ATSC Standard: 3DTV Terrestrial Broadcasting, Part 6 – Independent Coded 3D Using Real-Time Delivery

Doc. A/104 Part 6
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Advanced Television Systems Committee
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202-872-9160

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Specifically, ATSC is working to coordinate television standards among different communications media focusing on digital television, interactive systems, and broadband multimedia communications. ATSC is also developing digital television implementation strategies and presenting educational seminars on the ATSC standards.

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Revision History

Version	Date
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ATSC Standard: 3DTV Terrestrial Broadcasting, Part 6 – Independent Coded 3D Using Real-Time Delivery

1. SCOPE

This document provides detailed specification of the parameters of the Independent Coded 3D (IC3D) using real-time delivery This specification includes the video encoder input scanning formats, the service multiplex, transport layer characteristics, and normative specifications.

1.1 Documentation Structure

This document provides a general overview, technical description of IC3D system and a list of reference documents.

1.2 Introduction and Background

3D TV broadcasting service using IC3D specification consists of Stereoscopic 3D video, audio, and ancillary data. 3D contents is sometimes different from 2D contents even if shooting target is the same, because 3D contents production such as camera position, editing, post processing is optimized for 3D viewing in many cases. The Stereoscopic 3D video used for IC3D service provides full HD picture to each eye independent from 2D picture which may be transmitted via other virtual channel. Ancillary data includes program/channel signaling data and caption information, signaling data is transmitted via multiplexing while caption information is transmitted along with video signal of bit stream. Figure 1.1 illustrate IC3D broadcasting system.

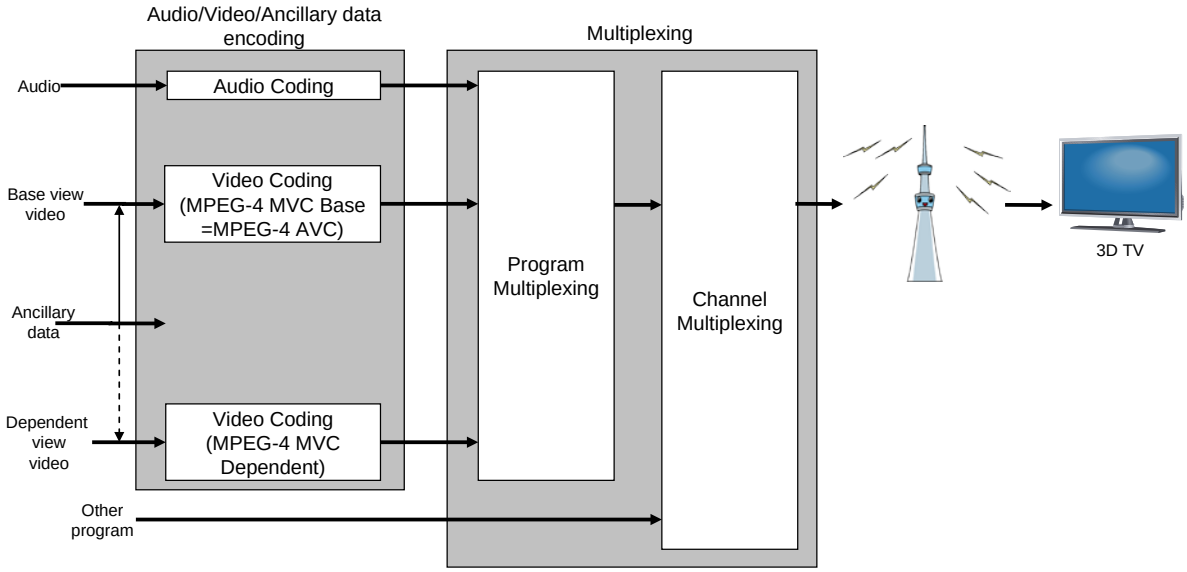

Figure 1.1 Independent Coded 3D Broadcasting System.

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 Independent 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 3D Digital Television Standard, Part 1 – System Definition," Doc. A/104, Part 1:2014, Advanced Television Systems Committee, Washington, D.C., 4 August 2014.

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

[4] ATSC: "ATSC Digital Television Standard, Part 4 – MPEG-2 Video System Characteristics," Doc. A/53 Part 4:2009, Advanced Television Systems Committee, Washington, D.C., 24 August 2009.

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

[6] ATSC: "Program and System Information Protocol for Terrestrial Broadcast and Cable," Doc. A/65:2013, Advanced Television Systems Committee, Washington, D.C., 7 August 2013.

[7] ATSC: "Use of AVC in the ATSC Digital Television System, Part 1 – Video System Characteristics," Doc. A/72 Part 1:2014, Advanced Television Systems Committee, Washington, D.C., 18 February 2014.

[8] ATSC: "Use of AVC in the ATSC Digital Television System, Part 2 – Transport Subsystem Characteristics," Doc. A/72 Part 2:2014, Advanced Television Systems Committee, Washington, D.C., 18 February 2014.

[9] ATSC: "Video and Transport Subsystem Characteristics of MVC for 3D-TV Broadcast in the ATSC Digital Television System," Doc. A/72 Part 3:2014, Advanced Television Systems Committee, Washington, D.C., 1 July 2014.

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

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

CLD – Component List Descriptor

CVCT – Cable Virtual Channel Table

HD – High Definition

IC3D – Independent Coded 3DTV

IEC – International Electrotechnical Commission

ISO – International Organization for Standardization

ITU – International Telecommunication Union

MPEG – Moving Picture Experts Group

MVC – Multi View Coding

PSIP – Program and System Information

TVCT – Terrestrial Virtual Channel Table

3.4 Terms

The following terms are used within this document.

Base view video, Base view video stream – A component of one Stereoscopic 3D video stream.

Compatible 2D video, Compatible 2D video stream – A 2D version video stream of an associated Stereoscopic 3D video stream. Content of the 2D version video stream may or may not be identical to content of one view from an associated Stereoscopic 3D video stream. The 2D version video stream (if exist) is transmitted via a virtual channel different from a virtual channel for the Stereoscopic 3D video stream.

Dependent view video, Dependent view video stream – A component of one Stereoscopic 3D video stream. The Dependent view video stream may not be presented without an associated Base view video stream.

Independent-coded 3D – 3D TV broadcasting service using a Stereoscopic 3D video stream which is independent from a video stream currently used for 2D broadcasting defined in [3].

Left view – Video provided for the left eye.

reserved – An element that is set aside for use by a future Standard.

Right view – Video provided for the right eye.

Stereoscopic 3D video, Stereoscopic 3D video stream – 3D Video composed of Base view video and Dependent view video.

4. INDEPENDENT CODED 3D-TV

4.1 Overall Description of Independent Coded 3D-TV

Elements of Independent Coded 3DTV (IC3D) include Stereoscopic 3D video, audio signals and ancillary data. Stereoscopic 3D video consists of a left view and a right view. In IC3D, left and right views are independently transmitted as two video elementary streams. One is a Base view video stream and the other is a Dependent view video stream. 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.

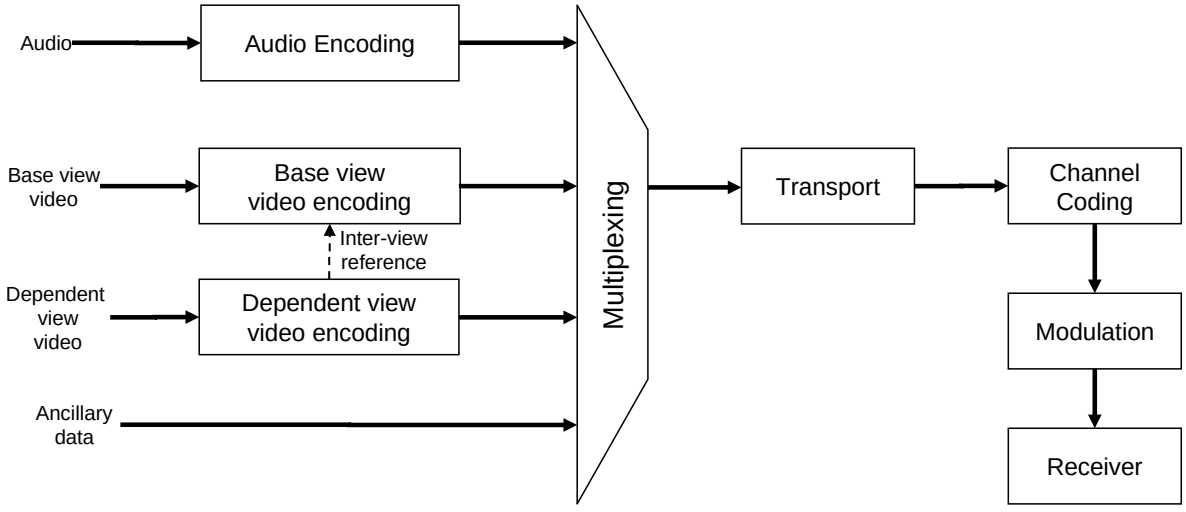

Figure 4.1 Overview of IC3D system.

4.2 Encoding and Decoding for IC3D

The compression format of the Stereoscopic 3D video is an MPEG-4 MVC video stream, and the MPEG-4 video stream shall conform to ATSC A/72 Part 3 [9].

4.3 Video Format for IC3D

The compression format for a Base view video stream and a Dependent view video stream of IC3D service shall be one of the formats listed in Table 5.3 of ATSC A/72 Part 3 [9].

4.4 Multiplexing for IC3D

Multiplex and Transport of the video and audio elements in IC3D service shall comply with ATSC A/53 Part 3 [3] and ATSC A/72 Part 3 [9].

4.5 Closed Captioning for IC3D

Closed captioning data is transported in the Base view video stream in compliance with ATSC A/72 Part 1 [7]. 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 [4].

4.6 Signaling for IC3D

4.6.1 PSI

4.6.1.1 stream_type

The MPEG-4 MVC Base view of IC3D service shall be signaled using stream_type value 0x1B and the MPEG-4 MVC Dependent view for IC3D service shall be signaled using stream_type value 0x20 as defined in ATSC A/72 Part 3 [9].

4.6.2 PSIP

4.6.2.1 Virtual channel signaling

A virtual channel that carries an IC3D service shall be identified by service_type equal to 0x09 (Extended Parameterized Service) in the TVCT or CVCT. 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 [5]) as specified in Section 4.6.2.2 below; and
2) Parameterized Service Descriptor (PSD) (A/71 [5]) with contents as specified in Section 4.6.2.3 below.

This placement is shown as an example in Table 4.1.

Table 4.1 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 IC3D 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 3DTV receivers to display the Stereoscopic 3D video.

4.6.2.2 Component_list_descriptor

The Component List Descriptor (CLD) as specified in A/71 [5] shall be present in the descriptor loop of the TVCT (or CVCT when present). The CLD describes video components of an IC3D service. For an IC3D service, the component_list_descriptor() shall include a stream_info_details() entry for the Base view video stream and a stream_info_details() entry for the Dependent view video stream.

4.6.2.2.1 Base View Component Signaling

When the Base view is encoded using MPEG-4 MVC Base view video stream constrained by A/72 Part 3 [9], the Component List Descriptor shall include stream_info_details() for stream_type = 0x1B as specified in ATSC A/72 Part 2 Table 6.1 [8].

4.6.2.2.2 Dependent View Signaling

For an IC3D service in which the Dependent view video stream is encoded using MPEG-4 MVC Dependent view video stream, the component_list_descriptor() shall include stream_info_details() for stream_type 0x20. The syntax and semantics of the stream_info_details() for stream_type 0x20 shall be as given in A/72 Part 3 [9].

The value of the MVC_dep_profile field shall be set to '00' to specify Stereo High Profile for IC3D service.

4.6.2.3 Parameterized Service Descriptor

The parameterized_service_descriptor() as defined in A/71 [5] 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 4.2. As shown, additional bytes following the last defined field may be present.

Table 4.2 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 4.3. Note that IC3D uses value 0x03.

Table 4.3 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

When the 3D event has an associated 2D event, the IC3D event info descriptor as specified in Section 4.6.2.4.1 shall be placed both in the descriptor loop of an EIT for the 3D event and in the descriptor loop of an EIT for the associated 2D event in order to indicate relationship among contents of Base view video stream, contents of Dependent view video stream, and contents of a Compatible video stream. (See the example in Table 4.4.)

When the 3D event has no associated 2D event, the IC3D event info descriptor shall not be placed in the descriptor loop.

Table 4.4 EIT Signaling Example

EIT
...
for (j < num_events_in_section) {
event_id
start_time
…
length_in_seconds
…
IC3D_event_info_descriptor()
…
}

4.6.2.4.1 IC3D Event Info Descriptor

It is expected that a broadcaster will transmit a Compatible 2D video stream compressed by MPEG-2 video codec to keep backward compatibility with IC3D incapable TVs.

When the Compatible 2D video stream is transmitted, there are two possible relationship among content of Base view video, content of Dependent view video, and content of the Compatible 2D video.

1) Content of one view from IC3D service is identical to content of the Compatible video stream.
2) Content of Left view nor Right view from IC3D service is not identical to content of the Compatible video stream. Two typical cases are as follows:
   - 2D dedicated view is prepared by contents authors because 3D content may have different scene change timing, different camera angle, different camera distance to alleviate eye fatigue and/or to emphasize 3D effect. (See camera angle in Figure 4.2.)
   - Side information such as broadcasters logo, weather information, traffic information, etc. are overlaid onto the video. Horizontal position of the information is changing according to an object behind the information in order to avoid interference between a 3D video and the information. (See "Weather info." in Figure 4.2.)

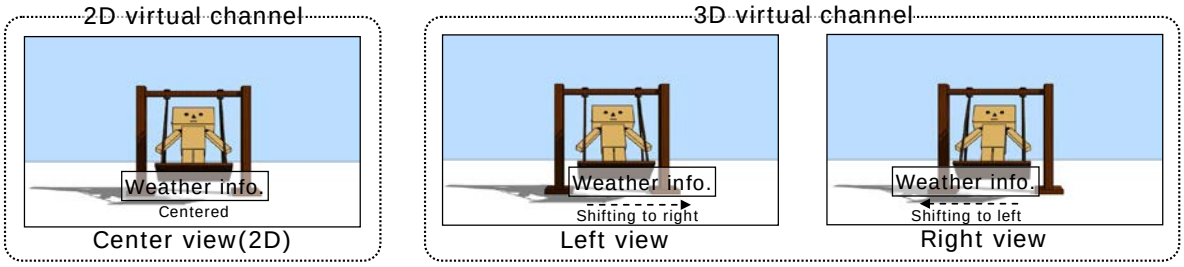

Figure 4.2 Example of content for 2D virtual channel and 3D virtual channel.

When a viewer switches 2D from 3D or vice versa, a receiver may use one view from IC3D service for 2D presentation for case 1) above. This 2D/3D switching can be faster than switching between a Compatible video stream and an associated Stereoscopic 3D video stream because no virtual channel transition happens and no video decoder termination nor initialization happens.

On the other hand, for case 2) above, receiver can choose an appropriate virtual channel depending on 2D or 3D presentation.

The IC3D event info descriptor is introduced to help receivers for quick 2D and 3D switching and to indicate content relationship between 2D and 3D content.

The syntax and semantics of the IC3D_event_info_descriptor() shall be given in Table 4.5 and the semantic descriptions that follow it.

Table 4.5 Bit Stream Syntax for the IC3D Event Info Descriptor

Syntax	No. of Bits	Format
IC3D_event_info_descriptor() {		
descriptor_tag	8	0xEB
descriptor_length	8	uimsbf
source_id	16	uimsbf
reserved	6	'111111'
content_identical_status	2	uimsbf
}		

descriptor_tag – This 8-bit unsigned integer shall have the value 0xEB, identifying this descriptor as IC3D_event_info_descriptor().

descriptor_length – This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

source_id – This 16-bit field specifies the source_id of the virtual channel carrying the associated 2D contents or 3D contents.

content_identical_status – This 2-bit field shall specify content identification status between 3D content in a virtual channel and the associated 2D content in other virtual channel. The coding for content_identical_status shall be as given in Table 4.6.

Table 4.6 Content Identical Status Encoding

content_identical_status	A Virtual Channel Carrying	Description
00	3D contents	Video content carried in the associated virtual channel is a 2D version of the content delivered in the 3D virtual channel.
	2D contents	Video content carried in the associated virtual channel is a 3D version of the content delivered in the 2D virtual channel.
01	3D contents	Video content of Dependent view video stream is identical to 2D video content carried in the associated 2D virtual channel.
	2D contents	2D video content is identical to video content of Dependent view video stream carried in the associated 3D virtual channel.
10	3D contents	Video content of Base view video stream is identical to 2D video content carried in the associated2D virtual channel.
	2D contents	2D video content is identical to video content of Base view video stream carried in the associated 3D virtual channel.
11		[Reserved for future ATSC use]

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