SMPTE STANDARD

HDR/WCG Metadata Packing and Signaling in the Vertical Ancillary Data Space

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Approved August 30, 2018

Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 32NF.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

This standard defines the transport of High Dynamic Range and Wide Color Gamut (HDR/WCG) metadata on the SMPTE Serial Digital Interface (SDI). The HDR/WCG data is transmitted as a SMPTE ST 291-1 ancillary data packet, the HDR/WCG Metadata Ancillary Data Packet.

Basic signaling parameters that describe aspects of the payload carried on the SMPTE Serial Digital Interface (SDI) are transmitted in a 4-byte payload identifier ancillary data packet as defined in SMPTE ST 352 and application specific documents that reference SMPTE ST 352. This standard does not replace SMPTE ST 352 or related application specific documents as the primary method for SDI format signaling, nor any other SDI format signaling methods, but is intended as an *extension* to such methods when they lack the capability to transmit HDR/WCG metadata parameters that are required or desired by HDR/WCG systems.

HDR/WCG data is carried in the HDR/WCG Metadata Ancillary Data Packet in the form of HDR/WCG Metadata Frames. These HDR/WCG Metadata Frames can include both static and dynamic metadata related to the HDR/WCG image. Such metadata can, for example, provide information to aid adaptation of an HDR/WCG image to the capabilities of a particular display, or facilitate conversion of the HDR/WCG image to or from an SDR image.

1 Scope

This standard defines how HDR/WCG metadata can be placed into ancillary data packets according to SMPTE ST 291-1, to form the HDR/WCG Metadata Ancillary Data Packet.

This standard specifies HDR/WCG metadata fields, however the information that these fields represent and their corresponding uses are defined in other standards identified herein.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI/SCTE 128-1:2013, AVC Video Constraints for Cable Television, Part 1 - Coding

ATSC A/341:2018 Video - HEVC

ETSI TS 103 433-1 V1.2.1, High-Performance Single Layer High Dynamic Range (HDR) System for use in Consumer Electronics devices; Part 1: Directly Standard Dynamic Range (SDR) Compatible HDR System (SL-HDR1)

Recommendation ITU-T H.265 (12/2016) High efficiency video coding

SMPTE RP 168:2009, Definition of Vertical Interval Switching Point for Synchronous Video Switching

SMPTE RP 291-2:2013, Ancillary Data Space Use - 4:2:2 SDTV and HDTV Component Systems and 4:2:2 2048 ×1080 Production Image Formats

SMPTE ST 291-1:2011, Ancillary Data Packet and Space Formatting

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

4.1 image essence

ordered sequence of rectangular images of same dimensions that can be indexed and the first image has the index of zero

Note: Image can be a field or a group of images.

4.2 static metadata

metadata that is constant for all portions of the image essence

4.3 dynamic metadata

metadata that can be different for different portions of the image essence

5 HDR/WCG Ancillary Data Packet — Specification and Carriage

5.1 Format of the Ancillary Data Packet

The HDR/WCG Metadata Ancillary Data Packet shall be a Type 2 ANC packet as defined in SMPTE ST 291-1. It consists of the ancillary data flag (ADF), the data ID (DID), the secondary data ID (SDID), the data count (DC), the user data words (UDW), and the checksum (CS).

The DID word shall be set to the value 41h. The SDID word shall be set to the value 0Ch.

DC is a count of the number of words in the UDW and shall be set according to the size of the metadata contained in the HDR/WCG Metadata Ancillary Data Packet.

The UDW consists of the data payload that contains the HDR/WCG metadata.

The Generalized format of the HDR/WCG Metadata Ancillary Data Packet shall be as shown in Table 1.

Table 1 - HDR/WCG Metadata Ancillary Data Packet Format

	b9 (MSB)	b8	b7	b6	b5	b4	b3	b2	b1	b0 (LSB)
Ancillary Data Flag	0	0	0	0	0	0	0	0	0	0
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
Data ID (DID)	Not b8	EP	0	1	0	0	0	0	0	1
Secondary Data ID (SDID)	Not b8	EP	0	0	0	0	1	1	0	0
Data Count (DC) = n	Not b8	EP	Data count range from 02h to a maximum of FFh. Actual range in accordance with the carriage of Metadata as defined in section 5.3							
UDW 1….n (HDR/WCG Metadata)	Not b8	EP	HDR/WCG Metadata as defined in section 5.3							
Checksum	Not b8	Sum of b0~b8 of DID through to the last UDW								

Where EP = even parity for b0 through b7.

5.2 Location and Timing of HDR/WCG Ancillary Data Packets

5.2.1 Timing of HDR/WCG Ancillary Data Packets

Transmission of one or more HDR/WCG Ancillary Data Packet shall take place once per video frame with which the metadata within the packet are associated.

5.2.2 Location of HDR/WCG Ancillary Data Packets

The packets shall be placed into any available Vertical Ancillary Data Space (VANC), as defined in SMPTE RP 291-2, from the second line following the line specified for vertical interval switching, as defined in SMPTE RP 168, inclusive through the last line before active video for the image to which the packet applies.

Placement of HDR/WCG Ancillary Data Packets shall be further constrained by the ancillary data mapping rules defined in each applicable interface mapping.

5.3 UDW Format

5.3.1 HDR/WCG Metadata

The user data words (UDW) shall consist of HDR/WCG Metadata as defined in this section.

HDR/WCG Metadata is grouped into HDR/WCG Metadata Frames. At least one HDR/WCG Metadata Frame shall be present in each HDR/WCG Metadata Ancillary Data Packet. Multiple HDR/WCG Metadata Frames may be present in a single HDR/WCG Metadata Ancillary Data Packet. Each HDR/WCG Metadata Frame shall be formatted according to the Table 2 and shall comprise at least the first two lines of Table 2.

Table 2 - HDR/WCG Metadata Frame Format

HDR/WCG Metadata Frame Type (uint8)
HDR/WCG Metadata Frame Length **j** (uint8)
HDR/WCG Metadata Frame Data Byte 1
….
HDR/WCG Metadata Frame Data Byte j

The HDR/WCG Metadata Frame Type shall be set according to Table 3.

Note: The defining standards of the Metadata Frame Data shows in Table 3 are not intended to limit where the metadata can be used, e.g., the Metadata Frame Data for Dynamic Metadata Type 1, though defined in ATSC A/341, is not intended by this standard to be constrained for use only in productions destined for ATSC 3.0 emission.

Table 3 - HDR/WCG Metadata Frame Types

Value	***HDR/WCG Metadata Frame Type***	***Defining Standard***	***Metadata Frame Data***
0	Static Metadata Type 1	Rec. ITU-T H.265	Mastering display colour volume SEI message
1	Static Metadata Type 2	Rec. ITU-T H.265	Content light level information SEI message
2	Dynamic Metadata Type 1	ATSC A/341	ATSC A/341 ST 2094-10_data SEI message
3	Reserved		
4	Reserved		
5	Reserved		
6	Dynamic Metadata Type 5	ETSI TS 103 433-1 SL-HDR1	SL-HDR information SEI message
All other values	Reserved		

Note: Metadata Frame Type values 3, 4, and 5 are reserved for dynamic metadata types corresponding to SMPTE ST 2094-20, ST 2094-30, and ST 2094-40, respectively.

The HDR/WCG Metadata Frame Length shall be set according to the number of Data Bytes contained in the HDR/WCG Metadata Frame.

The HDR/WCG Metadata Frame Data Bytes shall represent the Supplemental Enhancement Information (SEI) message specified in Table 3 for the HDR/WCG Metadata Frame Type, as described in sections 5.3.2 through 5.3.5. The SEI message shall comply with sei_message() as specified in Rec. ITU-T H.265 and shall be encoded such that Data Byte 1 begins the encoded payloadType.

When the Data Count (DC) of the ancillary data packet indicates additional user data words are present after the last Data Byte of an HDR/WCG Metadata Frame, it shall indicate the presence of additional HDR/WCG Metadata Frames. In this case the last Data Byte of the current HDR/WCG Metadata Frame shall be followed immediately by the HDR/WCG Metadata Frame Type of the next HDR/WCG Metadata Frame.

5.3.2 Static Metadata Type 1 (Mastering Display)

When the HDR/WCG Metadata Frame Type value is equal to 0, then the payload carried by the HDR/WCG Metadata Frame is a Mastering display colour volume SEI message as defined in Rec. ITU-T H.265 and the HDR/WCG Metadata Frame shall conform to the following constraints:

- HDR/WCG Metadata Frame Data Byte 1 shall be 0x89 (the SEI message payloadType=137);
- HDR/WCG Metadata Frame Data Byte 2 shall be 0x18 (the SEI message payloadSize);
- The HDR/WCG Metadata Frame Data Bytes 3 through 26 shall represent the Mastering display colour volume SEI message mastering_display_colour_volume() as described in Rec. ITU-T H.265;
- The HDR/WCG Metadata Frame Length shall be set to 0x1A.

Note: The Mastering display color volume SEI message described in Rec. ITU-T H.265 is an encoding of the metadata items to specify the color volume (the color primaries, white point, and luminance range) of the display that was used in mastering video content in accordance with SMPTE ST 2086.

No more than one HDR/WCG Metadata Frame Type value equal to 0 shall be associated with any video frame.

5.3.3 Static Metadata Type 2 (Content Light Level)

When the HDR/WCG Metadata Frame Type value is equal to 1, then the payload carried by the HDR/WCG Metadata Frame is a Content light level information SEI message as defined in Rec. ITU-T H.265 and the HDR/WCG Metadata Frame shall conform to the following constraints:

- HDR/WCG Metadata Frame Data Byte 1 shall be 0x90 (the SEI message payloadType=144);
- HDR/WCG Metadata Frame Data Byte 2 shall be 0x04 (the SEI message payloadSize);
- The HDR/WCG Metadata Frame Data Bytes 3 through 6 shall represent the Content light level information SEI message content_light_level_info() as described in Rec. ITU-T H.265;
- The HDR/WCG Metadata Frame Length shall be set to 0x06.

Note: The Content light level information SEI message described in Rec. ITU-T H.265 is an encoding of the Maximum Content Light Level (MaxCLL) and Maximum Frame Average Light Level (MaxFALL) metadata items as specified in Consumer Technology Association 861.3 specification.

No more than one HDR/WCG Metadata Frame Type value equal to 1 shall be associated with any video frame.

5.3.4 Dynamic Metadata Type 1 (ATSC A/341 ST 2094-10_data)

When the HDR/WCG Metadata Frame Type value is equal to 2, then the payload carried by the HDR/WCG Metadata Frame is a Metadata Based on SMPTE ST 2094-10_Data SEI message, as specified in ATSC A/341 and the HDR/WCG Metadata Frame shall conform to the following constraints:

- HDR/WCG Metadata Frame Data Byte 1 shall be 0x04 (the SEI message payloadType=4);
- HDR/WCG Metadata Frame Data Byte 2 shall be set to the result of 9 plus the size of the ST2094-10_data() (defined in ATSC A/341), in bytes;
- HDR/WCG Metadata Frame Data Bytes 3 through 9 shall be as specified for Caption, AFD and Bar Data Semantics to designate ATSC1_data() in ANSI/SCTE 128-1, and are summarized in Table 4;
- HDR/WCG Metadata Frame Data Byte 10 shall be 0x09 (user_data_type_code for ST2094-10_data() as specified in ATSC A/341);
- The HDR/WCG Metadata Frame Data Bytes, beginning with Byte 11, shall represent the 2094-10 metadata message ST2094-10_data() as defined in ATSC A/341;
- The HDR/WCG Metadata Frame Data Byte following the last byte representing ST2094-10_data() shall be 0xFF, the marker_bits concluding ATSC1_data() as specified in ANSI/SCTE 128-1;

- The HDR/WCG Metadata Frame Length shall be set to the result of 11 plus the size of the ST2094-10_data() in bytes.

Table 4 - SMPTE ST 2094-10 Header Bytes per ANSI/SCTE 128-1

Byte Number	*Value*	*Reference*
3	0xB5	itu_t_t35_country_code for the United States
4	0x00	itu_t_t35_provider_code (MSB) for ATSC
5	0x31	itu_t_t35_provider_code (LSB) for ATSC
6	0x47	user_identifier (MSB) for ATSC1_data()
7	0x41	user_identifier (continued)
8	0x39	user_identifier (continued)
9	0x34	user_identifier (LSB)

When an HDR/WCG Metadata Frame Type value equal to 2 is associated with a video frame, an HDR/WCG Metadata Frame Type value equal to 0 shall be associated with the same video frame.

Note: The Metadata Based on SMPTE ST 2094-10_Data SEI message is an encoding of certain ST2094-10 metadata items as specified in ATSC A/341.

No more than one HDR/WCG Metadata Frame Type value equal to 2 shall be associated with any video frame.

5.3.5 Dynamic Metadata Type 5 (ETSI TS 103 433-1 SL-HDR1)

When the HDR/WCG Metadata Frame Type is equal to 6, then the payload carried by the HDR/WCG Metadata Frame is an SL-HDR information SEI message wrapped in an HEVC “User data registered by Recommendation ITU-T T.35” SEI message as defined in ETSI TS 103 433-1, Annex A.2, and the HDR/WCG Metadata Frame shall conform to the following constraints:

- The SL-HDR information SEI message shall not exceed 251 bytes in length, resulting in a HDR/WCG Metadata Frame having no more than 253 HDR/WCG Metadata Frame Data Bytes;
- HDR/WCG Metadata Frame Data Byte 1 shall be 0x04 (the SEI message payloadType=4);
- HDR/WCG Metadata Frame Data Byte 2 is the SL-HDR information SEI message payload size in bytes and shall be the smallest integer greater than or equal to the result of the length of the SL-HDR information SEI message in bits divided by 8;
- The HDR/WCG Metadata Frame Data, beginning with Byte 3, shall represent the SL-HDR information SEI message sl_hdr_info() as defined in ETSI TS 103 433-1, Annex A.2;
- When the length of the SL-HDR information SEI message in bits is not evenly divisible by 8, in the last HDR/WCG Metadata Frame Data Byte, the first bit following the SL-HDR information SEI message shall be set to one and any less significant bits shall be set to zero;
- The HDR/WCG Metadata Frame Length shall be set to 2 plus the SL-HDR information SEI message payload size in bytes.

Bibliography (Informative)

CTA-861.3:2015, HDR Static Metadata Extension

Recommendation ITU-T T.35 (02/2000), Procedure for the allocation of ITU-T defined codes for non-standard facilities

SMPTE ST 352:2013, Payload Identification Codes For Serial Digital Interfaces

SMPTE ST 2086:2014, Mastering Display Color Volume Metadata Supporting High Luminance and Wide Color Gamut Images