PTP: Backbone of the SMPTE ST2110 Deployment

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1. Status on SMPTE ST2110
2. Wide vs Narrow (ST2110-21)
3. PTP system design and remaining issues
ST2110 High level overview

- **ST2110-21**: Traffic Shaping Uncompressed video
- **ST2110-20**: Uncompressed video
- **ST2110-30**: PCM Audio
- **ST2110-31**: AES3 Transparent Transport
- **ST2110-40**: Ancillary Data
- **ST2022-7**: Seamless Protection Switching of IP Datagrams

System Timing “ST2059-2” PTP profile

From IP Showcase Theatre at IBC 2018
Curated by the Video Services Forum vsf.tv
ST2110-50 now becomes “ST2022-8”

Formatting the ST2022-6 to follow ST2110

ST2110-20 “Format Agnostic”

ST2110-20
One Encapsulation Standard
ST-2110 “Compression”

Draft state:

Integration of Compressed signals

ST2110-22 Compressed video

State: FCD Ballot Opened

ST-2110-30 “PCM audio”

“-30” is defined to provide a lot of flexibility;

➢ Audio shuffling and breakaways in the network
➢ 1x PCM per flow, or 16 PCM per flow, or anything in between
➢ Redundancy with ST2022-7
ST-2110-30 “PCM audio”
“+ multiple audio profiles;

<table>
<thead>
<tr>
<th>Level</th>
<th>1 msec Packet time</th>
<th>125 μsec Packet Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48 KHz</td>
<td>96 KHz</td>
</tr>
<tr>
<td>A</td>
<td>1 to 8 ch</td>
<td></td>
</tr>
<tr>
<td>AX</td>
<td>1 to 8 ch</td>
<td>1 to 4 ch</td>
</tr>
<tr>
<td>B</td>
<td>1 to 8 ch</td>
<td></td>
</tr>
<tr>
<td>BX</td>
<td>1 to 8 ch</td>
<td>1 to 4 ch</td>
</tr>
<tr>
<td>C</td>
<td>1 to 8 ch</td>
<td></td>
</tr>
<tr>
<td>CX</td>
<td>1 to 8 ch</td>
<td>1 to 4 ch</td>
</tr>
</tbody>
</table>

But wait! Let’s be pragmatic…

1x Flow per channel
16 channels per Source
+ X2 for ST2022-7
= 32 flows per Source

Is this not a configuration nightmare?
Can the system really scale?
Do you really need that much flexibility?
ST-2110-30 “PCM audio”

More Reasonable Implementation:

- Reduce the number of flows to a reasonable quantity
- Group channels that should not be shuffled
- Use specialized audio channel matrix where needed

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Wide versus Narrow

NARROW Sender

Steady packet pacing (Isochronous)

WIDE Sender

Bursty packet pacing

Impact on the Receiver

NARROW Sender

Steady packet pacing (Isochronous)

WIDE Sender

Bursty packet pacing

Min - 720 Packets - recommended
Embrionix: 7 - 4096 = 1 UHD frame
Gapped versus Linear encapsulation

Gapped Sender

Incoming SDI / HDMI signal

Video IP flow

Gapped Versus Linear

Video IP flow

Linear Sender

Incoming SDI / HDMI signal + buffer

Computer generated video

Gapped Sender

ST2110-21 (profiles)

v=0
o= 1443716955 1443716955 IN IP4 192.168.39.140
s=st2110 0-0-0
t=0 0
m=video 20000 RTP/AVP 96
c=IN IP4 225.16.2.1/64
a=source-filter: incl IN IP4 225.16.2.1 192.168.39.140
a=rtpmap:96 raw/90000
a=fmtp:96 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=30000/1001; depth=10; TCS=SDR; colorimetry=BT709;
PM=2110GPM; SSN=ST2110-20:2017; TP=2110TPN; interlace=1
a=mediaclk:direct=0
a=ts-refclk:ptp=IEEE1588-2008:08-00-11-ff-fe-22-91-bb:0

TP=2110TPN --> NARROW
TP=2110TPNL --> NARROW LINEAR
TP=2110TPW --> WIDE
Receiver can adapt to the Sender type

**NARROW Sender**
- Video
- IP ENCAP

**WIDE Sender**
- Video
- IP ENCAP

**SDP file**

**ADAPTIVE Receiver**
- Control
- Process

**Short delay (7 µs)**

**NARROW**

**WIDE**

**NET**

**Longer delay (in ms)**
Dealing with Packet Impairments

Packet impairments can be introduced by the various physical layers inside your network!

TCP: Packets are retransmitted

UDP: Packets are lost / dropped

Possible Packet Impairments

Jitter / Accumulation / Busting Packets

Out of Order Packets
Possible Packet impairments

### Packet Duplication

- **Device**: 8 7 6 5 4 3 2 1
- **Network**: 8 7 6 5 4 3 2 1
- **Receiver**: 8 7 6 5 4 3 2 1

### Packet Drop

- **Device**: 8 7 6 5 4 3 2 1
- **Network**: 6 7 8 5 1 2 1
- **Receiver**: 8 7 6 5 4 3 2 1

### Packet Corruption

- **Device**: 8 7 6 5 4 3 2 1
- **Network**: 8 7 6 5 4 1 2 1
- **Receiver**: 8 7 6 5 4 3 2 1
Takeaways

- Recommended to design Narrow senders; especially when used for production / real time application
- Wide senders is a reality and the Receivers must take this into account
- Receiver must be capable to recover from eventual packet impairments from your network

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How do we genlock signals in IP?

- Used as a reference for Composite and SDI signals
- Horizontal and Vertical alignments
- Color phasing
- Switching accuracy

Black Burst Signal

How do we genlock signals in IP?

- Same role as Black Burst
- Servo-master – Slave Hierarchy type alignment process

PTP Timing
When is PTP required?

- Switching from one source to another

- Rebuilding a ST2110 (Video/Audio/ANC)

Typical IP Media facility
A closer look!

1- PTP master sends the sync time to the slave
2- Slave device sends a delay request to the master
3- Slave receives a delay response from the master

8x / sec ➞ AES-R16 profile

The locking time should take 5sec
PTP within a Spine / Leaf Architecture

Leaf switch establishes PTP reference with PTP Master Clock

Transparent clock simply modifies the PTP messages to compensate for its own propagation delay

Leaf switch establishes PTP reference with Leaf switch

Edge device establishes PTP reference with Leaf switch

PTP within a Spine / Leaf Architecture

Between Master and Slave

UNICAST PTP

M → S

MULTICAST PTP

M → S

HYBRID PTP

M → S

M ← S

M ← S

M ← S
Best Selection of Grand Master

1. Identifier
2. Quality
3. Priority
4. Variance

Packet Time Stamping for Realignment

Video, Audio and ANC packets are aligned using Timestamps Index.
Takeaways

• PTP is a necessity in any IP ST2110 deployment
• Black burst must be in phase with PTP
• PTP aware IP switches! “Boundary clock” is necessary in a Spine/Leaf architecture
• Redundancy; support of (BMCA) Best Selection of Grand Master
• Edge device packet buffering space to handle network latency and Wide sender profile

Thank You

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