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TECHNICAL SPECIFICATION

**High-Performance Single Layer High Dynamic Range (HDR) System for use in Consumer Electronics devices;
Part 3: Enhancements for Hybrid Log Gamma (HLG) transfer function based High Dynamic Range (HDR) Systems (SL-HDR3)**

Reference
DTS/JTC-040-3

Keywords
broadcasting, content, digital, distribution, HDR, HDTV, UHDTV, video

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

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The present document is part 3 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

European Broadcasting Union
CH-1218 GRAND SACONNEX (Geneva)
Switzerland
Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

Motivation

Today Ultra HD services have been launched or are being launched by broadcasters and network operators in many regions of the world. Besides higher resolution, wider colour gamut and higher frame rate, High Dynamic Range is a highly demanded feature.

The goal of ETSI TS 103 433-1 [1], SL-HDR1, is to standardize a single layer HDR system addressing direct SDR backwards compatibility i.e. a system leveraging 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.

The goal of ETSI TS 103 433-2 [2], SL-HDR2, is to specify enhancements for single layer Perceptual Quantization (PQ) transfer function based HDR systems, enabled by signal processing blocks that are similar/the same to those in SL-HDR1.

The goal of the present document is to specify enhancements for single layer Hybrid Log Gamma (HLG) transfer function based HDR systems, enabled by signal processing blocks that are similar/the same to those in SL-HDR1 and SL-HDR2. Similar to SL-HDR1 and SL-HDR2, these enhancements are enabled by use of dynamic metadata and a post processor in the Consumer Electronics device.

Pre-processing

At the distribution stage, an incoming HDR signal is analysed and content-dependent dynamic metadata is produced. This dynamic metadata can be produced in an automatic process or in a manual process where the image quality resulting of the metadata that has been set manually is judged on an SDR grading monitor and/or on a distribution channel grading monitor. This dynamic metadata can be used to create an optimal picture for a display that has different characteristics, most noticeably a different maximum luminance, than the display used when grading the HDR content. The HDR signal is encoded with any distribution codec (e.g. HEVC as specified in part 1 [1], Annex A) and carried throughout an HDR distribution network with accompanying metadata conveyed on a specific channel or embedded in an HDR bitstream. The dynamic metadata can for instance be carried in an SEI message when used in conjunction with an HEVC codec. The 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

The post-processing stage occurs just after HDR bitstream decoding. The post-processing takes as input an HLG video frame and associated dynamic metadata and the characteristic of the attached rendering device in order to optimize the HDR picture for the rendering device as specified in clause 7.

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 definition of terms, 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 of the content-based dynamic metadata common to systems based on ETSI TS 103 433 multi-part documents [i.2]. Specifically to the present document, the metadata are produced during the HDR-to-SDR decomposition stage and they enable reconstruction of the SDR signal from the decoded HDR signal using those metadata. Clause 7 specifies the reconstruction process of the SDR signal and an HDR signal that is adapted to the maximum luminance of the presentation display. The dynamic metadata format specified in clause 6 is normatively mapped from SEI messages representative of the SL-HDR system that are specified for HEVC and AVC respectively in Annex A and Annex B. Informative Annex C and Annex D provide information on an HDR-to-SDR decomposition process, and a gamut mapping process. Informative Annex E describes a way to transfer dynamic metadata by embedding it in the video transferred over a CE digital video interface. Informative Annex F proposes a recovery procedure when dynamic metadata are detected as missing by the post-processor during the HDR signal reconstruction. The recovery procedure may also be applied in case it is desirable to replace the original metadata by a fixed tone mapping function, e.g. when graphics overlays are inserted on the decoded video by a mid-device (e.g. STB) which transmits SL-HDR reconstruction metadata as well as the mixed video to an SL-HDR capable TV. Informative Annex G gives reference to a standard mechanism to carry SL-HDR reconstruction metadata through interfaces and Annex H provides a recommendation on the maximum presentation display luminance that display adaptation can be used with. Finally,Annex I provides information on SL-HDR metadata indication for CMAF based applications, and informative Annex J provides information on the use of SL-HDR in DVB Services.

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)
Clause 1	Scope of the document	Informative
Clause 2	References used in the document	Normative/Informative
Clause 3	Definition of terms, symbols, abbreviations	Informative
Clause 4	End-to-end system	Informative
Clause 5	Architecture of the HDR system	Informative
Clause 6	Metadata format abstraction layer (agnostic to the distribution format)	Normative
Clause 7	HDR-to-HDR/SDR reconstruction process	Normative
Annex A	SL-HDR reconstruction metadata using HEVC	Normative
Annex B	SL-HDR reconstruction metadata using AVC	Informative
Annex C	HDR-to-SDR decomposition principles and considerations	Informative
Annex D	Gamut mapping	Informative
Annex E	Embedded data on CE digital video interfaces	Informative
Annex F	Error-concealment and recovery procedure	Informative
Annex G	ETSI TS 103 433 [i.2] signalling in CTA-861-G	Informative
Annex H	Minimum and maximum value of L_{pdisp} for display adaptation	Informative
Annex I	SL-HDR metadata indication for CMAF based applications	Informative
Annex J	Use of SL-HDR in DVB Services	Informative
Annex K	Change History	Informative

1 Scope

The present document specifies the HDR-to-HDR/SDR content-based dynamic metadata and the post-decoding process. The post-decoding process takes the specified metadata and an HLG HDR signal as input, and enables the reconstruction of an SDR signal (typically 100 cd/m^2) or an HDR signal with a maximum luminance ranging from 100 cd/m^2 to a maximum luminance that is greater than that of the original HDR signal. 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] ETSI TS 103 433-1: "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)".

[2] ETSI TS 103 433-2: "High-Performance Single Layer High Dynamic Range (HDR) System for use in Consumer Electronics devices; Part 2: Enhancements for Perceptual Quantization (PQ) transfer function based High Dynamic Range (HDR) Systems (SL-HDR2)".

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

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

[5] Recommendation ITU-R BT.2100-2 (07/2018): "Image parameter values for high dynamic range television for use in production and international programme exchange".

[6] Recommendation ITU-R BT 2390-6 (04/2019): "High dynamic range television for production and international programme exchange".

[7] Recommendation ITU-T H.264 (04-2017): "Advanced video coding for generic audiovisual services".

[8] Recommendation ITU-T H 265 (12-2016): "High efficiency video coding".

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

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-G, November 2016: "A DTV Profile for Uncompressed High Speed Digital Interfaces".

[i.2] ETSI TS 103 433 (all parts): "High-Performance Single Layer High Dynamic Range (HDR) System for use in Consumer Electronics devices".

[i.3] Recommendation ITU-R BT 2035: "A reference environment for evaluation of HDTV program material or completed programmes".

[i.4] SMPTE Engineering Guideline EG 28-1993: "Annotated Glossary of Essential Terms for Electronic Production".

[i.5] SMPTE ST 2094-20:2016: "Dynamic Metadata for Color Volume Transform - Application #2".

[i.6] SMPTE ST 2094-30:2016: "Dynamic Metadata for Color Volume Transform - Application #3".

3 Definition of terms, symbols, abbreviations and conventions

3.1 Terms

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

colour correction: adjustment of the luma and chroma components of a signal derived from the HDR signal in order to avoid hue shift and preserve the colour look of the HDR signal in the SDR signal

display adaptation: adaptation of a video signal to the characteristics of the targeted Consumer Electronics display (e.g. maximum luminance of the CE display)

dynamic metadata: metadata that can be different for different portions of the video and can change at each associated picture

gamut: complete subset of colours which can be represented within a given colour space or by a certain output device

NOTE: Also known as colour gamut.

gamut mapping: mapping of the colour space coordinates of the elements of a source image to colour space coordinates of the elements of a reproduction

NOTE: Gamut mapping intent is not to change the dynamic range of the source but to compensate for differences in the source and output medium colour gamut capability.

High Dynamic Range (HDR) system: system specified and designed for capturing, processing, and reproducing a scene, conveying the full range of perceptible shadow and highlight detail, with sufficient precision and acceptable artefacts, including sufficient separation of diffuse white and specular highlights

luma: linear combination of non-linear-light (gamma-corrected) primary colour signals

luminance: objective measure of the visible radiant flux weighted for colour by the CIE Photopic Spectral Luminous Efficiency Function [i.4]

luminance mapping: adjustment of the luminance representative of a source signal to the luminance of a targeted system

post-production: part of the process of filmmaking and video production gathering many different processes such as video editing, adding visual special effects, transfer of colour motion picture film to video

presentation display: display that the IRD outputs to

reconstructed picture: output picture of SL-HDR post-processing stage

Single Layer High Dynamic Range (SL-HDR) system: system implementing at least one of the parts of the ETSI TS 103 433 multi-part document [i.2]

source picture: input picture of SL-HDR pre-processing stage

NOTE: Typically an HDR picture coming from post-production facilities.

Standard Dynamic Range (SDR) system: system having a reference reproduction using a luminance range constrained by Recommendation ITU-R BT 2035 [i.3], section 3.2

NOTE: Typically no more than 10 stops.

Supplemental Enhancement Information (SEI) message: carriage mechanism defined in Recommendation ITU-T H.264 [7] and Recommendation ITU-T H 265 [8] that is intended to assist in processes related to decoding, display or other purposes

3.2 Symbols

3.2.1 Arithmetic operators

Void.

3.2.2 Mathematical functions

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AVC	Advanced Video Coding
CE	Consumer Electronics
CIE	Commission Internationale de l'Eclairage
EOTF	Electro-Optical Transfer Function
HDMI	High-Definition Multimedia Interface
HDR	High Dynamic Range
HEVC	High Efficiency Video Coding
IRD	Integrated Receiver Decoder
MDCV	Mastering Display Colour Volume
OETF	Opto-Electrical Transfer Function
PQ	Perceptual Quantization
SEI	Supplemental Enhancement Information (as in AVC and HEVC)
SL-HDR	Single Layer High Dynamic Range
SL-HDRI	Single Layer High Dynamic Range Information
SMPTE	Society of Motion Picture and Television Engineers
STB	Set Top Box

3.4 Conventions

Unless otherwise stated, the following convention regarding the notation is used:

- Variables specified in the present document are indicated by bold Arial font 9 points lower camel case style e.g. **camelCase**. All those variables are described in clause 6.
- Internal variables of the present document are indicated by italic Cambria math font 10 points style e.g. *variable*.
- Structures of syntactic elements or structures of variables are indicated by Arial font 9 points C-style with parentheses e.g. structure_of_variables( ). Those structures are defined in clause 6 of part 1 [1], Annex A of part 1 [1], and Annex B of part 1 [1].
- Bitstream syntactic elements are indicated by bold Arial font 9 points C-style e.g. **syntactic_element**. All those variables are defined in Annex A of part 1 [1] and in Annex B of part 1 [1].
- Functions are indicated as *func*(*x*).
- Tables are indicated as *table[idx]*.

4 End-to-end system

Figure 1 shows an end-to-end workflow supporting content production and delivery to HDR and SDR displays and to displays with any maximum luminance level in-between SDR and HDR. The primary goal of this HDR workflow is to provide direct HLG backwards compatible services i.e. services which associated streams are directly compatible with HLG Consumer Electronics devices. This workflow is based on technologies and standards that facilitate an open approach.

It includes a single-layer HDR encoding-decoding, and uses static and dynamic metadata:

- Mastering Display Colour Volume (MDCV) standardized in HEVC [8] and SMPTE ST 2086 [9] specifications; and
- SL-HDR Information (SL-HDRI) based on both SMPTE ST 2094-20 [i.5] and SMPTE ST 2094-30 [i.6] specifications.

Single-layer encoding/decoding requires only one encoder instance at HDR encoding side, and one decoder instance at player/display side. It supports the real-time workflow requirements of broadcast applications.

The elements specifically addressed in the present document are related to the HDR/SDR reconstruction process and the associated dynamic metadata format.

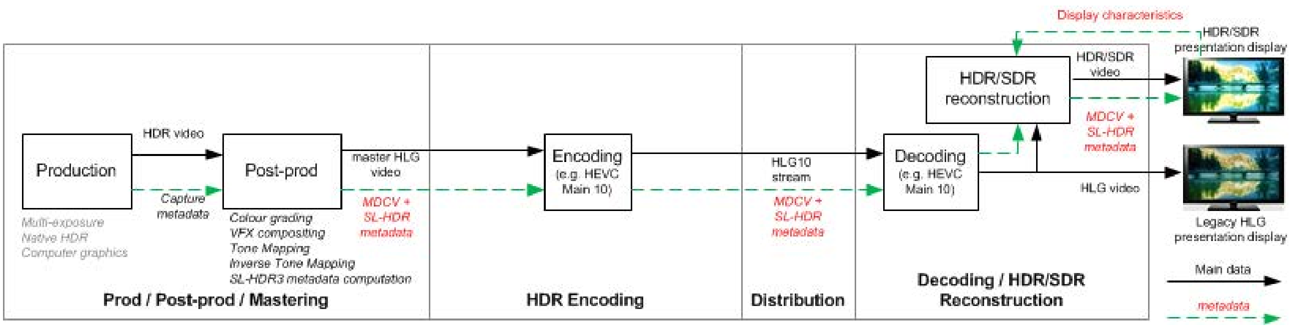


Figure 1: Example of an HDR end-to-end system

5 HDR system architecture

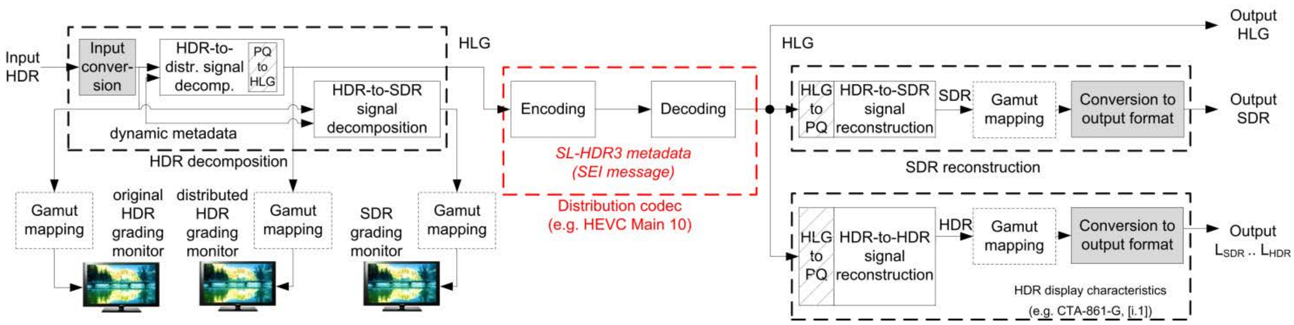
The block diagram in Figure 2 depicts in more detail the HDR decomposition and reconstruction processes of SL-HDR3. The SL-HDR3 system makes use of the SL-HDR2+ extension in SL-HDR2, see Annex I of [2], to which the diagonally shaded boxes are added. These boxes show "bridge point" conversions, see Recommendation ITU-R BT.2390-6 [6], section 7.2. The centre block included in dash-red box corresponds to the distribution encoding and decoding stages (e.g. based on HEVC video coding specifications). The left and right grey-coloured boxes respectively enable format adaptation to the input video signal of the HDR system and to the targeted system (e.g. a STB, a connected TV, etc.) connected with the HDR system. The black solid line boxes show the HDR specific processing. The additional HDR dynamic metadata are transmitted on distribution networks typically by way of the SEI messaging mechanism. The present document relates to both the HDR-to-HDR/SDR signal reconstruction process and the HDR metadata format. The core components of the HDR decomposition stage are the HDR-to-distributed signal decomposition that maps the input HDR with a maximum luminance larger than 1 000 cd/m^2 to 1 000 cd/m^2 for HLG distribution, see the "bridge point" conversion in Recommendation ITU-R BT.2390-6 [6], section 7.2, and the HDR-to-SDR decomposition that generates an SDR video from the HDR signal.

Using the additional HDR dynamic metadata, an SL-HDR3 decoder is able to:

- recreate the original HDR input at the production stage;
- recreate the SDR generated by the HDR-to-SDR decomposition at the production stage; and
- create outputs that are adapted to the maximum luminance of the attached display between 100 cd/m^2 (SDR) and values higher than that of the original HDR input at the production stage.

Optionally in the IRD, a block of gamut mapping may be used when the output HDR/SDR picture is represented in a colour space or colour gamut different from the one of the connected display. The parameters of the optional gamut mapping and their impact on the rendering may be controlled during the post-production stage.

Optionally in the IRD, a block of HDR-to-HDR signal reconstruction may be used as a display adaptation process. The dynamic range output of the display adaptation process may be less and may be more than the dynamic range of the HDR signal input to the HDR-to-SDR signal decomposition process. Figure 2 uses reference [i.1].



NOTE: The three diagonally shaded blocks are additional to an SL-HDR3 system compared to an SL-HDR2+ system.

Figure 2: HDR system architecture overview

6 Dynamic metadata format for HDR-to-HDR/SDR adaptation

Clause 6 of ETSI TS 103 433-2 [2] specifies the dynamic metadata format for signal reconstruction by referring to clause 6 of ETSI TS 103 433-1 [1] and specifying exceptions. In the present document, the dynamic metadata allows conversion of the HDR signal to any maximum luminance between SDR (100 cd/m^2) and a value higher than the original maximum luminance. A recommendation for the maximum luminance boundary can be found in Annex H.

Clause 6 of ETSI TS 103 433-2 [2], together with the SL-HDR2+ metadata extension specified in clause I.2 of ETSI TS 103 433-2 [2] shall apply to the present document.

7 HDR-to-HDR/SDR signal reconstruction process

7.1 Input streams

The input stream is composed of a decoded HLG HDR video stream, see Recommendation ITU-R BT.2100-2 [5], and associated dynamic metadata that are combined to reconstruct an HDR or an SDR video signal. The dynamic metadata shall be conveyed by a parameter-based mode (**payloadMode** 0). Concerning ITU-T or ISO/IEC based video codecs, the payload carriage mode is carried by the SL-HDR Information SEI message specified in ETSI TS 103 433-1 [1]. The HDR-to-HDR/SDR reconstruction process is specified in clause 7.2. This process employs variables specified in clause 6.2 of [1] and retrieved from parsed and mapped (see clause A.2.3 of ETSI TS 103 433-1 [1]) syntax elements of SL-HDR3 dynamic metadata streams. Semantics attached to the syntax elements is provided in clause 6.3 of ETSI TS 103 433-1 [1].

The reconstruction process makes use of the SL-HDR2+ extension in SL-HDR2, see Annex I of ETSI TS 103 433-2 [2]. Therefore, the associated metadata in an SL-HDR3 compatible input stream also contains L_{HDR_o}, the value of the maximum luminance of the original HDR input to the encoder, which value may be higher than 1 000 cd/m^2.

An SL-HDR2+ decoder is capable of adapting its output to the maximum luminance of the displaying monitor, with a minimum of 100 cd/m^2 to more than L_{HDR_o} the maximum luminance of the HDR input to the encoder, see Annex I of ETSI TS 103 433-2 [2].

7.2 Reconstruction process of an SDR or HDR stream

This clause specifies the reconstruction process enabling the generation of an SDR picture from an HLG HDR input picture with associated dynamic metadata.

This clause also specifies the reconstruction process enabling the generation of an HDR picture adapted for the maximum luminance, L_{pdisp}, of the presentation display from an HLG HDR input picture with associated dynamic metadata. This case is called display adaptation.

The reconstruction process is depicted in Figure 3.

Both in case of the generation of an SDR picture and in the case of display adaptation an HDR picture, the following four steps shall be taken:

- In the first step, the HLG HDR input picture, which is an Recommendation ITU-R BT.2100-2 [5] compatible HLG signal, shall be converted from Y'C'$_b$C'$_r$ to R'G'B', see Recommendation ITU-R BT.2100-2 [5], table 6.
- In step two, the output of step 1 shall be converted to a PQ signal using the "bridge point" conversion from HLG to PQ according to Recommendation ITU-R BT.2390-6 [6], section 7.2 figure 29.
- In step three, the R'G'B' PQ signal from step two shall be converted to Y'C'$_b$C'$_r$, see Recommendation ITU-R BT.2100-2 [5]. table 6.
- In the final step, the PQ signal as determined in step 3, together with the associated dynamic metadata shall be used as input for an SL-HDR2+ decoder as specified in clause I.3 of ETSI TS 103 433-2 [2].

The output of the SL-HDR2+ decoder is the output of the SL-HDR3 reconstruction process or SL-HDR3 decoder.

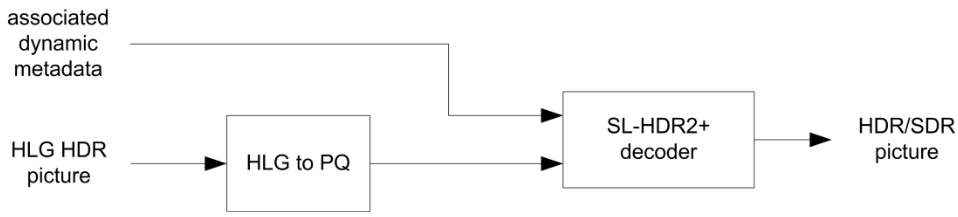


Figure 3: Overview of the HDR/SDR reconstruction process

Annex A (normative): SL-HDR reconstruction metadata using HEVC

Annex A of ETSI TS 103 433-1 [1] specifies the format of the SEI message that carries the SL-HDR reconstruction metadata for HEVC specification [8] as well as the mapping between the syntax elements of this SEI message and the dynamic metadata variables provided in clause 6 of ETSI TS 103 433-1 [1].

Annex A of ETSI TS 103 433-1 [1] shall apply to the present document, except for the following exceptions to clause A.2.2.4 of [1] "SL-HDR SEI message semantics":

- In bitstreams conforming to the present document, the value of **sl_hdr_mode_value_minus1** shall be equal to 2.
- In bitstreams conforming to the present document, the value of **sl_hdr_spec_major_version_idc** shall be equal to 1.
- In bitstreams conforming to the present document, the value of **sl_hdr_spec_minor_version_idc** shall be equal to 1.
- In bitstreams conforming to the present document, the value of **original_picture_info_present_flag** shall be equal to 1.
- In bitstreams conforming to the present document, the value of **sl_hdr_extension_present_flag** shall be equal to 0.
- In bitstreams conforming to the present document the value of **original_picture_primaries** shall be equal to 1 in case the **src_mdcv_primaries_x**[c], **src_mdcv_primaries_y**[c], **src_mdcv_ref_white_x**, **src_mdcv_ref_white_y** indicate the Rec. 709 colour space, or 9 in case they indicate the Rec. 2020 colour space, or 12 in case they indicate the P3 colour space.
- In bitstreams conforming to the present document, the value of **original_picture_min_luminance** shall be equal to 0.
- Decoders that comply with the present document shall ignore the values of **original_picture_primaries** and **original_picture_min_luminance**.
- Decoders that comply with the present document shall process the value of **original_picture_max_luminance** as described in Annex I of ETSI TS 103 433-2 [2].
- In bitstreams conforming to the present document, the value of **target_picture_max_luminance**, if present, shall be equal to 100.
- In bitstreams conforming to the present document, the value of **target_picture_min_luminance**, if present, shall be equal to 0.
- In bitstreams conforming to the present document, the value of **max_display_mastering_luminance** in the MDCV SEI, if present, shall be equal to $1\,000 \times 10\,000$.

NOTE 1: This indicates a "bridge point" of 1 000 cd/m² as defined in Recommendation ITU-R BT.2390-6 [6].

- In bitstreams conforming to the present document, the value of **src_mdcv_max_mastering_luminance**, if present, shall be equal to 1 000.
- In bitstreams conforming to the present document, the values of **chroma_to_luma_injection**[i] shall be equal to 0 for all values of i.
- In bitstreams conforming to the present document, the values of **k_coefficient_value**[i] shall be equal to 0 for all values of i.
- Decoders that comply with the present document shall ignore the values of **sl_hdr_extension_6bits** and **sl_hdr_extension_data_byte**[i] for all values of i, if they are present in a bitstream.

- In bitstreams conforming to the present document, **gamut_mapping_mode** equal to 4 and 5 specifies predetermined values used by the gamut mapping process (documented in Annex D) to respectively map the P3D65 (preset #3) or the BT.2020 (preset #4) gamut of the reconstructed picture to BT.709 gamut. In bitstreams conforming to the present document, the value of **gamut_mapping_mode** shall be in the range of 0 to 1, inclusive, in the range of 4 to 5, inclusive, or in the range of 64 to 127, inclusive. See also Table 2, Table 3 and Table 4 in clause 6 of ETSI TS 103 433-2 [2].

NOTE 2: In contrast with SL-HDR2+ ETSI TS 103 433-2 [2], **src_mdcv_info_present_flag** is always equal to 1, because this clause refers to Annex A of ETSI TS 103 433-1 [1].

Annex B (informative): SL-HDR reconstruction metadata using AVC

Annex B of ETSI TS 103 433-1 [1] specifies the format of the SEI message that carries the SL-HDR reconstruction metadata for AVC specification [7] as well as the mapping between the syntax elements of this SEI message and the dynamic metadata variables provided in clause 6 of ETSI TS 103 433-1 [1].

AVC is not supported by the present document.

Annex C (informative): HDR-to-SDR decomposition principles and considerations

The blocks "HDR-to-HDR reconstruction" and "HDR-to-SDR reconstruction" in Figure C.1 of the HDR-to-SDR decomposition process aim at converting the input HDR to an HLG compatible and an SDR compatible version. The process also uses side information such as the mastering display peak luminance, colour primaries, and the colour space in which the HDR, HLG and SDR pictures are represented. In the present document, the HDR-to-HLG and HDR-to-SDR conversion operate without changes of the colour gamut or space. The HDR, HLG and SDR pictures are defined in the same colour gamut or space. However, the pre-processor may include optional gamut mapping parameters in the dynamic metadata that the IRD can use to perform gamut mapping after reconstruction of the HDR/SDR signal to a different colour gamut or space than the one of the input HDR picture (source picture).

The decomposition processes generate an HLG HDR signal and an SDR backwards compatible version from the input HDR signal, using an invertible process that guarantees a high quality reconstructed HDR/SDR signal.

The process is summarized in Figure C.1 where the input HDR is PQ and has $L_{HDR\_o} \geq 1\ 000$ cd/m², where L_{HDR_o} is the maximum luminance of the HDR mastering display.

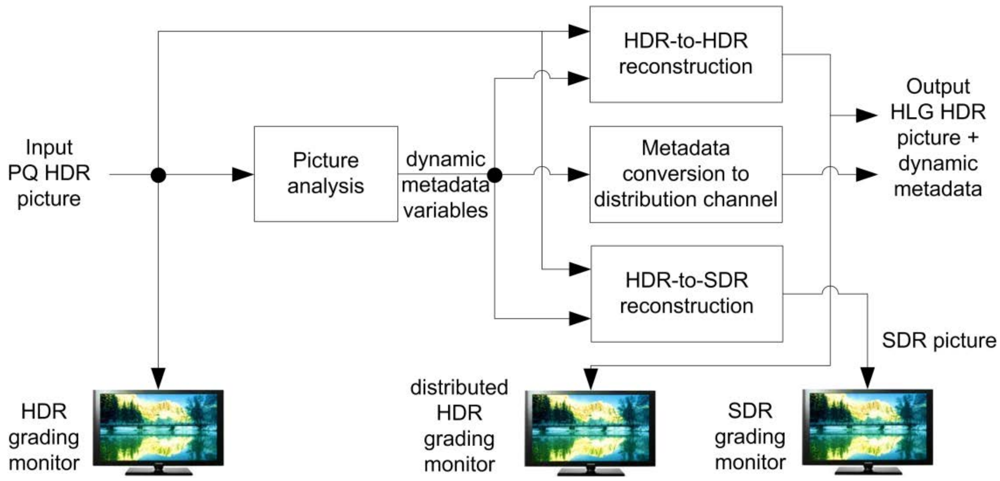


Figure C.1: Synopsis of the HDR-to-SDR decomposition process for PQ input

The input PQ HDR picture is assumed to be graded on an HDR monitor. Only the HDR monitor is shown in Figure C.1 without the rest of the HDR grading process. However, the characteristics of the HDR grading monitor are used in the picture analysis block and are part of the generated metadata.

From the input HDR picture and its characteristics, the dynamic metadata variables are derived in the block "Picture analysis". This may be an automatic process, e.g. a process as described in clause C.3 of ETSI TS 103 433-1 [1], in which case the block "HDR-to-SDR reconstruction" as well as the distribution HDR and SDR grading monitors are not required, or a process where a human grader observes the distributed HDR and SDR grading monitors while adjusting the metadata parameters for optimally graded distributed HDR and SDR pictures

NOTE: The SDR and distributed HDR pictures cannot be adapted independently from one another by adjusting the dynamic metadata variables.

In case the SDR grading monitor is used, the block "HDR-to-SDR reconstruction" in Figure C.1 functions as a decoder as specified in clause 7.2 of ETSI TS 103 433-2 [2],using dynamic metadata variables from the block "Picture analysis" instead of the ones from the metadata structures as specified in clause 6, the value of L_{HDR_o} instead of L_{HDR}, and with the maximum luminance of the presentation display, L_{pdisp}, set to L_{SDR}, i.e. the recomputation of metadata as specified in clause 7.3 of ETSI TS 103 433-2 [2] is not performed and the metadata values are used as determined in the block "Picture analysis".

The purpose of the block "HDR-to-HDR reconstruction" in Figure C.1 is to perform channel adaptation, i.e. tone mapping and colour correction from the maximum luminance of the HDR mastering display, L_{HDR_o}, to the maximum luminance of the distributed signal, L_{distr}, of 1 000 cd/m² and to convert from PQ to HLG. The block "HDR-to-HDR reconstruction" in Figure C.1 is the block "HDR-to-HDR reconstruction" as specified in clause I.4.4 of ETSI TS 103 433-2 [2], followed by the "bridge point" conversion from PQ to HLG according to Recommendation ITU-R BT.2390-6 [6], section 7.2, figure 28.

The output to video compression for e.g. video distribution is the output HLG HDR picture, together with the dynamic metadata variables. The dynamic metadata variables are stored in the SEI messages as specified by Annex A of ETSI TS 103 433-1 [1] as adapted by Annex A of the present document for HEVC.

In the case of a native HLG input signal, this signal has to be converted first to a 1 000 cd/m² PQ signal using the "bridge point" conversion from HLG to PQ according to Recommendation ITU-R BT.2390-6 [6], section 7.2 figure 29, before entering the decomposition process of Figure C.1. In that case, the output HLG signal of the encoder will be equal to the input HLG signal.

Example values of **matrix_coefficient_value**[i] for all values of i can be found in Table F.1 of SL-HDR2 [2].

Annex D (informative): Gamut mapping

This Annex provides the description of a (forward) gamut mapping (i.e. gamut compression) process that could apply in a display adaptation scenario typically when the output HDR picture of the HDR-to-HDR/SDR reconstruction process is provided in a wide colour gamut (e.g. Recommendation ITU-R BT 2020-2 [4] as specified by the variable **hdrPicColourSpace**), and is different from the colour gamut supported by the target presentation display (typically Recommendation ITU-R BT 709-6 [3] as specified by the variable **sdrPicColourSpace**).

Figure D.1 illustrates a typical scenario where (forward) gamut mapping is required. In this example, the HDR content is graded on a P3D65 HDR monitor (signalled by **hdrDisplayColourSpace**) and represented in a BT.2020 colour space (signalled by **hdrPicColourSpace**). However, the target HDR or SDR presentation display supports only BT.709 colour space (signalled by **sdrPicColourSpace**). Therefore, a (forward) gamut mapping from Recommendation ITU-R BT.2020-2 [4] to Recommendation ITU-R BT.709-6 [3] is required in addition to the dynamic range mapping from HDR to HDR/SDR.

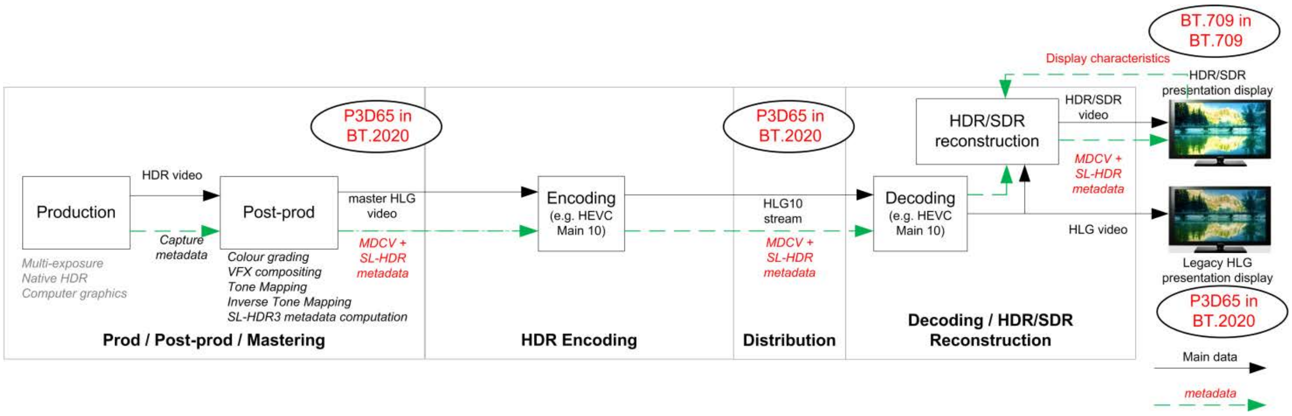


Figure D.1: Example of use case requiring a gamut mapping

The optional gamut mapping process documented in the present document may be applied in the IRD during the post-processing stage.

Notations and definitions of clause D.2 of ETSI TS 103 433-1 [1] should apply to this Annex. The gamut mapping process used in the present document should be the forward gamut mapping process documented in clause D.3 of ETSI TS 103 433-1 [1].

The interface of SL-HDR3 reconstruction with the gamut mapping process is as documented in clause D.4.2 of ETSI TS 103 433-1 [1].

Annex E (informative): Embedded data on CE digital video interfaces

Methods to transmit SL-HDR metadata in the form of the SL-HDR Information SEI message, sl_hdr_info(), see clause A.2.2 of ETSI TS 103 433-1 [1]; and a Graphics Indicator bit over CE digital video interfaces (e.g. HDMI, DisplayPort) can be found in Annex E of SL-HDR2 ETSI TS 103 433-2 [2].

Annex F (informative): Error-concealment: recovery in post-processor from metadata loss or corruption

Annex F of SL-HDR2 [2] provides an error-concealment method applicable to SL-HDR3 metadata.

In case the SL-HDR3 metadata is corrupt or got lost for an SL-HDR3 stream, the decoder can treat the stream as if it is an SL-HDR2 stream and apply the recovery procedure of Annex F of SL-HDR2 [2], with the value of **hdrDisplayMaxLuminance** set equal to the value of **hdrDistributedMaxLuminance**, which is set to 1 000 cd/m² according to Annex A of the present document.

Annex G (informative): ETSI TS 103 433 signalling in CTA-861-G

Information on how ETSI TS 103 433 multi-part deliverable [i.2] metadata can be carried on CE digital interfaces (e.g. HDMI) with dynamic metadata support can be found in Annex G of ETSI TS 103 433-1 [1].

For CE digital interfaces that do not specify carriage of SL-HDR metadata, a method to transport these metadata is described in Annex E.

Annex H (informative): Minimum and maximum value of L_{pdisp} for display adaptation

The same boundaries apply to L_{pdisp} as indicated in Annex H of ETSI TS 103 433-2 [2].

Annex I (informative): SL-HDR metadata indication for CMAF based applications

Annex H "SL-HDR metadata indication for CMAF based applications" of ETSI TS 103 433-1 [1] applies to the present document.

Annex J (informative): Use of SL-HDR in DVB Services

Annex I "Use of SL-HDR in DVB Services" of ETSI TS 103 433-1 [1] applies to the present document.

Annex K (informative): Change History

Date	Version	Information about changes
April 2017	V0.0.1	Early Draft
August 2019	V0.0.2	Stable Draft
November 2019	V0.0.3	Final Draft for Approval

History

Document history		
V1.1.1	March 2020	Publication