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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)

EBU
OPERATING EUROVISION

Reference

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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

The present document is part 1 of a multi-part document covering the High-Performance Single Layer High Dynamic Range (HDR) System for use in Consumer Electronics devices, as identified below:

Part 1: "Directly Standard Dynamic Range (SDR) Compatible HDR System (SL-HDR1)";

Part 2: "Enhancements for Perceptual Quantization (PQ) transfer function based High Dynamic Range (HDR) Systems (SL-HDR2)";

Part 3: "Enhancements for Hybrid Log Gamma (HLG) transfer function based High Dynamic Range (HDR) Systems (SL-HDR3)".

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Modal verbs terminology

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Introduction

Motivation

Today High Efficiency Video Coding (HEVC) enables first Ultra HD broadcast services (also referred as "4K" resolution) via existing DVB specifications. Recently some High Dynamic Range (HDR) standards have been released by SMPTE (SMPTE ST 2084 [1] and SMPTE ST 2086 [2]). However, they define an HDR video signal that is not directly compatible with Standard Dynamic Range (SDR) Consumer Electronics (CE) devices. Thus, these devices require upstream external processing adapting the HDR video signal to a supported video format in order to render the video signal. Additionally, existing production and distribution infrastructures as well as play out equipment may not be compatible with the SMPTE HDR standards with respect to carriage and signalling of the metadata in these standards.

The HDR system specified in the present document addresses direct backwards compatibility i.e. it leverages SDR distribution networks and services already in place and that enables high quality HDR rendering on HDR-enabled CE devices including high quality SDR rendering on SDR CE devices. Requirement for the present solution is that it is single layer to ensure that bit rate overhead for HDR and implementation complexity in CE devices will be low.

Pre-processing

At the distribution stage, an incoming HDR signal is decomposed in an SDR signal and content-dependent dynamic metadata. This stage is called "HDR-to-SDR decomposition", "HDR decomposition" or simply "decomposition". The SDR signal is encoded with any distribution codec (e.g. HEVC or AVC as respectively specified in Annex A and Annex B) and carried throughout the existing SDR distribution network with accompanying metadata conveyed on a specific channel or embedded in an SDR bitstream. The dynamic metadata can for instance be carried in an SEI message when used in conjunction with an HEVC or AVC codec. The HDR-to-SDR pre-processor that produces dynamic metadata is not a normative requirement of the present document. Nonetheless, the pre-processor is expected to produce a dynamic metadata stream matching the syntax specified in Annex A and Annex B.

Post-processing

In the present document, the post-processing stage that occurs in the IRD is functionally the inverse of the pre-processing stage and is called "SDR-to-HDR reconstruction", "HDR reconstruction" or just "reconstruction". It occurs just after SDR bitstream decoding. The post-processing takes as input an SDR video frame and associated dynamic metadata in order to reconstruct an HDR picture, as specified in clause 7, to be presented to the HDR compliant rendering device.

Structure of the present document

The present document is structured as follows. Clause 1 provides the scope of the present document . Clause 2 provides references used in the present document. Clause 3 gives essential definitions, symbols and abbreviations used in the present document. Clause 4 provides information on the end to end system. Clause 5 details the architecture of the HDR system. Clause 6 specifies the format abstraction layer (agnostic to the distribution format) implementing the content-based dynamic metadata common to systems based on ETSI TS 103 433 multi-part document. Specifically to the present document, the metadata are produced during the HDR-to-SDR decomposition stage and they enable reconstruction of the HDR signal from the decoded SDR signal and those metadata. Clause 7 specifies the reconstruction process of the HDR signal. The dynamic metadata format specified in clause 6 is normatively mapped from SEI messages representative of SL-HDR system that are specified for HEVC and AVC respectively in Annex A and Annex B. Informative Annex C, Annex D and Annex E provide information on an HDR-to-SDR decomposition process, a gamut mapping process as well as its inverse process and HDR-to-HDR display adaptation. Informative Annex F proposes a recovery procedure when dynamic metadata are detected as missing by the post-processor during the HDR signal reconstruction. Eventually, informative Annex G gives reference to a standard mechanism to carry SL-HDR reconstruction metadata through interfaces.

The structure of the present document is summarized in Table 1.

Table 1: Structure of the present document

Clause/Annex #	Description	Normative / Informative (in the present document)	Part(s) for which the clause/annex is valid
Clause 1	Scope of the document	Informative	1
Clause 2	References used in the document	Normative/Informative	1
Clause 3	Definitions, symbols, abbreviations	Normative	1
Clause 4	End-to-end system	Informative	1
Clause 5	Architecture of the HDR system	Informative	1
Clause 6	Metadata format abstraction layer (agnostic to the distribution format)	Normative	1, 2, 3
Clause 7	SDR-to-HDR reconstruction process	Normative	1
Annex A	SL-HDR reconstruction metadata using HEVC	Normative	1, 2, 3
Annex B	SL-HDR reconstruction metadata using AVC	Normative	1, 2, 3
Annex C	HDR-to-SDR decomposition process	Informative	1
Annex D	Invertible gamut mapping process	Informative	1
Annex E	HDR-to-HDR display adaptation process	Informative	1
Annex F	Error-concealment and recovery procedure	Informative	1
Annex G	ETSI TS 103 433 signalling in CTA-861-G	Informative	1, 2, 3

1 Scope

The present document specifies the content-based dynamic metadata common to systems based on ETSI TS 103 433 multi-part deliverable and the post-decoding process enabling reconstruction of an HDR signal from an SDR signal and the specified metadata. This reconstruction process is typically invoked in a Consumer Electronics device such as a TV set, a smartphone, a tablet, or a Set Top Box. Besides, it provides information and recommendations on the usage of the described HDR system.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] SMPTE ST 2084:2014: "High Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays".

[2] SMPTE ST 2086:2014: "Mastering Display Color Volume Metadata Supporting High Luminance and Wide Color Gamut Images".

[3] Recommendation ITU-T H.264 (02-2016): "Advanced video coding for generic audiovisual services".

[4] Recommendation ITU-T H.265 (04-2015): "High efficiency video coding".

[5] SMPTE RP 431-2:2011: "D-Cinema Quality - Reference Projector and Environment".

[6] Recommendation ITU-R BT.709-6 (06-2015): "Parameter values for HDTV standards for production and international programme exchange".

[7] Recommendation ITU-R BT.2020-2 (10-2015): "Parameter values for ultra-high definition television systems for production and international programme exchange".

[8] Recommendation ITU-R BT.1886 (03-2011): "Reference electro-optical transfer function for flat panel displays used in HDTV studio production".

[9] ISO 11664-1:2007 (CIE S 014-1/E:2006): "Colorimetry - Part 1: CIE standard colorimetric observers".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] CTA Standard CTA-861.3 (January 2015): "HDR Static Metadata extensions".

[i.2] Recommendation ITU-R BT.2035: "A reference environment for evaluation of HDTV program material or completed programmes".

[i.3] SMPTE ST 2094-20:2016: "Dynamic Metadata for Color Volume Transform - Application #2".

[i.4] SMPTE ST 2094-30:2016: "Dynamic Metadata for Color Volume Transform - Application #3".

[i.5] SMPTE RP 2077:2013: "Full Range Image Mapping".

[i.6] Recommendation ITU-R BT.2100: "Image parameter values for high dynamic range television for use in production and international programme exchange".

[i.7] SMPTE Engineering Guideline EG 28-1993: "Annotated Glossary of Essential Terms for Electronic Production".

[i.8] CTA Standard CTA-861-G (November 2016): "A DTV Profile for Uncompressed High Speed Digital Interfaces".

[i.9] SMPTE RP 177:1993: "Derivation of Basic Television Color Equations".

[i.10] Recommendation ITU-T T.35 (02-2000): "Procedure for the allocation of ITU-T defined codes for non-standard facilities".

[i.11] JCTVC-Z1017: "Conversion and Coding Practices for HDR/WCG Y'CbCr 4:2:0 Video with PQ Transfer Characteristics (Draft 4)".

[i.12] ETSI TS 103 433 (V1.1.1): "High-Performance Single Layer Directly Standard Dynamic Range (SDR) Compatible High Dynamic Range (HDR) System for use in Consumer Electronics devices (SL-HDR1)".

3 Definitions, symbols, abbreviations and conventions

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

anchor: invariant point that can be retrieved during the inverse hue mapping process

NOTE 1: Term specific to the invertible gamut mapping process.

NOTE 2: The anchor guarantees the invertibility of the hue mapping process.

chrominance: chrominance components are denoted U and V in the linear-light YUV colour space

NOTE 1: Term specific to the gamut mapping (or inverse) process.

NOTE 2: Typically, in the linear-light YUV colour space, it corresponds to the radial coordinate of the cylindrical representation of a colour i.e. $\mathrm{chrominance}(Y,U,V) = \sqrt{U^2 + V^2}$.