Audio Video Transport Protocol (AVTP)

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Harman International
Agenda

- IEEE 1722 Background
- AVTP Basic Concepts
  - Media clock reconstruction
  - Presentation Time
  - Latency normalization
  - Lip Sync
- AVTP Packetization
- MAC Address Acquisition Protocol
- IEEE p1722a Overview
IEEE 1722 - Audio Video Transport Protocol

- IEEE 1722 enables interoperable streaming by defining:
  - Media formats and encapsulations
    - Raw & compressed audio/video formats
  - Media synchronization mechanisms
    - Media clock reconstruction/synchronization
    - Latency normalization and optimization
  - Multicast address assignment
    - Assigning AVB Stream ID
    - Reserved pool of addresses
Where does the transport protocol fit?

- Control Applications (SomeIP, FBlocks, 1722.1, etc)
- Connection Management API
- IEEE 802.1AS Precision Time Protocol
- SRP Bandwidth Reservation
- IEEE 1722 AVTP
- FQTSS Shaping
- TCP/IP Protocol Stack
- IEEE 802 Ethernet Driver
AVTP Basic Concepts

• Media clock reconstruction
• Presentation Time
• Latency normalization
• Lip Sync
Media clocks are derived from cross-timestamping
Media clock info embedded in talker’s presentation timestamps

Talker Stream

<table>
<thead>
<tr>
<th>Timestamps</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>7166667</td>
<td></td>
</tr>
<tr>
<td>7333333</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>8666667</td>
<td></td>
</tr>
<tr>
<td>8833333</td>
<td></td>
</tr>
<tr>
<td>9000000</td>
<td></td>
</tr>
</tbody>
</table>

802.1AS Wall Time

Media clock (local oscillator)

Incoming Analog Data

AVBTP Timestamp Generator

A/D

1722 Data
Presentation Time Stamps and 802.1AS wall time used to recreate media clock

Listener Stream
Latency Normalization

Default Presentation Time is 2 mS...

Speaker A buffers audio until Speaker B receives audio and presentation time is reached
Default Presentation Time is 2 ms...

... but Presentation Time can be dialed down

Talker is responsible for setting delay...
Lip Sync Support

- AVTP provides a baseline for Lip Sync
- AVTP does not include codec and other Lip Sync related delays
AVTP packet components

- Ethernet header
  plus
- Common frame header
  - Control frames
    • Common control frame header
    • Protocol-specific headers & payload
  or
  - Streaming frames
    • Common stream data header
    • Streaming data headers & payload
AVTP packets encapsulated within Ethernet header

AVTP Frames are identified by a unique Ethertype
AVTP frame common header fields

**cd**: control or data packet  
**subtype**: protocol type  
**sv**: stream_id valid  
**version**: revision of 1722 standard  
**type_specific_data**: protocol specific info  
**stream_id**: IEEE 802.1Qat stream ID
Command/control packet header (cd=1)

control_data: protocol-specific data
status: status flags, values, etc
control_data_length: length in bytes of control payload

AVTP Control packets used in IEEE P1722.1
AVTP common stream data header

mr: media clock restart
r: reserved
gv: gateway_info field valid
tv: avtp timestamp valid
sequence_number: sequence number
tu: timestamp uncertainty

AVTP Stream packets require an SRP reservation
AVTP subtype field specifies streaming protocol

<table>
<thead>
<tr>
<th>Valued</th>
<th>Function</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>00_{16}</td>
<td>61883_IIDC</td>
<td>IEC 61883/IIDC over AVTP</td>
</tr>
<tr>
<td>01_{16}</td>
<td>MMA</td>
<td>MMA payload over AVTP</td>
</tr>
<tr>
<td>02_{16} – 7D_{16}</td>
<td>-</td>
<td>Reserved for future protocols</td>
</tr>
<tr>
<td>7E_{16}</td>
<td>MAC address acquisition protocol</td>
<td>MAAP</td>
</tr>
<tr>
<td>7F_{16}</td>
<td>Experimental</td>
<td>Experimental</td>
</tr>
</tbody>
</table>
Support for raw & compressed audio/video

• Formats based on IEC 61883 parts 1-8
  – 61883-2 SD-DVCR
  – 61883-4 MPEG2-TS Compressed Video
  – 61883-6 Uncompressed Audio
  – 61883-7 Satellite TV MPEG
  – 61883-8 Bt.601/656 Video
  – IIDC Uncompressed Industrial Cameras
61883-n header(streams) encapsulated in 1722 packets

<table>
<thead>
<tr>
<th>Subtype data</th>
<th>00</th>
<th>subtype (0)</th>
<th>sv</th>
<th>version</th>
<th>m</th>
<th>r</th>
<th>gv</th>
<th>tv</th>
<th>sequence_num</th>
<th>reserved</th>
<th>tu</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRP Stream ID</td>
<td>04</td>
<td>stream_id</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVTP Time</td>
<td>08</td>
<td>avtp_timestamp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Gateway info</td>
<td>12</td>
<td>gateway_info</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packet info</td>
<td>16</td>
<td>stream_data_length (bytes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIP #1</td>
<td>20</td>
<td>tag(1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>channel (0-63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>tcode(A16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIP #2</td>
<td>28</td>
<td>sy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>CIP Packet Data (all IEC 61883 types except -4 and -7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **What Stream?**
- **When to Play?**
- **What to Play?**
Example 61883-6 audio packet

IEEE 1722 packet format for 61883-6/AM824 (Multi-bit linear audio) 48kHz stereo stream

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.3 MAC header</td>
<td>DA (MAC destination address)</td>
</tr>
<tr>
<td>VLAN Tag field</td>
<td>SA (MAC source address)</td>
</tr>
<tr>
<td>AVTP type</td>
<td>TPID (802.1Q = 8100_{16})</td>
</tr>
<tr>
<td>SRP</td>
<td>EtherType (AVBTP = 22F0_{16})</td>
</tr>
<tr>
<td>Stream ID</td>
<td>sequence_num reserved tu stream_id</td>
</tr>
<tr>
<td>AVTP Timestamp</td>
<td>stream_id avtp_timestamp</td>
</tr>
<tr>
<td>gateway_info</td>
<td>gateway_info stream_data_length (bytes)</td>
</tr>
<tr>
<td>61883 CIP header</td>
<td>tag(1) channel (0-63) tcode(A_{16}) sy 0 0 SID (0-63) DBS (size in quadlets)</td>
</tr>
<tr>
<td>61883/AM824 Audio samples</td>
<td>SYT 24-bit audio sample #1 24-bit audio sample #2 24-bit audio sample #3 24-bit audio sample #4 24-bit audio sample #5 24-bit audio sample #6</td>
</tr>
</tbody>
</table>
Example 61883-8 video packet

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 1722</td>
<td>Packet format for 61883-8, Source Packet Type=0 (video data)</td>
</tr>
<tr>
<td>802.3</td>
<td>MAC header</td>
</tr>
<tr>
<td>VLAN Tag field</td>
<td>TPID (802.1Q = 8100)</td>
</tr>
<tr>
<td>AVTP type</td>
<td>EtherType (AVBTP = 22F0)</td>
</tr>
<tr>
<td>SRP Stream ID</td>
<td>sequence_num reserved tu</td>
</tr>
<tr>
<td>AVTP Timestamp</td>
<td>stream_id</td>
</tr>
<tr>
<td>gateway_info</td>
<td>avtp_timestamp gateway_info</td>
</tr>
<tr>
<td>61883 CIP header</td>
<td>tag(1) channel(0-63) tcode(A16) sy 0 0 SID(0-63)</td>
</tr>
<tr>
<td>Source Packet Data</td>
<td>byte 1 video data byte 2 video data</td>
</tr>
<tr>
<td>Video samples</td>
<td>byte 3 video data byte 4 video data</td>
</tr>
<tr>
<td></td>
<td>byte 5 video data byte 6 video data</td>
</tr>
<tr>
<td></td>
<td>byte 715 video data byte 716 video data</td>
</tr>
<tr>
<td></td>
<td>byte 717 video data byte 718 video data</td>
</tr>
<tr>
<td></td>
<td>byte 719 video data byte 720 video data</td>
</tr>
</tbody>
</table>
MAC Address Allocation Protocol

- Stream DA Addresses must be unique
- Method for dynamic address allocation
- Allocate addresses individually or in blocks
- Reserved set of MAC addresses for use by MAAP
- No need for vendors to assign multiple MAC addresses to a device that supports multiple streams
Address Acquisition Algorithm

- Pick random Stream Address(es)
- Probe
- Watch for Reply

1. **Stored Address?**
   - Yes
     - Send Probe
   - No
     - Pick random address from range

2. **Receive Reply**
   - Yes
     - Address available for use
   - No
     - Repeat n times

3. **Wait**
   - Yes
     - Pick random address from range
   - No
     - Repeat n times
Address Defense Algorithm

- Watch for Probe packets
- If a conflict, send a Reply
MAAP Control Frame
MAAP message types

<table>
<thead>
<tr>
<th>Value</th>
<th>Function</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>--</td>
<td>Reserved</td>
</tr>
<tr>
<td>1</td>
<td>MAAP_PROBE</td>
<td>Probe MAC address(es)</td>
</tr>
<tr>
<td>2</td>
<td>MAAP_DEFEND</td>
<td>Defend MAC address(es)</td>
</tr>
<tr>
<td>3</td>
<td>MAAP_ANNOUNCE</td>
<td>Announce acquired MAC address(es)</td>
</tr>
<tr>
<td>4 - 5</td>
<td>--</td>
<td>Reserved</td>
</tr>
</tbody>
</table>
## Reserved MAAP MAC addresses

<table>
<thead>
<tr>
<th>Address Range</th>
<th>Function</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>91:E0:F0:00:00:00–91:E0:F0:00:FD:FF</td>
<td>MAAP Dynamic Allocation Pool</td>
<td>These addresses are available for dynamic allocation by the MAAP.</td>
</tr>
<tr>
<td>91:E0:F0:00:FE:00–91:E0:F0:00:FE:FF</td>
<td>MAAP locally administered Pool</td>
<td>These addresses are reserved to be statically allocated.</td>
</tr>
<tr>
<td>91:E0:F0:00:FF:00–91:E0:F0:00:FF:FF</td>
<td>MAAP Reserved Pool</td>
<td>Reserved</td>
</tr>
</tbody>
</table>
IEEE P1722a – Amendment 1
Extensible Stream Formats

• Program Authorization Request (PAR) approved Sep 2011
• Feature Freeze end of 2012
• Sponsor Ballot mid 2013
• Final Standard end of 2013
IEEE 1722a

• Extensible Audio/Video Formats
  – AVTP Audio
  – AVTP Video
  – AVTP Control Streams

• Media Clock Negotiation Protocol
  – Automatic negotiation of media clock sources

• Diagnostics
  – Common diagnostic variables and counter to aid in detection of network problems
AVTP Audio

• Support for PCM Audio
• High channel counts
  – Less frame overhead
• Simpler data parsing
  – Fixed packet size
  – Single timestamp per packet
• No dependence on 125usec interval
AVTP Video

• Professional Studio quality Video
  – SMPTE 259, 292, 424, etc.
• MJPEG
• H.264
• JPEG 2000
AVTP Control Streams

• Support for Automotive Protocols
  – FlexRay
  – CAN
  – LIN

• Time Sensitive Control Stream
  – Generic format for sending non Audio/Video data in streams
  – Use cases
    • Meter data
    • Time sensitive controls (Lighting cues, etc.)
AVTP Control Streams

CAN Bus A (Bus ID = 2) → Data Encapsulation Gateway → Ethernet (Bus ID = 0) → Data Encapsulation Gateway → CAN Bus B (Bus ID = 1)
Media Clock Streams

• Ability to synchronize multiple devices to a single media stream
• Reduce the need for Sample Rate Conversion
Media Clock Streams

Talker Stream with Media Clock Stream
More info...

• Website

• Email reflector
  – subscribe avbtp `<FirstName> <LastName>` to Listserv@ieee.org

• Weekly phone conferences
  – See website for details

• Face-to-face meetings every two months