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Digital Video Broadcasting (DVB);
Plano-stereoscopic 3DTV;
Part 4: Service frame compatible Plano-stereoscopic 3DTV for HEVC coded services

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Contents

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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).

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.

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The Digital Video Broadcasting Project (DVB) is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulatory bodies, content owners and others committed to designing global standards for the delivery of digital television and data services. DVB fosters market driven solutions that meet the needs and economic circumstances of broadcast industry stakeholders and consumers. DVB standards cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. The consortium came together in 1993 to provide global standardization, interoperability and future proof specifications.

The present document is part 4 of a multi-part deliverable covering Digital Video Broadcasting (DVB); Plano-stereoscopic 3DTV, as identified below:

Part 1: "Overview of the multipart";

Part 2: "Frame Compatible Plano-stereoscopic 3DTV"**;**

Part 3: "HDTV Service Compatible Plano-stereoscopic 3DTV";

Part 4: "Service frame compatible Plano-stereoscopic 3DTV for HEVC coded services".

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

Plano-stereoscopic imaging systems deliver two images (left and right) that are arranged to be seen simultaneously, or near simultaneously, by the left and right eyes. Viewers perceive increased depth in the picture, which becomes more like the natural binocular viewing experience. Since 2010 many 3DTV capable consumer products have been launched in the market.

The present document specifies the delivery system for service frame compatible plano-stereoscopic 3DTV for HEVC coded services, enabling service providers to utilize their existing HDTV infrastructures to deliver 3DTV services that are compatible with 3DTV capable displays already in the market, while allowing existing HDTV receivers to extract the left view from the two views contained in the frame compatible plano-stereoscopic 3DTV service video stream and up-scale it to simulate the reception of an HDTV service. This system covers both use cases of a STB delivering 3DTV services to a 3DTV capable display device via an HDMI connection, and a 3DTV capable display device receiving 3DTV services directly via a built-in tuner and decoder.

1 Scope

The present document specifies the methods to encode and deliver DVB service frame compatible plano-stereoscopic 3DTV services over conventional HDTV broadcast infrastructures, and their decoding by a digital receiver. This includes the selection of frame compatible plano-stereoscopic 3DTV formats, the definition of signalling for making those formats service compatible, the definition of frame compatible plano-stereoscopic 3DTV service signalling information, and the handling of graphics and captions overlays in the receiver during the reception of a frame compatible plano-stereoscopic 3DTV service. Some elements are contained in amendments and extensions to the appropriate existing DVB specifications.

The production and contribution of service frame compatible plano-stereoscopic 3DTV content prior to delivery, as well as the method of rendering the frame compatible plano-stereoscopic 3DTV content to the viewer at the 3DTV capable display device after its reception and decoding, are outside the scope of the present document.

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 reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://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] Recommendation ITU-T H.265/ISO/IEC 23008-2:2015: "Information technology -- High efficiency coding and media delivery in heterogeneous environments -- Part 2: High efficiency video coding".

[2] ETSI TS 101 154: "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream".

[3] ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

[4] ETSI EN 300 743 (V1.4.1): "Digital Video Broadcasting (DVB); Subtitling systems".

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 reference document (including any amendments) applies.

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

[i.1] HDMI LLC: "High-Definition Multimedia Interface Specification" Version 2.0.

[i.2] ETSI TS 101 547-1: "Digital Video Broadcasting (DVB); Plano-stereoscopic 3DTV; Part 1: Overview of the multipart".

[i.3] ETSI TS 101 547-2: "Digital Video Broadcasting (DVB); Plano-stereoscopic 3DTV; Part 2: Frame Compatible Plano-stereoscopic 3DTV".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI TS 101 547-1 [i.2] and the following apply:

Top-and-Bottom (TaB): arrangement of the Frame Compatible spatial multiplex such that Left and Right eye pictures are anamorpically compressed vertically by a factor of two

NOTE: The processed Left eye picture is placed in the spatial multiplex to occupy the first (top) half of a single HD video frame, and the processed Right eye picture is placed in the spatial multiplex to occupy the second (bottom) half of a single HD video frame.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 101 547-1 [i.2] and the following apply:

EIT	Event Information Table
EPG	Electronic Program Guide
FPA	Frame Packing Arrangement
IDTV	Integrated Digital TV
IRD	Integrated Receiver Decoder
PMT	Program Map Table
PSI	Programme Specific Information
SDT	Service Description Table
SI	Service Information
TaB	Top-and-Bottom

4 Service frame compatible plano-stereoscopic 3DTV services in DVB delivery systems

4.1 Scope of DVB SFC-3DTV services

Figure 1 depicts the scope of the present document, highlighted by the grey area, and the general concept of the compatibility of DVB service frame compatible plano-stereoscopic 3DTV (SFC-3DTV) services with HDTV services over the encoding, transmission, and decoding stages of operation in a DVB delivery system. It shows, as a hypothetical example, a SFC-3DTV service being multiplexed with a conventional HDTV service into a single MPEG-2 Transport Stream for delivery to a population of IRDs, some of which are SFC-3DTV compliant (as defined in the present document), and some of which are HDTV capable, i.e. not SFC-3DTV compliant.

The present document defines signalling for SFC-3DTV services and deals with the handling of DVB subtitles for use with these services.

The delivery system for SFC-3DTV services defined in the present document is intended to be applicable for any broadcast or delivery channel that uses the DVB MPEG-2 Transport Stream to carry DVB services, as specified in ETSI TS 101 154 [2], hence no delivery-system specific features are defined.

The features of HDTV services and IRDs, as defined in ETSI TS 101 154 [2], are not impacted by the present document. They are depicted in the scope diagram due to the fact that SFC-3DTV service delivery utilizes the same HDTV infrastructure, in certain valid use cases even including a HDTV IRD that has no 3DTV service cognisance.

While the compatibility with HDTV infrastructure and content formats enables the rapid and convenient roll-out of 3DTV services due to the transparent re-use of the existing HDTV delivery infrastructure, there are potentially also complications that need to be addressed around SFC-3DTV service configuration and their co-existence with HDTV services within the delivery system.

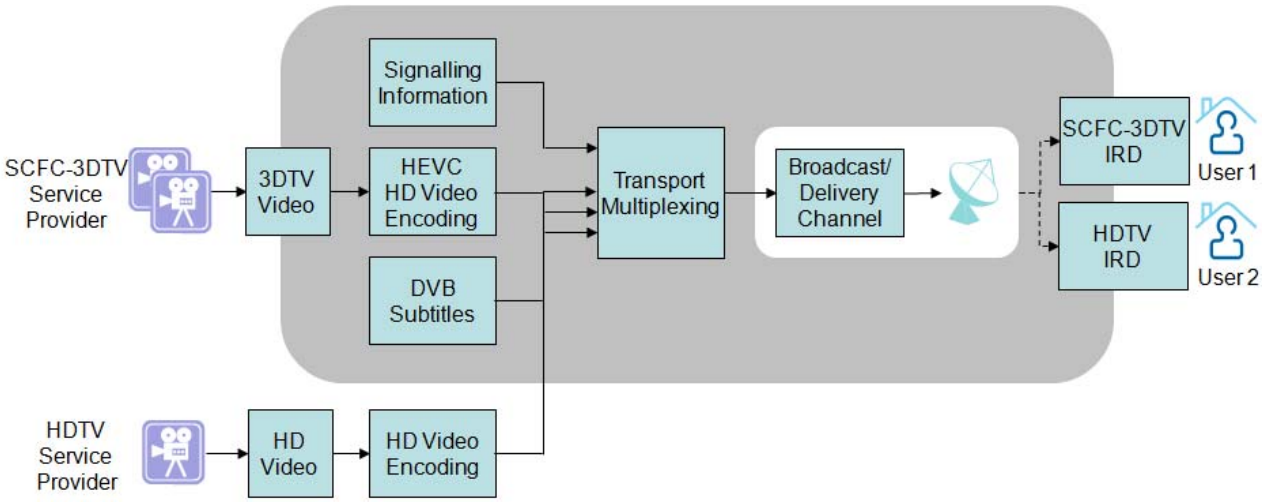

Figure 1: Scope of the service frame compatible plano-stereoscopic 3DTV specification

The following clauses discuss informatively various aspects of SFC-3DTV services and compliant IRDs.

Subsequent clauses specify normatively the features of the SFC-3DTV delivery system, also referring to revised versions of relevant existing DVB specifications that have been updated to include tools for SFC-3DTV service delivery. These are the codecs usage specification for services that use the MPEG-2 Transport Stream ETSI TS 101 154 [2], the DVB SI specification ETSI EN 300 468 [3], and the DVB subtitles specification ETSI EN 300 743 [4].

4.2 SFC-3DTV services

A SFC-3DTV service is a FC-3DTV service [i.3] optionally carrying signalling in the video bitstream allowing HDTV receivers to extract the left view from the two views contained in the frame compatible plano-stereoscopic 3DTV service video stream and up-scale it to simulate the reception of an HDTV service. A SFC-3DTV service differs from an HDTV service in that the video component of the 3DTV service is a frame compatible plano-stereoscopic video format bitstream, and that the SFC-3DTV service carries the SFC-3DTV service signalling as specified in the present document. The SFC-3DTV video bitstream conforms to HDTV video format requirements, so that the video frame encoder does not necessarily need to be cognisant of the frame compatible plano-stereoscopic 3DTV video format, apart from the video layer signalling. Associated audio and ancillary content streams adopt the same formats as with DVB HDTV services.

The present document provides signalling tools (see clause 6) to cater for all of the informatively defined types of 3DTV service described in clause 4.1 of ETSI TS 101 547-1 [i.2], when they are in the form of SFC-3DTV services.

Figure 2 depicts a hypothetical timeline of various types of DVB service, carrying various types of events, for the purposes of introducing the aspects specified in the present document, and the issues around the co-existence of SFC-3DTV services with HDTV services.

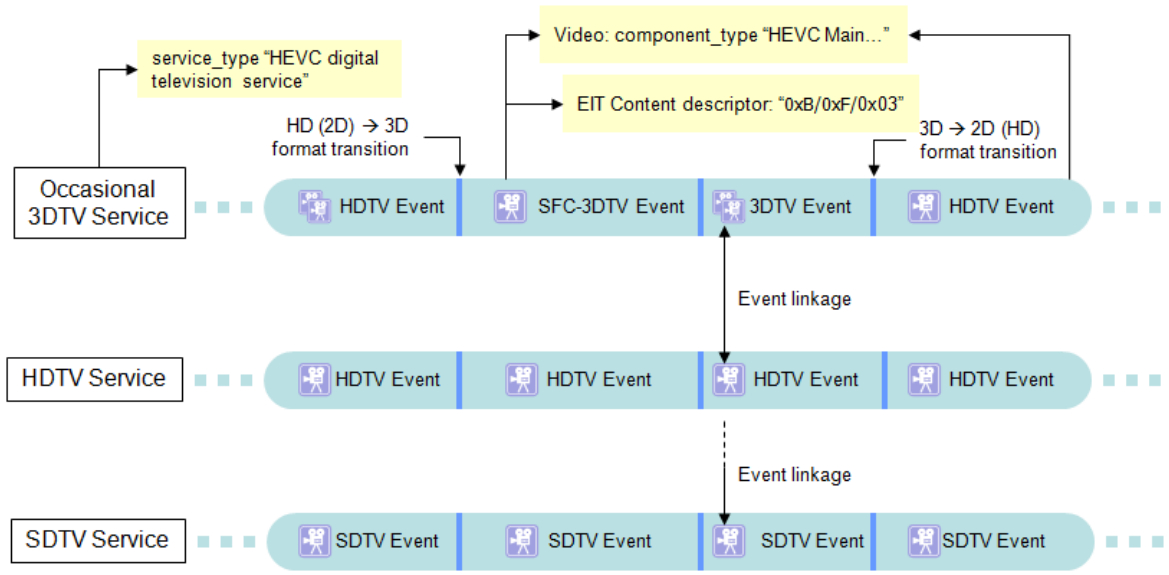

Figure 2: Service compatible frame compatible plano-stereoscopic 3DTV service scenarios

A 3DTV service is defined as a DVB service that is able to carry 3DTV events.A SFC-3DTV service shall be signalled with a service_type code allocation of "HEVC digital television service" as described in clause 6.2.

A SFC-3DTV event is defined as a DVB service event that contains a SFC-3DTV format video stream, as specified in clause 5.1. The permitted HD video encoding parameters (codec, resolution, and frame rate) for SFC-3DTV services are also specified below in clause 5.1.

Signalling for SFC-3DTV services is described in clause 6.

For the 3DTV service types that switch between 3DTV and HDTV modes, the video format transitions that occur when such a switch is performed (from a SFC-3DTV or FC-3DTV video format to an HDTV video format, or vice versa) should be signalled as specified in clause 6.5, in order to ensure consistent and reliable behaviour in the SFC-3DTV IRD.

As well as the 3DTV specific service signalling per se, the existing event linkage SI has been extended to allow more convenient event linkage signalling scenarios with the increased number of different service types, i.e. now including 3DTV services. This aspect is specified in clause 6.3.

4.3 3DTV IRDs

Due to the various capabilities with respect to 3DTV,and the different forms of IRD (e.g. STB or integrated TV), there are several scenarios for the reception of SFC-3DTV services, and the co-existence of SFC-3DTV compliant IRDs with existing HDTV (i.e. non-3DTV) equipment. Figure 3 depicts the predominant scenarios.

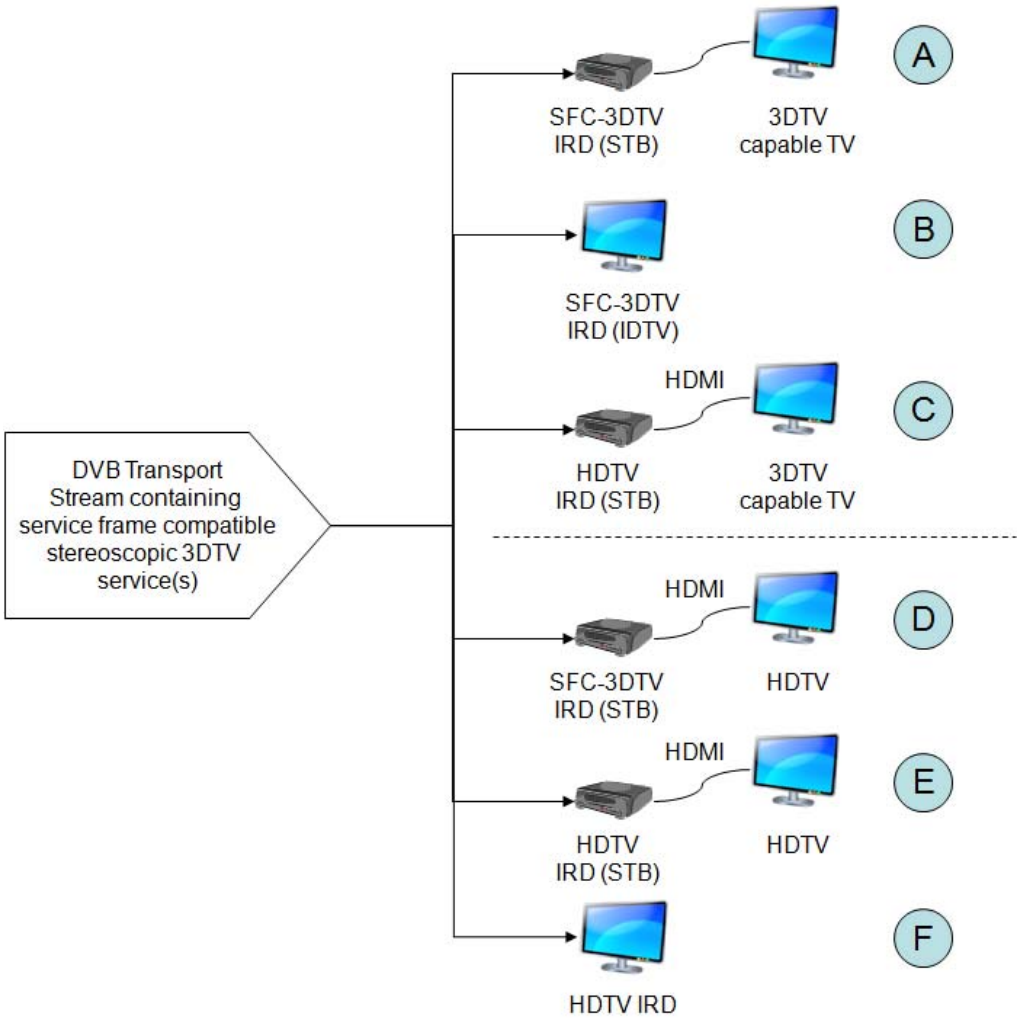

Figure 3: Service frame compatible plano-stereoscopic 3DTV IRD scenarios

3DTV IRD scenario A: The user has a SFC-3DTV compliant IRD (STB) connected to a 3DTV capable display device via HDMI. The user receives 3DTV services via the STB.

3DTV IRD scenario B: The user has a SFC-3DTV compliant IRD in the form of an IDTV, which receives 3DTV services directly from the delivery channel.

IRD scenarios A, B are the meaningful scenarios for the delivery of service frame compatible plano-stereoscopic 3DTV services to the consumer. Further scenarios are described in order to highlight some 3DTV and HDTV service co-existence issues.

3DTV IRD scenario C: The user has an HDTV, i.e. non- SFC-3DTV compliant IRD (STB), connected via HDMI to a 3DTV capable display device. The user receives SFC-3DTV services via the STB, even though the STB is not 3DTV cognisant itself. If the Default Display Window is signalled in the coded bitstream to make the frame compatible service service (2D) compatible (as explained in annex B), the STB might use it to crop and upscale the decoded picture, passing a single view to the display. If the Default Display Window is not signalled, the whole stereoscopic arrangement is passed to the display via the HDMI connection.

3DTV IRD scenario D: The user has a SFC-3DTV compliant IRD (STB), connected via HDMI to a non-3DTV compliant HDTV set. Naturally it is not possible for the user to properly render the 3DTV services that might be able to be received on the 3DTV capable STB. If the Default Display Window is signalled in the coded bitstream to make the frame compatible service service (2D) compatible, the STB crops and upscales the decoded picture to pass a single view to the display. If the Default Display Window is not signalled, the whole stereoscopic arrangement is passed to the display via the HDMI connection.

3DTV IRD scenario E: The user has an HDTV compliant, i.e. non SFC-3DTV compliant IRD (STB), connected via HDMI to a non-3DTV compliant HDTV set. Again, in this scenario it is not possible for the user to receive the 3DTV services. If the Default Display Window is signalled in the coded bitstream to make the frame compatible service service (2D) compatible, the STB might use it to crop and upscale the decoded picture, passing a single view to the display. If the Default Display Window is not signalled, the whole stereoscopic arrangement is passed to the display via the HDMI connection.

3DTV IRD scenario F: The user has an HDTV, i.e. non SFC-3DTV compliant IRD (IDTV). Again, in this scenario it is not possible for the user to receive the 3DTV services. If the Default Display Window is signalled in the coded bitstream to make the frame compatible service service (2D) compatible, the IDTV might use it to crop and upscale the decoded piture to display a single view. If the Default Display Window is not signalled, the whole stereoscopic arrangement is displayed.

5 Video and audio codecs usage

5.1 Video

This clause specifies the video formats for service frame compatible plano-stereoscopic 3DTV services and the requirements on service frame compatible plano-stereoscopic 3DTV IRDs.

Service frame compatible plano-stereoscopic 3DTV services shall apply video coding according to the following clauses:

a) Service frame compatible plano-stereoscopic 3DTV services shall use the HEVC video codec [1] for the coding of video content.

b) The frame compatible plano-stereoscopic video format used for service frame compatible plano-stereoscopic 3DTV services shall be Top-and-Bottom (TaB) as specified below in combination with the allowed frame rates and picture resolutions.

NOTE 1: Annex A provides an informative definition of the 3DTV frame compatible TaB video format, the pre-processing of source 3DTV video material in order to generate this format, and of the post-processing required in the IRD in order to regenerate the left-eye and right-eye views from the decoded frame compatible video stream.

c) Service frame compatible plano-stereoscopic 3DTV services shall apply vertical sub-sampling) to the original full-resolution left-eye and right-eye views in order to generate the half-resolution left and right views.

NOTE 2: TaB is the only sub-sampling method mandated by [i.1], hence it can be relied upon to be supported by 3DTV capable display devices when connected to a service frame compatible plano-stereoscopic 3DTV IRD via an HDMI connection.

NOTE 3: Other frame packing arrangement types might be added in future versions of this document.

d) Service frame compatible plano-stereoscopic 3DTV service video content shall be with 16:9 aspect ratio.

e) Service frame compatible plano-stereoscopic 3DTV services and IRDs shall comply with the common specifications for all HEVC IRDs and bitstreams as defined in clause 5.14.1 of ETSI TS 101 154 [2], and with the extension on HEVC service frame compatible plano-stereoscopic 3DTV as defined in annex X of ETSI TS 101 154 [2].

f) Service frame compatible plano-stereoscopic 3DTV services are divided into those applicable to 50 Hz and to 60 Hz HEVC IRDs, as is the case with the HEVC HDTV IRD specifications in ETSI TS 101 154 [2].

- 50 Hz 3DTV services and IRDs shall comply with the specifications of 50 Hz HEVC HDTV 10-bit IRDs and HEVC HDTV Bitstreams as defined in clause 5.14.2 of ETSI TS 101 154 [2], and with the provisions on 50 Hz 3DTV services and IRDs in the extension on HEVC service frame compatible plano-stereoscopic 3DTV in annex X of ETSI TS 101 154 [2].

- 60 Hz 3DTV services and IRDs shall comply with the specifications of 60 Hz HEVC HDTV 10-bit IRDs and HEVC HDTV Bitstreams as defined in clause 5.14.2 of ETSI TS 101 154 [2], and with the provisions on 60 Hz 3DTV services and IRDs in the extension on HEVC service frame compatible plano-stereoscopic 3DTV in annex X of ETSI TS 101 154 [2].

g) 50 Hz service frame compatible plano-stereoscopic 3DTV services may use the following video format:

- 1080p @ 50 Hz Top-and-Bottom (TaB).

h) 60 Hz service frame compatible plano-stereoscopic 3DTV services may use the following video format:

- 1080p @ 60 Hz Top-and-Bottom (TaB).

NOTE 4: As described in the previous clause, the 3DTV video content, in the form of a frame compatible video sequence, is encoded with an HDTV video encoder that does not need to be cognisant of the frame compatible format of the video stream. The 3DTV video content may pass through the same picture encoding, transmission and picture decoding stages as a conventional HDTV video stream.

i) Video layer signalling as specified in clause 6.4 shall be applied in order to differentiate service frame compatible plano-stereoscopic 3DTV video streams from conventional HDTV video streams.

Service frame compatible plano-stereoscopic 3DTV compliant IRDs shall comply with the following clauses:

j) SFC-3DTV IRDs shall support 16:9 aspect ratio for the reception of service frame compatible plano-stereoscopic 3DTV services.

k) the 50 Hz service frame compatible plano-stereoscopic SFC-3DTV IRD shall support the following video format:

- 1080p @ 50 Hz Top-and-Bottom (TaB).

l) the 60 Hz frame compatible plano-stereoscopic 3DTV IRD shall support the following video format:

- 1080p @ 60 Hz Top-and-Bottom (TaB).

It should be noted that there is no requirement for STB IRDs to match the HDMI mode to that of the broadcast format. In many cases it is better for a STB IRD to operate at the highest resolution mode supported by both the STB and the display. This eliminates the need for HDMI renegotiation and the resulting screen blanking when changing between different broadcast formats (e.g. when changing channel). It also allows the resolution of the receiver's user interface to remain fixed. STB IRDs can up-sample or down-sample the broadcast content to the negotiated HDMI resolution.

5.2 Audio

No particular usage requirements for FC-3DTV services exist for audio, so that the same audio codec usage applies for SFC-3DTV as for HDTV services as specified in ETSI TS 101 154 [2].

6 Signalling

6.1 Signalling Components

This clause specifies the signalling associated with SFC-3DTV services. This signalling consists of the following components:

- signalling in the transport layer, using MPEG-2 PSI and DVB Service Information (SI);
- signalling in the video stream, using the HEVC Supplemental Enhancement Information (SEI);
- signalling in the subtitles, as defined in an extension to the DVB subtitles specification ETSI EN 300 743 [4].

Figure 4 shows the various aspects of signalling specified for the carriage of SFC-3DTV services in DVB delivery systems.

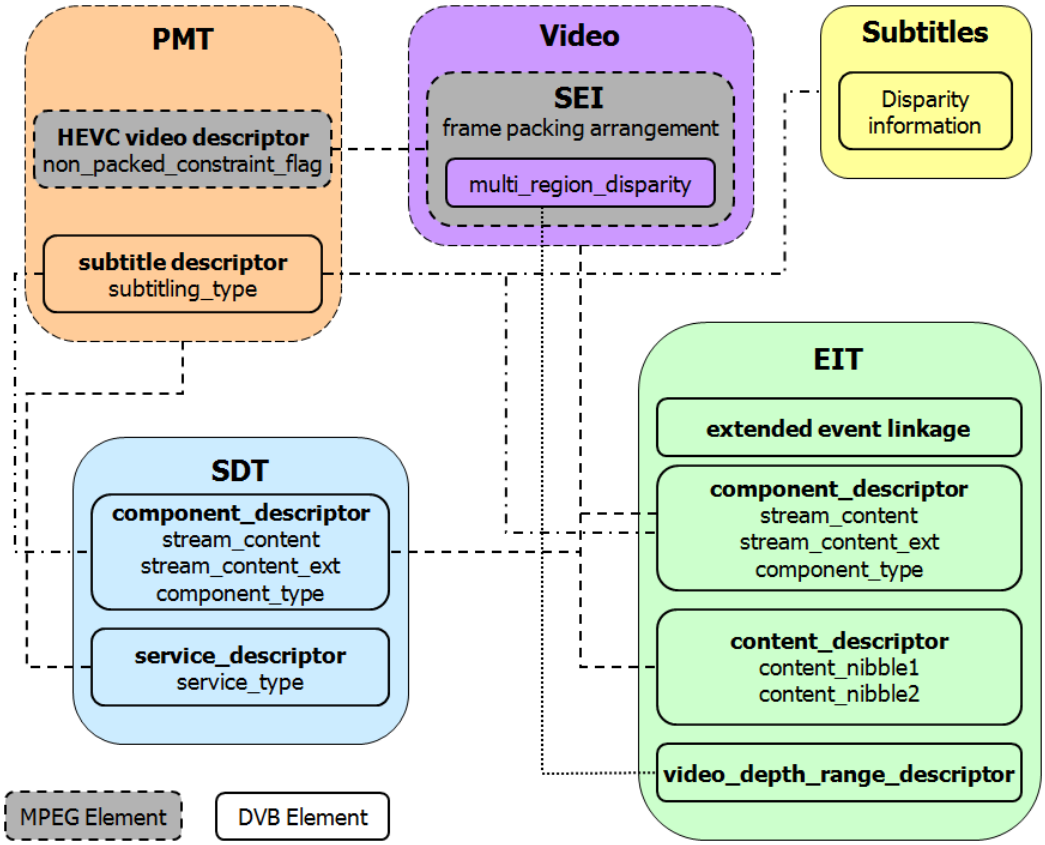

Figure 4: Elements of service frame compatible plano-stereoscopic 3DTV signalling

Since, by definition, SFC-3DTV services are carried in the same way as an HDTV service, frame compatible plano-stereoscopic 3DTV services and IRDs shall comply with the system layer specifications related to all HEVC IRDs and bitstreams as defined in clause 4 of ETSI TS 101 154 [2].

PSI and SI shall be used to signal the presence of SFC-3DTV services in the MPEG-2 TS according to the normative statements expressed in the present clause and using the referenced SFC-3DTV related extensions as specified in ETSI EN 300 468 [3].

6.2 Programme Specific Information

A SFC-3DTV service shall include the HEVC_video_descriptor in the descriptor loop for the respective elementary stream entry in the PMT of the Transport Stream carrying that service.

The non_packed_constraint_flag in the HEVC_video_descriptor carried in the PMT, as specified in ETSI EN 300 468 [3], shall be set according to the presence of the frame packing arrangement SEI message in the coded video sequence. The usage of the frame packing arrangement SEI message in the coded video sequence is specified in clause 6.4.

The non_packed_constraint_flag in the HEVC_video_descriptor shall be set to 0 to signal the presence of frame packing arrangement SEI message in the coded video sequence during carriage of a service frame compatible plano-stereoscopic 3DTV video format.

The non_packed_constraint_flag in the HEVC_video_descriptor may be set to 0 to signal the presence of frame packing arrangement SEI message in the coded video sequence also during carriage of an HDTV video format.

The non_packed_constraint_flag in the HEVC_video_descriptor may be set to 1, to signal that no frame packing arrangement SEI messages are being conveyed in the coded video sequence, only when an HDTV video format is in use, and when no format transition to a SFC-3DTV video format is about to occur, and when no format transition to a SFC-3DTV video format has just occurred. Clause 6.5 specifies the detailed behaviour of PSI and video layer signalling around such video format transitions.

6.3 Service Information

6.3.1 Overview

The DVB SI specification [3] has been extended to include several signalling features required for the implementation of SFC-3DTV services and delivery systems. This clause summarizes this set of extensions while formulating normatively their usage in conjunction with SFC-3DTV services.

In case of any doubt about the consistency between normative statements in ETSI EN 300 468 [3] and the repeated statements herein, the corresponding normative statement ETSI EN 300 468 [3] shall take precedence.

6.3.2 Service type

SFC-3DTV services shall use the service type assigned to "HEVC digital television service" in clause 6.2.33 in ETSI EN 300 468 [3]. Further details about the particular features of the service can be inferred from the component descriptors in the SDT and EIT (see clauses 6.2.8 and I.2.5 in ETSI EN 300 468 [3]). The frame packing format (indicating 3D) is signalled by a EIT component descriptor. The lack of a component descriptor signalling a frame packing format indicates 2D.

6.3.3 Component type

The component descriptor has been extended to include the frame compatible plano-stereoscopic 3DTV video format definitions, as specified in clause I.2.5 of ETSI EN 300 468 [3]. A new component type value, for stream_content_type 0xB and stream_content_ext 0xF, have been defined for signalling the frame packing format for SFC-3DTV services. IRDs may use this information to highlight SFC-3DTV services in the EPG.

Further aspects around the usage of the new component types with the various types of FC-3DTV services introduced in clause 4.1, and the impact on the various IRD scenarios introduced in clause 4.2 is discussed in clause 6.3.

6.3.4 Content descriptor

The content descriptor includes the following event characteristic for 3DTV events:

- Stereoscopic (content nibbles 0xB/0x4).

SFC-3DTV services may apply this event characteristic in the content_descriptor in the EIT.

SFC-3DTV IRDs may use this information to highlight such events in the EPG.

6.3.5 Linkage descriptor

The SI linkage descriptor, specified in clause 6.2.19 of ETSI EN 300 468 [3], provides a linkage type for "extended event linkage". This is specified in clause 6.2.19.3 of ETSI EN 300 468 [3], which assigns a combination of link_type and linkage_type for SFC-3DTV events. Events being broadcast in both, SFC-3DTV and another format should use this mechanism.

6.3.6 Video depth range descriptor

The video depth range descriptor may be applied to SFC-3DTV services to convey depth or disparity information for SFC-3DTV content.

The video depth range descriptor is a feature common to all variants of DVB plano-stereoscopic 3DTV systems, hence it is described in clause 5.1.1 of ETSI TS 101 547-1 [i.2].

6.4 Service Signalling scenarios

Signalling of SFC-3DTV services is defined in clause I.2.5.1 of ETSI EN 300 468 [3].

6.5 Video stream signalling

6.5.1 SFC-3DTV video format signalling

The coded video stream of a SFC-3DTV service shall apply the frame packing arrangement supplemental enhancement information (SEI) message in order to signal the format of the video component of the frame compatible plano-stereoscopic 3DTV service. The video format used and signalled shall be one of the formats specified in clause 5.1.

The coded video stream of a SFC-3DTV service shall convey the frame packing arrangement SEI message with every frame of video, if the video is in an SFC-3DTV format.

The setting of the frame_packing_arrangement_cancel_flag to '0' signals that a SFC-3DTV video format is being used, and the other fields of the SEI message signal the format of the SFC-3DTV video stream and its other characteristics.

The setting of the frame_packing_arrangement_cancel_flag to '1' signals that a non-3DTV video format is being used, i.e. an HDTV video format.

The detailed usage of the frame packing arrangement SEI message syntax for use with FC-3DTV services video streams is specified in annex J of ETSI TS 101 154 [2].

SFC-3DTV services that might switch between 3DTV and non-3DTV (i.e. HDTV) formats, are recommended to convey the frame packing arrangement SEI message also during the time of carriage of a HDTV format video stream, if this signalling tool is available in the encoder. Clause 6.5 specifies the signalling methods for such video format transitions.

6.5.2 Multi-region disparity information

Multi-region disparity information may be carried with SFC-3DTV services to convey depth or disparity information for SFC-3DTV content.

Multi-region disparity information is a feature common to all variants of DVB plano-stereoscopic 3DTV systems, hence it is described in clause 5.1.2 of ETSI TS 101 547-1 [i.2]. The multi-region disparity video layer signalling is specified normatively in clause B.11 of ETSI TS 101 154 [2].

The SFC-3DTV IRD may make use of the multi-region disparity information in order to position graphics correctly over the SFC-3DTV video content.

6.6 Video format transitions

A SFC-3DTV service may switch to or from the service frame compatible plano-stereoscopic video formats to or from an HDTV video format (i.e. a non- service frame compatible plano-stereoscopic 3DTV video format).

NOTE: A channel change between two 3DTV services might include an inherent format switch that might cause additional channel change delay in some cases.

A video format switch shall be applied only at a HEVC DVB_RAP as specified in ETSI TS 101 154 [2].

Due to the lack of tight synchronization between occurrences of the PMT in the Transport Stream and occurrences of pictures in the video stream, there is an inconsistency for a short time if the video format is switched during the running service frame compatible plano-stereoscopic 3DTV service. The carriage of HDTV (i.e. non-3DTV) video format content usually means that the frame packing arrangement SEI message is not applicable. However, an IRD that is presented with such a format switch might not handle the transition correctly due to the temporary inconsistency with the information contained in the previous occurrence of the PMT. This is depicted in figure 5 with the example of a video format switch from 1080p @ 50 Hz Top-and-Bottom frame compatible plano-stereoscopic 3DTV video to 1080p @ 50 Hz HEVC HDTV video.

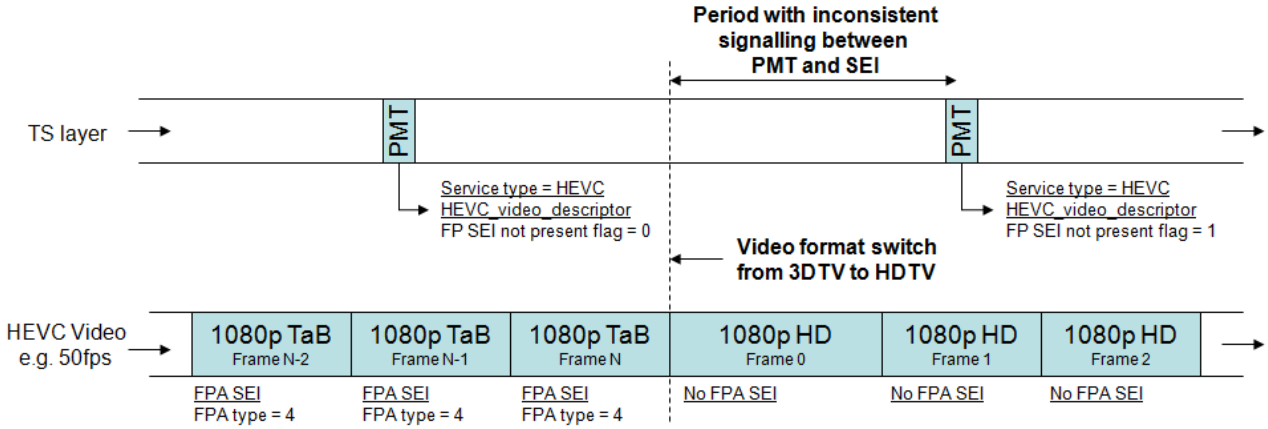

Figure 5: Example video format transition without transition assistance signalling

In this example there is an inconsistency between the information carried in the last occurrence of the PMT before the video format switch, and the information conveyed by the frame packing arrangement SEI message after the video format switch. This inconsistency could cause the IRD to assume the incorrect video format during the period of inconsistency, the length of which is not known due to the mentioned lack of tight synchronization between the PMT and coded video pictures.

Format transition assistance signalling is defined that enables assurance of the robustness of the decoding process in the IRD. It is recommended that this format transition assistance signalling is applied when a service frame compatible plano-stereoscopic 3DTV service includes periods of content in a non-3DTV video format.

The format transition assistance signalling consists of the inclusion of frame packing arrangement SEI messages also in the video stream containing HDTV format video content, with the field frame_packing_arrangement_cancel_flag set to '1' to signal affirmatively that no service frame compatible plano-stereoscopic 3DTV video format is being transmitted currently.

Figure 6 depicts the example of a video format switch from 1080p @ 50 Hz Top-and-Bottom service frame compatible plano-stereoscopic 3DTV video to 1080p @ 50 Hz HEVC HDTV video when the format transition assistance signalling is applied.

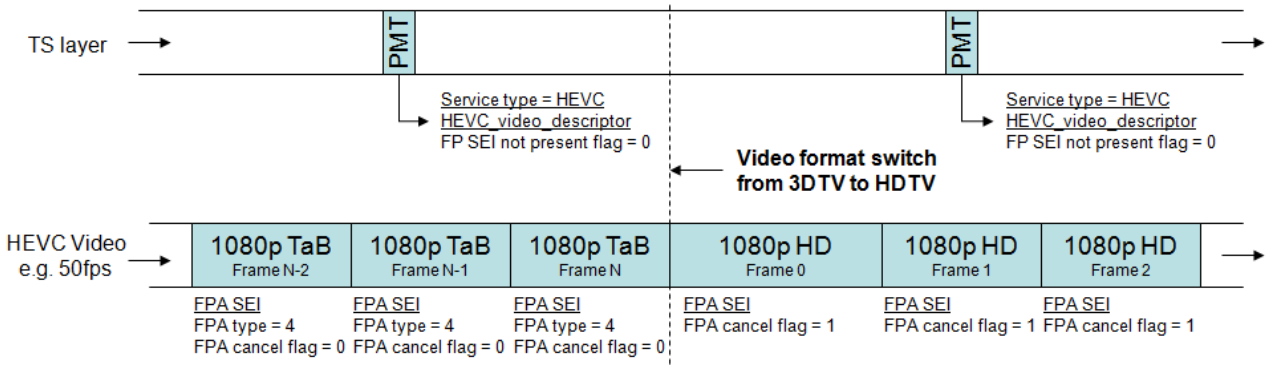

Figure 6: Example video format transition with transition assistance signalling

In order to maximize the robustness of the decoding process in the IRD, it is recommended that the service frame compatible plano-stereoscopic 3DTV service applies the frame packing arrangement SEI message also during carriage of the HDTV format, at least for a period of two seconds before and after a format switch between the HDTV video format and the service frame compatible plano-stereoscopic 3DTV video format.

When a video format transition occurs either to or from a HDTV video format, the *frame_packing_arrangement_cancel_flag* in the frame packing arrangement SEI message should be set to '1', indicating that a non-3DTV video format is being carried, for a period of at least two seconds after the transition from a service frame compatible plano-stereoscopic 3DTV video format to an HDTV video format has occurred, or for at least two seconds before the transition from a HDTV video format to a SFC-3DTV video format will occur.

Carriage of the frame packing arrangement SEI message with frame_packing_arrangement_cancel_flag setting to '1' may persist during the complete duration of HDTV video format content, at the discretion of the service provider. As well as enhancing the robustness of the handling by the IRD of video format transitions within a SFC-3DTV service, it also provides robustness in the case when the IRD performs a channel change from another service type to a SFC-3DTV service. In some circumstances it might be more convenient to continue to apply this signalling than to cease to convey it.

Figure 7 depicts the generic scenarios of SFC-3DTV service format transitions, with the following characteristics of PMT and FPA SEI signalling mapped to the example video formats depicted:

- PMT 1 { HEVC_video_descriptor with non_packed_constraint_flag = '0' }
- PMT 2 { HEVC_video_descriptor with non_packed_constraint_flag = '1' }
- FPA SEI 1 { frame_packing_arrangement_cancel_flag = '0'; frame_packing_arrangement_type = '4' }
- FPA SEI 2 { frame_packing_arrangement_cancel_flag = '1'}
- FPA SEI 3 { frame_packing_arrangement_cancel_flag = '0'; frame_packing_arrangement_type = '4' }

Note that figure 7 is a large-scale diagram with respect to the time axis, so that no detail is shown as regards the inconsistencies between PMT and HEVC SEI messages that arise at all video format transitions, and that the diagram depicts only those particular occurrences of "HEVC DVB_RAP" that occur at the video format transitions.

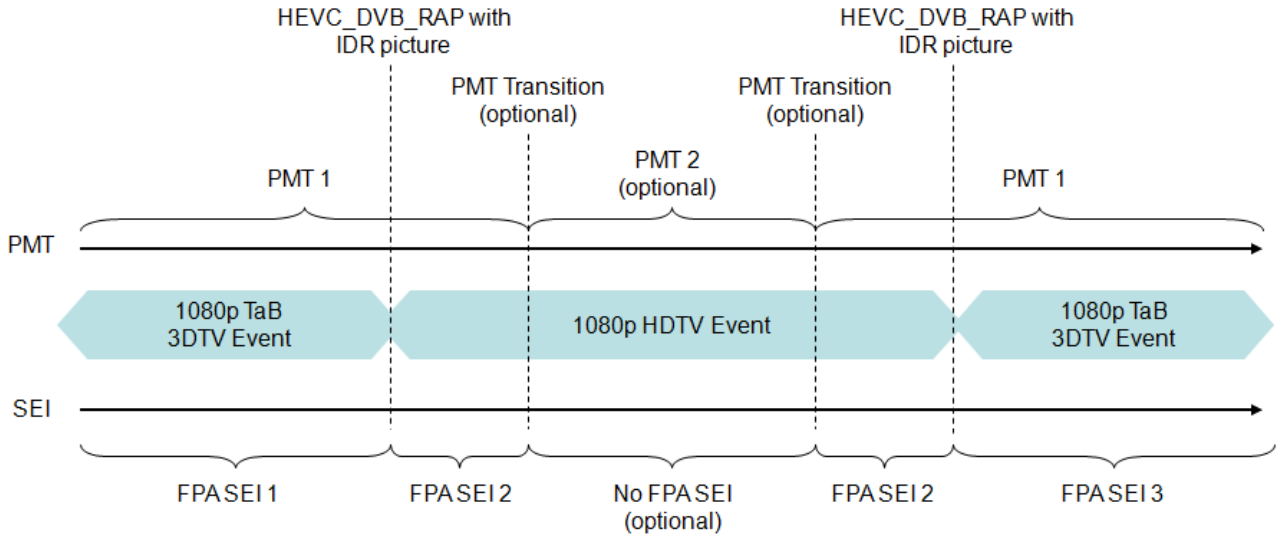

Figure 7: Generic scenarios of service frame compatible plano-stereoscopic 3DTV service format transitions

In any case the frame packing arrangement SEI message signalling shall be consistent with the video format carried, and takes precedence over other signalling as regards video format.

The temporary inconsistencies with the PMT mentioned above may occur, and are alleviated by the application of format transition assistance signalling as specified in the present clause.

Annex A (informative): An overview of service frame compatible plano-stereoscopic 3DTV video formats

A.1 Top-and-Bottom frame compatible video format

The Top-and-Bottom (TaB) format is defined as the arrangement of the frame compatible spatial multiplex such that the vertically anamorphic left-eye picture is placed in the spatial multiplex to occupy the first (top) half of a single HDTV video frame, and the right-eye picture is placed in the spatial multiplex to occupy the second (bottom) half of a single HDTV video frame.

The process for the generation of TaB format frame compatible plano-stereoscopic video is depicted in figure A.1. This corresponds to the function "3DTV Video" in the 3DTV scope diagram in clause 4 for a 3DTV service that uses the Top-and-Bottom frame compatible video format.

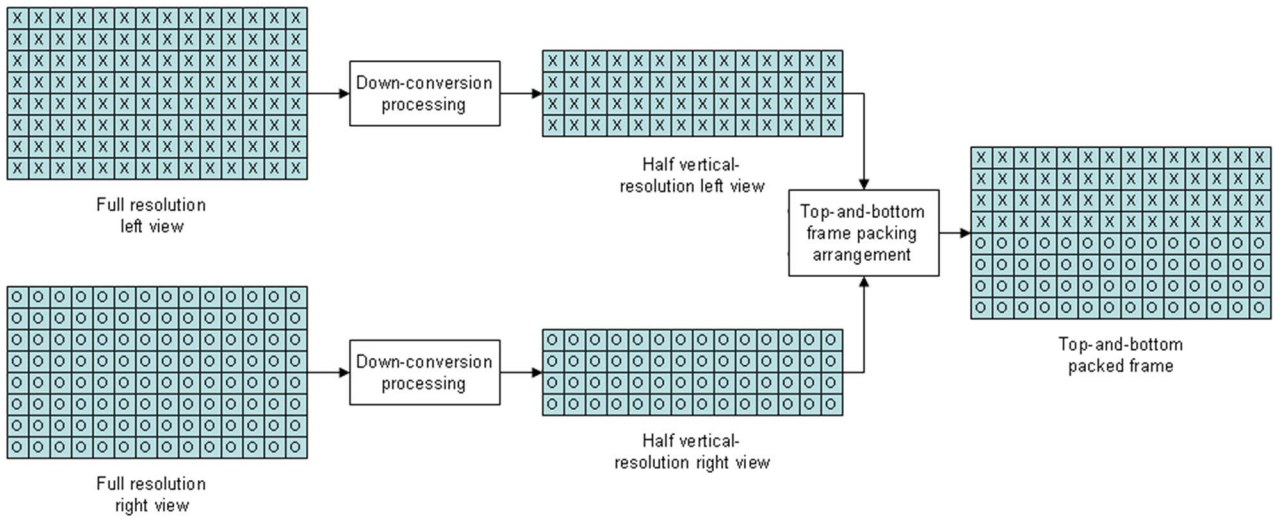

Figure A.1: Top-and-Bottom video frame composition

The Top-and-Bottom frame compatible 3DTV video frame has the same format as a conventional HDTV video frame.

The decomposition and up-conversion process in the 3DTV IRD to re-generate the left-eye and right-eye views from the decoded Top-and-Bottom frame compatible format is depicted in figure A.2. This figure is illustrative and does not intend to depict accurately the video resolution or aspect ratio.

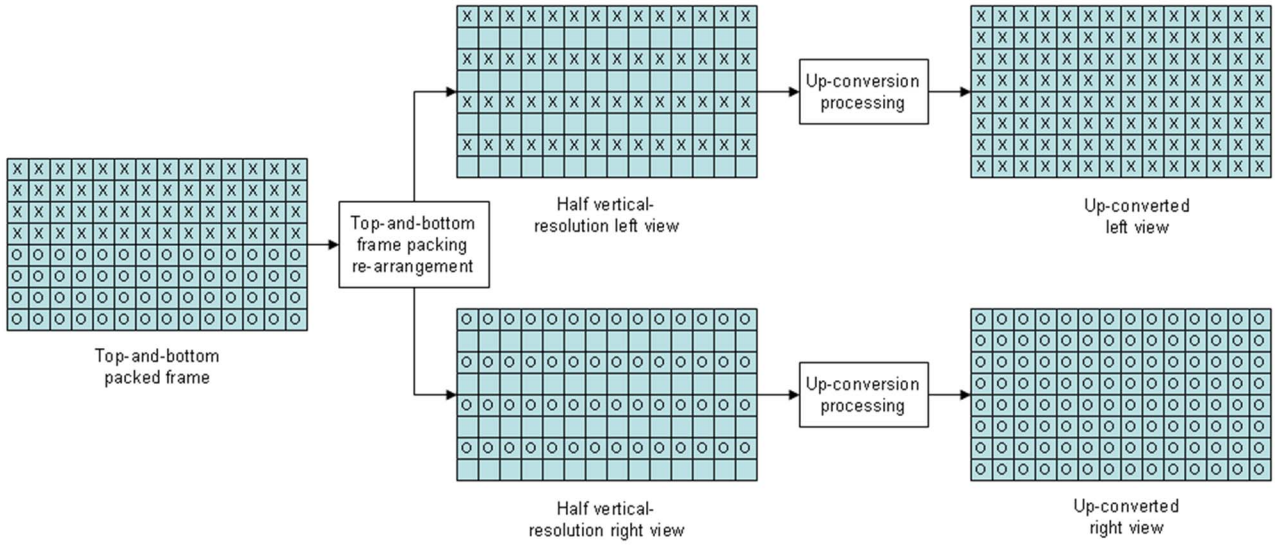

Figure A.2: Top-and-Bottom decoded video frame decomposition

Figure A.2 is illustrative and does not intend to depict accurately the video resolution or aspect ratio.

Annex B (informative): HDTV service compatibility for SFC-3DTV services

Service compatibility of frame compatible services is an optional mode of operation of plano stereoscopic 3DTV services. Such service compatible modes enable a service provider to transmit a single service that provides both frame compatible plano-stereoscopic 3DTV video and reduced-resolution HDTV video concurrently, whereas normally HDTV coverage with the same source content would be provided with a separate dedicated HDTV service.

This annex provides guidelines on possible modes of operation of frame compatible plano-stereoscopic 3DTV services that give service compatible operation with HDTV services. This kind of service compatibility is enabled by the HDTV decoder extracting the left view from the two views contained in the frame compatible plano-stereoscopic 3DTV service video stream, and up-scaling it to simulate the reception of an HDTV service. Such a transmission addresses 3DTV cognisant receivers and/or 3DTV incognisant receivers, whereby a 3DTV cognisant receiver is able to selectively output a video signal (either 3DTV or HDTV) that is appropriate for its own display capabilities, or for the capabilities of the connected display.

The Default Display Window from the VUI signalling of the HEVC video codec [1] should be used to transmit service compatible modes. In that case, the Default Display Window should be used by IRDs to restrict the displayed pixels to those corresponding to the left view and to rescale the picture to full screen.

NOTE: HEVC legacy IRDs may not be capable to use the Default Display Window for the above described functionality.

To apply the default display window feature, the field default_display_window_flag of the HEVC vui_parameters () is set to '1'. Table B.1 provides the settings of default display window offsets (in terms of luma samples) for the service frame compatible plano-stereoscopic 3DTV video format specified in clause 5.1 that are suitable for application of this signalling. These settings apply to both 50 Hz and 60 Hz video formats. Furthermore, a sample aspect ratio of 1:2 should be assumed. However, service providers should keep in mind that legacy HEVC receivers might not support a sample aspect ratio that is not 1:1.

Table B.1: HEVC default display window signalling for the service compatible modes

Frame compatible plano-stereoscopic 3DTV video format	Default display window top offset (luma samples)	Default display window right offset (luma samples)	Default display window bottom offset (luma samples)	Default display window left offset (luma samples)
1 920 x 1080p Top-and-Bottom	0	0	540	0

History

Document history		
V1.1.1	June 2015	Publication