PTP: Backbone of the SMPTE ST2110 Deployment

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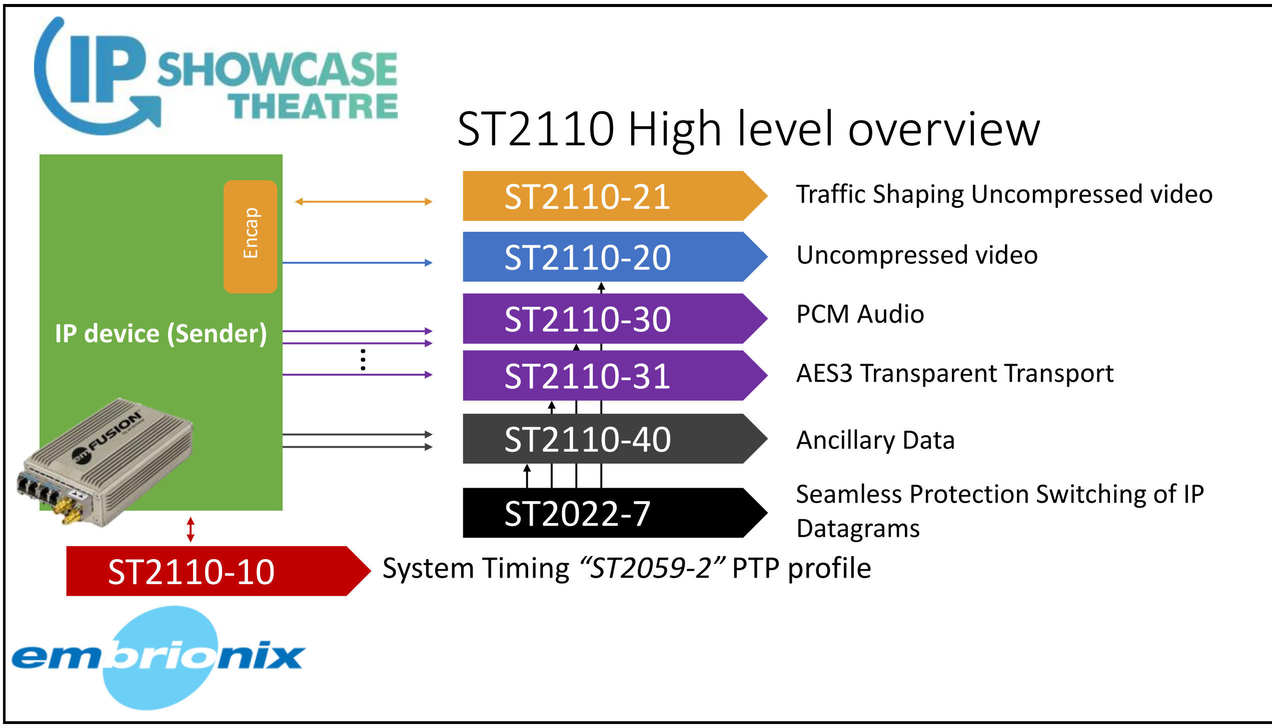
Embrionix

IP SHOWCASE THEATRE AT IBC – SEPT. 14-18, 2018

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


IP SHOWCASE THEATRE
ST2110 High level overview
Encap
IP device (Sender)
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
ST2110-10
System Timing *"ST2059-2"* PTP profile
FUSION
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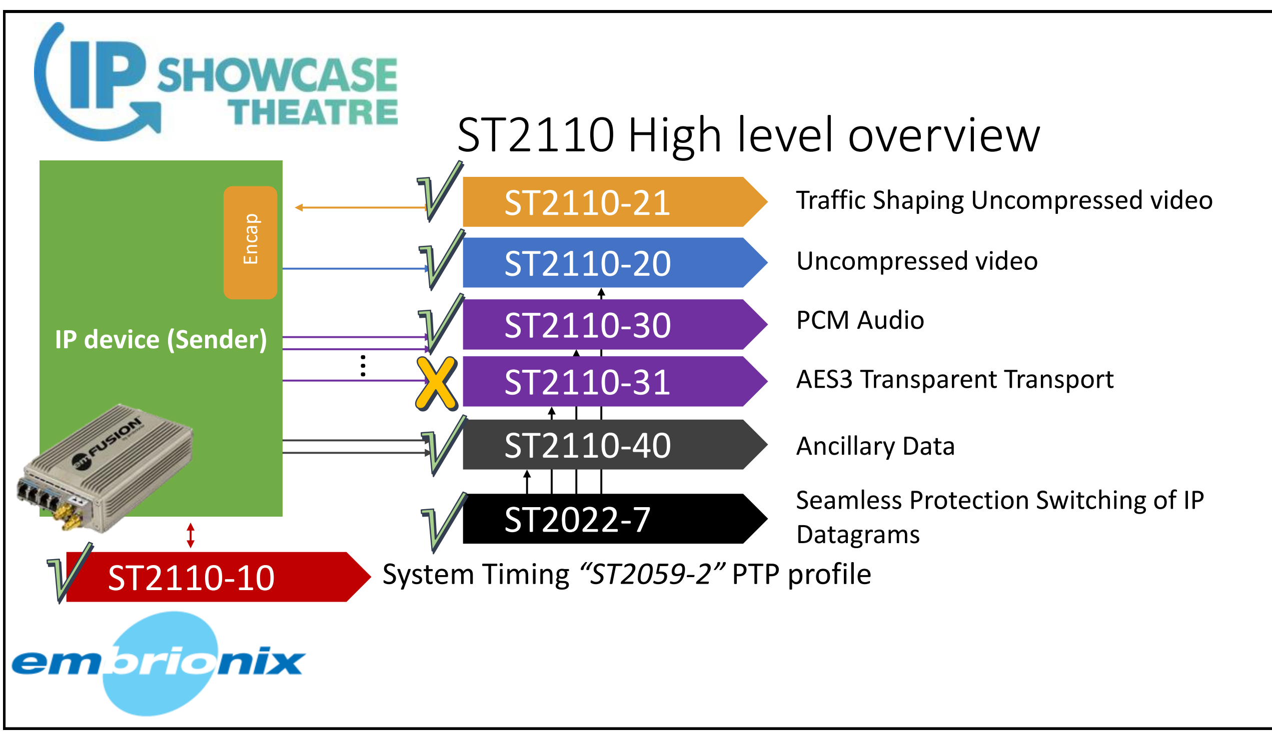
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FUSION
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IP SHOWCASE THEATRE

~~ST2110-50~~

ST2110-50 now becomes “ST2022-8”

ST2022-8

Formatting the ST2022-6 to follow ST2110

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ST-2110-20 “Format Agnostic”

SD SDI

HD SDI

3G SDI

4K

8K

SDR

HDR

ST2110-20

One Encapsulation Standard

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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;

Level	1 msec Packet time		125 µsec Packet Time	
	48 KHz	96 KHz	48 KHz	96 KHz
A	1 to 8 ch			
AX	1 to 8 ch	1 to 4 ch		
B	1 to 8 ch		1 to 8 ch	
BX	1 to 8 ch	1 to 4 ch	1 to 8 ch	1 to 8 ch
C	1 to 8 ch		1 to 64 ch	
CX	1 to 8 ch	1 to 4 ch	1 to 64 ch	1 to 32 ch

ST-2110-30 "PCM audio"

But wait ! Let's be pragmatic…

1x Flow per channel

16 channels per Source

\+

X2 for ST2022-7

=

<u>32 flows per Source</u>

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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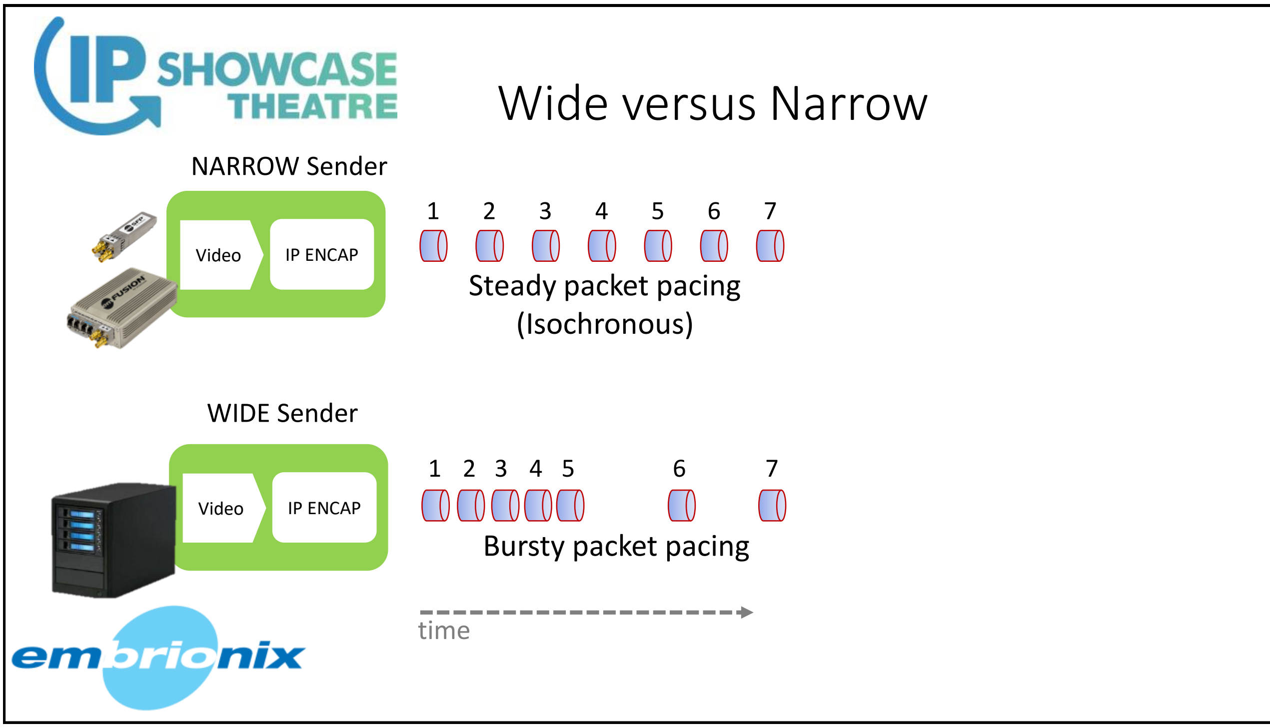
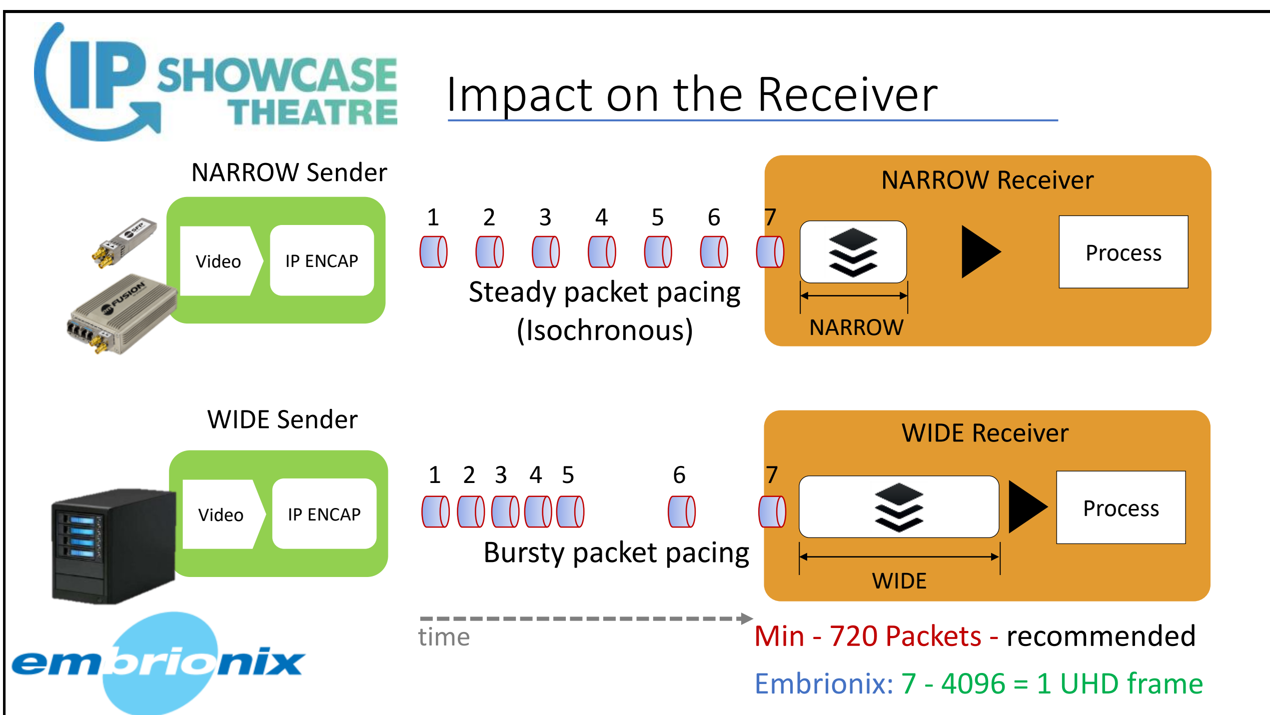
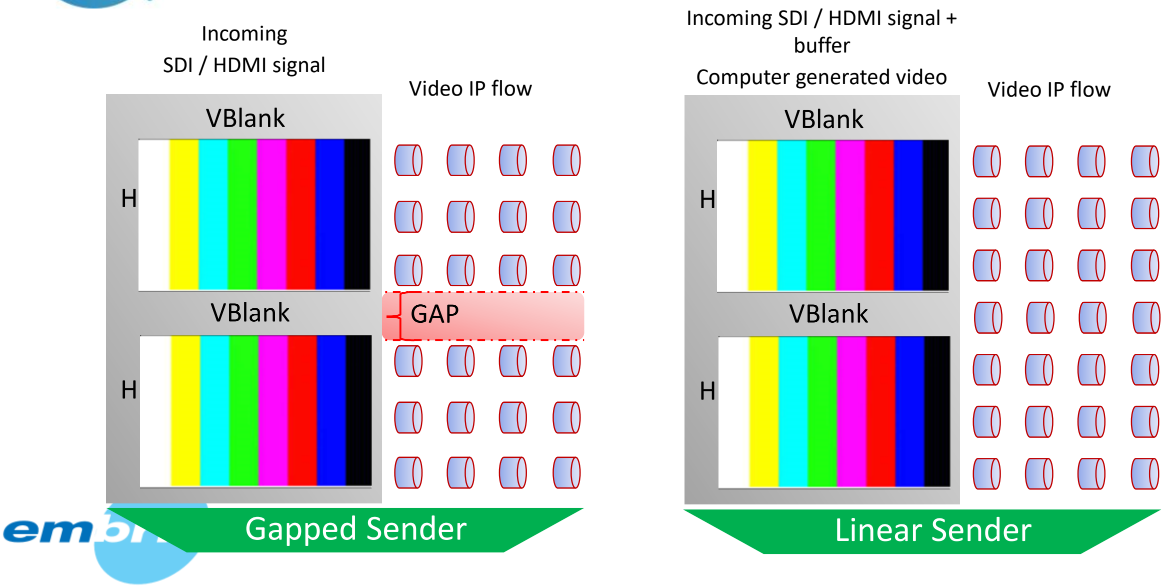

Wide versus Narrow
NARROW Sender
Video
IP ENCAP
1 2 3 4 5 6 7
Steady packet pacing
(Isochronous)
WIDE Sender
Video
IP ENCAP
1 2 3 4 5 6 7
Bursty packet pacing
time


Impact on the Receiver
NARROW Sender
Video
IP ENCAP
1 2 3 4 5 6 7
Steady packet pacing
(Isochronous)
NARROW Receiver
Process
NARROW
WIDE Sender
Video
IP ENCAP
1 2 3 4 5 6 7
Bursty packet pacing
WIDE Receiver
Process
WIDE
time
Min - 720 Packets - recommended
Embrionix: 7 - 4096 = 1 UHD frame

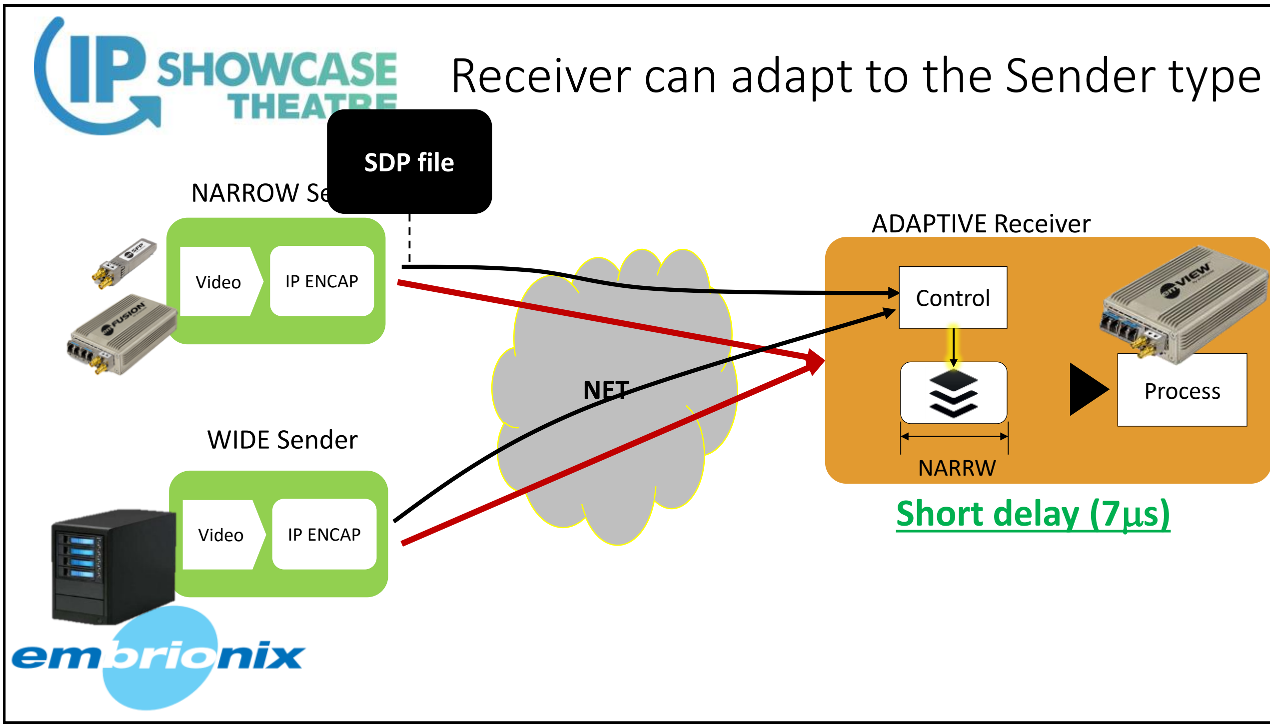
Gapped versus Linear encapsulation

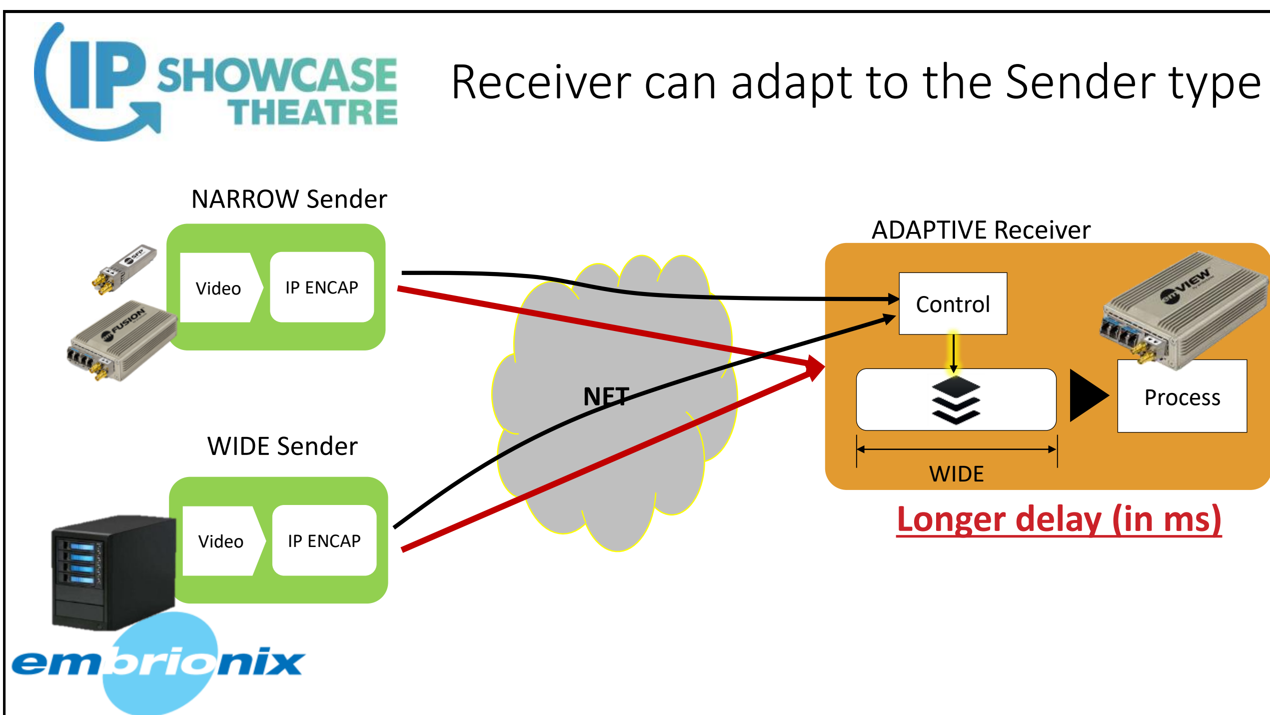


ST2110-21 (profiles)

```
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
SDP file
NARROW Se
Video
IP ENCAP
WIDE Sender
Video
IP ENCAP
NET
ADAPTIVE Receiver
Control
Process
NARRW
Short delay (7µs)


Receiver can adapt to the Sender type
NARROW Sender
Video
IP ENCAP
WIDE Sender
Video
IP ENCAP
NET
ADAPTIVE Receiver
Control
Process
WIDE
Longer delay (in ms)

IP SHOWCASE THEATRE

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

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IP SHOWCASE THEATRE

Possible Packet Impairments

Jitter / Accumulation / Busting Packets

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

Out of Order Packets

Device

8 7 6 5 4 3 2 1

Network

6 7 8 5 3 4 2 1

Receiver

8 7 6 5 4 3 2 1

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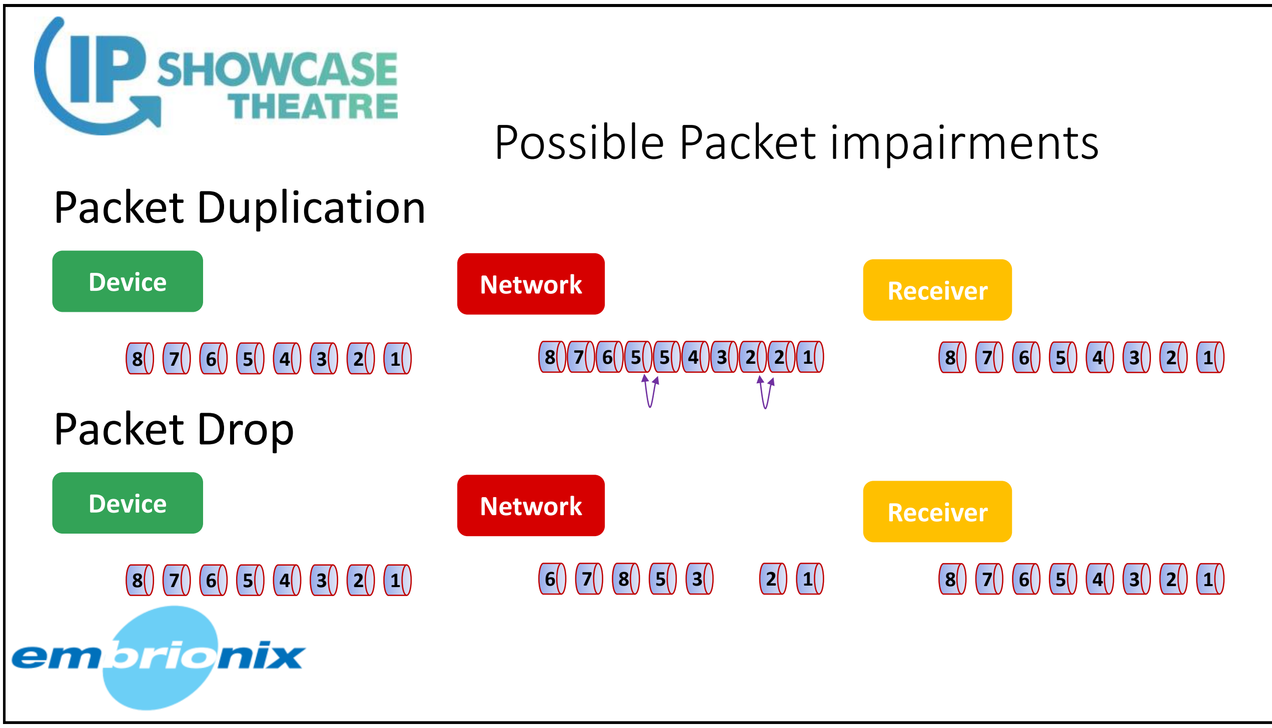
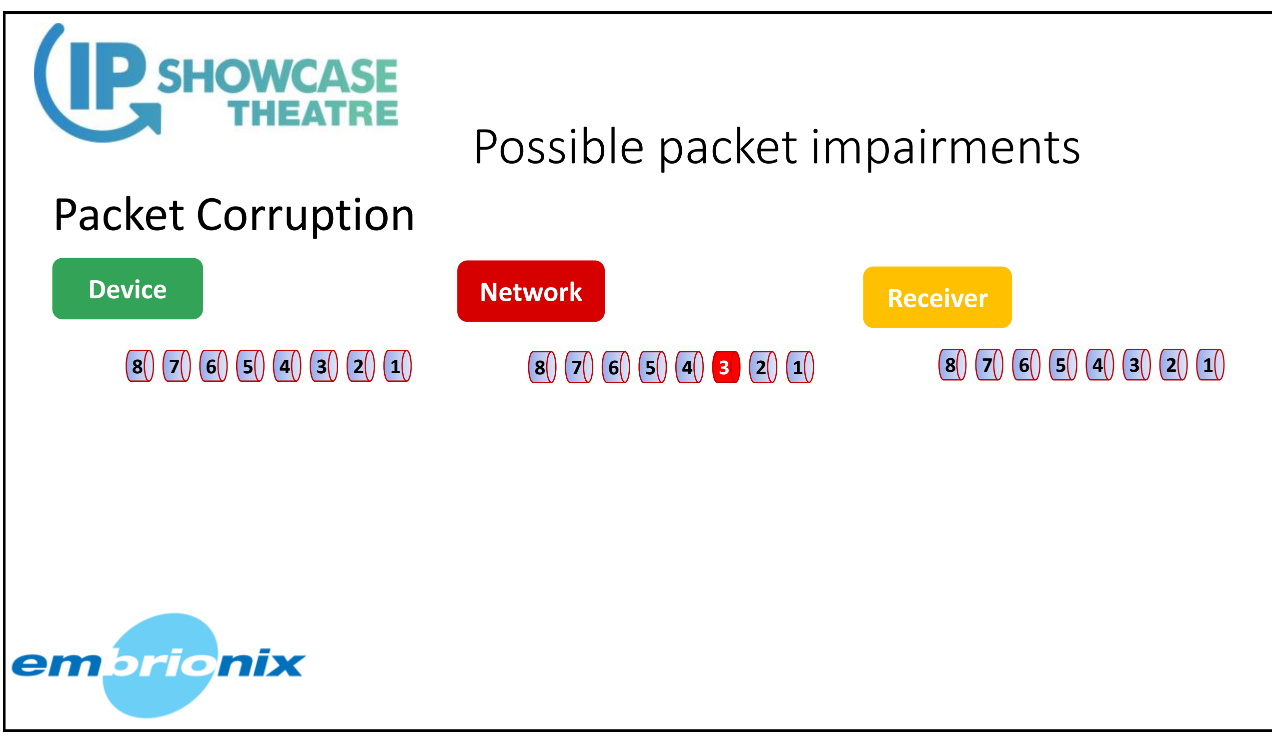

Possible Packet impairments
Packet Duplication
Device
Network
Receiver
8 7 6 5 4 3 2 1
8 7 6 5 5 4 3 2 2 1
8 7 6 5 4 3 2 1
Packet Drop
Device
Network
Receiver
8 7 6 5 4 3 2 1
6 7 8 5 3 2 1
8 7 6 5 4 3 2 1


Possible packet impairments
Packet Corruption
Device
Network
Receiver
8 7 6 5 4 3 2 1
8 7 6 5 4 3 2 1
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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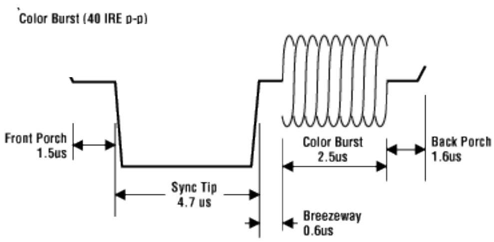
How do we genlock signals in IP ?

SDI System



Black burst Signal

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

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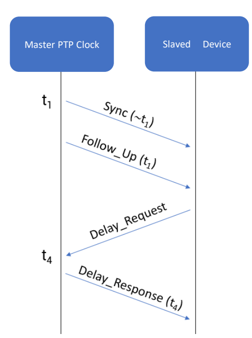
How do we genlock signals in IP ?

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

IP System



PTP Timing

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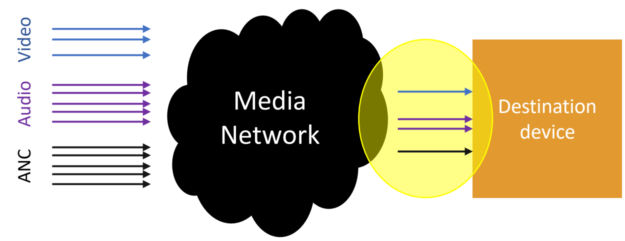
When is PTP required ?

- Switching from one source to another

- Rebuilding a ST2110 (Video/Audio/ANC)



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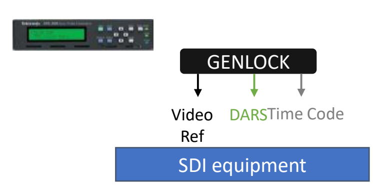
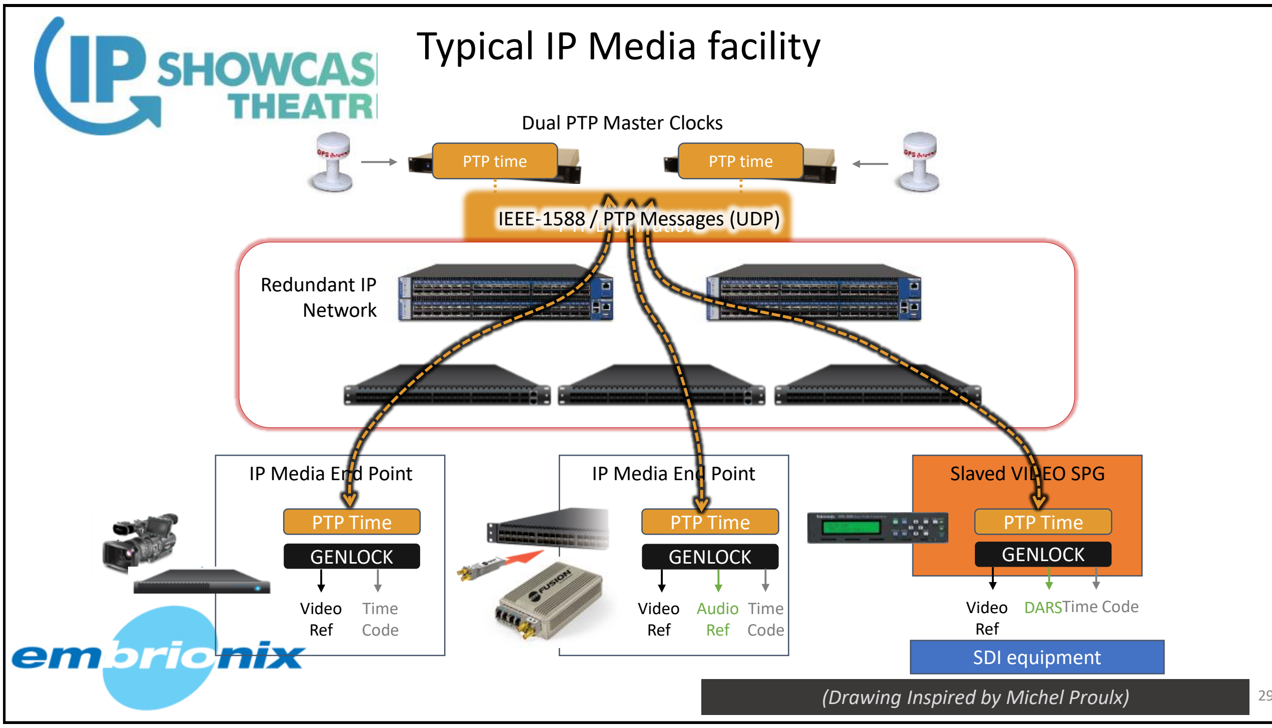
Typical IP Media facility



28


Typical IP Media facility
Dual PTP Master Clocks
PTP time
PTP time
IEEE-1588 / PTP Messages (UDP)
Redundant IP Network
IP Media End Point
PTP Time
GENLOCK
Video Ref
Time Code
IP Media End Point
PTP Time
GENLOCK
Video Ref
Audio Ref
Time Code
Slaved VIDEO SPG
PTP Time
GENLOCK
Video Ref
DARS
Time Code
SDI equipment
(Drawing Inspired by Michel Proulx)
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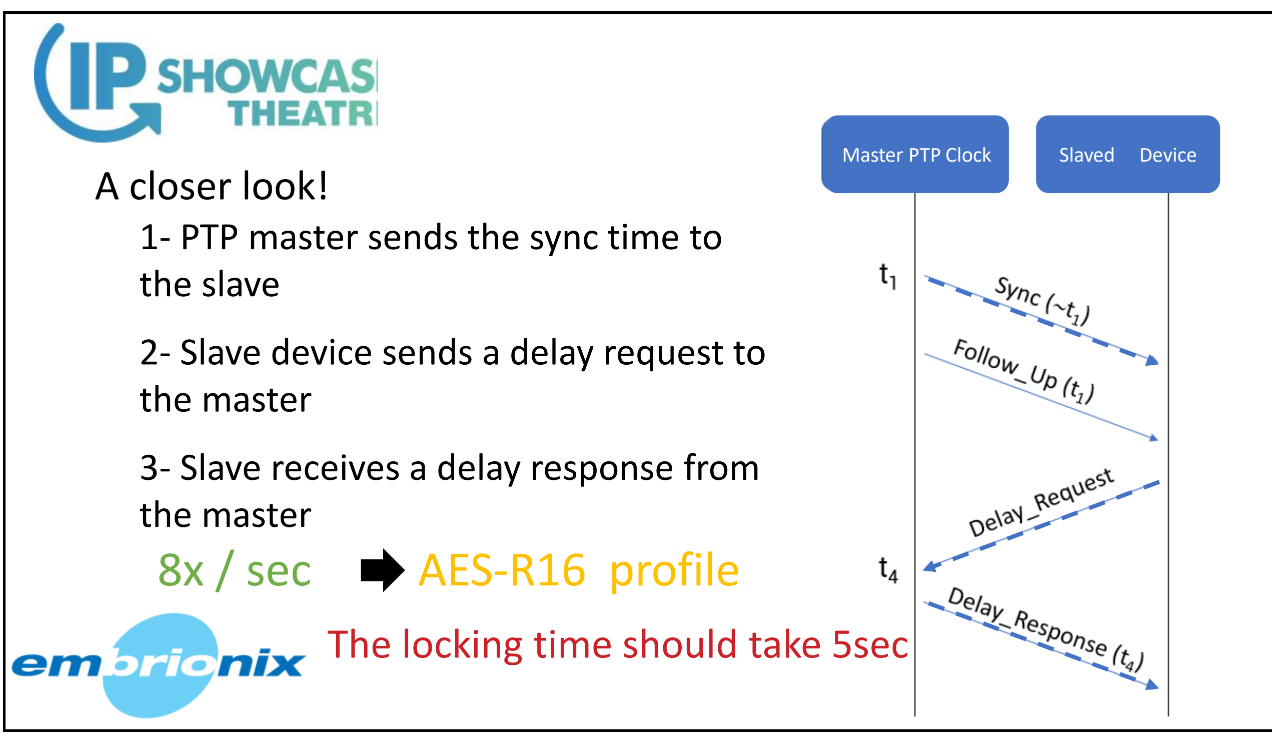
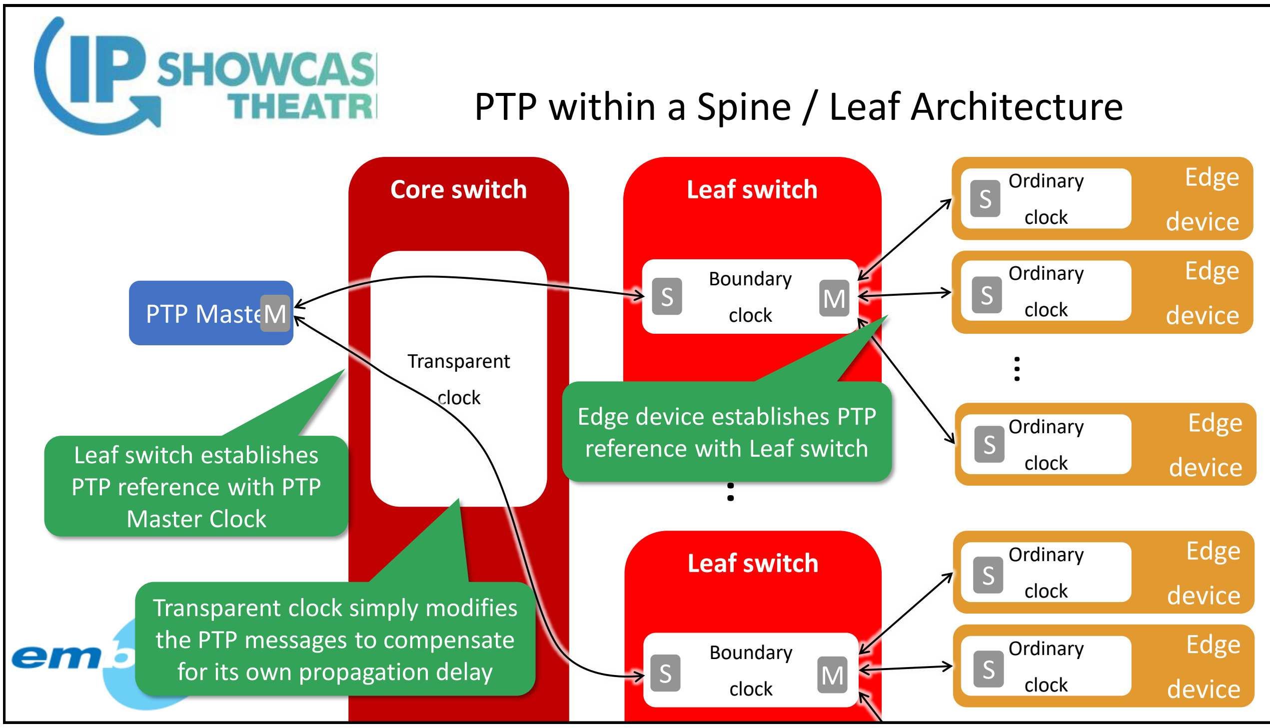
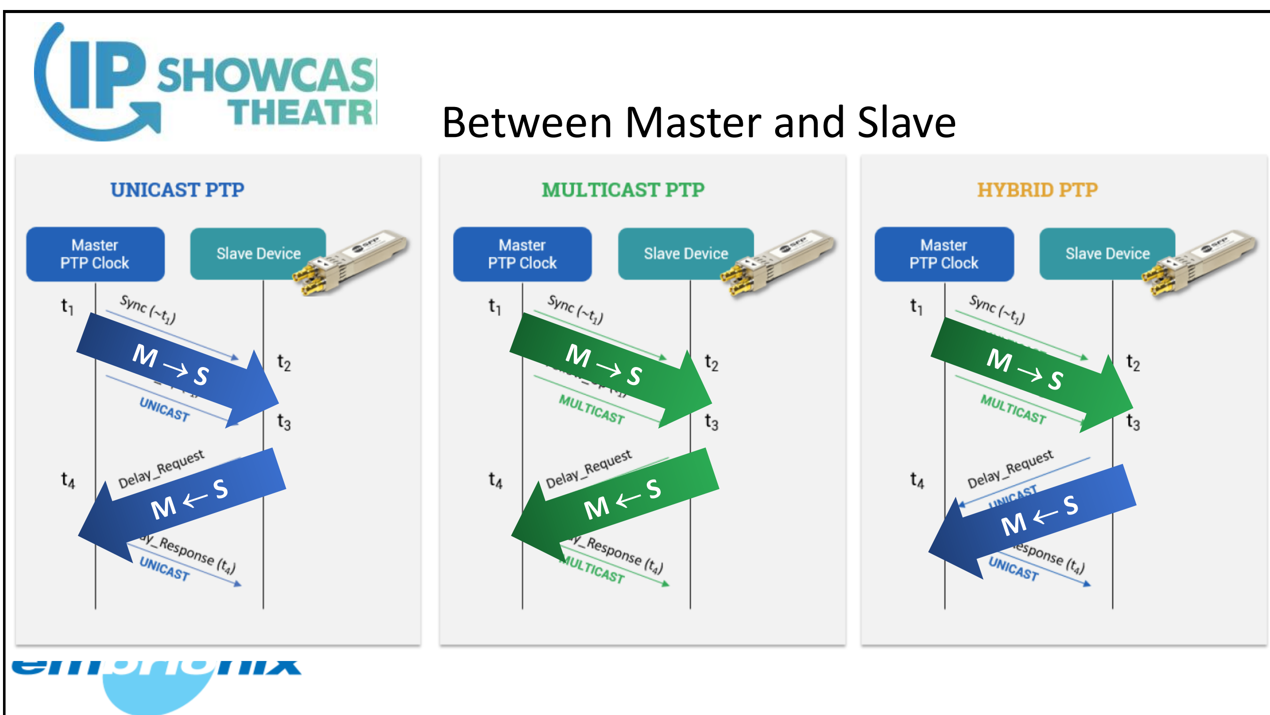
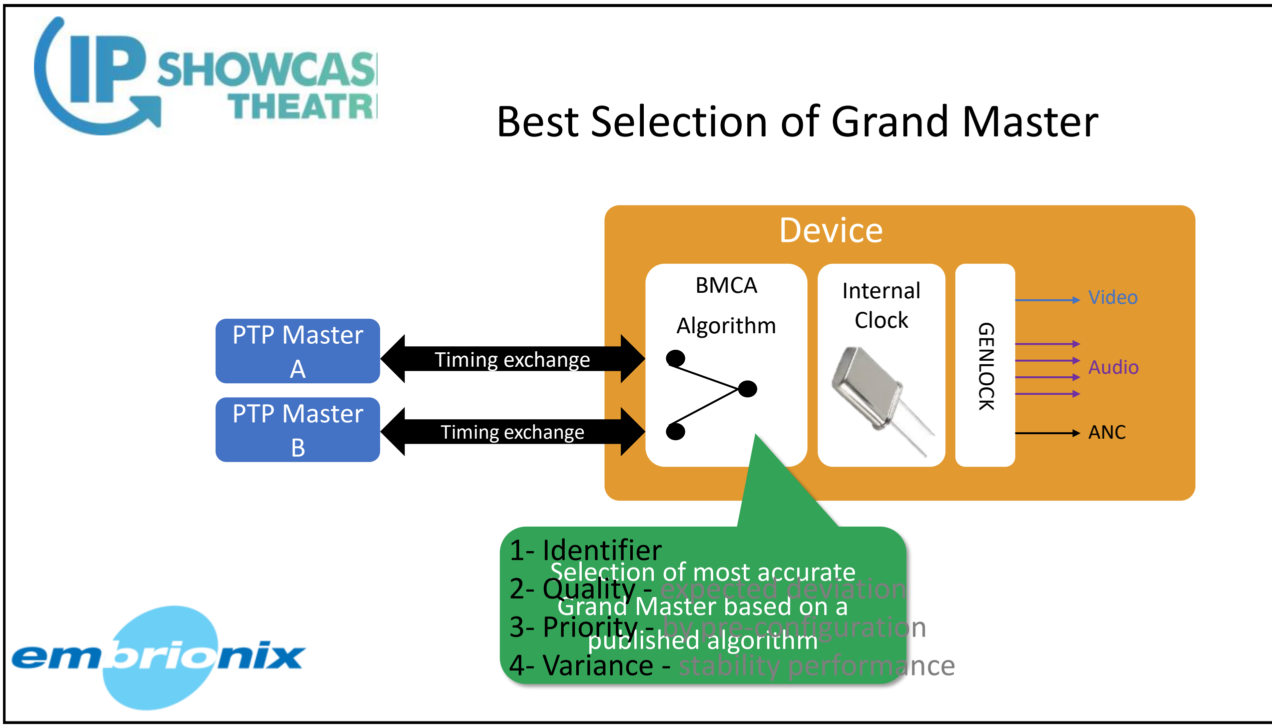

A closer look!
1- PTP master sends the sync time to the slave
2- Slave device sends a delay request to the master
3- Slave receives a delay response from the master
8x / sec
AES-R16 profile
The locking time should take 5sec
Master PTP Clock
Slaved Device
t_1
Sync (~t_1)
Follow_Up (t_1)
Delay_Request
t_4
Delay_Response (t_4)


PTP within a Spine / Leaf Architecture
Core switch
Leaf switch
Leaf switch
PTP Master
M
Transparent clock
S
Boundary clock
M
Ordinary clock
Edge device
Leaf switch establishes PTP reference with PTP Master Clock
Edge device establishes PTP reference with Leaf switch
Transparent clock simply modifies the PTP messages to compensate for its own propagation delay


Between Master and Slave
UNICAST PTP
MULTICAST PTP
HYBRID PTP
Master PTP Clock
Slave Device
Sync (~t1)
M → S
UNICAST
MULTICAST
Delay_Request
M ← S
t1
t2
t3
t4


IP SHOWCASE THEATRE
Best Selection of Grand Master
Device
PTP Master A
PTP Master B
Timing exchange
Timing exchange
BMCA Algorithm
Internal Clock
GENLOCK
Video
Audio
ANC
1- Identifier
2- Quality - expected deviation
3- Priority - by pre-configuration
4- Variance - stability performance
Selection of most accurate Grand Master based on a published algorithm
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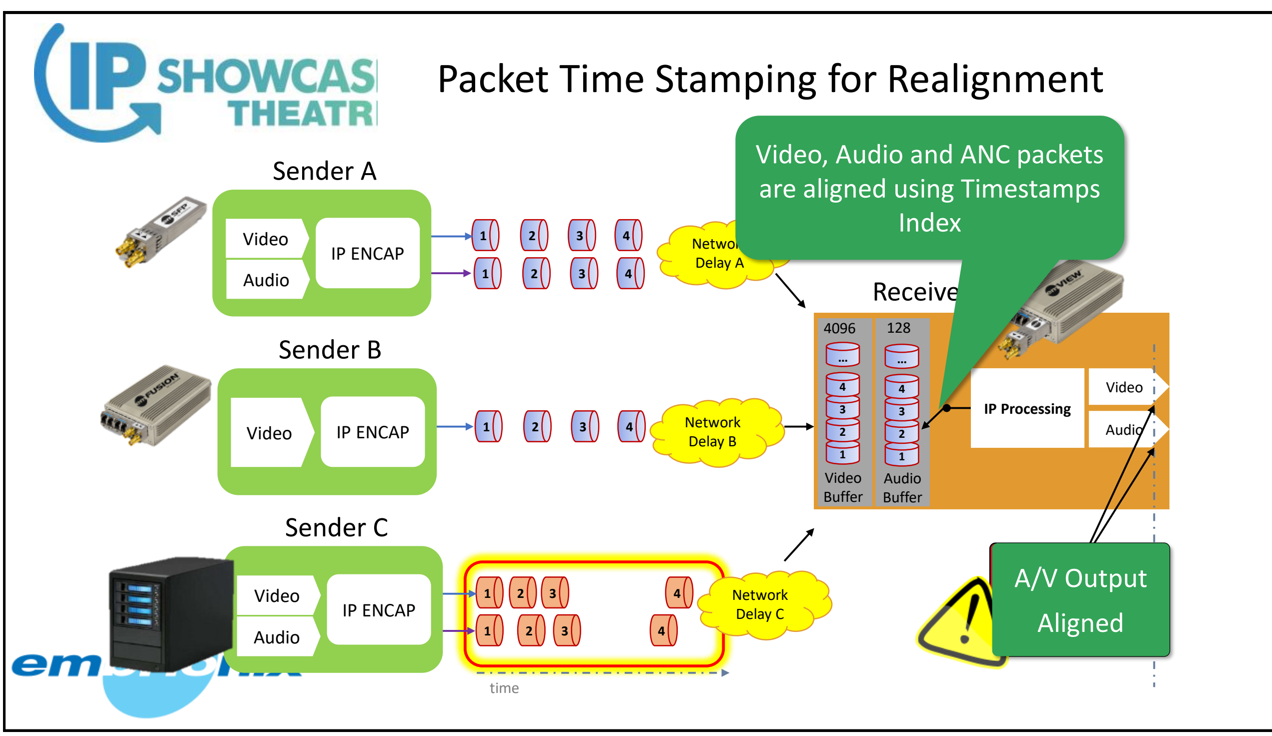
IP SHOWCASE THEATRE
Packet Time Stamping for Realignment
Sender A
Video
Audio
IP ENCAP
Sender B
Video
IP ENCAP
Sender C
Video
Audio
IP ENCAP
Network Delay A
Network Delay B
Network Delay C
time
Video, Audio and ANC packets are aligned using Timestamps Index
Receiver
4096
128
Video Buffer
Audio Buffer
IP Processing
Video
Audio
A/V Output Aligned
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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

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Thank You

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