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**Information technology — Multimedia  
application format (MPEG-A) —**

Part 19:  
**Common media application format  
(CMAF) for segmented media**

**AMENDMENT 1: SHVC media profile and  
additional audio media profiles**

*Technologies de l'information — Format pour application multimédia  
(MPEG-A) —*

*Partie 19: Format CMAF (Common Media Application Format) pour  
médiAs segmentés*

*AMENDEMENT 1: Profil média SHVC et profils médias audio  
supplémentaires*



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This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

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# Information technology — Multimedia application format (MPEG-A) —

## Part 19: Common media application format (CMAF) for segmented media

### AMENDMENT 1: SHVC media profile and additional audio media profiles

#### Clause 2

Add the following normative references:

ISO/IEC 23008-3:—<sup>1)</sup>, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 3: 3D audio*

ISO/IEC 23091-3, *Information technology — Coding-independent code points — Part 3: Audio*

ISO/IEC 23003-4:2015, *MPEG audio technologies — Part 4: Dynamic range control*

#### Clause 3

Add the following terms and definitions to subclause 3.2:

##### 3.2.10

##### **audio programme**

complete collection of all audio programme components and, if present, a set of accompanying presets

##### 3.2.11

##### **audio programme component**

smallest addressable unit of an audio programme

#### Clause 5

Add the following new paragraphs at the end of Clause 5:

Annex H specifies the CMAF media profile for scalable HEVC (SHVC).

Annex I specifies the CMAF media profile for multichannel AAC.

Annex J specifies the CMAF media profile for MPEG-H audio.

1) Under preparation. Stage at the time of publication: ISO/FDIS 23008-3:2018.

*Subclause 9.1*

Before the last paragraph in subclause 9.1, add a new paragraph:

An additional CMAF media profile for scalable HEVC (SHVC) is defined in Annex H.

*Subclause 10.1*

Replace the first sentence with:

This clause specifies CMAF audio tracks derived from the CMAF track format, with additional constraints specific to CMAF audio tracks and audio CMAF media profiles.

Additional CMAF media profiles are defined in

- Annex I for multichannel AAC, and
- Annex J for MPEG-H 3D audio.

*Annex G*

Following Annex G, add new Annexes H, I and J:

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## Annex H (normative)

### Scalable HEVC media profile and track format

#### H.1 Dependent CMAF tracks

Dependent CMAF tracks can only be processed with the availability of one or more CMAF tracks. Specifically, CMAF fragments of dependent CMAF track can only be decoded and/or rendered if the corresponding CMAF fragment of all of the CMAF tracks it depends on are available. CMAF tracks that are not dependent CMAF tracks are regular CMAF tracks.

In a hypothetical CMAF receiver, the corresponding CMAF fragments of CMAF tracks depended on, are expected to be available prior to the CMAF fragments of the dependent CMAF track.

A manifest offering CMAF presentations with dependent CMAF tracks is expected to provide signalling of dependent and required CMAF tracks.

#### H.2 Scalable HEVC CMAF tracks

Scalable HEVC CMAF tracks shall conform to Clauses 7, 8, 9, and 12, and shall additionally conform to the constraints specified in this Annex.

Each scalable HEVC CMAF track that does not contain VCL NAL units with `nuh_layer_id` and `TemporalID` both equal to 0 is a dependent CMAF track and the constraints specified for dependent CMAF tracks in Clause H.1 shall apply. It is expected that the manifest provides signalling to express the dependency of a dependent CMAF track on another CMAF track, for example, using the `@dependencyID` in a DASH MPD.

#### H.3 CMAF switching set constraints for scalable HEVC CMAF tracks and media profiles

##### H.3.1 General

Subclause 9.2.3 applies, and additionally the following constraints apply:

- Each CMAF track with sample entry 'hev1' shall conform to the HEVC media profile and track format as specified in Annex B.
- Each CMAF track containing a scalable HEVC bitstream or part thereof shall contain exactly one ISO BMFF track.
- When multiple CMAF tracks are present for carrying a scalable HEVC bitstream, the corresponding ISO BMFF tracks shall use distinct track IDs.
- CMAF switching sets containing a media profile listed in Clause H.6 with sample entry 'hev2' and 'lhev1' shall conform to single initialization CMAF switching set constraints.

Each coded video sequence in a scalable HEVC bitstream shall contain the necessary sequence parameter set and picture parameter set NAL units to signal decoding parameters changes allowed between CMAF tracks in the same switching set.

### H.3.2 Sample Description Box ('std')

Subclauses 9.2.4 and 9.3.2.2 shall apply with the following additional restrictions:

A decoder configuration record:

- shall signal other sequence parameter set and picture parameter set fields used by the video track as specified in ISO/IEC 14496-15:2017, subclause 8.3.3.1,
- For a visual sample entry with `codingname` 'hev1', 'hev2', and 'lhe1' shall contain one or more decoding parameter sets (containing VPS, SPS, and PPS NALs for HEVC video). Each video sample in the CMAF track shall reference a parameter set in the sample entry.
- may contain additional SEI NAL units to signal colour encoding and rendering, such as `mastering_display_colour_volume`, SEI `payloadType=137` (ISO/IEC 23008-2), or `alternative_transfer_characteristics`, SEI `payloadType =147` (ISO/IEC 23008-2).

### H.3.3 Track Header Box ('tkhd')

The requirements of 7.5.4 apply.

NOTE Normalized width and height can be derived from a sequence parameter set NAL in each segment and coded video sequence for 'hev1', 'hev2', and 'lhe1' video samples. See subclause 9.2.3.3 for the storage and semantics of video sequence parameter sets.

### H.3.4 Access units

Clause 9.2.6 applies.

Access units shall conform to the requirements of a sample of the indicated description ('hev1', 'hev2', or 'lhe1') as specified in ISO/IEC 14496-15.

CMAF fragments containing samples identified by the 'hev1', 'hev2', or 'lhe1' type shall contain all SPS and PPS NALs referenced by a coded video sequence in the first access unit of that sequence, immediately following its first access unit delimiter NAL (if any).

NOTE Access units of type 'hev1', 'hev2', and 'lhe1' can retain filler data (NAL units or SEI messages) and SEI messages that would change hypothetical reference decoder bitstream conformance if such conformance is necessary, such as the case where bitstreams are to be repackaged and conformance tested in MPEG-2 transport streams.

### H.3.5 Decoding of adaptively switched scalable HEVC CMAF tracks

Subclause 6.6.6 applies to switching between single-layer bitstreams, wherein a “conceptual” track is generated by concatenating segments from different tracks among which the switching occurs. The same applies for each of the multiple tracks carrying a scalable bitstream, with the only difference being that, in this case multiple “conceptual” tracks are generated by concatenation of CMAF fragments. Once the multiple “conceptual” tracks are generated, the process specified in ISO/IEC 14496-15:2017, Clause 9 is applied to construct the bitstream to be decoded by the video decoder.

## H.4 Sample and CMAF fragment constraints

### H.4.1 Storage of scalable high efficiency video coding elementary streams

#### H.4.1.1 Conformance

Scalable high efficiency video coding (scalable HEVC) video tracks shall comply with ISO/IEC 14496-15:2017, Clause 9, with the following constraints:

- Each track shall carry only one layer or only a subset of one layer.

- Aggregators (as defined in ISO/IEC 14496-15:2017, Annex A) shall not be included in any track.
- The external base layer sample group shall not be included in any track.

The base layer (coded according to HEVC specification) shall be stored as described in subclause B.3.1.

#### H.4.1.2 Visual sample entry

The base track's syntax and values for a visual sample entry shall conform to sample entry 'hev1' as defined in ISO/IEC 14496-15.

- For each track that carries a subset of the base layer where the subset contains VCL NAL units with `TemporalId` greater than 0 only, the sample entry type shall be 'hev2'.
- For each track that carries a layer for which the VCL NAL units have `nuh_layer_id` greater than 0 or a subset of such a layer, the sample entry type shall be 'lhe1'.

#### H.4.1.3 HEVCDecoderConfigurationRecord and LHEVCDecoderConfigurationRecord

The `HEVCDecoderConfigurationRecord` and the HEVC compatible base layer shall conform to subclause B.3.1.3.

The `LHEVCDecoderConfigurationRecord` and the enhancement layers shall conform to subclause B.3.1.3. inclusion, use and passing of SEI messages.

### H.4.2 Constraints on scalable HEVC elementary streams

#### H.4.2.1 General

The following constraints apply to all CMAF scalable HEVC elementary streams. See Clause H.6 for media profile constraints on tier, profile, level, and frame rates.

#### H.4.2.2 General constraints

- The bitstream shall contain at most two layers, a base layer and possibly an enhancement layer.
- The base layer shall conform to HEVC Main 10 profile and main tier.
- The enhancement layer, when present, shall conform to HEVC scalable Main 10 profile and main tier.
- The spatial resolution of the enhancement layer shall be equal to X times that of the base layer both horizontally and vertically. The value of X shall be 1.5, 2, or 3.
- Each layer shall contain at most two sub-layers, with `TemporalId` equal to 0 and 1 when there are two sub-layers, and the value of `sps_max_sub_layers_minus1` of each SPS shall be set equal to 0 or 1. If there is only one sub-layer, the `TemporalId` shall be 0.
- The value of `sub_layer_level_present_flag[ 0 ]` shall be equal to 1. This constraint requires the signalling of the level of the sub-layer representation with `TemporalId` equal to 0.

#### H.4.2.3 Picture rate related constraints

- An enhancement layer shall only be present, if the base layer has constant picture rate.
- The enhancement layer, if present, shall have the same number of sub-layers as the base layer.
- When a layer has two sub-layers, the sub-layer representation with `TemporalId` equal to 0 shall have a constant picture rate (as indicated by the presence of `elemental_duration_in_tc_minus1[ 0 ]`), and the picture rate shall be exactly half of that of the entire layer's picture rate

(i.e., `elemental_duration_in_tc_minus1[ 0 ]` is equal to  $2 * \text{elemental\_duration\_in\_tc\_minus1}[ 1 ]$ ).

- The enhancement layer, when present, shall have the same picture rate as the base layer.
- The `vps_vui_present_flag` in each VPS shall be set equal to 1, `pic_rate_present_vps_flag` shall be set equal to 1, `pic_rate_present_flag[ i ][ j ]` shall be set equal to 1 and `constant_pic_rate_idc[ i ][ j ]` shall be set equal to 1 for all *i*, for all *j*.
- The `vui_parameters_present_flag` in each SPS shall be set equal to 1, `vui_timing_info_present_flag` in each SPS shall be set equal to 1, `vui_hrd_parameters_present_flag` in each SPS shall be set equal to 1, and `fixed_pic_rate_general_flag[ i ]` shall be set equal to 1 or `fixed_pic_rate_within_cvs_flag[ i ]` shall be set equal to 1 for all values of *i* in the range of 0 to `maxNumSubLayersMinus1`, inclusive.
- If `vps_num_hrd_parameters` is greater than 0, the following shall apply:
  - For each `hrd_parameters()` syntax structure in the VPS: `fixed_pic_rate_general_flag[ i ]` shall be set equal to 1 or `fixed_pic_rate_within_cvs_flag[ i ]` shall be set equal to 1 for all values of *i* in the range 0 to `maxNumSubLayersMinus1`, inclusive.
  - For each value of *i* in the range 0 to `maxNumSubLayersMinus1`, inclusive, the value of the syntax element `elemental_duration_in_tc_minus1[ i ]` in the `hrd_parameters()` syntax structure applicable to the enhancement layer shall be equal to the value of the syntax element `elemental_duration_in_tc_minus1[ i ]` in the `hrd_parameters()` syntax structure applicable to the base layer.

NOTE This profile is restricted to equal picture rates on both layers. Implementations can, however, be capable of switching between different picture rates.

#### H.4.2.4 Picture type

All pictures shall be encoded as coded frames, and shall not be encoded as coded fields.

#### H.4.2.5 Video parameter sets (VPS)

##### H.4.2.5.1 VPS fields

Each scalable HEVC video sample in the CMAF track shall reference the VPS in the CMAF header sample entry according to ISO/IEC 14496-15. VPS shall not change within CMAF tracks or between CMAF tracks in a switching set. A CMAF scalable HEVC track shall conform to ISO/IEC 23008-2:2017, Annexes F and H with the following additional constraints:

- The following fields shall have values set as follows for each `profile_tier_level()` structure in VPS:
  - `general_progressive_source_flag` shall be set to 1.
  - `general_frame_only_constraint_flag` shall be set to 1.
  - `general_interlaced_source_flag` shall be set to 0.
  - `general_non_packed_constraint_flag` shall be set to 0.
  - `vps_extension_flag` shall be set to 1.
  - `vps_vui_present_flag` shall be set to 1.
- The condition of the following fields for each `profile_tier_level()` structure in VPS shall not change throughout an scalable HEVC elementary stream:
  - `general_profile_space`

- `general_profile_idc`
- `general_tier_flag`
- `general_level_idc`
- The value of `vps_max_layers_minus1` of each VPS shall be set equal to 1.
- The value of `sub_layer_level_present_flag[ 0 ]` shall be equal to 1 only when the value of `sub_layer_level_idc[ 0 ]` is different than the value of `general_level_idc`.

#### H.4.2.5.2 VPS visual usability information (VPS VUI) fields

VPS VUI parameters that occur within a CMAF scalable HEVC track shall conform to ISO/IEC 23008-2:2017, Annexes F and H with the following additional constraints:

- `pic_rate_present_vps_flag` shall be set equal to 1.
- `pic_rate_present_flag[ i ][ j ]` shall be set equal to 1.
- `constant_pic_rate_idc[ i ][ j ]` shall be set equal to 1 for all *i*, for *j* equal to `MaxSubLayersInLayerSetMinus1[ i ]`.

The values of the following fields in each `video_signal_info()` in VPS VUI shall not change throughout a CMAF track and switching set:

- `vps_video_format`
- `video_full_range_vps_flag`
- `colour_primaries_vps`
- `transfer_characteristics_vps`
- `matrix_coeffs_vps`

#### H.4.2.6 Sequence parameter sets (SPS)

##### H.4.2.6.1 SPS fields

Sequence parameter set NAL units that occur within a CMAF scalable HEVC track shall conform to ISO/IEC 23008-2:2017, Annexes F and H with the following additional constraints:

- The following fields shall have pre-determined values as follows:
  - `general_progressive_source_flag` shall be set to 1.
  - `general_frame_only_constraint_flag` shall be set to 1.
  - `general_interlaced_source_flag` shall be set to 0.
  - `general_non_packed_constraint_flag` shall be set to 0.
  - `vui_parameters_present_flag` shall be set to 1.
  - `vui_timing_info_present_flag` shall be set to 1, `vui_hrd_parameters_present_flag` shall be set to 1, and `fixed_pic_rate_general_flag[ i ]` shall be set equal to 1 or `fixed_pic_rate_within_cvs_flag[ maxNumSubLayersMinus1 ]` shall be set equal to 1.

**H.4.2.6.2 Visual usability information (VUI) fields**

VUI parameters that occur within a CMAF scalable HEVC track shall conform to ISO/IEC 23008-2:2017, Annexes F and H with the following additional constraints:

- The following fields shall have pre-determined values as defined:
  - `video_full_range_flag` shall be set to 0.

Specification for:

`colour_description_present_flag, overscan_info_present_flag, low_delay_hrd_flag, colour_description_present_flag, colour_primaries, transfer_characteristics, matrix_coeffs, vui_time_scale, vui_num_units_in_tick` as specified in 9.4.2.2.2 apply.

**H.4.2.7 Maximum bitrate**

The maximum bitrate of HEVC elementary streams shall be calculated by implementation of the buffer and timing model defined in ISO/IEC 23008-2:2017, Clause F.13.

**H.4.2.8 Frame rate in the elementary stream**

Sample durations stored in the ISO Media Track Run Box shall determine the frame rate of a track.

**H.5 Video codec parameters**

**H.5.1 Scalable HEVC signalling of “codecs” parameters**

Presentation applications should signal video codec profile and levels of each scalable HEVC track and switching set using parameters conforming to IETF RFC 6381 and ISO/IEC 14496-15:2017, Clause E.4.

**H.5.2 Cropping**

If picture cropping is used, it shall be set by SPS cropping parameters `conf_win_right_offset, conf_win_top_offset, conf_win_left_offset` and `conf_win_bottom_offset`. SPS cropping parameters. `conf_win_top_offset` and `conf_win_left_offset` shall be set to 0.

**H.6 Scalable HEVC media profile and track brands**

Scalable HEVC media profiles and track brands shall conform to Clause A.2 except for Table H.1.

**Table H.1 — Scalable HEVC video media profiles**

Media profile	Codec	Profile	Level	colour primaries in VUI	transfer characteristics in VUI <sup>a</sup>	matrix coefficients in VUI	Max frame height	Max frame width	Max frame rate	CMAF file brand
SHV10	Scalable HEVC	12.3.1.1.1.1 scalable Main 10 main tier	5.2	1 <sup>a</sup> 9 <sup>b</sup>	1 <sup>a</sup> 14 <sup>b</sup>	1 <sup>a</sup> 9 <sup>c</sup>	2 160	3 840	120	'csh1'

<sup>a</sup> This value is equivalent to the definitions in ITU-R BT.709. For details refer to ISO/IEC 23008-2.  
<sup>b</sup> This value is equivalent to the definitions in ITU-R BT.2020. For details refer to ISO/IEC 23008-2.  
<sup>c</sup> This value is commonly also known as ITU-R BT.2020 non-constant luminance. For details refer to ISO/IEC 23008-2.

NOTE ITU-R BT.2100 is not supported since this media profile is considered to build on top of non-HDR media.

## Annex I (normative)

### AAC multichannel CMAF media profiles and track format

#### I.1 General

This annex specifies the track format of additional AAC based audio CMAF media profiles. These media profiles are inherited from the existing AAC Core CMAF audio media profiles and allow for multichannel configurations. In particular, the following two CMAF media profiles are described:

- An “AAC multichannel” CMAF media profile that specifies constraints on AAC CMAF tracks to enable interoperability and random access of CMAF switching sets containing a single CMAF track encoded with one of the AAC profiles for the mono, stereo, 5.0, 5.1 and 7.1 channel configurations.
- An “AAC multichannel adaptive” CMAF media profile that specifies additional constraints on AAC CMAF tracks, fragments, samples, and metadata to allow seamless switching between alternative tracks and bitrates in an AAC multichannel adaptive CMAF switching set.

#### I.2 AAC multichannel audio CMAF media profile

AAC multichannel audio CMAF media profile shall conform to the general AAC CMAF track format specified in subclause 10.3, with the following additional constraints:

- Each AAC elementary stream shall be encoded using MPEG-4 AAC LC or HE-AAC profiles, level 6.
- When using HE-AAC and HE-AACv2 bitstreams, explicit backwards compatible signalling shall be used to indicate the use of the SBR and PS coding tools.
- AAC multichannel CMAF tracks shall not exceed eight audio channels (where the LFE channel, if any, is included in the count).
- AAC multichannel elementary streams shall not exceed 48 kHz sample rate.
- The `channelConfiguration` parameter (see subclause 10.3.4.2.5) shall be set according to one of the channel configurations given in Table I.2.
- The value of the `channelcount` parameter in the `AudioSampleEntry` box defined in ISO/IEC 14496-12 shall be set to the total number of channels (including the LFE).
- The arrangement of syntactic elements (see subclause 10.3.5.2.2) shall be according to ISO/IEC 14496-3:2009, Table 1.19. For convenience, the arrangement of elements for the allowed channel configurations is reported in Table I.1:

**Table I.1 — Arrangement of audio syntactic elements**

Channel configuration	Number of channels	Audio syntactic elements
5	5.0	<SCE>, <CPE>, <CPE>, <optional additional elements>, <TERM>
6	5.1	<SCE>, <CPE>, <CPE>, <LFE>, <optional additional elements>, <TERM>
7 12	7.1 Front 7.1 Back	<SCE>, <CPE>, <CPE>, <CPE>, <LFE>, <optional additional elements>, <TERM>
14	7.1 Top	<SCE>, <CPE>, <CPE>, <LFE>, <CPE>, <optional additional elements>, <TERM>

- The brand that indicates compatibility with the AAC multichannel media profile is 'camc' and should be used to indicate CMAF tracks that conform to this media profile.
- If the brand 'camc' is present, the CMAF track shall conform to the AAC multichannel media profile.

NOTE The usage of this brand is recommended for multichannel AAC encoded tracks while the 'caac' brand is recommended for mono and stereo AAC encoded tracks.

### I.3 AAC multichannel adaptive audio CMAF media profile

The AAC multichannel adaptive CMAF media profile shall conform to the AAC multichannel media profile, with the following additional constraints:

- Each AAC elementary stream shall be encoded following the constraints defined from subclause 10.5.2 to subclause 10.5.5.
- The AAC multichannel adaptive media profile FileTypeBox compatibility brand shall be 'cama' and should be used to indicate CMAF tracks that conform to this CMAF media profile.

### I.4 AAC multichannel media profiles and track brands

The parameters defined in this annex for AAC multichannel CMAF media profiles are summarized in Table I.2. The AAC multichannel adaptive audio CMAF media profile ('cama') is a constrained subset of the AAC multichannel audio CMAF media profile ('camc'), therefore the 'cama' CMAF tracks always conform to the 'camc' CMAF media profile.

Table I.2 — AAC multichannel CMAF media profiles

Media profile	Codec	Profile	Level	Channel configurations	Max sampling rate	File brand
AAC multichannel	MPEG-4 AAC	AAC-LC, HE-AAC	6	As defined in ISO/IEC 14496-3: 1, 2, 5, 6, 7, 12, 14	48 kHz	'camc'
AAC multichannel adaptive	MPEG-4 AAC	AAC-LC, HE-AAC	6	As defined in ISO/IEC 14496-3: 1, 2, 5, 6, 7, 12, 14	48 kHz	'cama'

NOTE AAC multichannel adaptive audio CMAF media profile is AAC multichannel constrained for adaptive switching.

### I.5 Recommendations for AAC multichannel encoding

All recommendations described in Annex G still hold for AAC multichannel encoding. Additionally, Figures I.1 and I.2 provide typical 5.1 and 7.1 bitrates for AAC and HE-AAC. For example, in case of 5.1 surround audio, a good audio quality can be maintained at 128 kbit/s and broadcast quality is commonly provided at 160 kbit/s.

Profile	AOT	@codecs	bit rate [kbit/s] for 44.1/48 kHz							
			64	96	128	160	192	256	320	
HE-AAC	2+5	mp4a.40.5								
AAC	2	mp4a.40.2								

Figure I.1 — Typical 5.1 bitrates for AAC encoded CMAF tracks (with normal operation range highlighted)

Profile	AOT	@codecs	bit rate [kbit/s] for 44.1/48 kHz							
			96	128	192	224	288	320	448	
HE-AAC	2+5	mp4a.40.5								
AAC	2	mp4a.40.2								

Figure I.2 — Typical 7.1 bitrates for AAC encoded CMAF tracks (with recommended operation range highlighted)

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## Annex J (normative)

### MPEG-H 3D audio track format and CMAF media profile

#### J.1 General

This annex specifies the track format and brand of the MPEG-H 3D audio CMAF media profile. An MPEG-H audio CMAF track conforms to the general audio CMAF track format defined in subclause 10.2 with further constraints specified in this annex.

#### J.2 Codecs parameter signalling

The signalling of the codecs MIME parameter is according to IETF RFC 6381 and ISO/IEC 23008-3:—, Clause 21, as shown in Table J.1.

**Table J.1 — MPEG-H audio MIME parameter according to IETF RFC 6381 and ISO/IEC 23008-3**

Codec	MIME type	Codecs parameter	ISO BMFF encapsulation
MPEG-H Audio LC Profile Level 1	audio/mp4	mhm1.0x0B	ISO/IEC 23008-3
MPEG-H Audio LC Profile Level 2	audio/mp4	mhm1.0x0C	ISO/IEC 23008-3
MPEG-H Audio LC Profile Level 3	audio/mp4	mhm1.0x0D	ISO/IEC 23008-3
MPEG-H Audio LC Profile Level 1, multi-stream	audio/mp4	mhm2.0x0B	ISO/IEC 23008-3
MPEG-H Audio LC Profile Level 2, multi-stream	audio/mp4	mhm2.0x0C	ISO/IEC 23008-3
MPEG-H Audio LC Profile Level 3, multi-stream	audio/mp4	mhm2.0x0D	ISO/IEC 23008-3

NOTE See Clause J.6 for MPEG-H 3D audio multi-stream.

#### J.3 Considerations for MPEG-H audio encoding

The audio signals shall be encoded according to Level 1, 2 or 3 of the MPEG-H 3D Audio Low Complexity (LC) Profile, as defined in ISO/IEC 23008-3:—, subclause 4.8.

#### J.4 Storage of MPEG-H audio media samples

##### J.4.1 Bitstream encapsulation

Audio data shall be encapsulated into MPEG-H audio stream (MHAS) packets according to ISO/IEC 23008-3:—, Clause 14.

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

- PACTYP\_CRC16;
- PACTYP\_CRC32;
- PACTYP\_GLOBAL\_CRC16;
- PACTYP\_GLOBAL\_CRC32.

If Audio Scene Information, defined in ISO/IEC 23008-3:—, Clause 15 is present, it shall be encapsulated in an `MHAS_PACTYP_AUDIOSCENEINFO` packet. Audio Scene Information shall not be included in the `mpegh3daConfig()` structure carried in the `MHAS_PACTYP_MPEGH3DACFG` packet.

#### J.4.2 ISO BMFF encapsulation

The sample entry 'mhm1' shall be used for encapsulation of MHAS packets into ISO BMFF files, according to ISO/IEC 23008-3:—, subclause 20.6.

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:—, subclause 14.6.

If the `MHAConfigurationBox()` is present, the parameters carried in the `MHADecoderConfigurationRecord()` shall be consistent with the configuration of the audio bitstream. In particular, the MPEG-H 3D audio profile and level indicator `mpegh3daProfileLevelIndication` shall be set to "0x0B", "0x0C", or "0x0D" for MPEG-H 3D audio LC profile Level 1, Level 2, or Level 3, respectively.

#### J.4.3 Random access point and stream access point

CMAF fragments shall start with a stream access point (SAP) of type 1 (i.e. a sync sample). For MPEG-H 3D audio a sync sample shall consist of the following MHAS packets, in the following order:

- `PACTYP_MPEGH3DACFG`
- `PACTYP_AUDIOSCENEINFO` (if Audio Scene Information is present)
- `PACTYP_BUFFERINFO`
- `PACTYP_MPEGH3DAFRAME`

MPEG-H 3D audio sync samples contain Immediate Playout Frames (IPF), as specified in ISO/IEC 23008-3:—, subclause 20.2, thus the audio data encapsulated in the MHAS packet `PACTYP_MPEGH3DAFRAME` shall contain the `AudioPreRoll()` syntax element, as defined in ISO/IEC 23008-3:—, subclause 5.5.6 and shall follow the requirements for stream access points as defined in ISO/IEC 23008-3:—, subclause 5.7.

The audio configuration is delivered as part of the MHAS packet `PACTYP_MPEGH3DACFG` and, therefore, the `AudioPreRoll()` structure carried in the MHAS packet `PACTYP_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:—, subclause 20.6.1 regarding sync samples shall apply.

The sample flags in the Track Run Box ('trun') shall be used to describe the sync samples. The `sample_is_non_sync_sample` flag shall be set to "0" for a SAP as defined above; it shall be set to "1" for all other samples.

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_AUDIOSCENEINFO` packet shall directly follow the `PACTYP_MPEGH3DACFG` packet, as defined in ISO/IEC 23008-3:—, subclause 14.4.

#### J.5 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.