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**Digital Video Broadcasting (DVB);
Plano-stereoscopic 3DTV;
Part 3: HDTV Service Compatible Plano-stereoscopic 3DTV**

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Reference

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Foreword

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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 3 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".**

Introduction

The present document specifies the delivery system for HDTV service compatible plano-stereoscopic 3DTV services, enabling service providers to provide 3DTV services with full resolution high-definition video per eye, while allowing existing HDTV receivers to derive a conventional full-resolution HDTV service from the 3DTV 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 HDTV service compatible plano-stereoscopic 3DTV (SC-3DTV) services, and their decoding by a digital receiver. This includes the selection of SC-3DTV formats, the definition of SC-3DTV service signalling information, and the handling of graphics and captions overlays in the receiver during the reception of a SC-3DTV service. The underlying mechanisms are specified in amendments and extensions to the appropriate existing DVB specifications.

The production and contribution of SC-3DTV content prior to delivery and the method of rendering the SC-3DTV content on a display after its reception and decoding are outside the scope of the present document.

2 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.

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

2.1 Normative references

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

- [1] ITU-T Recommendation H.222.0 (2012)/ISO/IEC 13818-1: "Information technology - Generic coding of moving pictures and associated audio information: Systems".
- [2] ITU-T Recommendation H.264 (2012)/ISO/IEC 14496-10:2012: "Advanced video coding for generic audiovisual services"./"Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding".
- [3] ETSI TS 101 154 (V1.11.1): "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream".
- [4] DVB BlueBook A038 (09/12): "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".
- [5] ETSI EN 300 743 (V1.4.1): "Digital Video Broadcasting (DVB); Subtitling systems".

2.2 Informative references

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 1.4a", March 4, 2010.

NOTE: Available at <http://www.hdmi.org/manufacturers/specification.aspx>.

- [i.2] Blu-ray Disc Association: "White Paper Blu-ray Disc™ Read-Only Format 2.B Audio Visual Application Format Specifications for BD-ROM Version 2.5", July 2011.

NOTE: Available at http://blu-raydisc.com/assets/Downloadablefile/BD-ROM-AV-WhitePaper_110712.pdf.

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

- [i.4] 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 TS 101 547-1 [i.3] apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TS 101 547-1 [i.3] and the following apply:

ES	Elementary Stream
IDTV	Integrated Digital TV
MVC	Multiview Video Coding

NOTE: As defined in [2].

PID	Packet Identifier
-----	-------------------

4 HDTV service compatible plano-stereoscopic 3DTV services in DVB delivery systems

Figure 1 depicts the scope of the present document, highlighted by the grey area, and the general concept of the compatibility of DVB HDTV service compatible plano-stereoscopic 3DTV (SC-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 SC-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 SC-3DTV compliant (as defined in the present document), some of which are FC-3DTV compliant (as defined in TS 101 547-2 [i.4]), and some of which are HDTV capable, i.e. not SC-3DTV compliant.

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

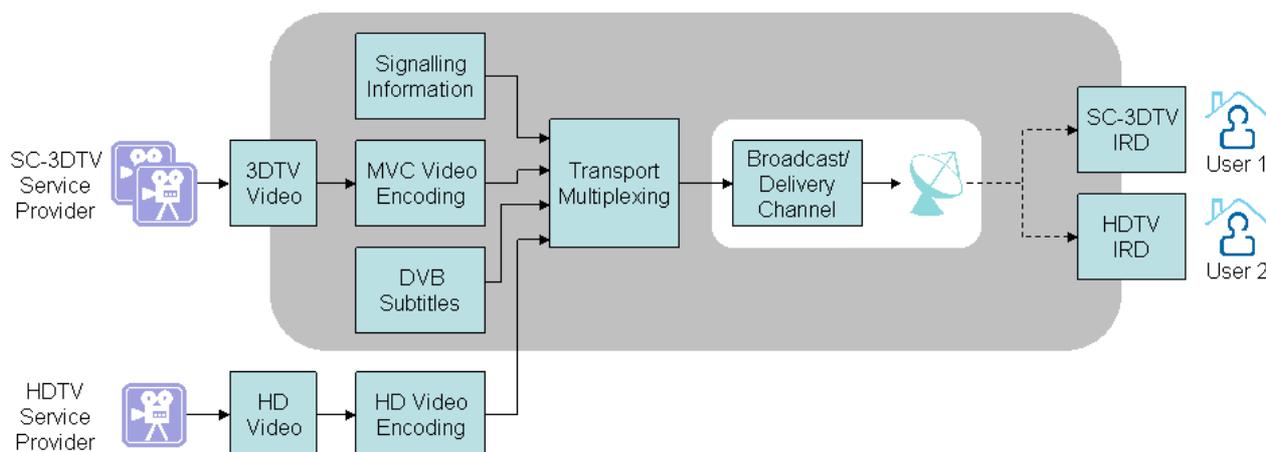


Figure 1: Scope of the HDTV service compatible plano-stereoscopic 3DTV specification

The following clauses discuss informatively various aspects of HDTV service compatible plano-stereoscopic 3DTV (SC-3DTV) services and compliant IRDs.

Subsequent sections specify normatively the features of the SC-3DTV delivery system, referring to revised versions of relevant existing DVB specifications that have been updated to include tools for SC-3DTV service delivery. These are the codecs usage specification for services that use the MPEG-2 Transport Stream [3], the DVB SI specification [4], and the DVB subtitles specification [5].

4.1 HDTV service compatible plano-stereoscopic 3DTV services

SC-3DTV services adopt the MVC Stereo High Profile video format defined in [2]. The application of MVC Stereo High Profile for SC-3DTV is specified in the present document and in [3]. A SC-3DTV service differs from a HDTV service in that the video content of the 3DTV service contains two component video elementary streams, namely the MVC Stereo Base, or Independent Layer, and the MVC Stereo Dependent Layer.

The MVC Stereo Base Layer video stream is backwards compatible with HDTV video streams, as specified in clause 5.1. In addition, SC-3DTV service signalling is specified such that existing non-SC-3DTV capable IRDs will recognise the SC-3DTV service as a HDTV service and decode the associated MVC Stereo Base Layer video stream as if the IRD was receiving a conventional HDTV service.

The MVC Stereo Dependent Layer supplements the MVC Stereo Base Layer, applying the methods specified in annex H of [3], to provide the second view of a stereo pair of views at a reduced bit rate compared to independent encoding, at an equivalent level of picture quality.

Associated audio and ancillary content streams of SC-3DTV services, except for DVB subtitles, 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 TS 101 547-1 [i.3], when they are in the form of SC-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 SC-3DTV services with HDTV services.

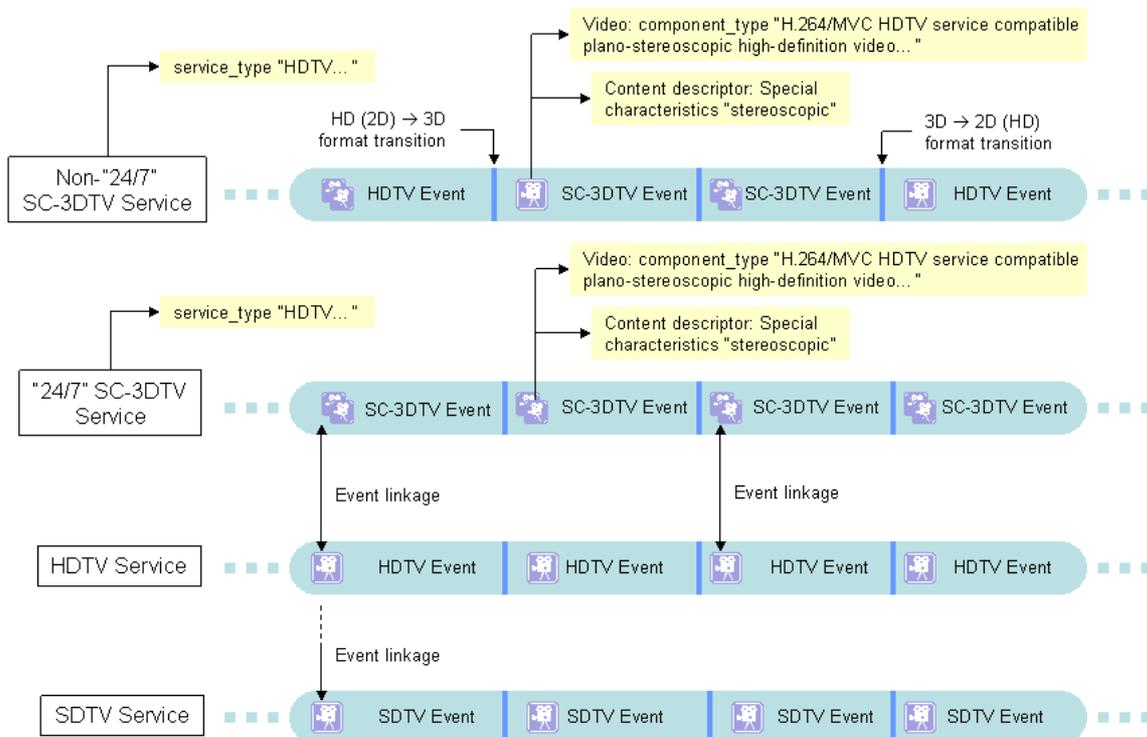


Figure 2: SC-3DTV service scenarios

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

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

As well as the SC-3DTV specific 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.

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

4.2 HDTV service compatible plano-stereoscopic 3DTV IRDs

Due to the backwards compatibility of SC-3DTV services with HDTV services and the different types of IRD (e.g. STB or integrated TV), there are several scenarios for the reception of SC-3DTV services, and the co-existence of SC-3DTV compliant IRDs with existing frame compatible plano-stereoscopic 3DTV (FC-3DTV) compliant IRDs and HDTV (i.e. non-3DTV) equipment. Figure 3 depicts the predominant scenarios.

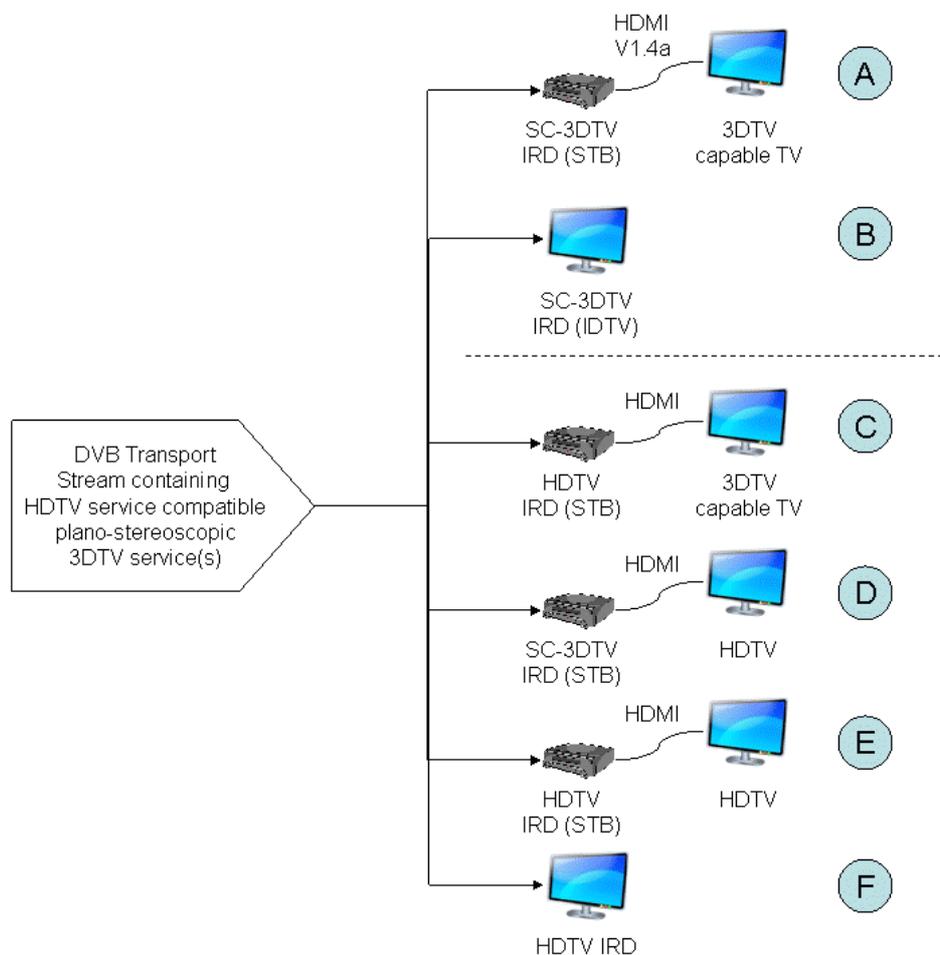


Figure 3: HDTV service compatible plano-stereoscopic 3DTV IRD scenarios

3DTV IRD scenario A: The user has a SC-3DTV compliant IRD (STB) connected to a 3DTV capable display device via HDMI V1.4a. If the display device is SC-3DTV format compliant via its HDMI interface then the user receives SC-3DTV services via the STB. If the display device is FC-3DTV format compliant via its HDMI interface then the SC-3DTV compliant IRD (STB) may be able to convert the SC-3DTV service to a FC-3DTV compliant format, otherwise the user will receive the SC-3DTV service in backwards-compatible HDTV mode.

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

IRD scenarios A and B are the meaningful scenarios for the delivery of HDTV service compatible plano-stereoscopic 3DTV services to the consumer. Further scenarios are described in order to highlight the backwards compatibility of SC-3DTV services with conventional HDTV IRDs.

3DTV IRD scenario C: The user has a HDTV or FC-3DTV STB, i.e. non-SC-3DTV compliant IRD (STB), connected via HDMI to a SC-3DTV capable display device. Here the user will receive the SC-3DTV service in backwards-compatible HDTV mode.

3DTV IRD scenario D: The user has a 3DTV compliant IRD (STB), connected via HDMI to a non-SC-3DTV compliant HDTV or FC-3DTV set. Here the user will receive the SC-3DTV service in backwards-compatible HDTV mode.

3DTV IRD scenario E: The user has a HDTV or FC-3DTV compliant, i.e. non-SC-3DTV compliant IRD (STB), connected via HDMI to a non-SC-3DTV compliant HDTV set. Here the user will receive the SC-3DTV service in backwards-compatible HDTV mode.

3DTV IRD scenario F: The user has a HDTV or FC-3DTV, i.e. non-SC-3DTV compliant IRD (IDTV). Here the user will receive the SC-3DTV service in backwards-compatible HDTV mode.

5 Video and audio codecs usage

This clause profiles [3] to specify the video and audio codecs usage for SC-3DTV services, and the carriage of SC-3DTV services in the MPEG-2 Transport Stream.

5.1 Video

This clause specifies the video format for SC-3DTV services and the requirements on SC-3DTV IRDs.

The video format for HDTV service compatible plano-stereoscopic 3DTV services shall be H.264/AVC Stereo High Profile Level 4.0. Its usage for SC-3DTV services is specified normatively in clause 5.13, "MVC Stereo HDTV IRDs and Bitstreams", of [3]. The video format adopted is aligned closely with that used for Blu-ray disc 3D content [i.2].

H.264/AVC Stereo High Profile Level 4.0 video consists of two H.264/AVC coded video component streams for each of the left- and right-eye 3DTV views. The two component streams are referred to as the MVC Stereo Base Layer and the MVC Stereo Dependent Layer. Which of the two video layers it is that provides the left and right views is determined by the content provider. Video layer signalling, described in clause 6.4, is provided in order to identify which eye view is contained in the Base Layer and Dependent Layer respectively.

SC-3DTV services shall apply video coding according to the following clauses:

- a) SC-3DTV services shall use H.264/AVC video codec Stereo High Profile [2] for the coding of video content.
- b) SC-3DTV service video content shall be with 16:9 aspect ratio.
- c) SC-3DTV services and IRDs shall comply with the common specifications for all MVC Stereo HDTV IRDs and bitstreams as defined in clause 5.13 of [3], and with the further specification contained in annex I of [3].
- d) SC-3DTV services are divided into those applicable to 25 Hz and to 30 Hz video system environments, as is the case with the existing SD and HD format specifications in [3]:
 - 25 Hz SC-3DTV services and IRDs shall comply with the specifications of 25 Hz H.264/MVC Stereo HDTV IRDs and bitstreams as defined in clause 5.13.2 of [3], and with the provisions on 25 Hz SC-3DTV services and IRDs in the extension on SC-3DTV in annex I of [3].
 - 30 Hz SC-3DTV services and IRDs shall comply with the specifications of 30 Hz H.264/MVC Stereo HDTV IRDs and bitstreams as defined in clause 5.13.3 of [3], and with the provisions on 30 Hz SC-3DTV services and IRDs in the extension on SC-3DTV in annex I of [3].

- e) 25 Hz SC-3DTV services may use the following video formats for the Base and Dependent Layers, whereby both Layers shall use the same format:
- 1 280 x 720p @ 50 Hz;
 - (1 920 or 1 440) x 1 080i @ 25 Hz;
 - (1 920 or 1 440) x 1 080p @ 25 Hz.

NOTE 1: The 1 080p @ 25 Hz format is an optional format for compliance with [i.1]. Some 3DTV capable display devices might not support this 3DTV video format. However such content can be converted to 1 080i @ 25 Hz or 1 080p @ 50 Hz for transmission over HDMI.

- f) 30 Hz SC-3DTV services may use the following video formats for the Base and Dependent Layers, whereby both Layers shall use the same format:
- 1 280 x 720p @ 59,94 / 60 Hz;
 - (1 920 or 1 440) x 1 080i @ 29,97 / 30 Hz;
 - (1 920 or 1 440) x 1 080p @ 30 Hz;
 - 1 920 x 1 080p @ 23,98 / 24 Hz.

NOTE 2: The 1 080p @ 30 Hz format is an optional format for compliance with [i.1]. Some 3DTV capable display devices might not support this 3DTV video format. However such content can be converted to 1 080i @ 30 Hz or 1 080p @ 60 Hz for transmission over HDMI.

- g) Video layer signalling as specified in clause 6.4 shall be applied.

SC-3DTV compliant IRDs shall comply with the following clauses:

- h) SC-3DTV IRDs shall support 16:9 aspect ratio for the reception of SC-3DTV services.
- i) The 25 Hz SC-3DTV IRD shall support the following video formats:
- 1 280 x 720p @ 50 Hz;
 - (1 920 or 1 440) x 1 080i @ 25 Hz;
 - (1 920 or 1 440) x 1 080p @ 25 Hz.
- j) The 30 Hz SC-3DTV IRD shall support the following video formats:
- 1 280 x 720p @ 59,94 / 60 Hz;
 - (1 920 or 1 440) x 1 080i @ 29,97 / 30 Hz;
 - (1 920 or 1 440) x 1 080p @ 29,97 / 30 Hz;
 - 1 920 x 1 080p @ 23,98 / 24 Hz.

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 SC-3DTV services exist for audio, so that the same audio codec usage applies for SC-3DTV as for HDTV services as specified in [3].

5.3 SC-3DTV service carriage in MPEG-2 TS

The underlying H.264/AVC specification [3] allows the MVC High Profile Base view and Stereo High Profile Dependent view coded video to be carried in the MPEG-2 Transport Stream (TS) either using TS packets with the same PID value for both streams, or using TS packets with two different PID values, as specified in [1]. In order to ensure predictable error-free behaviour of legacy HDTV IRDs already deployed in the field, SC-3DTV services shall allocate two separate PID values for the carriage of the MVC High Profile Base view and Stereo High Profile Dependent view coded video in the MPEG-2 TS.

Further specification about the carriage of SC-3DTV content in the MPEG-2 TS are provided in clause 4 of [3], referring to MVC Bitstreams, and clause I.2 of [3].

6 Signalling

This clause specifies the signalling associated with SC-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 H.264/AVC Supplemental Enhancement Information (SEI);
- signalling in the subtitles, as defined in an extension to the DVB subtitles specification [5].

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

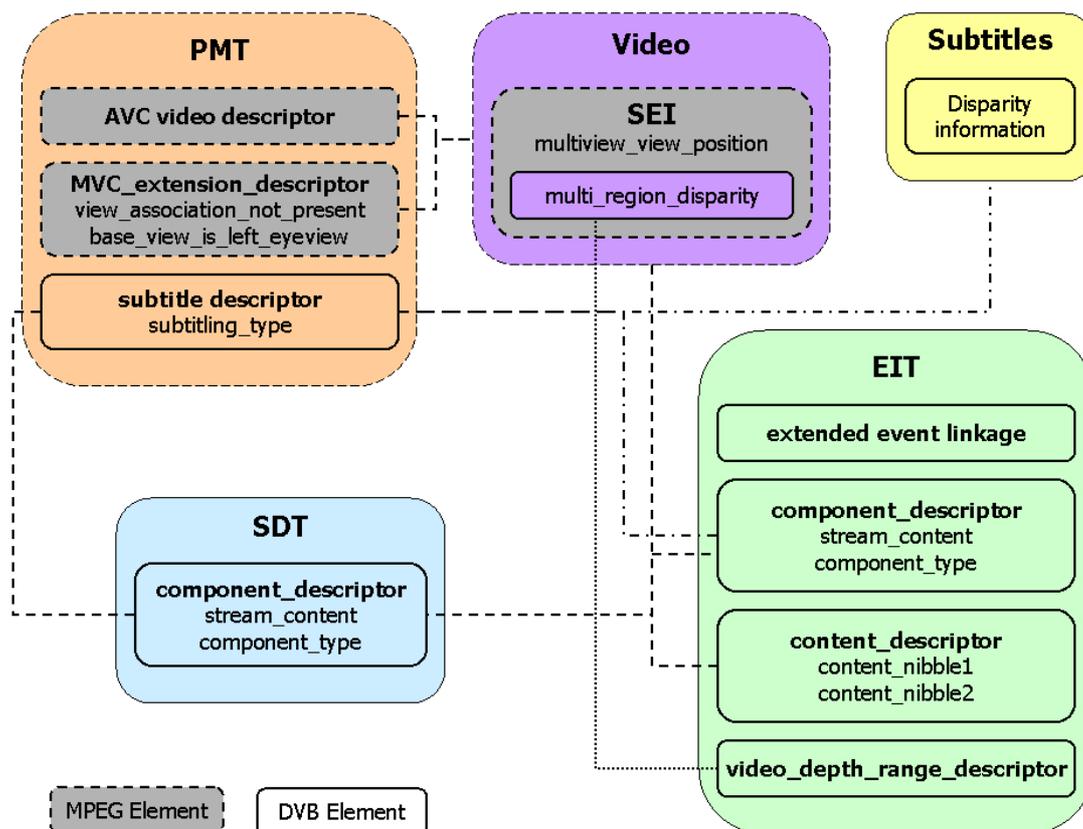


Figure 4: Elements of HDTV service compatible plano-stereoscopic 3DTV signalling

SC-3DTV services and IRDs shall comply with the system layer specifications related to all H.264/MVC IRDs and bitstreams as defined in clause 4 of [3].

PSI and SI shall be used to signal the presence of SC-3DTV services in the MPEG-2 TS according to the normative statements expressed in the present clause and using the referenced SC-3DTV related extensions as specified in [4].

6.1 Programme Specific Information

The MVC_extension_descriptor shall be present in the ES loop of the PMT of the MVC Stereo Dependent Layer video, as specified in clause 4.1.8.20 of [3]. The MVC_extension_descriptor contains information to associate the Base and Dependent views with the Left or Right eye view as appropriate, as set by the content provider.

The AVC_video_descriptor shall be applied for the MVC Stereo Base Layer if it contains H.264/AVC still pictures, as specified in clause 4.1.8.18 of [3].

6.2 Service Information

The DVB SI specification [4] has been extended to include several signalling features required for the implementation of SC-3DTV services and delivery systems. This clause summarizes this set of extensions while formulating normatively their usage in conjunction with SC-3DTV services.

In case of any doubt about the consistency between normative statements in [4] and the repeated statements herein, the corresponding normative statement [4] shall take precedence.

6.2.1 Service type

SC-3DTV services are not identified by any new dedicated SI service type. Due to the prime requirement for backwards-compatibility with conventional HDTV services, SC-3DTV services shall adopt the existing service type codes for "advanced codec HD services" (types 0x19, 0x1A, and 0x1B).

SC-3DTV compliant IRDs shall recognise SC-3DTV services using the corresponding video component type signalling specified in clause 6.2.2.

6.2.2 Video component type

The component descriptor has been extended to include the additional format definition needed for MVC Stereo Dependent Layer of SC-3DTV video content, as specified in clause 6.2.8 of [4].

The Base view of a SC-3DTV services shall be allocated the appropriate existing *component_type* value for "H.264/AVC high definition video", as specified in clause 6.2.8 of [4].

A new SI *component_type* for *stream_content* type 0x05, namely with value 0x84 for "H.264/MVC dependent view, plano-stereoscopic service compatible video", has been defined for the dependent layer video component for use with SC-3DTV services.

The usage of *stream_content* and *component_type* for SC-3DTV is summarised in table 1.

Table 1: Video component type values for SC-3DTV

SC-3DTV system	Base view stream_content / component_type	Dependent view stream_content / component_type
25 Hz	0x05 / 0x0B	0x05 / 0x84
30 Hz	0x05 / 0x0F	0x05 / 0x84

SC-3DTV services should carry the component_descriptor in the EIT and apply the appropriate component_type according to the video format being used.

24 Hz frame rate video content shall use the appropriate H.264/MVC video component type as defined for 30 Hz content.

Further aspects around the usage of the new component types with the various types of SC-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 Video stream signalling

6.3.1 Multiview view position SEI

The *multiview_view_position_SEI* message shall be applied to the MVC Stereo Base view as specified in clause 5.13.1.8 of [3]. This SEI message indicates the MVC Stereo video format and associates the Base and Dependent views with the Left and Right eye views of the SC-3DTV service.

The SC-3DTV IRD shall receive and interpret *multiview_view_position_SEI* messages.

6.3.2 Multi-region disparity

Multi-region disparity information, described in clause 5.1.2 of TS 101 547-1 [i.3], and specified normatively in clause B.11 of [3], may be applied to SC-3DTV services.

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

6.4 Video format transitions

A SC-3DTV service may switch video format between the SC-3DTV video format to or from a HDTV video format (i.e. a non-SC-3DTV video format), as depicted in the SC-3DTV service scenarios in clause 4.1.

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 between an SC-3DTV and a HDTV format shall be applied only at a service event boundary, at a RAP with an IDR or Intra-coded video frame.

With SC-3DTV services there are two methods by which to carry non-3DTV HDTV video formats. The first, depicted schematically in figure 5, occurs when the video switched from MVC Stereo High Profile to a conventional HDTV video format. In this case the MVC Stereo Dependent stream ceases to be carried.

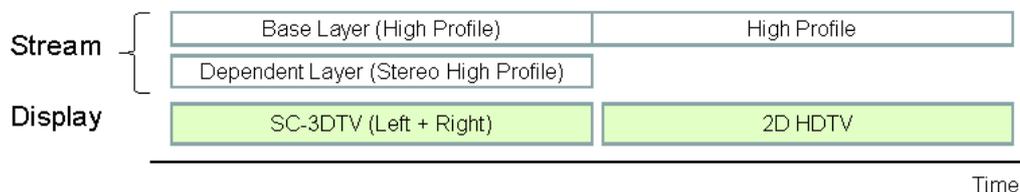


Figure 5: Video format transition from SC-3DTV to a conventional HDTV format

The second method is realised when the SC-3DTV service maintains carriage of the MVC Stereo High Profile video format, but by sending an MVC Stereo Dependent Layer video stream consisting entirely of groups of skipped macroblocks, i.e. it is "empty" and does not convey any additional video information compared to the Base Layer. In this case the IRD will display the Base Layer view also for the view allocated to the Dependent Layer. This case is depicted schematically in figure 6.

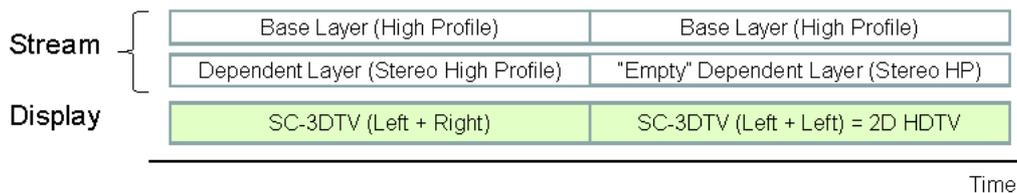


Figure 6: Video format transition from SC-3DTV to 2D mode using an "empty" Dependent Layer stream

Format switches of the second type, depicted in figure 6, are not problematic, as the SC-3DTV IRD is able to determine the switch to the non-3DTV HDTV video format by the defined MVC Stereo High Profile mechanisms.

With the first type of switch, however, the SC-3DTV IRD is not able to determine that the switch has occurred until the next occurrence of the changed PMT, signalling that the MVC Stereo Dependent Layer view is no longer present. This is depicted in figure 7. Due to the lack of tight synchronisation between the PMT and coded video pictures, the IRD might decide that an error has occurred due to perceived Dependent Layer video buffer underflow, with potentially unpredictable consequences for the user experience.

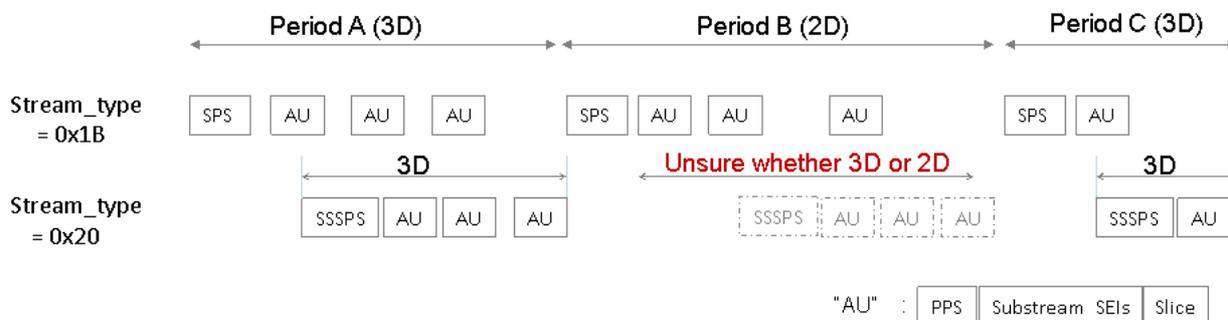


Figure 7: Example video format transition without transition assistance signalling

In order to prevent such fault scenarios occurring with SC-3DTV IRDs, the SC-3DTV service shall apply video layer signalling, i.e. the *multiview_view_position_SEI* message, as specified in clause 5.13.1.8 of [3] in every coded picture of the MVC Stereo Base Layer during carriage of MVC Stereo High Profile video content. Thus when the service switches to non-3DTV HDTV mode by ceasing carriage of the Dependent Layer video stream, the SC-3DTV IRD is able to determine the switch immediately when the first frame of non-SC-3DTV format video is received, and react accordingly to avoid errors in the MVC Stereo High Profile decoding process. This scenario is depicted in figure 8.

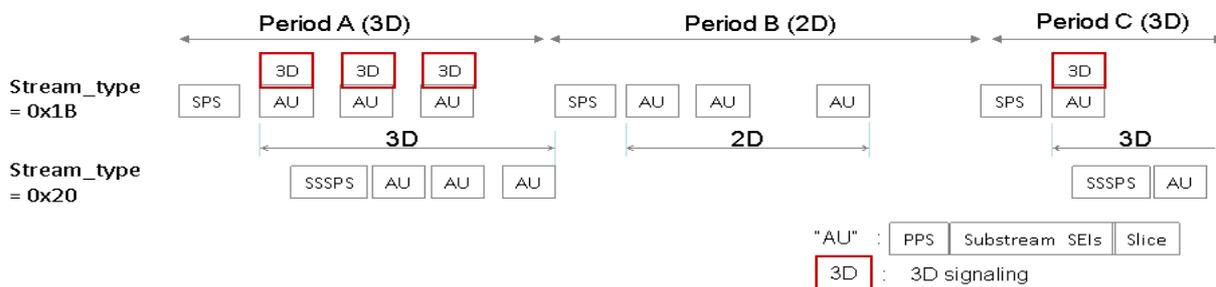


Figure 8: Example video format transition with transition assistance signalling

Annex A (informative): Bibliography

ETSI TS 101 211 (V1.10.1): "Digital Video Broadcasting (DVB); Guidelines on implementation and usage of Service Information (SI)".

History

Document history		
V1.1.1	November 2012	Publication