



ATSC

ADVANCED TELEVISION
SYSTEMS COMMITTEE

ATSC Candidate Standard: A/342 Part 3, MPEG-H System

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The Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards for digital television. The ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

Specifically, ATSC is working to coordinate television standards among different communications media focusing on digital television, interactive systems, and broadband multimedia communications. ATSC is also developing digital television implementation strategies and presenting educational seminars on the ATSC standards.

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ATSC Digital TV Standards include digital high definition television (HDTV), standard definition television (SDTV), data broadcasting, multichannel surround-sound audio, and satellite direct-to-home broadcasting.

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This specification is being put forth as a Candidate Standard by the TG3/S34 Specialist Group. This document is an editorial revision of the Working Draft (S34-1898r2) dated 30 March 2016. All ATSC members and non-members are encouraged to review and implement this specification and return comments to cs-editor@atsc.org. ATSC Members can also send comments directly to the TG3/S34 Specialist Group. This specification is expected to progress to Proposed Standard after its Candidate Standard period.

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ATSC Candidate Standard: A/342 Part 3, MPEG-H System

1. SCOPE

This document standardizes the MPEG-H Audio system for use in the ATSC 3.0 Digital Television System. It describes the characteristics of the MPEG-H Audio system and establishes a set of constraints on MPEG-H Audio [2] [4] for use within ATSC 3.0 broadcast emissions.

1.1 Introduction and Background

The ATSC 3.0 audio system provides an enhanced feature set and improves upon the capabilities of past ATSC audio systems. The system provides listeners with both a personalized and an immersive experience. The ATSC 3.0 audio system establishes a common framework for multiple Next Generation Audio (NGA) systems, both current and future. The MPEG-H Audio system is one of the NGA systems standardized in ATSC 3.0.

1.2 Organization

This document is organized as follows:

- Section 1 – Outlines the scope of this document and provides a general introduction.
- Section 2 – Lists references and applicable documents.
- Section 3 – Provides a definition of terms, acronyms, and abbreviations for this document.
- Section 4 – Describes the MPEG-H Audio application for the ATSC 3.0 Audio System.
- Annex A – Provides examples of File Format structures
- Annex B – Describes Decoder Guidelines for MPEG-H Audio
- Annex C – Describes the MPEG-H Audio Low Complexity Profile (separate document)

2. REFERENCES

All referenced documents are subject to revision. Users of this Standard are cautioned that newer editions might or might not be compatible.

2.1 Normative References

The following documents, in whole or in part, as referenced in this document, contain specific provisions that are to be followed strictly in order to implement provisions of this Standard.

- [1] IEEE: “Use of the International Systems of Units (SI): The Modern Metric System,” Doc. SI 10, Institute of Electrical and Electronics Engineers, New York, N.Y.
- [2] ISO/IEC: “Information technology – High efficiency coding and media delivery in heterogeneous environments – Part 3: 3D audio,” Doc. 23008-3:2015, International Standards Organization / International Electrotechnical Commission, Geneva Switzerland.
- [3] ISO/IEC: “Information technology – High efficiency coding and media delivery in heterogeneous environments – Part 3: 3D audio,” AMENDMENT 2¹, Doc. 23008-3:2015, International Standards Organization / International Electrotechnical Commission, Geneva Switzerland.

¹ Amendment 2 is currently in FDAM stage

- [4] ISO/IEC: “Information technology -- High efficiency coding and media delivery in heterogeneous environments – Part 3: 3D audio”, AMENDMENT 3², Doc. 23008-3:2015, International Standards Organization / International Electrotechnical Commission, Geneva Switzerland.
- [5] ISO/IEC: “Information technology -- High efficiency coding and media delivery in heterogeneous environments – Part 3: 3D audio”, AMENDMENT 4³, Doc. 23008-3:2015, International Standards Organization / International Electrotechnical Commission, Geneva Switzerland.
- [6] ISO/IEC: “MPEG audio technologies – Part 4: Dynamic Range Control,” Doc. 23003-4:2015, International Standards Organization / International Electrotechnical Commission, Geneva Switzerland.
- [7] ISO/IEC: “Information technology -- High efficiency coding and media delivery in heterogeneous environments – Part 3: 3D audio”, AMENDMENT 1, Doc. 23008-3:2015, International Standards Organization / International Electrotechnical Commission, Geneva, Switzerland.

2.2 Informative References

The following documents contain information that may be helpful in applying this Standard.

- [8] ATSC: “Techniques for Establishing and Maintaining Audio Loudness for Digital Television,” Doc. A/85:2013, Advanced Television Systems Committee, Washington, D.C., 12 March 2013.
- [9] ATSC: “ATSC Candidate Standard: A/342 Part 1, Audio Common Elements,” Doc. A/342-1:2016, Advanced Television Systems Committee, Washington, D.C., [\[Date\]](#).
- [10] ITU: “Multichannel stereophonic sound system with and without accompanying picture,” Recommendation ITU-R BS.775-3, International Telecommunications Union, Geneva, Switzerland.
- [11] ITU: “Algorithms to measure audio programme loudness and true-peak audio level,” Recommendation ITU-R BS.1770-4, International Telecommunications Union, Geneva, Switzerland, 2015.
- [12] ITU: “Requirements for Loudness and True-Peak Indicating Meters,” Recommendation ITU-R BS.1771-1, International Telecommunications Union, Geneva, Switzerland.
- [13] ITU: “Advanced sound system for programme production,” Recommendation ITU-R BS.2051, International Telecommunications Union, Geneva, Switzerland.

3. DEFINITION OF TERMS

With respect to definition of terms, abbreviations, and units, the practice of the Institute of Electrical and Electronics Engineers (IEEE) as outlined in the Institute’s published standards **Error! Reference source not found.** shall be used. Where an abbreviation is not covered by IEEE practice or industry practice differs from IEEE practice, the abbreviation in question will be described in Section 3.3 of this document.

² Amendment 3 is currently in DAM stage

³ Amendment 4 is currently in DAM stage

3.1 Compliance Notation

This section defines compliance terms for use by this document:

shall – This word indicates specific provisions that are to be followed strictly (no deviation is permitted).

shall not – This phrase indicates specific provisions that are absolutely prohibited.

should – This word indicates that a certain course of action is preferred but not necessarily required.

should not – This phrase means a certain possibility or course of action is undesirable but not prohibited.

3.2 Treatment of Syntactic Elements

This document contains symbolic references to syntactic elements used in the audio, video, and transport coding subsystems. These references are typographically distinguished by the use of a different font (e.g., `restricted`), may contain the underscore character (e.g., `sequence_end_code`), and may consist of character strings that are not English words (e.g., `dynrng`).

3.2.1 Reserved Elements

One or more reserved bits, symbols, fields, or ranges of values (i.e., elements) may be present in this document. These are used primarily to enable adding new values to a syntactical structure without altering its syntax or causing a problem with backwards compatibility, but they also can be used for other reasons.

The ATSC default value for reserved bits is ‘1.’ There is no default value for other reserved elements. Use of reserved elements except as defined in ATSC Standards or by an industry standards setting body is not permitted. See individual element semantics for mandatory settings and any additional use constraints. As currently-reserved elements may be assigned values and meanings in future versions of this Standard, receiving devices built to this version are expected to ignore all values appearing in currently-reserved elements to avoid possible future failure to function as intended.

3.3 Acronyms and Abbreviation

The following acronyms and abbreviations are used within this document.

ATSC – Advanced Television Systems Committee

ASI – Audio Scene Information

DASH – Dynamic Adaptive Streaming over HTTP

GUI – Graphical User Interface

HOA – Higher Order Ambisonics

IPF – Immediate Play-out Frame

ISOBMFF – ISO Base Media File Format

MAE – Metadata Audio Element

MHAS – MPEG-H Audio Stream

mh1 – ISO Base Media File Format sample entry type for MPEG-H Audio Stream

M&E – Music & Effects

RAP – Random Access Point

UI – User Interface

3.4 Terms

The following terms are used within this document.

reserved – Set aside for future use by a Standard.

Fragment – One part of a fragmented ISOBMFF file

Scalable/Layered Audio – An audio system that uses hierarchical techniques to: (1) Provide increasing quality of service with improving reception conditions, and/or (2) Provide different levels of service quality as required by different device types or presentation environments.

4. MPEG-H AUDIO SYSTEM OVERVIEW

4.1 Introduction

The MPEG-H Audio System (ISO/IEC 23008-3 [2] [4]) offers methods for coding of channel-based content, coding of object-based content, and coding of scene-based content (using Higher Order Ambisonics [HOA] as a sound-field representation). An MPEG-H Audio encoded program may consist of a flexible combination of any of the audio program elements that are defined in ATSC A/342-1 Section 5.3.2, namely:

- Channels (i.e., signals for specific loudspeaker positions),
- Objects (i.e., signals with position information) and
- Higher Order Ambisonics, HOA (i.e., sound field signals).

4.2 MPEG-H System Features

4.2.1 Metadata Audio Elements

MPEG-H Audio uses a set of static metadata, the “Metadata Audio Elements” (MAE), to define an “Audio Scene.” An Audio Scene represents an Audio Program as defined in ATSC A/342-1 Section 4 [9].

Audio Objects are associated with metadata that contains all information necessary for personalization, interactive reproduction, and rendering in flexible reproduction layouts.

The metadata (MAE) is structured in several hierarchy levels. The top-level element of MAE is “AudioSceneInfo.” Sub-structures of the Audio Scene Info contain “Groups,” “Switch Groups,” and “Presets.” Groups represent Audio Program Components, Presets represent Audio Presentations as defined in ATSC A/342-1 Section 4 [9].

4.2.1.1 Groups of Elements

The concept of an element group enables arranging related element signals that are to be treated together as a unit, e.g., for interactivity in common or for simultaneous rendering. A use case for groups of elements is the definition of channel-based recordings as audio elements (e.g., a stereo recording in which the two signals should only be manipulated as a pair). Grouping of elements allows for signaling of stems and sub-mixes by collecting the included element signals into groups that then can be treated as single objects.

4.2.1.2 Switch Groups of Elements

The concept of a switch group describes a grouping of elements that are mutually exclusive with one another. It can be used to ensure that exactly one of the switch group members is enabled at a time. This allows for switching between, e.g., different language tracks, when it is not sensible to simultaneously enable multiple language tracks.

4.2.1.3 Presets

Presets can be used to offer pre-configured combinations of groups and objects for more convenient user selection. Properties of the groups, like default gain or position can be set differently for each preset. It is not necessary to include all groups and objects in a preset.

4.2.1.4 Personalization and Interactive Control

Using the information in MAE, the MPEG-H Audio System offers listeners the ability to interactively control and adjust various elements of an audio scene within limits set by broadcasters (e.g., to adjust the relative level of dialogue only in a range specified within the AudioSceneInfo structure).

4.2.1.5 MAE Audio Scene Example

Figure 4.1 contains an example of MPEG-H Audio Scene Information with five different groups and one switch group. The switch group contains three commentaries from which to choose – two different English commentaries and one foreign language. Additionally, the user may select the “sound effects” object. In this case, the sound effects object is not a single mono source but rather a multi-channel object with pre-rendered content.

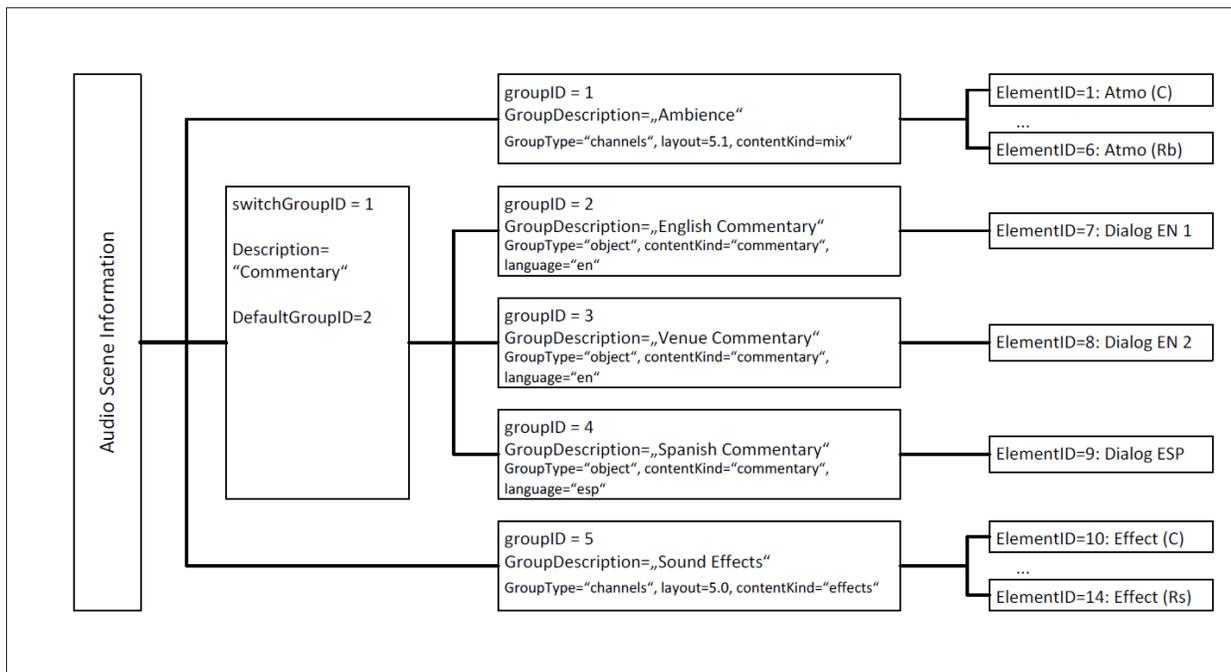


Figure 4.1 MPEG-H Audio Scene Information example.

4.2.2 Multi-Stream Delivery

The multi-stream-enabled MPEG-H Audio System is capable of handling streams delivered in a hybrid environment (e.g., one stream, containing one complete presentation, delivered over Broadcast and one or more additional streams, containing different languages, delivered over Broadband). The MAE information contained in each stream allows the MPEG-H Audio decoder to correctly merge the streams into one stream containing several sub-streams.

Figure 4.2 illustrates an example of such a hybrid delivery scenario, in which, out of several incoming streams, the main stream (stream #0) and the second stream (stream #1) are selected and

merged into a single stream, while the last stream (stream #2) is discarded based on information obtained from the systems level.

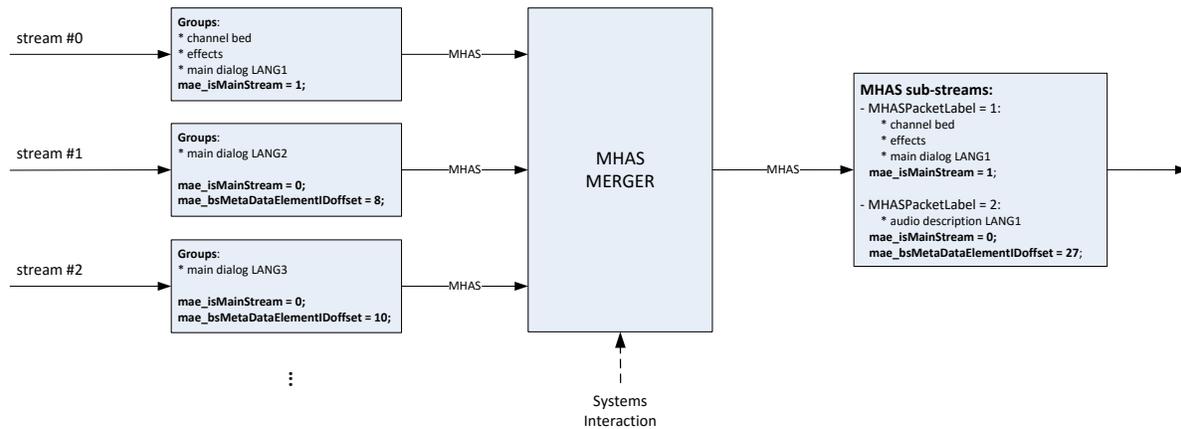


Figure 4.2 Example of switching and merging multiple incoming streams.

4.2.3 Audio/Video Fragment Alignment and Seamless Configuration Change

The MPEG-H Audio System allows for sample-accurate splicing and reconfiguration of the audio stream at Fragment boundaries. For coding efficiency, the audio and video streams usually use different frame rates, however, some applications may require the audio and video streams to be aligned at the end of certain Fragments (e.g., for stream splicing – normally used for commercial insertion). In this case, at least some audio frames usually need to be truncated to a number of audio samples lower than the normal audio frame size.

The MPEG-H Audio System uses a packet structure, called the MPEG-H Audio Stream (MHAS), to transport encoded audio and corresponding metadata. The MHAS packet design guarantees that any MHAS packet payload always is byte-aligned so that the truncation information is easily accessible on the fly and can be easily inserted, removed or modified by, e.g., a stream splicing device.

Another application of the truncation method is changing the configuration of an MPEG-H Audio stream (e.g., a stereo program may be followed by a program with 5.1 channels and additional audio objects). The configuration usually will change at a video frame boundary that is not aligned with the granules of the audio stream. Using the audio sample truncation method, the configuration change can be aligned to the video frame boundary.

4.2.4 Seamless Switching

The MPEG-H Audio System allows for seamless transitions between audio streams by making use of Immediate Play-out Frames (IPFs). Random-access points can be created, for example, by introducing IPFs at arbitrary positions in the audio stream.

IPFs carry additional information of “previous” audio frames and thereby allow seamless transitions between audio streams, e.g., in a DASH streaming scenario. Having IPFs at DASH segment boundaries allows for glitch-free bitrate adaptation of different audio representations and for on-the-fly reconfiguration of the stream.

4.2.5 Loudness and Dynamic Range Control

The MPEG-H Audio System includes advanced tools for loudness and dynamic range control inherited from MPEG-D DRC. MPEG-D DRC defines a comprehensive and flexible metadata

format that includes transmission of loudness metadata according to recommendations ITU-R BS.1770 [8] and ITU-R BS.1771 [12] among others. Further, MPEG-D DRC is compliant to worldwide regulations including those based on ATSC A/85 [8].

The dynamic range control tool offers a rich feature set for accurate adaptation of both complete audio scenes and single elements within audio scenes for different receiving devices and different listening environments. For personalization, the MPEG-H stream can include optional DRC configurations selectable by the user that, e.g., offer improved dialog intelligibility.

In addition to compression provisions, the dynamic range control tool offers broadcaster-controlled ducking of selected audio elements by sending time-varying gain values (e.g., for audio scenes that are combined with voice-overs or audio descriptions).

4.2.6 Interactive Loudness Control

MPEG-H Audio enables listeners to interactively control and adjust different elements of an audio scene within limits set by broadcasters. To fulfill applicable broadcast regulations and recommendations with respect to loudness consistency, the MPEG-H Audio System includes a tool for automatic compensation of loudness variations due to user interactions.

5. MPEG-H AUDIO SPECIFICATION

5.1 Audio Encoding

Audio signals shall be encoded and decoded according to ISO/IEC 23008-3, MPEG-H Low Complexity Profile, as defined in [4], or according to MPEG-H Main Profile, as defined in ISO/IEC 23008-3 Amendment 1 [7].

- Encoding: Bit-streams shall be encoded according to the MPEG-H Audio LC Profile Level 1, 2, or 3 [4] or the MPEG-H Audio Main Profile Level 1, 2, or 3 [7].
- Decoding: Receiving devices shall be capable of decoding MPEG-H Audio LC Profile bit-streams of Level 1, 2, and 3 [4] or MPEG-H Audio Main Profile bit-streams of Level 1, 2, and 3 [7].

5.2 Bit Stream Encapsulation

5.2.1 MHAS (MPEG-H Audio Stream) Elementary stream

Audio data shall be encapsulated into MPEG-H Audio Stream (MHAS) packets according to ISO/IEC 23008-3, Clause 14 [2].

Except for the restriction on packet types listed below, all MHAS packet types defined in ISO/IEC 23008-3, Clause 14 [2] and ISO/IEC 23008-3 Amendments 3 and 4 [4][5] may be present in the stream.

The following packet types shall not be present in the stream:

- PACTYP_CRC16
- PACTYP_CRC32
- PACTYP_GLOBAL_CRC16
- PACTYP_GLOBAL_CRC32

The following packet types may be present in the bit-stream. If they are present, however, they shall be ignored by decoders:

- PACTYP_SYNC
- PACTYP_SYNCGAP

If Audio Scene Information according to ISO/IEC 23008-3, Clause 15 [2] is present, it always shall be encapsulated in an MHAS PACTYP_AUDIOSCENEINFO packet [4]. Audio Scene Information shall not be included in the mpeg3daConfig() structure in the MHAS PACTYP_MPEGH3DACFG packet.

5.2.2 ISOBMFF Encapsulation

5.2.2.1 MPEG-H Audio Sample Entry

The sample entry “mhm1” shall be used for encapsulation of MHAS packets into ISOBMFF files, according to ISO/IEC 23008-3 Amendment 2, Clause 2.6 [3].

The sample entry “mhm2” shall be used in cases of multi-stream or hybrid delivery, i.e., when the MPEG-H Audio Scene is split into two or more streams for delivery as described in ISO/IEC 23008-3, Clause 14.6 [2].

The MPEG-H Profile-Level Indicator `mpeg3daProfileLevelIndication` in the `MHADecoderConfigurationRecord()` shall be set to “0x0B,” “0x0C,” or “0x0D” for MPEG-H Audio Low Complexity Profile Level 1, Level 2, or Level 3, respectively, or to “0x01,” “0x02,” or “0x03” for MPEG-H Audio Main Profile Level 1, Level 2, or Level 3, respectively.

5.2.2.2 Random Access Point and Stream Access Point

A random access point (RAP) shall be signaled by means of the File Format sync sample box “stss,” as defined in ISO/IEC 23008-3 Amendment 2, Clause 2.2 [3].

The first sample of an ISOBMFF file shall be a RAP. In cases of fragmented ISOBMFF files, the first samples of new Fragments shall be RAPs.

A File Format sample containing a RAP (i.e., a RAP into an MPEG-H Audio Stream) 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

All rules defined in ISO/IEC 23008-3 Amendment 2, Clause 2.6.1 [3] regarding sync samples shall apply. Furthermore, the audio data encapsulated in the MHAS packet PACTYP_MPEGH3DAFRAME shall follow the rules for random access points as defined in ISO/IEC 23008-3, Clause 5.7 [2].

Note that 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 Amendment 3 [4] Clause 14.4.

5.2.2.3 Configuration Change

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.

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 ISOBMFF 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 (RAP) as defined above.

A sync sample that contains a configuration change and the last sample before such a sync sample may contain a truncation message (PACTYP_AUDIOTRUNCATION) as defined in ISO/IEC 23008-3 Amendment 3 [4]. If MHAS packets of type PACTYP_AUDIOTRUNCATION are present, they shall be used as described in ISO/IEC 23008-3 Amendment 3 [4].

5.3 Metadata

5.3.1 Audio Loudness and DRC signaling

Loudness metadata shall be embedded within the `mpegh3daLoudnessInfoSet()` structure as defined in ISO/IEC 23008-3, Clause 6.3 [2]. 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 [2]).

DRC metadata shall be embedded in the `mpegh3daUniDrcConfig()` and `uniDrcGain()` structures as defined in ISO/IEC 23008-3, Clause 6.3 [2]. For each included DRC set the `drcSetTargetLoudnessPresent` field as defined in ISO/IEC 23003-4, Clause 7.3 [6] 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.

Loudness compensation information (`mae_LoudnessCompensationData()`), as defined in ISO/IEC 23008-3 Amendment 3, Chapter 11, Clause 15.5 [4], shall be present in the Audio Scene Information if the `mae_allowGainInteractivity` field (according to ISO/IEC 23008-3, Clause 15.3 [4]) is set to 1 for at least one group of audio elements.

5.3.2 Systems Metadata Transmission

Audio bit streams may carry systems metadata information that is encapsulated in MHAS packets of type PACTYP_SYSMETA, as defined in ISO/IEC 23008-3 Amendment 4 [5].

Systems metadata that can be used in the systems engine can be transmitted through an MHAS packet. This mechanism allows the transmission of systems metadata that is otherwise impossible, due to the nature of the transmission path, via audio bit streams for retransmission, such as via MPEG2-TS, or content retransmission using an HDMI cable. The reception operation is specified in ISO/IEC 23008-3 Amendment 4 [5].

If the URL of systems metadata is transmitted via an MHAS packet of type PACTYP_SYSMETA, a receiver can fetch the systems metadata located at the given URL, thereby permitting the retransmission of systems metadata.

Annex A: Examples

A.1 EXAMPLES OF MPEG-H AUDIO FILE STRUCTURE

This Annex describes an example of an MPEG-H Audio file as it may be used to form the basis for an MMT MPU or a DASH Segment. The file contains a single audio track; audio is not multiplexed with video or other media.

Figure A.1.1 outlines the structure of a fragmented ISO/BMFF MPEG-H Audio File with sample type “mhm1”.

MHM1 File Structure

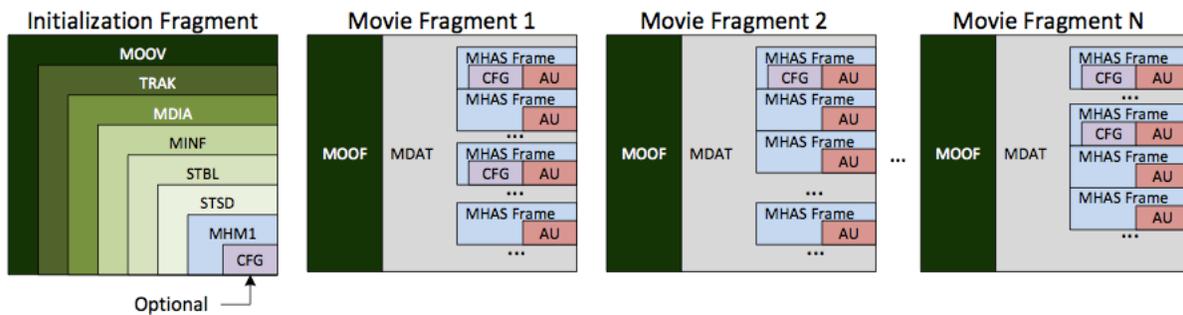


Figure A.1.1 File Structure of a fragmented MPEG-H Audio file (“mhm1”).

Legend for Figure A.1.1:

- MOOV: Movie Box
- TRAK: Track Box (only one audio track in this example)
- MDIA: Media Box
- MINF: Media Information Box
- STBL: Sample Table Box
- STSD: Sample Description Box
- MOOF: Movie Fragment Box
- MDAT: Media Data Container
- MHAS Frame: only CFG and AU Packet types are shown here; may include additional MHAS Packets of other Packet types
- CFG: Audio Configuration
- AU: Access Unit

Annex B: Decoder Guidelines

B.1 MPEG-H AUDIO DECODER OVERVIEW

MPEG-H Audio offers the possibility to code channel-based content, object-based content and scene-based content, the latter using Higher Order Ambisonics (HOA) for a sound-field representation. Figure B.1.1 gives a brief overview of signal flow in an MPEG-H Audio decoder from bit-stream input to loudspeaker or headphone output. As a first step, all transmitted audio signals are decoded by the MPEG-H Audio Core Decoder. Channel-based signals are mapped to the target reproduction loudspeaker layout using the Format Conversion module. Object-based signals are rendered to the target reproduction loudspeaker layout by the Object Renderer. Scene-based content is rendered to the target reproduction loudspeaker layout using associated HOA metadata and an HOA decoder/renderer. Channel-based signals, rendered objects, and rendered HOA are mixed together in the Mixer. The mixed channels are then processed by a DRC and Post-Proc module for loudspeaker output, or by a Binaural Renderer, DRC, and Post-Proc module for headphone output.

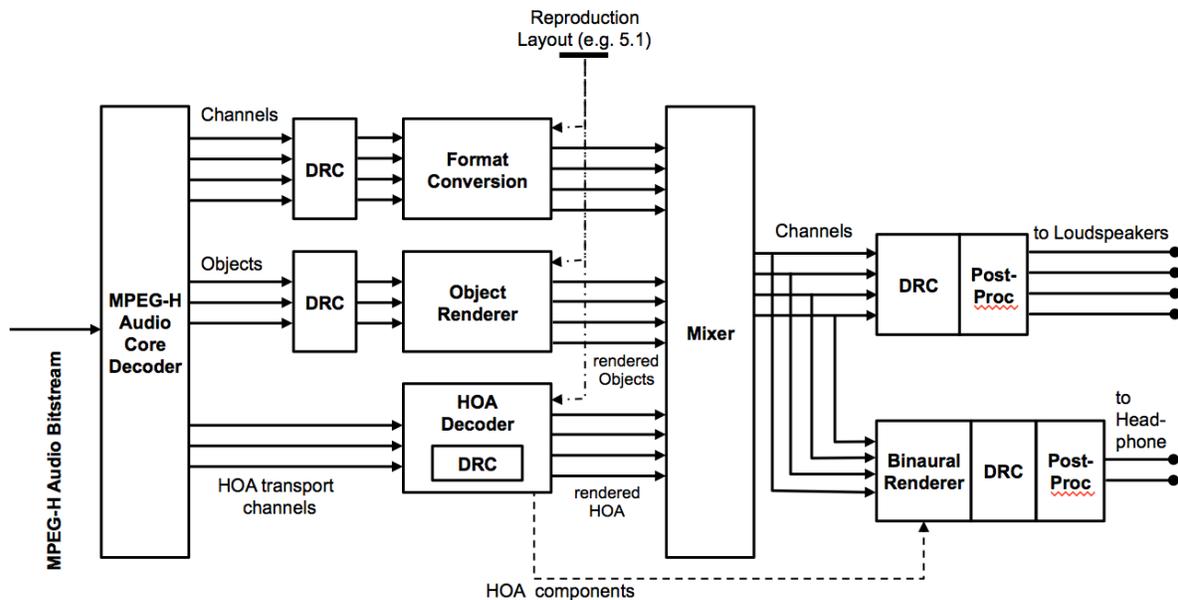


Figure B.1.1 MPEG-H Audio Decoder (features, block diagram, signal flow).

B.2 OUTPUT SIGNALS

B.2.1 Loudspeaker Output

The MPEG-H Audio Decoder is able to render the encoded input signals to loudspeaker output channel signals for any target loudspeaker layout geometry.

The MPEG-H Low Complexity Profile Level 3 [4] limits the maximum number of output channels to 12.

The receiving device obtains the target loudspeaker layout from external information supplied during system setup and passes that information to the MPEG-H Audio decoder during its initialization, as defined in ISO/IEC 23008-3, Clause 17.2 [2].

Examples for target loudspeaker layouts:

- 2.0 Stereo
- 5.1 Multi-channel audio
- 10.2 Immersive audio

Stereo and 5.1 configurations are defined in ITU-R BS.775-3 [10].

The channel configuration for 10.2 is specified in ITU-R BS.2051 [13].

B.2.2 Binaural Output to Headphones

If the receiving device supports headphone reproduction, the MPEG-H Audio Decoder can render the encoded input signals to a binaural signal for headphone playback, as defined in ISO/IEC 23008-3, Clause 13 [2].

BRIR/HRTF data for binaural rendering can be fed to the decoder as defined in ISO/IEC 23008-3, Clause 17.4 [2].

The value of `nBrirPairs` in `BinauralRendering()` should be

- Maximum 2 for level 1,
- Maximum 6 for level 2,
- Maximum 11 for level 3.

The value of `kMax` in `FdBinauralRendererParam()` should be equal to or less than 48 (bands). The value of `kConv` in `FdBinauralRendererParam()` should be equal to 32. The average of `nFilter[k]` values in `VoffBrirParam()` should be less than or equal to 64. The values of `rt60[k]` in `SfrBrirParam()` should be less than or equal to 1.0 (sec).

If binaural rendering is activated, measured BRIR positions should be passed to `mpegh3daLocalSetupInformation()`.

All renderer stages thereby are set to a target layout that is equal to the BRIR measurement setup. Preferably, the BRIR measurement positions for standard target layouts 2.0, 5.1, 10.2 and 7.1.4 should be provided.

B.3 DECODER BEHAVIOR

B.3.1 Tune-in

A tune-in happens at a channel change of a receiving device. The audio decoder is able to tune in to a new audio stream at every random access point (RAP).

Starting from the first sync sample (i.e., the RAP) in an ISOBMFF file, the decoder receives ISOBMFF samples containing MHAS packets. As defined above, the sync sample contains the configuration information (`PACTYP_MPEGH3DACFG` and `PACTYP_AUDIOSCENEINFO`) that is used to initialize the audio decoder. After initialization, the audio decoder reads encoded audio frames (`PACTYP_MPEGH3DAFRAME`) and decodes them.

To avoid buffer underflow during reception, the decoder must wait before starting to decode audio frames, as indicated in `PACTYP_BUFFERINFO`.

Note, that it may be necessary to feed several audio frames into the decoder before the first decoded PCM output buffer is available, as described in ISO/IEC 23008-3 Amendment 2, Clause 4 [3].

It is recommended that, on tune-in, the receiving device performs a 100ms fade-in on the first PCM output buffer that it receives from the audio decoder.

B.3.2 Configuration Change

MPEG-H Audio enables seamless configuration change in broadcast and streaming environments.

If a decoder receives an ISOBMFF sample that contains a configuration change, the decoder performs a configuration change according to the updated clause 5.5.6 in ISO/IEC 23008-3 Amendment 3, Section 8.4 [4].

The configuration change can be detected through the change of the MHASPacketLabel of the packet PACTYP_MPEGH3DACFG compared to the value of the Label of previous MHAS packets.

Note that a change in the `mpegh3daLoudnessInfoSet()` and `mpegh3daUniDrcConfig()` may occur that do not trigger a configuration change.

B.3.3 DASH Adaptive Bitrate Switching

MPEG-H Audio enables seamless bitrate switching in a DASH environment with different Representations (i.e., bit streams encoded at different bitrates) of the same content, i.e., those Representations are part of the same Adaptation Set.

If the decoder receives a DASH Segment of another Representation of the same Adaptation Set, the decoder performs an adaptive switch according to the updated clause 5.5.6 in ISO/IEC 23008-3 Amendment 3, Section 8.4 [4].

B.4 USER INTERFACE FOR INTERACTIVITY

B.4.1 Audio Scene and User Interactivity Information

If the MPEG-H Audio bit stream enables user interactivity, i.e., it contains an MHAS packet with PACTYP_AUDIOSCENEINFO, the user may change certain aspects of the rendered audio scene during playback, e.g., change the level or position of an audio object.

The Audio Scene Information, as defined in ISO/IEC 23008-3, Clause 15[2] and ISO/IEC 23008-3 Amendment 3 [4], contains information as to what the user is allowed to change and by how much, e.g., which audio elements are enabled for interactivity and what the maximum allowed changes of those audio elements are (e.g., in terms of gain or position).

The Audio Scene Information also may contain descriptions of “Presets”, i.e., combinations of audio elements that are a subsets of the complete audio scene, with gain and positions that are different from the default values. Typical examples for such Presets are:

- “Dialogue Enhancement” with increased dialogue signal level and attenuated background signal level, and
- “Live Mix,” e.g., for a sports event, with enhanced ambience, an additional ambience object signal, and a muted dialogue object that contains commentary.

The Audio Scene Information also may contain textual labels with descriptions of audio elements or presets that can be used in a Graphical User Interface (GUI).

Changes that result from user interactivity in the GUI are taken into account by the MPEG-H Audio decoder during rendering of the audio scene.

If user interactivity results in gain changes of one or more audio elements in an audio scene, loudness compensation, as defined in ISO/IEC 23008-3 Amendment 3, Chapter 11 [4], is applied.

Two examples are described regarding how audio scene information can be provided to the GUI and how user interactivity information can be provided from the GUI to the audio decoder:

- Through an interface (API) of the MPEG-H Audio decoder, as further described in the following sub-section, or
- Through a separate building block at the systems level of the receiving device, as further described in the subsequent subsection.

B.4.2 MPEG-H Audio Decoder API for User Interface

In the scenario described in this section, an audio decoder has two interfaces: a data interface for the encoded bit stream data and an additional interface for user interactivity information. The additional interface is defined in ISO/IEC 23008-3, Clause 17.7 [2].

As shown in Figure B.4.1, the MPEG-H Audio decoder makes the audio scene information available to an application for usage in a GUI. In return, the MPEG-H Audio decoder receives user interactivity information from the application through the `mpeg3daElementInteraction()` structure as defined in ISO/IEC 23008-3, Clause 17.7 [2], with the `ei_interactionMode` field set to one.

Optionally, the MPEG-H Audio decoder may receive an `mpeg3daLoudnessDrcInterface()` structure as defined in ISO/IEC 23008-3, Clause 14.2.2 [2] for selection of a preferred DRC configuration.

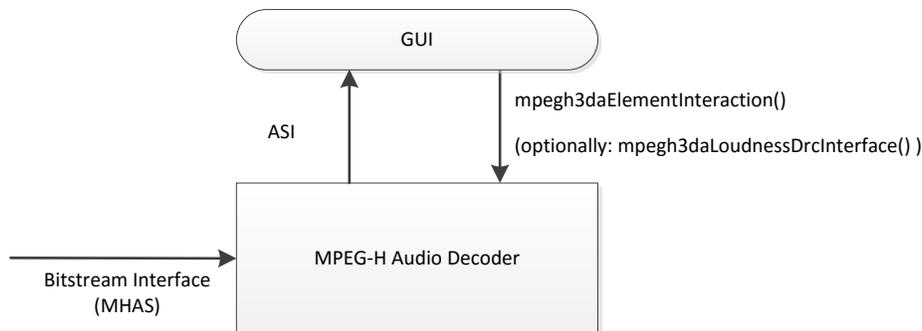


Figure B.4.1 MPEG-H Audio Decoder Interface for user interactivity.

B.4.3 User Interface on Systems Level

In the scenario described in this section, the audio decoder has only the data interface for the encoded bit stream data and no additional interface for user interactivity.

As shown in Figure B.4.2, the audio scene information is extracted from the MPEG-H Audio bit stream at systems level. A separate “MHAS” building block at systems level is connected to the GUI. This building block parses the MHAS packet stream and extracts the MHAS packet `PACTYP_AUDIOSCENEINFO` and makes it available to the application layer for usage in a GUI.

In return, the MHAS building block accepts the user interactivity information from the application layer. The user interactivity information is carried in the `mpeg3daElementInteraction()` structure and is further encapsulated in the MHAS packet of type

PACTYP_USERINTERACTION, as defined in ISO/IEC 23008-3, Clause 14.4.9 [2], with the `ei_interactionMode` field in the `mpegh3daElementInteraction()` structure set to one.

The MHAS building block embeds the MHAS packet PACTYP_USERINTERACTION into the MHAS packet stream that is fed into the audio decoder. Optionally, the MHAS packet PACTYP_LOUDNESS_DRC, as defined in ISO/IEC 23008-3, Clause 14.4.10 [2], also is embedded into the MHAS packet stream, if the preferred DRC configuration is intended to be changed in the GUI.

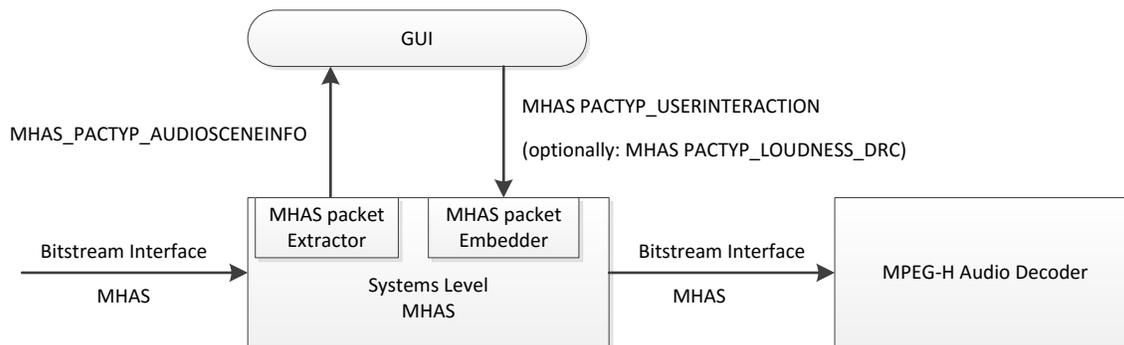


Figure B.4.2 Interface on systems level for user interactivity.

B.5 SYSTEMS METADATA TRANSMISSION AND DECODING

If the bit-stream carries systems metadata information that is encapsulated in an MHAS packet of type PACTYP_SYSMETA, as defined in ISO/IEC 23008-3 Amendment 4 [5], the MPEG-H Audio decoder is expected to extract the MHAS Packet with PACTYP_SYSMETA and deliver the complete packet (including the MHAS header) in binary form to the application system engine.

An alternative that enables better integration with the system engine is to extract the packet from the MPEG-H Audio bit stream systems level through the following procedure:

A separate “MHAS Parser” building block parses the MHAS packet stream and extracts the MHAS packet PACTYP_SYSMETA and delivers the complete packet (including the MHAS header) in binary form to the application system engine. If the PACTYP_SYSMETA packet is already extracted at systems level, it should be removed from the MHAS packet stream to avoid it being extracted again by the audio decoder.

B.6 LOUDNESS NORMALIZATION AND DYNAMIC RANGE CONTROL

The loudness normalization feature of the MPEG-H Audio decoder shall be enabled constantly. The target level for normalization typically is fixed and dependent on the specific receiving device type (e.g., AV receiver, TV set, Mobile device). The maximum target level allowed at the decoder is expected to be restricted to a practical value.

The following default parameters, as defined in ISO/IEC 23003-4 [6], shall be applied:

- `loudnessDeviationMax` = 0 dB
- `outputPeakLevelMax` = 0 dBFS

The preferred Loudness and DRC configuration is controlled by the `mpegh3daLoudnessDrcInterface()` structure, as defined in ISO/IEC 23008-3, Clause 14.2.2 [2] and ISO/IEC 23003-4, Annex B [6]. (Also, see above in the section “User Interface for Interactivity”). The interface shall be restricted with respect to changes within the `loudnessNormalizationControlInterface()` and `dynamicRangeControlInterface()` structures, in

which `loudnessNormalizationOn` and `dynamicRangeControlOn` shall have values of one, respectively.

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