ETSI TS 101 547-1 V1.1.1 (2012-11)

Technical Specification

Digital Video Broadcasting (DVB);
Plano-stereoscopic 3DTV;
Part 1: Overview of the multipart

Reference
DTS/JTC-DVB-321-1

Keywords
3DTV, DVB

ETSI

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

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

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or
perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF).
In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive
within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status.
Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Copyright Notification

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://ipr.etsi.org).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

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.

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

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 1 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

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 provides an overview of the "phases" of DVB 3DTV specifications, which constitute the further parts of this multi-part deliverable.

TS 101 547-2 [i.1] specifies the delivery system for frame compatible plano-stereoscopic 3DTV 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. 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. The abbreviated name for Part 2 is FC-3DTV.

TS 101 547-3 [i.2] 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. The abbreviated name for Part 3 is SC-3DTV.

1 Scope

The present document provides an overview of the methods to encode and deliver DVB plano-stereoscopic 3DTV services and their decoding by a digital receiver. Each part includes the selection of corresponding plano-stereoscopic 3DTV formats, the definition of plano-stereoscopic 3DTV service signalling information, and the handling of graphics and captions overlays in the receiver during the reception of the respective plano-stereoscopic 3DTV service. Some elements are contained in amendments and extensions to the appropriate existing DVB specifications.

The production and contribution of plano-stereoscopic 3DTV content prior to delivery, as well as the method of rendering the 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

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.

2.1 Normative references

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

[1]   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".

[2]   DVB BlueBook A038 (09/12): "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

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

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

[i.3]   ITU-T Recommendation H.264: "Advanced video coding for generic audiovisual services".

[i.4]   ITU-T Recommendation H.222.0: "Information technology - Generic coding of moving pictures and associated audio information: Systems".

3 Definitions and abbreviations

3.1 Definitions

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

3DTV: DVB plano-stereoscopic three-dimensional television

3DTV cognisant IRD: IRD that is able to identify plano-stereoscopic 3DTV services via the corresponding Service Information (DVB-SI), and the plano-stereoscopic 3DTV video format, but that is not necessarily able to render plano-stereoscopic 3DTV video content correctly

3DTV compliant IRD: IRD that is both 3DTV cognisant and that is able to render plano-stereoscopic 3DTV video content correctly, being either a **25 Hz plano-stereoscopic 3DTV IRD** or a **30 Hz plano-stereoscopic 3DTV IRD** as defined in TS 101 154 [1]

3DTV incognisant IRD: IRD that is not able to identify plano-stereoscopic 3DTV services via the corresponding Service Information (DVB-SI), nor the plano-stereoscopic 3DTV video format

captions: text and visual elements intended to be overlaid on the picture as an optional feature, e.g. subtitles for foreign language source material, or for viewers with impaired hearing

disparity: difference between the horizontal positions of a pixel representing the same point in space in the right and left views

> NOTE: Positive disparity (horizontal right coordinate greater than horizontal left coordinate) implies a position behind the plane of display, and negative disparity implies a position in front of the display.

Frame Compatible (FC): arrangement of the Left and Right images in a spatial multiplex which results in an image which can be treated like a normal HDTV image by the receiver demodulator and compression decoder

natural binocular viewing: process of viewing with two eyes, as is done by most people

pixel arrangements: arrangement of horizontal and vertical image samples

> NOTE: This has an impact on vertical, horizontal, or diagonal resolution.

plano-stereoscopic: three-dimensional picture that uses two single pictures, Left and Right, displayed on a single plane surface (the TV screen in the case of 3DTV)

polarisation planes: optical filter system used to direct the left and right eye images to the appropriate eye

Service Compatible (SC): arrangement of the Left and Right images such that an existing HDTV receiver is able to extract a 2D version of the video content from a plano-stereoscopic 3DTV service

service guide: usually information on programme choice displayed on the screen, and often derived from now and next information broadcast in the multiplex

simulcast: parallel broadcasting of the same programme, often in different forms or formats

titles: usually all forms of text and graphics that appear on top of a TV scene or another background, intended to be visible for all TV viewers

3.2 Abbreviations

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

3DTV	Three Dimensional Television
AVC	Advanced Video Coding
CI	Common Interface
DSS	Disparity Signalling Segment
DVB	Digital Video Broadcasting

EIT   Event Information Table
EPG   Electronic Programme Guide
FC   Frame Compatible
HD   High Definition
HDMI   High-Definition Multimedia Interface
HDTV   High Definition Television
IDR   Instantaneous Decoding Refresh
IRD   Integrated Receiver Decoder

NOTE: As defined in ITU-T Recommendation H.264 [i.3].

MPEG-2   Motion Picture Experts Group version 2
NVOD   Near Video On Demand
PES   Packetised Elementary Stream
PMT   Programme Map Table

NOTE: As defined in ITU-T Recommendation H.222.0 [i.4].

PSI   Programme Specific Information

NOTE: As defined in ITU-T Recommendation H.222.0 [i.4].

RAP   Random Access Point
SC   Service Compatible
SD   Standard Definition (Video)
SDT   Service Description Table
SDTV   Standard Definition TV
SEI   Supplemental Enhancement Information

NOTE: As defined in ITU-T Recommendation H.264 [i.3].

SI   Service Information
STB   Set Top Box
STC   System Time Clock
TV   Television

4   Plano-stereoscopic 3DTV services in DVB delivery systems

Figure 1 depicts the scope of this multi-part deliverable, highlighted by the grey area, and the general concepts of the compatibility of DVB plano-stereoscopic 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 frame compatible plano-stereoscopic 3DTV (FC-3DTV) service and a HDTV service compatible plano-stereoscopic 3DTV (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 and/or FC-3DTV compliant (as defined in this multi-part deliverable), and some of which are HDTV capable, i.e. not 3DTV compliant.

Each 3DTV format-specific part of this multi-part deliverable defines signalling for the respective format of plano-stereoscopic 3DTV services.

The delivery system for plano-stereoscopic 3DTV services defined in this multi-part deliverable is intended to be applicable for any broadcast or delivery channel that uses the DVB MPEG-2 Transport Stream to carry DVB services, hence no delivery-system specific features are defined.

The features of HDTV services and IRDs are not impacted by the present document. They are depicted in the scope diagram due to the fact that plano-stereoscopic 3DTV service delivery may share 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 3DTV service configuration and their co-existence with HDTV services within the delivery system.
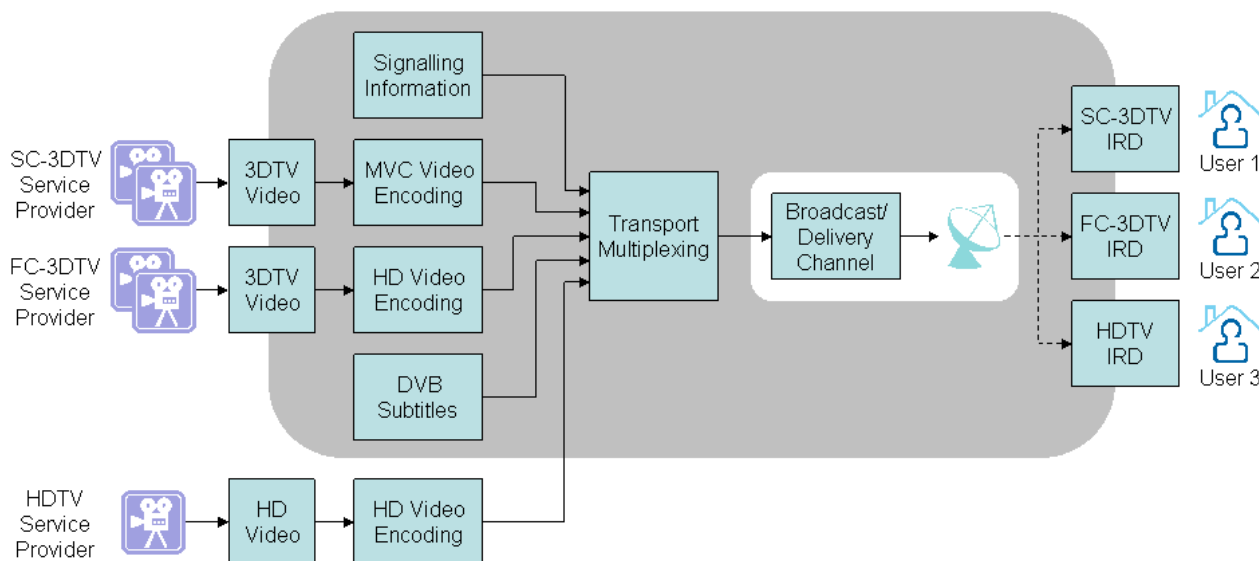
Figure 1: Scope of the DVB plano-stereoscopic 3DTV specification

Each of the variants of DVB plano-stereoscopic 3DTV delivery systems is specified in the further parts of the present document. Each part contains an informative description of various aspects of the respective 3DTV system and some normative specification for compliant services and IRDs. Each variant refers normatively to revised versions of other DVB specifications that have been created to provide relevant 3DTV-specific features.

Clause 5 of the present document contains the normative specification of features that are common to all variants of DVB plano-stereoscopic 3DTV systems.

4.1 3DTV Services

For the purpose of discussing the various service configuration and co-existence scenarios, various generic forms of 3DTV service are defined informatively:

- The "24/7" 3DTV service, i.e. a 3DTV service that operates permanently in 3DTV mode.

- The "time-exclusive" 3DTV service, i.e. a 3DTV service that operates for only a certain fixed time (e.g. daily, weekly), and whose network resources are relinquished for use by another service at other times.

- The "predominant" 3DTV service, i.e. a service that contains predominantly 3DTV format content, but occasionally switches to HDTV mode.

- The "composite" 3DTV service, i.e. a service that has an arbitrary mix of HDTV and 3DTV format content.

- The "occasional" 3DTV service, i.e. a service that contains predominantly HDTV content, but occasionally switches to 3DTV mode.

Figure 2 depicts a hypothetical timeline of various types of DVB service, including the above generic 3DTV service types, for the purposes of introducing the aspects specified in this multi-part deliverable, the issues around the co-existence of plano-stereoscopic 3DTV services with HDTV services, and the possible event linkage between 3DTV services, and HDTV and SDTV services.
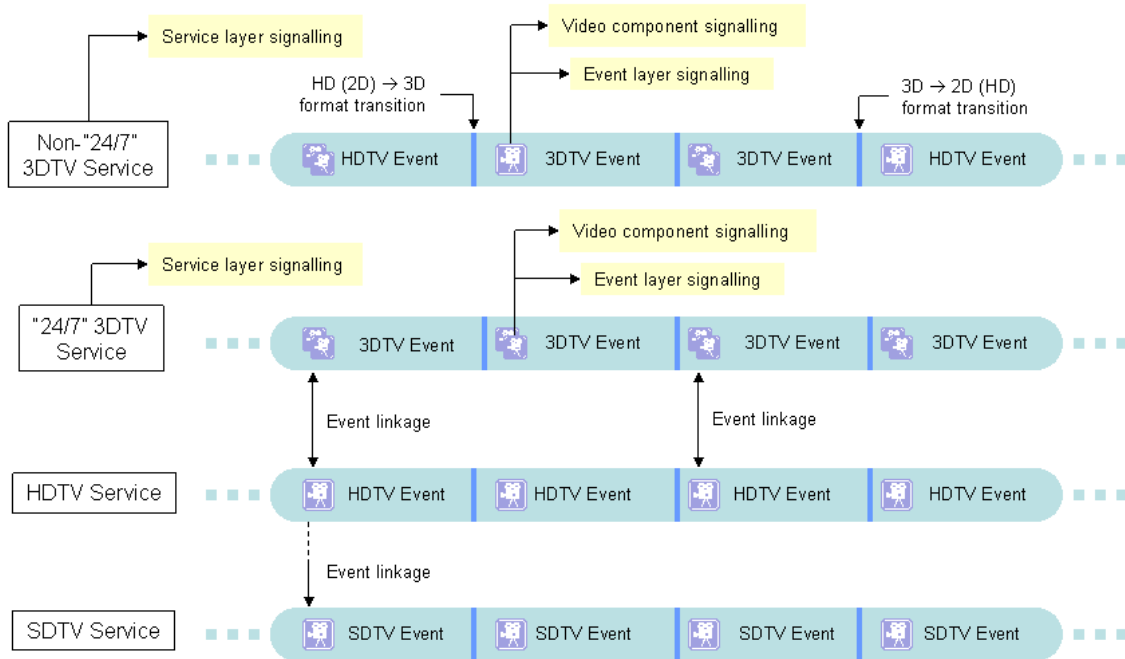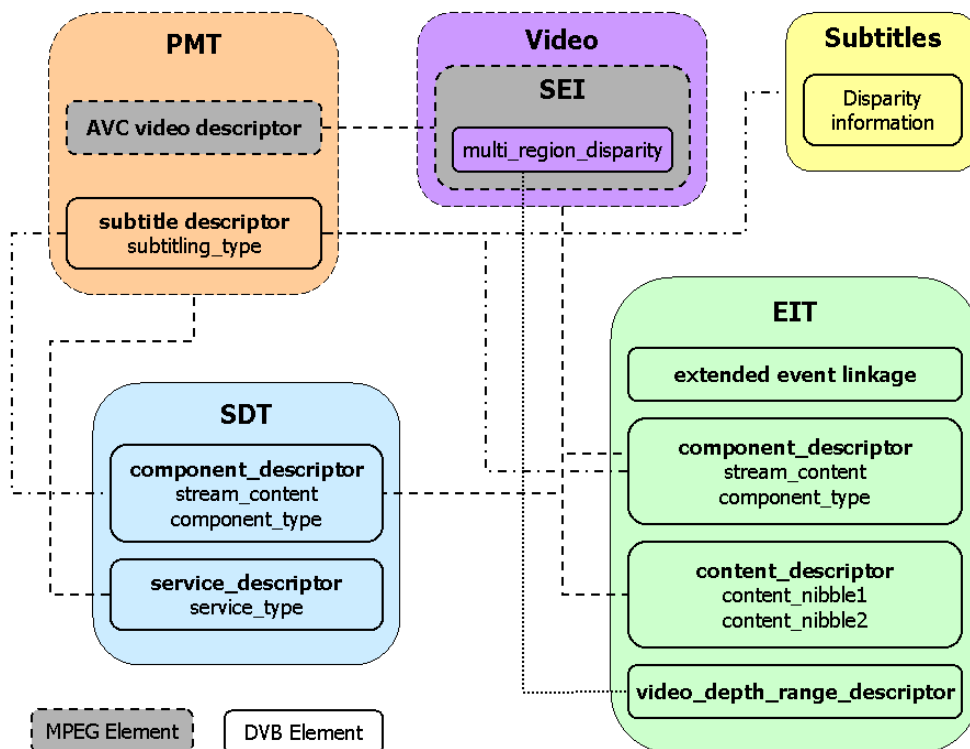
Figure 2: DVB plano-stereoscopic 3DTV service scenarios

A 3DTV event is defined as a DVB service event that contains a plano-stereoscopic 3DTV format video stream, as further specified in the respective 3DTV system-specific part of this multi-part deliverable.

Video formats for each of the specific 3DTV systems are specified in the respective part of this multi-part deliverable.

Figure 3 depicts the generic structure of, and the logical links within the set of signalling tools defined for DVB plano-stereoscopic 3DTV services, to cater for all of the types of 3DTV service described above. The specific signalling tools within each 3DTV system vary within this generic set and are specified in the respective part of this multi-part deliverable.

Figure 3: DVB plano-stereoscopic 3DTV service signalling

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 plano-stereoscopic 3DTV video format to a HDTV video format, or vice versa) should be signalled as specified in the respective 3DTV format-specific part of this multi-part deliverable, in order to ensure consistent and reliable behaviour in the 3DTV IRD. Switches between FC-3DTV and SC-3DTV formats are not considered in the present document, but they are not forbidden. If such transitions are implemented, the service provider should endeavour to avoid inconsistent signalling being transmitted around the transition. This might present a challenge, considering the lack of tight synchronisation between signalling in the video and transport stream layers.

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.

TS 101 547-2 [i.1] specifies the features required for the delivery of DVB frame compatible plano-stereoscopic 3DTV (FC-3DTV) services and their decoding by the FC-3DTV IRD.

The first edition of the present document (TS 101 547 V1.1.1) consisted of the original single-part specification for DVB frame compatible plano-stereoscopic 3DTV, which is now TS 101 547-2 [i.1]. The only technical change to TS 101 547-2 [i.1] compared to the previous version is the addition of the 1 920 x 1 080p @ 25 Hz video format. Apart from that only editorial changes have been made.

TS 101 547-3 [i.2] specifies the features required for the delivery of DVB HDTV service compatible plano-stereoscopic 3DTV (SC-3DTV) services and their decoding by the SC-3DTV IRD.

4.2 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 plano-stereoscopic 3DTV services, and the co-existence of plano-stereoscopic 3DTV compliant IRDs with existing HDTV (i.e. non-3DTV) equipment. Figure 4 depicts the generic set of IRD scenarios.

The FC-3DTV and SC-3DTV systems have differing requirements and capabilities as regards compatibility and co-existence with HDTV IRDs, hence TS 101 547-2 [i.1] and TS 101 547-3 [i.2] deal with the IRD scenarios in detail as regards the way they apply to the respective 3DTV system.
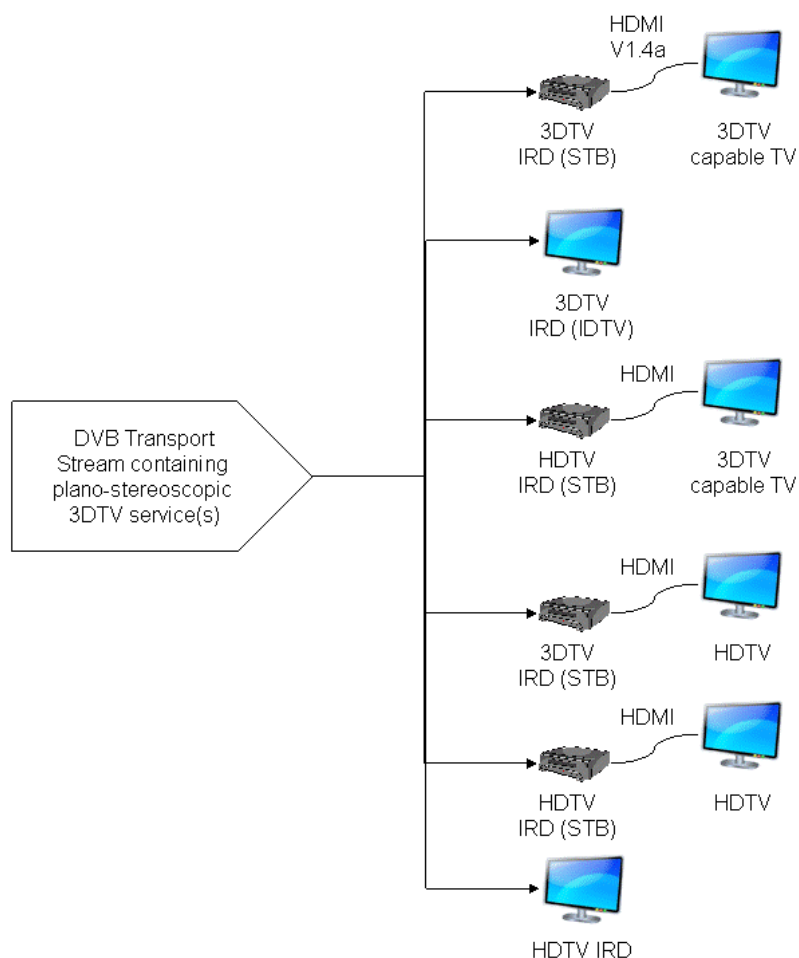
Figure 4: Generic DVB plano-stereoscopic 3DTV IRD scenarios

5   Graphics and captions display with DVB plano-stereoscopic 3DTV systems

Special consideration needs to be given to the display of graphics and captions (including subtitles) over 3DTV video, in that they need to be positioned harmoniously within the three-dimensional scene, i.e. at a certain depth, in order not to impact detrimentally the 3DTV viewing experience. This clause provides some background which might help better understand the applicable methods for graphics rendering over 3DTV video content.

Graphics display is addressed in clause 5.1. This aspect gives rise to two methods to provide disparity information to accompany 3DTV content.

Clause 5.2 describes an extension to the DVB subtitling specification [3] that enables disparity information to be carried for subtitle streams that may be decoded and rendered in conjunction with 3DTV content.

5.1   Graphics display

During normal operation, a receiver may have to display some kind of graphics (both broadcaster- and IRD-generated graphics, e.g. display message or other content) to the viewer in response to an event caused by either the viewer, a device sub-system (such as the CI sub-system), or from the broadcast channel. The graphic may occupy the entire screen or just a part of it. During a non-3DTV transmission, displaying a graphic is just a question of video overlay and does not have any further consequence. During a 3DTV transmission, however, displaying that same graphic with the wrong depth can cause it to be unreadable. For example, if the graphic is placed at a certain screen depth and there is a solid object in the video that is closer to the viewer, then that graphic will appear to have "punched a hole", i.e. causing inconsistent depth cues in the video. "Hole punching" can be avoided by knowing how close the objects come to the viewer, and then placing the graphics even closer. The results of this mechanism depend on the temporal granularity of the depth information available for the video objects. In any case, graphics should not be positioned too close to the viewer as this causes visual discomfort, since there is a comfort zone of depth within which graphics can be placed.

If no video object depth information is available, a possible way to keep the graphics overlays within the viewer's comfort zone is to switch the video to 2D mode and to place the overlays at screen depth or in front of the screen.

Another possibility is to "push back" the video, for which another parameter is required, namely how far behind the screen an object may be, or even better, where is infinity. Assuming a reference screen size and a viewing distance, the comfort zone extends from somewhere in front of the screen to somewhere behind the screen. For the majority of the time, all 3DTV objects should remain within this zone. The zone limits may be exceeded for short periods of time for specific editorial needs, such as short term visual impact. The extent of this zone behind this screen is not determined by a perceived distance, which may be infinity, but by the extent to which any viewer can be expected to fuse the image.

If all of the 3DTV content is well within the comfort zone for most of the time, then it may be possible to re-render the 3DTV content further backwards, away from the viewer. In doing so it may become possible now to place a graphics overlay closer to the viewer, while remaining within the comfort zone.

How far objects are in front or behind the screen can be expressed in terms of disparity. There are two methods defined in the present document to convey disparity information to the 3DTV IRD for the rendering of graphics:

- the video depth range SI descriptor, and

- the multi-region disparity video layer signalling.

Both methods are applicable to both the FC-3DTV and the SC-3DTV systems and both may be applied together with either type of 3DTV service. Support of either method is optional for the 3DTV IRD.

The *video_depth_range_descriptor*, described in clause 5.1.1, provides disparity information at either the service and/or event levels and the disparity information provided is static for the corresponding service or for the duration of the corresponding event.

The multi-region disparity video layer signalling, described in clause 5.1.2, provides more dynamic disparity information, namely with every frame of 3DTV video, and for different spatial regions of each frame.

5.1.1   Video depth range descriptor

The *video_depth_range_descriptor*, specified in clause 6.4.12 of [2], is designed to accommodate a choice of methods to convey depth or disparity information for 3DTV content. This information may be used by the 3DTV IRD for the depth positioning of any of its own graphics overlays on top of the 3DTV content currently being displayed.

In the current version of [2] only one method is specified, namely the production disparity hint information, consisting of minimum and maximum disparity values occurring with the associated 3DTV video content event or service.

In the production disparity hint, disparity is measured as a number of pixels on a reference screen with a horizontal resolution of 11 520 pixels.

Table 1 shows how the disparity on the reference screen is converted to the disparity on actual screens corresponding to the horizontal resolutions of the plano-stereoscopic 3DTV video formats.

Table 1: Conversion of disparity on reference screen

(DISPARITY / 11 520) x	Horizontal screen resolution	=	Pixel disparity
	1 280		DISPARITY / 9
	1 440		DISPARITY / 8
	1 920		DISPARITY / 6

Knowledge of both the minimum and maximum disparity may be used for purposes other than the display of graphics. This information may also be used by the receiver to improve the 3DTV viewing experience by shifting the 3DTV image to a position that is optimal for the screen and the viewer.

The usage of the video depth range descriptor with DVB plano-stereoscopic 3DTV services is optional, and its support in the DVB plano-stereoscopic 3DTV IRD is optional.

This descriptor may be present in the SDT or EIT. If present in the SDT, then it identifies the video depth range type for the service. If present in the EIT, then it overrides the same video depth range type that may be present in the SDT of that service.

The video depth range descriptor should not be included in the service signalling if the minimum and maximum disparity values are either unknown or unreliable. If a receiver uses incorrect values, the results can be uncomfortable for the viewer.

5.1.2 Multi-region disparity video layer signalling

The multi-region disparity video layer signalling consists of disparity data sent with each frame of 3DTV video, whereby overall maximum disparity value for the video frame are provided, as well as minimum disparity values for up to sixteen screen regions, whereby the region partitioning scheme is selected as one of a set of pre-defined raster patterns.

The multi-region disparity video layer signalling is specified normatively in clause B.11 of [1].

5.2 Subtitles display

As with SDTV and HDTV, subtitling remains an important component of a 3DTV service. Along with graphics, it is of crucial importance that subtitles are positioned accurately over 3DTV video content, in terms of both depth and of their timing, such that the 3DTV viewing experience is supported rather than degraded.

The specification for DVB subtitling systems [3] has been revised to take into account plano-stereoscopic 3DTV services, by including the means of signalling the disparity with which each provided subtitle caption is intended to be positioned by the 3DTV IRD.

A new segment, the Disparity Signalling Segment (DSS), is specified in clause 7.2.7 of [3]. This includes the definition of subregions within a region. Different disparity values can be transmitted for each subregion, enabling the placement of subtitles at varying depths within the region, and within the page. Disparity can be carried with sub-pixel accuracy, which enables optimal placing within the 3DTV scene. A default page disparity value is also carried in the DSS, used by decoders that are unable to apply different disparities to different regions on the screen page.

Temporal updates of disparity values for each defined sub-region can be carried with a temporal accuracy of periods of the 90 kHz System Time Clock (STC). They can be carried in the subtitle PES packet stream as usual, or more efficiently grouped together using the disparity update sequence mechanism, as illustrated in annex C of [3].

History

Document history		
V1.1.1	November 2012	Publication