ATSC Candidate Standard: A/341 Amendment: 2094-10

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Advanced Television Systems Committee
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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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Note: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith. One or more patent holders have, however, filed a statement regarding the terms on which such patent holder(s) may be willing to grant a license under these rights to individuals or entities desiring to obtain such a license. Details may be obtained from the ATSC Secretary and the patent holder.

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 S34-262r0 dated 13 April 2017. 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.

Revision History

Version	Date
Candidate Standard approved	18 May 2017
Amendment approved	[date]

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1. OVERVIEW

This document describes technology documented in ST 2094-10 "Dynamic Metadata for Color Volume Transform — Application #1" which is a technology for the use of dynamic metadata for HDR content. If approved by the ATSC, A/341-Video-HECV (*date of current public version*) ("A/341") would be amended according to the edits described herein.

2. REFERENCES

The following references would be added to A/341.

2.1 Normative References

No new normative references are needed.

2.2 Informative References

[1] SMPTE: "Dynamic Metadata for Color Volume Transformation – Core Components," Doc. ST 2094-1 (2016), Society of Motion Picture and Television Engineers, White Plains, NY.

[2] SMPTE: "Dynamic Metadata for Color Volume Transformation – Application #1," Doc. ST 2094-10 (2016), Society of Motion Picture and Television Engineer, White Plains, NY.

3. DEFINITION OF TERMS

No new acronyms, abbreviations or terms would be added to A/341.

4. CHANGES TO A/341

In this section of this document, "[ref]" indicates that a cross reference to a cited referenced document that is listed in A/341 would be inserted (or as otherwise described within the square brackets). An actual cross reference to a referenced document listed in this document would be updated with the reference number of the newly added references that would be incorporated into A/341.

Add a Bullet to 6.3.2.2

Add the bullet item below to the bullet list found in 6.3.2.2 "PQ Transfer Characteristics":

- The bitstream may contain SEI messages with payloadType value equal to 4. This allows for the optional transmission of the ST 2094-10 metadata message described in [ref to new subsection described below].

Add a new subsection under Section 6.3.2.2

Add the text below to A/341 as a new subsection under Section 6.3.2.2 "PQ Transfer Characteristics." The new subsection is titled Section 6.3.2.2.x "Encoding and Transport of SMPTE ST 2094-10 Metadata Message." (For readability, the following text is not shown in markup.)

Section 6.3.2.2.x "Encoding and Transport of SMPTE ST 2094-10 Metadata Message

The HEVC video bitstream may contain the 2094-10 metadata message in order to provide dynamic information about the video signal. When a 2094-10 metadata message is present, this information can be employed by the display to adapt the delivered HDR imagery to the capability of the display device. Furthermore, this metadata can be used to derive an SDR (ITU-R BT.709 [ref]) picture by receiving devices such as an ATSC 3.0 receiver/converter. The information conveyed in the 2094-10 metadata message defined in [ref to new Annex described below] provides carriage for metadata elements defined in ST 2094-1 [1] and ST 2094-10 [2].

2094-10 metadata, when present, shall be encoded and transported as User data registered by a Recommendation ITU-T T.35 Supplemental Enhancement Information (SEI) message per the ATSC1_data() structure defined in Table 14 of ANSI/SCTE 128-1 [ref] and the assigned value for user_data_type_code is shown in [ref to Table x.x].

Table x.x user_data_type_code

user_data_type_code	user_data_type_structure
0x09	ST2094-10_data()

The syntax and semantics for payload ST2094-10_data() shall be as specified in [ref to new Annex described below] clause [ref to new Annex, Section 1 described below]. Where present the corresponding NAL unit type shall be set equal to SUFFIX_SEI_NUT.

If a 2094-10 metadata message is present, the following constraints shall apply:

- The 2094-10 metadata message shall be associated with every access unit of the bitstream. If this message is present, it shall only be present once per access unit.
- app_identifier shall be set equal to 1.
- app_version shall be set equal to 0.
- Mastering Display Color Volume SEI messages (containing SMPTE ST 2086 [ref] static metadata) shall be present in the bitstream.
- The number of extension blocks with ext_block_level equal to 1 shall be constrained to be equal to 1.
- The number of extension blocks with ext_block_level equal to 2 shall be constrained to be less than or equal to 16.
- The number of extension blocks with ext_block_level equal to 5 shall be constrained to be equal to 0 or 1.

Add a new Annex to A/341

Add the text below as a new Annex to A/341. The Annex is titled "Metadata Based on SMPTE ST 2094-10_Data." (For readability, the following text is not shown in markup.)

A.1 METADATA BASED ON ST 2094-10_DATA (NORMATIVE)

This clause specifies the syntax and semantics of ST2094-10_data().

The syntax for ST2094-10_data() is shown in Table Y.Y, Table Z.Z, and Table M.M.

The parsing process of each syntax element by the descriptors f(n), i(n), ue(v) and u(n) is described in HEVC[ref].

Note: The metadata elements are defined according to the SMPTE standards ST 2086[ref], ST 2094-1[1], or ST 2094–10 [2].

Table Y.Y ST2094_data()

ST2094-10_data () {	**Descriptor**
app**_identifier**	ue(v)
app_version	ue(v)
metadata_refresh_flag	u(1)
if(metadata_refresh_flag) {	
num_ext_blocks	ue(v)
if(num_ext_blocks) {	
while(!byte_aligned())	
dm_alignment_zero_bit	f(1)
for(i = 0; i < num_ext_blocks; i ++) {	
ext_dm_data_block(i)	
}	
}	
else {	
while(!byte_aligned())	
dm_alignment_zero_bit	f(1)
}	
}	
}	

Table Z.Z ext_dm_data_block()

ext_dm_metadata_block(i) {	**Descriptor**
ext_block_length[i]	ue(v)
ext_block_level [i]	u(8)
ext_dm_data_block_payload(ext_block_length[i], ext_block_level [i])	
}	

Table N.N ext_dm_data_block_payload()

ext_dm_data_block_payload(ext_block_length, ext_block_level) {	**Descriptor**
ext_block_len_bits = 8 * ext_block_length	
ext_block_use_bits = 0	
if(ext_block_level == 1) {	
min_PQ	u(12)
max_PQ	u(12)
avg_PQ	u(12)
ext_block_use_bits += 36	
}	
if(ext_block_level == 2) {	
target_max_PQ	u(12)
trim_slope	u(12)
trim_offset	u(12)
trim_power	u(12)
trim_chroma_weight	u(12)
trim_saturation_gain	u(12)
ms_weight	i(13)
ext_block_use_bits += 85	
}	
if(ext_block_level == 5) {	
active_area_left_offset	u(13)
active_area_right_offset	u(13)
active_area_top_offset	u(13)
active_area_bottom_offset	u(13)
ext_block_use_bits += 52	
}	
while(ext_block_use_bits++ < ext_block_len_bits)	
ext_dm_alignment_zero_bit	f(1)
}	

This clause defines the semantics for ST2094-10_data().

For the purposes of the present clause, the following mathematical functions apply:

$$\text{Abs(x)} = \begin{cases} x & ; \quad x \geq 0 \\ -x & ; \quad x < 0 \end{cases}$$

Floor(x) is the largest integer less than or equal to x.

$$\text{Sign(x)} = \begin{cases} 1 & ; \quad \text{x} > 0 \\ 0 & ; \quad x = 0 \\ -1 & ; \quad x < 0 \end{cases}$$

$$\text{Clip3(x, y, z)} = \begin{cases} x & ; \quad z < x \\ y & ; \quad z > y \\ z & ; \quad otherwise \end{cases}$$

$$Round(x) = Sign(x)*Floor(Abs(x)+0.5)$$

/ = Integer division with truncation of the result toward zero. For example, 7/4 and −7/−4 are truncated to 1 and −7/4 and 7/−4 are truncated to −1.

app_identifier identifies an application in the ST 2094 suite.

app_version specifies the application version in the application in the ST 2094 suite.

metadata_refresh_flag when set equal to 1 cancels the persistence of any previous extended display mapping metadata in output order and indicates that extended display mapping metadata follows. The extended display mapping metadata persists from the coded picture to which the SEI message containing ST2094-10_data() is associated (inclusive) to the coded picture to which the next SEI message containing ST2094-10_data() and with **metadata_refresh_flag** set equal to 1 in output order is associated (exclusive) or (otherwise) to the last picture in the CVS (inclusive). When set equal to 0 this flag indicates that the extended display mapping metadata does not follow.

num_ext_blocks specifies the number of extended display mapping metadata blocks. The value shall be in the range of 1 to 254, inclusive.

dm_alignment_zero_bit shall be equal to 0.

ext_block_length[i] is used to derive the size of the i-th extended display mapping metadata block payload in bytes. The value shall be in the range of 0 to 1023, inclusive.

ext_block_level[i] specifies the level of payload contained in the i-th extended display mapping metadata block. The value shall be in the range of 0 to 255, inclusive. The corresponding extended display mapping metadata block types are defined in Table E.1.4. Values of ext_block_level[i] that are ATSC reserved shall not be present in the bitstreams conforming to this version of ATSC specification. Blocks using ATSC reserved values shall be ignored.

When the value of ext_block_level[i] is set equal to 1, the value of ext_block_length[i] shall be set equal to 5.

When the value of ext_block_level[i] is set equal to 2, the value of ext_block_length[i] shall be set equal to 11.

When the value of ext_block_level[i] is set equal to 5, the value of ext_block_length[i] shall be set equal to 7.

Table M.M Definition of Extended Display Mapping Metadata Block Type

ext_block_level	extended display mapping metadata block type
0	ATSC Reserved
1	Level 1 Metadata – Content Range
2	Level 2 Metadata – Trim Pass
3	ATSC Reserved
4	ATSC Reserved
5	Level 5 Metadata – Active Area
6…255	ATSC Reserved

When an extended display mapping metadata block with ext_block_level equal to 5 is present, the following constraints shall apply:

- An extended display mapping metadata block with ext_block_level equal to 5 shall be preceded by at least one extended display mapping metadata block with ext_block_level equal to 1 or 2.

- Between any two extended display mapping metadata blocks with ext_block_level equal to 5, there shall be at least one extended display mapping metadata block with ext_block_level equal to 1 or 2.
- No extended display mapping metadata block with ext_block_level equal to 1 or 2 shall be present after the last extended display mapping metadata block with ext_block_level equal to 5
- The metadata of an extended display mapping metadata block with ext_block_level equal to 1 or 2 shall be applied to the active area specified by the first extended display mapping metadata block with ext_block_level equal to 5 following this block.
- When the active area defined by the current extended display mapping metadata block with ext_block_level equal to 5 overlaps with the active area defined by preceding extended display mapping metadata blocks with ext_block_level equal to 5, all metadata of the extended display mapping metadata blocks with ext_block_level equal to 1 or 2 associated with the current extended display mapping metadata block with ext_block_level equal to 5 shall be applied to the pixel values of the overlapping area.

min_PQ specifies the minimum luminance value of the current picture in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit min_PQ value with full range is calculated as follows:

$$min\_PQ = Clip3(0, 4095, Round(Min * 4095))$$

where Min is MinimumPqencodedMaxrgb as defined in clause 6.1.3 of SMPTE ST 2094-10 [2]

max_PQ specifies the maximum luminance value of current picture in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit max_PQ value with full range is calculated as follows:

$$max\_PQ = Clip3(0, 4095, Round(Max * 4095))$$

where Max is MaximumPqencodedMaxrgb as defined in clause 6.1.5 of SMPTE ST 2094-10 [2].

avg_PQ specifies the midpoint luminance value of current picture in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit avg_PQ value with full range is calculated as follows:

$$avg\_PQ = Clip3(0, 4095, Round(Avg * 4095))$$

where Avg is AveragePqencodedMaxrgb as defined in section 6.1.4 of SMPTE ST 2094-10 [2].

target_max_PQ specifies the maximum luminance value of a target display in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. The target_max_PQ is the PQ encoded value of TargetedSystemDisplayMaximumLuminance as defined in clause 10.4 of SMPTE ST 2094-1 [1].

If there is more than one extended display mapping metadata block with ext_block_level equal to 2, those blocks shall have no duplicated target_max_PQ.

trim_slope specifies the slope metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_slope is not present, it shall be inferred to be 2048. Note that the 12-bit slope value is calculated as follows:

$$trim\_slope = \text{Clip3}(0, 4095, \text{Round}((S\text{-}0.5) * 4096))$$

where *S* is the ToneMappingGain as defined in clause 6.2.3 of SMPTE ST 2094-10 [2].

trim_offset specifies the offset metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_offset is not present, it shall be inferred to be 2048. Note that the 12-bit offset value is calculated as follows:

$$trim\_offset = \text{Clip3}(0, 4095, \text{Round}((O+0.5) * 4096))$$

where *O* is the ToneMappingOffset as defined in clause 6.2.2 of SMPTE ST 2094-10 [2].

trim_power specifies the power metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_power is not present, it shall be inferred to be 2048. Note that the 12-bit power value is calculated as follows:

$$trim\_power = \text{Clip3}(0, 4095, \text{Round}((P\text{-}0.5) * 4096))$$

where *P* is the ToneMappingGamma as defined in clause 6.2.4 of SMPTE ST 2094-10 [2].

trim_chroma_weight specifies the chroma weight metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_chroma_weight is not present, it shall be inferred to be 2048. Note that the 12-bit chroma weight value is calculated as follows:

$$trim\_chroma\_weight = \text{Clip3}(0, 4095, \text{Round}((CW+0.5) * 4096))$$

where *CW* is the ChromaCompensationWeight as defined in clause 6.3.1 of SMPTE ST 2094-10 [2].

trim_saturation_gain specifies the saturation gain metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_saturation_gain is not present, it shall be inferred to be 2048. Note that the 12-bit saturation gain value is calculated as follows:

$$trim\_saturation\_gain = \text{Clip3}(0, 4095, \text{Round}((SG+0.5) * 4096))$$

where *SG* is the SaturationGain as defined in clause 6.3.2 of SMPTE ST 2094-10 [2].

ms_weight specifies the multiscale weight metadata. The value shall be in the range of -1 to 4095, inclusive. If ms_weight is not present, it shall be inferred to be 2048. Where ms_weight is equal to -1, the bit stream indicates ms_weight is unspecified. The 13-bit multiscale weight value is calculated as follows:

$$ms\_weight = \text{-1 OR Clip3}(0, 4095, \text{Round}(MS * 4096))$$

where *MS* is the ToneDetailFactor as defined in clause 6.4.2 of SMPTE ST 2094-10 [2].

active_area_left_offset, active_area_right_offset, active_area_top_offset, active_area_bottom_offset specify the active area of current picture, in terms of a rectangular region specified in picture coordinates for active area. The values shall be in the range of 0 to 8191, inclusive. See also UpperLeftCorner and LowerRightCorner definitions in ST 2094-1.

If active_area_left_offset, active_area_right_offset, active_area_top_offset, active_area_bottom_offset are not present, they shall be inferred to be 0.

The coordinates of top left active pixel is derived as follows:

$$X_{top\_left} = active\_area\_left\_offset$$

$$Y_{top\_left} = active\_area\_top\_offset$$

The coordinates of top left active pixel are defined as the UpperLeftCorner in clause 9.2 of SMPTE ST.2094-1 [1].

With Xsize is the horizontal resolution of the current picture and Ysize is the vertical resolution of current picture, the coordinates of bottom right active pixel are derived as follows:

$$X_{bottom\_right} = XSize - 1 - active\_area\_right\_offset$$

$$Y_{bottom\_right} = YSize - 1 - active\_area\_bottom\_offset$$

where X_{bottom_right} greater than X_{top_left} and Y_{bottom_right} greater than Y_{top_left}.

The coordinates of bottom right active pixel are defined as the LowerRightCorner in clause 9.3 of SMPTE ST.2094-1 [1].

ext_dm_alignment_zero_bit shall be equal to 0.

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