

IEEE Standard for Systems of Advanced Audio and Video Coding

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IEEE Std 1857.3™-2013

IEEE Standard for Systems of Advanced Audio and Video Coding

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Abstract: Storage file formats and real-time transport protocol (RTP) payload formats for IEEE 1857™ video and IEEE 1857.2™ audio are defined. The storage of video and audio not only uses the existing capabilities of the ISO base media file format, but also defines extensions to support specific features of the IEEE 1857 video codec and IEEE 1857.2 audio codec. The target applications and services include but are not limited to Internet media streaming, IPTV, video conference, video telephony, and video-on-demand.

Keywords: audio, box, file format, IEEE 1857.3™, NAL unit, packetization, RTP payload format, storage, system, track, transmission, video

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Introduction

This introduction is not part of IEEE Std 1857.3-2013, IEEE Standard for Systems of Advanced Audio and Video Coding.

This standard defines the storage file formats and RTP payload formats for IEEE 1857 video and IEEE 1857.2 audio.

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1. Overview

1.1 Scope

This standard specifies the storage file format and real-time transport protocol (RTP) payload format for the compressed video data created by IEEE Std 1857™ and the compressed audio data created by IEEE Std 1857.2™.¹ The storage format is aimed at extending the *ISO base media file format* to support specific features of IEEE 1857 video and IEEE 1857.2 audio, and the RTP payload format defines the specific payload format to convey IEEE 1857 video and IEEE 1857.2 audio by RTP packets.

1.2 Purpose

This standard provides regular and efficient system level tool sets that describe the file storage format and RTP payload format for IEEE Std 1857 video and IEEE 1857.2 audio while storing and streaming over Internet protocol (IP) networks.

¹ Information on references can be found in Clause 2.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 1857™, IEEE Std for Advanced Audio and Video Coding.^{2, 3}

IEEE Std 1857.2™, IEEE Std for Advanced Audio Coding.

IETF RFC 2327, SDP: Session Description Protocol.⁴

IETF RFC 3264, An Offer/Answer Model with Session Description Protocol (SDP).

IETF RFC 3548, The base16, base32, and base64 Data Encodings.

IETF RFC 3550, RTP: A Transport Protocol for Real-time Applications.

ISO/IEC 14496-12, Information Technology—Coding of audio-visual objects—Part 12: ISO base media file format.⁵

3. Definitions, acronyms, and abbreviations

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁶ The terms and definitions specified in IEEE Std 1857, IEEE Std 1857.2, and ISO/IEC 14496-12 also apply.

3.1 Definitions

access unit: A series of network abstraction layer units (NALUs) that constitute a frame of coded picture.

NOTE—Besides picture header and slice data, an access unit can also contain other types of coding data. All data within the same access unit should have the same timestamp value for RTP packetization.⁷

decoding order number (DON): Network abstraction layer unit (NALU) decoding order indicated by a field in the real-time transport protocol (RTP) payload structure or a derived variable.

NOTE—Values of DON are in the range from 0 to 65535, inclusive. After reaching the maximum value, the value of DON wraps around to 0.

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⁷ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

media aware network element (MANE): A network element capable of parsing certain aspects of the real-time transport protocol (RTP) payload headers or the RTP payload and reacting to the contents.

NOTE—Examples for MANE are intelligent middleboxes and application layer gateways. Compared with normal routers or gateways, MANE should know the contents of the signal (e.g., mapping of media stream payload types). Furthermore, MANE should be a trusted entity when secure real-time transport protocol (SRTP) is in use. MANE has the advantage of losing packets according to the needs of media coding. For example, if MANE should discard packets due to congestion of some link, it can identify and discard the packets that minimize the impact on user experience.

NALU: A network abstraction layer unit (NALU) composed of one byte header and one or more bytes data.

NOTE—NALU for IEEE 1857 video is defined in 4.1. NALU for IEEE 1857.2 audio is defined in 6.1.

NALU decoding order: The order of network abstraction layer units (NALUs) in an NALU stream.

NALU stream: A sequence composed of one or more network abstraction layer units (NALUs).

packet: Datagram encapsulated using Internet protocol (IP).

transmission order: The order of packets in ascending real-time transport protocol (RTP) sequence number order (in modulo arithmetic).

3.2 Acronyms and abbreviations

AVS	audio and video coding standard
DON	decoding order number
DONB	decoding order number base
DOND	decoding order number difference
FU	fragmentation unit
IDR	instantaneous decoding refresh
MANE	media aware network element
MIME	multipurpose Internet mail extension
MTAP	multi-time aggregation packet
MTAP16	MTAP with 16-bit timestamp offset
MTAP24	MTAP with 24-bit timestamp offset
MTU	maximum transfer unit
NAL	network abstraction layer

NALU	network abstraction layer unit
PSI	payload structure indicator
RTP	real-time transport protocol
STAP	single-time aggregation packet
STAP-A	single-time aggregation packet (STAP) type A
STAP-B	single-time aggregation packet (STAP) type B

4. File format for IEEE 1857 video

4.1 NAL unit

The conversion process from video bitstream defined in IEEE 1857 video to NAL unit (NALU) stream is as follows: first, map the data between every two consecutive start code prefixes (0x000001) in the video bitstream (including start code values but excluding start code prefixes) into the NALU data, and then insert an NALU header before the NALU data according to the start code value and its context.

The format of an NALU header is shown in Figure 1.

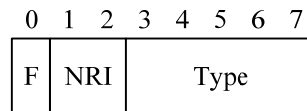


Figure 1—Format of IEEE 1857 video NALU header

The syntax and semantics of the NALU header are as follows:

- **F:** This 1-bit field is for forbidden zero bit. Its value should be 0.
- **NRI:** This 2-bit field is for NAL reference identification (`nal_ref_idc`). The value of non-zero means that the data contained in this NALU is sequence header or reference frame data. The value of 0 means that the data contained in this NALU is not reference frame data. For sequence header NALU, `nal_ref_idc` should not be 0. For a certain frame, if `nal_ref_idc` of one NALU is 0, then `nal_ref_idc` of all NALUs in the same frame should be 0. `Nal_ref_idc` of NALUs for I frames should not be 0.
- **Type:** This 5-bit field is for the NALU type (`nal_unit_type`). The value of this field is decided according to the start code value and the picture header contained in the following NALU data, and their context, as shown in Table 1.

Table 1—Value assignment for the NALU type field in NALU header

Type	Type description	Reason for type assignment
0	Reserved	—
1	Sequence header	Start code value is B0
2	Video extension	Start code value is B5
3	User data	Start code value is B2
4	Video edit	Start code value is B7
5	Picture header of I frame	Start code value is B3
6	Picture header of P frame	Start code value is B6 and the picture coding type of the picture header is 01
7	Picture header of B frame	Start code value is B6 and the picture coding type of the picture header is 10
8	Slice data of I frame	Start code value is 00 AF and the start code value of the last picture header before this NALU is B3
9	Slice data of P frame	Start code value is 00 AF and the start code value of the last picture header before this NALU is B6, and the picture coding type of the picture is 01
10	Slice data of B frame	Start code value is 00 AF and the start code value of the last picture header before this NALU is B6, and the picture coding type of the picture is 10
11–23	Reserved	—
24–31	Unspecified	—

Before using the file format defined by this subclause, IEEE 1857 video bitstream should be converted into an NALU stream at first.

When the decoder receives the NALU stream, before decoding, it shall discard every NALU header of an NALU, and then insert a start code prefix (0x000001) in the same position to transform the NALU stream back into an IEEE 1857 video bitstream.

4.2 IEEE 1857 video elementary stream and sample definitions

This subclause specifies the elementary stream and sample structure used to store IEEE 1857 video content inside the file format.

4.2.1 Elementary stream structure

The NALU stream should be converted from the IEEE 1857 video bitstream in the way specified in 4.1.

Using the video elementary stream, the visual content shall be stored with the following constraints:

- Sequence header NALUs shall be stored in the sample description of this track.
- All NALUs, including sequence header NALUs, shall be present in the samples of this video elementary stream.

4.2.2 Sample and configuration definition

4.2.2.1 Sample definition

IEEE 1857 video sample: An IEEE 1857 video sample contains an IEEE 1857 video access unit.

4.2.2.2 Canonical order and restrictions

The elementary stream is stored in the ISO base media file format in the following *canonical* format so that systems that need to customize the stream for delivery over different transport protocols—MPEG-2 systems, RTP, and so on—should not have to *remove* information from the stream while being free to *add* to the stream.

- **Video data NALUs (coded picture header, coded slice):** The picture header and all slice NALUs for a coded picture shall be contained within the sample whose decoding time and composition time are those of the picture. Each IEEE 1857 video sample shall contain at least one picture header NALU and one slice NALU.
- **NALUs sequence:** The sequence of NALUs in an elementary stream and within a single sample shall be in a valid decoding order for those NALUs as specified in IEEE 1857 video.
- **Timing information:** All timing information is provided by the information stored in the various sample metadata tables. Timing provided within the IEEE 1857 video stream in this file format should be ignored.
- **No start code prefixes:** The elementary streams shall not include start code prefixes. Systems that wish to deliver, from this file format, a stream using start code prefixes will need to reformat the stream back into IEEE 1857 video bitstream by inserting those start code prefixes and discarding those NALU headers.

4.2.2.3 Sample structure definition

An IEEE 1857 video access unit is made up of one or a set of NALUs. Each NALU is represented with the length of NALU and the NALU itself:

- *Length:* Indicates the length in bytes of the following NALU. The length field can be configured to be of 1, 2, or 4 bytes.
- *NALU:* Contains an NALU header followed by NALU data as specified in 4.1.

For syntax and semantics of the sample structure, please refer to 4.2.3.3.2.

4.2.2.4 Decoder configuration information

A decoder configuration record contains the size of the length field used in each sample as well as the initial sequence header.

This record contains a version field. This version of this specification defines version 1 of this record. Incompatible changes to the record will be indicated by a change of version number. Readers shall not attempt to decode this record or the streams to which it applies if the version number is unrecognized.

Compatible extensions to this record will not change the configuration version code. Readers should be prepared to ignore unrecognized data beyond the definition of the data they understand (e.g., after the initial sequence header in this part).

The values of *AvsProfileIndication* and *AvsLevelIndication* shall be valid for all sequence headers of the stream described by this record. *AvsLevelIndication* shall indicate a level of capability equal to or greater than the highest level indicated in the included sequence header. *AvsProfileIndication* shall indicate a profile to which the entire stream conforms. If the sequence headers are marked with different profiles, then the stream may need examination to determine which profile, if any, the stream conforms to. If the stream is not examined, or the examination reveals that there is no profile to which the stream conforms, then the

stream shall be split into two or more substreams with separate configuration records in which these rules can be met.

Syntax and semantics description of decoder configuration record are as follows:

aligned(8) class AvsDecoderConfigurationRecord

```
{  
  
    unsigned int(8) configurationVersion = 1;  
  
    unsigned int(8) AvsProfileIndication;  
  
    unsigned int(8) AvsLevelIndication;  
  
    bit(6) reserved = '111111'b;  
  
    unsigned int(2) lengthSizeMinusOne;  
  
    bit(3) reserved = '111'b;  
  
    unsigned int(5) numOfSequenceHeader;  
  
    for (i=0; i< numOfSequenceHeader; i++)  
    {  
        unsigned int(16) SequenceHeaderLength ;  
  
        bit(8* SequenceHeaderLength) SequenceHeaderNALUnit;  
    }  
}
```

- **AvsProfileIndication** contains the profile code as defined in IEEE Std 1857.
- **AvsLevelIndication** contains the level code as defined in IEEE Std 1857.
- **lengthSizeMinusOne** indicates the length in bytes of the NALUnitLength field in an IEEE 1857 video sample minus one. For example, a size of one byte is indicated with a value of 0. The value of this field shall be one of 0, 1, or 3, corresponding to a length encoded with 1, 2, or 4 bytes, respectively.
- **numOfSequenceHeader** indicates the number of initial sequence header sets for decoding the elementary stream.
- **SequenceHeaderLength** indicates the length in bytes of the sequence header NALU.
- **SequenceHeaderNALUnit** contains a sequence header NALU.

4.2.3 Derivation from ISO base media file format

4.2.3.1 File type and identification

The brand ‘avs2’ indicates a file is compliant with the extension to ISO base media file format as specified in this subclause. ‘avs2’ can be defined as a major brand by certain specification. In this case, file extension name and features required are defined by that specification.

Conformance with this specification is indicated by the presence of the brand of a specification that permits the inclusion of IEEE 1857 video content, in the compatible brands list of the FileTypeBox as defined in the ISO base media file format specification. The file extension name is defined as “.asm” (audio and video coding standard (AVS) streaming media).

Readers conforming to this standard should read the file if a suitable brand occurs in the compatible-brands list. Other structures and/or track types, defined in specifications other than that identified by the brand, may be present, and these may be ignored by a reader conformant with the specification identified by the brand.

4.2.3.2 Track structure

In the terminology of the ISO base media file format specification, tracks that stores IEEE 1857 video are video tracks with the following constraints:

- A handler_type of ‘vide’ in the HandlerBox;
- A video media header ‘vmhd’;
- A sample entry of VisualSampleEntry.

4.2.3.3 IEEE 1857 video stream definition

4.2.3.3.1 Sample entry

a) Definition

- Box types: ‘avs2’, ‘avss’
- Container: Sample table box (‘stbl’)
- Mandatory: The ‘avs2’ box is mandatory
- Quantity: One or more sample entries may be present

An IEEE 1857 video stream sample entry *shall* contain an AvsSequenceInfoBox, including a decoder configuration record AvsDecoderConfigurationRecord.

An optional BitRateBox may be present in the sample entry to signal the bit rate information of the video stream.

Multiple sample descriptions may be used, as permitted by the ISO base media file format specification, to indicate sections of video that use different decode configurations or sequence header.

b) Syntax

```
class AvsSequenceInfoBox extends Box('avss')
{
    AvsDecoderConfigurationRecord AvsConfig;
}

class BitRateBox extends Box('btrt')
{
    unsigned int(32) maxBitRate;
    unsigned int(32) avgBitRate;
}

class AvsSampleEntry() extends VisualSampleEntry ('avs2'){
    AvsSequenceInfoBox SeqInfo;
    BitRateBox(); // optional
}
```

c) Semantics

Compressorname in the base class VisualSampleEntry indicates the name of the compressor used with the value "\016AVS1-P2 Coding" being recommended (\016 is 14, the length of the string as a byte).

maxBitrate gives the maximum rate in bits/second over any window of one second.

avgBitrate gives the average rate in bits/second over the entire presentation.

4.2.3.3.2 Sample format

a) Syntax

```
class AvsSample
{
    unsigned int PictureLength = sample_size;
    for (i=0; i<PictureLength; )
    {
        unsigned int((AvsDecoderConfigurationRecord.lengthSizeMinusOne+1)*8)
        NALUnitLength;
```

```
        bit(NALUnitLength * 8) NALUnit;  
  
        i += (AvsDecoderConfigurationRecord.lengthSizeMinusOne+1) + NALUnitLength;  
  
    }  
  
}
```

b) Semantics

NALUnitLength indicates the size of an NALU measured in bytes, not including the length field itself.

NALUnit contains a single NALU.

4.2.3.4 Template fields used

The ISO base media file format defines a number of fields that have default values but which may be defined for use by specific subsystems. Tracks containing IEEE 1857 video data use the following template field:

- `alternate_group` in the `TrackHeaderBox`

4.2.3.5 Visual width and height

The width and height fields in a `VisualSampleEntry` shall correctly document the cropped frame dimensions (visual presentation size) of the video stream that is described by that entry. If the width and height of the sequence change, then a new sample description (that is sample entry) is needed.

The width and height fields in the track header may not be the same as the width and height fields in the one or more `VisualSampleEntry` in the video track. As specified in the ISO base media file format, if normalized visual presentation is needed, all the sequences are normalized to the track width and height for presentation.

4.2.3.6 Decoding time (DTS) and composition time (CTS)

Samples are stored in the file format in decoding order. If picture reordering is not used and decoding and composition times are the same, then presentation is the same as decoding order and only the time-to-sample ‘stts’ (time-to-sample table) table is used.

If decoding time and composition times differ, the composition time-to-sample ‘ctts’(composition time-to-sample) table is also used in conjunction with the ‘stts’ table.

4.2.3.7 Sync sample

An IEEE 1857 video sample is considered as a sync sample if ALL of the following conditions are met:

- Picture contained in the sample is instantaneous decoding refresh (IDR) picture.
- Sequence header needed to decode the video data NALUs in the sample of the IDR picture is contained in the decoder configuration of the video elementary stream.