EBU

OPERATING EUROVISION AND EURORADIO

TECH 3372

UHD / HDR SERVICE PARAMETERS

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Abstract

This document specifies a set of UHD/HDR service parameters which are expected to offer interoperability with the large majority of CE devices (televisions, IRDs, etc.) expected to be available on the European market from 2020.

The parameters in this document have been drafted based on discussions in several EBU and related industry groups (including the EBU Audio Systems group, the EBU Video Systems group, and FAME) which include EBU Members and representatives of major CE equipment manufacturers.

In addition to the technical details, background information is provided on the reasons for their specification.

EBU Members are encouraged to comply with these parameters which represent a minimum set of programme production and distribution requirements.

Note: Broadcast services are typically specified at national level as well as at individual provider level (e.g. between public and commercial broadcasters sharing common platforms). This means there may be cases where EBU Members require additions or changes to the parameters in this specification to meet particular national demands.

Contents

UHD / HDR service parameters

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1. Introduction

1.1 Goal

Media organizations are faced with an ever-widening range of standards and technical parameters when providing audio-visual services via traditional broadcasting, online distribution and hybrid systems. Similarly, CE equipment manufacturers need to understand and decide which type and what level of services to support in their devices.

To avoid user confusion and dissatisfaction, it is important that content creators, broadcasters and manufactures have a clear idea of what options may be available subject to national or platform requirements. This document has been created to help provide such understanding by focussing on parameters that content providers can expect to be supported provided these guidelines are followed.

1.2 Scope

Content providers can expect the parameters in this specification are:

- *supported in consumer equipment in the European market;*
- *relevant for equipment appearing on the market from 2020.*
- *focused on the first generation UHD services (including 1080p resolution[1]).*
- *not precluding provision of existing SD and HD (including audio) services.*

Background

It is well known that non-European markets differ substantially in their choice of technical parameters. Examples include frame rate, dominant audio systems, and modulation techniques.

The choice of parameters for the products expected in 2020, is based on CE manufacturers' product planning and the interest shown by EBU members in providing services with higher than current HD quality audio/video content.

It is acknowledged that some equipment manufactured before 2020 may not be fully interoperable with some of the parameters in this specification. Broadcasters and content providers need to consider this when making decisions pertinent to their current and future service planning.

It is assumed that services will feature High Dynamic Range (HDR) and Wide Colour Gamut

[1] See Recommendation ITU-R BT.2100 [4] for the system parameters used by content creators and distributors and that are expected to be supported by CE devices

(WCG) content which is progressively scanned and has a minimum resolution of 1920 x 1080.

It is clear that not all broadcasters in Europe will migrate to UHD services at the same time, which means current HD and SD services will be in use for a considerable time. CE equipment traditionally has provided excellent backwards compatibility and is expected to continue to do so.

The rationale behind the assumption of 1080p with HDR & WCG is the desire for content providers to have options when planning the migration to full UHD services by first distributing 1080p content with HDR & WCG.

The benefit of this approach has been demonstrated in EBU tests, and it is acknowledged that the results of this approach look very good, especially when the source is UHD.

2. Target devices

The UHD HDR services will be provided in such a way that they can be rendered by devices that support the features described in the following sections.

Note: According to the DVB specification ETSI 101 154 the target devices are HEVC HDR UHDTV IRDs.

2.1 ETSI TS 101 154 and ETSI EN 300 468

The CE device can be assumed to comply with ETSI TS 101 154 v 2.5.1 [1] and ETSI EN 300 468 v1.17.1 [2]. These documents define the encoding and signalling of services. Local profiles provide further restrictions and/or additional requirements over the DVB specifications. Receiver features are defined in local profiles such as DTG and NorDig. Device interoperability testing is usually undertaken at this local profile level. Additional profiles may lead to changes to these DVB documents and these local profiles to support future requirements.

Background

This provides the basics of audio & video coding used in the European broadcast industry. All current CE device implementations are based on it.

All existing SD and HD (including audio) and all new UHD service formats listed in this document (EBU Tech 3372) are expected to be supported.

Some formats listed in [1] are not expected to be supported, for example: 3D TV. This feature is for the CE manufacturers to decide.

2.2 Event-based switching for UHD Services

Event-based switching is required by broadcasters (see background below), e.g. HDR to SDR (in backwards compatible mode only), 5.1 to NGA (see 4.1.1).

Note 1: DVB does not permit service type changes (e.g. HLG to PQ) in a running service.

Note 2: It is expected that any event-based switching is provisioned by signalling in the elementary stream based on MPEG and DVB specifications.

Given the current state of UHD programme production and CE technology, where already provisioned by DVB or national profiles, programme makers and broadcasters are advised that event-based switching should only occur at programme boundaries (or where commercials are inserted into programmes).

It is expected that changes will occur at video frame boundaries with simultaneous audio and video

switching. Audio-only switching should be possible at any video frame boundary.

When viewed in the home viewing environment described in ITU-R BT.500-13 [3], event-based switching would need the following requirements to be defined in local profiles:

- device is stable in 0.25 seconds or less.
- switching should be initiated no more than 40ms after an event-based switch signal has been received.

Where event-based switching occurs, the device is not expected to crash, and it is expected to continue to operate "normally". It is acceptable for on-screen format identifiers to be displayed for a short period (e.g. 2 - 3 seconds). Disturbances to the image and the sound should be minimal.

It is however, acknowledged that any event switching disruption is a balance between consumer experience and what is realistic for vendors to achieve at any given time.

Background

Event switching is required because services contain a mix of content from a wide range of new and legacy formats. Event switching by changing the service type is not permitted.

From past experience broadcasters understand that event switching at programme junctions and commercial insertion, during a continuous service (e.g. television channel) can cause audio and video disturbances. These disruptions cause audience annoyance and complaints.

It must be assumed that for some time to come, content providers will have to handle different event switches between parameters, such as image resolution, dynamic range, audio formats etc., on a programme-by-programme basis. Broadcasters may choose to convert these multiple inputs to a single output format.

Disturbances of audio and video when there is an event switch, should not be disruptive to the audience. Experience has shown that an event switch which is stable within 0.25 seconds is the maximum duration the audience will accept as a graceful interruption to a service.

It is recognised that event switching due to channel changes and during EPG navigation may require longer than 0.25 seconds. In this case the event change should not cause picture disruption or audio "noise". E.g. black and silence or a holding frame is acceptable.

2.3 HDMI

Content providers should be able to assume the CE device will feature as a minimum the HDMI options that enable services supplied to this specification to be supported via ***all*** of the inputs.

Background

The HDMI options should provide the required signaling for the primary HDR technologies and wider colour gamut as described in this document including any static metadata requirements.

CE manufactures may exceed this parameter as suited to their product ranges. It is desirable that consumers can easily identify input functionality as defined in this document when some inputs implement more capabilities than others.

2.4 HDCP 2.2

Content providers must be assured the CE device will feature HDCP 2.2 on ***all*** of its inputs.

Background

Broadcasters in Europe purchase and supply content in world-wide markets and many content

owners, creators or distributors insist that connectivity between devices (e.g. set-top boxes) protects as much as possible from illegal or illicit copying.

3. Video

The following video parameters refer to INPUT formats, not the device reproduction format. It is expected a device will recognise the input signal parameters and process these as required for the device's display. The video signal presented can have any of the characteristics detailed in sections 3.2 to 3.6, below.

Note: As stated in the scope of this document, the following does NOT PRECLUDE the continued use of existing HD and SD services. These are assumed to continue to be supported by the CE devices as backwards-compatible modes.

3.1 Image Impairment Assessment

"Not Noticeable"

For the purposes of this document the results of any image processing, when viewed in the home environment described in ITU-R BT.500-13[2] [3], is deemed to be "not noticeable" should there be no more than half of one point variance between the processed and unprocessed image (measured using the DSIS method described in ITU-R BT.500-13).

3.2 Image formats

The following image resolutions may be used for content creation and distribution. They are expected to be supported as input options to devices and should be rendered with minimum aliasing and/or scaling artefacts.

- *3840 x 2160*
- *3200 x 1800*
- *2560 x 1440*
- *1920 x 1080*

Background

As stated in Section 2, it is expected content formats will migrate from 1080p to UHD-1 resolution (3840 x 2160 pixels) over a period of time.

The sub-resolutions 3200 x 1800 and 2560 x 1440 can be used as transmission formats to reduce the video-bit rate at the expense of spatial resolution. Images using these sub-resolution formats will be 16:9 and should therefore be rendered as 16:9.

1080p resolution with HDR & WCG is expected to be used for many years as part of migration planning toward 2160p services (Recommendation ITU-R BT.2100 [4]).

It is NOT assumed a display will have a native resolution of one of the above resolutions. It is assumed that a display will be capable of rendering images that are provided in above resolutions without introducing noticeable scaling artefacts (see section 3.1). It is also expected that CE manufacturers will exploit specific display technologies of their own choosing. The use of oversampling and sub-pixel arrangements etc. is a matter for their specific business and marketing requirements.

[2] Although the ITU-R BT.500 home viewing environment specifies a display peak luminance of 200 cd/m^2, for the purposes of this document and until a specific HDR viewing environment is defined, it can be assumed valid for displays up to 1000 cd/m^2

When image scaling is carried out, there should be no discernible artefacts introduced (see section 3.1), however it is recognized there is no strict definition of what 'minimum aliasing and/or scaling artefacts' are. It is expected CE manufactures will employ their own scaling technologies and definition of terms.

3.3 Frame rate

It is known that CE manufactures will include support for the frame rates commonly used in 60 Hz territories (including the fractional variants) listed in ETSI TS 101 154 v2.5.1, table 19 [1]. In addition to these 60 Hz based frame rates *and* the existing 50 Hz based HD and SD frame rates (e.g. 576i/25, 1080i/25, 720p/50), the following progressive frame rates will be used for distribution of content and CE devices are expected to support them natively.

- *25 frames/second*
- *50 frames/second*

Background

The two frame rates above are those most commonly used in the European broadcast industry.

For some OTT content, especially international events (e.g. Olympics, World Cup…), European broadcasters may choose, or may even be required to distribute content in the native frame rate of the host territory, which therefore assumes support for all the 60 Hz based frame rates.

High Frame Rate (HFR) support is currently NOT required in CE devices (that is, frame rates above 50 or 60 frames/second). Content makers are still studying the optimum choice of frame rate, shutter and coding methods required for HFR production, which remain unresolved.

Should HFR services (i.e. above 50/60 fps) be required in the future, broadcast services would be delivered compliant to ETSI TS 101 154, using dual PIDs. For OTT, HFR can use either temporal layer encoding or separate streams for different frame rates.

It is expected that future devices capable of displaying HFR services will be backward compatible when displaying current frame rates.

It should be noted that EBU Members have expressed the desire for users to be able to display an image at its received/incoming frame rate which for movies and some episodic content would be 24 frames/second (including the fractional variant).

3.4 HDR

The following High Dynamic Range (HDR) systems can be used for distribution (minimum requirement):

- *HLG10[3] (backwards compatible with DVB receivers which don't recognize HLG i.e. ITU-R BT.2020)*
- *PQ10[4]/HDR10[5] (non-backwards compatible)*

Broadcasters will signal the HDR format[6] used.

[3] HLG as used in [1]: HLG HDR solution with 10-bit coding, non-constant luminance YCbCr, narrow range and colour primaries, as defined in Recommendation ITU-R BT.2100

[4] PQ10 as used in [1]: HDR solution with 10-bit coding, non-constant luminance YCbCr, narrow range and colour primaries, as defined in Recommendation ITU-R BT.2100

[5] HDR10 as described in [12]: transfer curve: BT.2100 (PQ), colour space: BT.2020, bit depth: 10 bit, metadata: ST 2086, MaxFALL, MaxCLL

[6] [6]This document assumes the colour space for HDR services is ITU-R BT.2100 colorimetry.

Event based switching between HDR<>SDR in backwards compatible mode is expected to meet the requirements described in Section 2.2.

> ***Background***
> *EBU TR 038 [5] notes that HLG10 and PQ10 offer similar quality. Both can provide HDR with an image quality that exceeds that of conventional SDR. Report ITU-R BT.2390 [6] contains detailed information on both systems.*
>
> *Systems using PQ10 may specify carriage of some static metadata, in which case the system is designated "HDR10". Some PQ delivery systems may additionally provide dynamic metadata.*
>
> *It is desirable that all inputs (tuner, HDMI, IP, USB) use the same processing steps while rendering provided all required signaling information is included in the bitstream. On-screen identification can help the user identify problems. However, it is not guaranteed such information is shown on all displays. Broadcasters have indicated to CE manufacturers the desirability of on-screen identification of the HDR/SDR mode the display is in.*

3.5 Colour

The CE device can be assumed to offer colour rendering better than ITU-R BT.709 and to be able to decode all ITU-R BT.2100 colour primaries with appropriate processing and presentation.

Switching between different gamuts and encoding systems, e.g. between ITU-R BT.709 and ITU-R BT.2100, is assumed to be acceptable.

> ***Background***
> *ITU-R BT.709 is now often referred to as "HD colour".*
>
> *With the introduction of HDR, a better colour rendition is expected. Wide Colour Gamut (WCG) (ITU-R BT.2100[7]) offers better colour rendition than HD televisions currently reproduce. There are multiple ways to map signal colours to the capabilities of a display, but whichever method is used, the resultant image should offer a perceived improvement over HD colour.*

3.6 Compression

HEVC is expected to be used. The minimum supported bitstream format is:

HEVC Main10 Level 5.1 as defined in DVB specification ETSI TS 101 154

> ***Background***
> *HEVC is the dominant codec for broadcast UHD content and has shown good performance both in bitrate and encoding/decoding speeds.*
>
> *Additional codecs (such as AV1) are desirable and may be implemented at the CE device manufacturers' discretion.*

4. Audio

The following does NOT PRECLUDE content distributors from continuing to provide services in existing audio formats (e.g. stereo, 5.1) linked to existing SD/HD/UHD[8] broadcasts. These audio formats can

[7] ITU-R BT.2100 colour primaries are those specified in ITU-R BT.2020. ITU-R BT.2100 simply adds high dynamic ranges and 1080p to ITU-R BT.2020

[8] For UHD services the EBU encourages the use of NGA.

be distributed independently of the NGA stream, or can be supported by CE devices as backward compatible modes of the NGA system in use.

4.1 Next Generation Audio

EBU Members have expressed a desire to be able to choose which NGA solution to use. This choice might be different on different platforms. Local regulations or market conditions might mandate the choice of solutions. It is recognised that manufacturers may be reluctant to implement more than one NGA decoder, hence devices being sold as supporting NGA may not necessarily support the NGA bitstream being transmitted, so the broadcasters should consider the need to provide simulcast of legacy codecs. An NGA decoder implemented in a receiver should be able to work on all inputs (tuner, HDMI, IP, USB).

However, it is recognised that the audio format supported in consumer devices will depend on the format(s) support in the platform's specification (e.g. a national broadcast or platform specification), where stereo, 5.1 and a minimum of one of the NGA systems defined in the DVB Toolbox [1] is supported.

All NGA systems listed in ETSI TS 101 154 v2.5.1 have a renderer specified either as an ISO MPEG or ETSI standard document. Although it is desirable that, for every NGA system supported (see ETSI TS 101 154 [1]), the corresponding NGA system's reference renderer is implemented, it is recognised that renderers such as the ITU-R ADM Renderer (see section 4.1.2) are also acceptable. Any renderer implementation should reproduce the NGA as closely as possible to the reference render used in production.

Background – there are several factors that inform the approach described:

- *The purpose of a specified renderer for an NGA system is to reassure broadcasters that their content will be reproduced as closely as possible to the intended experience when processed by the receiving or decoding device.*
- *Broadcasters must be able to assume all ways of providing a 3-D spatial audio experience (such as channel-based, object-based, and scene-based) that are supported by the NGA system, are implemented.*
- *Where appropriate it is desirable that a device is able to pass an NGA stream to an external renderer or decoding device via an HDMI connection, either from an external source device (e.g. a set top box) or from an internal source.*
- *Rendering to 5-channel surround sound should be supported (Recommendation ITU-R BS.2051 [7] configuration B, or better) and rendering for 2.0, 5.1, headphones and an external soundbar via HDMI (ARC) should be supported*

4.1.1 Configuration Switching

Broadcasters expect there will be no perceptible disturbance during channel-based audio format switching where the output channels persist through a change of configuration when using the *same* NGA codec. For example, when a receiver is not doing any down-mixing, the front left and front right signals should not be affected by a format switch to 5-channel surround sound and back.

Similarly, when switching between any of channel-based audio, object-based audio, and scene-based audio representations, when using the same NGA codec there should be no perceptible interruption to the audio output.

Possible options for switching could include:

- Using two elementary streams with two PIDs both running continuously, one using a legacy codec, one using an NGA codec with the NGA codec content being switched between channel-, scene- and object-based operation in accordance with the codec specification. Local profile receiver behaviour rules covering the correct selection of elementary stream would be required.
- Using two services, one with a legacy codec and one with an NGA codec, and switching the services on and off as and when NGA audio is available. If a receiver were required to switch between services with no viewer interaction, local profile receiver behaviour rules covering the correct selection of service would be required.
- Dynamically changing service audio codecs may not meet the timing requirements outlined in this document dependant on local network design and would require effort from DVB to create the required signalling and would require significant local profiling.

Content providers can consider as a reasonable expectation that audio format switching between options in an NGA system within a CE device should take no longer than a video transition and preferably should take less time.

Note: Currently there is no provision for codec switching within DVB and significant receiver behaviour profiling would be required.

Background
See the Background of section 2.2.

4.1.2 ITU-R ADM Renderer

For the production of NGA content, the ITU-R has specified a renderer in Recommendation ITU-R BS.2127-0 "*ADM renderer for advanced sound systems*" [8].

It is recommended that this renderer be used during all stages of the production workflow.

Support of, or compliance with the ITU-R ADM Renderer is also encouraged in all CE devices but is optional.

Background

- *To make sure that sound engineers and programme makers can reliably author and monitor NGA programmes, the EBU is proposing that renderers implemented in IRDs should be compliant with Recommendation ITU-R BS.2127-0.*
- *Note: In EBU R 151 Recommended Strategy for Adoption of Next-Generation Audio (NGA) Technology [9], the EBU has argued that, ideally, manufacturers should implement in CE equipment support for all DVB Toolbox NGA systems. In practice some devices are known to implement multiple systems, but they do not necessarily activate them, due to licensing costs. This might differ from one country to another.*
- *Support for NGA over interconnections will depend on the CE device.*

5. OTT services

Minimum options for OTT services.

5.1 MPEG-DASH

For UHD content being delivered over IP, MPEG-DASH as profiled in ETSI TS 103 285 v1.2.1 [10] should be used.

> ***Background***
> *MPEG-DASH is the predominant transport mechanism for ISO BMFF based content, used in HbbTV and other systems particularly where UHD with HDR & WCG (and in the future HFR) is to be distributed. It is recognised that if only UHD resolution (no HDR, HFR…) is distributed, MP4 progressive download is an option. This is a discussion point between CE manufactures and local/national distribution requirements.*

5.2 HbbTV

HbbTV as per ETSI TS 102 796 v1.5.1 [11] should be used.

The audio and video formats that are supported via broadcast are also supported via broadband HbbTV delivery.

There may be devices that can handle HDR already, with a lower HbbTV ETSI version number.

> ***Background***
> *ETSI TS 102 796 v1.5.1 is the earliest version of HbbTV that includes feature detection for HDR media profiles and display resolution.*
>
> *If a device supports HDR via broadcast, it shall support this via HbbTV, as well. This is a requirement in [11].*

5.3 Other OTT services

It is expected that other HDR OTT services using non-standard application frameworks can be supported, but this is a conversation between App providers and CE vendors in the various countries. In any case it can be assumed such applications will not affect the running of HbbTV applications.

> ***Background***
> *The OTT Apps supported typically are either country-specific (e.g. for Public Service Media) or global (e.g. movie distribution).*

5.4 Adaptive streaming

Broadcasters will NOT change the dynamic range system and/or colour gamut for adaptive streaming reasons[9].

Streaming in HDR will be 10-bit.

> ***Background***
> *Devices are expected to handle streams with resolutions below 1080p.*
>
> *Adaptive streaming is meant to gracefully optimize the picture (and sound) quality based on*

[9] Event-based format switching may still lead to dynamic range (system) and/or colour gamut changes, but these are fully predictable and typically only take place at programme boundaries (see section 2.2).

the available bandwidth and/or end-user device.

Changes in the dynamic range (system) and/or colour gamut are not considered graceful, as they can have a very noticeable effect on the end-user's perception of quality.

6. References

[1] *ETSI TS 101 154 v2.5.1 Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcast and Broadband Applications*

https://www.etsi.org/deliver/etsi_ts/101100_101199/101154/02.05.01_60/ts_101154v020501p.pdf

[2] *DVB Blue Book A038 (June 2019) Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems*

https://www.dvb.org/resources/public/standards/a038_tm1217r37_en300468v1_17_1_-_rev-134_-_si_specification.pdf

[3] *ITU-R BT.500-13, Methodology for the subjective assessment of the quality of television pictures, January 2012*

https://www.itu.int/rec/R-REC-BT.500-13-201201-I/en

[4] *ITU-R BT.2100, Image parameter values for high dynamic range television for use in production and international exchange.*

https://www.itu.int/rec/R-REC-BT.2100

[5] *EBU Tech Report 038, Subjective Evaluation of Hybrid Log Gamma (HLG) for HDR and SDR distribution, March 2017*

https://tech.ebu.ch/publications/tr038

[6] *ITU-R BT.2390 High dynamic range television for production and international exchange*

https://www.itu.int/pub/R-REP-BT.2390/en

[7] *ITU-R BS.2051-2, Advanced sound system for programme production, July 2018,*

https://www.itu.int/rec/R-REC-BS.2051/en

[8] *Recommendation ITU-R BT.2127 "ADM renderer for advanced sound systems"*

https://www.itu.int/rec/R-REC-BS.2127/en

[9] *EBU R 151 Recommended Strategy for Adoption of Next-Generation Audio (NGA) Technology*

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[10] *ETSI TS 103 285 v1.2.1, Digital Video Broadcasting (DVB); MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks*

https://www.etsi.org/deliver/etsi_ts/103200_103299/103285/01.02.01_60/ts_103285v010201p.pdf

[11] *ETSI TS 102 796 v1.5.1 Hybrid Broadcast Broadband TV*

https://www.etsi.org/deliver/etsi_ts/102700_102799/102796/01.05.01_60/ts_102796v010501p.pdf

[12] *Ultra HD Forum Guidelines, Revision: 2.0*

https://ultrahdforum.org/wp-content/uploads/Ultra-HD-Forum-Guidelines-v2.0.pdf

Note All links are current at the time of publishing this document.