Interoperable Intercom in an IP World

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Interoperability Considerations

Payload  Timing  Control
Interoperability

Payload
Interoperability

Payload

Standards
Protocols for AoIP
Commonalities and Interoperability
## ST 2110-30 (AES67 Constraints)

<table>
<thead>
<tr>
<th></th>
<th>AES67</th>
<th>ST 2110-30</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Media Payload</strong></td>
<td>PCM Uncompressed Audio</td>
<td>PCM Uncompressed Audio</td>
</tr>
<tr>
<td><strong>PTP version</strong></td>
<td>IEEE1588-2008 (PTPv2)</td>
<td>IEEE1588-2008 (PTPv2)</td>
</tr>
<tr>
<td><strong>PTP Profile</strong></td>
<td>AES67 Profile</td>
<td>SMPTE 2059-2 Profile</td>
</tr>
<tr>
<td><strong>PTP Leader/Follower</strong></td>
<td>Leader or Follower, selected by BMCA</td>
<td>Must be configurable for Follower Only Mode</td>
</tr>
<tr>
<td><strong>Connection Management</strong></td>
<td>SIP or Unicast</td>
<td>SDP can be used but manual configuration must be possible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NMOS IS-04/IS-05</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>Unicast or Multicast</td>
<td>Multicast only</td>
</tr>
<tr>
<td><strong>Payload and Packet Time</strong></td>
<td>• 1-8 Channels, 1ms, @48kHz mandatory</td>
<td>• Level A: 1-8 Channels, 1ms, @48 kHz</td>
</tr>
<tr>
<td></td>
<td>• all other possibilities allowed</td>
<td>• Level B: 1-8 Channels, 0.125ms, @48 kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Level C: 1-64 Channels, 0.125 ms, @48 kHz</td>
</tr>
</tbody>
</table>
Commonalities and Interoperability

ST 2110-30

SMPTE

Now with AES67

Dante

SPOKEN HERE
## Dante AES67

<table>
<thead>
<tr>
<th></th>
<th>ST 2110-30</th>
<th>Dante – AES67</th>
<th>Dante - 2110</th>
</tr>
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<tr>
<td><strong>Media Payload</strong></td>
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</tr>
<tr>
<td><strong>PTP version</strong></td>
<td>PTPv2 (ST-2059-2 Profile)</td>
<td>PTPv2 (AES67 Profile) AND PTPv1</td>
<td>PTPv2 (ST-2059-2 Profile, AES67 Profile) and PTPv1</td>
</tr>
<tr>
<td><strong>Multicast IP Address</strong></td>
<td>Any address from 239.0.0.1-239.255.255.255</td>
<td>Only addresses that are defined in the Scope in Dante controller.</td>
<td>Any address from 239.0.0.1-239.255.255.255</td>
</tr>
<tr>
<td><strong>PTP Leader/Follower</strong></td>
<td>Must be configurable for Follower Only Mode</td>
<td>Leader or Follower, selected by BMCA. Not configurable for Follower Only Mode</td>
<td>Same as “Dante AES67”</td>
</tr>
<tr>
<td><strong>Connection Management</strong></td>
<td>SDP can be used but manual configuration must be possible.</td>
<td>SAP Discovery. No manual subscription is possible</td>
<td>SAP Discovery. Manual subscription is possible.</td>
</tr>
<tr>
<td></td>
<td>NMOS IS-04/IS-05</td>
<td></td>
<td>No NMOS Support</td>
</tr>
</tbody>
</table>
| **Payload and Packet Time**| • Level A: 1-8 Channels, 1ms, @48 kHz  
• Level B: 1-8 Channels, 0.125ms, @48 kHz  
• Level C: 1-64 Channels, 0.125 ms, @48 kHz | • 1-8 Channels, 1ms, @48kHz only  
• Level B: 1-8 Channels, 0.125ms, @48 kHz  
• Level C: 1-64 Channels, 0.125 ms, @48 kHz | • Level A: 1-8 Channels, 1ms, @48 kHz  
• Level B: 1-8 Channels, 0.125ms, @48 kHz  
• Level C: 1-64 Channels, 0.125 ms, @48 kHz |
Interoperability

Payload

Islanding
Interoperability and Islanding
Interoperability and Islanding
Interoperability and Islanding
Interoperability and Islanding
Payload

Interoperability and Islanding
Interoperability and Islanding
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Interoperability and Islanding
Interoperability and Islanding

Audio Island

Intercom Island

Video Island
Interoperability and Islanding
Interoperability and Islanding
Interoperability and Islanding
Interoperability

Questions?
Interoperability

Timing
PTP – IEEE 1588

- Replaces Sync Pulse Generators
- Started in 2002
  - IEEE-1588-2002 or PTPv1
  - Created to synchronize financial transactions (i.e. wall street)
    - Mobile Phone Tower Transmissions
    - Basically networks that require precise timing but lack access to satellite navigation signals.
- IEEE-1588-2008 (PTPv2)
  - Improves accuracy, precision and robustness
  - Not backwards compatible with PTPv1
PTP – IEEE 1588

- PTP Group 224.0.1.129
  - Sync
  - Follow up
  - Announce
  - Management
  - Delay Request
  - Delay Response

- Hybrid Delay Request and Delay Response are sent via Unicast instead of Multicast
PTP – IEEE 1588

Timing

LEADER

12:00:00
12:00:01
12:00:02
12:00:03
12:00:04
12:00:05
12:00:06
12:00:07
12:00:08
12:00:09
12:00:10
12:00:11
12:00:12
12:00:13

FOLLOWER

11:59:40
11:59:41
11:59:42
11:59:43
11:59:44
12:00:03
12:00:04
12:00:05
12:00:06
12:00:07
12:00:08
12:00:09
12:00:10
12:00:13

Time Stamps
12:00:01
12:00:02
12:00:03
12:00:04
12:00:05
12:00:06
12:00:07
12:00:08
12:00:09
12:00:10
12:00:11
12:00:12
12:00:13

Follow Up (12:00:01)
SYNC
Delay Request
Delay Response (12:00:09)

Time Stamps
11:59:43
- 12:00:01
00:00:18
00:00:18
+ 11:59:45
12:00:03
12:00:05
- 12:00:09
00:00:04

/2
2
PTP – IEEE 1588

BMCA Algorithm

- Best Master Algorithm for the Leader / Follower decision
- Priority 1
- ClockClass
- ClockAccuracy
- Variance
- Priority 2
- ClockIdentity (Based on MAC Address)
LEADER

12:00:04

PTP

FOLLOWER

Boundary Clock

PTP – IEEE 1588

IN SYNC!
Boundary Clock (BC) switch terminates the PTP connection from the Leader and creates a NEW PTP connection towards the Follower.

BC removes Packet Delay Variations (PDV) between itself and the next upstream clock.

BC’s may be installed in every network element for the highest level of performance at the Follower device.

Allows for significantly larger networks.
PTP – IEEE 1588

Timing

LEADER 12:00:04

PTP

SWITCH

Processing Time 00:00:02

FOLLOWER

IN SYNC!

Time Stamp A 12:00:04

Time Stamp B 12:00:06

PTP + Processing Time

12:00:06 - 00:00:02

12:00:04
PTP Aware Transparent Clock Switch

• Takes into consideration processing time incurred within the switch
• TC modifies the PTP packet as it flows through the switch
  - TC removes only its own processing time (end-to-end operation)
• Does not terminate the PTP connection as in BC enabled Switches
• Not scalable to a limitless size
• Good for small to medium size networks
PTP – IEEE 1588

Network Topology In Reality
Interoperability

Questions?
Interoperability

Control
Interoperability

Control

SDP
(Session Description Protocol)
Traditional Approach
Example AES67

v=0
o=- 1311738121 1311738121 IN IP4 192.168.1.1
s=Stage left I/O
c=IN IP4 239.0.0.1/32
t=0 0
m=audio 5004 RTP/AVP 96
i=Channels 1-8
a=rtpmap:96 L24/48000/8
a=recvonly
a=ptime:1
a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FF-FE-07-CB-D0:domain-nmbr=0
a=mediaclock:direct=963214424
Session Description Protocol SDP Example 2110

v=0
o=- 123456 11 IN IP4 192.168.1.1
s=Professional Networked Media Test i=A test of video, audio, and ANC
t=0 0
a=group:LS V1 A1 M1 a=recvonly
m=video 50000 RTP/AVP 96 c=IN IP4 239.0.0.1/32
a=rtpmap:96 raw/90000
a=fmtp:96 sampling=YCbCr-4:2:2; width=1280; height=720; depth=10; colorimetry=BT.2020;EOTF=SMPTE2084
a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FF-07-CB-D0:0
a=mediaclk:direct=2216659908 a=mid:V1
m=audio 50010 RTP/AVP 97 c=IN IP4 239.0.0.2/32
a=rtpmap:97 L24/48000/6 a=ptime:0.250
a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FF-07-CB-D0:0
a=mediaclk:direct=963214424
a=fmtp:97 channel-order=SVIP.(L,C,R,Lrs,Rrs,LFE) a=mid:A1
m=video 50020 RTP/AVP 98 c=IN IP4 239.0.0.3/32
a=rtpmap:98 smpte291/90000
a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FF-07-CB-D0:0
a=mediaclk:direct=2216659908 a=mid:M1
REST Client

Device IP Address: 10.41.5.34

v:0
o: 1443716955 1443716955 IN IP4 10.41.5.34
s: fusion 38.4.0.0-0
a: 0
at: IN IP4 239.20.1.34/64
av: source: filter: incl IN IP4 239.20.1.34 10.41.5.34
ar: rtmp://97 w://10000
a: format: YCbCr-4:2:2; width=1920; height=1080; exact:framerate=60; depth=10; TCS:SDR;
colorimetry: BT709; PM: 2110GPM; SSN: ST2110-29:2017; TP: 2110TP;
amedia: clock: dir=0
acts: refclk: pt= IEEE1588-2008: 00-19:7C-FF-02-57-12:0
ar: mid: primary
mv: video 20000 RTP/AVP 97
c: IN IP4 239.0.0.1/34
as: source: filter: incl IN IP4 239.0.0.1 192.168.0.1
ar: rtmp://97 w://10000
a: format: YCbCr-4:2:2; width=1920; height=1080; exact:framerate=60; depth=10; TCS:SDR;
colorimetry: BT709; PM: 2110GPM; SSN: ST2110-29:2017; TP: 2110TP;
a: medias: clock: dir=0
acts: refclk: pt= IEEE1588-2008: 00-19:7C-FF-02-57-12:0
ar: mid: secondary
ar: inactive
And enter into here....

![Properties of Port 'Test Talk to GV Cam' (Type Split Input AE57)](image)

- **Multicast IP:** 239.32.37.1
- **Multicast Port:** 50030
- **Channels:** 8

**Click here!**
Interoperability

Control

NMOS
Interoperability

• AMWA NMOS Interface Specifications
  - IS-04 – Discovery & Registration
  - IS-05 – Device Connection Management
  - IS-06 – Network Control
  - IS-07 – Event & Tally
  - IS-08 – Audio Channel Mapping
  - IS-09 – System Parameters
  - IS-10 – Authorization
  - IS-11 – Sink Metadata Processing (WIP)
NMOS – Networked Media Open Specification

- ST2110’s Search Engine
- Three Main Components

- **IS-04**
  - Discovery & Registration
  - Pizza menu is listed on doordash

- **IS-05**
  - Connection Management
  - You order the pizza you want

- **IS-06**
  - Network Control
  - DoorDash tells the driver the best way to get to you
IS-04
Discovery and Registration
IS-04 Workflow

IS-04 Registry

DNS-SD _nmos-registration._tcp

Node
  Device
    Sender

Node
  Device
    Receiver
IS-04 Workflow

IS-04 Registry

DNS-SD _nmos-registration._tcp

I am a Registration Server

Node
Device
Sender

mDNS

Node
Device
Receiver

mDNS
IS-04 Workflow

IS-04 Registry

DNS-SD _nmos-registration._tcp

I am a Registration Server

HTTP POST Resources

(Node / Device / ...)

mDNS

(Node / Device / ...)

mDNS
### Devices

<table>
<thead>
<tr>
<th>Label</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Config #1 AE67</td>
<td>um-x-rmos-device/generic</td>
</tr>
<tr>
<td>AES67-108 G2 Bey 1</td>
<td>um-x-rmos-device/generic</td>
</tr>
</tbody>
</table>

**Options:** FIRST, PREV, NEXT, LAST
IS-05
Connection Management
IS-04 & IS-05

IS-05 Workflow

Control System / UI

HTTP GET
Transport File
SDP
Enable Sender

HTTP POST SDP

IGMP Join

Node
Device
Sender

Node
Device
Receiver

IS-04 Registry
IS-04 & IS-05
IS-06
Network Control
SDN – Software Define Networking
Software Defined Networking (SDN)

PMN Architecture

Control

Broadcast Controller (BC)

BC:
1) Tells sources to send
2) Allows flows
3) Tells endpoints to receive

Network Controller (NC)

REST PMN SDN API

Netconf, OF, etc.

Sources

IP Network

Destinations

IGMP Join
Goal: registered network with all devices, controllers and flows
IS-07
Event & Tally Specification
NMOS IS-07
Dataminer Playout Control

Receive an alarm

SmartPanel Keys & Rotaries make changes in Control System

Control system info reflected in the SmartPanel display

NMOS IS-07
Interoperability Considerations

Payload  Timing  Control
Key to IP Intercom Interoperability is

- Remove payload limitations
  - Don’t Island your network
  - Keep Your Protocols Open
- Remove Timing Limitations
  - Keep your timing as accurate as possible with as robust a PTP implementation as possible
- Remove Control Limitations
  - Implement open control protocols
  - Implement monitoring for troubleshooting and security
Interoperability

Questions?
Interoperable Intercom in an IP World

Thank You!

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