ATSC Standard: 3D-TV Terrestrial Broadcasting, Part 2 – Service Compatible Hybrid Coding Using Real-Time Delivery

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Advanced Television Systems Committee
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Revision History

Version	Date
Initial version of this standard approved	26 December 2012
Minor editorial items corrected	5 August 2014

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ATSC Standard: 3D-TV Terrestrial Broadcasting, Part 2– SCHC Using Real-Time Delivery

1. SCOPE

This document provides detailed specification of the parameters of the Service Compatible Hybrid-Coded 3D (SCHC) system, which is one particular case of the Service Compatible 3D-TV system using Real-time Delivery (SCRT). This standard includes the video encoder input scanning formats and the service multiplex, and transport layer characteristics and normative specifications.

1.1 Documentation Structure

This document provides a general overview, technical description of SCHC system and a list of reference documents.

1.2 Introduction and Background

The 3D-TV broadcasting service using SCHC consists of Stereoscopic 3D video, audio, and ancillary data. The Stereoscopic 3D video has left view and right view, where one of the two views can be used as 2D image for the legacy 2D-TV. The Stereoscopic 3D video is transmitted as two independent video elementary streams, where one of them is compatible with the legacy 2D TV service. Ancillary data includes program/channel signaling data and caption information. Signaling data is transmitted via multiplexing, while caption information is transmitted along with the video bit stream. Figure 1.1 illustrates the SCHC Broadcasting System.

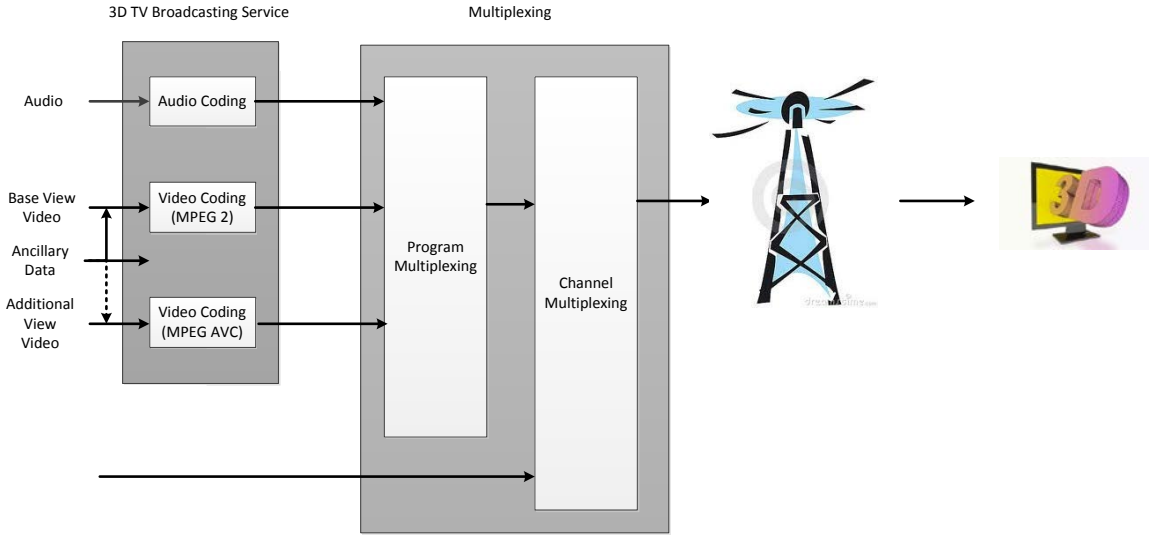

Figure 1.1 Service Compatible Hybrid Coded 3D-TV Broadcasting System.

1.3 Organization

This document is organized as follows:

- Section 1 – Scope of this document and a general introduction.
- Section 2 – List of references and applicable documents.

- Section 3 – Definition of terms, acronyms, and abbreviations for this document.
- Section 4 – Description of Service Compatible Hybrid Coded 3D-TV.)

2. REFERENCES

All referenced documents are subject to revision. Users of this Standard are cautioned that newer editions might or might not be compatible.

2.1 Normative References

The following documents, in whole or in part, as referenced in this document, contain specific provisions that are to be followed strictly in order to implement a provision of this Standard.

[1] IEEE/ASTM: "Use of the International Systems of Units (SI): The Modern Metric System," Doc. SI 10-2002, Institute of Electrical and Electronics Engineers, New York, N.Y.

[2] ATSC: "ATSC Digital Television Standard, Part 3 – Service Multiplex and Transport Subsystem Characteristics," Doc. A/53, Part 3:2019, Advanced Television Systems Committee, Washington, D.C., 7 August 2009.

[3] ATSC: "ATSC Digital Television Standard, Part 4 – MPEG-2 Video System Characteristics," Doc. A/53, Part 4:2019, Advanced Television Systems Committee, Washington, D.C., 7 August 2009.

[4] ATSC: "Use of AVC in the ATSC Digital Television System, Part 1 – Video System Characteristics," Doc. A/72, Part 1, Advanced Television Systems Committee, Washington, D.C., 29 July 2008.

[5] ATSC: "Program and System Information Protocol for Terrestrial Broadcast and Cable," Doc. A/65:2009, Advanced Television Systems Committee, Washington, D.C., 3 August 2009.

[6] ATSC: "ATSC Parameterized Services Standard," Doc. A/71:2012, Advanced Television Systems Committee, Washington, D.C., 3 December 2012.

[7] ITU: "Information technology – Generic coding of moving pictures and associated audio information: Video," ITU-T Recommendation H.262 | ISO/IEC 13818-2:2000, International Telecommunications Union, Geneva.

[8] ITU: "Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding," ITU-T Recommendation H.264 | ISO/IEC 14496-10:2010, International Telecommunications Union, Geneva.

[9] ITU: "Information technology -- Generic coding of moving pictures and associated audio information: Systems," ITU-T Recommendation H.222.0:2012 | ISO/IEC 13818-1:2012, International Telecommunications Union, Geneva.

[10] CEA: "Digital Television Closed Captioning: 3D Extensions," Doc. CEA-708.1, Consumer Electronics Association, Arlington, VA, 2012.

[11] ATSC: "Use of AVC in the ATSC Digital Television System, Part 2 – Transport Subsystem Characteristics," Doc. A/72, Part 2, Advanced Television Systems Committee, Washington, D.C., 29 July 2008.

2.2 Informative References

The following documents contain information that may be helpful in applying this Standard.

[12] TTA: "Transmission and Reception for Terrestrial 3DTV Broadcasting, Part 1 – Existing Channel," Doc. TTAK.KO-07.0100-cor1, Telecommunications Technology Association, Korea, 21 December 2011.

3. DEFINITION OF TERMS

With respect to definition of terms, abbreviations, and units, the practice of the Institute of Electrical and Electronics Engineers (IEEE) as outlined in the Institute's published standards [1] shall be used. Where an abbreviation is not covered by IEEE practice or industry practice differs from IEEE practice, the abbreviation in question will be described in Section 3.3 of this document.

3.1 Compliance Notation

This section defines compliance terms for use by this document:

shall – This word indicates specific provisions that are to be followed strictly (no deviation is permitted).

shall not – This phrase indicates specific provisions that are absolutely prohibited.

should – This word indicates that a certain course of action is preferred but not necessarily required.

should not – This phrase means a certain possibility or course of action is undesirable but not prohibited.

3.2 Treatment of Syntactic Elements

This document contains symbolic references to syntactic elements used in the audio, video, and transport coding subsystems. These references are typographically distinguished by the use of a different font (e.g., restricted), may contain the underscore character (e.g., sequence_end_code) and may consist of character strings that are not English words (e.g., dynrng).

3.2.1 Reserved Elements

One or more reserved bits, symbols, fields, or ranges of values (i.e., elements) may be present in this document. These are used primarily to enable adding new values to a syntactical structure without altering its syntax or causing a problem with backwards compatibility, but they also can be used for other reasons.

The ATSC default value for reserved bits is '1.' There is no default value for other reserved elements. Use of reserved elements except as defined in ATSC Standards or by an industry standards setting body is not permitted. See individual element semantics for mandatory settings and any additional use constraints. As currently-reserved elements may be assigned values and meanings in future versions of this Standard, receiving devices built to this version are expected to ignore all values appearing in currently-reserved elements to avoid possible future failure to function as intended.

3.3 Acronyms and Abbreviation

The following acronyms and abbreviations are used within this document.

ATSC Advanced Television Systems Committee

SCHC Service Compatible Hybrid Coded 3D-TV

SCRT Service Compatible 3D-TV using Real-time Delivery

3.4 Terms

The following terms are used within this document.

Additional view video – Stereoscopic 3D video component added to the Base view video to compose stereoscopic 3D video.

Base view video – Stereoscopic 3D video component which is used for legacy 2D-TV service.

Hybrid-coded 3D – 3D-TV broadcasting service using two different video codecs, where one image is transmitted via MPEG-2 video stream per A/53 Part 4 [3], and the second image is transmitted via another video codec.

left view – Video provided for the left eye.

reserved – Set aside for future use by a Standard.

right view – Video provided for the right eye.

Service compatible – 3D-TV broadcasting service composed of two or more compressed video images, where at least one of them is the legacy 2D-TV image having the same resolution as the production resolution.

Stereoscopic 3D video – Video composed of a left view and a right view.

4. SERVICE COMPATIBLE HYBRID CODED 3D-TV

4.1 Overall Description of Service Compatible Hybrid Coded 3D-TV

Elements of Service Compatible Hybrid Coded 3D-TV (SCHC) include Stereoscopic 3D video, audio signals, and ancillary data. Stereoscopic 3D video basically consists of a left view and a right view. In SCHC, left and right views are independently transmitted as separate video elementary streams, one of which is a base view video and the other of which is an additional video. Ancillary data can be caption information, program/channel signaling data, etc. Caption information is transmitted along with the video signal of a bit stream, while signaling data is transmitted via multiplexing. An overview of the system is illustrated in Figure 4.1.

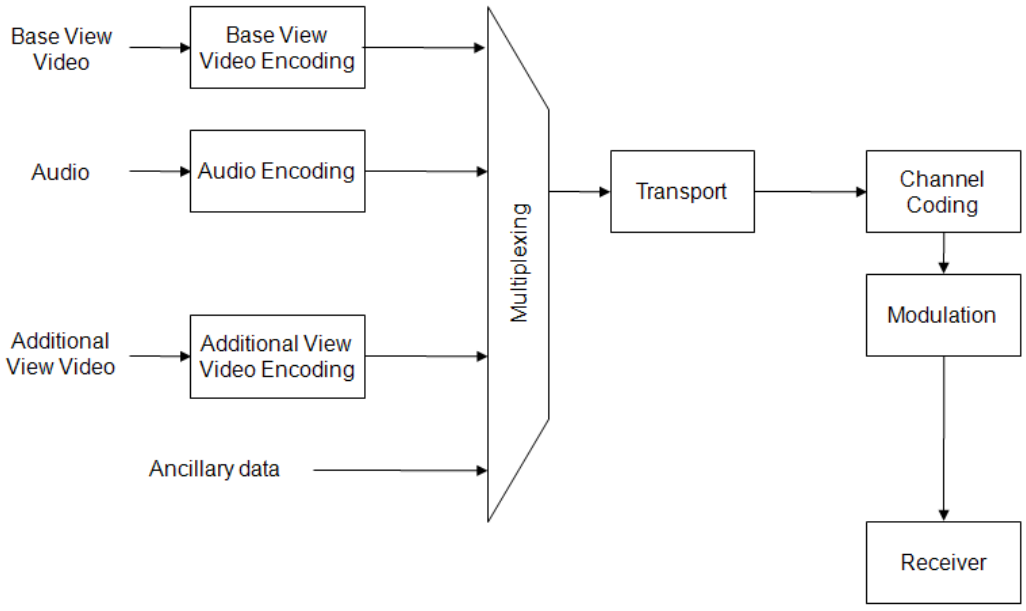

Figure 4.1. Overview of the SCHC system.

4.2 Encoding and Decoding for SCHC

The compression format of the base view video shall conform to MPEG-2 video Main Profile @ High Level [7] while the compression format of the additional view video shall conform to AVC/H.264 Main Profile @ Level 4.0 or High Profile @ Level 4.0 [8].

With the exception of video compression formats, additional constraints for video compression of base and additional view video shall conform to ATSC A/53 Part 4 and ATSC A/72 Part 1 respectively.

4.3 Video Format for SCHC

The compression format for the base view and additional view of SCHC service shall be one of the formats listed in Table 4.1. The compression format of the both views shall be identical.

Table 4.1 Video Compression Formats

Vertical Size	Horizontal Size	Display Aspect Ratio / Sample Aspect Ratio	Frame Rate	Progressive/ Interlaced
1080	1920	16:9 / square sample	23.976, 24, 29.97, 30	P
1080	1920	16:9 / square sample	29.97, 30	I
720	1280	16:9 / square sample	23.976, 24, 29.97, 30, 59.94, 60	P

In order to facilitate fast channel change or quick random access, the coded GOP structure for base view and additional view video stream should be the same. In other words, when the base view video is an I frame of MPEG-2 video, the corresponding additional view video should be an AVC RAP (random access point).

4.4 Closed Captioning for SCHC.

Closed captioning data is transported in the Base video in compliance with ATSC A/53 Part 4 [3]. Closed captioning commands to support z-axis placement of caption windows (e.g. disparity data) shall be formatted in accordance with CEA-708.1 [10] and carried in the cc_data() specified in Section 6.2.3.1 of A/53 Part 4 [3].

4.5 Multiplexing for SCHC

Multiplex and Transport of the video and audio elements in SCHC shall comply with ATSC A/53 Part 3 [2].

4.6 Signaling for SCHC

4.6.1 PSI

4.6.1.1 stream_type

The base view of SCHC service shall be signaled using stream_type value 0x02 and the additional view of SCHC service shall be signaled using stream_type value 0x23 as defined in [9].

4.6.1.2 Program and Program Element Descriptors

The Stereoscopic_program_info_descriptor() and Stereoscopic_video_info_descriptor() as specified in [9] shall be used in signaling of SCHC program.

4.6.1.2.1 Stereoscopic_program_info_descriptor

Stereoscopic_program_info_descriptor() as specified in [9] shall be present in the loop following program_info_length field in the PMT to signal the existence of an SCHC program. For SCHC service, the stereoscopic_service_type shall be set to '011'.

The stereoscopic_service_type can be set to '001' to indicate that the base view and the additional view video elementary streams of the SCHC program are carrying the same video.

4.6.1.2.2 Stereoscopic_video_info_descriptor

Stereoscopic_video_info_descriptor() as specified in [9] shall be present in the loop following ES_info_length field in the PMT to identify the view component of an SCHC program; i.e., the base view video stream and the additional view video stream.

The values of horizontal_upsampling_factor and vertical_upsampling_factor shall be used to signal the up-sampling factor of the additional view video.

4.6.2 PSIP

4.6.2.1 Virtual Channel Signaling

A virtual channel that carries an SCHC service shall be identified by service_type equal to 0x09 (Extended Parameterized Service) in the TVCT. In addition, the following descriptors shall be present in the descriptor loop following the descriptors_length field of the terrestrial_virtual_channel_table_section() or cable_virtual_channel_table_section():

1) Component List Descriptor (A/71 [6]) as specified in Section 4.6.2.2 below; and
2) Parameterized Service Descriptor (PSD) (A/71 [6]) with contents as specified in Section 4.6.2.3 below.

This placement is shown as an example in Table 4.2.

Table 4.2 Example TVCT Composition

TVCT
…
for (i<num_channels_in_section) {
…
major_channel_number = 0x003
minor_channel_number = 0x002
…
program_number = 0x0002
…
service_type = 0x09 (extended parameterized service)
…
component_list_descriptor()
parameterized_service_descriptor()
…
}

The component_list_descriptor() provides information about the codecs used to encode the SCHC service. The parameterized_service_descriptor() with application_tag = 0x01 provides information about the type of 3D service carried.

This information can facilitate the behaviours of the 3D-TV receivers to display the Stereoscopic 3D video.

4.6.2.2 Component_list_descriptor

The Component List Descriptor (CLD) as specified in A/71 [6] shall be present in the descriptor loop of the TVCT (or CVCT when present). The CLD describes video components of an SCHC service. For an SCHC program, the component_list_descriptor() shall include a stream_info_details() entry for the video stream comprising the base view if necessary as described in Section 4.5.2.2.1 and a stream_info_details() entry for the video stream comprising the additional view.

4.6.2.2.1 Base View Component Signaling[1]

When the base view video is encoded using MPEG-2 video constrained by A/53 Part 4, the Component List Descriptor shall not include stream_info_details() for stream_type = 0x02, since the MPEG-2 video is signaled in the Service Location Descriptor as defined in A/65[5].

> Note that when the base view video is encoded using MPEG-2 video not constrained by A/53 Part 4, stream_info_details() for stream_type = 0x02 may be defined in the future version.

4.6.2.2.2 Additional View Signaling

For an SCHC service in which the additional view video is encoded using AVC, the component_list_descriptor() shall include stream_info_details() for stream_type 0x23. The syntax and semantics of the stream_info_details() for stream_type 0x23 shall be as given in Table 4.3 and the semantic descriptions that follow it.

Table 4.3 Stream Info Details Syntax for stream_type 0x23

Syntax	No. of Bits	Format
stream_info_details() {		
additional_view_AVC_profile	2	uimsbf
additional_view_level_idc	6	uimsbf
horizontal_upsampling_factor	4	uimsbf
vertical_upsampling_factor	4	uimsbf
}		

additional_view_AVC_profile – This 2-bit unsigned integer field shall indicate the AVC profile used for the additional view. The semantics of this 2-bit field shall be the same as the AVC_profile field in the stream_info_details() for AVC video specified in Section 6.3 of A/72 Part 2 [11].

additional_view_level_idc – This 6-bit unsigned integer field shall indicate the AVC level used for the additional view. The semantics of this 6-bit field shall be the same as the field level_idc in the stream_info_details() for AVC video specified in Section 6.3 of A/72 Part 2 [11].

The value of the profile/level shall represent the most complex value of the programs announced by the EITs for this virtual channel.

horizontal_upsampling_factor and **vertical_upsampling_factor –** These fields provide higher-level information on any up-sampling that may facilitate optimization of the display of the decoded video component. When not set to '0001', the values and description of up-sampling

[1] For some specification using the base view encoded using AVC, the Component List Descriptor could include information for stream_type 0x1B, with the semantics of stream_info_details() as specified in Section 6.3 of A/72 Part 2 [11] using the corresponding value of profile or level defined in A/72 Part 1 [4].

factors shall match those that represent the value of the programs announced by the EITs for this virtual channel. The encoding of horizontal_upsampling_factor and vertical_upsampling_factor fields shall be the same as the encoding of these fields as they appear in the Stereoscopic_video_info_descriptor() in ISO/IEC 13818-1:2012 [9]. The coding is provided in Table A.1 for convenience.

4.6.2.3 Parameterized Service Descriptor

The parameterized_service_descriptor() as defined in A/71 [6] shall be used for the delivery of parameters specific to a particular application. For virtual channels containing 3D content, the value of application_tag shall be 0x01. The application_data() for application_tag value 0x01 shall be as shown in Table 4.4. As shown, additional bytes following the last defined field may be present.

Table 4.4 Bit Stream Syntax of Application Data for Application Tag 0x01

Syntax	No. of Bits	Format
application_data(0x01) {		
reserved	3	uimsbf
3D_channel_type	5	uimsbf
for (i=0; i<N; i++) {		
reserved	8	bslbf
}		
}		

3D_channel_type – This 5-bit unsigned integer field shall indicate the type of 3D service carried in the virtual channel associated with this Parameterized Services Descriptor. The coding for 3D_channel_type shall be as given in Table 4.5. Note that SCHC uses value 0x03.

Table 4.5 3D Channel Type Encoding

3D_channel_type	Description
0x00	Frame compatible stereoscopic 3D service – side-by-side
0x01	Frame compatible stereoscopic 3D service – top and bottom
0x02	Reserved
0x03	Full-frame stereoscopic 3D service – base and additional view streams; additional view in-band
0x04-0x1F	ATSC Reserved

4.6.2.4 EIT

The stereoscopic program info descriptor as specified in [9] shall be placed in the descriptor loop of the 3D event in the EIT in order to indicate the future event is in 3D. See the example in Table 4.6.

Table 4.6 EIT Signalling Example

EIT
...
for (j < num_events_in_section) {
event_id
start_time
…
length_in_seconds
…
stereoscopic_program_info_descriptor()
…
}

4.6.3 Signaling at 2D/3D Boundaries

4.6.3.1 Recommended PMT Signaling

For 3D/2D switching, the recommended practice is to maintain the SCHC service structure for both 2D and 3D service. The stereoscopic_program_info_descriptor() in the PMT provides the information about whether the service is 2D or 3D. For a 2D service, the base and the additional view video streams are identical, with the PMT containing information about both the base view and the additional view video streams.

Where the broadcasters desire not to send the additional view video stream during a 2D service, the following scheme is recommended.

In the case of a 3D-to-2D switch, the associated PMT signaling should precede the actual switching from the dual stream to the single stream structure. After the associated PMT signaling, the additional view video stream should exist for a few seconds, and carry the same view video as the base view video stream.

In the case of a 2D-to-3D switch, the associated PMT signaling should take place after the actual switching of the stream structure from single stream to dual stream. The additional view video stream should be available a few seconds before the associated PMT signaling. For these few seconds, the additional view video stream carries the same view video as the base view video stream.

4.6.3.2 Optional Video Stream Signaling

Frame_packing_arrangement_data in extensions_and_user_data(2) of MPEG-2 video may be used in addition to PMT signaling in order to provide frame-accurate signaling of the mode transition from 3D to 2D or 2D to 3D. If frame_packing_arrangement_data is used for frame-accurate signaling, frame_packing_arrangement_data with arrangement_type value ‘0001000’ (2D video) shall be included in the MPEG-2 video stream during the 2D portion of the service, and frame_packing_arrangement_data shall not be included in the MPEG-2 video stream during the 3D portion of the service.

Annex A: Horizontal and Vertical Up-Sampling Factors

A.1 HORIZONTAL AND VERTICAL UP-SAMPLING FACTORS

The encoding of horizontal_upsampling_factor and vertical_upsampling_factor in the Stereoscopic_video_info_descriptor() in ISO/IEC 13818-1:2012 [9] is shown below in Table A.1 for convenience.

Table A.1 Horizontal and Vertical Up-sampling Factors

Value	Description
'0000'	Forbidden
'0001'	unspecified
'0010'	Coded resolution is same as coded resolution of base view
'0011'	Coded resolution is ¾ coded resolution of base view
'0100'	Coded resolution is $^2/_3$ coded resolution of base view
0101'	Coded resolution is ½ coded resolution of base view
'0110'-'1000'	reserved
'1001'-'1111'	user private