IEEE P1722 AVBTP Encapsulations

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Revision History

Rev	Date	Comments
0.01	2007-06-24	First version using formats and notes based on what probably will start going into the draft P1722 specifications.
0.02	2007-06-27	Added draft proposal for fragmentation for discussion on how to handle large CIP packets broken up into smaller packets for the case of 1394/61883 to AVBTP /61883 interworking. Cleaned up some diagrams to correct areas "grey" or white depending on scope of fields versus the diagram (what the diagram was trying to convey as fields of interest).
0.03	2007-07-02	Changed proposed Proprietary/Experimental based on feedback from John Nels Fuller on 2007-07-02 teleconference
0.04	2007-08-08	Changed frame formats and updated diagrams to: •Accommodate latest fragmentation/reassembly proposal (Alan Bartky) •Accommodate for latest "cross timestamp" control frame proposal (Chuck Harrison) •Prepare for draft 0.03 of the P1722 specification. •Updated proposal for "escape type" protocol to accommodate new proposal for standardized fragmentation/reassembly and packet length at "standard" places. Removed detailed description of fields (see draft 0.02 or upcoming 0.03 P1722 specification for those details) except for the new proposal for fragmentation/reassembly .

Encapsulation Design Assumptions

- AVBTP shall use 802.1AS for time base
- AVBTP shall be able to react to change in 802.1AS time (user changing time of day, change in Grandmaster, etc. (see 802.1AS assumptions from AVB document)).
- 61883 format over AVBTP will support presentation time in the same manner as 1394/61883 using the SYT field and in 24.576 MHz cycle time based on 802.1AS clock.
  - 61883-4 & 61883-7: Source Packet Header format with 0-127 seconds, 0-7999 8 kHz cycles, 0-3072 24.576 MHz sub-cycles.
  - All other 61883 encapsulations: CIP header format with 0-15 8 kHz cycles, 0-3072 24.576 MHz sub-cycles.
- AVBTP 61883 presentation time shall be relative to the 802.1AS clock
  - Adapt 1394 AV/C Function Control Protocol (FCP) for use in 61883 over AVBTP.
  - Allow for Proprietary encapsulations via different subtype
  - Allow for other future expansions via different subtypes.

Encapsulation Assumptions

- Approved by Consensus:
  - For AVBTP stream data frames, MAC Destination Addresses shall always be multicast addresses and shall be unique for the Layer 2 network. This address shall be used for stream identification.
  - For AVBTP stream control frames, MAC Destination Address may be unicast, multicast or broadcast depending on the specification of the usage of each AVBTP control frame.

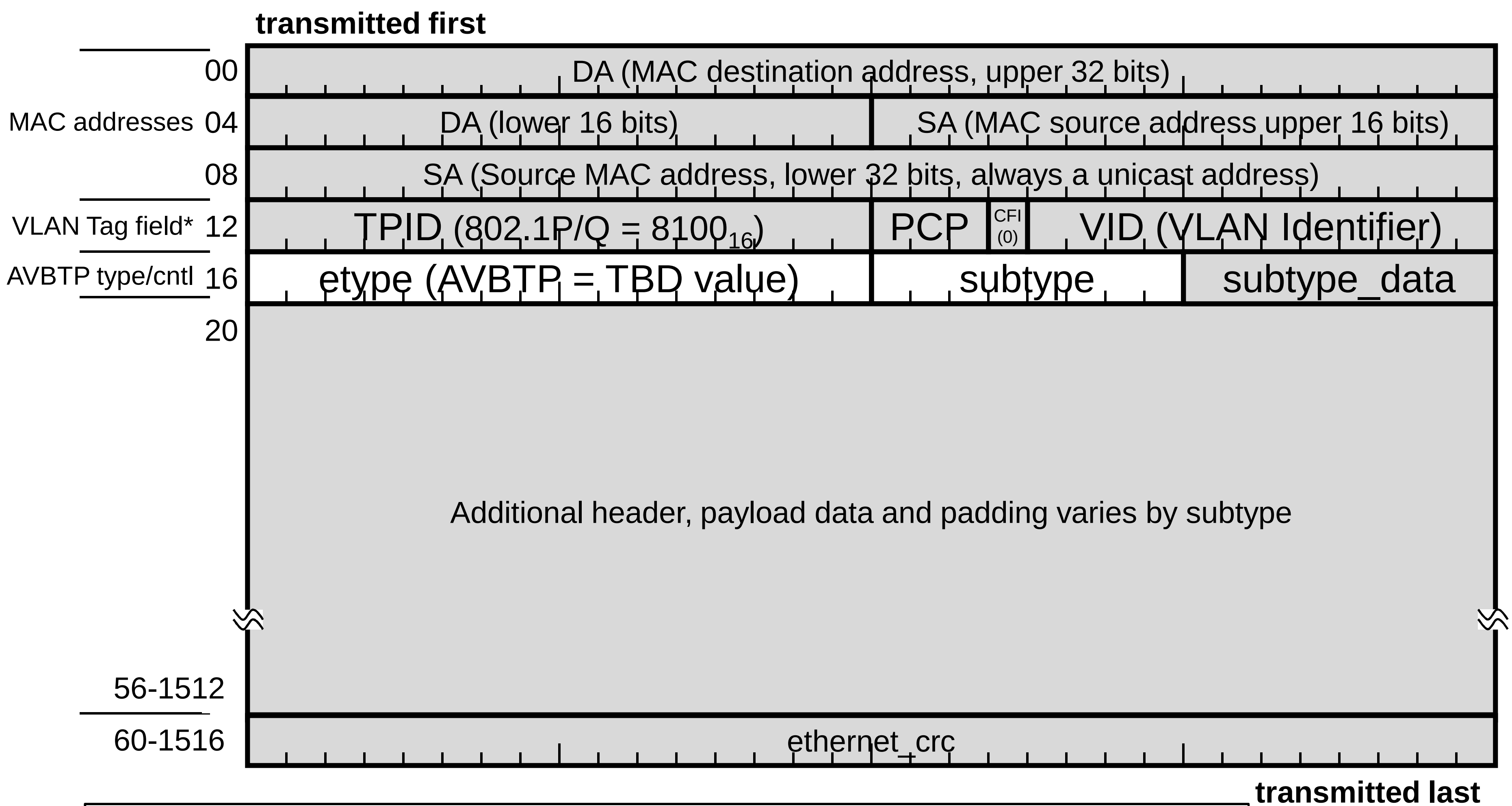
Encapsulation Assumptions

- Approved by Consensus:
  - All talkers shall always send stream data frames with 1st Ethertype field set to 0x8100 for 802.1 P/Q type.
  - For AVBTP, talkers and controllers are not required to send stream control frames with an 802.1 P/Q tag.
  - All devices must always be able to accept data and control frames with an 802.1 P/Q tag.

Encapsulation Assumptions

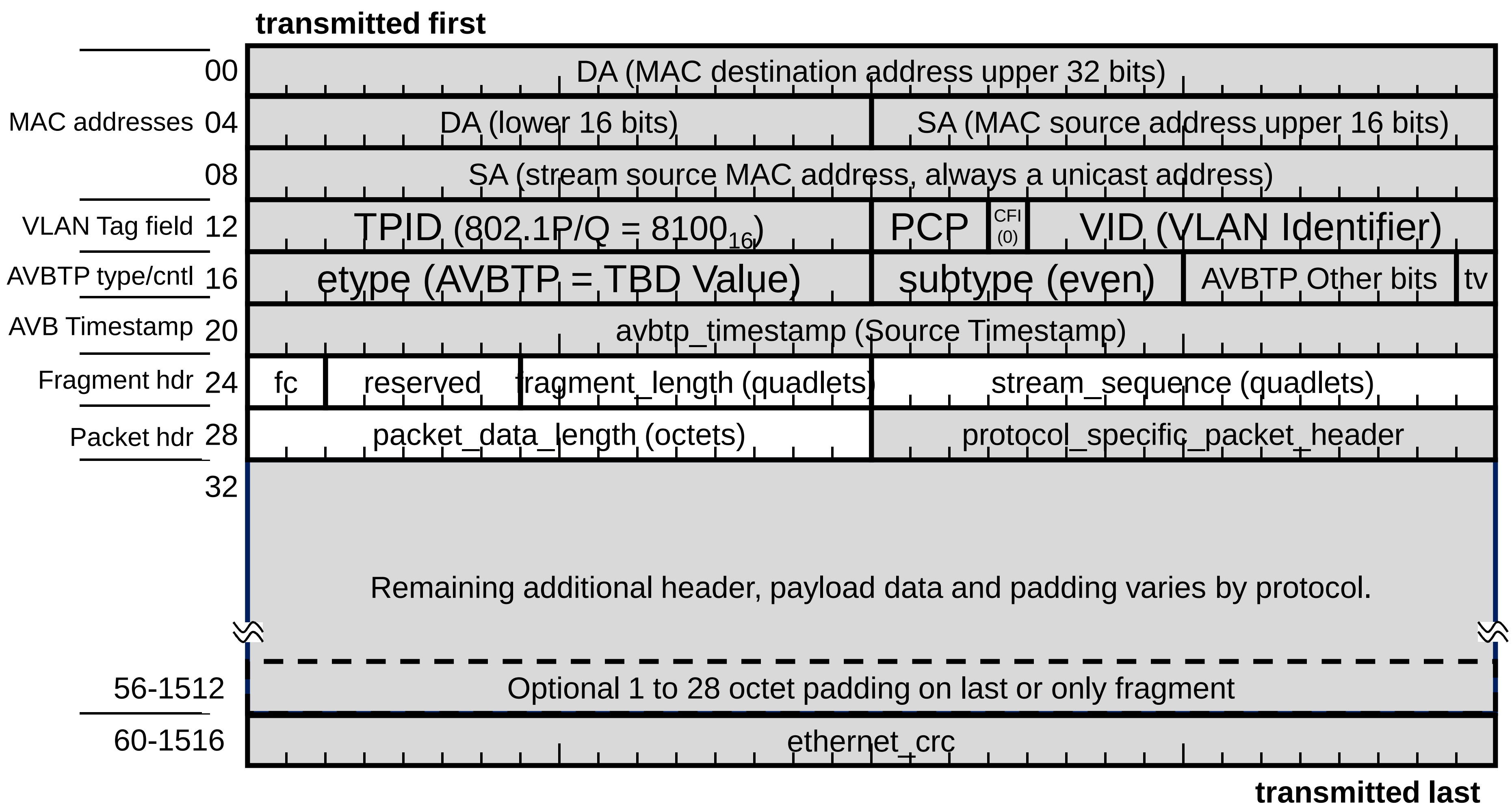
- Approved by Consensus:
  - VLAN Identifier (VID), 12 bits:
    - The VID is a VLAN and not a Stream Identifier
    - AVBTP stations must support VLAN ID of zero to send or receive for stream data traffic.
    - AVBTP stations are recommended to support other VLAN IDs, but it is not required.
    - Receiving AVBTP stations not supporting VLANs or if supported and configured for a given set of VLANs shall discard any frames for which it is not a member of the specified VLAN.
  - Canonical Format Indicator (CFI), 1 bit
    - AVBTP will only support CFI of zero.
  - Priority Code Point (PCP), 3 bits:
    - For data streams, AVBTP shall always specify the appropriate value (default or as administered to a different value) for IEEE 802.1Qav class A or class B traffic.

Draft AVBTP packet



***Note: VLAN Tag field is mandatory for some subtypes and optional for others**

AVBTP stream type, general



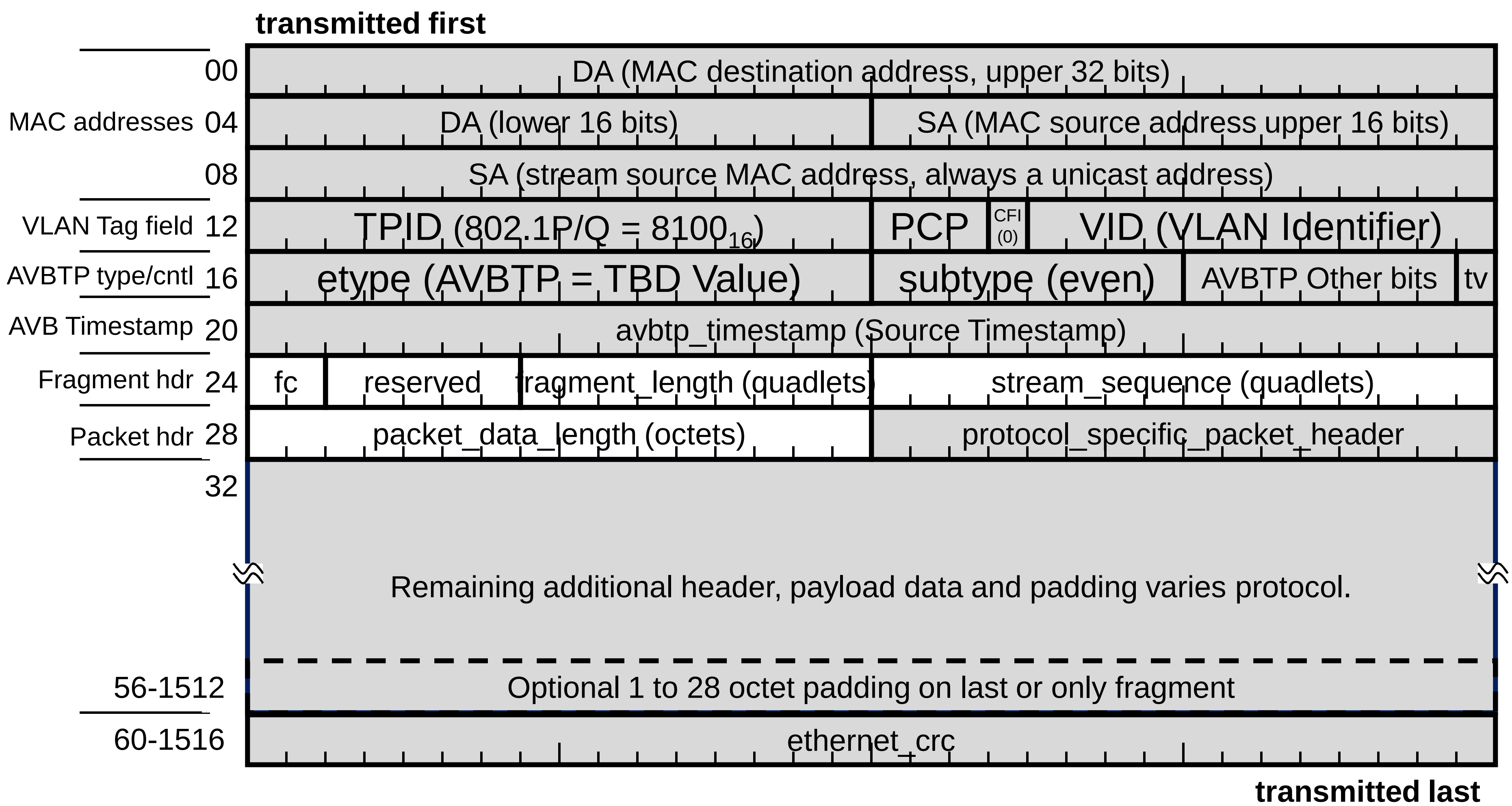
First or only fragment stream packet format

transmitted first

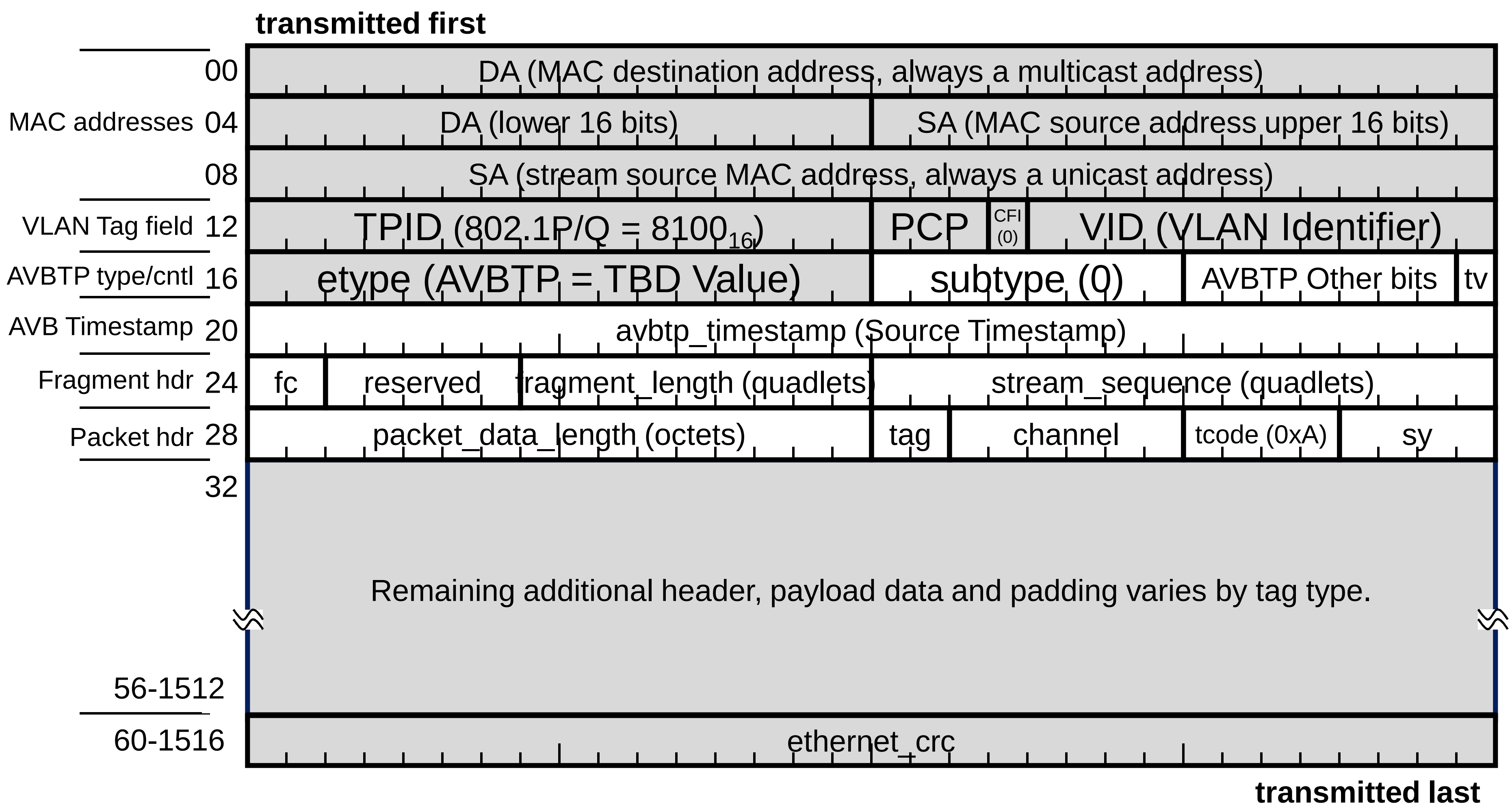
	Offset				
MAC addresses	00	DA (MAC destination address)			
	04	DA (lower 16 bits)	SA (MAC source address upper 16 bits)		
	08	SA (stream source MAC address, always a unicast address)			
VLAN Tag field	12	TPID (802.1P/Q = 8100_{16})	PCP	CFI (0)	VID (VLAN Identifier)
AVBTP type/cntl	16	etype (AVBTP = TBD Value)	subtype (even)	AVBTP Other bits	tv
AVB Timestamp	20	avbtp_timestamp (Source Timestamp)			
Fragment hdr	24	fc	reserved	fragment_length (quadlets)	stream_sequence (quadlets)
Packet hdr	28	packet_data_length (octets)	protocol_specific_packet_header		
	32	Remaining additional header, payload data and padding varies by protocol.			
	56-1512	Optional 1 to 28 octet padding on last or only fragment			
	60-1516	ethernet_crc			

transmitted last

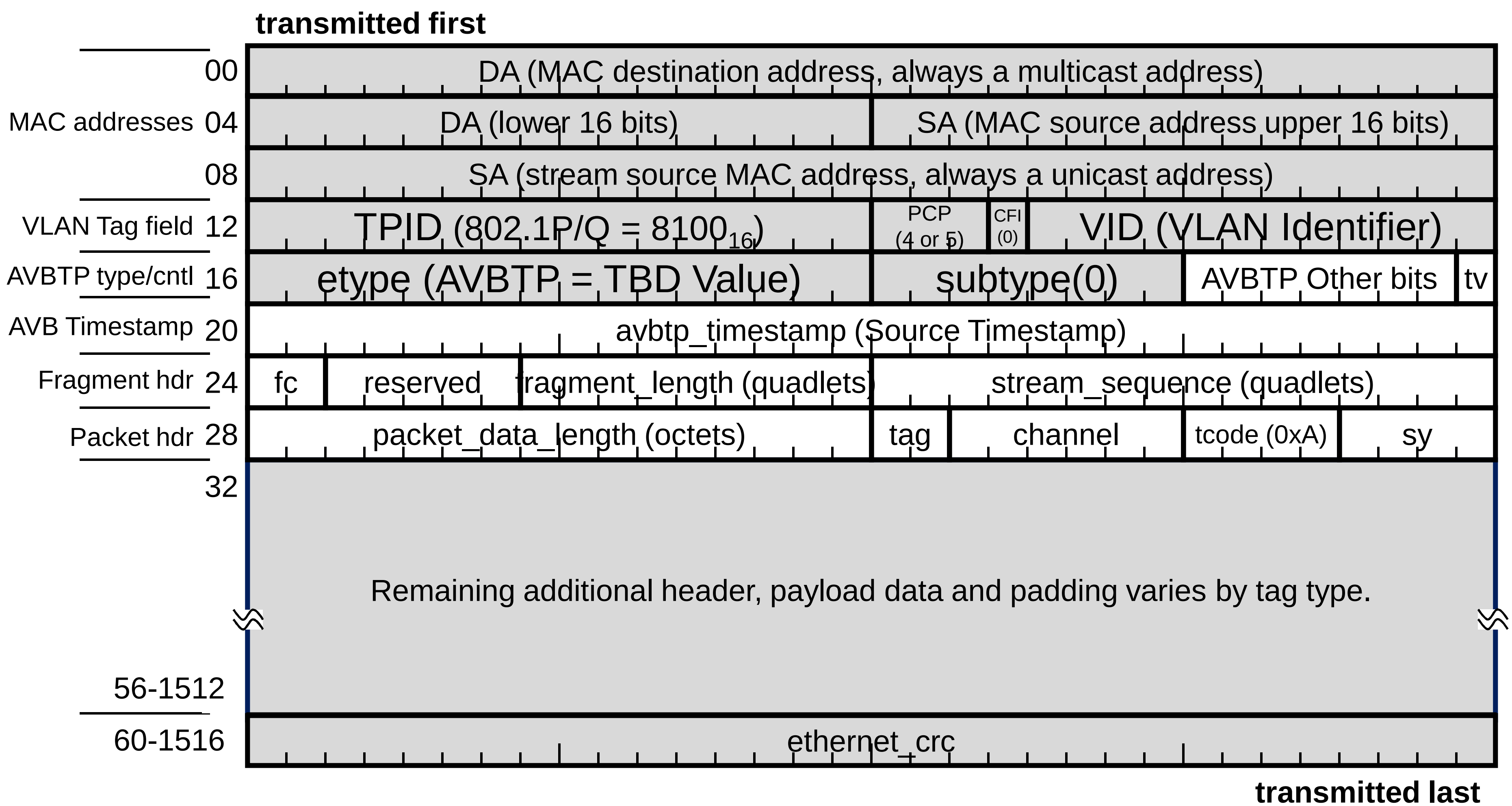
First or only fragment stream packet format



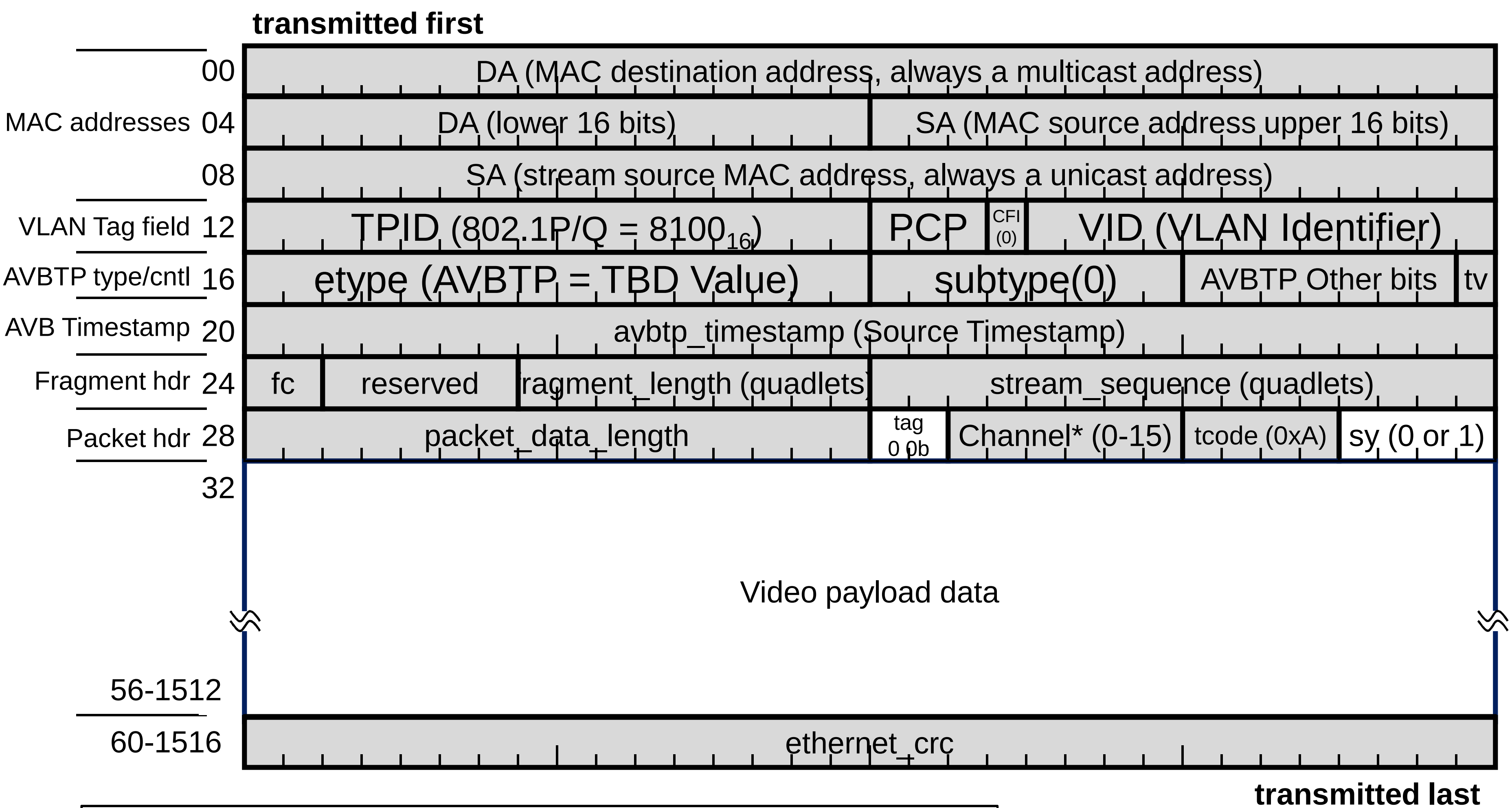
Draft AVBTP Subtype 0, general



Draft AVBTP Subtype 0, 61883/IIDC data packet

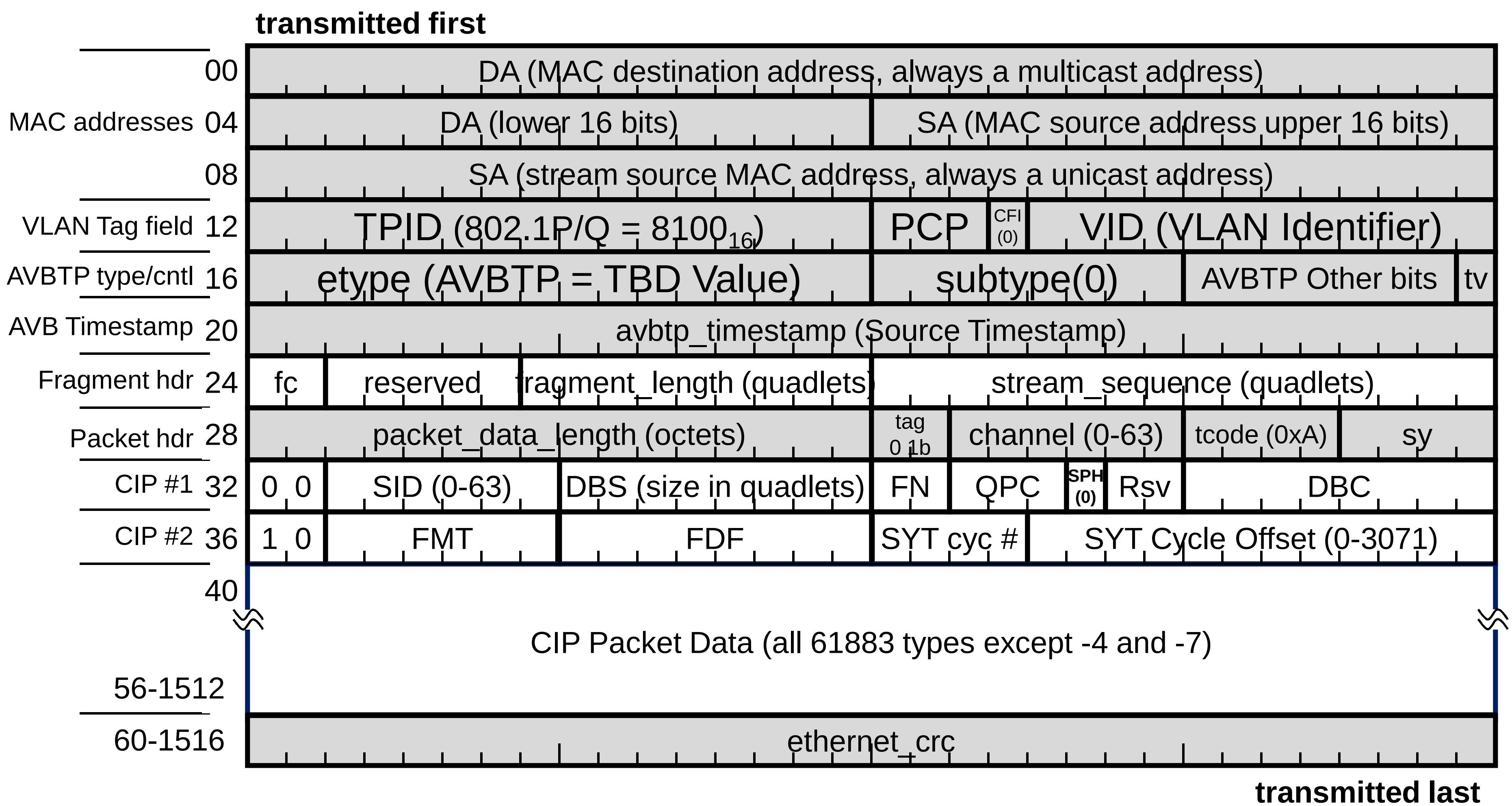


Draft AVBTP IIDC Stream Data packet



***Note: Current standard for IIDC restricts channel ID to 0-15**

Draft AVBTP CIP Stream Data packet, SPH(0)



Draft AVBTP CIP Stream Data packet, SPH(1)

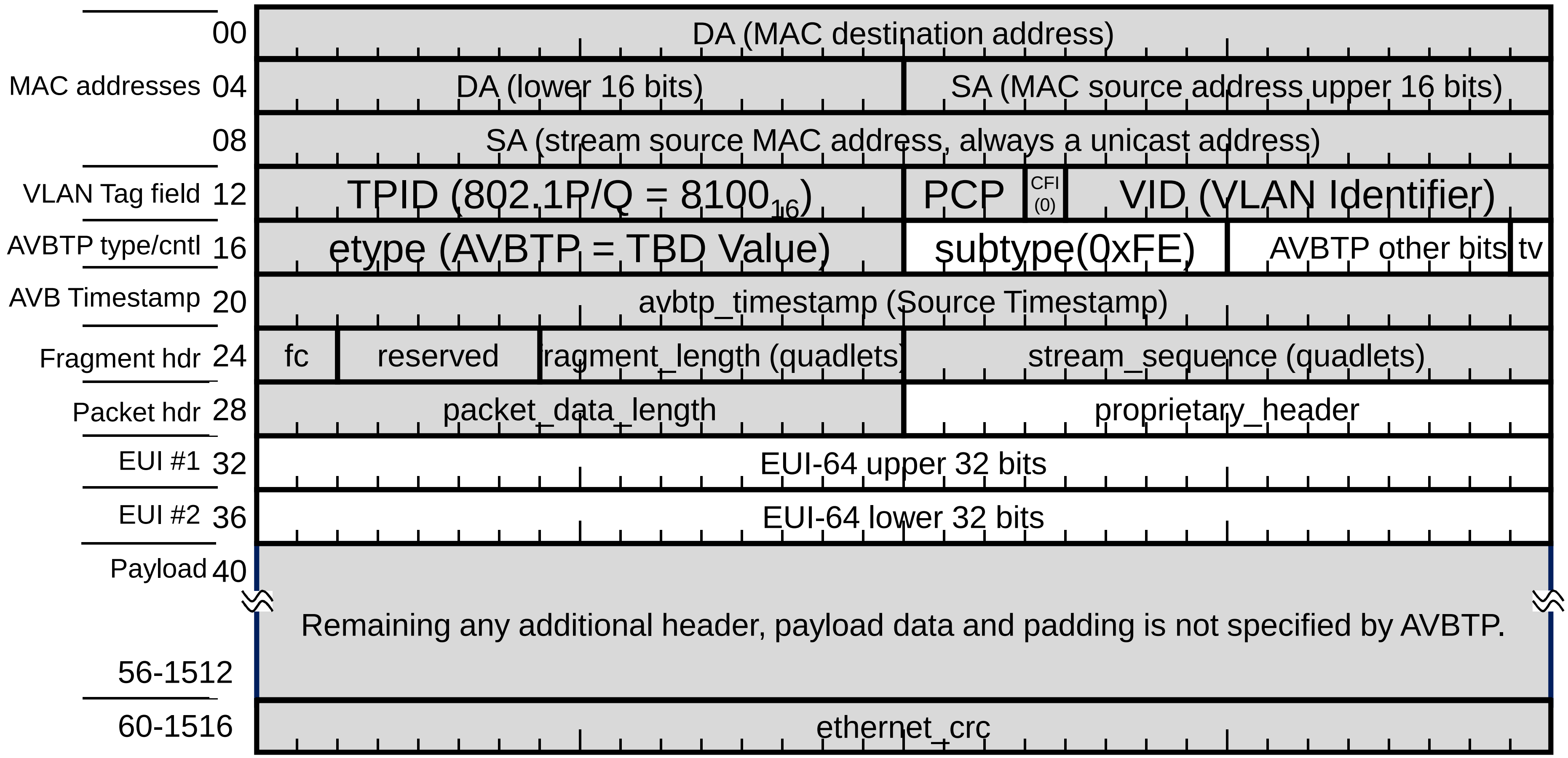
transmitted first

	Offset								
	00	DA (MAC destination address, always a multicast address)							
MAC addresses	04	DA (lower 16 bits)	SA (MAC source address upper 16 bits)						
	08	SA (stream source MAC address, always a unicast address)							
VLAN Tag field	12	TPID (802.1P/Q = 8100_{16})	PCP	CFI (0)	VID (VLAN Identifier)				
AVBTP type/cntl	16	etype (AVBTP = TBD Value)	subtype(0)	AVBTP Other bits	tv				
AVB Timestamp	20	avbtp_timestamp (Source Timestamp)							
Fragment hdr	24	fc	reserved	fragment_length (quadlets)	stream_sequence (quadlets)				
Packet hdr	28	packet_data_length (octets)	tag 0 1b	channel (0-63)	tcode (0xA)	sy			
CIP #1	32	0 0	SID (0-63)	DBS (size in quadlets)	FN	QPC	SPH (1)	Rsv	DBC
CIP #2	36	1 0	FMT	FDF					
Src Packet hdr*	40	reserved	SYT Cycle (0-7999)	SYT Cycle Offset (0-3071)					
	44 56-1512	1st Source Packet Data + optional additional Source Packets (Timestamps & Data) (Note: All timestamps 61883 8 kHz cycle, 24.576 MHz cycle-offset format)							
	60-1516	ethernet_crc							

transmitted last

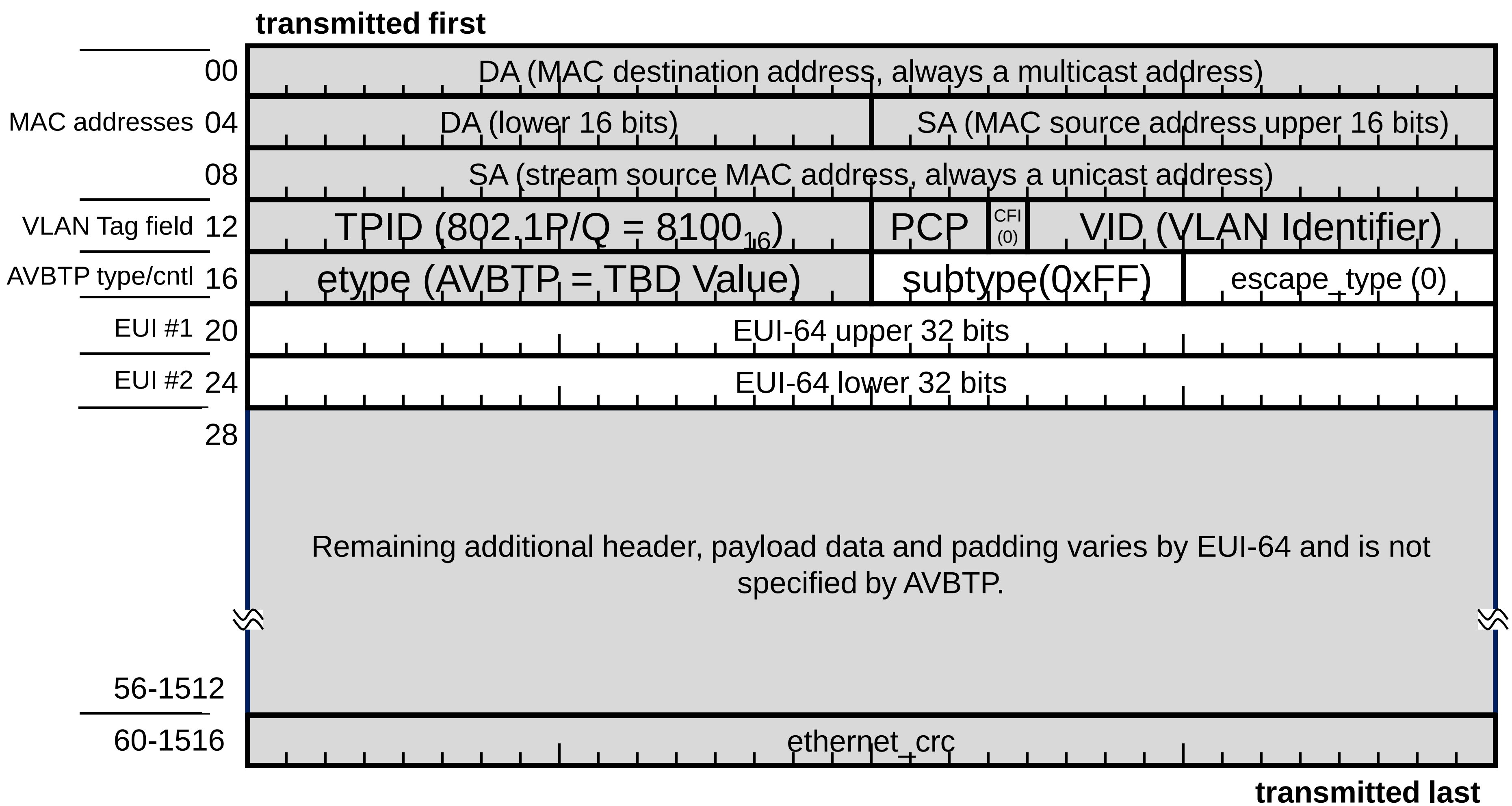
Draft AVBTP “Escape” Stream Data format

transmitted first



transmitted last

Draft AVBTP “Escape” type 0 control format



Fragmentation/Reassembly Details

Cut and pasted, then edited from http://www.avbtp.org/contributions/avbtp-bartky-fragmentation-v0-01-2007-08-03.pdf

Design Goals

- Fragmentation/Reassembly mechanism should be:
  - Efficient
    - only use one quadlet
  - Consistent
    - Common mechanism to serve 61883, IIDC and future applications)
    - Define standard format for fragment length, packet length, sequencing (for both packet loss and possible out of order condition)
  - Simple
    - Implementable by HW or SW
    - Make algorithm simple such that lower bit rate streams that do not need fragmentation (less than about 90 Mbits/sec)
  - Scalable
    - Solve problem from 100 megabit to 10 gigabit
    - Proposal to do all fragmentation, reassembly and sequencing based on quadlets
  - Functional
    - Provide additional functionality of a standard mechanism for sequencing.
    - Provide fields of use for future new protocols to run over AVBTP using the same mechanism.

Proposal Summary

- Provide a fragmentation/reassembly service based on an integral number of quadlets
- Add one additional quadlet to AVBTP header for all stream data frames
- Standardize use of packet length field to use in conjunction with fragmentation and reassembly algorithms (e.g. used as sanity check for reassembly)
  - Use 1394 isochronous packet byte length field from previous proposals

Proposal Summary

- Add the following new fields:
  - Fragment Length (quadlet count)
  - Fragment Control (2 bit control field)
  - Stream Sequence (quadlet count)
- Reuse the 1394 based packet length field, but standardize for all stream types.
- Mandate "smart fragmentation" for cases such as 61883 where packets are to be fragmented on source packet boundaries
  - Fragmentation rules passed to on a per stream basis
    - Per stream needed anyway to handle sequence number control
- Allow for delivery of received pipelined fragments and/or incomplete reassembled packets at AVBTP to upper layer.

Specific fields and rules

- fc: Fragmentation Control (2 bits)
  - NOTE: To make non-fragmented streams easier, a value of 0 is used to indicate first and last status
  - 00_2: Only Fragment
    - Used for all packets that are not fragmented
  - 10_2: First Fragment
    - Indicates to receiver that this fragment contains a packet length and to start reassembly process
      - Store packet length for later sanity check
      - Store stream sequence for order and length checks of subsequent fragments
  - 11_2: Intermediate Fragment
    - Indicates to receiver that this fragment is an intermediate fragment and to continue process
      - Check stream sequence if correct (Else packet lost or out of order fragment received)
      - Check if Packet MTU exceeded (Else packet too large, protocol error)
  - 01_2: Last Fragment
    - Indicates to receiver that this fragment is an last packet fragment and to continue process
      - Check stream sequence if correct (Else packet lost or out of order fragment received)
      - Check if Packet MTU exceeded (Else packet too large, protocol error)
      - If all checks OK and not pipelined, OK to forward complete packet to upper layer and prepare hardware and or software for next stream packet.
      - If desired, the packet length can be checked as an additional sanity check.

General rules

- "If it fits, you must not split"
  - For packets that fit into a single Ethernet frame, the talker shall not break it up into fragments
    - Allows to handle streams up to ~90 Mbits/second without fragmentation/reassembly (keep cost down, possible simplifications, etc. for applications such as speakers, low res cameras, etc.)
- Fragmentation/Reassembly shall be based on quadlets, not bytes.
    - Forces alignment on 32 bit boundaries
    - Reduces bits needed in fragmentation/reassembly control field (one quadlet)
    - Should help it scale better to higher bandwidth streams for both hardware and software.
    - Standard packet octet based length field used if padding necessary.

Specific fields and rules

- stream_sequence(quadlets): 16 bits
  - Indicates current count of stream in quadlets.
  - Talker algorithm
    - Before any packets sent, transmit stream sequence counter is set to zero.
    - Each time a stream fragment (only, first, intermediate or last) is to be sent.
      - Fragment length and current stream sequence counter value is put into the fragment.
      - Fragment length (quadlets) is added to the stream sequence counter.
      - Fragment is transmitted.
  - Listener algorithm
    - On reception of initial “first” or “only” fragment of a stream
      - Stream Sequence value from the fragment is copied to the receive stream sequence counter.
      - Fragment length from the packet is added to the receive stream sequence counter
    - Each time a subsequent stream fragment (only, first, intermediate or last) is received
      - If receive stream sequence counter is not equal to the value in the received frame, then a fragment was lost, received out of order or there was a protocol error.
      - If sequence number is OK, then the fragment can be processed “normally” and the fragment length (quadlets) from the frame is added to the receive stream sequence counter.
      - If frames are not pipelined, then receiver waits for next “first” or “only” packet and discards and resets the receive sequence counter when one of those frames is received.

Specific fields and rules

- packet_length (bytes): 16 bits
  - Same format as 1394, indicates number of octets including any subsequent headers (e.g. CIP) in this packet.
  - As fragmentation is done based on an integral number of quadlets, also used to ignore any optional padding octets at the end of the "last" or "only" fragment.
    - NOTE: 1394 based "portations" to AVBTP should already handle this case have this issue as they already handle this case as 1394 also provides a "quadlet based" service, and 61883-2 through -7 do not have any padding cases as currently defined.

Fragmentation control variables

- All variables are per stream
- packet_header_length:
  - 0 to n quadlets
  - Size in quadlets of packet header, starting at first quadlet past the packet length quadlet
- packet_payload_fragmentaton_unit_size:
  - 1 to n quadlets
  - Size in quadlets of "minimum sized chunks" past the packet_header_length quadlets to break the packet into fragments
- maximum_packet_size:
  - 1 to n quadlets
  - Maximum size for packets sent by talker or received by listener

Fragmentation control variables

- 61884-4 Example:
  - 61883-4 MPEG 192 byte source packets with a 2 quadlet CIP header per CIP packet
  - packet_header_length = 2 quadlets (8 bytes)
  - packet_payload_framentation_unit_size = 48 quadlets (192 bytes)
  - maximum_packet_size = as specified by the application, for this example, lets say max 10 MPEG packets per 125 microsecond cycle, so 2 + (48*10) = 482 quadlets
  - Fragmenter sends 1st fragment with CIP header and 7 MPEG packets and 2nd fragment with remaining 3 MPEG packets.

Fragmentation control variables

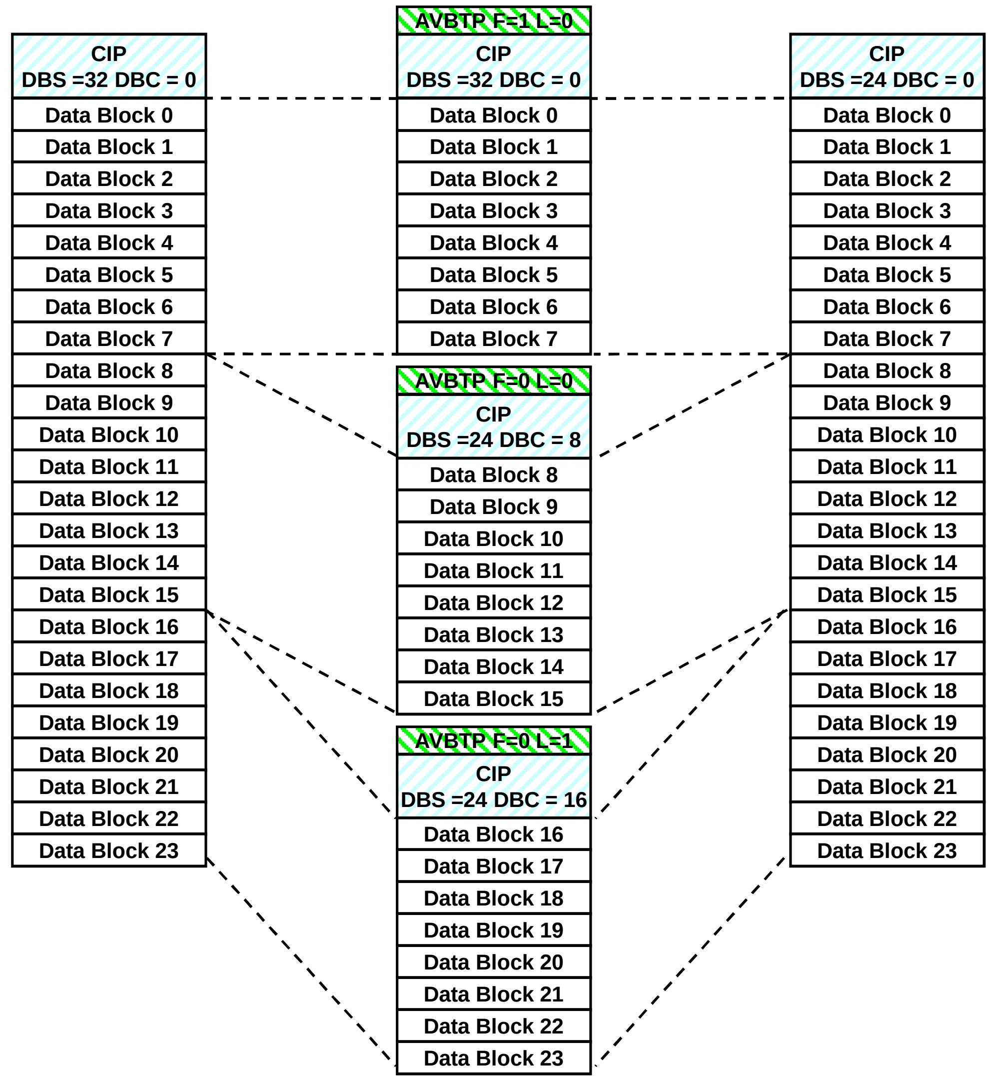
- IIDC Example:
  - IIDC with no CIP packet structure.
  - packet_header_length = 0 quadlets
  - packet_payload_framentation_unit_size = 1 quadlets (4 bytes)
  - maximum_packet_size = as specified by the application, for this example, lets say max of 2000 bytes (500 quadlets)
  - Fragmenter fills 1st fragment with 1488 bytes (372 quadlets) and 2nd fragment with 512 bytes (128 quadlets)

Backup

Previous proposal on fragmentation based on splitting up and creating multiple CIP packets.

Example Data Block Fragmentation

- Example fragmentation based on Data Blocks
- Use case, 61883-6, 192 kHz audio, 32 channels.
  - (24 samples per 8 kHz cycle) * (4 bytes per sample) * 32 channels = 3072 total bytes contained in 24 Data Blocks each 32 quadlets long.
- Need to break into 3 Ethernet Frames
  - First Frame: F bit = 1, L bit = 0, DBC = 0, SYT field copied from source.
  - Middle Frame: F bit =0, L bit = 0, DBC = 8, SYT field set to all ones.
  - Last Frame: F bit = 0, L bit = 1, DBC = 16, SYT field set to all ones
- Reassembly if needed is straight forward:
  - DBS, DBC, SYT copied from packet with F bit = 1,
  - Length calculated by adding lengths of all fragments minus CIP headers of intermediate or last packets.
  - Lost fragments detected by sequence number mismatch (just like for normal streams)



Example Source Packet Fragmentation

- Example fragmentation based on Source Packets
- Use case, 300 megabits/second 422P@HL MPEG-2 (1920x1080 @ 30Hz)
  - ~ 25 MPEG packets per 8 kHz cycle
  - 188 byte packets with 1 quadlet header(192 bytes per Source packet), 8 x 6 quadlet Data Blocks per source packer as per 61883-4 specification.
  - SYT field in source packet headers, not in CIP header.
- Need to break into 4 Ethernet Frames
  - First Frame: First Packet (F) bit = 1, Last Packet (L) bit = 0, DBC = 0
  - 2 Middle Frames: F bit =0, L bit = 0, DBC = 42 & 84
  - Last Frame: F bit = 0, L bit = 1, DBC = 126
- Reassembly if needed is straight forward:
  - DBS & DBC copied from packet with F bit = 1,
  - Length calculated by adding lengths of all fragments minus CIP headers of intermediate or last packets.
  - Lost fragments detected by DBC sequence number mismatch (just like for normal streams)