Guidelines for Implementation: DASH-AVC/264 Interoperability Points

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Note: This document is no specification.

1 Scope

2 The scope of the interoperability points defined in this document is to provide basic support for
3 high-quality video distribution over the top. Both live and on-demand services are supported.

Disclaimer

The document is intended to enable creating test cases and test vectors that include restrictions and combinations of MPEG-DASH, system and codec technologies to spur basic interoperability. The document is not intended to be a specification and is not intended to be normatively referenced by any external specification.

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Acronyms, abbreviations and definitions

For acronyms, abbreviations and definitions refer to ISO/IEC 23009-1 [1].

In addition, the following abbreviations and acronyms are used in this document:

AAC	Advanced Audio Coding
AVC	Advanced Video Coding
DRM	Digital Rights Management
DTV	Digital Television
FCC	Federal Communications Commission
GOP	Group-of-Pictures
KID	common Key IDentification
IDR	Instantaneous Decoder Refresh
PPS	Picture Parameter Set
PS	Parametric Stereo
SBR	Spectral Band Replication
SD	Standard Definition
SMPTE	Society of Motion Picture and Television Engineers
SPS	Sequence Parameter Set
TT	Timed Text
TTML	Timed Text Markup Language

1. Introduction

The scope of the DASH-AVC/264 interoperability point is the basic support high-quality video distribution over the top. Both live and on-demand services are supported. It is expected that the client supports at least

- presentation of progressive high-definition video up to 720p (based on H.264/AVC [5][6] Progressive High Profile),
- presentation of stereo audio (based on HE-AAC v2 Profile [9]),
- support of basic subtitles (based on ISO/IEC 14496-30 [20]),
- basic support for encryption/DRM (based on ISO/IEC 23001-7 [21]).

In addition, it is recognized that certain clients may only be capable to operate with H.264/AVC Main Profile. Therefore content authors may provide and signal a specific subset of DASH-AVC/264 by providing a dedicated interoperability identifier referring to a standard definition presentation. This interoperability point is defined as DASH-AVC/264 SD.

Test cases and test vectors for DASH-AVC/264 Interoperability Points are defined in [23]. The conformance and reference software for DASH-AVC/264 Interoperability Points is defined in [24] (based on the MPEG conformance software [2]).

This version of the document defines the following Interoperability Points:

Table 1 Interoperability Points defined in this document

Interoperability Point	Identifier	Section
DASH-AVC/264	`http://dashif.org/guidelines/dash264`	6.3
DASH-AVC/264 SD	`http://dashif.org/guidelines/dash264#sd`	7.3

Beyond these initial IOPs, it is expected that additional IOPs and extensions to these IOPs will be defined.

2. Definition and Usage of Interoperability Points

2.1. Profile Definition in ISO/IEC 23009-1

MPEG DASH defines formats for MPDs and segments. In addition MPEG provides the ability to further restrict the applied formats by the definition of *Profiles* as defined on section 8 of ISO/IEC 23009-1 [1]. Profiles of DASH are defined to enable interoperability and the signaling of the use of features.

Such a profile can also be understood as permission for DASH clients that implement the features required by the profile to process the Media Presentation (MPD document and Segments).

Furthermore, ISO/IEC 23009-1 permits external organizations or individuals to define restrictions, permissions and extensions by using this profile mechanism. It is recommended that such external definitions be not referred to as profiles, but as *Interoperability Points*. Such an interoperability point may be signalled in the `@profiles` parameter once a URI is defined. The owner of the URI is responsible to provide sufficient semantics on the restrictions and permission of this interoperability point.

This document makes use of this feature and provides a set of Interoperability Points. Therefore, based on the interoperability point definition, this document may be understood in two ways:

- a collection of content conforming points, i.e. as long as the content conforms to the restrictions as specified by the IOP, clients implementing the features can consume the content.
- a client capability points that enable content and service providers for flexible service provisioning to clients conforming to these client capabilities.

2.2. Usage of Profiles

A Media Presentation may conform to one or multiple profiles/interoperability points and conforms to each of the profiles indicated in the **`MPD`**`@profiles` attribute is specified as follows:

When `ProfA` is included in the **`MPD`**`@profiles` attribute, the MPD is modified into a profile-specific MPD for profile conformance checking using the following ordered steps:

1. The **`MPD`**`@profiles` attribute of the profile-specific MPD contains only `ProfA`.
2. An **`AdaptationSet`** element for which `@profiles` does not or is not inferred to include `ProfA` is removed from the profile-specific MPD.
3. A Representation element for which `@profiles` does not or is not inferred to include `ProfA` is removed from the profile-specific MPD.
4. All elements or attributes that are either (i) in this Part of ISO/IEC 23009 and explicitly excluded by `ProfA`, or (ii) in an extension namespace and not explicitly included by `ProfA`, are removed from the profile-specific MPD.
5. All elements and attributes that "may be ignored" according to the specification of `ProfA` are removed from the profile-specific MPD.

An MPD is conforming to profile `ProfA` when it satisfies the following:

1. `ProfA` is included in the **`MPD`**`@profiles` attribute.
2. The profile-specific MPD for `ProfA` conforms to ISO/IEC 23009-1
3. The profile-specific MPD for `ProfA` conforms to the restrictions specified for `ProfA`.

A Media Presentation is conforming to profile `ProfA` when it satisfies the following:

1. The MPD of the Media Presentation is conforming to profile `ProfA` as specified above.

2. There is at least one Representation in each Period in the profile-specific MPD for `ProfA`.
3. The Segments of the Representations of the profile-specific MPD for `ProfA` conform to the restrictions specified for `ProfA`.

2.3. Interoperability Points and Extensions

This document defines Interoperability Points and Extensions. Both concepts make use of the profile functionality of ISO/IEC 23009-1.

Interoperability Points provide a basic collection of tools and features to ensure that content/service providers and client vendors can rely to support a sufficiently good audio-visual experience. Extensions enable content/service providers and client vendors to enhance the audio-visual experience provided by an Interoperability Point in a conforming manner.

The only difference between Interoperability Points and Extensions is that Interoperability Points define a full audio-visual experience and Extensions enhance the audio-visual experience in typically only one dimension.

Example for the usage of the `@profiles` signaling are provided in Annex A.

3. DASH-Related Aspects

3.1. Scope

DASH-AVC/264 is uses ISO base media file format based encapsulation and has significant commonality with a superset of the ISO BMFF On-Demand and the ISO BMFF Live profile as defined in ISO/IEC 23009-1 [1], sections 8.3 and 8.4, respectively. DASH-AVC/264 is intended to provide basic support for on-demand and live content. The primary constraints imposed by this profile are the requirement that each Representation is provided in one of the following two ways

- as a single Segment, where Subsegments are aligned across Representations within an Adaptation Set. This permits scalable and efficient use of HTTP servers and simplifies seamless switching. This is mainly for on-demand use cases.
- as a sequence of Segments where each Segment is addressable by a template-generated URL. Content generated in this way is mainly suitable for dynamic and live services.

In both cases (Sub)Segments must begin with Stream Access Points (SAPs) of type 1 or 2, i.e. regular IDR frames in case of video. In addition, (Sub)Segments are constrained so that for switching video Representations within one Adaptation Set the boundaries are aligned without gaps or overlaps in the media data. Furthermore, switching is possible by a DASH client that downloads, decodes and presents the media stream of the come-from Representation and then switches to the go-to Representation by downloading, decoding and presenting the new media stream. No overlap in downloading, decoding and presentation is required for seamless switching of Representations in one Adaptation Set.

3.2. DASH features

3.2.1. Introduction

This section introduces the detailed constraints of the MPD and the DASH segments in a descriptive way referring to ISO/IEC 23009-1 [1]. The DASH-based restrictions have significant commonality with the ISO BMFF Live and On-Demand profiles from the MPEG-DASH specification.

Specifically:

- Segment formats are based on ISO BMFF with fragmented movie files, i.e. (Sub)Segments are encoded as movie fragments containing a track fragment as defined in ISO/IEC 14496-12 [4], plus the following constraints to make each movie fragment independently decodable:
  - Default parameters and flags are stored in movie fragments ('`tfhd`' or '`trun`' box) and not track headers ('`trex`' box)
  - Track Fragment Header Box ('`tfhd`') base_data_offset is not present (this is a byte offset from the start of a file)
- Alignment with ISO BMFF Live & On-Demand Profiles, i.e. within each Adaptation Set the following applies
  - Fragmented movie files are used for encapsulation of media data
  - (Sub)Segments are aligned to enable seamless switching

Beyond the constraints provided in the ISO BMFF profiles, the following additional restrictions are applied.

- IDR-like SAPs (i.e., SAPs type 2 or below) at the start of each (Sub)Segment for simple switching.
- Segments have almost equal duration. The maximum tolerance of segment duration is ±50% and the maximum accumulated deviation over multiple segments is ±50% of the signaled segment duration (i.e. the `@duration` attribute or the **`S`**`@d` in the **`SegmentTimeline`**). Such fluctuations in actual segment duration may be caused by for example ad replacement or specific IDR frame placement. Note that the last segment in a representation may be shorter according to ISO/IEC 23009-1 [1].

  > Note: If accurate seeking to specific time is required and at the same time a fats response is required one may use On-Demand profile for VoD or the **`SegmentTimeline`** based addressing. Otherwise the offset in segment duration compared to the actual media segment duration may result in a less accurate seek position for the download request, resulting in some increased initial start-up. However, this problem is expected to be specific for only a small subset of applications.

- The **`SegmentTimeline`** adheres to similar constraints as above and is only used in order to signal occasional shorter Segments (possibly caused by encoder processes) or to signal gaps in the time line. It is not used for providing Segments with significantly varying duration. The timing in the segment timeline shall be accurate and no constraints on segment

duration deviation are added except the maximum segment duration as specified in the MPD.

- only non-multiplexed Representations are supported, i.e. each Representation only contains a single media component.
- Addressing schemes are restricted to
    - templates with number-based addressing
    - templates with time-based addressing
    - subsegments with segment index. In this case either the `@indexRange` attribute is expected to be present.
- the '`lmsg`' brand for signaling the last segment is applied for any content with **`MPD`**`@minimumUpdatePeriod` present and the **`MPD`**`@type="dynamic"`.
- In case multiple Adaptation Sets with `@contentType='video'` are offered, exactly one video Adaptation Set is signaled as the main one unless different Adaptation Sets contain the same content with different quality or different codecs. In the latter case, all Adaptation Sets with the same content shall be signaled as the main content. Signalling as main content shall be done by using the Role descriptor with `@schemeIdUri="urn:mpeg:dash:role:2011"` and `@value="main"`.
- Restrictions on the presence of certain elements and attributes as defined section 3.2.4.

It is expected that a DASH-AVC/264 client is able to process content offered under these constraints. More details on expected client procedures are provided in section 3.3.

3.2.2. Media Presentation Description constraints

DISCLAIMER: This section serves for the definition of the interoperability point in a similar way, as done for the profile definitions in ISO/IEC 23009-1, but is not intended as a normative specification.

NOTE: The term "ignored" in the following description means, that if an MPD is provided and a client that complies with DASH-AVC/264 removes the element that may be ignored, then the MPD is still complying with the constraints of the MPD as defined in ISO/IEC 23001-9, section 5.

The Media Presentation Description shall conform to the following constraints:

— The rules for the MPD and the segments as defined in ISO/IEC 23001-9, section 7.3, shall apply.

— Representations with value of the `@mimeType` attribute other than `xxx/mp4` with `xxx={video, audio, application, text, subtitle}` or `application/ttml+xml` may be ignored. Additional profile or codec specific parameters may be added to the value of the MIME type attribute. For details refer to specific parameters below.

— The **`Subset`** element may be ignored.

- The **Period.SegmentList** element shall not be present.
- If the **AdaptationSet.SegmentList** is present in an **AdaptationSet** element then this **AdaptationSet** element may be ignored.
- If the **Representation.SegmentList** is present in a **Representation** element then this **Representation** element may be ignored.
- Elements using the `@xlink:href` attribute may be ignored from the MPD. The Representations conforming to this profile are those not accessed through an Adaptation Set that uses an `@xlink:href`.
- An **AdaptationSet** containing **ContentComponent** element may be ignored, i.e. an Adaptation Set with multiplexed media streams may be ignored. Note that the information present in the **ContentComponent** element may be added to the **AdaptationSet** element.
- An **AdaptationSet** element not including the parameters as mandated in section 3.2.4 for an Adaptation Set may be ignored.
- A **Representation** element not including the parameters as mandated in section 3.2.4 may be ignored.
- If the **MPD**`@type` is equal to "`static`" and the **MPD**`@profiles` attribute includes "`urn:mpeg:dash:profile:isoff-on-demand:2011`" then
  - **AdaptationSet** elements with **AdaptationSet**`@subsegmentAlignment` not present, or set to '`false`' may be ignored.
  - **Representation** elements with a `@subsegmentStartsWithSAP` value absent, zero or greater than 2 may be ignored.
  - If the **Representation** element does not contain a **BaseURL** element then this **Representation** element may be ignored.
- If the **MPD**`@type` is equal to "`dynamic`", then
  - the **MPD**`@profiles` attribute shall include the signaling for the "`urn:mpeg:dash:profile:isoff-live:2011`"
- if the **MPD**`@profiles` attribute includes "`urn:mpeg:dash:profile:isoff-live:2011`", then
  - **AdaptationSet** elements with **AdaptationSet**`@segmentAlignment` not present, or set to '`false`' may be ignored.

— **Representation** elements with a @segmentStartsWithSAP value absent, zero or greater than 2 may be ignored.

— The attribute **MPD**@maxSegmentDuration shall be present.

— If a Period contains multiple Adaptation Sets with @contentType="video" then at least one Adaptation Set shall contain a Role element <Role schemeIdUri="urn:mpeg:dash:role:2011" value="main"> and each Adaptation Set containing such a **Role** element shall provide perceptually equivalent media streams.

3.2.3. Segment format constraints

Representations and Segments referred to by the Representations in the profile-specific MPD for this profile, the following constraints shall be met:

— Representations shall comply with the formats defined in ISO/IEC 23009-1, section 7.3.

— In Media Segments, all Segment Index ('sidx') and Subsegment Index ('ssix') boxes, if present, shall be placed before any Movie Fragment ('moof') boxes.

— If the **MPD**@type is equal to "static" and the **MPD**@profiles attribute includes "urn:mpeg:dash:profile:isoff-on-demand:2011", then

— Each Representation shall have one Segment that complies with the Indexed Self-Initializing Media Segment as defined in section 6.3.5.2 in ISO/IEC 23009-1.

— If the **MPD**@type is equal to "dynamic" and **MPD**@minimumUpdatePeriod is present, then if the Media Segment is the last Media Segment in the Representation, this Media Segment shall carry the 'lmsg' compatibility brand.

3.2.4. Presence of Attributes and Elements

Elements and attributes are expected to be present for certain Adaptation Sets and Representations to enable suitable initial selection and switching.

Specifically the following applies:

- For any Adaptation Sets with @contentType="video" the following attributes shall be present
    - @maxWidth (or @width if all Representations have the same width)
    - @maxHeight (or @height if all Representations have the same height)
    - @maxFrameRate (or @frameRate if all Representations have the same frame rate)
    - @par

Note: The attributes `@maxWidth` and `@maxHeight` are expected to be used such that they describe the target display size. This means that they may exceed the actual largest size of any coded Representation in one Adaptation Set.

- For any Representation within an Adaptation Set with `@contentType="video"` the following attributes shall be present:
  - `@width`, if not present in **`AdaptationSet`** element
  - `@height`, if not present in **`AdaptationSet`** element
  - `@frameRate`, if not present in **`AdaptationSet`** element
  - `@sar`
- For Adaptation Set or for any Representation within an Adaptation Set with `@contentType="video"` the attribute `@scanType` shall either not be present or shall be set to "`progressive`".
- For any Adaptation Sets with value of the `@contentType="audio"` the following attributes shall be present
  - `@lang`
- For any Representation within an Adaptation Set with value of the `@contentType="audio"` the following elements and attributes shall be present:
  - `@audioSamplingRate`, if not present in **`AdaptationSet`** element
  - **`AudioChannelConfiguration`**, if not present in **`AdaptationSet`** element

3.2.5. Dimension Constraints

No constraints are defined on MPD size, or on the number of elements.

3.2.6. Generic Metadata

Generic metadata may be added to MPDs based on DASH. For this purpose, the Essential Property Descriptor and the Supplemental Property Descriptor as defined in ISO/IEC 23009-1 [1], clause 5.8.4.7 and 5.8.4.8, may be added.

Metadata identifiers for content properties are provided here: http://dashif.org/identifiers.

However, it is not expected that DASH-AVC/264 clients supports all metadata at http://dashif.org/identifiers unless explicitly mentioned.

3.3. Client Implementation Guidelines

As mentioned, the DASH-related aspects of the interoperability point as defined in section 3.2 can also be understood as permission for DASH clients that only implement the features required by the description to process the Media Presentation (MPD document and Segments). However, the detailed DASH-AVC/264 DASH-related client operation is not specified. Therefore, it is also unspecified how a DASH client exactly conforms. This document however provides guidelines on what is expected for conformance to this interoperability point.

The DASH-related aspects in DASH-AVC/264 as well as for the ISO BMFF based On-Demand and Live profiles of ISO/IEC 23009-1 are designed such that a client implementation can rely on relatively easy processes to provide an adaptive streaming service, namely:

- selection of the appropriate Adaptation Sets based on descriptors and other attributes
- initial selection of one Representation within each adaptation set
- download of (Sub)Segments at the appropriate time
- synchronization of different media components from different Adaptation Sets
- seamless switching of representations within one Adaptation Set

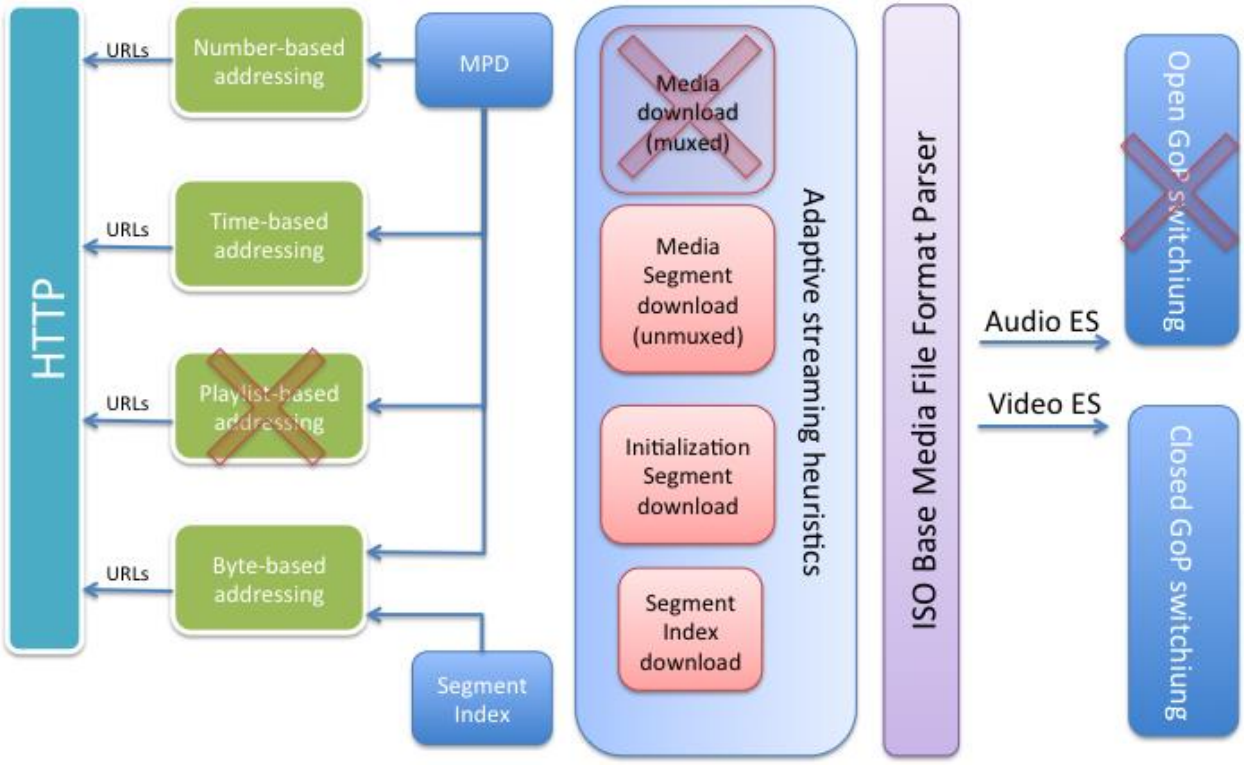


Figure 1 DASH aspects of a DASH-AVC/264 client compared to a client supporting the union of DASH ISO BMFF live and on-demand profile.

Figure 1 shows the DASH aspects of a DASH-AVC/264 client compared to a client supporting all features of the DASH ISO BMFF Live and On-Demand profile. The main supported features are:

- support of HTTP GET and partial GET requests to download Segments and Subsegments
- three different addressing schemes: number and time-based templating as well as byte range based requests.
- support of metadata as provided in the MPD and Segment Index
- download of Media Segments, Initialization Segments and Segment Index

- ISO BMFF parsing
- synchronized presentation of media components from different Adaptation Sets
- switching of video streams at closed GOP boundaries

The features of the client are expected to be tested in an interoperability effort to ensure full support. Based on test cases, more detailed client requirements may be added.

3.4. Transport-Related Issues

3.4.1. General

It is expected that servers and clients operating in DASH-AVC/264 environments support the normative parts of HTTP/1.1 as defined in RFC2616 [18]. Specifically

- Clients are expected to support byte range requests, i.e. issue partial GETs to subsegments. Range requests may also be issued by using Annex E of 23009-1 using the syntax of the second example in Annex E.3,

  ```
  BaseURL@byteRange="$base$?$query$&range=$first$-$last$"
  ```

- HTTP Servers serving segments are expected to support suitable responses to byte range requests (partial GETs). HTTP Servers may also support the syntax using Annex E of 23009-1 using the syntax of the second example in Annex E.3,

  ```
  BaseURL@byteRange="$base$?$query$&range=$first$-$last$"
  ```

- Clients are expected to follow the reaction to HTTP status and error codes as defined in section A.7 of ISO/IEC 23009-1.

4. Media Coding Technologies

4.1. Introduction

In addition to DASH-specific constraints, DASH-AVC/264 also adds restrictions on media codecs and other technologies. This section provides an overview on technologies for different media components and how they fit into the DASH-related aspects of DASH-AVC/264.

4.2. Video

4.2.1. General

The codec considered for basic video support up to 1280 x 720p at 30 fps is H.264 (AVC) Progressive High Profile Level 3.1 decoder [6]. This choice is based on the tradeoff between content availability, support in existing devices and compression efficiency.

Further, it is recognized that certain clients may only be capable to operate with H.264/AVC "Progressive" Main Profile Level 3.0 and therefore content authors may provide and signal a specific subset of DASH-AVC/264.

Note that H.264 (AVC) Progressive High Profile Level 3.1 decoder [6] can also decode any content that conforms to

- H.264 (AVC) Constrained Baseline Profile up to Level 3.1
- H.264 (AVC) "Progressive" Main Profile up to Level 3.1.

Note that H.264 (AVC) H.264/AVC "Progressive" Main Profile Level 3.0 decoder [6] can also decode any content that conforms to H.264 (AVC) Constrained Baseline Profile up to Level 3.0.

Full HD video as well as other video-related enhancements will be defined in extensions.

4.2.2. DASH-specific aspects for H.264/AVC video

For the integration of the above-referred codecs in the context of DASH, the following applies for H.264 (AVC):

- The encapsulation of H.264/MPEG-4 AVC video data is based on the ISO BMFF as defined in ISO/IEC 14496-15 [7].
- Clients are expected to support Inband Storage for SPS/PPS based ISO/IEC 14496-15, Amendment 2 [22], i.e. sample entry '`avc3`' and '`avc4`'.
- SAP types 1 and 2 correspond to IDR-frames in [6].
- The signaling of the different video codec profile and levels for the codecs parameters according to RFC6381 [8] is documented in Table 2. Note that any of the codecs present in Table 1 conforms to the profile level combination that is supported in DASH-AVC/264.

Table 2 H.264 (AVC) Codecs parameter according to RFC6381 [8]

Profile	Level	Codec Parameter
H.264 (AVC) Constrained Baseline Profile X=?1????00	1.1	`avc[1..4].42X00B`
	1.2	`avc[1..4].42X00C`
	1.3	`avc[1..4].42X00D`
	3.0	`avc[1..4].42X01E`
H.264 (AVC) "Progressive" Main Profile Y=??????00	1.1	`avc[1..4].4DY00B`
	1.2	`avc[1..4].4DY00C`
	1.3	`avc[1..4].4DY00D`
	3.0	`avc[1..4].4DY01E`
H.264 (AVC) Progressive High Profile Y=??????00	1.1	`avc[1..4].64Y00B`
	1.2	`avc[1..4].64Y00C`
	1.3	`avc[1..4].64Y00D`

	3.0	avc[1..4].64Y01E
	3.1	avc[1..4].64Y01F

4.2.3. Video Metadata

The provisioning of video metadata in the MPD is discussed in section 3.2.4.

4.3. Audio

4.3.1. General

Content offered according to DASH-AVC/264 IOP is expected to contain an audio component in most cases. Therefore, clients consuming DASH-AVC/264-based content are expected to support stereo audio. Multichannel audio support and support for additional codecs will be defined in extensions.

The only candidate codec that was considered for basic stereo audio support is MPEG-4 High Efficiency AAC v2 Profile, level 2 [9]. Note that HE-AACv2 is also standardized as Enhanced aacPlus in 3GPP TS 26.401 [11].

Note that HE-AACv2 Profile decoder [6] can also decode any content that conforms to

- MPEG-4 AAC Profile [9]
- MPEG-4 HE-AAC Profile [9]

Therefore, Broadcasters and service providers encoding DASH-AVC/264 content are free to use any AAC version. It is expected that clients supporting the DASH-AVC/264 interoperability point will be able to play AAC-LC, HE-AAC and HE-AACv2 encoded content.

For all HE-AAC and HE-AACv2 bitstreams, explicit backwards compatible signaling shall be used to indicate the use of the SBR and PS coding tools.

4.3.2. DASH-specific aspects for HE-AACv2 audio

In the context of DASH, the following applies for the High Efficiency AAC v2 Profile

- The content is expected to be prepared according to the MPEG-DASH Implementation Guidelines [3] to make sure each (Sub)Segment starts with a SAP of type 1.
- The signaling of MPEG-4 High Efficiency AAC v2 for the codecs parameters is according to IETF RFC6381 [8] and is documented in Table 3. Table 3 also provides information on the ISO BMFF encapsulation.

Table 3 HE-AACv2 Codecs parameter according to RFC6381 [8]

Codec	Codec Parameter	ISO BMFF Encapsulation	SAP type

MPEG-4 AAC Profile [9]	`mp4a.40.2`	ISO/IEC 14496-14 [10]	1
MPEG-4 HE-AAC Profile [9]	`mp4a.40.5`	ISO/IEC 14496-14 [10]	1
MPEG-4 HE-AAC v2 Profile [9]	`mp4a.40.29`	ISO/IEC 14496-14 [10]	1

Note: Since both, HE-AAC and HE-AACv2 are based on AAC-LC, for the above-mentioned "Codec Parameter" the following is implied:

- `mp4a.40.5` = `mp4a.40.2` + `mp4a.40.5`
- `mp4a.40.29` = `mp4a.40.2` + `mp4a.40.5` + `mp4a.40.29`

4.3.3. Audio Metadata

4.3.3.1. General

Metadata for audio services is defined in ISO/IEC 23009-1.

4.3.3.2. ISO/IEC 23009-1 audio data

With respect to the audio metadata, the following elements and attributes from ISO/IEC 23009-1 are relevant:

- the `@audioSamplingRate` attribute for signaling the sampling rate of the audio media component type in section 5.3.7 of ISO/IEC 23009-1
- the **`AudioChannelConfiguration`** element for signaling audio channel configuration of the audio media component type.in section 5.3.7 of ISO/IEC 23009-1.

4.4. Auxiliary Components

4.4.1. Introduction

Beyond regular audio and video support, TV programs typically also require support for auxiliary components such as subtitles and closed captioning. For example, a Federal Communications Commission (FCC) Advisory Committee has recommended that a standard for the closed-captioning of online video content developed by the Society of Motion Picture and Television Engineers (SMPTE). DASH-AVC/264 addresses these requirements.

4.4.2. Basic Subtitles and Closed Captioning

The chosen technology for basic subtitles and closed captioning is W3C TTML [14] and the SMPTE profile on SMPTE Timed Text [15]. Graphics-based subtitles and closed captioning are also supported by SMPTE Timed Text [15].

Support for other technologies such as

- CEA-708 Digital Television (DTV) Closed Captioning [12]

- 3GPP Timed Text [13]
- Web VTT [16]

are not expected in DASH-AVC/264, but may be required in certain environments. Conversion of CEA-608 and CEA-708 into SMPTE TT may be done according to SPMTE 2052-10 [19].

Note that by the choice of SMPTE TT as the supported format at the client, other formats such as EBU TT [17] are also supported as long as only the subset that is also supported by SMPTE TT is used in the content authoring.

4.4.3. DASH-specific aspects of Auxiliary components

In the context of DASH, the following applies for text/subtitling:

- All graphics type samples are SAP type 1.
- The signalling of the different text/subtitling codecs for the codecs parameters is according to RFC6381 [8] is documented in Table 4. Table 4 also provides information on ISO BMFF encapsulation.
- For live services, encapsulation in ISO BMFF is definitely necessary. However, for On-Demand cases, the full file of subtitles may be provided as XML data only.

Table 4 Subtitle Codecs parameter according to RFC6381 [8]

Codec	MIME type	Codec Parameter @codecs	ISO BMFF Encapsulation
SMPTE Timed Text [15] without encapsulation	`application/ttml+xml`	`not present`	n/a
SMPTE Timed Text [15] with ISO BMFF encapsulation	`application/mp4`	`stpp`	Text of ISO/IEC CD 14496-30 Timed Text and Associated Images in ISO Base Media File Format [20]

5. DRM-Related Aspects

5.1. Introduction

DASH-AVC/264 does not intend to specify a full end-to-end DRM system. However DASH-AVC/264 provides a framework for multiple DRMs to protect DASH content by adding instructions or *Protection System Specific*, proprietary information in predetermined locations to DASH content that is encrypted with Common Encryption as defined in ISO/IEC 23001-7 [21].

The Common Encryption ('`cenc`') protection scheme specifies encryption parameters that can be applied by a scrambling system and key mapping methods using a common key identification (KID) to be used by different DRM systems such that the same encrypted version of a file can be combined with different DRM systems that can store proprietary secure information for licensing and key retrieval in the Protection System Specific Header box ('`pssh`'). The DRM scheme for each `pssh` box is identified by the `SystemID` in that box.

The recommendations in this document reduce the encryption parameters and use of the encryption metadata to specific use cases for VOD and live content with key rotation.

5.2. Base Technologies

The base standards to support common encryption in combination with ISO BMFF are

- Common Encryption with CTR mode as defined in ISO/IEC 23001-7:2011 [21].
- Key rotation as defined in ISO/IEC 23001-7 [21]. Note: the latter was added as AMD1 to the 1st edition of ISO/IEC 23001-7:2011

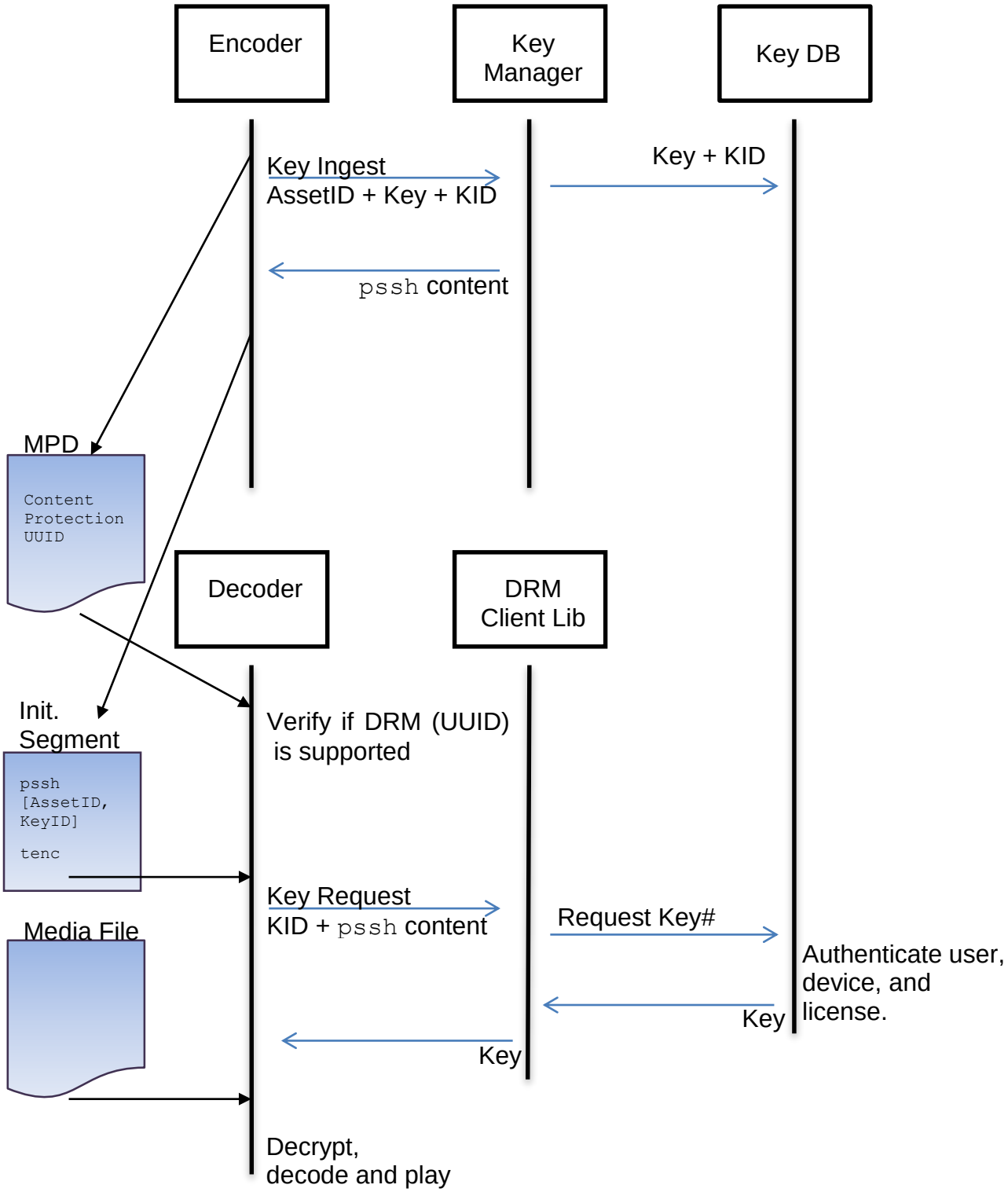
The main DRM elements are:

1. The **`ContentProtection`** descriptor (see [1] 5.3.7.2-Table 9, 5.8.5.2 and [1] 5.8.4.1) that contains the URI for signaling of the Common Encryption Scheme as well as the specific DRM.
2. '`tenc`' parameters that specify encryption parameters and KID (see [21] 8.2.1). The '`tenc`' information is in the Initialization Segment (see [21] 8.2.1). The default KID information may also appear in the MPD (see [21] 11.1)
3. '`pssh`' parameters that are "Protection System Specific" (see [21] 8.1). The `pssh` information is in Initialization or Media Segments (See [21] 8.1 and 8.2). It may also be present in the MPD (see [1] 5.8.4.1, [21] 11.2.1) in a scheme-specific way. Information in the MPD increases the MPD size but may allow faster parsing, earlier access and addition of DRMs without content modification.

5.3. Workflow Overview

Figure 2 below shows a simple workflow with `pssh` information in the Initialization Segment for informational purpose.

Figure 2 Workflow with `pssh` information in the Initialization Segment.



5.4. Integration and Mapping to DASH

5.4.1. MP4 Structure Overview

Table 5 provides pointers to relevant information in the specifications to understand the standard DRM components and where the relevant information is located. The table is for informational purpose only.

Table 5 Boxes relevant for DRM systems

Box	Full Name / *Usage*	Info at
`moof`	movie fragment header *One 'moof' box for each fragment in each stream*	ISO BMFF [4], 8.32 + [1]
`moov`	movie header, container for all the metadata *One 'moov' box per elementary stream. 1 x for each video stream, + 1 x for the audio stream*	ISO BMFF [4] , 8.1
`pssh`	protection system specific header box	[21], 8.1.1
`saio`	SampleAuxiliaryInformationOffsetsBox *Contains the offset of the IVs & encryption data.*	[21], 5
`saiz`	SampleAuxiliaryInformationSizesBox *Contains the size of the IVs & encryption data.*	[21], 5
`schi`	scheme information box	[21], 4
`seig`	CencSampleEncryptionInformation GroupEntry *Contains tenc information in sample in segments for key rotation.*	[21], 6
`sinf`	protection scheme information box	[21], 4
`stsd`	sample descriptions (codec types, initialization etc.)	ISO BMFF [4], 8.16
`tenc`	track encryption box *contains tenc parameters*	[21], 8.2.1

5.4.2. Box Hierarchy

The following shows the box hierarchy and composition:

- In the 'moov' box:
  - one or more 'pssh' boxes
  - in 'trak::mdia::minf::stbl::stsd':
    - the 'sinf' box that contains:
      - the 'frma' box
      - the 'schm' box
      - the 'schi' box that contains:
        - the 'tenc' box

- In the ‘moof’ box:
  - in the ‘traf’ box:
    - the ‘saiz’ box
    - the ‘saio’ box
    - if using key rotation, the ‘sbgp’ box
    - if using key rotation, the ‘sgpd’ box that contains:
      - the ‘seig’ box

5.5. DRM Aspects for DASH-AVC/264

5.5.1. General

To enable signaling of a specific DRM scheme in DASH using the Base Technologies as presented in section 5.2 one of the following options as provided in section 5.5.2 can be applied.

5.5.2. `pssh` and `tenc` Parameters in Movie or Movie Fragment Box

The `pssh` and `tenc` parameters are exclusively provided in the movie or movie fragment box, i.e. in the Initialization Segment (and possibly in the movie fragment box for key rotation) for the live profile or in the movie box for the On-Demand profile:

- ‘`tenc`’ parameters are provided by '`tenc`' box in the content file that specify encryption parameters and KID as specified in [21], section 8.2.1.
- ‘`pssh`’ parameters are provided by `pssh` box in the content file as specified in [21], section 8.1.

5.5.3. Use of Content Protection Descriptor

5.5.3.1. General

`ContentProtection` descriptor shall always appear on the **`AdaptationSet`** level.

5.5.3.2. Generic ContentProtection Descriptor

`ContentProtection` descriptor with `@schemeIdUri` value of `"urn:mpeg:dash:mp4protection:2011"` must be present.

Default KID value, as specified by the '`tenc`' box, should be carried in the MPD, within the above **`ContentProtection`** descriptor, using the `@cenc:default_KID` attribute defined in [21], section 11.1. The value of the attribute is the KID value in a UUID notation.

```
<ContentProtection schemeIdUri="urn:mpeg:dash:mp4protection:2011"
    value="cenc" cenc:default_KID=”34e5db32-8625-47cd-ba06-68fca0655a72”/>
```

DASH allows the `@cenc:default_KID` attribute in every DRM-specific **`ContentProtection`** descriptor, but for DASH-AVC/264, the latter should only be included in **`ContentProtection`** descriptor with the `urn:mpeg:dash:mp4protection:2011` `@schemeIdUri`

value, so that it is available in one place for all applications. The 'tenc' parameter that specifies encryption parameters and KID is also present in the movie box, as specified in [21], section 8.2.1.

5.5.3.3. DRM-specific ContentProtection Descriptor

A **ContentProtection** descriptor in MPD specifies a specific DRM scheme. An example is provided below:

```
<ContentProtection
    schemeIdUri="urn:uuid:xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx"
    value="DRMNAME version"/>
```

The URI (marked by x) is generated and provided by single DRM provider and uniquely identifies this DRM system.

The @value attribute describes the DRM system and version in a human readable form

5.5.3.4. pssh Parameter in MPD

Carrying tenc and pssh parameters in the MPD are useful to allow license evaluation, key identification and retrieval before availability of the initialization segment, which may distribute client requests and is relevant to allow an early decision by the client if this key is already available and to otherwise retrieve it before or during download of the Initialization Segment.

Carriage of tenc parameters is described in 5.5.3.2 above.

pssh parameters can be carried in the MPD within a DRM-specific **ContentProtection** descriptor and in the DRM-specific syntax and namespace. Examples are provided in 5.8.3 and in [21] sec. 11.2.

5.6. Key Rotation

5.6.1. Introduction

Key rotation is mainly used to allow changes in entitlement for continuous live content. It is used as defined in [21] with the following requirements:

- In the initialization segment, the movie box 'moov' contains 'tenc' parameters and may contain a 'pssh' box for each DRM to store root license information for authentication and authorization.
- In addition, each Movie Fragment may contain at most one 'pssh' in each 'moof' box per SystemID that contains sufficient information to acquire keys for this movie fragment, when combined with:
    - information from 'pssh' in 'moov'
    - KID from 'seig' box

  (This will likely result in some redundant pssh boxes but will facilitate processing and trick play, of linear content that is later made available as VOD assets)

- Any KIDs in Movie Fragments override the 'tenc' parameter of the 'default_KID', as well as the 'not encrypted' parameter.

5.6.2. Encryption of Different Representations

Generally, different Representations of one Adaptation Set are protected by the same license, i.e. encrypted with the same key. That means all Representations have the same value of 'default_KID' in their 'tenc' boxes in their Initialization Segments.

In the case of key rotation, that applies to the root license (one per DRM) and the same value of KID in each leaf license contained in each Media Segment.

In cases where HD and SD content are contained in one asset, different license rights may be required for each quality level. It then is often advisable to create individual Adaptation Sets for each quality level, each with a different **ContentProtection** descriptor in the Adaptation Set. While there may be some Representations that are equivalent in both Adaptation Set and therefore increase the content size, their size typically relatively small and switching between an HD and SD Adaptation Set is difficult to be applied seamlessly because these quality levels typically vary in DRM output controls, use different decryption licenses and keys and use different decoding parameters for e.g. subsampling, entropy coding, aspect ratios and color spaces.

The test vectors are limited to a single license (per DRM) per Adaptation Set but this does not explicitly exclude the viability of different licenses within one Adaptation Set.

5.7. Signaling

The DRM system is signaled with a URI as described in ISO/IEC 23009-1 [1] 5.8.5.2. The list of enabled DRMs can be found in the DASH identifier repository available here: http://www.dashif.org/identifiers/content-protection.

5.8. Common Encryption Test DRM

5.8.1. Introduction

In order to test common encryption without the necessity to do tests for a specific DRM, or all supported DRMs, a common encryption *Test-DRM* is defined.

Specifically the following aspects are defined for the *Test-DRM*:

- To test the encryption with common encryption scheme parameters, the key is provided in a separate file.
- To test the parsing of DRM relevant fields, two different test scenarios are defined to communicate the encryption parameters in the MPD and in the movie box (see section 5.5.2). The latter case also includes key rotation.

In the interest of testing independently of a specific DRM system, the keys are provided directly in lieu of the DRM information that is otherwise used to obtain the keys.

The use of an external file allows flexible referencing of the same key from different locations, to e.g. use the same key for audio, video or different Representations.

5.8.2. Test of Common Encryption

The key file location is the MPD directory or configurable in the player to avoid OS dependent path references. Its file name is the KID in 32 Hex lower case digits with .txt extension. The content is the decryption key in lower case Hex digits e.g.

`bdff1a347bd8e9f523f5ee6b16273d6e.txt` contains:
`050526bf6d3c386ffe5fc17c93506eca`

The key file name can be stored in the `pssh` to verify the creation and parsing of `pssh` information. If the `pssh` information is not present, the file name can also be derived directly with the knowledge of the KID.

In the test vectors 3 different test values for `@schemeIdUri` are defined to represent multi DRMs:

`00000000-0000-0000-0000-000000000000`
`00000000-0000-0000-0000-000000000001`
`00000000-0000-0000-0000-000000000002`

The test of common decryption is included in the successful decryption in the above cases.

5.8.3. ContentProtection descriptor

An extension namespace is defined in order to enable inclusion of `pssh` parameters in the **`ContentProtection`** element for the test DRMs above.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:dashif:iop:drm:2013"
    attributeFormDefault="unqualified"
    elementFormDefault="qualified"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns="urn:dashif:iop:drm:2012" >


    <xs:simpleType name="KeyIdType">
        <xs:restriction base="xs:hexBinary">
            <xs:length value="32"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="KeyIdListType">
        <xs:list itemType="KeyIdType" />
    </xs:simpleType>


    <xs:complexType name="Pssh">
        <xs:sequence>
            <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
        </xs:sequence>

        <!-- base64-encoded content of the `pssh` box -->
        <xs:attribute name="data" type="xs:base64Binary" use="required"/>
        <xs:attribute name="keyIdList" type="KeyIdListType"/>

        <xs:anyAttribute namespace="##other" processContents="lax"/>
```

```
    </xs:complexType>

</xs:schema>
```

An example is provided below:

```
<ContentProtection schemeIdUri="urn:uuid:00000000-0000-0000-0000-000000000000" value="42">
   <dash264drm:Pssh data=”BASE64 encoded DRM specific pssh data”/>
</ContentProtection>
```

5.8.4. Test Scenarios

5.8.4.1. Introduction

Different test scenarios are defined which are then mapped to specific test cases in [23]. The first test scenario uses a single key with

1. `pssh` and `tenc` parameters in the movie box
2. `pssh` and `default_KID` parameters in the MPD.

Another test scenario implements key rotation with `tenc` and `pssh` information in the MPD. Finally, a use case for interleaving of unencrypted content is added.

5.8.4.2. Test Scenario 1: pssh and tenc Parameters in Movie Box

The simulation verifies the signaling of the DRM in the MPD, specifically the `pssh` and `tenc` information as it must be exercised to access the keys.

The signaling of encryption scheme(s) in MPD:

```
<ContentProtection schemeIdUri="urn:uuid:00000000-0000-0000-0000-000000000000">
<ContentProtection schemeIdUri="urn:uuid:00000000-0000-0000-0000-000000000001">
<ContentProtection schemeIdUri="urn:uuid:00000000-0000-0000-0000-000000000002">
```

The `pssh` box, if present, contains the base64 encoded filename of the key file.

5.8.4.3. Test Scenario 2: pssh and tenc Parameters in MPD

The simulation verifies the encoding of the parameters in the MPD as described in 5.5.3. The key file is indicated in the **`Pssh`**`@data` attribute as base64 encoded KID in lower case with .txt extension. For example, for a KID of `bdff1a347bd8e9f523f5ee6b16273d6`, the key will be in the file `bdff1a347bd8e9f523f5ee6b16273d6e.txt`.

Full **`Pssh`**`@data` with required base64 encoding in this case is:

```
<dash264iop:Pssh data=
”YmRmZjFhMzQ3YmQ4ZTlmNTIzZjVlZTZiMTYyNzNkNmUudHh0”/>
```

A separate key file is used for each key when key rotation is used.

5.8.4.4. Test Scenario 3: pssh and KID Parameters in MPD with Key Rotation

In this case, the `pssh` information may contain root license information. For the test scenario, the `pssh` information does not contain relevant key information but is present as a place holder. The static place holder is the base64 encoding of the string: `"possible root pssh license info"`, i.e.:

```
<dash264iop:Pssh data="cG9zc2libGUgcm9vdCBwc3NoIGxpY2Vuc2UgaW5mbw=="/>
```

A separate key file with different `$KeyId$` value is used for each new key.

5.8.4.5. Test Scenario 4: pssh and tenc Parameters in MPD with Key Rotation and unencrypted elements

This extends the previous test scenario with segments that are signaled as unencrypted that are combined with encrypted segments.

6. Interoperability point DASH-AVC/264

6.1. Introduction

The scope of the DASH-AVC/264 interoperability point is the basic support of high-quality video distribution over the top. Both, live and on-demand services are supported. It is expected that the client supports at least the presentation of

- high-definition video up to 720p
- stereo audio
- basic subtitle support
- basic support for encryption/DRM

The compliance to DASH-AVC/264 may be signalled by an `@profiles` attribute with the value "`http://dashif.org/guidelines/dash264`"

6.2. Supporters

This interoperability point is supported by at least the following DASH-IF members: Akamai, bitmovin, CastLabs, Cisco, Dolby, Digital Primates, DTS, Elemental Technologies, Envivio, Ericsson, Fraunhofer, Harmonic, Imagine Communications, Intel, InterDigital, Media Excel, Microsoft, Netflix, Path1, Qualcomm Incorporated, RealNetworks, RGB Networks, Sony, Sorenson Media, Thomson Video Networks, Verimatrix.

6.3. Definition

Content may be authored claiming conformance to this IOP if a client can be properly play the content by supporting at least the following features:

- All DASH-related features as defined in section 3 of this document.

- H.264/MPEG AVC Progressive High Profile at level 3.1 as defined in section 4.2.
- MPEG-4 HE-AAC v2 level 2 profile audio codec as defined in section 4.3. Dynamic Range Control is not expected to be supported.
- subtitle and closed captioning support using SMPTE-TT as defined in section 4.4.2
    - For On-Demand single file download is sufficient.
    - For live services and/or if key rotation is to be supported, the encapsulation into ISO BMFF is necessary.
- content protection based on common encryption and key rotation as defined in section 5. And specifically, the client supports MPD-based parsing and movie box based parsing of DRM related parameters for common encryption.

In addition, content authored claiming conformance to this IOP the following holds:

- each Initialization Segment within one Adaptation Set shall contain an equivalent `pssh` box, i.e. license acquisition for one Representation is sufficient to ensure switching within Adaptation Set.
- in case of inband key delivery, the `pssh` box version 2 (as defined in 5.5.3) shall be equivalent for all Representations within one Adaptation Set, i.e. license acquisition for one Representation is sufficient to ensure switching within Adaptation Set.

If content is offered claiming conformance to this IOP, the content author is encouraged to use the HTTP-URL construction as defined in [3], section 5.1.4.

7. Interoperability Point DASH-AVC/264 SD

7.1. Introduction

It is recognized that certain clients may only be capable to operate with H.264/AVC Main Profile. Therefore content authors may provide and signal a specific subset of DASH-AVC/264 by providing a specific profile identifier referring to a standard definition presentation. This interoperability point is defined as DASH-AVC/264 SD.

The compliance to DASH-AVC/264 SD may be signaled by an `@profiles` attribute with the value "`http://dashif.org/guidelines/dash264#sd`"

7.2. Supporters

This interoperability point is supported by the following DASH IF members: Akamai, bitmovin, CastLabs, Cisco, Dolby, Digital Primates, DTS, Elemental Technologies, Envivio, Ericsson, Fraunhofer, Harmonic, Imagine Communications, Intel, InterDigital, Media Excel, Microsoft, Netflix, Path1, Qualcomm Incorporated, RealNetworks, RGB Networks, Sony, Sorenson Media, Thomson Video Networks, Verimatrix.

7.3. Definition

A client that attempts to consume content generated conforming to this profile is expected to support the following features:

- All features as defined in section 6.3, except:
    - Instead of H.264/MPEG AVC Progressive High Profile at level 3.1, the highest video codec configuration is H.264/MPEG AVC Progressive Main Profile at level 3.0 as defined in section 4.2.

8. References

[1] ISO/IEC 23009-1:2012 Information technology -- Dynamic adaptive streaming over HTTP (DASH) -- Part 1: Media presentation description and segment formats, Cor.1 (available as w13495).

[2] ISO/IEC 23009-2:2012 Information technology -- Dynamic adaptive streaming over HTTP (DASH) -- Part 2: Conformance and Reference Software (2nd Study of DIS, available as w13512).

[3] ISO/IEC 23009-3:2012 Information technology -- Dynamic adaptive streaming over HTTP (DASH) -- Part 3: Implementation Guidelines (Study of ISO/IEC PDTR, available as w13514).

[4] ISO/IEC 14496-12:2012 Information technology -- Coding of audio-visual objects -- Part 12: ISO base media file format

[5] ISO/IEC 14496-10: Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding

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

[7] ISO/IEC 14496-15:2010 Information technology -- Coding of audio-visual objects -- Part 15: Advanced Video Coding (AVC) file format

[8] IETF RFC 6381, The 'Codecs' and 'Profiles' Parameters for "Bucket" Media Types, August 2011.

[9] ISO/IEC 14496-3:2009 - Information technology -- Coding of audio-visual objects -- Part 3: Audio

[10] ISO/IEC 14496-12:2012 Information technology -- Coding of audio-visual objects -- Part 14: The MP4 File Format

[11] 3GPP (2005-01-04). "ETSI TS 126 401 V6.1.0 (2004-12) - Universal Mobile Telecommunications System (UMTS); General audio codec audio processing functions; Enhanced aacPlus general audio codec; General description (3GPP TS 26.401 version 6.1.0 Release 6)"

[12] CEA-708-D: Digital Television (DTV) Closed Captioning, August 2008

[13] 3GPP TS 26.245: "Transparent end-to-end Packet switched Streaming Service (PSS); Timed text format"

[14] W3C Timed Text Markup Language (TTML) 1.0, November 2010.

[15] SMPTE ST 2052: "Timed Text"

[16] W3C WebVTT - W3C Web Video Text Tracks, Living Standard — Last Updated 15 February 2012

[17] EBU Tech 3350, "EBU-TT, Part 1, Subtitling format definition", July 2012, http://tech.ebu.ch/docs/tech/tech3350.pdf?vers=1.0

[18] IETF RFC2616, Hypertext Transfer Protocol -- HTTP/1.1, June 1999.

[19] Recommended Practice (Conversion from CEA 608 to SMPTE-TT) RP 2052-10-2012 https://www.smpte.org/sites/default/files/rp2052-10-2012.pdf

[20] MPEG M13484, " Study of ISO/IEC DIS 14496-30 Timed Text and Other Visual Overlays in ISO Base Media File Format", April 2013.

[21] ISO/IEC 23001-7:201X 2nd Edition: "Information technology -- MPEG systems technologies -- Part 7: Common encryption in ISO base media file format files",

[22] MPEG M13478: "ISO/IEC 14496-15:2010/FDAM 2 Carriage of HEVC", April 2013.

[23] DASH Industry Forum, "Guidelines for Implementation: DASH-AVC/264 Test Cases and Vectors", under development.

[24] DASH Industry Forum, "Guidelines for Implementation: DASH-AVC/264 Conformance Software", under development.

[25] DASH Identifiers Repository, available here: http://dashif.org/identifiers

9. Annex A: Examples for Profile Signalling

9.1. Example 1

In this case DASH-AVC/264 content is offered, but in addition a non-conforming Adaptation Set is added.

Here is an example for an MPD:

- **MPD**@profiles="urn:mpeg:dash:profile:isoff-on-demand:2011, http://dashif.org/guidelines/dash264"
  - **AdaptationSet**@profiles="urn:mpeg:dash:profile:isoff-on-demand:2011, http://dashif.org/guidelines/dash264"
  - **AdaptationSet**@profiles ="http://dashif.org/guidelines/dash264"
  - **AdaptationSet**@profiles ="urn:mpeg:dash:profile:isoff-on-demand:2011"

Pruning process for IOP `http://dashif.org/guidelines/dash264` results in

- **MPD**@profiles ="http://dashif.org/guidelines/dash264"
  - **AdaptationSet**@profiles ="http://dashif.org/guidelines/dash264"
  - **AdaptationSet**@profiles ="http://dashif.org/guidelines/dash264"

It is now required that the pruned MPD conforms to DASH-AVC/264.

9.2. Example 2

In this case DASH-AVC/264 content is offered, but in addition a non-conforming Adaptation Set is added and one DASH-IF Example Extension Adaptation Set is added with the virtual IOP signal `http://dashif.org/guidelines/dashif#extension-example`.

Here is an example for an MPD:

- **MPD**@profiles ="urn:mpeg:dash:profile:isoff-on-demand:2011, http://dashif.org/guidelines/dash264, http://dashif.org/guidelines/dashif#extension-example"
  - @id = 1, **AdaptationSet**@profiles ="urn:mpeg:dash:profile:isoff-on-demand:2011, http://dashif.org/guidelines/dash264"
  - @id = 2, **AdaptationSet**@profiles ="http://dashif.org/guidelines/dash264"
  - @id = 3, **AdaptationSet**@profiles ="urn:mpeg:dash:profile:isoff-on-demand:2011, http://dashif.org/guidelines/dashif#extension-example"

Pruning process for profile `http://dashif.org/guidelines/dash264` results in

- MPD@profiles="http://dashif.org/guidelines/dash264"
  - @id = 1, **AdaptationSet**@profiles="http://dashif.org/guidelines/dash264"
  - @id = 2, **AdaptationSet**@profiles="http://dashif.org/guidelines/dash264"

It is now required that the pruned MPD conforms to DASH-AVC/264.

Pruning process for profile `http://dashif.org/guidelines/dashif#extension-example` results in

- **`MPD`**`@profiles="http://dashif.org/guidelines/dash264"`
  - `@id = 3, `**`AdaptationSet`**`@profiles="http://dashif.org/guidelines/dashif# extension-example"`

It is now required that the pruned MPD conforms to DASH-IF Example Extension Adaptation Set.

10. Document Errata History

Version 1.01: Change http://dashif.org/metadata to http://dashif.org/identifiers.

Version 1.02: Correct `application/xml+ttml` to `application/ttml+xml`.

Version 1.03: Updated the disclaimer section.