

AVTP Pro Video Formats

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Rob Silfvast, Avid

Collaboration effort among notable players is actively underway

- Rob Silfvast, Avid (Audio System architect, AVB instigator)
- Damian Denault, Avid (Director of Engineering, Video HW)
- Willem-Jan Dirks, Axon (Senior HW Engineer, AVB project lead)
- Eldridge Mount, LabX Technologies (VP Advanced Development, AVB Video project lead)
- Bob Edge, Independent Consultant (Television, Broadcast, SMPTE)

Key Objectives

Application

- Layer-2 Transport
 - Distributing video (and ANC data) within a production facility (i.e. a LAN)
 - Low Latency
 - LAN infrastructure is assumed to be reliable and not subject to frequent re-configuration
 - Includes provisions for AVB Gen2 “content aware” switching

Solution Space

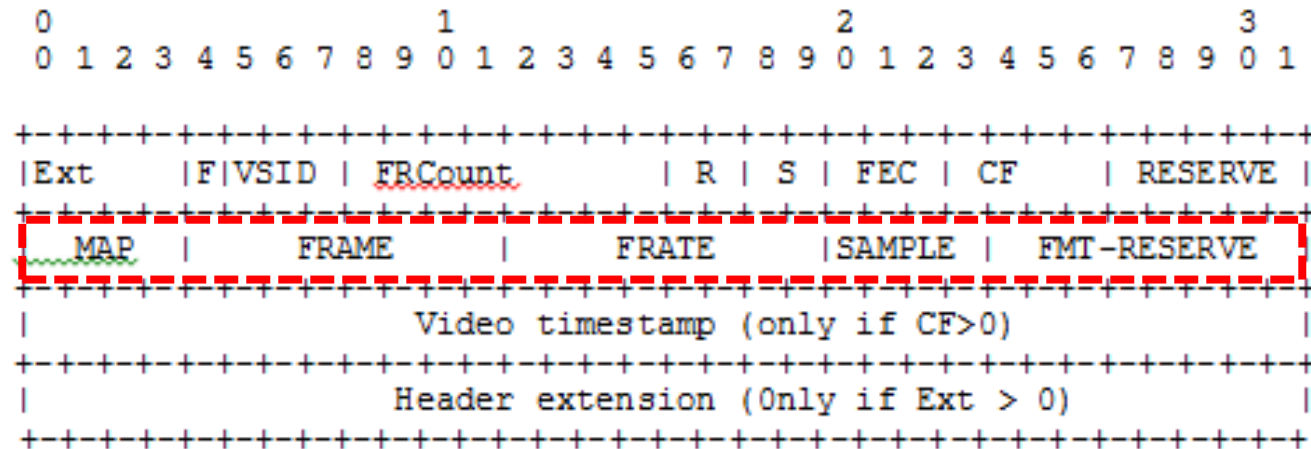
- Direct encapsulation of SDI streams (SMPTE 259, 292, 424, etc)
- Harmonize with SMPTE 2022-6 (High Bit Rate Media Transport) which is designed for “contribution links” (commonly WAN based)
- Leverage 1722a MCN spec to solve for “House Sync” requirement

SMPTE 2022-6 Review

Note: Slides 4-8 of this presentation contain content directly copied from the SMPTE 2022-6 draft specification. All rights remain with SMPTE for this content.

SMPTE 2022-6 defines a “High Bit Rate Media Transport” based on mapping SDI raster (including ANC data) formats onto RTP over IP. It provides for optional Forward Error Correction scheme defined in SMPTE 2022-5. Its primary application in the industry is for off-site contribution links (across wide area networks). This standard is in final ratification process, and is currently in use (deployed in equipment from multiple manufacturers).

6.4 High Bit Rate Media Payload Header



<= Video Source
Format fields

Description of Header Fields (1 of 4)

Extension field: (Ext) 4 bits

“0000” = No extension

“0001- 1111” = Payload header is extended by this number x 4 octets (bytes)

Video source format flag: (F) 1 bit. The F bit is set to

“0” = Video source format is not present (i.e. not indicated in payload header)

“1” = Video source format is present (i.e. indicated in payload header)

For the method specified in SMPTE 2022-6, the F bit shall be set to 1, and the video source format shall be transmitted. The F bit setting and the presence or absence of the video Source Format shall be constant for the duration of the session

Video source ID (VSID) Protection profile: 3 bits

(I think this is related to FEC protection, but it identifies backup streams for fail-over which might be useful in 1722a)

Set to 000 - primary stream

Set to 001 - protect stream

010-111 - reserved

Description of Header Fields (2 of 4)

Frame Count (FRCOUNT): 8 bits

This field identifies a video frame counter value. The counter shall increment to a new value for the next RTP sequence numbered datagram immediately after the end of video frame M marker bit and shall roll over after 256 frames.

Reference for time stamp (R): 2 bit Specific reference to the source of the time stamp

- Set to 00 - not locked Set to 01 - reserved
- Set to 10 - locked to UTC time/frequency reference
- Set to 11 - locked to a private time frequency reference

Video Payload Scrambling (S): 2 bits (we should learn specifically what this field references)

Payload scrambling control. Setting this field to a value other than 00 is outside the scope of this standard.

- Set to 00 - not scrambled
- Set to 01 – 11 reserved for future use

FEC usage (FEC): 3 bits

Identifies whether or not FEC streams have been associated with the media stream at the sender

- 000 = No FEC stream
- 001 = L (Column) FEC utilized
- 010 = L & D (Column & Row) FEC utilized
- All other values – reserved

Description of Header Fields (3 of 4)

Clock Frequency (CF) 4 bits

Indicates the video word clock frequency of the payload video

0000 = No time stamp

0001 = 27 MHz

0010 = 148.5 MHz

0011 = 148.5 /1.001 MHz

0100 = 297 MHz

0101 = 297/1.001MHz

0110-1111 = Reserved

If the clock frequency field is set to non-zero by the sender, then the sender shall include the Video Timestamp. If this field is set to zero (0) by the sender, then the sender shall not include Video Timestamp octets in the payload header. The CF field may be set to zero by the sender, indicating that no timestamps are being transmitted. A compliant receiver shall handle both the CF=0000 and CF not 0000 cases.

“Note: Video can be timed locally at the receiver via internal frame sync and local genlock”

Note: Usage of this field must be reconciled against solution for House Sync using MCN

Reserved (RESERVE):

These fields are reserved for future use and shall be set to 0 by the sender.

Description of Header Fields (4 of 4)

Video Source Format fields:

The following five fields comprise the Video Source Format whose presence or absence is indicated by the “F” bit defined above.

MAP: Defines which SMPTE mapping scheme is used (direct mapping, dual link common stream, dual streams)

FRAME: Defines the raster size

FRATE: Defines the frame rate

SAMPLE: Defines the pixel sampling/quantization scheme

FMT-RESERVE: Reserved for future use

Frame and Line Numbering

- Frame numbering
 - Use FRcount field from HBRM payload header (8 bits, rolls over every 256 frames)
 - Use AVTP Video M0 bit in the same way that M bit is used in 2022-6 RTP header
 - M bit marks last packet of the video frame; presumably this allows receiver to know in advance that next packet will be a new frame.
 - Use AVTP Video M1 bit to distinguish between the first and second field in an interleaved pair.
 - Clear bit for all packets of Field 1, Set bit for all packets of Field 2
 - If format is non-interleaved, M1 bit is always 0.
 - Possible problem: the order of the two fields in an interleaved frame might not be always the same (or known a-priori)
 - Question: Should we adopt a toggling scheme rather than set/clear for usage of the M0 bit?
 - Should we define more Marker bits since we are using up both already?
- Line Numbering
 - Provide mechanism for mid-frame recovery from data loss
 - Proposal: Use 2022-6 header with Header Extension
 - Define a 16-bit field in extended header space to contain line number

Delineate packets according to lines?

- SMPTE 2022-6 has no provision for this
 - Every HBRM Transport packet uses 1376 bytes of payload
 - Maximizes use of link bandwidth (minimizes header/payload ratio)
 - Last packet of a video frame is zero-padded to fill up the 1376 bytes
- Mid-frame recovery from data-loss is important for production video use cases
 - But if we map each video line to an integer number of Ethernet frames (or vice versa), we have to modify the packet size or add excess padding
 - Need to do the Math for all anticipated raster sizes (before next F2F!)
 - Desire: All Frames of a given stream are the same size.

Example Math re: packet size

Encoding for 1722a				
Max Frame size (bytes)	1542	bytes	q-tagging in use	
Ethernet framing overhead	42	bytes	incl tag, CRC, IFG, preamble, SA, DA, type	
1722 common stream header	24	bytes		
AVTP Video Header	0	bytes		
HBRM Payload Header	16	bytes	Extended by one quadlet for Line Number	
Payload available	1460	bytes		
Format	SD-SDI-NTSC SMPTE 259C	1080p 60Hz	4k full aperture (cinema)	
Y:Pb:Pr	4:2:2 (10 bit)	4:2:2 (10 bit)	4:4:4 (12 bit)	
Width (pxls)	720	1920	4096	
Height (pxls)	486	1080	3112	
Bits/pxl	20	20	36	
Frame Rate (Hz)	29.97	60	24	
Video bits/sec	2.097E+08	2.488E+09	1.101E+10	
Ancillary data budget	2.0%	2.0%	2.0%	(place holder, this will change)
Total Bytes/sec	2.674E+07	3.173E+08	1.404E+09	
Packets per second	18,317	217,302	961,769	(minimum, not considering how frames are broken up into packets)
Packets per video frame	611.16	3,621.70	40,073.69	
Bits per line	14400	38400	147456	
Bytes per line	1800	4800	18432	
Max frames/line	1.23	3.29	12.62	

Should we use the “Video Timestamp” field defined in HBRM Transport?

- Video Timestamp carries units defined by the CF field (also in HBRM payload header). This is the video pixel clock rate.
- The presentation timestamp in 1722 remains available. It carries units of gPTP time (async to video pixel clock)
- Discussion: Do we have a good reason to use both? Or favor one over the other?
 - We certainly expect to use the 1722 presentation time
 - Note that Video Timestamp is considered invalid if CF set to 0

Definitions and Terminology for p1722A draft

- What is the official name for our format?
 - Considerations:
 - Harmonize with SMPTE
 - Directly target the application space (intra-plant distribution, SDI replacement)
 - A few suggestions
 - Professional Video Format
 - “High Bit Rate Media” Format (same as SMPTE 2022-6)
 - Pro Video+ANC Format (PVA)
 - “Production Plant Video” (PPV) or similar name
 - Production Video
 - SDI Was Great, But... (SWGB)
- Shall we define an AVTP Video “RTP Payload subtype” that maps exactly onto SMPTE 2022-6?
 - Might cause confusion or ambiguity with L2 AVTP Pro Video which is our primary 1722A format
 - If we want this, we must reconcile AVTP Video and RTP headers to make sure all required fields are conveyed.
 - RFC 4175 is a notable alternative for uncompressed video over IP (and not yet listed in the AVTP RTP Payload subtype list)
 - **After discussion: The group is inclined to NOT support this in 1722A. If a user wants direct RTP format, then just use RTP/IP and not translate to 1722A.**

Is it a FORMAT or FORMAT_SUBTYPE?

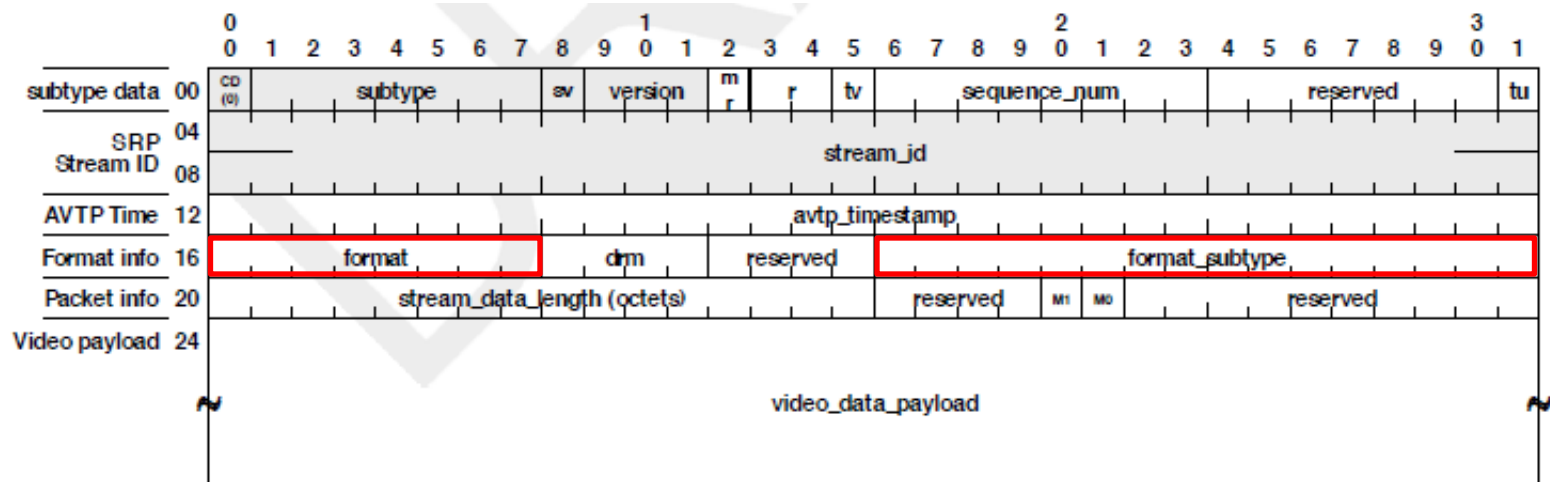


Figure 9.1. AVTP Video PDU format

9.2.1. format field

The format field identifies the video format of the PDU as defined in Table 9.1, “format field”. If a AVTP video PDU is received with a reserved format, the PDU shall be ignored.

Table 9.1. format field

Value	Description
00 ₁₆	Reserved
01 ₁₆	AVTP format We will use this FORMAT code (and rename it)
02 ₁₆	RTP Payload type
03-FD ₁₆	Reserved
FE ₁₆	Vendor Specific
FF ₁₆	Experimental

Using MCN for House Sync

- MCN supports the advertising and selection of house sync clocks
- Stream format needs to be defined
 - Should we create a new 1722 subtype, or should it be a FORMAT under AVTP Video Format list? (answer TBD)
 - Should use as little bandwidth as possible
 - Work with audio contributors to define a similar format for audio and video house clocks (same framework, different formats)
- Details are deferred until next update on AVTP Pro Video

Thank You