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Information technology — Multimedia application format (MPEG-A) — Part 19: Common media application format (CMAF) for segmented media, AMENDMENT 2: MV-HEVC, metadata tracks and other improvements

DIS stage

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The committee responsible for this document is ISO/IEC JTC1 SC29.

The main changes compared to the previous edition are as follows:

* definition of a set of MV-HEVC media profiles
* carriage of metadata tracks in a single CMAF track
* Definition of the cmf1 brand

# Clause 3, Terms and definitions

Add the following note after the definition of the CMAF track (3.2.1)

Note: In addition to a Primary Media Track (3.2.14) the CMAF track can also contain Supplementary Metadata Tracks (3.2.15).

Add 2 new definitions to Clause 3.2

**3.2.14**

**Primary Media Track**

The primary media track refers to the main content track that carries the primary audio, video, or audiovisual data. This track is essential for the core playback experience and is always present in the MovieBox.

**3.2.15**

**Supplementary Metadata Track**

A Supplementary Metadata Track refers to a metadata track that is directly related to the media data within the same CMAF track (3.2.1).

Add 3 new definitions to Clause 3.3

**3.3.19**

**Texture picture**

A picture that carries pixel data corresponding to information that can be rendered on a screen or some other device, either directly or indirectly after the consideration of additional information, such as alpha, depth, display, colour format, colour processing, and/or other information that can be associated with such pixel data.

**3.3.20**

**Alpha picture**

A picture that contains a video signal representing information indicating the opacity level of each pixel in an associated foreground picture and how that associated picture should be blended with other pictures for purposes of alpha blending.

**3.3.21**

**Depth picture**

A picture that contains a video signal, commonly associated with a texture picture, representing depth information indicating the distance of objects from the camera at each pixel location of the associated texture picture.

# Clause 4, Abbreviated terms

Add the following abbreviated terms:

|  |  |
| --- | --- |
| MSE | media source extension |
| MV | multi-view |
| NAL | network abstraction layer |

# Clause 7, CMAF track format

## Clause 7.1, Overview

Replace the following text:

The CMAF track format is derived from the ISO base media file format in this clause and structural brands are specified. At this point, the 'cmfc' and the 'cmf2' CMAF structural brands are defined. The 'cmf2' brand further restricts the 'cmfc' brand.

Several CMAF media objects are derived from the CMAF track format.

with:

The CMAF track format is derived from the ISO base media file format in this clause and structural brands are specified. At this point, the 'cmfc', the 'cmf1', and the 'cmf2' CMAF structural brands are defined. The 'cmf2' brand further restricts the 'cmfc' brand. The 'cmf1' brand both extends and restricts the 'cmfc' brand.

Several CMAF media objects are derived from the CMAF track format.

## Clause 7.2, CMAF brands

Replace Table 1 with:

**Table 1 — CMAF brands**

|  |  |  |
| --- | --- | --- |
| **Brand** | **Location** | **Conformance requirements** |
| cmfc | FileTypeBox and SegmentTypeBox | 7.6 |
| cmf2 | FileTypeBox and SegmentTypeBox | 7.7 |
| cmf1 | FileTypeBox and SegmentTypeBox | 7.8 |
| cmfs | SegmentTypeBox | 7.3.3.1 |
| cmfl | SegmentTypeBox | 7.3.3.2 |
| cmff | SegmentTypeBox | 7.3.2.3 |
| cmfr | SegmentTypeBox | 7.3.2.4 |

## Clause 7.3, CMAF media objects

### Clause 7.3.1, CMAF boxes

Update the following entry of Table 3:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | trak |  |  |  |  | 1 | ISO/IEC 14496-12 |  | Container for each track |

with:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | trak |  |  |  |  | + | ISO/IEC 14496-12 | CMAF 7.5.21 | Container for each track |

Update the following entry of Table 3:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | trex |  |  |  | 1 | ISO/IEC 14496-12 | CMAF 7.5.14 | Track extends box |

with:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | trex |  |  |  | + | ISO/IEC 14496-12 | CMAF 7.5.14 | Track extends box |

Update the following entry of Table 5:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | traf |  |  |  |  | 1 | ISO/IEC 14496-12 |  | Track fragment |

with:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | traf |  |  |  |  | + | ISO/IEC 14496-12 | CMAF 7.5.21 | Track fragment |

### Clause 7.3.2.1, CMAF header

Replace the bullet point c.4:

1. The MovieBox shall contain exactly one track containing media data as specified in subclause 7.3.2.2.

NOTE Timed metadata tracks can be provided as separate CMAF tracks in a separate selection set.

with:

1. The MovieBox shall contain exactly one Primary Media Track containing media data as specified in subclause 7.3.2.2.

NOTE Timed metadata tracks can be provided as separate CMAF Timed Metadata Tracks in a separate selection set. Alternatively, Supplementary Metadata Tracks can be included in the same CMAF selection set.

### Clause 7.3.2.2, CMAF track

Replace the bullet point d:

d) Each CMAF track contains a single ISO BMFF track and TrackBox, as determined by CMAF header constraints specified in subclause 7.3.2.1.

with:

d) Each CMAF track contains a single Primary Media Track and TrackBox for the media data, as determined by the CMAF header constraints specified in subclause 7.3.2.1. A CMAF track can contain additional TrackBoxes if it carries Supplementary Metadata Tracks.

### Clause 7.3.2.3, CMAF chunk

Replace the following bullet points:

b) The MovieFragmentBox shall conform to the constraints of the structural CMAF brand constraints specified in Table 5, such as containing only one TrackFragmentBox that contains only one TrackRunBox.

NOTE 1 Since there is only one TrackRunBox per MovieFragmentBox, all media samples of a CMAF chunk are located in a single track run in one MediaDataBox.

c) The MediaDataBox shall contain all media samples referenced by the TrackRunBox and should immediately follow the TrackRunBox in byte order.

f) A CMAF chunk shall contain a TrackFragmentDecodeTimeBox containing the baseMediaDecodeTime of the first media sample.

with:

b) The MovieFragmentBox shall conform to the constraints of the structural CMAF brand constraints specified in Table 5 and clause 7.5.21. The MovieFragmentBox shall contain only one TrackFragmentBox of the Primary Media Track and can contain TrackFragmentBoxes of the Supplementary Metadata Tracks.

c) The MediaDataBox shall contain all media samples referenced by the TrackRunBox. The MediaDataBox should follow the TrackRunBox in byte order unless another TrackFragmentBox follows within the same MovieFragmentBox. If multiple TrackFragmentBoxes are present within a MovieFragmentBox, the MediaDataBox shall follow the last TrackFragmentBox in that MovieFragmentBox, ensuring all samples referenced by the TrackRunBoxes are contained in the corresponding MediaDataBox.

f) A CMAF chunk shall contain a TrackFragmentBaseMediaDecodeTimeBox containing the baseMediaDecodeTime of the first media sample.

### Clause 7.3.3.3, CMAF track file

Replace the bullet points d) and e)

d) A video CMAF track may use an offset edit list as specified in subclauses 7.5.13 and 10.2.6.

e) A video CMAF track may use v1 TrackRunBoxes using negative composition offsets to adjust the composition time of the earliest presented video media sample in each CMAF fragment to its baseMediaDecodeTime and the earliest video media sample in the CMAF track file to zero, without using an offset edit list.

with

d) A CMAF track can use an offset edit list as specified in subclauses 7.5.13, 10.2.6 and 9.2.7.

e) A video CMAF track can use version 1 TrackRunBoxes using negative composition offsets to adjust the composition time of the earliest presented video media sample in each CMAF fragment to its baseMediaDecodeTime and the earliest video media sample in the CMAF track file to zero, without using an offset edit list.

## Clause 7.5, Constraints on ISO Base Media File Format boxes

### Clause 7.5.14, Track Extends Box ('trex')

Replace the paragraph:

A TrackExtendsBox shall be present in a CMAF track since it is a fragmented file as defined in ISO/IEC 14496-12.

with:

At least one TrackExtendsBox shall be present in a CMAF track since it is a fragmented file as defined in ISO/IEC 14496-12.

### Clause 7.5.21

Add a new Clause 7.5.21

**7.5.21 Constraints on the number of tracks in a single CMAF track**

A single Primary Media Track that carries the primary media shall always be present in a CMAF Track. Additional Supplementary Metadata Tracks can be present, and if present, shall use the 'cdsc' track reference type to link the metadata track to the Primary Media Track it describes.

## Clause 7.7, The structural CMAF Brand 'cmf2'

### Clause 7.7.2, Edit List Box ('elst')

Replace:

For video CMAF Tracks, the EditBox and in particular the EditListBox shall not be present.

For video CMAF Track files as well as any other media types, the EditListBox may be present following the constraints in subclause 7.5.13.

with:

For video CMAF Tracks that are not video CMAF track files, the EditBox and, in particular, the EditListBox shall not be present.

For other CMAF tracks and for video CMAF Track files as well as any other media types, the EditListBox can be present following the constraints in subclause 7.5.13.

## New Clause 7.8

Add a new Clause 7.8

**7.8 The Structural CMAF Brand 'cmf1'**

**7.8.1 General**

A CMAF track conforming to the CMAF structural brand 'cmf1' shall conform to constraints of the CMAF structural brand 'cmfc' and all remaining constraints and exceptions in this clause 7.8.

These constraints are introduced to signal that the CMAF tracks and CMAF switching set track headers are conforming as if all CMAF Tracks of the presentation also conforming to this brand would be included in a single ISO BMFF file.

**7.8.2 Movie Box (**'moov'**)**

The MovieBox shall contain exactly one TrackBox of the Primary Media Track and can contain one or more additional TrackBoxes of Supplementary Metadata Track(s) with closely associated metadata.

**7.8.3 Track Header Box (**'tkhd'**)**

CMAF TrackHeaderBoxes shall conform to subclause 7.5.4 with the following additional constraints.

~~— The MovieFragmentBox shall contain exactly one TrackFragmentBox of the Primary Media Track and may contain one or more additional TrackFragmentBox of Supplementary Metadata Track(s) with closely associated metadata~~

— If all CMAF tracks of the CMAF presentation are combined into a single ISO BMFF container, then the track header shall be valid. This for example included that:

— The track\_ID is set to a unique identifier over within this CMAF presentation.

— All tracks within one CMAF switching set have alternate\_group shall be set to the same value. Each CMAF switching set in the CMAF presentation shall have a unique value for the alternate\_group.

— For a video track, every decoder output signal shall have its decoded and cropped image size in video spatial samples measured on a uniformly sampled square grid identical to the value of width and height defined in the Track Header.

**7.8.4 Track Reference Box (**'tref'**)**

The TrackReferenceBox shall be present only in Supplementary Metadata Tracks and shall contain a single TrackReferenceTypeBox specifying its relation to the corresponding Primary Media Track.

**7.8.5 Media Header Box (**'mdhd'**)**

CMAF MediaHeaderBoxes shall conform to subclause 7.5.5 with the following additional constraints.

— If one or more Supplementary Metadata Track(s) are present, the value of the timescale should be the same as set in the Primary Media Track.

**7.8.6 Track fragment decode time box (**'tfdt'**)**

The value of the baseMediaDecodeTime in the TrackFragmentBaseMediaDecodeTimeBox of a Supplementary Metadata Track should be set to the same value as the baseMediaDecodeTime in the TrackFragmentBaseMediaDecodeTimeBox of the corresponding Primary Media Track.

**7.8.7 Duration Consistency**

The duration of a Supplementary Metadata Track should match the duration of the corresponding Primary Media Track within a CMAF Track. The sum of sample durations in the TrackRunBox elements of a Supplementary Metadata Track should be equal to the sum of sample durations in the TrackRunBox elements of the corresponding Primary Media Track.

**7.8.8 Metadata Track Switching and Presence in CMAF Fragments**

Supplementary Metadata Tracks shall be present in each CMAF Fragment of a CMAF Track. The boundaries of Supplementary Metadata Tracks shall align with the boundaries of the Primary Media Track within a CMAF Track to allow seamless switching at CMAF Fragment boundaries. This ensures consistent availability of metadata across all fragments and enables adaptive switching without playback interruptions.

# Clause 9, Video CMAF tracks

## Clause 9.2.4, Sample Description Box ('stsd')

Add the following bullet point at the end of the clause 9.2.4 (before the note):

— one or more ColourInformationBoxes with sub-type 'nclx' as specified in ISO/IEC 14496-12.

## Clause 9.3.2.2, Sample Description Box ('stsd')

Fix the spelling of the ColorInformationBox to ColourInformationBox:

— shall contain one or more ColourInformationBoxes with sub-type 'nclx' and a PixelAspectRatioBox 'pasp', as documented in ISO/IEC 14496-12, if the first sample entry contains no SPS NAL unit with a VUI in the decoder configuration record.

## Clause 9.3.7, Single initialization CMAF switching set constraints for NAL structured video tracks and media profiles

Fix the spelling of the ColorInformationBox to ColourInformationBox in bullet point c):

2) can contain a sample entry without NAL units that shall include one or more ColourInformationBoxes with sub-type 'nclx' and a PixelAspectRatioBox, as specified in ISO/IEC 14496-12.

## Clause 9.6, Video Media Profiles

Add the following bullet points at the end of the clause:

* Annex O specifies packaging and codec constraints for some CMAF media profiles using the LCEVC video codec. Systems claiming conformance to CMAF using LCEVC shall conform to the provisions of Annex O.
* Annex P specifies packaging and codec constraints for some CMAF media profiles using the MV-HEVC video codec. Systems claiming conformance to CMAF using MV-HEVC shall conform to the provisions of Annex P.

# Clause 13, Timed metadata tracks

Change the title and the contents of Clause 13 from:

**13 Timed metadata tracks**

Timed metadata tracks carry information relating to the CMAF presentation, such as programme metadata or geo-location information.

CMAF timed metadata tracks shall conform to timed metatracks as defined in ISO/IEC 14496-12 and shall adhere to the CMAF track structure defined in Clause 7.

CMAF timed metadata tracks use the null media header ('nmhd') and MetaSampleEntry is used to declare the type of the metadata track. The URIMetaSampleEntry can be used to signal a specific timed metadata scheme by a URI in URIBox.

Each ISO BMFF sample in a timed metadata track encloses metadata relevant to the presentation interval of that sample as defined in ISO/IEC 14496-12.

Metadata applying to other intervals can be present if this is supported by a metadata scheme, however such metadata should also be carried in an ISO BMFF sample with an overlapping presentation time interval (if such sample is present). In other words, metadata should be repeated in all samples during which it applies; otherwise players can miss metadata in case of random access to the metadata track.

All samples are sync samples. In addition, no knowledge of a prior sample should be required to correctly interpret the metadata carried in an ISO BMFF sample.

Timed metadata track files can use the filename extension 'cmfm'.

to:

**13 CMAF timed metadata tracks**

CMAF timed metadata tracks carry information relating to the CMAF presentation, such as programme metadata or geo-location information. It is important to clarify that the CMAF Timed Metadata Tracks are distinct from Supplementary Metadata Tracks, as defined in clause 3.2.15 of this document. While Supplementary Metadata Tracks are carried within the same CMAF track as the Primary Media Track and maintain a one-to-one dependency with the media data, CMAF timed metadata tracks are standalone metadata tracks. These tracks contain a single TrackBox in a MovieBox and are intended to carry general timed metadata independently.

CMAF timed metadata tracks shall conform to timed metadata tracks as defined in Clause 12.3 of ISO/IEC 14496-12 and shall adhere to the CMAF track structure defined in Clause 7 of this document. MetaDataSampleEntry is used to declare the type of metadata in the track. The URIMetaSampleEntry is one example of a metadata sample entry that can be used to signal a specific timed metadata scheme via a URI in URIBox.

Each ISO BMFF sample in a CMAF timed metadata track encloses metadata relevant to the presentation interval of that sample as defined in ISO/IEC 14496-12.

Metadata applying to other intervals can be present if this is supported by a metadata scheme, however such metadata should also be carried in an ISO BMFF sample with an overlapping presentation time interval (if such sample is present). In other words, metadata should be repeated in all samples during which it applies; otherwise players can miss metadata in case of random access to the metadata track.

All samples are sync samples. In addition, no knowledge of a prior sample should be required to correctly interpret the metadata carried in an ISO BMFF sample.

# Annex B, HEVC video CMAF track format and CMAF media profiles

## Annex B.1, HEVC video CMAF tracks

Replace the text:

This annex defines HEVC video tracks and specific CMAF media profiles with HEVC elementary stream constraint sets. Applications that do not conform to the HEVC video track or any of these CMAF media profiles can either specify their own HEVC video track definition or CMAF media profile or both. Applications can also signal brand conformance to just a CMAF structural brand defined in this document (e.g. 'cmfc' or 'cmf2').

HEVC tracks shall conform to subclause 9.3, as additionally constrained in this annex.

with:

This annex defines HEVC video tracks and specific CMAF media profiles with HEVC elementary stream constraint sets. Applications that do not conform to the HEVC video track or any of these CMAF media profiles can either specify their own HEVC video track definition or CMAF media profile, or both. Applications can also signal brand conformance to just a CMAF structural brand defined in this document (e.g. 'cmfc', 'cmf1', or 'cmf2').

HEVC tracks shall conform to subclause 9.3, as additionally constrained in this annex.

# Annex H, Scalable HEVC media profile and track format

## Annex H.1, Dependent CMAF tracks

Replace the first paragraph:

Dependent CMAF tracks can only be processed with the availability of one or more other 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.

with:

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

## Annex H.3.2, Sample Description Box ('stsd')

Replace the second bullet point:

* 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.

with:

* A visual sample entry with codingname 'hev1', 'hev2', and 'lhe1' shall contain one or more parameter sets (containing VPS, SPS, and PPS NAL units for HEVC video). Each video sample in the CMAF track shall reference a parameter set in the sample entry.

## Annex H.4.1.3, H.4.1.3 HEVCDecoderConfigurationRecord and LHEVCDecoderConfigurationRecord

Replace the text from:

The HEVCDecoderConfigurationRecord and the HEVC compatible base layer shall conform to subclause B.2.4.

The LHEVCDEcoderConfigurationRecord and the enhancement layers shall conform to subclause B.2.4. inclusion, use and passing of SEI messages.

with:

The HEVCDecoderConfigurationRecord, the HEVC compatible base layer, the LHEVCDEcoderConfigurationRecord, and the HEVC enhancement layers shall conform to subclause B.2.4.

## Annex H.4.2.2, General constraints

Remove the 4th bullet point on scalable resolution restriction in H.4.2.2:

— The bitstream shall contain at most two layers, a base layer and possibly an enhancement layer.

— The base layer shall conform to the HEVC Main 10 profile and main tier.

— The enhancement layer, when present, shall conform to the 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.

# Annex O, LCEVC media profile and track format

## Annex O.5.1, LCEVC signalling of "codecs" parameters

Replace:

Presentation applications should signal video codec profile and levels of each Base Layer and LCEVC Enhancement Layer track and switching set using parameters conforming to IETF RFC 6381 and ISO/IEC 14496-15:2022, Clause E.4.

with:

Presentation applications should signal the video coding specification profile and levels of each Base Layer and LCEVC Enhancement Layer track and switching set using parameters conforming to IETF RFC 6381 and ISO/IEC 14496-15:2022, Clause E.4. Table O.1 specifies the video codecs parameters.

clv1.vprf<prof>.vlev<level>

**Table O.1 — Video codecs parameters for the LCEVC media profiles**

|  |  |  |  |
| --- | --- | --- | --- |
| **codecs parameter** | Description | CMAF LCEVC Main Profile | CMAF LCEVC Main 4:4:4 Profile |
| <prof> | profile\_idc | 0 | 1 |
| <level> | level\_idc | <level>  Examples  For level 4.1: 41  For level 5.1: 51  For level 6.1: 61 | |

## Annex O.6, LCEVC media profile and track brands

Replace:

LCEVC media profiles and track brands shall conform to Table O.1.

with:

LCEVC media profiles and track brands shall conform to Table O.2.

Replace:

Table O.1 - LCEVC video media profiles

with:

Table O.2 - LCEVC video media profiles

# New Annex P on MV-HEVC

Add a new Annex P

**Annex P**(normative)

**CMAF Track and media profiles for MV-HEVC**

* 1. Introduction

This Annex defines CMAF tracks and media profiles for MV-HEVC. It also defines the CMAF Switching Set constraints for MV-HEVC in CMAF. This Annex defines three media profiles for MV-HEVC, the *MV-HEVC Mixed Media Profile* in Clause P.2, the *MV-HEVC* *Auxiliary* *Media Profile* in Clause P.3, and the *MV-HEVC Stereo Media Profile* in Clause P.4. These profiles are specified in an order of increasing constraints. The overview of these profiles is depicted in Table P.1. The codecs parameter for CMAF Tracks conforming to the MV-HEVC media profiles is provided in clause P.5. On a high level, the MV-HEVC Mixed Media Profile can be used for the transport of stereo video in association with one or more auxiliary videos or for a monoscopic video with multiple auxiliary videos. For a CMAF application with a monoscopic video and a single auxiliary video, the MV-HEVC Auxiliary Media Profile as defined in clause P.3 should be used. For a CMAF application that only intends to use a stereo video without auxiliary video, the MV-HEVC Stereo Media Profile as defined in Clause P.4 should be used.

Table P.1: Overview of MV-HEVC profiles in CMAF

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Media Profile Name and Brand** | **Max Layers** | **BitDepth** | **Profile layer\_id=0** | **Profile(s) layer\_id>0** | **Auxiliary video allowed** | **Max Number of Texture Layers** |
| MV-HEVC Stereo  'mvst' | 2 | 8 or 10 | Main or Main 10 | Multiview Main  Multiview Extended  Multiview Main 10  Multiview Extended 10 | No | 2 |
| MV-HEVC Auxiliary  'mvax' | 2 | 8 or 10 | Main or Main 10 | Multiview Main  Multiview Extended  Multiview Main 10  Multiview Extended 10  Multiview Monochrome  Multiview Monochrome 10 | Yes | 1 |
| MV-HEVC Mixed  'mvmx' | 3 or 4 | 8 or 10 | Main or Main 10 | Multiview Main  Multiview Extended  Multiview Main 10  Multiview Extended 10  Multiview Monochrome  Multiview Monochrome 10 | Yes | 2 |

* 1. MV-HEVC Mixed Media Profile
     1. General

The Clause P.2 defines the MV-HEVC Mixed Media Profile for CMAF. If a CMAF track conforms to the requirements in this clause, it can use the brand 'mvmx'.

A CMAF track compliant to this profile carries all video layers in the single Primary Media Track. The definition includes the definition of a CMAF track, a CMAF switching set, and the MV-HEVC elementary stream constraints.

Applications that do not conform to the MV-HEVC video track or any of these CMAF media profiles can either specify their own MV-HEVC video track definition or CMAF media profile, or both. Applications can also signal brand conformance to just a CMAF structural brand defined in this document.

* + 1. CMAF track constraints

The Primary Media Track of a CMAF track conforming to the MV-HEVC mixed media profile:

* shall conform to the single track layered HEVC elementary stream and sample definitions from Clause 9 of ISO/IEC 14496-15
* shall be a single video track
* shall contain 2 or more layers in the single video track
* shall not contain extractors
* shall not contain aggregators
* can contain the Operating Points Information ('oinf') sample group
* can contain the Layer Information ('linf') sample group

NOTE Sample groups 'oinf' and 'linf' are not mandatory for a single L-HEVC track.

* shall not contain the external base layer sample group ('lbli')
* shall conform to the requirements for the Track Header Box ('tkhd') as defined in clause 9.2.3.
* shall conform to the requirements for the Sample Description Box ('stsd') as defined in clause 9.2.4 and shall use the same sample entry type for all sample entries. Constraints on the visual sample entry are defined in clause P.2.4.
* shall conform to the requirements of NAL structured video CMAF tracks as defined in subclause 9.3
  + 1. CMAF switching set constraints

For a CMAF switching set conforming to the MV-HEVC mixed media profile the following applies:

* Each CMAF track in the CMAF switching set shall conform to CMAF track constraints as defined in clause P.2.2.
* The CMAF switching set shall conform to constraints for NAL structured video CMAF switching sets as specified in subclause 9.3.6 or 9.3.7.
* the additional constraints defined in clause P.2 for CMAF switching sets.
  + 1. Visual sample entry

The syntax and values of a visual sample entry shall conform to HEVCSampleEntry

or HEVCLHVCSampleEntry as defined in ISO/IEC 14496-15. The sample entry type shall be either 'hvc1' or 'hev1'.

The width and height fields specified in the VisualSampleEntry shall be set according to clause 4.5 of ISO/IEC 14496-15 using only the base layer information.

The depth field specified in the VisualSampleEntry shall be set to 0x0020 if samples of the track referencing this sample entry carry alpha pictures as auxiliary video in any of the layers.

* + - 1. HEVC Configuration Box ('hvcC')

The HEVCDecoderConfigurationRecord and the HEVC compatible base layer shall conform to subclause B.2.4.

* + - 1. Layered HEVC Configuration Box ('lhvC')

The LHEVCDecoderConfigurationRecord and the enhancement layers shall conform to subclause B.2.4.

* + 1. Constraints on MV-HEVC elementary streams

The following constraints apply to CMAF MV-HEVC elementary streams.

* Access units and media samples shall conform to subclause 9.3 and to the requirements of a media sample of the indicated description ('hvc1' or 'hev1') as specified in ISO/IEC 14496-15.
* The bitstream shall contain three or four layers.
* The base layer with nuh\_layer\_id equal to 0 shall carry the texture picture.
* The first enhancement layer with nuh\_layer\_id greater than 0 shall carry the texture picture if stereoscopic video is carried by the CMAF track.
* The base layer with nuh\_layer\_id equal to 0 shall conform to HEVC Main or HEVC Main 10 profile.
* The enhancement layers with nuh\_layer\_id greater than 0 shall conform to one of these profiles:
  + Multiview Main
  + Multiview Extended
  + Multiview Main 10
  + Multiview Extended 10
  + Multiview Monochrome
  + Multiview Monochrome 10
* All pictures shall be encoded as coded frames and shall not be encoded as coded fields.

CMAF fragments containing access units identified by the 'hev1' sample description shall contain all SPS and PPS NAL units referenced from a coded video sequence in the first access unit of that sequence, immediately following its first access unit delimiter NAL unit, if an access unit delimiter NAL unit is present.

Access units identified by the 'hev1' sample description can retain filler data (in NAL units or SEI messages) and SEI messages that would change the hypothetical reference decoder bitstream conformance if removed.

Access units of type 'hvc1' shall reference a video parameter set in the sample entry of the CMAF header associated with the containing CMAF track.

**Video parameter sets (VPS)**

Each MV-HEVC video sample in the CMAF track shall reference the VPS in the CMAF header sample entry according to ISO/IEC 14496-15. The VPS shall not change within CMAF tracks or between CMAF tracks in a switching set. A CMAF MV-HEVC track shall conform to the multi-layer extensions and multiview high efficiency video coding specification requirements specified in Annex G of ISO/IEC 23008-2 with the following additional constraints:

* vps\_extension\_flag shall be set to 1
* vps\_extension( ) shall be present as specified in Annex F of ISO/IEC 23008-2.
* The value of vps\_max\_layers\_minus1 of each VPS shall be set to 2 or 3.

The following fields shall have values set as follows for each profile\_tier\_level() structure in the 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 1.

The condition of the following fields for each profile\_tier\_level() structure in the VPS shall not change throughout the multiview HEVC elementary stream:

* general\_profile\_space
* general\_profile\_idc
* general\_tier\_flag
* general\_level\_idc

**Sequence parameter sets (SPS)**

Sequence parameter set NAL units that occur within a CMAF MV-HEVC track shall conform to the multi-layer extensions and multiview high efficiency video coding specified in ISO/IEC 23008-2 with the following additional constraints:

* 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 1.
* vui\_parameters\_present\_flag shall be set to 1.

The value for each of the following fields in the active SPS shall not change from one coded video sequence to another throughout a CMAF MV-HEVC track:

* general\_profile\_space
* general\_profile\_idc
* general\_tier\_flag
* general\_level\_idc
  + 1. Encryption

The encryption of a CMAF track conforming to the MV-HEVC mixed media profile shall be compliant with Clause 8.

* 1. MV-HEVC Auxiliary Media Profile
     1. General

The Clause P.3 defines the MV-HEVC Auxiliary Media Profile for CMAF, which is targeted at the transport of monoscopic video carrying texture pictures alongside a single auxiliary video containing alpha or depth pictures in an additional layer. If a CMAF track conforms to the requirements in this clause, it can use the brand 'mvax'.

A CMAF track compliant to this profile carries two video layers in the single Primary Media Track. The definition includes the definition of a CMAF track, a CMAF switching set, and the MV-HEVC elementary stream constraints.

Applications that do not conform to the MV-HEVC video track or any of these CMAF media profiles can either specify their own MV-HEVC video track definition or CMAF media profile, or both. Applications can also signal brand conformance to just a CMAF structural brand defined in this document.

* + 1. CMAF track constraints

The Primary Media Track of a CMAF Track conforming to the MV-HEVC Auxiliary Media Profile shall comply with the constraints defined in Clause P.2.2, with the following additional constraints:

* shall contain exactly 2 layers in the single video track
  + 1. CMAF switching set constraints

The constraints from Clause P.2.3 apply.

* + 1. Visual sample entry

The constrains from Clause P.2.4 apply.

* + 1. Constraints on MV-HEVC elementary streams

The constrains from Clause P.2.5 apply with additional constraints defined in this clause:

* The bitstream shall contain exactly two layers.
* The base layer with nuh\_layer\_id equal to 0 shall carry the primary picture.
* The first enhancement layer with nuh\_layer\_id greater than 0 shall carry an auxiliary picture.

**Video parameter sets (VPS) additional constraints**

* The value of vps\_max\_layers\_minus1 of each VPS shall be set equal to 1.
  + 1. Encryption

The constraints from Clause P.2.6 apply.

* 1. MV-HEVC Stereo Media Profile
     1. General

The Clause P.4 defines the MV-HEVC Stereo Media Profile for CMAF that can be used for the transport of stereoscopic video. If a CMAF track conforms to the requirements in this clause, it can use the brand 'mvst'.

A CMAF track compliant to this profile carries two video layers in the single Primary Media Track. The definition includes the definition of a CMAF track, a CMAF switching set, and the MV-HEVC elementary stream constraints.

Applications that do not conform to the MV-HEVC video track or any of these CMAF media profiles can either specify their own MV-HEVC video track definition or CMAF media profile, or both. Applications can also signal brand conformance to just a CMAF structural brand defined in this document.

* + 1. CMAF track constraints

The Primary Media Track of a CMAF Track conforming to the MV-HEVC Auxiliary Media Profile shall comply with the constraints from Clause P.2.2, with the following additional constraints:

* shall contain exactly 2 layers in the single video track
  + 1. CMAF switching set constraints

The constraints from Clause P.2.3 apply.

* + 1. Visual sample entry

The constrains from Clause P.2.4 apply with additional constraints defined in this clause.

* + 1. Constraints on MV-HEVC elementary streams

The constrains from Clause P.2.5 apply with additional constraints defined in this clause.

* The bitstream shall contain exactly two layers.
* The base layer with nuh\_layer\_id equal to 0 shall carry the primary picture.
* The first enhancement layer with nuh\_layer\_id greater than 0 shall carry the primary picture.
* The first enhancement layer with nuh\_layer\_id greater than 0 shall conform to one of these profiles:
  + Multiview Main
  + Multiview Main Extended
  + Multiview Main Extended 10

**Video parameter sets (VPS) additional constraints**

* The value of vps\_max\_layers\_minus1 of each VPS shall be set equal to 1.
  + 1. Encryption

The constraints from Clause P.2.6 apply.

* 1. Video codecs string parameter

Presentation applications should signal video codec profile and levels of each HEVC track and CMAF switching set using parameters conforming to IETF RFC 6381 and ISO/IEC 14496-15.