SMPTE REGISTERED DISCLOSURE DOCUMENT

Bitstream Syntax and Semantics for Carriage of HDSDI Ancillary Data in an MPEG-2 Transport Stream

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Errors in this document should be reported to the proponent identified below, with a copy to eng@smpte.org.

All other inquiries in respect of this document, including inquiries as to intellectual property requirements that may be attached to use of the disclosed technology, should be addressed to the proponent identified below.

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1 Overview

This Registered Disclosure Document (RDD) describes a bitstream syntax and semantics used to transmit SMPTE 291 formatted ancillary data (both VANC and HVANC) from the input of an encoder, through an MPEG-2 Transport Stream, and to reconstruct the ancillary data accurately at the output of a decoder. This protocol is in current use within several fielded products[i,ii]. In addition, this data format has been in use by a major television network for HD contribution and distribution applications since mid 2003.

2 Intellectual Property

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3 Background

The HDSDI signal documented in SMPTE292M is designed to carry ancillary data in addition to the active video signal. Ancillary data packets and formats are defined in SMPTE 291M. Certain Ancillary signals have specific methods of transport within the MPEG-2 Transport Stream (such as audio, or SMPTE 334M VANC caption data). This RDD documents a specific mechanism for transporting arbitrary Ancillary data in an MPEG-2 transport stream, and re-inserting it into the decoded video signal accurately. While this mechanism has been in use in some networks for several years, system designers should be mindful of other mechanisms which are in use from various standards organizations worldwide.

It is anticipated that use of Ancillary data signals will increase over time, especially if adequate transport mechanisms are in place. The below-documented transport mechanism is defined based on the following high-level requirements:

1) Transparent transmission of an Ancillary data signal complaint to SMPTE 291M.
2) Reinsertion of Ancillary data packets on the same frame, line, and space (HVANC or VANC) that they were extracted from.
3) Ability to limit (or manage) the amount of bandwidth consumed by transport of Ancillary data.

In addition to these requirements on the transport mechanism, we have found it useful to have the following behaviors on the encoding equipment:

1) Do not transport embedded audio using this mechanism, as there are other more commonly-used mechanisms for doing so (including SMPTE 302M).
2) Do not transport the embedded, audio control packets, as they should be generated by the receiver if/when it re-embeds the audio, based on information which can only be known by the receiver.
3) Ability to limit (or manage) the amount of bandwidth consumed by transport of Ancillary data.

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[i] WaveStar®, FlexiCoder®, VideoRunner® and NetVX™ systems [i]. The WaveStar® Decoder HD 4:2:2 and NetPlus™ model 200 and model 300 HD Receivers also support the format documented here.

[ii] WaveStar® is a registered trademark of Lucent Technologies, used under license. VideoRunner® is a registered trademark of Harris Corporation, assigned by Aastra Technologies, Ltd. FlexiCoder® and NetVX™ are trademarks of Harris Corporation.

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2) Do not transport the embedded audio control packets, as they should be generated by the receiver if/when it re-embeds the audio, based on information which can only be known by the receiver.
3) Keep track of the amount of bandwidth consumed by this transport, and drop whole packets of ancillary data if necessary; never try to send partial packets.
4) Do not bother transporting packets which are marked for deletion.
5) Do not bother transporting start marker packets or end marker packets. The decoder should regenerate these space permitting.

4 SI/PSI issues and mapping overview

The Ancillary data for a source frame of video are organized into a single PES unit for transport. This PES unit is then packaged into MPEG-2 transport stream packets using the methods described in ISO/IEC 13818-1. Every Ancillary data PES is marked with a Presentation Timestamp (PTS) which shall (with the exception of 3:2 pulldown processing noted below) correlate with the PTS of a video frame.

Each Ancillary data PES packet shall be TS aligned, using the adaptation layer stuffing mechanism as may be necessary.

The Ancillary data service shall be on a separate data PID, indicated in the PMT with stream type 0x06 (user private data). A registration descriptor is carried in the PMT with the format_identifier value “LU-A” which uniquely indicates that the data is of the format described in this document.

In the event that the encoder is using the MPEG-2 repeat-first-field/top-field-first method for inverse telecine processing, ancillary data PES is still sent on an “original frames” basis. Care must be taken to correctly associate the ancillary data with the correct source (or reconstructed) frame. In this case, for coded pictures indicating top-field-first, the PTS of an ancillary data PES shall match the PTS of the coded picture. There may be ancillary data PES packets for which no corresponding video PTS exists, however these ancillary data PTS values shall match the values which would have been on the video coded pictures had the sequence been coded at its original frame rate.

The Ancillary data PES packets are transmitted in the order in which they are presented.

5 Transmission Timing and Buffer Size

PES data shall be transmitted as close to CBR (constant-bit-rate) as reasonably possible. Since the amount of Ancillary data may vary frame-to-frame, the encoder shall be provisioned with a peak bit-rate for transmission, in order to facilitate planning of the other bit-rates in the multiplex. PES data shall be transmitted not exceeding this peak rate.

The timing of transmission of the ancillary data from the encoder (relative to the STC) shall be based on the T-STD decoder buffer model, with the assumption that the buffer of the decoder is large enough to hold two full frames of ancillary data, and shall be filled at a rate not to exceed 1.2 times the nominal peak transmission rate.

6 Ancillary data PES packet syntax and semantics

In keeping with the provisions of ISO/IEC 13838-1, ancillary data is packaged into MPEG-2 “Packetized Elementary Stream” or PES units, one per original video frame. Each ancillary data PES packet looks like the following:

Field	Bits	Value
Start_Code_Prefix	24	0x000001
Stream_id	8	0xBD (private_stream_1)
PES_packet_length	16	Length of the remainder of the packet, in bytes
Marker_bits	2	‘10’
PES_scrambling_control	2	‘00’ (not scrambled)
PES_priority	1	‘0’
Data_alignment_indicator	1	‘0’
Copyright	1	‘0’ or ‘1’
Original_or_copy	1	‘1’
PTS_DTS_flags	2	‘10’ (PTS will be present)
ESCR_flag	1	‘0’
ES_rate_flag	1	‘0’
DSM_trick_mode_flag	1	‘0’
Additional_copy_info_flag	1	‘0’
PES_CRC_flag	1	‘0’
PES_extension_flag	1	‘0’
PES_header_data_length	8	0x05 (5 bytes of PTS to follow)
Marker_bits	4	‘0010’
PTS[32..30]	3	PTS bits 32..30
Marker_bit	1	‘1’
PTS[29..15]	15	PTS bits 29..15
Marker_bit	1	‘1’
PTS[14..0]	15	PTS bits 14..0
Marker_bit	1	‘1’
Ancillary_Data_Structure()	Variable	Ancillary data structure

The fields listed above have the meanings defined in ISO/IEC 13818-1.

Ancillary data information for a video frame is organized into an ancillary_data_structure( ) unit as defined below. The structure organizes ancillary data by “spaces” where the data was found; for example the HVANC space on line 9, and the VANC space on line 9, are considered two separate spaces. The structure shall list all data in the order in which it must be re-inserted (monotonically increasing line numbers, etc.)

Description	Bits	Value
Ancillary_Data_Structure() {		
Marker_bit	1	‘1’
Final_packet_flag	1	Final_packet_flag
Bandwidth_limit_flag	1	Bandwidth_limit_flag
Reserved	5	0x00
Number_of_spaces	16	Number of ancillary_space_structure() units which follow in this PES packet.
Ancillary_payload_size	16	Size (in bytes) of the ancillary space structures
For (i=0; i<Number_of_spaces; i++)) {		
Ancillary_space_structure();		
}		
}		

Final_packet_flag: a value of "1' indicates this is the final PES packet for this frame. A value of '0' indicates that there may be additional PES packets for this frame. Multiple packets for the same original frame might be used based on buffer size constraints of the encoder, for example.

Bandwidth_limit_flag: a value of '1' indicates that some ancillary data was discarded by the encoder due to transmission bandwidth limitations. This flag is only indicated during a "final packet" for a frame as indicated by Final_packet_flag.

Number_of_spaces: the number of Ancillary_space_structure() units to be transmitted in this PES packet. If there is no ancillary data for a given frame, then set this to zero and send no structures.

Ancillary_space_structure() {		
Marker_bit	1	'1'
Reserved	3	0x00
Video_line_number	12	Video_Line_Number
Marker_bit	1	'1'
Ancillary_space_type	3	Ancillary_space_type
Reserved	2	0x00
Number_of_anc_packets	10	Number_of_anc_packets
For (i=0; i<Number_of_anc_packets; i++) {		
Ancillary_Packet_Struct()		Ancillary data packet structure
}		
}		

Video_line_number: the line number where this ancillary space is located. (line numbers are as defined in SMPTE 274M or SMPTE 296M or equivalent defining standard for the prevailing video format) NOTE THAT THE ANCILLARY DATA MUST BE TRANSMITTED IN THE BITSTREAM IN THE ORDER IN WHICH IT APPEARS IN THE VIDEO FRAME.

Ancillary_space_type: a 3-bit code marking what type of space these packets came from according to the following table:

'000'	VANC Chroma	Vertical Ancillary Space – Chroma bus
'001'	VANC Luma	Vertical Ancillary Space – Luma bus
'010'	HANC Chroma	Horizontal Ancillary Space – Chroma bus
'011'	HANC Luma	Horizontal Ancillary Space – Luma bus
'100' – '111'	Reserved	Reserved

Number_of_anc_packets: the number of ancillary data packets transmitted in this space.

Ancillary_Packet_Struct() {		
Marker_bit	1	'1'
Reserved	6	0x00
Number_of_words	9	Number_of_words
For (k=0; k<Number_of_words; k++) {		
Ancil_word	10	10-bit word from the HDSDI
}		
Byte_Realignment_bits	0, 2, 4, or 6	0xff. Restore byte alignment of the stream.
}		

Number_of_words: indicates the number of 10-bit words present in this ancillary data packet. Each packet (as defined in SMPTE 291M) consists of the Ancillary Data Flag (ADF) sequence 0x000 0x3ff 0x3ff which is not transmitted, followed by DID, DBN/SDID, and DC words (which are transmitted) followed by count DC words of ancillary data. Each SMPTE 291M packet ends with a checksum (CS) word. The checksum (CS) word at the end of the packet is transmitted. Number_of_words in this transmission format is equal to DC+4.

Ancil_Word: is the 10-bit value as extracted from the HDSDI signal.

Byte_Realignment_bits: a 2, 4, 6, or 0 (zero) bit stuffing item, in order to get the Ancillary_Packet_Struct( ) to be an exact multiple of eight bits long.

7 Implementation Limits

The above definition covers both the current implementation in fielded encoders and decoders, and also some cases which are not implemented at the present time but might arise in the future. Each specific implementation has limits on the amount of ancillary data which may be transmitted per frame, and which ancillary data spaces may be supported (among other limits).

Generally, current implementations are limted to 2000 10-bit words per frame, and a maximum PES data rate of 720 kBits/sec. Although the protocol allows for multiple PES packets per frame, in practice all of the data is currently packaged into a single PES packet.