Audio Amendment to Guidelines for Implementation: DASH-IF Interoperability Points, Version 4.3

Scope

This document is an audio supplement to "Guidelines for Implementation: DASH-IF Interoperability Points" Version 4.3 published on November 15, 2018. It includes updates to existing audio IOP requirements and adds new interoperability points.

This document addresses the following work items:

- Updates for E-AC-3 and AC-4 for V5 (github issue #268)

- AC-4 Alignment with DVB/ATSC 3.0 (github issue #141)

- MPEG-H audio encapsulation ATSC3.0/DVB alignment (github issue #149)

- DTS-UHD addition and general update of DTS formats (github issue #398)

Document Conventions

Instructions written in *green* tell the reader how the indicated information is to be taken in context to the DASH-IF IOP Version 4.3 specification.

Note that a cross reference of indexed for references and tables to that of the DASH-IF IOP Guidelines version 4.3 is found in Annex A.

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List of Tables

Acronyms, abbreviations and definitions

For acronyms, abbreviations and definitions refer to ISO/IEC 23009-1 [4]. Additional definitions may be provided in the context of individual sections.
In addition, the following abbreviations and acronyms are used in this document:

AAC	Advanced Audio Coding
AC-3	Dolby AC-3 audio coding system
AC-4	Dolby AC-4 audio coding system
Audio Component	Media Component as defined in ISO/IEC 23009-1 [1]
DRM	Digital Rights Management
DTS-HD	Extended DTS audio coding system
DTS-UHD	DTS-UHD Audio coding system
E-AC-3	Enhanced AC-3
DVB	Digital Video Broadcasting
HE-AAC	High Efficiency AAC
HEVC	High-Efficiency Video Coding
HTTP	HyperText Transport Protocol
IOP	InterOperability Point
ISO	International Standards Organization
JOC	Joint Object Coding
MHA	Encapsulation of raw MPEG-H 3D Audio frames into ISO BMFF
MHAS	MPEG-H 3D Audio Stream
MHM	Encapsulation of MHAS packets into ISO BMFF
MPEG	Moving Pictures Experts Group
PCM	Pulse Code Modulation
Preselection	A subset of Audio Components as defined in ISO/IEC 23009-1 [1]
SAP	Stream Access Point
SBR	Spectral Band Replication
URL	Universal Resource Location

USAC   Unified Speech and Audio Coding

xHE-AAC   Extended High Efficiency AAC: a specific USAC profile

References

If appropriate, the references refer to specific versions of the specifications. However, implementers are encouraged to check later versions of the same specification, if available. Such versions may provide further clarifications and corrections. However, new features added in new versions of specifications are not added automatically.

A cross reference to the reference index values in DASH-IF IOP [18] is in Annex A.1

[1]   ISO/IEC 23009-1: 2019 "Information technology - Dynamic adaptive streaming over HTTP (DASH) - Part 1: Media presentation description and segment formats, 4th Edition"

[2]   ISO/IEC 23091-3:2018, "Information technology - Coding-independent code points - Part 3: Audio"

[3]   ETSI TS 102 366 v1.4.1, "Digital Audio Compression (AC-3, Enhanced AC-3) Standard"

[4]   ETSI TS 103 190-2 V1.2.1, "Digital Audio Compression (AC-4) Standard; Part 2: Immersive and personalized audio"

[5]   ETSI TS 102 114 v1.6.1 2019-08, "DTS Coherent Acoustics; Core and Extensions with Additional Profiles"

[6]   ETSI TS 103 491 v 1.2.1 (2019-05), "DTS-UHD Audio Format; Delivery of Channels, Objects and Ambisonic Sound Fields"

[7]   ISO/IEC 23008-3:2019, "Information technology - High efficiency coding and media delivery in heterogeneous environments - Part 3: 3D Audio, Second Edition"

[8]   ETSI TS 103 420 v1.2.1, "Backwards-compatible object audio carriage using Enhanced AC-3"

[9]   "MLP (Dolby TrueHD) streams within the ISO Base Media File Format, May 2019", https://developer.dolby.com/technology/dolby-audio/dolby-truehd/

[10]   ATSC A/342-2:2017 "Part 2, AC-4 System"

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

[12]   ISO/IEC 23003-1:2007, " Information technology - MPEG audio technologies - Part 1: MPEG Surround"

[13]   ISO/IEC TR 23009-3:2015, "Information technology - Dynamic adaptive streaming over HTTP (DASH) - Part 3: Implementation Guidelines"

[14]   ISO/IEC 14496-3:2019, " Information technology -- Coding of audio-visual objects - Part 3: Audio"

[15]   ISO/IEC 14496-14:2020, " Information technology - Coding of audio-visual objects - Part 14: MP4 file format"

[16]   ISO/IEC 23003-4:2020, " Information technology - MPEG audio technologies - Part 4: Dynamic range control"

[17]   ISO/IEC 23000-19:2020, "Information technology - Multimedia application format (MPEG-A) - Part 19: Common media application format (CMAF) for segmented media"

[18]   DASH-IF "Guidelines for Implementation: DASH-IF Interoperability Points" Version 4.3

Interoperability Points

This table updates the audio interoperability points found in DASH-IF IOP Table 2 [18].

Table 1 DASH-IF Audio Interoperability Points

Extension	Identifier	Version	Clause
DASH-IF multichannel audio extension with Enhanced AC-3	`http://dashif.org/guide lines/dashif#ec-3`	2.0	9.4.2
DASH-IF multichannel audio extension with Dolby TrueHD	`http://dashif.org/guide lines/dashif#mlpa`	2.0	9.4.2
DASH-IF multichannel audio extension with AC-4	`http://dashif.org/guide lines/dashif#ac-4`	3.1	9.4.2
DASH-IF multichannel audio extension with DTS Digital Surround	`http://dashif.org/guide lines/dashif#dtsc`	2.0	9.4.3
DASH-IF multichannel audio extension with DTS-HD High Resolution Audio and DTS-HD Master Audio	`http://dashif.org/guide lines/dashif#dtsh`	2.0	9.4.3
DASH-IF multichannel audio extension with DTS Express	`http://dashif.org/guide lines/dashif#dtse`	2.0	9.4.3
DASH-IF multichannel audio extension with DTS-HD Lossless (no core)	`http://dashif.org/guide lines/dashif#dtsl`	2.0	9.4.3
DASH-IF multichannel audio extension with DTS-UHD Profile 2	`http://dashif.org/guide lines/dashif#dtsx`	new	9.4.3
DASH-IF multichannel audio extension with DTS-UHD Profile 3	`http://dashif.org/guide lines/dashif#dtsy`	new	9.4.3
DASH-IF multichannel audio extension with MPEG Surround	`http://dashif.org/guide lines/dashif#mps`	2.0	9.4.4
DASH-IF multichannel audio extension with HE-AACv2 level 4	`http://dashif.org/guide lines/dashif#heaac-mc51`	2.0	9.4.3
DASH-IF multichannel audio extension with HE-AACv2 level 6	`http://dashif.org/guide lines/dashif#heaac-mc71`	2.0	9.4.3
DASH-IF multichannel audio extension with MPEG-H 3D Audio	`http://dashif.org/guide lines/dashif#mpeg-h-3da`	4.2	9.4.4
DASH-IF audio extension with USAC	`http://dashif.org/guide lines/dashif#cxha`	4.3	9.4.5

Audio Annotation

The following text updates the existing clause 3.9.4.6 in DASH-IF IOP [18]

3.9.4.6   **Audio Target Version Annotation**

Audio Adaptation Sets of one alternative content shall differ by at least by one of the following annotation labels:

- `@codecs`: specifies the codecs present within the Representation. The codecs parameters shall also include the profile and level information where applicable.

- `@lang`: specifies the dominant language of the audio

  o If not present, the language is unknown or no language applies

- `@audioSamplingRate` specifies the maximum sampling rate of the content

  o If not present, the audio sampling rate is unknown

- **AudioChannelConfiguration** specifies support for output devices that may only be able to render specific values. This element should be present.

  o If **AudioChannelConfiguration** is not present, then this value is unknown.

  o If the CICP schema `"urn:mpeg:mpegB:cicp:ChannelConfiguration"` is used, then the parameter for **AudioChannelConfiguration** is defined as *ChannelConfiguration* according to ISO/IEC 23091-3 [2].

  o Alternatively, the following codec dependent schemas may also be used:

    ▪ for codecs defined in DASH-IF IOP Table 22 [18], Table 10, or Table 11 `"urn:mpeg:dash:23003:3:audio_channel_configuration:2011"`, as defined in ISO/IEC 23009-1 [1]

    ▪ for `'ec-3'`, according to Table 5, `"tag:dolby.com,2014:dash:audio_channel_configuration:2011"`, as defined in TS 102 366 Annex I.1.2.1 [3]

    ▪ for `'ac-4'`, according to Table 5, `"tag:dolby.com,2015:dash:audio_channel_configuration:2015"`, as defined in TS 103 190-2 Annex G.3 [4]

    ▪ for `'dtsc'`,`'dtsh'`,`'dtse'` or `'dtsl'` according to Table 7, `"tag:dts.com,2014:dash:audio_channel_configuration:2012"`, as defined in TS 102 114 Annex G.3.2 [5]

    ▪ for `'dtsx'` or `'dtsy'`, according to Table 7, `"tag:dts.com,2018:uhd:audio_channel_configuration"` as defined in TS 103 491 Annex D.3 [6].

  Details on the application of the CICP schema and the codec dependent schemas may be found in the respective codec specific clauses within clause 9.

- `EssentialProperty`: specifies information about the containing element that is considered essential by the Media Presentation author selecting this component.

- `Role`: The `Role` descriptor scheme as defined in ISO/IEC 23009-1 [1].

- `Accessibility`: The `Accessibility` descriptor as specified in clause 9.

The following replaces clause 9 in the DASH-IF IOP [18].

9 Multi-Channel Audio Extensions

9.1 General

9.1.1 Scope

The Scope of the Multichannel Audio Extension is the support of audio with additional channels and codecs beyond the basic audio support as specified in the DASH-AVC/264 base, which is limited to Stereo HE-AAC. Multichannel audio is widely supported in all distribution channels today, including broadcast, optical disc, and digital delivery of audio, including wide support in adaptive streaming delivery.

It is expected that clients may choose which formats (codecs) they support.

9.1.2 NGA Overview

Next Generation Audio (NGA) codecs include AC-4, defined in ETSI TS 103 190-2 [4], MPEG-H 3D Audio, defined in ISO/IEC 23008-3 [7], and DTS-UHD defined in ETSI TS 103 491 [6].

New concepts and signaling mechanisms have been introduced as part of ISO/IEC 23009-1 [1] in order to support the variety of new use-cases that Next Generation Audio enables. In particular, the concept of Preselections has been introduced as a method for defining and signaling audio personalization options.

9.1.3 Signaling of Preselections

The NGA codecs support the concept of component-based audio, i.e. the audio program can be constructed from set of separate Audio Components (i.e. media content components containing audio). Examples of Audio Components are: dialogs (in potentially different languages), ambient background sound, music or effects. The Audio Components may be delivered in a single stream or in multiple streams.

The concept of Preselections as defined in ISO/IEC 23009-1 [1], allows the codec to offer different combinations of those Audio Components, either for automatic selection based on user preferences or for manual selection by the user.

Two different methods are defined to signal Preselections in the MPD: The Preselection Descriptor and the Preselection Element. The Preselection descriptor, defined in ISO/IEC 23009-1 clause 5.3.11.2 [1], enables simple setups and backward compatibility but may not be suitable for advanced use cases. See codec-specific details below.

The Preselection Element is defined in ISO/IEC 23009-1 clauses 5.3.11.3 and 5.3.11.4 [1]. The `@lang` attribute, the Role and Accessibility descriptors in the Preselection Element, as well as other parameters, such as a profile & level indication on the `@codecs` attribute are related only to that Preselection and not to the stream(s) referenced by the Preselection element.

For all adaptation sets referenced by preselection elements, the following rules presented in Table 2 shall apply:

Table 2 NGA element and attribute settings

Element or Attribute Name	Description
`SupplementalProperty`	If an `AdaptationSet` referring to the Main Audio stream is referenced by one or more `Preselection` elements, the `AdaptationSet` should include a `Preselection SupplementalProperty` descriptor as specified in MPEG-DASH
`EssentialProperty`	An `AdaptationSet` referring to Auxiliary audio streams shall include a `Preselection EssentialProperty` descriptor as specified in MPEG-DASH
`@preselectionComponents`	Specifies the IDs of the contained Adaptation Sets or Content Components that belong to this Preselection as white space separated list in processing order. The first tag defines the main media component

Additional MPD Elements and Attributes are recommended for use when describing an NGA Preselection. These are listed in Table 3. With NGA preselections, typical audio experiences should be signaled by utilizing the descriptors as provided in Table 4. Note that additional guidance in applying these parameters to specific NGA Audio codecs may be included in their respective clauses.

Table 3 Additional recommended MPD elements for NGA

Element or Attribute Name	Description
`@lang`	If a Preselection includes dialog, this attribute should be used to indicate the language.
`Role`	DASH role scheme, urn:mpeg:dash:role:2011, to indicate a key attribute of the Preselection.
`Accessibility`	Indicate whether a Preselection or a Component has accessibility considerations.
`Label`	If there are multiple Preselections, this label should be set by the content author.

Table 4 Recommended NGA signaling with Preselections

Experience Description	Role Descriptor @value	Accessibility descriptor @value
Normal Audio	`main`	–
Secondary Language (dubbed audio)	`dub`	–

Visual Description Service (=Audio Decsription)	`alternate`	`description`
Enhanced Intelligibility	`alternate`	`enhanced-audio-intelligi-bility`
Emergency Information (for the hard of viewing)	`alternate`	`emergency`

Both, the `Role` and, if used, the `Accessibility` descriptor utilize the Role schema as defined in ISO/IEC 23009-1 [1], identified through setting the `@schemeIdUri` attribute set to `"urn:mpeg:dash:role:2011"`.

9.2   Technologies

9.2.1   Dolby Multichannel Technologies

9.2.1.1   Overview

The considered technologies from Dolby for advanced audio support are:

- Enhanced AC-3 (Dolby Digital Plus), ETSI TS 102 366 [3]
- Dolby TrueHD, Dolby MLP [9]
- AC-4, ETSI TS 103 190-2 [4]

9.2.1.2   DASH-specific issues

In the context of DASH, the following applies:

- The signaling of the different audio codecs for the codecs parameters is documented in ETSI TS 102 366 [3], ETSI TS 103 190-2 [4] and Dolby MLP [9] which also provides information on ISO BMFF encapsulation.

- For E-AC-3 the Audio Channel Configuration may use any of the following:

  o `urn:mpeg:mpegB:cicp:ChannelConfiguration` as defined by *ChannelConfiguration* in ISO/IEC 23091-3 [2]

  o `tag:dolby.com,2014:dash:audio_channel_configuration:2011` as defined in TS 102 366 [3] Annex I.1.2.1.

- For AC-4, the Audio Channel Configuration may use any of the following used as further specified in TS 103 190-2 [4] Annex G.3.1:

  o `urn:mpeg:mpegB:cicp:ChannelConfiguration` as defined by *ChannelConfiguration* in ISO/IEC 23091-3 [2]

  o `tag:dolby.com,2015:dash:audio_channel_configuration:2015` as defined in TS 103 190-2 [4] Annex G.3.1

- For E-AC-3, the presence of JOC enhanced AC-3 extension information is signaled using the following supplemental descriptors as specified in ETSI TS 103 420, clause D.2 [8]

  o `tag:dolby.com,2018:dash:EC3_ExtensionType:2018`

o `tag:dolby.com,2018:dash:EC3_ExtensionComplexityIndex:2018`

Table 5 Dolby Technologies: Codec parameters and ISO BMFF encapsulation

Codec	Codec Parameter	ISO BMFF Encapsulation	SAP type
Enhanced AC-3	`ec-3`	ETSI TS 102 366 Annex F [3]	1
Dolby TrueHD	`mlpa`	Dolby MLP [9]	1
AC-4	`ac-4`	ETSI TS 103 190-2 Annex E [4]	1

9.2.1.3 Dolby AC-4 specific issues

9.2.1.3.1 General

This section provides more details on Attributes and Elements used with AC-4. See ATSC A/342-2 [10].

ISO Base Media File Format Packaging Rules for AC-4 are described in ETSI TS 103 190-2 Annex E [4].

9.2.1.3.2 AC-4 Element and Attribute Settings

Table 6 summarizes the mapping of relevant MPD elements and attributes to AC-4 Audio.

Most of the elements can be derived from the AC-4 `ac4_dsi_v1` structure as described in Annex E of ETSI TS 103 190-2 [4].

Note that usage of the elements and attributes listed below depends on the employed DASH profile.

Table 6 AC-4 element and attribute settings

Element or Attribute Name	Description
`@codecs`	For AC-4 the value of the codecs attribute shall be created according to the syntax described in RFC 6381 [11]. The value shall consist of the dot-separated list of the 4 following parts of which the latter three are represented by two-digit hexadecimal numbers: • The `fourCC 'ac-4'` • The `bitstream_version` as indicated in the `ac4_dsi_v1` structure. • The `presentation_version` as indicated for the referenced presentation in the `ac4_dsi_v1` structure. • The `mdcompat` parameter, indicating the compatibility level for the referenced presentation. Example: `ac-4.02.01.03`

	In case of AdaptationSets, the term *referenced presentation* shall refer to that presentation with the lowest `mdcompat` value amongst all presentations with `presentation_version < 2` and that are fully contained in this `AdaptationSet`.
Preselection@tag	This field shall correspond to the value of the `presentation_id` in the `ac4_presentation_v1_dsi` associated with the referenced AC-4 presentation.
AudioChannelConfiguration	For AC-4 the Audio Channel Configuration descriptor shall use one of the following schemes `urn:mpeg:mpegB:cicp:ChannelConfiguration` as defined by *ChannelConfiguration* in ISO/IEC 23091-3 [2] `tag:dolby.com,2015:dash:audio_channel_configuration:2015` as defined in TS 103 190-2 Annex G.3.1 [4]. `urn:mpeg:mpegB:cicp:ChannelConfiguration` is the preferred scheme.
@audioSamplingRate	The value shall be set to the sampling frequency as specified in TS 103 190-2 Annex G.2.6 [4]. Example: For `fs_index` = 1 and `dsi_fs_multiplier` = 0, the value is 48000.
RandomAccess@type	The `type` attribute of the `RandomAccess` element shall be set to "`closed`".
@mimeType	The MIME type attribute shall be set to "`audio/mp4`".
@startWithSAP	The `startWithSAP` attribute shall be set to 1.
@lang	The language indicated by the `lang` attribute should correspond to that language signaled in the `language_tag_bytes`, which is tagged as "`dialog`" or "`complete main`" in the corresponding `content_classifier`. NOTE: The `language_tag_bytes` are contained in the `ac4_substream_group_dsi` structure, within the `ac4_dsi_v1` structure. For `AdaptationSets` that are referenced by Preselection elements, the `lang` attribute should not be present on the `AdaptationSet` element. In cases where it is present, the indicated language should correspond to that presentation with the lowest `mdcompat` value amongst all presentations

	with `presentation_version` < 2 and that are fully contained in this `AdaptationSet`.
Role	The Role for a Preselection should be set by the content author.
	Note: The indication of the `content_classifier` from the `ac4_substream_group_dsi` structure is not sufficient to enable setting of an accurate indication for the Role descriptor in context of Preselections, describing entire experiences rather than individual audio elements.
Accessibility	In case one or more audio elements contained in a Presentation indicate a content type `visually impaired`, an `Accessibility` descriptor shall indicate `description` according to the `Role` scheme defined in ISO/IEC 23009-1 [1].
	If one or more audio elements contained in a Presentation indicate a content type other than `music and effects`, an `Accessibility` descriptor indicating `enhanced-audio-intelligibility` according to the `Role` scheme defined in ISO/IEC 23009-1 [1] may be used.
	In case one or more audio elements contained in a Presentation indicate `Associated service: emergency (E)`, an `Accessibility` descriptor may indicate `emergency` according to the `Role` scheme defined in ISO/IEC 23009-1 [1].
SupplementalProperty	If the content of a Presentation has been tailored for consumption via headphones, an Immersive Audio for Headphones `SupplementalProperty` descriptor should be used as specified in ETSI TS 103 190-2 clause G.2.12.1 [4].
	An audio framerate `SupplementalProperty` descriptor should be used as specified in ETSI TS 103 190-2 clause G.2.12.2 [4].

9.2.2   DTS Audio Technologies

9.2.2.1   Overview

The considered technologies from Xperi (DTS) for advanced audio support are:

- DTS-HD, TS 102 114 [5]

- DTS-UHD, TS 103 491 [6]

9.2.2.2 DASH-specific issues

Table 7 provides a list of the relevant code points and their reference for ISOBMFF encapsulation.

Table 7 DTS codec parameters and ISOBMFF encapsulation

Codec	Codec Parameter	ISO BMFF Encapsulation
DTS Digital Surround	`dtsc`	
DTS-HD Master Audio	`dtsh`	TS 102 114 Annex E [5]
DTS-HD Express	`dtse`	
DTS-HD Lossless (no core)	`dtsl`	
DTS-UHD Profile 2	`dtsx`	TS 103 491 Annex B [6]
DTS-UHD Profile 3	`dtsy`	

A summary of MPD elements and attributes specific to DTS-HD are found in Table 8.

Table 8 DTS codec parameters and ISOBMFF encapsulation

Element or Attribute Name	Description
`@codecs`	This attribute specifies the codecs used to encode all representations within the adaptation set and the value shall be one of `"dtsc"`, `"dtsh"`, `"dtsl"` or `"dtse"` corresponding to the composition of the elementary stream. This value shall match the DTS AudioSampleEntry
`AudioChannelConfiguration`	`tag:dts.com,2014:dash:audio_channel_configuration:2012` where the `@value` is set to the number of output channels, as defined in ETSI TS 102 114 Annex G [5] or `urn:mpeg:mpegB:cicp:ChannelConfiguration` as defined by *ChannelConfiguration* in ISO/IEC 23091-3 [2].
`RandomAccess`	The type attribute of `RandomAccess` shall be set to `"closed"`. For DTS-HD, every sample is a random access point.

Additional requirements for delivering DTS-HD using DASH are discussed in TS 102 114 Annex G [4].

A summary of MPD elements and attributes specific to DTS-UHD are found in Table 9.

Table 9 Relevant MPD elements and attributes for DTS-UHD

Element or Attribute Name	Description
`@codecs`	The value of the codecs attribute shall be created according to the syntax described in RFC 6381 [11]. For DTS-UHD, `@codecs` is the associated 4cc with no additional suffix. if DecoderProfile = 2 then `@codecs = 'dtsx'` if DecoderProfile = 3 then `@codecs = 'dtsy'` This value shall match that used for the `AudioSampleEntry`
`preselection@tag`	DTS-UHD bitstreams carry two levels of organization that can be signaled with the `preselectionComponents` value. When a `Component` is identified by an Audio Presentation Index, the tag value shall be formatted as "P*x*" where *x* is the presentation ID within the elementary stream. When discrete audio objects are being selected from the elementary stream, the `@tag` parameter is a space delimited string of the desired Object IDs. (See TS 103 491 [6])
`AudioChannelConfiguration`	When *RepresentationType* (defined in DTS-UHD Annex B) is set to 0, 1 or 2, then DTS-UHD shall use one of the following schema to describe the channel layout: • `tag:dts.com,2018:uhd:audio_channel_configuration` where the value is according to TS 103 491 Annex D [6], or • `urn:mpeg:mpegB:cicp:ChannelConfiguration` as defined by *ChannelConfiguration* in ISO/IEC 23091-3 [2].
`RandomAccess`	The type attribute of RandomAccess shall be set to "closed"
`Accessibility`	A DTS-UHD elementary stream carries accessibility information in the object property *m_ucAssociatedAssetType* as described in ETSI TS 103 491 [6].

Additional requirements for delivering DTS-UHD using DASH are discussed in TS 103 491 Annex D [6].

Other mandatory and recommended elements and attributes for delivery of audio tracks are according to this specification and ISO/IEC 23009-1 [1].

9.2.2.3 DTS-UHD specific issues

9.2.2.3.1 Sink frames and non-sync frames

DTS-UHD elementary streams are organized in groups of frames (GoF) that begin with a sync frame. Following the sync frame are non-sync frames. Playback can on start on a sync frame, therefore any random-access point requires sync frame alignment.

9.2.2.3.2 DTS-UHD Profiles

Two DTS-UHD profiles are currently defined, described in TS 103 491 Annex F [6].

9.2.2.3.3 Multi-stream support

DTS-UHD can be used with the Preselection Descriptor to facilitate multi-stream playback. Additional considerations for multi-stream are discussed in TS 103 491 Annex G [6].

9.2.3 MPEG Surround

9.2.3.1 Overview

MPEG Surround, as defined in ISO/IEC 23003-1 [12], is a scheme for coding multichannel signals based on a down-mixed signal of the original multichannel signal and associated spatial parameters. The down-mix shall be coded with MPEG-4 High Efficiency AAC v2 according to ISO/IEC 14496-3 clause 5.3.3.

MPEG Surround shall comply with level 4 of the Baseline MPEG Surround profile.

9.2.3.2 DASH-specific issues

In the context of DASH, the following applies for audio codecs

- The signaling of the different audio codecs for the codecs parameters is according to RFC6381 [11] is documented in Table 10. Table 10 also provides information on ISO BMFF encapsulation.

- The content is expected to be prepared according to ISO/IEC TR 23009-3 [13] to make sure each (sub-)segment starts with a SAP of type 1.

Table 10 Codecs parameter according to RFC6381 [11] and ISO BMFF encapsulation for MPEG Surround codec

Codec	Codec Parameter	ISO BMFF Encapsulation	SAP type
MPEG Surround [12]	`mp4a.40.30`	ISO/IEC 14496-14 [15]	1

Note: Since MPEG Surround is based on a down-mix coded with AAC-LC and HE-AAC, for the above mentioned "Codec Parameters" the following is implied:

mp4a.40.30 = AOT 2 + AOT 5 + AOT 30

9.2.4 MPEG-4 High Efficiency AAC Profile v2, level 6

9.2.4.1 Overview

Support for multichannel content is available in the HE-AACv2 Profile, starting with level 4 for 5.1 and level 6 for 7.1. All MPEG-4 HE-AAC multichannel profiles are fully compatible with the

DASH-AVC/264 baseline interoperability point for stereo audio, i.e. all multichannel decoders can decode DASH-IF IOPS stereo content.

9.2.4.2 DASH-specific issues

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

- The content shall be prepared according to ISO/IEC TR 23009-3 [13] to make sure each (sub-)segment starts with a SAP of type 1.

- Signaling of profile levels is not supported in RFC 6381 but the channel configuration shall be signaled by means of the ChannelConfiguration element in the MPD.

- The signaling of MPEG-4 High Efficiency AAC v2 for the codecs parameters is according to RFC6381 [11] and is documented in Table 11. Table 11 also provides information on the ISO BMFF encapsulation.

- For all HE-AAC bitstreams, explicit backward-compatible signaling of SBR shall be used.

- The content should be prepared incorporating loudness and dynamic range information into the bitstream also considering DRC Presentation Mode in ISO/IEC 14496-3 [14], Amd. 4.

- Decoders shall support decoding of loudness and dynamic range related information, i.e. dynamic_range_info() and MPEG4_ancillary_data() in the bitstream.

Table 11 Codecs parameter according to RFC6381 [11] and ISO BMFF encapsulation

Codec	Codec Parameter	ISO BMFF Encapsulation	SAP type
MPEG-4 AAC Profile [14]	`mp4a.40.2`	ISO/IEC 14496-14 [15]	1
MPEG-4 HE-AAC Profile [14]	`mp4a.40.5`	ISO/IEC 14496-14 [15]	1
MPEG-4 HE-AAC v2 Profile [14]	`mp4a.40.29`	ISO/IEC 14496-14 [15]	1

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

mp4a.40.5 = AOT 2 + AOT 5

9.2.5 MPEG-H 3D Audio

9.2.5.1 Overview

MPEG-H 3D Audio is defined in ISO/IEC 23008-3 [7] and is a Next Generation Audio (NGA) codec. MPEG-H 3D Audio encoded content shall comply with Level 1, 2 or 3 of the MPEG-H Low Complexity (LC) Profile, as defined in ISO/IEC 23008-3 clause 4.8 [7].

The clauses to follow clarify DASH specific requirements for MPEG-H 3D Audio, such as:

- Codec parameters settings and signalling

- Usage of MPD elements and attributes

- File format encapsulation modes and requirements

- Loudness and Dynamic Range Control requirements

9.2.5.2 DASH-specific Issues

The carriage of MPEG-H 3D Audio in the ISO BMFF is specified in ISO/IEC 23008-3 clause 20 [7]. Two different packaging methods are specified:

- MHA: storage of raw audio frames, as specified in ISO/IEC 23008-3 clause 20.5 [7]. Clause 9.2.5.4. provides more information on this encapsulation.

- MHM: storage of MHAS streams, as specified in ISO/IEC 23008-3 clause 20.6 [7]. The MPEG-H Audio Stream (MHAS) format is defined in ISO/IEC 23008-3 clause 14 [7]. Clause 9.2.5.5. provides more information on this encapsulation.

9.2.5.3 Element and Attribute Settings

Table 12 summarizes the mapping of relevant MPD elements and attributes to MPEG-H Audio.

Table 12 Summary of relevant MPD elements and attributes for MPEG-H Audio

Element or Attribute Name	Description
`@codecs`	The signalling of the codecs parameters is according to RFC6381 [11] and ISO/IEC 23008-3 clause 21 [7]. The value consists of the following two parts separated by a dot: • the sample entry 4CC code (`'mha1'`, `'mha2'`, `'mhm1'`, `'mhm2'`) • `'0x'` followed by the hex value of the profile-level-id, as defined in in ISO/IEC 23008-3 [7] See Table 13 and Table 14 for more details.
`AdaptationSet@`tag	This field lists the `mae_groupIDs` as defined in ISO/IEC 23008-3 [7] that are contained in the Adaptation Set separated by white spaces.
`Preselection@`tag	This field indicates the `mae_groupPresetID` as defined in ISO/IEC 23008-3 [7] that refers to a Preset in the scope of MPEG-H Audio.
`ContentComponent@`tag	This field indicates the `mae_groupID` as defined in ISO/IEC 23008-3 [7] which contains the Media Content Component.
`AudioChannelConfiguration`	For MPEG-H Audio, the Audio Channel Configuration descriptor shall use the scheme URI `"urn:mpeg:mpegB:cicp:ChannelConfiguration"`. The value shall be taken from the *ChannelConfiguration* table as defined in ISO/IEC 23091-3 [2]. Valid numbers for value are 0-7, 9-12, 14-17 or 19. The value 0 should only be used if the exact Audio Channel Configuration cannot

	be determined, e.g. a live service with in-band configuration changes within a period, or for object only audio scenes.
@audioSamplingRate	Example: "`48000`" for 48 kHz
	The indication shall correspond to the sampling frequency derived from the usacSamplingFrequencyIndex or usacSamplingFrequency as defined in ISO/IEC 23003-3 [7].
RandomAccess	The type to be used with MPEG-H Audio shall be "`closed`", i.e. the SAP type is 1.
`@mimeType`	The MIME type to be used with MPEG-H Audio shall be "`audio/mp4`".
`@lang`	The language indicated should correspond to the information conveyed in `mae_contentLanguage` of the default dialog element. The default dialog corresponds to the Group (`mae_groupDefinition()`) which is marked as default in `mae_switchGroupDefaultGroupID` and is tagged in `mae_contentKind` as dialogue. This information is carried in the `mae_audioSceneInfo()` of the MPEG-H Audio stream as defined in ISO/IEC 23008-3 [7].
	The language of a Preselection should correspond to the information conveyed in `mae_contentLanguage` of the selected dialog. The selected dialog corresponds to the Group (`mae_groupDefinition()`) which is marked as on (`mae_groupPresetConditionOnOff == 1`) for the given **Preselection**`@tag` and is tagged in `mae_contentKind` as `dialogue`. This information is carried in the `mae_audioSceneInfo()` of the MPEG-H Audio stream as defined in ISO/IEC 23008-3 [7].
Role	The Role for a Preselection should be set by the content author.
Accessibility	If the `mae_contentKind` value of at least one Audio Element is set to '9' ("audio-description/visually impaired"), an Accessibility descriptor shall indicate "`description`" according to the Role scheme defined in ISO/IEC 23009-1 [1].
	If at least the Audio Elements with a `mae_contentKind` value of '2' ("dialogue") have `mae_allowGainInteractivity` set to '1' and `mae_interactivityMaxGain` set to a non-zero value in the corresponding

> mae_GroupDefinition() structure, an Accessibility descriptor with the value "enhanced-audio-intelligibility" according to the Role scheme defined in ISO/IEC 23009-1 [1] may be used to indicate that the Preselection enables the ability for a receiver to change the relative level of dialog to enhance dialog intelligibility.
>
> If the mae_contentKind value of at least one Audio Element is set to '12' ("emergency"), an Accessibility descriptor may indicate "emergency" according to the Role scheme defined in ISO/IEC 23009-1 [1].
>
> The accessibility information indicated for a Preselection should also correspond to the mae_groupPresetKind.
>
> The mae_contentKind field and all other fields mentioned above that start with a "mae_" prefix are carried in the AudioSceneInformation() of the MPEG-H Audio stream as defined in ISO/IEC 23008-3 [7].

If present, the Preselection Tag value of the Preselection Descriptor, shall be set to the corresponding mae_groupPresetID as defined in ISO/IEC 23008-3 [7].

9.2.5.4   MHA Encapsulation

Storage of raw MPEG-H audio frames in the ISO BMFF shall be according to ISO/IEC 23008-3 clause 20.5 [7], with the following constraints:

- One audio ISO BMFF sample shall consist of a single mpegh3daFrame() structure, as defined in ISO/IEC 23008-3 clause 20.5 [7].

- The parameters carried in the MHADecoderConfigurationRecord() shall be consistent with the configuration of the audio bitstream. In particular, the mpegh3daProfileLevelIndication shall be set to "0x0B", "0x0C", or "0x0D" for MPEG-H Audio LC Profile Level 1, Level 2, or Level 3, respectively.

- The referenceChannelLayout field carried in the MHADecoderConfigurationRecord() shall be equivalent to what is signaled by **ChannelConfiguration** according to ISO/IEC 23091-3 [2].

- The content is expected to be prepared according to the ISO/IEC TR 23009-3 [13] to make sure each (sub-)segment starts with a SAP of type 1 (i.e. a sync sample). MPEG-H Audio sync samples contain Immediate Playout Frames (IPFs), as specified in ISO/IEC 23008-3 clause 20.2 [7]. For such frames, the raw MPEG-H audio frames shall contain the AudioPreRoll() syntax element, as defined in ISO/IEC 23008-3 clause 5.5.6 [7], and shall follow the requirements for stream access points as defined in ISO/IEC 23008-3 clause 5.7 [7]. The AudioPreRoll() syntax element carried in the IPFs shall contain a valid configuration structure (AudioPreRoll.Config()) and should contain one pre-roll frame (AudioPreRoll.numPreRollFrames = 1).

Note: the `mpegh3daConfig()` structure is expected to be different for each representation in an adaptation set.

Table 13 Codecs parameter and ISO BMFF encapsulation (MHA flavor)

Code	Codec Parameter	ISO BMFF Encapsulation	SAP Type
MPEG-H 3D Audio LC Profile Level 1	`mha[1, 2].0x0B`	ISO/IEC 23008-3	1
MPEG-H 3D Audio LC Profile Level 2	`mha[1, 2].0x0C`	ISO/IEC 23008-3	1
MPEG-H 3D Audio LC Profile Level 3	`mha[1, 2].0x0D`	ISO/IEC 23008-3	1

9.2.5.5 MHM Encapsulation

Storage of MHAS into ISO BMFF shall be according to ISO/IEC 23008-3 clause 20 [7] with the additional constraints described below.

The sample entry `'mhm1'` shall be used for encapsulation of MHAS packets into ISO BMFF files, according to ISO/IEC 23008-3 clause 20.6 [7]. The sample entry `'mhm2'` shall be used in cases of multi-stream delivery, i.e. the MPEG H Audio Scene is split into two or more streams for delivery as described in ISO/IEC 23008-3 clause 14.6 [7].

All MHAS packet types defined in ISO/IEC 23008-3 clause 14 [7], may be present in the stream, except the following packet types that shall not be present:

- `PACTYP_CRC16`
- `PACTYP_CRC32`
- `PACTYP_GLOBAL_CRC16`
- `PACTYP_GLOBAL_CRC32`

If Audio Scene Information, defined in ISO/IEC 23008-3 clause 15 [7], is present, it shall be always encapsulated in an MHAS packet of type `PACTYP_AUDIOSCENEINFO`. Audio Scene Information shall not be included in the `mpegh3daConfig()` structure carried in the MHAS packet of type `PACTYP_MPEGH3DACFG`.

As defined in ISO/IEC 23008-3 clause 20.6 [7], the `MHAConfigurationBox()` is optional for MHM, but if present it shall also be consistent with the configuration of the audio bitstream, as described in 9.2.5.4.

> Note: In case of in-band configuration changes within a period, the `MHAConfigurationBox()` should not be present in the corresponding sample entry.

The content is expected to be prepared according to the ISO/IEC TR 23009-3 [13] to make sure each (sub-)segment starts with a Stream Access Points (SAP) of type 1 (i.e. a sync sample). For MHM encapsulation in particular, a sync sample shall consist of the following MHAS packets, in the following order:

1. `PACTYP_MPEGH3DACFG`

2. `PACTYP_AUDIOSCENEINFO` (if Audio Scene Information is present)

3. `PACTYP_BUFFERINFO`

4. `PACTYP_MPEGH3DAFRAME`

MPEG-H Audio sync samples contain Immediate Playout Frames (IPFs), as specified in ISO/IEC 23008-3 clause 20.2 [7], thus the audio data encapsulated in the MHAS packet `PAC-TYP_MPEGH3DAFRAME` shall contain the `AudioPreRoll()` syntax element, as defined in ISO/IEC 23008-3 clause 5.5.6 [7], and shall follow the requirements for stream access points as defined in ISO/IEC 23008-3 clause 5.7 [7].

The audio configuration is delivered as part of the MHAS packet `PACTYP_MPEGH3DACFG` and, therefore, the `AudioPreRoll()` structure carried in the MHAS packet `PAC-TYP_MPEGH3DAFRAME` shall not contain the `Config()` structure, i.e. the `configLen` field of the `AudioPreRoll()` shall be 0. All rules defined in ISO/IEC 23008-3 clause 20.6.1 [7] regarding sync samples shall also apply.

The `MHASPacketLabel` shall have different values for all representations that comprise an experience.

Additional MHAS packets may be present between the MHAS packets listed above or after the MHAS packet `PACTYP_MPEGH3DAFRAME`, with one exception: when present, the `PACTYP_AU-DIOSCENEINFO` packet shall directly follow the `PACTYP_MPEGH3DACFG` packet, as defined in ISO/IEC 23008-3 clause 14.4 [7].

Table 14 Codecs parameter for ISO BMFF encapsulation (MHM flavor)

Codec	Codecs Parameter	ISO BMFF Encapsulation	SAP Type
MPEG-H 3D Audio LC Profile Level 1	`mhm[1, 2].0x0B`	ISO/IEC 23008-3	1
MPEG-H 3D Audio LC Profile Level 2	`mhm[1, 2].0x0C`	ISO/IEC 23008-3	1
MPEG-H 3D Audio LC Profile Level 3	`mhm[1, 2].0x0D`	ISO/IEC 23008-3	1

9.2.5.6   MHM Configuration Change Constraints

A configuration change takes place in an audio stream when the content setup or the Audio Scene Information changes (e.g., when changes occur in the channel layout, the number of objects etc.) and, therefore, new `PACTYP_MPEGH3DACFG` and `PACTYP_AUDIOSCENEINFO` packets are required upon such occurrences. A configuration change usually happens at program boundaries, but it may also occur within a program.

The following constraints apply:

- At each configuration change, the `MHASPacketLabel` shall be changed to a different value from the `MHASPacketLabel` in use before the configuration change occurred. A configuration change may happen at the beginning of a new ISO BMFF file or at any position within the file. In the latter case, the File Format sample that contains a configuration change shall be encoded as a sync sample (i.e. an IPF) as defined above. Note, that also after a configuration change the `MHASPacketLabel` needs to have different values for all representations comprising an experience.

- A sync sample that contains a configuration change and the last sample before such a sync sample may contain a truncation message (i.e., a `PACTYP_AUDIOTRUNCATION` packet in the MHAS stream) as defined in ISO/IEC 23008-3 clause 14.4 [7]. If MHAS packets of type `PACTYP_AUDIOTRUNCATION` are present, they shall be used as described in ISO/IEC 23008-3 clause 14.4 [7].

9.2.5.7   MPEG-H Audio Multi-Stream Constraints

The multi-stream-enabled MPEG-H Audio System is capable of handling Audio Components delivered in several different elementary streams (e.g., the main MHAS stream containing one complete audio main, and one or more auxiliary MHAS streams, containing different languages and audio description). The MPEG-H Audio Metadata information (MAE) allows the MPEG-H Audio Decoder to correctly decode several MHAS streams.

The following constraints apply when using the sample entry `'mhm2'`:

- One MHAS stream shall be the main stream (Main Adaptation Set), i.e., in exactly one MHAS stream the Audio Scene Information shall have the `mae_isMainStream` field set to 1. In all other MHAS streams the `mae_isMainStream` shall be set to 0. All Representations of an MHAS stream with `mae_isMainStream` set to 1 form the Main Adaptation Set.

- In each auxiliary MHAS stream (i.e., streams with `mae_isMainStream` field set to 0) the `mae_bsMetaDataElementIDoffset` field in the Audio Scene Information shall be set to the index of the first metadata element in the auxiliary MHAS stream minus one. Each auxiliary Stream (and all its representations) form(s) a Partial Adaptation Set.

- For the main and the auxiliary MHAS stream(s), the `MHASPacketLabel` shall be set according to ISO/IEC 23008-3 clause 14.6 [7].

- All MHAS elementary streams that carry Audio Components of one complete experience shall be time aligned.

- In each auxiliary MHAS elementary stream (i.e., streams with `mae_isMainStream` field set to 0), IPFs shall be aligned to the IPFs present in the main stream (i.e., the stream with `mae_isMainStream` field set to 1).

9.2.5.8   Loudness and Dynamic Range Control

Loudness metadata shall be embedded within the `mpegh3daLoudnessInfoSet()` structure as defined in ISO/IEC 23008-3 clause 6.3 [7]. Such loudness metadata shall include at least the loudness of the content rendered to the default rendering layout as indicated by the `referenceLayout`

field (see ISO/IEC 23008-3 clause 5.3.2 [7]). More precisely, the `mpegh3daLoudness-InfoSet()` structure shall include at least one `loudnessInfo()` structure with `loudness-InfoType` set to 0, whose `drcSetId` and `downmixId` fields are set to 0 and which includes at least one `methodValue` field with `methodDefinition` set to 1 or 2 (see ISO/IEC 23008-3, clause 6.3.1 [7] and ISO/IEC 23003-4 clause 7.3 [16]). The indicated loudness value shall be measured according to applicable regional loudness regulations.

DRC metadata shall be embedded in the `mpegh3daUniDrcConfig()` and `uniDrcGain()` structures as defined in ISO/IEC 23008-3 clause 6.3 [7]. For each included DRC set the `drcSetTargetLoudnessPresent` field as defined in ISO/IEC 23003-4 clause 7 [16] shall be set to 1. The `bsDrcSetTargetLoudnessValueUpper` and `bsDrcSetTargetLoudnessValueLower` fields shall be configured to continuously cover the range of target loudness levels between -31 dB and 0 dB. The embedded DRC metadata should allow for a decoder output loudness of at least -16 LKFS.

Loudness compensation information (`mae_LoudnessCompensationData()`), as defined in ISO/IEC 23008-3 clause 15.5 [7] shall be present in the Audio Scene Information if the `mae_allowGainInteractivity` field (according to ISO/IEC 23008-3 clause 15.3 [7]) is set to 1 for at least one group of audio elements.

9.2.6 MPEG-D Unified Speech and Audio Coding

9.2.6.1 Overview

MPEG-D Unified Speech and Audio Coding (USAC) has been designed to provide consistently high audio quality with a variety of content that comprises a mixture of audio and speech signals. Using such a codec in a DASH streaming environment enables adaptive switching capability from 12 kbps stereo up to transparency.

ISO/IEC 23000-19 [17] defines a media profile for MPEG-D USAC that is suitable for streaming applications and therefore can be referenced here.

9.2.6.2 DASH-specific issues

In the context of DASH-IF IOPs, the following applies to the xHE-AAC profile:

- Content representations encoded with MPEG-D USAC shall comply with the Extended High Efficiency AAC (xHE-AAC) CMAF media profile 'cxha', as defined in ISO/IEC 23000-19 [17], providing support up to 5.1 multichannel coding.

- All representations of an adaptation set shall conform to the CMAF switching set constraints.

- The codec signaling is according to RFC6381 [11] and documented in Table 15.

- The profiles mime sub- parameter of the @mimetype attribute should include 'cxha'.

- If the ChannelConfiguration parameter is present in the Movie header, then the identical channel configuration shall be signaled by means of the AudioChannelConfiguration element in the MPD, according to the values specified in ISO/IEC 23000-19 Table K.2 [17].

- The CMAF xHE-AAC media profile defined in ISO/IEC 23000-19 [17] requires each CMAF Fragment to start with an SAP of type 1.

Table 15 Codecs parameters according to RFC 6381 [11] and ISO BMFF encapsulation for MPEG-D USAC

Codec	Codec Parameter	ISO BMFF Encapsulation	SAP type
MPEG-D USAC [17]	`mp4a.40.42`	ISO/IEC 23000-19 [17]	1

9.3   Client Implementation Guidelines

Independent of the codec, a client that supports one or more codecs of multichannel sound playback should exhibit the following characteristics:

- Playback multichannel sound correctly given the client operating environment. As an example, if the audio track delivers 5.1 multichannel sound, the client might perform one or more of the following: decode the multichannel signal on the device and output either 6ch PCM over HDMI, or pass that multichannel audio with no changes to external AVRs, or if the device is rendering to stereo outputs such as headphones, either correctly downmix that multi-channel audio to 2-channel sound, or select an alternate stereo adaptation set, or other appropriate choices.

- Adaptively and seamless switch between different bitrates as specified in the adaptation sets according to the playback client's logic. Seamless switching is defined as no perceptible interruption in the audio, and no loss of A/V sync. There is no expectation that a client can seamlessly switch between formats.

9.4   Extensions

9.4.1   General

9.4.1.1   Definitions

A *multichannel audio client* at least supports the following features:

- All DASH-related features as defined in DASH-IF IOP clause 3 [18].

- content protection based on common encryption and key rotation as defined in DASH-IF IOP clause 7 [18]. And specifically, the client supports MPD-based parsing and movie box based parsing of DRM related parameters for common encryption.

- The client implementation guidelines in clause 9.3.

9.4.1.2   Recommendations

If content is offered claiming conformance to any extension in this section, the content author is encouraged to use the HTTP-URL construction as defined in ISO/IEC TR 23009-3 clause 5.1.4 [13].

9.4.2   Dolby Extensions

9.4.2.1   Introduction

For the support of Dolby advanced audio support, three additional extensions are defined.

Conformance to *DASH-IF multichannel extension with AC-4* may be signaled by an `@profile` attribute with the value "`http://dashif.org/guidelines/dashif#ac-4`".

Conformance to *DASH-IF multichannel extension with Dolby TrueHD* may be signaled by an `@profile` attribute with the value "`http://dashif.org/guidelines/dashif#mlpa`".

Conformance to *DASH-IF multichannel extension with AC-4* may be signaled by an `@profile` attribute with the value "`http://dashif.org/guidelines/dashif#ac-4`".

9.4.2.2 Definition

Content may be authored claiming conformance to DASH-IF multichannel audio extension with Enhanced AC-3

- if the content is multichannel audio content as defined in clause 9.4.1, and
- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

- Enhanced AC-3 (Dolby Digital Plus) ETSI TS 102 366 [3] and the DASH-specific features defined in clause 9.2.1.2.

Content may be authored claiming conformance to *DASH-IF multichannel extension with Dolby TrueHD*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o Dolby TrueHD and the DASH-specific features defined in clause 9.2.1.2

Content may be authored claiming conformance to *DASH-IF multichannel extension with AC-4*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o AC-4 and the DASH-specific features defined in clause 9.2.1.2

9.4.3 DTS Extensions

9.4.3.1 Introduction

For the support of DTS advanced audio support, six additional extensions are defined.

Conformance to DASH-IF multichannel audio extension with DTS Digital Surround may be signaled by a `@profile` attribute with value `http://dashif.org/guidelines/dashif#dtsc`.

Conformance to DASH-IF multichannel audio extension with DTS-HD High Resolution and DTS-HD Master Audio may be signaled by a `@profile` attribute with value `http://dashif.org/guidelines/dashif#dtsh`.

Conformance to DASH-IF multichannel audio extension with DTS Express may be signaled by a `@profile` attribute with value `http://dashif.org/guidelines/dashif#dtse`

Conformance to DASH-IF multichannel extension with DTS-HD Lossless (no core) may be sig-naled by a `@profile` attribute with value `http://dashif.org/guidelines/dashif#dtsl`

Conformance to DASH-IF multichannel extension with DTS-UHD Profile 2 may be signaled by a `@profile` attribute with value `http://dashif.org/guide-lines/dashif#dtsx`

Conformance to DASH-IF multichannel extension with DTS-UHD Profile 3 may be signaled by a `@profile` attribute with value `http://dashif.org/guide-lines/dashif#dtsy`

9.4.3.2   Definition

Content may be authored claiming conformance to *DASH-IF multichannel audio extension with DTS Digital Surround*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

    o   all multichannel audio client features as defined in clause 9.4.1

    o   DTS and the DASH-specific features defined in clause 9.2.2.2.

Content may be authored claiming conformance to DASH-IF multichannel audio extension with DTS-HD High Resolution and DTS-HD Master Audio

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

    o   all multichannel audio client features as defined in clause 9.4.1

    o   DTS-HD High Resolution and DTS-HD Master Audio and the DASH-specific fea-tures defined in clause 9.2.2.2.

Content may be authored claiming conformance to *DASH-IF multichannel audio extension with DTS Express*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

    o   all multichannel audio client features as defined in clause 9.4.1

    o   DTS-HD Express and the DASH-specific features defined in clause 9.4.1

Content may be authored claiming conformance to DASH-IF multichannel extension with DTS-HD Lossless (no core)

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

    o   all multichannel audio client features as defined in clause 9.4.1

    o   DTS-HD Lossless (no core) and the DASH-specific features defined in clause 9.2.2.2.

Content may be authored claiming conformance to *DASH-IF multichannel extension with DTS-UHD* Profile 2

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o DTS-UHD Profile 2 and the DASH-specific features defined in clause 9.2.2.2.

Content may be authored claiming conformance to *DASH-IF multichannel extension with DTS-UHD Profile 3*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o DTS-UHD Profile 3 and the DASH-specific features defined in clause 9.2.2.2.

9.4.4 MPEG Surround Interoperability Points

9.4.4.1 Introduction

For the support of MPEG Surround advanced audio the following extension is defined.

Conformance to *DASH-IF multichannel audio extension with MPEG Surround* according to ISO/IEC 23003-1 [12] may be signaled by an `@profile` attribute with the value `"http://dashif.org/guidelines/dashif#mps"`.

9.4.4.2 Definition

Content may be authored claiming conformance to *DASH-IF multichannel audio extension with MPEG Surround*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o ISO/IEC 23003-1:2007 and the DASH-specific features defined in clause 9.2.3.2.

9.4.5 MPEG HE-AAC Multichannel Interoperability Points

9.4.5.1 Introduction

Conformance to *DASH-IF multichannel audio extension with HE-AACv2 level 4* [14] may be signaled by an `@profile` attribute with the value `"http://dashif.org/guidelines/dashif#heaac-mc51"`.

Conformance to *DASH-IF multichannel audio extension with HE-AACv2 level 6* [14] may be signaled by an `@profile` attribute with the value `"http://dashif.org/guidelines/dashif#heaac-mc71"`.

9.4.5.2 Definition

Content may be authored claiming conformance to *DASH-IF multichannel audio extension with HE-AACv2 level 4*

- if the content is multichannel audio content as defined in 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o HE-AACv2 level 4 [14] and the DASH-specific features defined in clause 9.2.4.2

Content may be authored claiming conformance to *DASH-IF multichannel audio extension with HE-AACv2 level 6*

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o HE-AACv2 level 6 [14] and the DASH-specific features defined in clause 9.2.4.2

9.4.6 MPEG-H 3D Audio Interoperability Points

9.4.6.1. Introduction

Compliance to DASH-IF multichannel audio extension with ISO/IEC 23008-3 [7] may be signaled by a `@profile` attribute with the value `"http://dashif.org/guidelines/dashif#mpeg-h-3da"`.

9.4.6.2 Definition

Content may be authored claiming conformance to DASH-IF multichannel audio extension with MPEG-H 3D Audio,

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if a client can properly play the content by supporting at least the following features:

  o all multichannel audio client features as defined in clause 9.4.1,

  o MHA, MHM and the DASH-specific features defined in clause 9.2.5.

9.4.7 MPEG-D USAC Interoperability Points

9.4.7.1 Introduction

Conformance to DASH-IF audio extension with USAC according to ISO/IEC 23000-19 [17] may be signaled by an `@profile` attribute with the value `"http://dashif.org/guide-lines/dashif#cxha"`.

9.4.7.2 Definition

Content may be authored claiming conformance to DASH-IF audio extension with USAC

- if the content is multichannel audio content as defined in clause 9.4.1, and

- if the content conforms to what has been defined in clause 9.2.6.2

- if a client can properly play the content by supporting at least the following features

  o all multichannel audio client features as defined in clause 9.4.1

  o DASH-specific features defined in clause 9.2.6.2.

Annex A:
Numerical cross reference to DASH-IOP Version 4.3

A.1 References

Reference	Corresponding DASH-IF IOP 4.3	Specification
1	4 (updated)	ISO/IEC 23009-1
2	49 (updated)*	ISO/IEC 23091-3 (replaces 23001-8)
3	35 (updated)	ETSI TS 102 366
4	new	ETSI TS 103 190-2
5	37 (updated)	ETSI TS 102 114
6	new	ETSI TS 103 491
7	64 (updated)	ISO/IEC 23008-3
8	new	ETSI TS 103 420
9	36 (updated)	Dolby MLP
10	8	ATSC A/342
11	10	IETF RFC 6381
12	38	ISO/IEC 23003-1
13	6 (updated)	ISO/IEC TR 23009-3
14	11 (updated)	ISO/IEC 14496-3
15	12 (updated)	ISO/IEC 14496-14
16	new	ISO/IEC 23003-4
17	91 (updated)	ISO/IEC 23000-19
obsoleted	34	DTS 9302J81100
obsoleted	39	DTS 9302K62400

*Note that 23001-8 has been replaced by 23091-1, 23091-2 and 23091-3

A.2 Tables

Table	Corresponding DASH-IF IOP 4.3	Caption
1 (excludes video IOP)	2	Interoperability Point Extensions
2	new 1	NGA Element and Attribute Settings
3	new 2	Additional recommended MPD Elements for NGA Audio
4	new 3	Recommended NGA Signaling with Preselections
5	25	Dolby Technologies: Codec parameters and ISO BMFF encapsulation
6	new 4	AC-4 Element and Attribute Settings
7	26	DTS codec parameters and ISOBMFF encapsulation
8	new 5	DTS codec parameters and ISOBMFF encapsulation
9	new 6	Relevant MPD Elements and Attributes for DTS-UHD
10	27	Codecs parameter according to RFC6381 [11] and ISO BMFF encapsulation for MPEG Surround codec
11	28	Codecs parameter according to RFC6381 [11] and ISO BMFF encapsulation
12	new 7	Summary of relevant MPD elements and attributes for MPEG-H Audio
13	29	Codecs parameter and ISO BMFF encapsulation (MHA flavor)
14	new 8	Codecs parameter for ISO BMFF encapsulation (MHM flavor)
15	30	Codecs parameters according to RFC 6381 [11] and ISO BMFF encapsulation for MPEG-D USAC