:dash:cif-ts:avc-sps:2018 @schemeIdUri=urn:scte:dash:cif-ts:avc-pps:2018 -or- HEVC contentType- **hevc-sps**, **hevc-pps** @value=unformatted string @schemeIdUri=urn:scte:dash:cif-ts:hevc-sps:2018 @schemeIdUri=urn:scte:dash:cif-ts:hevc-pps:2018 Two-digit zero-padded decimal sps_id, followed by "=", followed by base64-coded SPS RBSP. Note: This information may be needed because of restrictions on end client player adaptive streaming technologies being used.
	[1] For Video ContentType	
	ANY	
	__	**StreamFormatLabel** @value=unformatted string @schemeIdUri=urn:scte:dash:cif-ts:streamFormatLabel:2018
	[1] for single media components	
	ANY	

Element or Attribute Name <Representation- Common> Table 9 in section 5.3.7.2 [8]	CIF Use	Description
	[0 ..1]	**VBVBuffer** @value=space separated key-value pairs @schemeIdUri= “urn:scte:dash:cif-ts:vbvbuffer:2018” used for QAM Mux reconstruction - size = bytes - maxbitrate = bits/ sec taken from maximum Bitrate descriptor in ATS stream. e.g. VBV of 2Mbytes <SupplementalProperty schemeIdUri= “urn:scte:dash:cif-ts:vbvbuffer:2018” value=”size=2000000 maxbitrate=8000000”/>
InbandEventStream [0..N]	___	Not used.

*The 'Use' column in the Table SHALL be interpreted to mean that an attribute marked with 'M' SHALL be available for a Representation, i.e. it SHALL either be present in the **Representation** element, or if not, it SHALL be in the containing **AdaptationSet** element. An attribute marked with 'O' MAY be absent in both.

7.6. DASH SubRepresentation Element

This section describes SubRepresentation level related information for use in the CIF MPD. This is an optional element that can describe a single media component if needed. It SHALL be used to describe the audio auxiliary media components for the muxed case. The bandwidth of the audio can be determined though the subRepresentation@bandwidth attribute. Other media components in the multiplexed case have the option to also be described.

7.6.1. SubRepresentation Elements Semantics

CIF SubRepresentation level semantics shall be as specified in Table 8.

Table 8 - CIF SubRepresentation Semantics

Element or Attribute Name <SubRepresentation> Table 8 in section 5.3.6.2 [8]	**CIF Use**	**Description**
SubRepresentation	— M For MUXed Components ANY	Specifies a subrepresentation.
@level [O]	—	Not used.
@dependencyLevel [O]	—	Not used.
@bandwidth [O]	— M For MUXed Components ANY	Identical to the @bandwidth definition in representation, but applied to this subrepresentation.
@contentComponent [O]	— M For MUXed Components ANY	Lists the ContentComponent@id (aka the PID value) of the specific media content component in the muxed case. e.g., contentComponent="101"
CommonAttributesElements		Common attributes and elements (attributes and elements from base type ***RepresentationBaseType***). For details see Section 5.3.7.
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>…<maxOccurs> (N=unbounded) Elements are **bold**; attributes are non-bold preceded with an @, List of elements and attributes is in ***italics bold*** referring to those taken from the Base type that has been extended by this type.		

7.6.2. SubRepresentation- Common Attributes and Elements

CIF SubRepresentation-Common level semantics shall be as specified in Table 9.

Table 9 - CIF SubRepresentation Common Attributes & Elements Semantics

Element or Attribute Name <SubRepresentation- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
Common attributes and elements	— M For MUXed Components ANY	
@profiles [O]	—	Not used.

Element or Attribute Name <SubRepresentation- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
@width [O]	__	Not used.
@height [O]	__	Not used.
@sar [O]	__	Not used.
@frameRate [O]	__	Not used.
@audioSamplingRate [M]	___	See Section 6.3 point 10a SCTE 214-1 [2]: Used for audio media content components in the audio subrepresentation of a muxed component. In cases of advanced AAC formats, the audioSamplingRate follows the pre-SBR (AAC core) rate. Note: (as a guideline) The @codecs value can determine if an audio stream is SBR-enabled or not. When the pre-SBR rate is 32, 44.1, 48 KHz, then the SBR sampling rate= pre-SBR sampling rate. When pre-SBR sampling rate is <32KHz, then SBR sampling rate = 2* pre-SBR sampling rate. This will not hold for ARIB originated audio files. Note: If CIF MPD is intended to be modified for a downstream DASH client player then this attribute needs to be changed to the SBR sampling rate.
	M For Audio ContentTypes in a MUX	
	ANY	
@mimeType [M]	__	Not used.
@segmentProfiles [O]	__	Not used.
@codecs [O]	M	Video: See Section 6.5 point 2d of SCTE 214-1 [2]. Audio: See Section 6.3 point 10b of SCTE 214-1 [2]: applied to the audio subrepresentation of the muxed component.

Element or Attribute Name <SubRepresentation- Common> Table 9 in section 5.3.7.2 [8]	**CIF Use**	**Description**
@maximumSAPPeriod [O]	__	Not used.
@startWithSAP [O]	__	Not used
@maxPlayoutRate [O]	__	Not used.
@codingDependency [O]	__	Not Used
@scanType [O]	__	Not used.
FramePacking [0..N]	__	Not used.
AudioChannelConfiguration [0..N]	__ [1] for each Audio ContentType in the MUX ANY	See SCTE 214-1 [2]: Used for audio media components of an audio subrepresentaion of a muxed component. Note: MPEG-Audio uses Channel Configuration Table 9 in CICP [32]. Use schemeIdUri = "urn:mpeg:mpegB:cicp:ChannelConfiguration" Dolby Audio uses Channel Map Locations Table E5 in ETSI TS 102 366 [31]. Use schemeIdUri = "urn:mpeg:mpegB:cicp:ChannelConfiguration"
ContentProtection [0..N]	__	Not used.
EssentialProperty [0..N]	__	Not used.
SupplementalProperty [0..N] Specifies supplemental information about the containing element that MAY be used by the CIF client optimizing the processing.	__ [1] for all Mux Components ANY	**StreamFormatLabel** @value=unformatted string @schemeIdUri= urn:scte:dash:cif-ts:streamFormatLabel:2018
InbandEventStream [0..N]	—	Specifies the presence of an in-band event stream in the associated Representations.

Legend:
For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory.
For elements: <minOccurs>..<maxOccurs> (N=unbounded)
Elements are **bold**; attributes are non-bold and preceded with an @.

7.7. ContentProtection

The ContentProtection element provides information on encrypted media segments to the CIF Client device [11]. This ContentProtection information can be passed onto other devices to generate keys used to decrypt these media segments. The CIF Client can then decrypt the Media segment and reencrypt the media segments using DRMdata for client player devices. ContentProtection semantics shall be as specified in Table 10.

Table 10 - ContentProtection

Element or Attribute Name **<ContentProtection>** **Table 1-6 in section 5.1 [11]**	**CIF Use**	**Description**
ContentProtection	M Storage	This element covers how to decrypt stored segments that are being fetched by the CIF client device (*e.g.,* packagers) using the CIF MPD. Each segment of the asset is encrypted by the asset origination system upon ingest of the content. The asset origination system passes the asset identifier to the CKM and receives back the parameters needed (cipherKey, cipherKeyID) and generates the initialization vector needed to encrypt each segment of the asset as it is stored. The ContentProtection element and its attributes are then listed in the CIF MPD. The CIF client (*e.g.,* the Packager) uses the ContentProtection element in the CIF MPD to retrieve the cipherKey from the CKM which is necessary to retrieve the Asset and decrypt the asset. This element exists at the AdaptationSet level or below.
@schemeIdUri [M]	M	"urn:mpeg:dash:sea:2013" [11]
sea:SegmentEncryption [1]	[1]	Name of this asset to present to CKM for decryption; defaults to MPD@id.
@schemeIdUri [M]	M	"urn:mpeg:dash:sea:aes128-cbc:2013" [11]
@keylength [OD]	__	Not used.
@ivlength [OD]	__	Not used.
@authTagLength [OD]	__	Not used.
@earlyAvailability [OD]	__	Not used.
@livEncryptionFlag [OD]	__	Not used.
sea:License [0..N]	__	Not used.
@keySystemUri [M]	__	Not used.
@keyLicenseUrlTemplate [O]	__	Not used.
sea:CryptoPeriod [0..N]	[1]	Initialization vector expressed as hexadecimal bytes. Defaults to all zeros. Format of this can change depending on the underlying encryption/CKM software. Today it is 128 bits (16 bytes).

Element or Attribute Name **<ContentProtection>** **Table 1-6 in section 5.1 [11]**	**CIF Use**	**Description**
@startOffset [OD]	__	Not used.
@IV [O]	M	Used.
@aad [O]	__	Not used.
@numSegments [O]	__	Not used.
@keyUriTemplate [M]	M	Specifies the template for key URI generation, using same syntax and variable substitution as defined in ISO/IEC 23009-1:2014, 5.3.9.4.4.[8] In the CIF specification, variable substitution shall not be used, and the URI shall either be a tag URI (RFC 4151 [30]) with a tagging authority for a key system (e.g. at-rest.scte.com), or an HTTP(S) URL. The host Url URL can be stripped and the uri URI can be reconstructed and appended with the extracted information for DRM key ID and CKMmetadata/Token.
@ivUriTemplate [O]	__	Not used.
sea:CryptoTimeline [0..N]	__	Not used.
@numCryptoPeriods [O]	__	Not used.
@firstStartOffset [OD]	__	Not used.
@ivBase [OD]	__	Not used.
@aadBase [OD]	__	Not used.
@numSegments [O]	__	Not used.
@ivUriTemplate [O]	__	Not used.

Extracted example of a ContentProtection element from a sample MPD:


```
<ContentProtection schemeIdUri="urn:mpeg:dash:sea:2013">
    <segmentEncryption schemeIdUri="urn:mpeg:dash:sea:aes128-cbc:2013">
        <cryptoPeriod IV="0a0b0c0d0e0f00010203040506070809" keyUriTemplate=
"tag:rest.scte.com,2016:ckm/clk/drm/none/drmkid/ae93294d-ef38-b174-16dd-
87578dad9d30/ckmmetadata/QjCCAQcMATIXDTE2MTAyMDE3NDQwNVoMATQEEMcvnL90arJei
kFVw1XjsnIMATUEFDZuLwBxH59GyuLjvhDLfZWALtxyDAE2BIGsMIGpDApja206cG9saWN5DA
VjYXJ2MQwMY2ttOnBvbGljeUlkDAVjYXJ2MqwKY29udGVudDppZAwULWt1eTdpd245ZGFmN29
0dHJxci0MCWRybTprZXlJZAwkYWU5MzI5NGQtZWYzOC1iMTc0LTE2ZGQtODc1NzhkYWQ5ZD
MwDBpjb250ZW50OmtleURlcml2YXRpb25LZXlJZAwQY2ttLWNrZGstdDAxLTAwMwwBNwwQY
2ttLW1kbWstdDAxLTAxNA&#xA"></cryptoPeriod>
        </ContentProtection>
```

7.8. Ad Insertion/ESAM Events

ANSI/SCTE 35 (2017) provides a robust stream-signaling infrastructure. Reasons for signals include advertising opportunities, blackouts, program boundaries, chapter boundaries, and in-band channel identification, which are captured in segmentation_type_id in Table 22 of SCTE 35 [13]. CIF packagers convert SCTE 35 stream signals information into periods, events, elements and attributes in the MPD. Except for "0x00 not indicated" and "0x01 content identification," all splice_command_type value 0x05 and 0x06 time signals result in a new period.

For a description of a SCTE 35 signaling workflow between transcoders, and packagers, refer to the SCTE signaling workflow description in Appendix D.

> Note: Many SCTE 35 signals come in Start/End pairs, for example program, chapter, or ad boundaries. A component restart or other timed workflow may cause components to join a CIF stream between the start and end of an SCTE-35 signal.
>
> In this case, the component would need to know that it's in the middle of a signal. For example, if the signal marks boundaries of a blackout region of the stream, a downstream JIT packager or manifest manipulator would need to know that the content may (or not) be viewable. Often, the ATS stream will include a content identifier with the segment to inform components if they are in the middle of a start/end sequence. This may be sourced from a content provider who inserts a periodic SCTE 35 tag of "0x01 content identification" segmentation_type_id in the source stream.
>
> In the MPD, a different mechanism is used to maintain such state information: all preceding SCTE 35 signals that are in a start state are carried in MPDs through an MPD event stream until the end signal arrives, at which point the start signal is dropped.

7.8.1. Conversion of SCTE 35 Signals and Payloads to the CIF MPD

When SCTE 35 signals arrive in the stream prior to the splice point, CIF servers generate new period elements in an MPD based on the arrival time of signals in the stream. Prior to a signal, the MPD contains periods numbered 1 to N. The receipt of a signal causes the MPD to have an additional "empty" period element N+1 added after period N. Periods 1 to N contain the AdaptationSet, SegmentTimeline, Representation, and S elements that occurred prior to the signal. Period N+1 contains the EventStream and event elements carried by the signal. The event element contains the base-64 encoding of:

- All preceding SCTE 35 signal event information that are still in an open state, if they are known.
- The new signal payload from the immediate SCTE 35 signal that arrived.

As the live point of the video progresses, S elements whose sequence numbers come before the splice_time of the SCTE 35 appear inside period N (see Figure 6). S elements whose sequence number come at or after the splice_time appear inside period N+1 along with the EventStream and event that contains the relevant SCTE 35 signal. Although the period N+1 was initially created with only the EventStream information, it becomes populated with segment information when the described splice insert time has been reached. Once the EventStream information is created for period N+1, it then becomes a permanent part of that period for purposes of stored or VoD applications. In the case of VoD, the CIF MPD MAY generate period elements with an empty duration that do not contain video segments. This indicates an empty "splice point" period in between the periods with video content*. The empty period indicates a region that later could be populated with advertisements.

*This maintains a similar period structure as with ad-insertion processes in linear services.

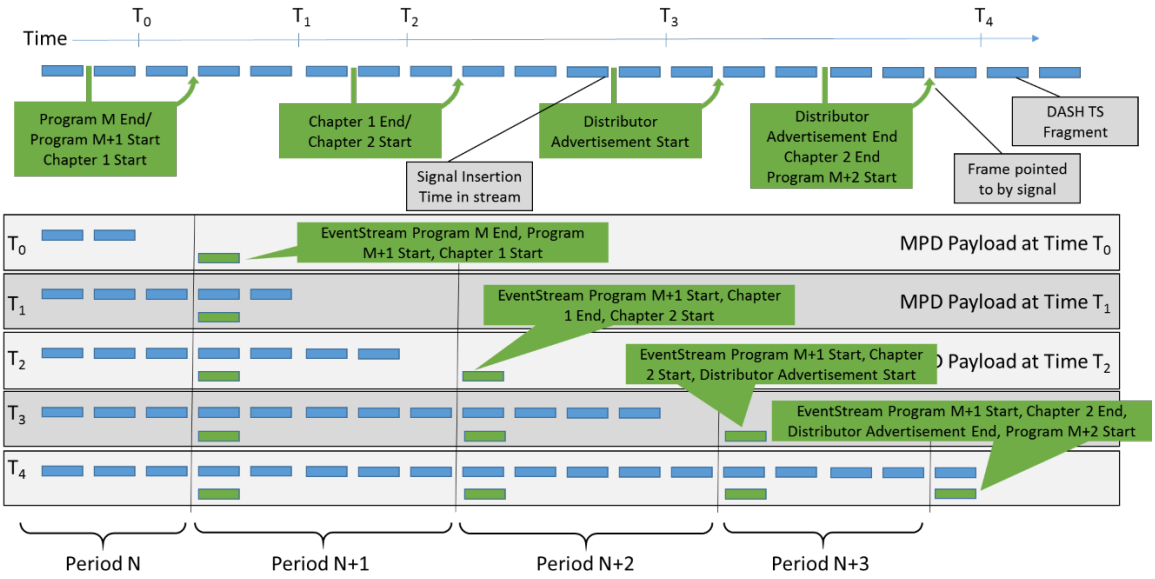


Figure 6 - SCTE 35 Signal Insertion and Open Events Across Successive Periods

7.8.2. Conversion of SCTE 35 Information into an Eventstream Element

The SCTE 35 splice_info payload is embedded as a binary base64 value of an event element as part of an event stream [12]. The tables below describe the EventStream and event element structures. Note that period can contain multiple EventStream elements. EventStream semantics for SCTE 35 information shall be as specified in Table 11.

Table 11 - SCTE35 EventStream Element

Element or Attribute Name	CIF Use	Description
EventStream		Contains event elements
@xlink:href [O]	__	Not used.
@xlink:actuate [OD]	__	Not used.
@schemeIdUri [M]	M	Identifies the message scheme using a URN; events coming from SCTE 35 signals SHALL coalesce under a single EventStream using schemeIdUri= "urn:scte:scte35:2014:xml+bin".
@value [O]	M	EventStreams generated from SCTE 35 signals SHALL have value="scte35".
@timescale [O]	M	EventStreams from SCTE 35 signals SHALL use timescale="90000".
Event [0..N]	[0 .. N]	Events in event streams SHALL be ordered such that their presentation time is non-decreasing.
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>..<maxOccurs> (N=unbounded) Elements are bold; attributes are non-bold and preceded with an @.		

Event semantics for SCTE 35 information shall be specified in Table 12. Events not closed out in the previous period is to be carried over and appended to the current period's EventStream.

Table 12- SCTE35 Event Element

Element or Attribute Name	CIF Use	Description
Event		Each event is generated from a single SCTE 35 signal. Its element content has type xs:string and contains the base 64 [12] encoding of the splice_info_section of the SCTE 35 [12].
@id [O]	O	Specifies an identifier for this instance of the event. Events with equivalent content and attribute values in the event element SHALL have the same value for this attribute. The scope of the @id for each event is with the same @schemeIdUri and @value pair. Note that @id has type xs:unsignedInt.
@presentationTime [OD]	OD	Specifies the presentation time of the event relative to the start of the period. The value of the presentation time in seconds is the division of the value of this attribute and the value of the @timescale attribute. If not present, the value of the presentation time is 0.
@messageData [O]	__	Not used. Note: This attribute is not in use since content is being carried.

Element or Attribute Name	CIF Use	Description
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>..<maxOccurs> (N=unbounded) Elements are bold; attributes are non-bold and preceded with an @.		

The following code shows an EventStream Template with a single event element and a second event element carried from the previous period.

```
<EventStream schemeIdUri="urn:scte:scte35:2014:xml+bin" value="scte35" timescale="90000">
  <Event id="1001" presentationTime="0" >
    <scte35:signal>
      <scte35:binary>
        /DBMAAAABvK8AP/wBQaBILyqewA2AjRDVUVJQUJDRH//AAApMuAJIFJreGFiVlZP
YUVWRlpVc3phMmRDVVZablJVRm1aejA5NAAA3PStoQ==
      </scte35:binary>
    </scte35:signal>
  </Event>
  <Event id="1002" presentationTime="0" >
    <scte35:signal>
      <scte35:binary>
        /DBMAAAABvK8AP/wBQaBILyqewA2AjRDVUVJQUJDRH//AAApMuAJIFJreGFiVlZP
YUVWRlpVc3phMmRDVVZablJVRm1aejA5NAAAE4569m==
      </scte35:binary>
    </scte35:signal>
  </Event>
</EventStream>
```

7.9. Description of Identifier Elements and Descriptors

This section describes some additional usage details that need more description for the structure of the identifier elements or element descriptors used in the CIF MPD.

7.9.1. Program information (MPD Level)

See SCTE 214-1 [2]: In this implementation, the ProgramInformation element will carry UPIDs at the period level with the @type/@value attributes being used for the @lang/@moreInformationURL. Use of a UPID MID is discouraged since multiple contentIdentifiers elements can be used.

Table 13- Program Information Semantics

Element or Attribute Name	Use	Description
ProgramInformation [UPID]		Represents a textual value.
@lang [@type]	[1]	Type corresponding to SCTE 35 UPID type as specified in Table 21 in SCTE 35 [13]. The value of this attribute SHALL be same as the value of segmentation_upid() (i.e., 3rd column of the table). MID SHALL NOT be used – the structure SHALL be translated into multiple UPID elements.

Element or Attribute Name	Use	Description
@moreInformationURL [@value]	[1]	Textual representation of the UPID value. It SHALL correspond to the description in the Description column (i.e., 4th column) of Table 21 in SCTE 35 [13]. In case of the UPID contains binary encoding (e.g., EIDR and ISAN), a full textual representation as specified by the applicable standard SHALL be used. [Note: to be replaced with reference to SCTE 35 XML schema when possible]
Legend: For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory. For elements: <minOccurs>...<maxOccurs> (N=unbounded) Elements are **bold**; attributes are non-bold and preceded with an @.		

7.9.2. Role Descriptor

A DASH role descriptor can be added to an AdaptationSet element to further describe an AdaptationSet that contains a media component type to which this role is associated. The URN "urn:mpeg:dash:role:2011" is defined to identify the role scheme defined in Table 14.

Table 14- Role Descriptor Details

Role@value	Description
caption	Used if present in the video component AdaptationSet
subtitle	Used if present in video component AdaptationSet.
main	Used to indicate the default of the media component type AdaptationSet (*i.e.,* Video, Audio) in the period. In all cases, the audio "main" role descriptor SHALL be explicitly indicated. In rare circumstances if no audio "main" role descriptor is explicitly indicated, then the lowest common audio PID in the AdaptationSet is assumed to be the "main" audio.
alternate	Used for full service tracks such as the visually impaired complete track.
supplementary	Not used.
commentary	Used.
dub	Used to indicate dubbed languages.
descriptions	Used for VI tracks
sign	Not used.
metadata	Not used.
enhanced-audio-intelligibility	Used for HI.

NOTES

1) A normal audio/video program labels both the primary audio and video as "main". However, when the two media component types are not equally important, for example (a) video providing a pleasant visual experience to accompany a music track that is the primary content or (b) ambient audio accompanying a video showing a live scene such as a sports event, that is the primary content, the accompanying media may be assigned a "supplementary" role.
2) Alternate media content components SHOULD carry other descriptors to indicate in what way it differs from the main media content components (*e.g.,* a Viewpoint descriptor or a Role descriptor), especially when multiple alternate media content components, including multiple supplementary media content components, are available.
3) Open ("burned in") captions or subtitles would be marked as media type component "video" only, but would having a descriptor saying "caption" or "subtitle".
4) Role descriptors with values such as "subtitle", "caption", "description", "sign" or "metadata" may be used to enable assignment of a "kind" value in HTML5 applications for tracks exposed from a DASH MPD.

7.10. Timing Elements and Attributes in Services

7.10.1. Linear

The CIF MPD of a linear segmented channel provides access only to a limited amount of time of the channel (typically about ½ hour of content of the linear channel). Players that want to access content from the linear channel in the past that is beyond this segment of time will need to have access to recorded cDVR assets from that linear channel. As current segments are added to the manifest or segments are dropped off of the manifest, the player sees these changes as manifests are updated or as a manifest template structure is used. The linear case is known to have a rolling window, where the first segment and current segment available is changing in relation to the availabilityStartTime and presentationTimeOffset.

The linear case is more complex than the cDVR or VoD case since the manifest is dynamically changing. To better understand the dynamics on the linear case, the example below is used to calculate the segment availability time. To begin, the following definitions for the examples are described:

- **Packager Time:** this is the clock time on the linear packager. For simplicity, the example starts the clock at zero.
- **MPD@publishTime:** This is when the manifest is published and is slightly later than the packager time
- **MPD@availabilityStartTime**: This is the availabilityStartTime of the manifest (aka the left edge). During an MPD update, the AvailabilityStartTime could be shifted to the most recent period once the old period rolls off. For the Cloud2Ground case, the availabilityStartTime of the manifest (aka the left edge) can remain fixed and set to POST EPOCH time and not shift.
- **Period@start:** This is the time of the start of the period from the availabilityStartTime (aka Left edge). The period at the left edge has Period@start = 0 unless the availabilityStartTime is set to EPOCH and in this case the Period@start is set to UTC of the first segment of the period. If a second period exists in the manifest then it's Period@start is also the time duration measured from the AvailabilityStartTime and NOT the measured duration from the previous period. For the Cloud2ground case where the AvailabilityStartTime is set to POST EPOCH, the period@start of any period is always the UTC of the first segment in the period.
- **Segment AvailabilityStartTime:** this is when a specific segment is available. This needs to include the time that the segment first appears plus the duration of the segment itself since the segment needs to be complete to be available. Note that all times are relative to the manifest availabilityStartTime. The time of the first appearance of the segment is the Time duration of S@t from the manifest availabilityStartTime. If S@t is marked as a PTS time, then the difference of S@t and the pts time of the first segment of the manifest which is marked down as the presentationTimeOffset. To simplify the example, S@t is not represented in pts time.

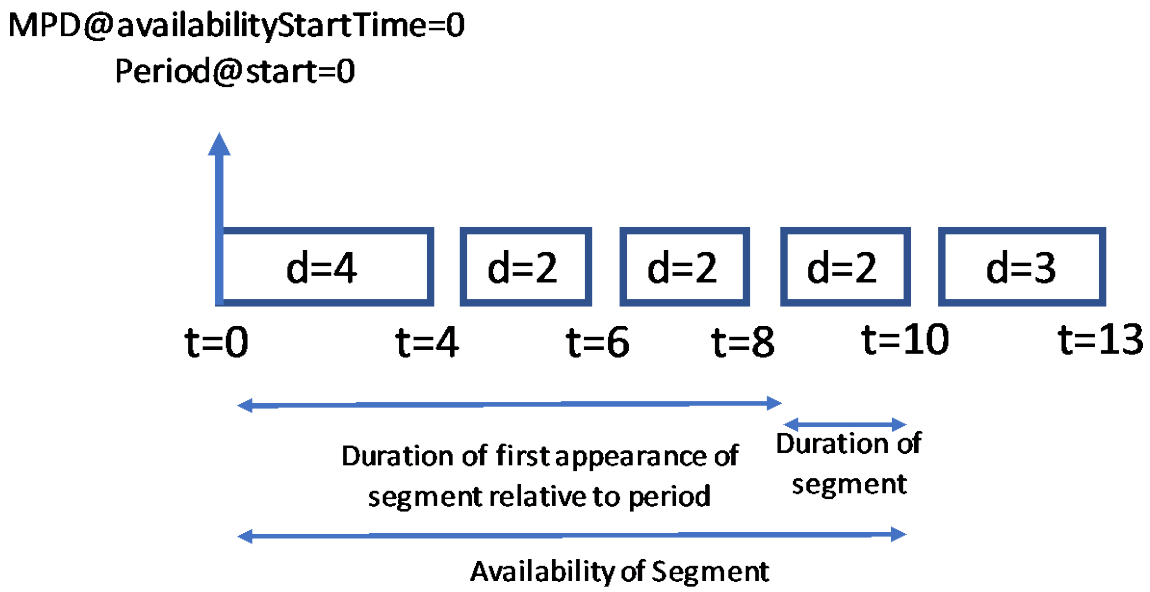


Figure 7 - Example of Segment AvailabilityStarttime Calculation(Cloud2Ground Case)

Table 15 - Example of Calculation of Segment Availability Time

Packager Time	MPD@AST-availability Start Time	Period@Start	S@t (really pts of the segment)	S@d	PresentationTimeOffset (really pts of first segment in the period)	S-AT- segment availabilty time
0	POST EPOCH	$UTC_{first\ seg}$	0	4	0	$UTC_{first\ seg} + 4$
4	POST EPOCH	$UTC_{first\ seg}$	4	2	0	$UTC_{first\ seg} + 6$
6	POST EPOCH	$UTC_{first\ seg}$	6	2	0	$UTC_{first\ seg} + 8$
8	POST EPOCH	$UTC_{first\ seg}$	8	2	0	$UTC_{first\ seg} + 10$
10	POST EPOCH	$UTC_{first\ seg}$	10	3	0	$UTC_{first\ seg} + 13$

The generalized equation to determine the segment Availability Time is described below:

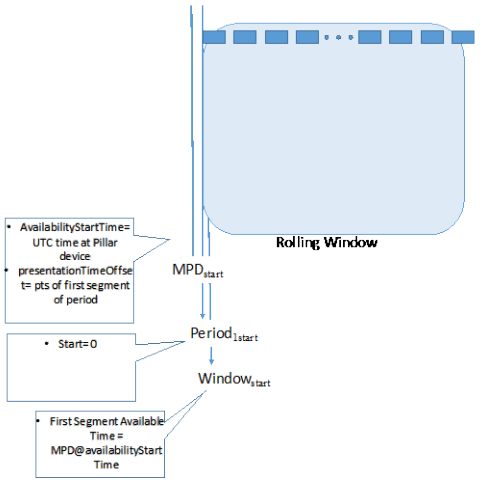
$$Availability\ Time_{seg(i)} = MPD@availabilityStartTime + Period@start_{current\text{-}period} + (S@t_{seg(i)} - presentationTimeOffset_{current\text{-}period}) + SD_{seg\text{-}duration}$$

Equation 1 - Calculation of Availability Time of current segment (latest segment on the rolling window)

Note that EBP time is still needed to align the Manifest with virtual segments in the linear stream, this is done through a Period supplemental property called “utc-time” which is used to indicate the EBP time at the beginning of the period. All segment EBP times can be determined from the calculated duration time relative to the start of the current period to the beginning of indicated segment and adding this to the utc time described in the supplemental property for the current period.

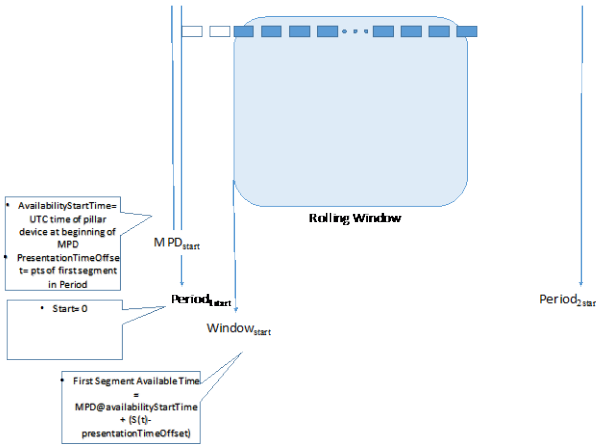
Figure 8 encampasses the first five diagarams illustrated below. In cases 1-3 in Figure 8 where the first period is still within the rolling window, the presentationTimeOffset is assigned as the PTS of the first segment of the period and is used to calculate duration of first available segment from the current period. This is needed since S@t is based on PTS time and a duration needs to be calculated. As the rolling window moves across a period boundary, the availabilityStartTime and presentationTimeOffset will change to the Successive Period settings as soon as the first available segment rolls into the successive period (Figure 9). In cases 1-3 in Figure 10, this covers the Cloud2ground case where the availabilityStartTime (aka “the left edge”) remains fixed.

Linear- Case 1



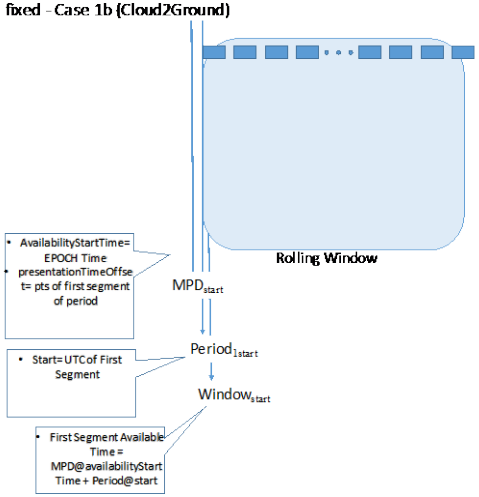
First Segment Available Time = AvailabilityStartTime + Period@Start+ (S@t-presentationTimeOffset)

Linear- Case 2



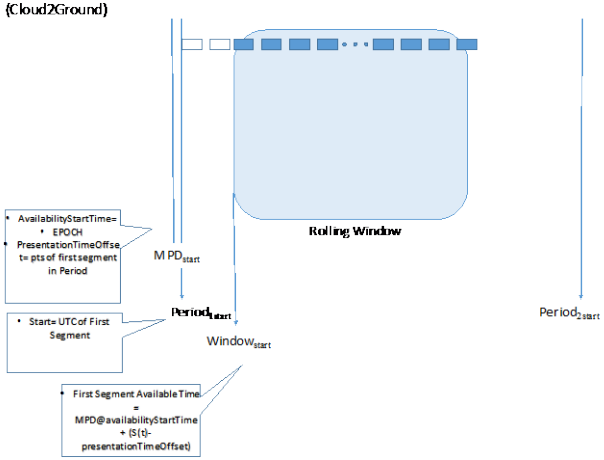
First Segment Available Time = AvailabilityStartTime + Period@Start+ (S@t- presentationTimeOffset)

Linear/ AvailabilityStartTime fixed – Case 1b (Cloud2Ground)



First Segment Available Time = AvailabilityStartTime + Period@start+ (S@t-presentationTimeOffset)

Linear- Case 2b (Cloud2Ground)



First Segment Available Time = AvailabilityStartTime + Period@Start+ (S@t- presentationTimeOffset)

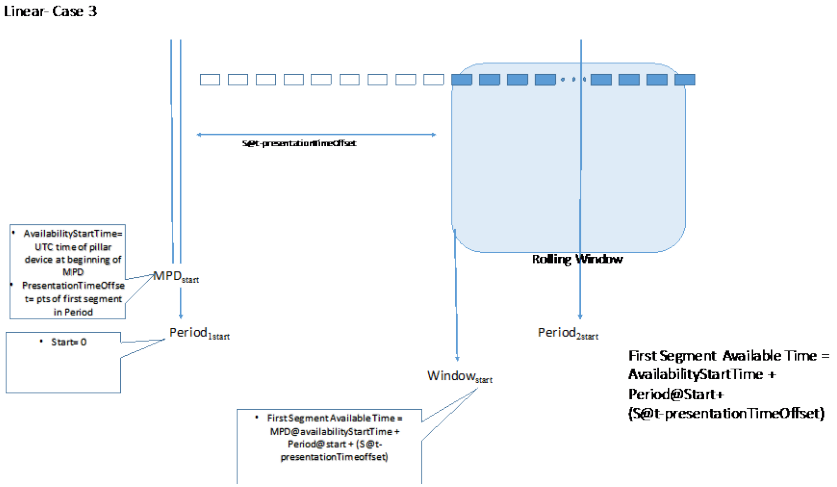


Figure 8 - Calculation of first available segment in MPD as rolling window moves across a period into successive period

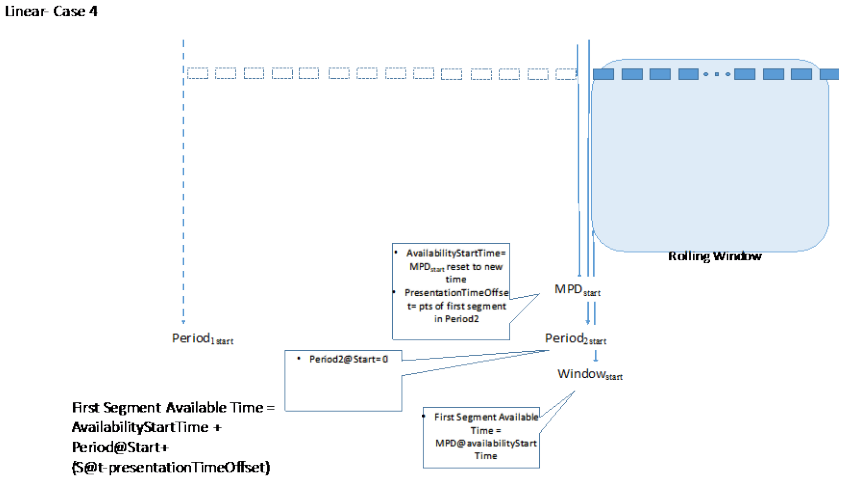


Figure 9 - Calculation of first available segment in Manifest as rolling window completely moves into successive period

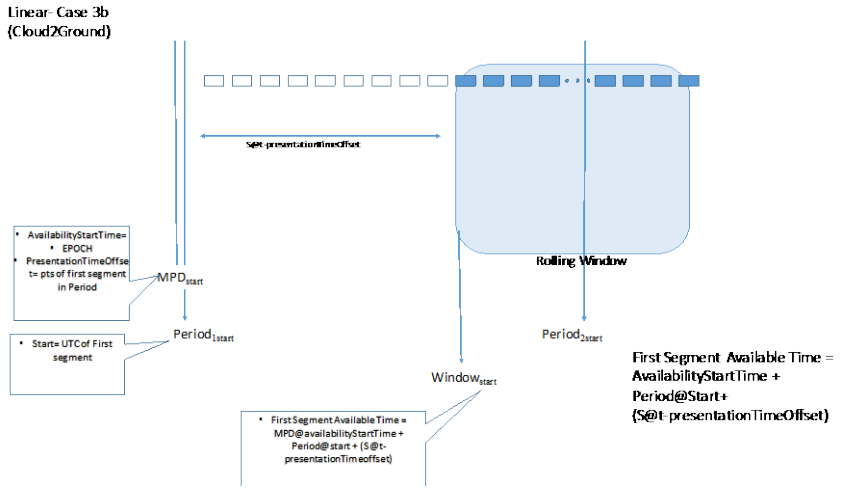


Figure 10 - Calculation of first available segment in MPD as rolling window moves across a period into successive period with fixed left edge

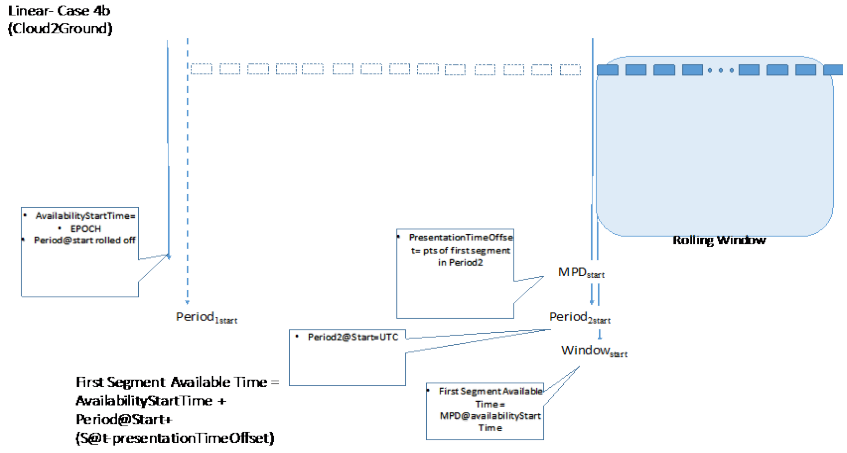


Figure 11 - Calculation of first available segment in Manifest as rolling window completely moves into successive period with fixed left edge

7.10.2. Predictive Template MPD Approach for Linear

This is an alternative approach to describing a linear service CIF MPD. It predictively determines the availability time of a future segment as a function of the sequence number. This future predictiveness can be done within a certain tolerance if it follows the +/- 50% length and slip rules as described in section 9.3.2 Segments of SCTE 214-1[2]. If the rolling window segment availability is known, then then the first retrievability segment availability is known by a predictive calculation from a known Segment Time and its sequence number. The benefits of using a template manifest is that a very short manifest can be used to describe the linear service.

$$Availability\ Time_{seg(i)} = MPD@availabilityStartTime_{current\text{-}period} + Period@start_{current\text{-}period} + [(S@n_{seg(i)} - S@n_{first\text{-}segment\text{-}of\text{-}perod} + 1)*SD_{reg\text{-}seg\text{-}duration}]]$$

Equation 2 - Calculation of Availability Time of segment in a linear service using predictive approach

7.10.3. CDVR – Hot Recording

The CIF MPD of a cDVR hot recording of a linear channel differs from the CIF MPD of a linear channel because the first available segment of the start of the recording does not drop off like it will in a linear CIF MPD. The CIF MPD simply grows as the recording gets longer until the recording is completed. The player sees the growth in the CIF MPD through MPD updates.

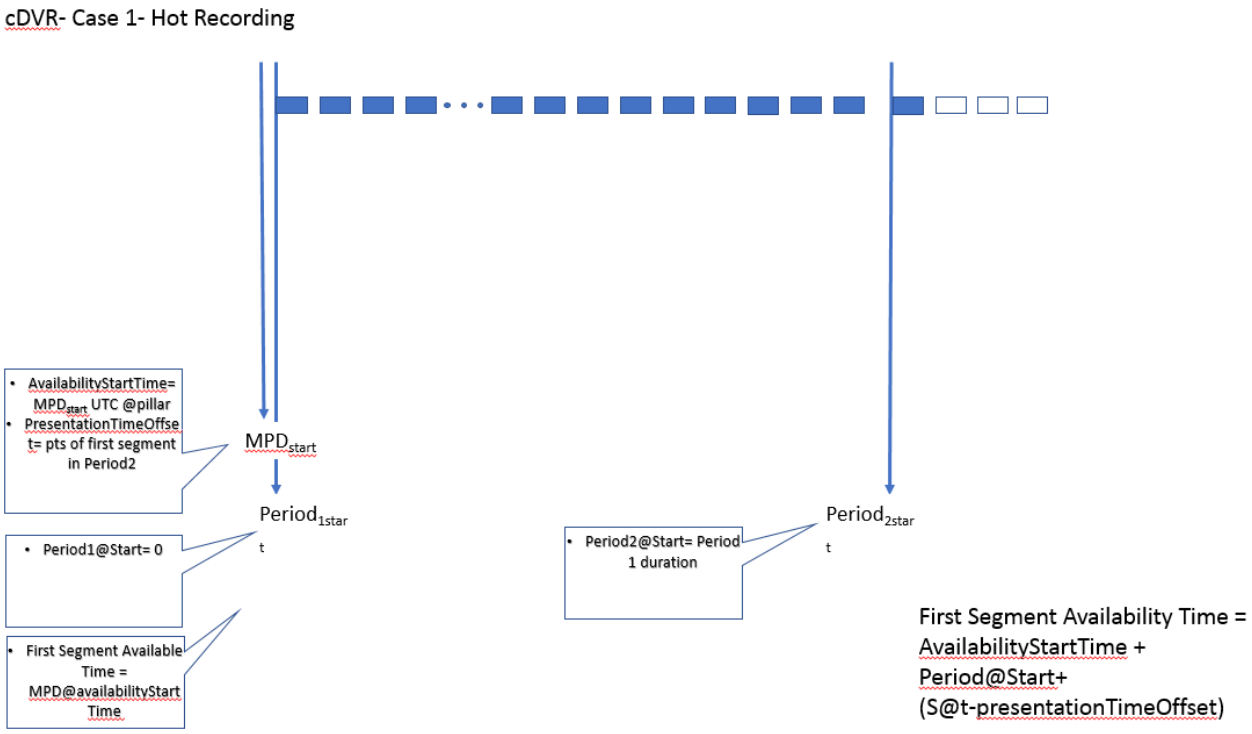


Figure 12 - Calculation of Current Segment Availability as a Recorded Manifest Grows

7.10.4. VOD & CDVR – Complete Assets

The CIF MPD of a cDVR cold recording of a linear channel differs from the CIF MPD of a linear channel because the first available segment of the start of the recording does not drop off like it will in a linear CIF MPD. Since the recording is complete, the manifest needs to be only fetched once by the JITP and updates are unnecessary. For cDVR, the availabilityStartTime may be available since it is coming from a linear channel and may be the completion of a hot recording. This slightly differs from a VoD service where the CIF MPD needs to be fetched by the packager since the asset is also complete. But the availabilityStartTime is not known because it has never been assigned to a static asset.

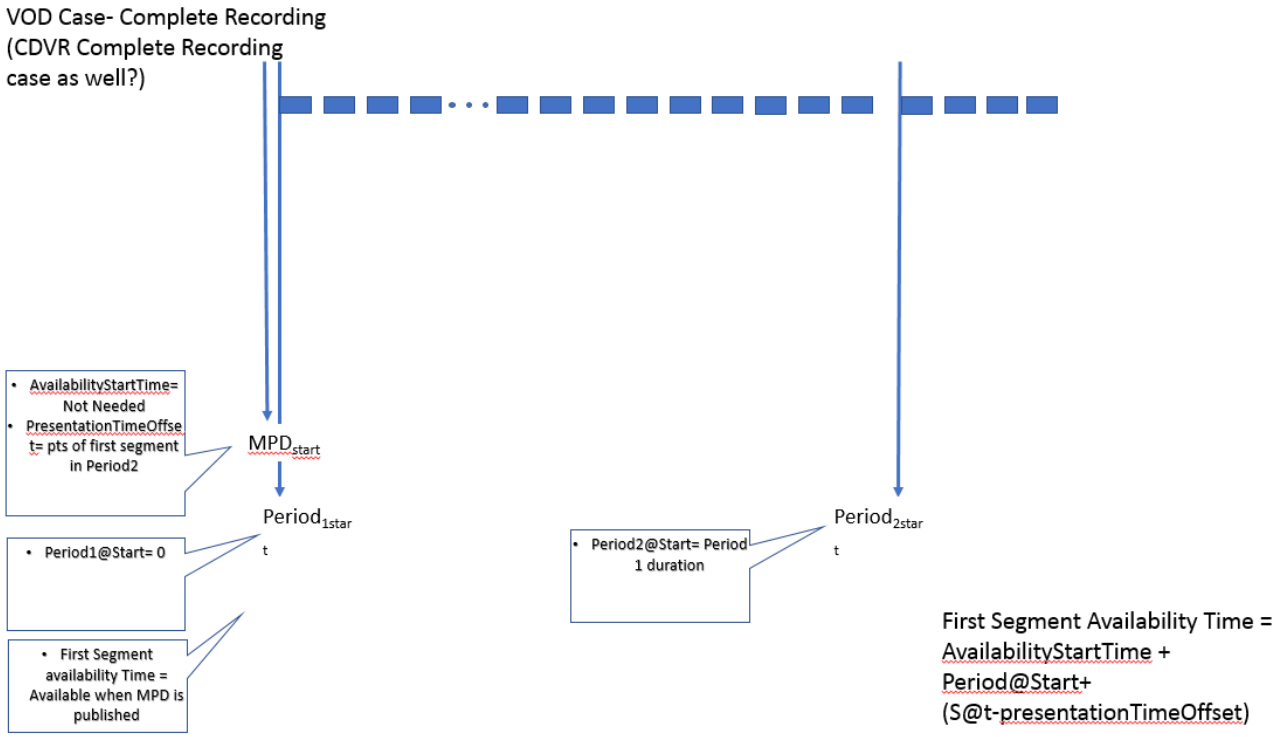


Figure 13 - Segments in a Completed cDVR or VOD Asset

APPENDIX A APPLICATION SYNTAX EXAMPLES

A.1 Linear Channel Examples

See Informational Zip package: “LinearChannelExample.xml”.

A.2 cDVR Examples

A.2.1 Hot Recordings

See Informational Zip package: “cDVRHotExample.xml”.

A.2.2 Cold Recordings (Complete MPD of “Hot Recording”)

See Informational Zip package: “cDVRColdExample.xml”.

A.3 VoD Syntax Example

See Informational Zip package: “VoDSidxExample.xml”.

A.4 Multiple Codecs AdaptationSets Syntax Example

See Informational Zip package: “ShortExamples.xml”.

A.5 Trickmode AdaptationSet Approach Syntax Example

See Informational Zip package: “ShortExamples.xml”.

A.6 SCTE35 Syntax Example

See Informational Zip package: “ShortExamples.xml”.

A.7 Audio Role Examples

See Informational Zip package: “ShortExamples.xml”.

APPENDIX B LOCATIONS TABLE

The table listed below describes the attributes/elements and location(s) in the CIF MPD hierarchy. If an attribute is described and it is optionally defined in a second location, then the location in the lowest level in the MPD hierarchy takes precedence.

See Informational Zip package: “CIFLocationsTable.xml”.

[Note: this is an excel file with two sheets]

APPENDIX C SOURCE OF AUTHORITY OF VALUES IN ATTRIBUTES/ELEMENTS

Attributes and elements described in the CIF MPD can have values that originate from a C2Index File, SCTE 35 tags, PMT, or just out-of-band (OOB). The information could also be hardcoded, derived from a file configuration, response from a content management system, or directly from a file itself. A lot of information is in the file itself, but there is a certain amount of time needed and it MAY be easier to use file calculations as a verification mechanism. The table listed below gives a general overview on originating source points for values of attributes described in the CIF MPD.

See Informational Zip package: “CIFSOATable.xml”.

[Note: this is an excel file with two sheets]

APPENDIX D SCTE 35 SIGNALING WORKFLOW

ANSI/SCTE 35 (2017) [13] provides a robust stream signaling infrastructure. Reasons for signals include advertising opportunities, blackouts, program boundaries, chapter boundaries, and in-band channel identification. DASH packagers convert SCTE 35 stream signals information into periods, elements and attributes in the MPD.

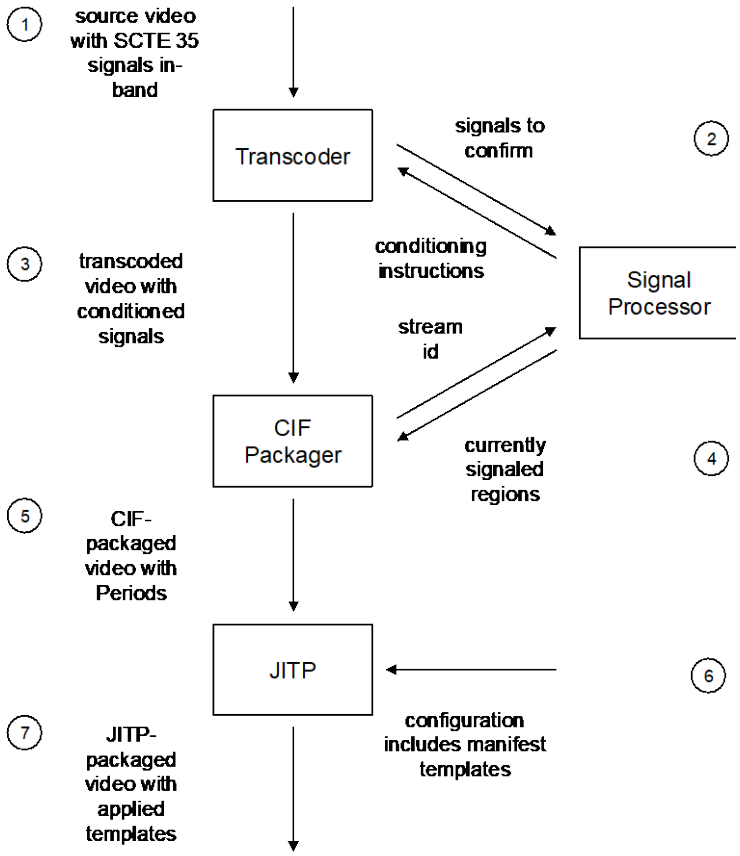


Figure 14 - SCTE 35 Signaling Workflow

The SCTE workflow proceeds as follows (see Figure 14).

1. For each video service stream, including VoD, linear, and cDVR, the transcoder receives a single high-resolution video source and generates adaptive transport stream video with multiple profiles with different bitrates and resolutions. The source stream can contain SCTE 35 signals.

2. When the source video contains SCTE 35 signals at program, chapter, blackout, and advertising boundaries, the transcoder confirms each signal with a signal processor. The signal processor receives the signal to confirm and responds with stream conditioning instructions, which can instruct the transcoder to remove the signal, modify the signal, or place the signal in each output stream exactly as it appears in the source stream.

3. The CIF packager receives multiple streams from the transcoder, each with matching signals that were previously confirmed by the signal processor.

4. On packager restart, the CIF packager contacts the signal processor with the stream identifier and receives the SCTE 35 signals for all currently signaled regions.

5. From new signals in the stream and those obtained from the signal processor, the CIF packager generates its manifest output with the period elements as indicated by signals in the stream. Open signals from prior periods will be appended in the EventStream to the new signals that caused the new period to be created.

6. The Just-in-time packager (JITP) is configured with manifest templates for each signal type and downstream format.

7. The JITP packages its downstream video using the period elements and the included EventStream and event elements it receives from the CIF packager.

Except “00 not indicated” and “01 content identification,” all type 0x05, 0x06 time signals cause a CIF packager to create a new period.

APPENDIX E HELPER HTTP ERROR CODES

The HTTP server in errored condition will return the following error codes as described in Table 16.

Table 16 - HTTP error codes to Packagers

HTTP Status Code	Meaning	JITP Behavior
404	Segment not currently available from Helper	Retry later
410	Segment permanently missing. SHOULD NOT occur on VoD content	No Retry
503	Not enough bandwidth on Helper across all clients	JITP SHOULD reduce rate of requests and MAY retry later

APPENDIX F EBP-SOURCED ELEMENTS AND ATTRIBUTES FOR MPD

This informational diagram explains what MPD information originates from parameters in the EBP structure [6]. The diagram also indicates how EBP parameters are initially populated.

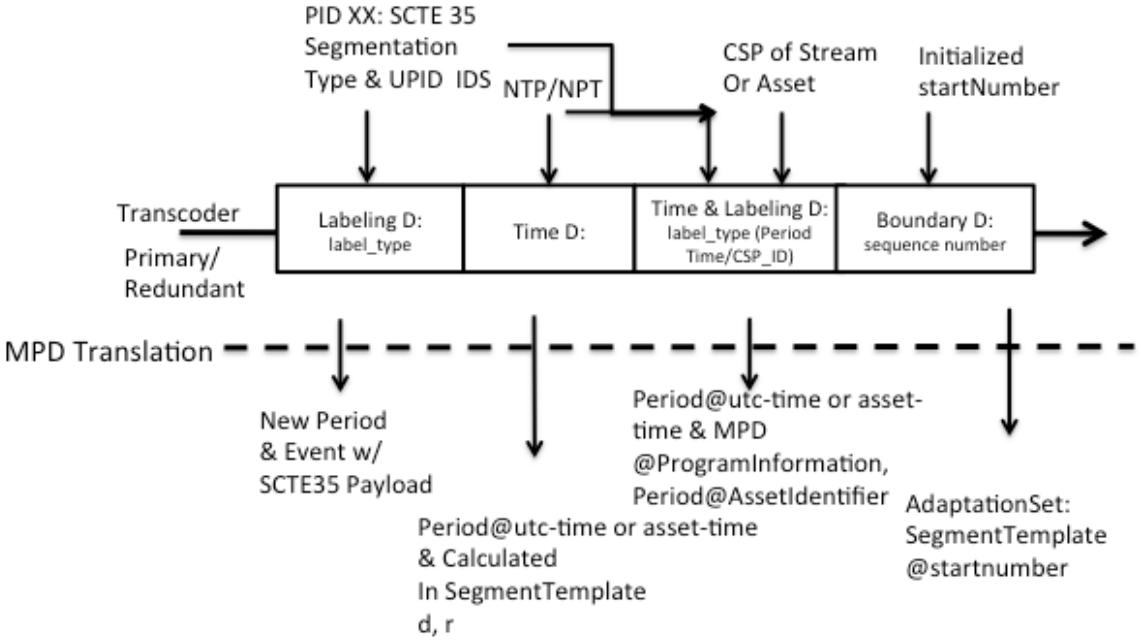


Figure 15 - EBP Sourced Information for CIF MPD

URNs (SCTE)

MPD@profiles	urn:scte:dash:2018#ts
MPD/ProgramInformation	urn:scte:dash:asset-id:id-list:2018
SP:powered-by	urn:scte:dash:powered-by:2018
SP:built-with	urn:scte:dash:built-with:2018
SP: generation-info	urn:scte:dash:generation-info:2018
SP: syscode	urn:scte:dash:cif-ts:syscode:2018
Period@assetIdentifier	urn:scte:dash:asset-id:upid:2018
SP:asset-time	urn:scte:dash:asset-time
SP: UTC-Time	urn:scte:dash:utc-time
SP:asset-End	urn:scte:dash:asset-end
SP: alternate-Id	urn:scte:dash:asset-id:upid:2018
Accessability	check on URNs should be DASH
Role	urn:scte:dash:role:2011
AudioChannelConfiguration	urn:mpeg:mpegB:cicp:ChannelConfiguration
EventStream	urn:scte:scte35:2014:xml+bin
SP:qamDelivery	urn:scte:dash:cif-ts:qamdelivey:2018
SP:streamFormatLabel	urn:scte:dash:cif-ts:streamFormatLabel:2018
SP:DRMData	urn:scte:dash:cif-ts:drmdata:2018
SP:avc-sps	urn:scte:dash:cif-ts:avc-sps:2018
SP:vbvBuffer	urn:scte:dash:cif-ts:vbvbuffer:2018
SP:avc-pps	urn:scte:dash:cif-ts:avc-pps:2018
SP:hevc-sps	urn:scte:dash:cif-ts:hevc-sps:2018
SP:hevc-pps	urn:scte:dash:cif-ts:hevc-pps:2018
EP:Slate	urn:scte:dash:cif-ts:urlAlternative:2018
EP:SegmentTimeline	urn:scte:dash:cif-ts:segmentLossTimeline:2018
EP:Variants	urn:scte:dash:cif-ts:variants:2018

Specification Version

SCTE Common Intermediate Format (CIF/TS) Manifest for ATS Streams	SCTE-CIF-TS-I01.1