ATSC Standard: 3D-TV Terrestrial Broadcasting, Part 3 – Frame Compatible Stereo Coding Using Real-Time Delivery

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Advanced Television Systems Committee
1776 K Street, N.W.
Washington, D.C. 20006

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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

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3D-TV Terrestrial Broadcasting, Part 3 – Frame Compatible Stereo Coding Using Real-Time Delivery

1. SCOPE

This document provides detailed specification of the parameters of the Frame Compatible 3DTV system using Real-Time (FCRT) delivery and the Multi-Resolution Frame Compatible 3DTV system using Real-Time (MFCRT) delivery including 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 FCRT system and MFCRT system and a list of reference documents.

1.2 Introduction and Background

3DTV broadcasting service consists of Stereoscopic 3D video, audio and ancillary data. Stereoscopic 3D video includes both a Left-eye view and a Right-eye view. In FCRT, 3D video is composed of two compressed video images, where each image has half the resolution of the production resolution. The Left- and Right-eye views are both included within the coded frame, with the two views either placed side-by-side, or with one view above the other. Ancillary data includes program/channel signaling data and caption information. Signaling data is transmitted within the transport multiplex while caption data is transmitted within the video bit stream. Figure 1.1 illustrates the FCRT Broadcasting System.

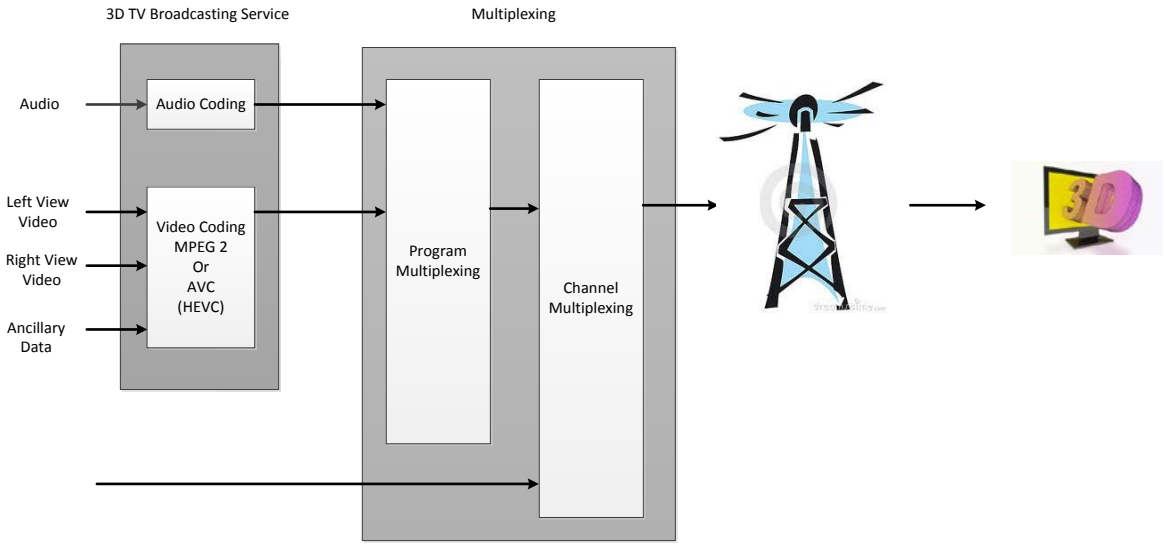

Figure 1.1 Frame Compatible 3D Broadcasting System.

In MFCRT, 3D video provides enhanced HD picture to each eye. It contains two video streams: Base view video (or Base layer Frame Compatible video) and Dependent view video (or Enhancement layer video). The Base view video is composed of two compressed video images, where each image has half the production resolution. The Left- and Right-eye views are both included within a coded picture in Base view, with the two views either placed side-by-side, or

with one view above the other. So, the Base view is backward compatible to FCRT. The Dependent view video provides additional information to recover high frequencies of full HD picture. Ancillary data includes program/channel signaling data and caption information. Signaling data is transmitted within the transport multiplex while caption data is transmitted within the video bit stream. Figure 1.2 illustrates the MFCRT Broadcasting System.

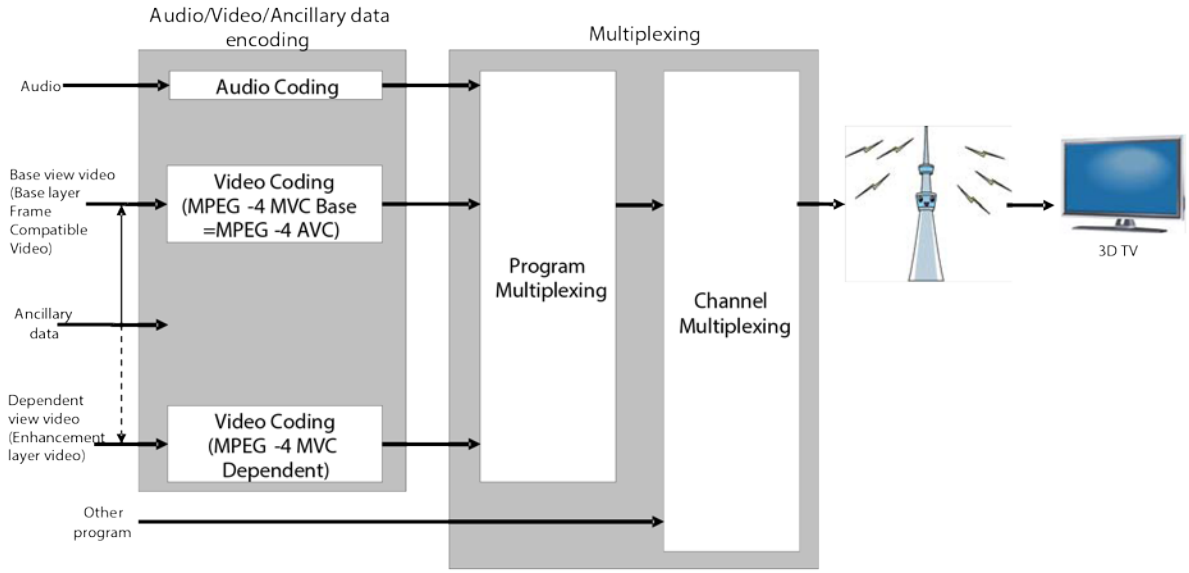

Figure 1.2 Multi-Resolution Frame Compatible 3D Broadcasting System.

1.3 Organization

This document is organized as follows:

- Section 1 – Scope of this document and a general introduction.
- Section 2 – List of normative reference documents.
- Section 3 – Definition of terms, acronyms, and abbreviations for this document.
- Section 4 and 5– Specification of Frame Compatible 3DTV
- Section 6 – Specification of Multi-Resolution Frame Compatible 3DTV

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 3:2013, Advanced Television Systems Committee, Washington, D.C., 7 August 2013.

[3] 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., 7 August 2009.

[4] ATSC: "ATSC Digital Television Standard, Part 5 – AC-3 Audio System Characteristics," Doc. A/53, Part 5:2010, Advanced Television Systems Committee, Washington, D.C., 6 July 2010.

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

[6] ATSC: "AVC Video Transport Subsystem Characteristics," Doc. A/72, Part 2:2014, Advanced Television Systems Committee, Washington, D.C., 18 February 2014.

[7] 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.

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

[9] 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.

[10] ITU-T Recommendation H.222.0 (2012) | ISO/IEC 13818-1:2012, "Information technology – Generic coding of moving pictures and associated audio information: Systems."

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

[12] SCTE 187-1, "Stereoscopic 3D Formatting and Coding for Cable," Society of Cable Telecommunications Engineers, 2012.

[13] SCTE 187-2, "Stereoscopic 3D PSI Signaling," Society of Cable Telecommunications Engineers, 2012.

[14] 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.

[15] ISO: "Text of ISO/IEC FDIS 14496-10:201X" Doc. MPEG N13916, International Standards Organization, Geneva, 2014 /"ITU-T Rec H.264: Advanced video coding for generic audiovisual services", February 2014.

2.2 Informative References

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

[16] MPEG/JCT3V: "Test Model 2 for Multi-resolution Frame Compatible Stereo Coding", Doc. MPEG N13754/JCT3V-E1008, August, 2013.

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

CVCT – Cable Virtual Channel Table

FCRT – Frame Compatible 3DTV using Real-time Delivery

MFCRT – Multi-Resolution Frame Compatible 3DTV using Real-time Delivery

PMT – Program Map Table

SCTE – Society of Cable Telecommunications Engineers

TVCT – Terrestrial Virtual Channel Table

3.4 Terms

The following terms are used within this document.

Frame compatible – Refers to video content composed of left and right eye stereoscopic image pairs assembled into single packed video frames for delivery through legacy video distribution systems. The left and right image pair are typically subject to a filtering, decimation and formatting process to generate a packed frame that has the same pixel count as the original left

or right frame. A reverse of this process is performed to reconstruct the full stereoscopic image pair prior to display. Examples of frame-compatible formats include top-bottom and side-by-side.

Multi-Resolution Frame Compatible – Refers to video content composed of Base view video (or Base layer video) and Dependent view video (or Enhancement layer video). The Base view video is frame compatible video content. The Dependent view video is complementary video content that carries high frequencies lost in the aforementioned filtering. A reconstruction process is performed to reconstruct the full resolution stereoscopic images.

Base view video, Base view video stream – A component of one MFC video stream.

Dependent view video, Dependent view video stream – A component of one MFC video stream. The Dependent view video stream shall not be present without an associated Base view video stream.

Left view – Video image provided for the left eye.

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

Right view – Video image provided for the right eye.

SbS – Side-by-side.

Stereoscopic 3D video, Stereoscopic 3D video stream in FC: .Video composed of a left view and a right view.

Stereoscopic 3D video, Stereoscopic 3D video stream in MFC: 3D Video composed of Base view video and Dependent view video.

TaB – Top and bottom.

4. FRAME COMPATIBLE 3D-TV

4.1 Overall Description of Frame Compatible 3DTV

Elements of Frame Compatible 3DTV (FCRT) include 3D video, audio signals and ancillary data. 3D video basically consists of a left view and a right view. In FCRT, left and right views are transmitted as a single video elementary stream. Ancillary data can be caption information, program/channel signaling section 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 describes the FCRT system in a high-level block diagram form.

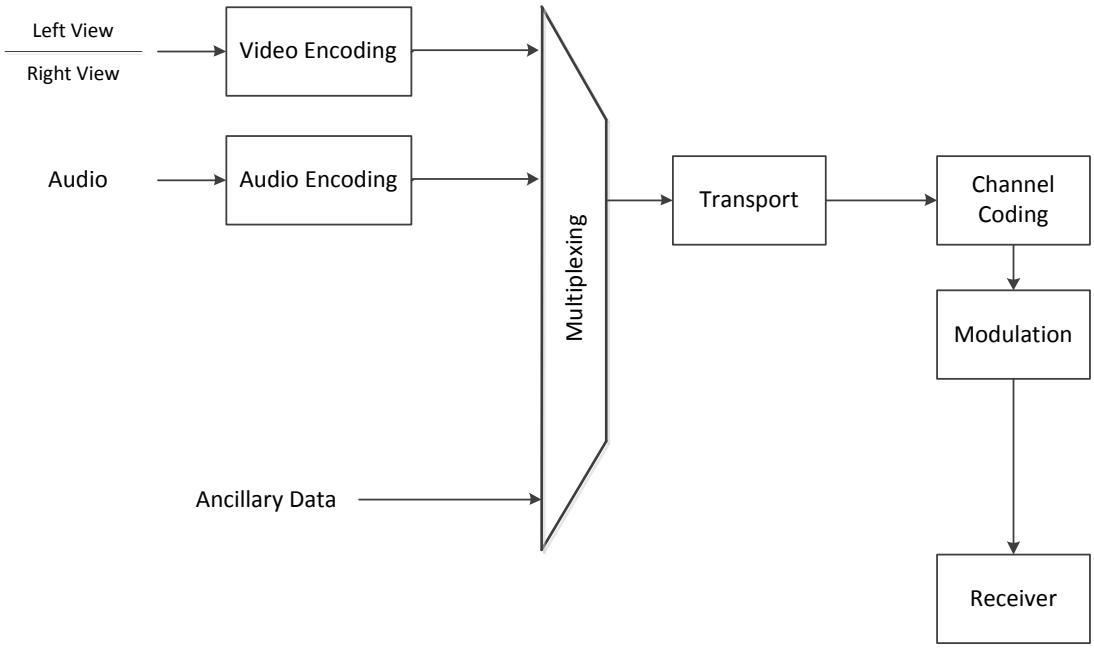

Figure 4.1 Overview of FCRT System.

5. ENCODING AND DECODING FOR FCRT

5.1 Video Synchronization

Synchronization of Left-eye and Right-eye video shall conform to SCTE 187-1 Section 8.1 [12]. For both Tab and SbS formatting, video is coded with time-synchronous Left-eye and Right-eye images within a single frame.

5.2 Top-and-Bottom Format

When frame-compatible 3D video is sent in top-and-bottom (TaB) format, formatting shall be per SCTE 187-1 Section 8.2 [12], which includes:

- Formatting of pixel placement and blanking areas.
- Requirement to use TaB formatting with progressive (720p and 1080p) video formats;
- Placement of the Left view image on the top of the TaB frame and the Right view image on the bottom of the TaB frame, with no inversion or mirroring.

Figure 5.1 diagrams the TaB multiplexing.

TaB formatting shall vertically down-sample the left and right views symmetrically using any anti-aliased resizing algorithm that reduces resolution and size only in the vertical direction and combines adjacent lines. This means that a simple 2-dimensional image processed in this way will produce exactly the same reduced image for the left and right views.

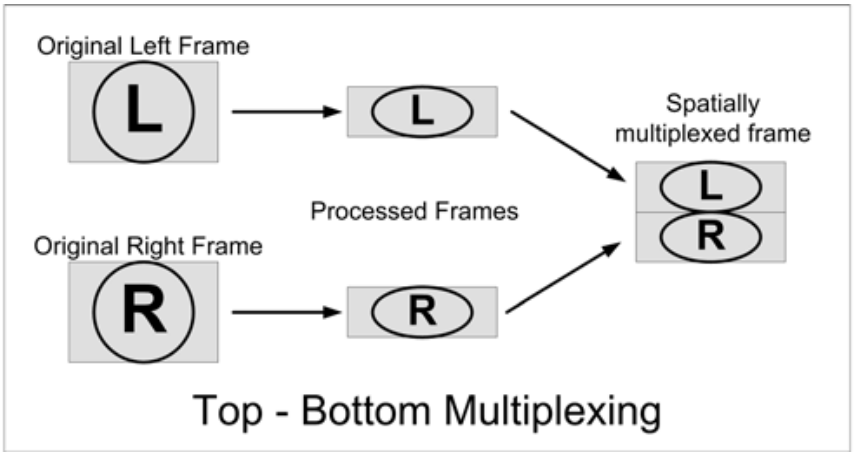

Figure 5.1 Top-Bottom Multiplexing[1].

5.3 Side-by-Side Format

SbS formatting shall be oriented with the Left-eye image on the left half of the frame and Right-eye image on the right half of the frame, without any inversion or mirroring.

SbS formatting shall horizontally down-sample the left and right views symmetrically using any anti-aliased resizing algorithm that reduces resolution and size only in the horizontal direction and combines adjacent pixels. This means that a simple 2-dimensional image processed in this way will produce exactly the same reduced image for the left and right views.

5.3.1 1080i SbS Format

When frame-compatible 3D video in 1080i format is sent in side-by-side (SbS) format, formatting shall be per SCTE 187-1 Section 8.3 [12], which includes formatting of pixel placement and blanking areas;

In addition to the requirements specified in SCTE 187-1 Section 8.3 [12], the present standard allows the optional use of SbS formatting with progressive (1080p or 720p) video formats. The use of SbS formatting with progressive video is not recommended when the content might be distributed to digital cable set-top boxes in the US, because such decoders may not be compatible with this format.

5.3.2 720p SbS Format

When frame-compatible 3D video in 720p format is sent in side-by-side (SbS) format, pixel placement and placement of Left- and Right-eye images shall be per Figure 5.2 below. As shown, the Left-eye image occupies samples 0 to 639 and the Right-eye image occupies samples 640 to 1279 of the SMPTE 274M frame.

[1] Figure courtesy SCTE; used with permission.

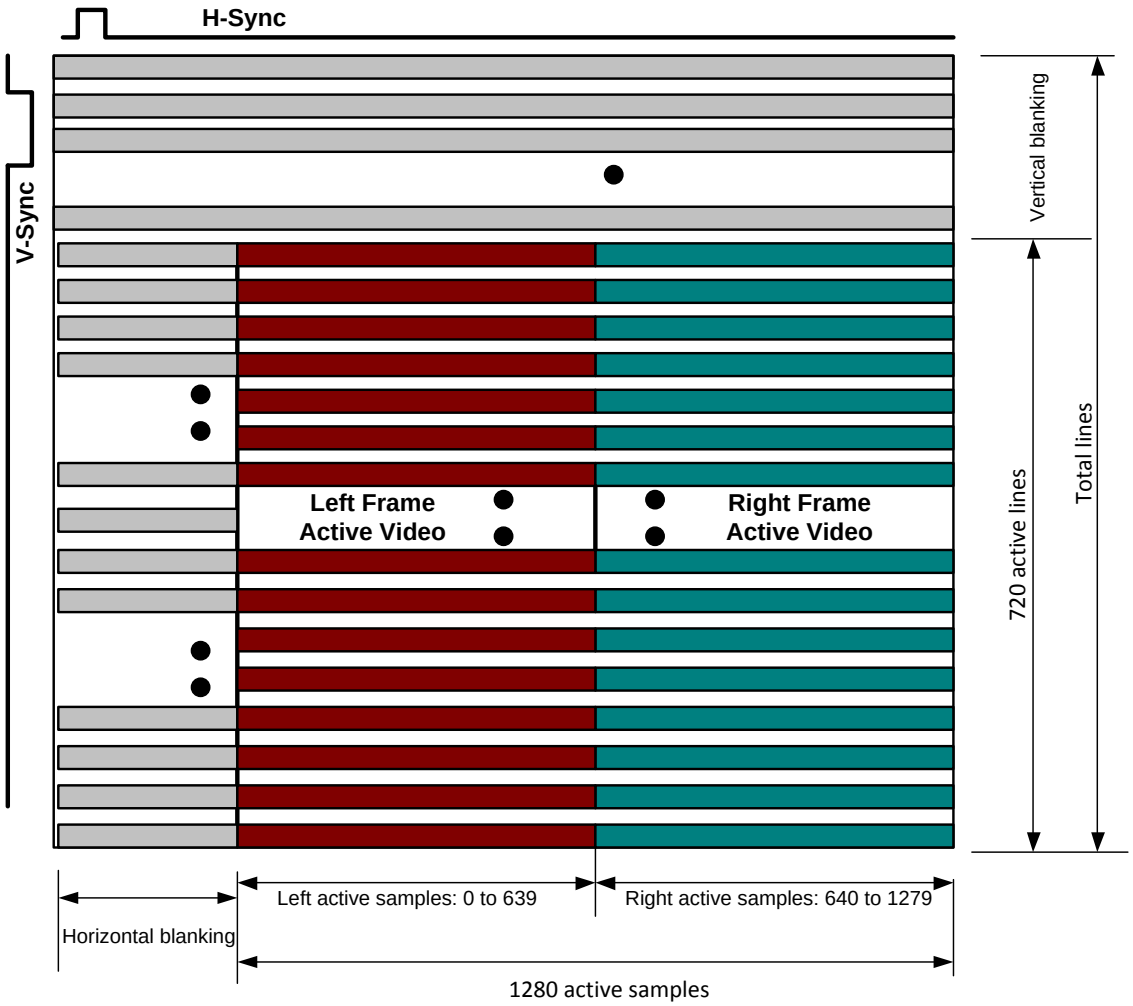

Figure 5.2 SbS source formatting for 720p video format[2].

5.3.3 1080p SbS Format

When frame-compatible 3D video in 1080p format is sent in side-by-side (SbS) format, pixel placement and placement of Left- and Right-eye images shall be per Figure 5.3 below. As shown, the Left-eye image occupies samples 0 to 959 and the Right-eye image occupies samples 960 to 1919 of the SMPTE 274M frame.

[2] Figure source courtesy SCTE; used with permission.

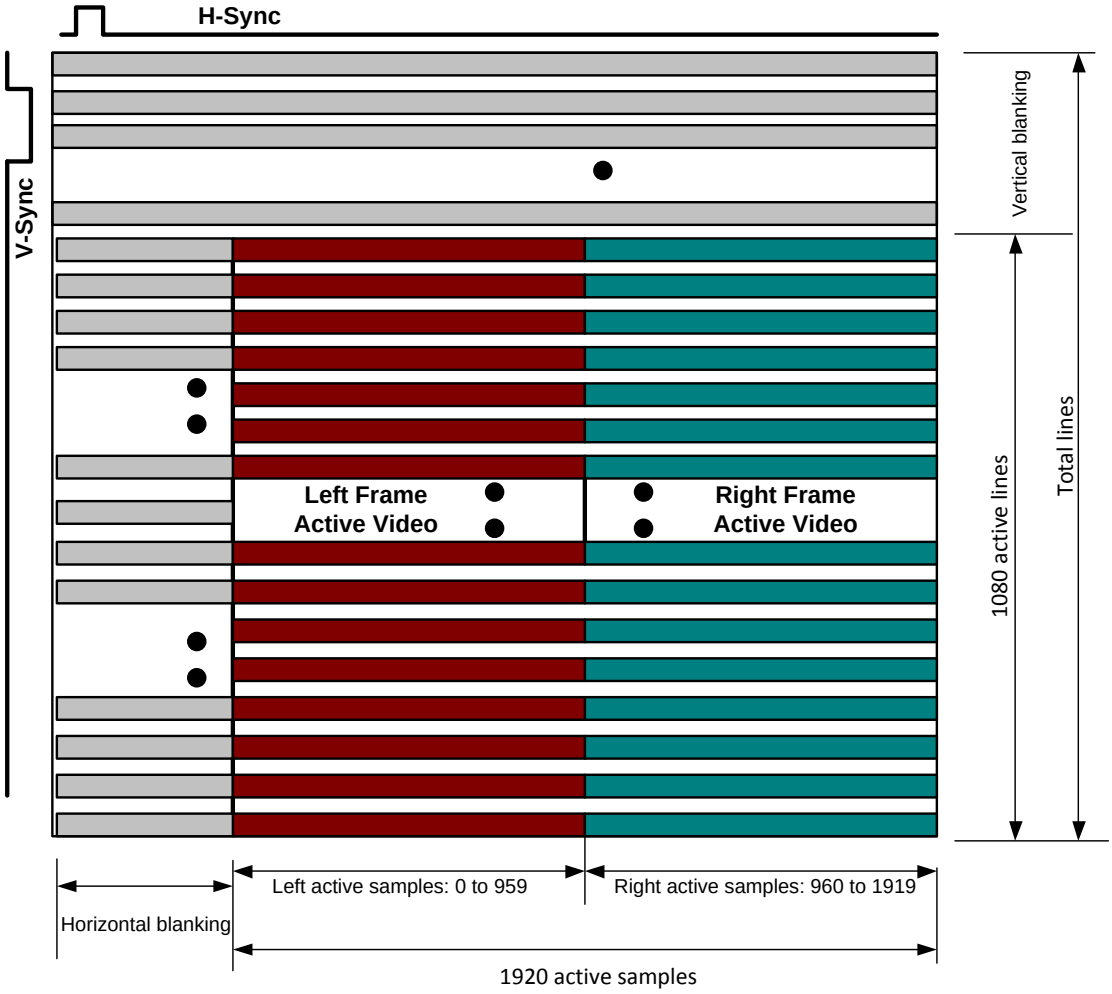

Figure 5.3 SbS source formatting for 1080p video format[3].

Figure 5.4 diagrams the SbS multiplexing.

[3] Figure source courtesy SCTE; used with permission.

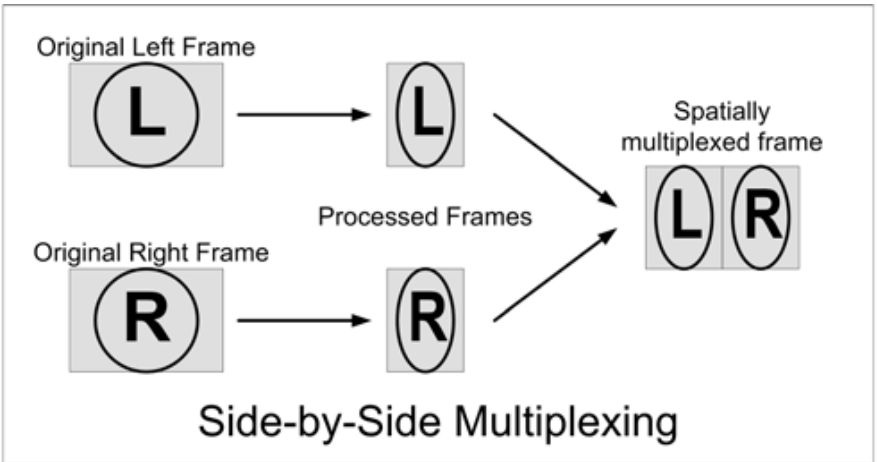

Figure 5.4 Side-by-Side Multiplexing[4].

5.4 Video Format and Encoding Constraints

When MPEG-2 video is used, the compression format of the video shall conform to A/53 Part 4 [3].

When AVC video is used, video formats are constrained as follows:

- Resolution shall be 720 x 1280 or 1080 x 1920, corresponding to entries in Table 6.3 of A/72 Part 1 [5].
- Frame rates shall be per Table 6.2 of A/72 Part 1 [5], excluding 25 Hz and 50 Hz rates.

Accordingly, the compression format for the FCRT service conforms to one of the formats listed in informative Table 5.1. Allowed frame packing format for each video compression format is also shown.

Table 5.1 Video Compression Formats (Informative)

Vertical size	Horizontal size	Display aspect ratio / sample aspect ratio	Frame rate	Progressive/ Interlaced	FCRT Format
1080	1920	16:9 / square sample	23.976, 24, 29.97, 30	P	TaB, SbS
1080	1920	16:9 / square sample	29.97, 30	I	SbS
720	1280	16:9 / square sample	23.976, 24, 29.97, 30, 59.94, 60	P	TaB, SbS

5.5 Video Layer Signaling

This section specifies requirements for video layer signaling of 3D content.

5.5.1 Video Layer Signaling for MPEG-2 Coded 3D Content

Signaling in the video layer for FCRT content encoded with the MPEG-2 video codec shall conform to Section 9.0 of SCTE 187-1 [12]. Specific provisions incorporated in this requirement include:

- Required use of the S3D_video_format_signaling() user data construct defined in SCTE 187-1 [12];

[4] Figure courtesy SCTE; used with permission.

- Required placement of the S3D_video_format_signaling() user data construct in the video syntax, and with respect to other user data (following captions and AFD/Bar data if present).

Signaling at boundaries between 2D and 3D content encoded with the MPEG-2 video codec shall conform to the provisions of Section 9.0 of SCTE 187-1 [12].

5.5.2 Video Layer Signaling for AVC Coded 3D Content

Signaling in the video layer for FCRT content encoded with the AVC video codec shall conform to Section 10.0 of SCTE 187-1 [12]. Specific provisions incorporated in this requirement are listed here for the convenience of the reader:

- Required use of the frame_packing_arangement() SEI message with payload type 0x2D (see SCTE 187-1 [12] Section 10.1).
- Required use of the frame packing arrangement SEI per SCTE 187-1 [12] Section 10.2.
- Required values for parameters in the frame_packing_arangement() SEI message:
  - frame_packing_arrangement_id = 0
  - frame_packing_arrangement_cancel_flag = 0
  - frame_packing_arrangement_type = 0000011 (SbS) or 0000100 (TaB)
  - quincunx_sampling_flag = 0
  - content_interpretation_type = 000001
  - spatial_flipped_flag = 0
  - frame0_flipped_flag = 0
  - field_views_flag = 0
  - current_frame_is_frame0_flag = 0
  - frame0_self_contained_flag = 0
  - frame1_self_contained_flag = 0
  - frame0_grid_position_x, frame0_grid_position_y, frame1_grid_position_x, frame1_grid_position_y set according to values allowed in Section 10.3 of SCTE 187-1 [12]
  - frame_packing_arrangement_reserved_byte = 00000000
  - frame_packing_arrangement_repetition_period = 0
  - frame_packing_arrangement_extension_flag = 0
  - For FCRT content encoded as SbS, aspect_ratio_info_present_flag = 1, aspect_ratio_idc = 1, sar_width to 1, sar_height = 1
  - For FCRT content encoded as TaB, aspect_ratio_info_present_flag = 1, aspect_ratio_idc = 1, sar_width = 1, sar_height = 1

5.6 Transport and Multiplex Constraints

When MPEG-2 video coding is used for the FCRT service, the multiplex and transport of the video and audio elements in the FCRT service shall comply with ATSC A/53 Part 3 [2].

When AVC video coding is used for the FCRT service, the multiplex and transport of the video elements in the FCRT service shall comply with ATSC A/72 Part 2 [6], and the audio elements in the FCRT service shall comply with ATSC A/53 Part 3 [2].

5.6.1 Stream Type Values

The stream_type value for MPEG-2 video program elements used for an FCRT service shall be as defined in ISO/IEC 13818-1 [10]. The value is 0x02.

The stream_type value for AVC video program elements used for an FCRT service shall be as defined in ISO/IEC 13818-1 [10]. The value is 0x1B.

5.6.2 FCRT PSI Signaling

When MPEG-2 video coding is used for the service, the MPEG2_stereoscopic_video_format_descriptor() per ISO/IEC 13818-1 [10] shall be used. The use of the MPEG2_stereoscopic_video_format_descriptor() shall conform to Section 8.1.1 of SCTE 187-2 [13].

When the FCRT service uses AVC video coding, the AVC_video_descriptor() per ISO/IEC 13818-1 [10] shall be used. The use of the AVC_video_descriptor() shall conform to Section 8.2.1 of SCTE 187-2 [13].

5.6.3 PSIP Signaling

5.6.3.1 Virtual Channel Signaling

A Virtual Channel per ATSC A/65 [7] that carries 3DTV service using the MPEG-2 video codec shall be identified by one of the following two signaling methods in the TVCT:

1. service_type equal to 0x02;
2. service_type equal to 0x09, Extended Parameterized Service, per A/71 [8].

It should be noted that legacy 3D-capable receivers may not offer virtual channels labeled with service_type 0x09 to the user. Providing the option to label the frame-compatible 3D as service_type 0x02 (regular DTV service) allows the broadcaster to offer the service in a way that permits legacy 3D-capable receivers to access the virtual channel.

A Virtual Channel per ATSC A/65 [7] that carries 3DTV service using the AVC video codec shall be identified by service_type equal to 0x09.

5.6.3.2 Signaling for Service Type 0x09

When service_type 0x09 is used, the component_list_descriptor() and the parameterized_service_descriptor() provide information that the receiver can use to determine whether it has the hardware and software resources necessary to render a meaningful presentation of the FCRT service.

When service_type 0x09 is used, 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) Parameterized Service Descriptor (PSD) (A/71 [8]) as specified in Section 5.6.3.2.1 below; and
2) When the FCRT service is encoded using AVC video, the Component List Descriptor (A/71 [8]) as specified in Section 5.6.3.2.2 below.

This placement is shown as an example in Table 5.2.

Table 5.2 Example TVCT Composition for Service Type 0x09

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()
…
}

5.6.3.2.1 Parameterized Service Descriptor

The Parameterized Service Descriptor as specified in A/71 [8] shall be present in the descriptor loop of TVCT to indicate the program is an FCRT service. The value of the application_tag in the parameterized_service_descriptor() shall be 0x01. The syntax and semantics of application_data() for application_tag value 0x01 shall be as shown in Annex A of A104 Part 1 [9]. The value of 3D_channel_type shall be as follows:

- When the channel is formatted as SbS, 3D_channel_type shall be set to 0x00;
- When the channel is formatted as TaB, 3D_channel_type shall be set to 0x01.

5.6.3.2.2 Component List Descriptor

When the FCRT service is encoded using the AVC video codec, the Component List Descriptor as specified in A/71 [8] shall be present in the descriptor loop of the program in the TVCT to signal the components of the FCRT program and shall include stream_info_details() for stream_type = 0x1B per A/72 Part 2, Section 6.3 [6].

If the audio components of the FCRT service are encoded with an audio codec other than AC-3 audio constrained per ATSC A/53 Part 5 [4], the Component List Descriptor shall include stream_info_details() for the applicable audio stream_type.

5.6.4 EIT

The stereoscopic_program_info_descriptor() as specified in MPEG-2 *Systems* [10] 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 5.3.

Table 5.3 EIT Signalling Example

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

5.7 Closed Captioning for FCRT Services.

Closed captioning commands to support z-axis placement of caption windows (e.g. disparity data) shall be formatted in accordance with CEA-708.1 [11] and carried in the cc_data() specified in Sec. 6.2.3.1 of A/53 Part 4 [3].

When the FCRT service uses MPEG-2 video coding, closed captioning data is transported in video in compliance with ATSC A/53 Part 4 [3]. When the FCRT service uses AVC video coding, closed caption data is transported in video in compliance with ATSC A/72 Part 1 Section 6.4 [5].

5.8 Concatenation of FC-S3D with Full-Resolution 2D Content

If 2D content is included at certain times within the FCRT service, the methods described in SCTE 187-1 Section 8.4 [12] should be used at the splice points.

6. MULTI-RESOLUTION FRAME COMPATIBLE 3DTV

6.1 Overall Description of Multi-resolution Frame Compatible 3DTV

Elements of MFCRT include Stereoscopic 3D video, audio signals and ancillary data. Stereoscopic 3D video consists of a left view and a right view. In MFCRT, two video elementary streams are independently transmitted. One is a Base view video stream, which is the same as Frame Compatible elementary stream as in Section 5, and the other is a Dependent view video stream. Ancillary data can be caption information, program/channel signaling section data, etc. Caption information is transmitted along with the video signal of a bit stream, while signaling data is transmitted via multiplexing. Figure 1.2 describes the MFCRT system in a high-level block diagram form.

6.2 Video Encoding and Decoding

The compression format of the Stereoscopic 3D video is an MPEG-4 MVC video stream, and the Base view video is a Frame Compatible video stream conforming to the description in Section 5, and the Dependent view video is another Frame Compatible video stream conforming to the description in Section 5. The association between the frame packing arrangement types for the Base view video and the Dependent view video is specified in Table 6.1. The generation of the Dependent view video may be done using the method described in [16]. The decoding process follows Annex H of the AVC specification [15].

Table 6.1 Association between frame packing arrangement types

Constraints on the frame packing arrangement SEI message syntax for view components of the Base view	Corresponding frame packing arrangement type inferred for view components of the Dependent view
frame_packing_arrangement_type shall be equal to 3 (side-by-side)	frame_packing_arrangement_type equal to 4 (top-bottom)
frame_packing_arrangement_type shall be equal to 4 (top-bottom)	frame_packing_arrangement_type equal to 3 and quincunx_sampling_flag equal to 0 (side-by-side)

After decoding both the Base view video and Dependent view video, a reconstruction process is required to form full HD image. The informative enhanced resolution reconstruction process is described in Section H.8.6 of the AVC specification [15].

6.3 Video Format for MFCR

Both the Base view video format and encoding format and Dependent view video format and encoding format shall conform to the description in Section 5. The compression format for a Base view video stream and a Dependent view video stream of MFCRT service shall be one of the formats listed in Table 5.1.

6.4 Video Layer Signaling

This section specifies requirements for video layer signaling of Stereoscopic 3D content.

6.4.1 Video Layer Signaling for MPEG-4 MVC Base View AVC

Signaling in the Base view video layer for MFCRT content encoded with the AVC video codec shall conform to Section 5.5.2.

6.4.2 Video Layer Signaling for MPEG-4 MVC Dependent View AVC

Signaling in the Dependent view video layer for MFCRT content encoded with the AVC video codec shall conform to the following specific provisions:

- The use of frame_packing_arangement() SEI message with payload type 0x2D shall be prohibited.
- For Dependent view video, a frame packing arrangement is inferred as follows:
  - frame_packing_arrangement_id = 0
  - frame_packing_arrangement_cancel_flag = 0
  - frame_packing_arrangement_type = 0000011 (SbS) or 0000100 (TaB)
  - quincunx_sampling_flag = 0
  - content_interpretation_type = 000001
  - spatial_flipped_flag = 0
  - frame0_flipped_flag = 0
  - field_views_flag = 0
  - current_frame_is_frame0_flag = 0
  - frame0_self_contained_flag = 0
  - frame1_self_contained_flag = 0
  - frame0_grid_position_x, frame0_grid_position_y, frame1_grid_position_x, frame1_grid_position_y set according to values allowed in Section 10.3 of SCTE 187-1 [12]
  - frame_packing_arrangement_reserved_byte = 00000000
  - frame_packing_arrangement_repetition_period = 0

- frame_packing_arrangement_extension_flag = 0
- For MFCRT content encoded as SbS, aspect_ratio_info_present_flag = 1, aspect_ratio_idc = 1, sar_width = 1, and sar_height = 1
- For MFCRT content encoded as TaB, aspect_ratio_info_present_flag = 1, aspect_ratio_idc = 1, sar_width = 1, and sar_height = 1

6.5 Transport and Multiplex Constraints

The multiplex and transport of the video elements in the MFCRT service shall comply with ATSC A/72 Part 2 [6] and ATSC A/72 Part 3 [14] and the audio elements in the MFCRT service shall comply with ATSC A/53 Part 3 [2].

6.5.1 PSI signaling

The AVC_video_descriptor() per ISO/IEC 13818-1 [10] shall be used. The use of the AVC_video_descriptor() for the Base view video shall conform to Section 8.2.1 of SCTE 187-2 [13].

For the Dependent view video, the AVC_video_descriptor() shall be associated in the PMT for the video components with stream_type values equal to 0x20 and frame_packing_SEI_not_present_flag is set to '1'.

6.5.1.1 stream_type value

The MPEG-4 MVC Base view of MFCRT service shall be signaled using stream_type value 0x1B and the MPEG-4 MVC Dependent view of MFCFR service shall be signaled using stream_type value 0x20 as defined in ATSC A/72 Part 3 [14].

6.5.2 PSIP

6.5.2.1 Virtual channel signaling

A virtual channel that carries an MFCRT 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 [8]) as specified in Section 6.5.2.2 below; and
2) Parameterized Service Descriptor (PSD) (A/71 [8]) with contents as specified in Section 6.5.2.3 below.

This placement is shown as an example in Table 6.2.

Table 6.2 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 MFCRT 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.

6.5.2.2 Component_list_descriptor

The Component List Descriptor (CLD) as specified in A/71 [8] shall be present in the descriptor loop of the TVCT (or CVCT when present). The CLD describes video components of an MFCRT service. For an MFCRT 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.

If the audio components of the MFCRT service are encoded with an audio codec other than AC-3 audio constrained per ATSC A/53 Part 5 [4], the Component List Descriptor shall include stream_info_details() for the applicable audio stream_type.

6.5.2.2.1 Base View Component Signaling

When the Base view is encoded using MPEG-4 MVC Base view video stream constrained by Section 5, the Component List Descriptor shall include stream_info_details() for stream_type = 0x1B as specified in ATSC A/72 Part 2 Table 6.1 [6].

6.5.2.2.2 Dependent View Signaling

For an MFCRT 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 [14].

The value of the MVC_dep_profile field shall be set to '01' to specify MFC High Profile for MFCRT service.

6.5.2.3 Parameterized Service Descriptor

The parameterized_service_descriptor() as defined in A/71 [8] 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 Annex A of A/72 Part 3 [9]. The value of 3D_channel_type shall be as follows:

- When the channel of the Base view video is formatted as SbS, 3D_channel_type shall be set to 0x00;
- When the channel of the Base view video is formatted as TaB, 3D_channel_type shall be set to 0x01.

6.5.2.4 EIT

The stereoscopic_program_info_descriptor() as specified in MPEG-2 Systems [10] 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 6.3.

Table 6.3 EIT Signaling Example

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

6.6 Closed Captioning for MFCRT

Closed captioning data is transported in the Base view video stream. Closed captioning commands to support z-axis placement of caption windows (e.g., disparity data) shall be formatted in accordance with CEA-708.1 [11] and carried in the cc_data() specified in Sec. 6.2.3.1 of A/53 Part 4 [3]. The closed caption data is transported in video in compliance with ATSC A/72 Part 1 Section 6.4 [5].

6.7 Concatenation of MFC-S3D with Full-Resolution 2D Content

If 2D content is included at certain times within the MFCRT service, the same methodology described in SCTE 187-2 Section 8.5 [13] should be used at the splice points. The recommended concatenation method is to pre-format the full-resolution 2D content as MFC-S3D with zero disparity (MFC-S3D-ZD) such that the video, transport, and signaling parameters match the adjacent MFC-S3D content. To be more specific, the input full resolution right view is set to be the same as the input full resolution left view. 2D content formatted in this way is fully MFC-S3D compliant. It is signaled, processed, and displayed as MFC-S3D of the same resolution as the preceding or following stereoscopic content but with a flat 2D visual experience. The benefit is that video mode transitions are avoided at the splice points. Decoders will not need to respond to video mode transitions and so the potential for decoding disruptions is avoided.

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