Tektronix

IP Transition Case Study

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Case Studies

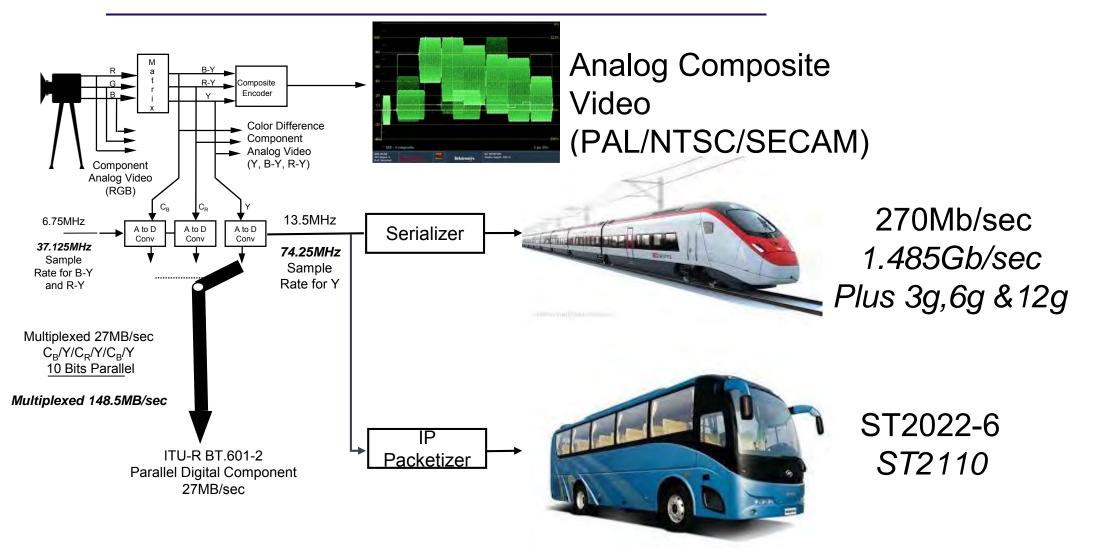
Over the past few years Tektronix has participated in:

- All the ST2110 Inter-ops
- Many Proof of Concept Systems
- Small hybrid ST20220-6 or ST2110 Systems
- Full ST2110 and PTP Implementations

Things we need to remember

- The main goal of the Video industry is to get the RGB signals from a Camera to the RGB inputs of a Display at the best Quality possible.
- ST2110 defines an I/O for Video, Audio and Ancillary Data
 - An I/O that will significantly change the way we design systems
 - $\circ\,$ We need additional tools to make the transition seamless for the operators
 - NMOS, SDN and API
- ST2110 does not change how IP works
 - Multicast static streams
 - Multicast managed streams (IGMP)
- Using IP and PTP for Video and Timing does not automatically solve timing issue.
 - Long distance feeds will still have the same or greater delay using IP

Video I/Os



Will need not only deal with the travel distance But will also with varying traffic conditions.

Basics of ST2110 specs

- 2110-10: system timing
- 2110-**20**: video
 - 2110-21: video distribution in time (timing model)
 - 2110-22: Compressed Video Essence (in progress)
- 2110-**30**: audio
 - 2110-31: support for legacy AES3 (in progress)
- 2110-40: Ancillary data
- 2022-7: Seamless Protection Switching

ST 2022-6 vs ST 2110

2022-6

- Bundled (Audio, Video, Metadata together)
 - Audio/Video/Metadata/Sync travel coherently
 - Need to unpack to use separate essences
 - All packets have a timestamp based on when it was created
- Suited for Playout/Distribution workflows
 - WAN/Contribution across timing domains

2110

- Essence Based (Audio, Video, Metadata separate)
- Ideal for Studio/Production workflows
- Individual essence kept in sync using PTP timing
- All packets of a given video frame share the same timestamp

The ST2110 Standard is still evolving

JT-NM Roadmap of Networked Media Open Interoperability*

NAB18 NAB20 NAB15 NAB 10 NAB19 BONS 18018 1BC19 BC10 NABIT BONT 18020 IV. Dematerialized facilities** Cloud-fit LEGEND: Open, secure, public/private Standard / Specification (on-premises) cloud solutions **EBU R146** Cloud Security for Media Companies -Published Widely available-AMWA Content Model and APIs Agile Media Machine Core Study / Activity Non-media-specific IT JT-NM Security Recommendations "Top-Ten" Security Tests Self-describing, open APIs Recommended minimum Security Tests **EBU R148** suitable for virtualization III. Network & Resource Management AMWA Event & Tally System-level management and AMWA Timing and Identity Including mapping to ST 2110 automated provisioning for flexible AMWA IS-06 Network Control and sharable infrastructure at scale AMWA IS-05 Connection management AMWA IS-04 **Discovery & Registration** II. Elementary flows More flexible and efficient workflows SMPTE ST 2110-nn Transport of compressed video New formats like UHD SMPTE ST 2110 Transport of separate essences VSF TR-03 and mezzanine compression SMPTE ST 2059 Timing profile AES67 SMPTE ST 2022-8 Bridging SDI over IP with Elementary flows I. SDI over IP **SMPTE ST 2022-6** Current and mature technology 0. SDI Number not yet assigned. **See Dematerialized Facilities FAQ at JT-NM.org for more information (cc) BY-ND * JT-NM assumption as of March 2018 and will evolve over time. Visit JT-NM org for the latest update. Feedback to it-nm-info@videoservicesforum.org

AAAVA EBU SMPTE VSF

Lessons Leaned

- The ST2110 Standard is still evolving
- Manufacturers ST2110 product still in development
 - Beta Code
 - Still working to implement all the parts of ST2110
- Every ST2110 deployment is an InterOp
 - Getting different pieces of equipment to work together
 - Devices are in different stages of development
- Need a mechanism to verify sources before connecting the IP Switch
- PTP (ST2059) is a stable standard
 - More challenging than Black Burst



Verifying Your Multicast Flows

END DEVICES CONNECT TO THE ROUTERS AS A STATIC MULTICAST

Verify the following

- Protocols
- Bitrates
- Multicast

Before connecting to the router

ID	PORT	PROTOCOL	BITRATE	SOURCE IP	DEST IP
8	1	52110.20	1.311 Gb/s	192.168.100.13:50000	239.192.0.1.50000
9	1	S2110.30	9.68 Mb/s	192.168.100.13:50000	239.192.0.2.50000
2	1	PTP_Gen	12.08 kb/s	192.168.100.1:320	224.0.1.129:320
5	1	PTP_Evt	5.76 kb/s	192.168.100.1:319	224.0.1.129.319
4	1	PTP_Gen	1,168 kb/s	192,168,100,11:320	224,0,1,129:320
	1	Other Level 3	256 b/s		
10	1	PTP_Gen	0b/s	192.168.100.12:320	224.0.1.129:320
	1	S2110.20	0b/s	192.168.0.1:10000	239.0.1.2:20000
	1	Other UDP	0b/s	192,168.0 1:10000	239.0.1.12:20000
	1	S2110.30	0b/s	192,168,100,13:50000	239.192.0.4:50000
11	1	Other UDP	Ob/s	0.0.0.0:10000	0.0.0.0:20000
	1	UDP	Ob/s		
1	1	S2110.20	0b/s	192.168.100.13:50000	239.192.0.3:50000





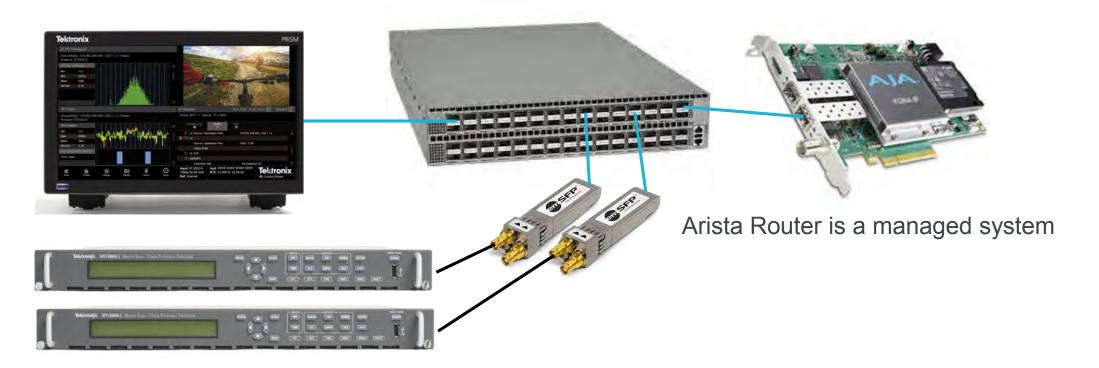
Plugged directly into a CG

IP	Status	5		Run Time: 0d, 00:01:26			
0	Port 1: Total:	ОК 9.823 Gb/	s I	2	Ş	4	
	ID	PORT	PROTOCOL	BITRATE	SOURCE IP	DEST IP	
	i	1	S2022.6	2.817 Gb/s	10.195.181.120:10	239.53.1.2:20000	
Θ	2	1	S2022.6	1.399 Gb/s	10.195.181.120:10	239.53.1.1:20000	
8	3	1	S2022.6	2.803 Gb/s	10.195.181.120:10	239.52.1.2:20000	
Θ	4	1	S2022.6	2.804 Gb/s	10.195.181.120:10000	239.52.1.1:20000	
0	5	1	S2022.6	0b/s	10.195.181.120:10000	239.52.1.1:20000	
	6	1	S2022.6	0b/s	10.195.181.120:0	255.255.255.255:0	
0	7	1	S2022.6	0b/s	10.195.181.120:10	239.52.1.2:20000	
6	.8	1	S2022.6	0b/s	10.195.181.120;8	239.52.1.2:20000	

Multicast and IGMP

- Multicast is used to send a packet from one host to a selected group of hosts
 - Members of the group could be present anywhere on the network.
 - $\circ\,$ Members join and leave the group and indicate this to the routers
 - Senders and receivers are distinct i.e. a sender need not be a member
 - * Multicast addresses are in the range 224.0.0.0 through 239.255.255.255
- IGMP is used to manage membership of multicast groups
 - Who wants to watch which content ? Multicast Join request
 - Who is watching which content ? Host Membership query

Managed system



The Prism or any other Device needs to send a join command in order to see a stream.

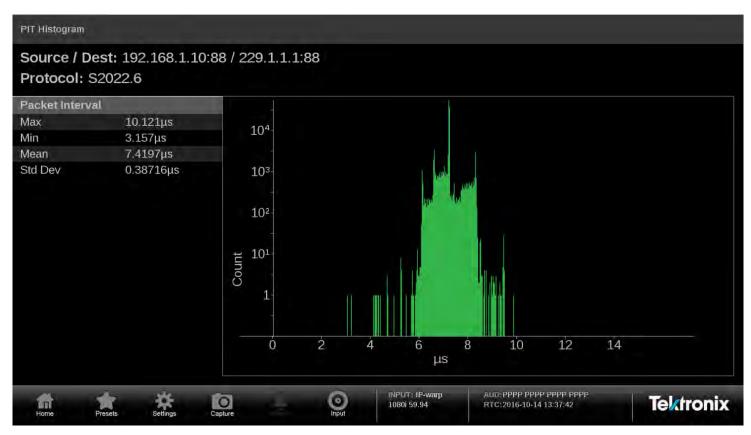
Troubleshooting Technique Mirror a Device's Port with the Prism's Port



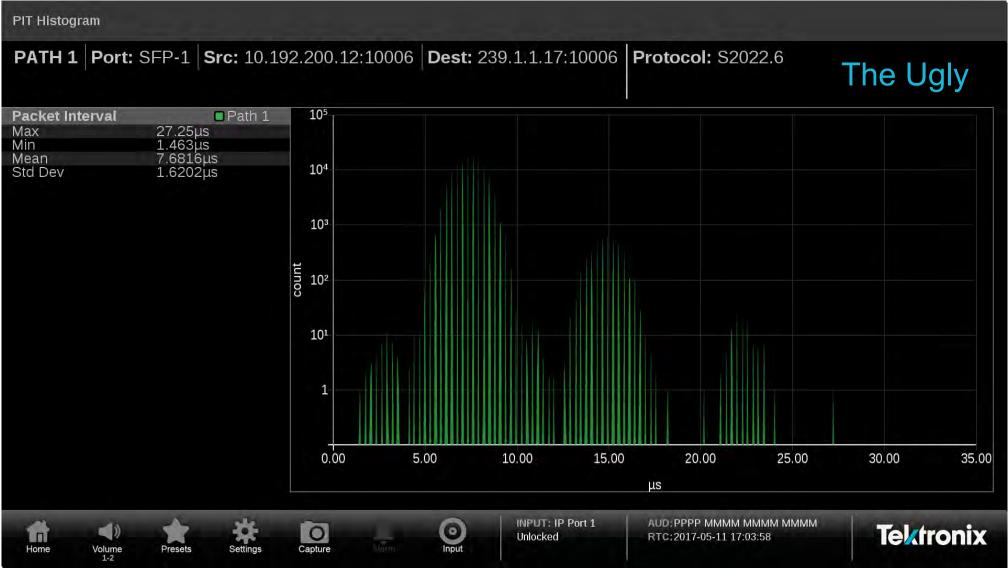
PIT Histogram (ST2022-6)

"QUICKNESS TO TROUBLE SHOOT AND RESOLVE PROBLEMS"

- "Ensure the healthiness of entire IP system"
 - Burst events at too short / long PIT could cause buffer over / under flow



PIT Histogram (ST2022-6)



PIT Histogram (ST2110)

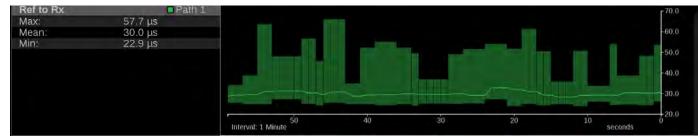


ST2110

Tools not widely Implemented

ST2110-10

- Specifies how PTP (SMPTE 2059) timing is used for ST2110
- Specifies the RTP timestamp calculations for Video, Audio, and ANC signals



- Specifies general requirements of the IP streams
- Specifies using the *Session Description Protocol (SDP)*

Session Description Protocol

- All streams have SDP (session description protocol) defined
- SDP is from RFC 4566, originally used for managing video and audio over IP networks (telecom)
- SDP description for a stream tells receiver what it is getting
 - Definitions for each ST2110 stream are defined in

SMPTE 2110-10 spec

Session Description Protocol

An Example SDP File:

```
v=0
0=- 1472821477 1472821477 IN IP4 172.29.226.31
s=IP Studio Stream
t=0 0
                                  Payload Type
m=video 5000 RTP/AVP 103
c=IN IP4 232.25.176.223/32
                                                                   Video Format
a=source-filter:incl IN IP4 232.25.176.223 172.29.226.31
a=rtpmap:103 raw/90000
a=fmtp:103 sampling=YCbCr-4:2:2; width=1920; height=1080; depth=10;
interlace=1; colorimetry=BT709-2
a=extmap:1 urn:x-nmos:rtp-hdrext:sync-timestamp
a=extmap:2 urn:x-nmos:rtp-hdrext:origin-timestamp
a=extmap:4 urn:x-nmos:rtp-hdrext:flow-id
a=extmap:5 urn:x-nmos:rtp-hdrext:source-id
a=extmap:7 urn:x-nmos:rtp-hdrext:grain-flags
a=extmap:6 urn:x-nmos:rtp-hdrext:grain-duration
```

Session Description Protocol

IP Session				Run Time: 0d, 01:53:39	Running
LAYER 1/2	VIDEO	AUDIO	DATA	PTP	NMOS
IP Session > Last SDP Fil	e			× 3	
VIDEO	AUDIO DATA				
v=0 o=- 1504701982 1504701982 IN	IP4 192.168.10.10				>
s=NMOS Example Stream t≃0 0 m=video 5004 RTP/AVP 96					>
c=IN IP4 239.45.54.32/32 a=source-filter: incl IN IP4 239.45					
a=ts-refclk:ptp=IEEE1588-2008:0 a=rtpmap:96 raw/90000 a=fmtp:96 sampling=YCbCr-4:2:	08-00-11-tt-te-21-e1-b0 2; width=1920; height=1080; depth=	=10; colorimetry=BT709-2			
a=mediaclk:direct=1595650436 r a=framerate:25	ate=90000				
a=extmap:1 urn:x-nmos:rtp-hdrex	a.ongin-umestamp				
		-			
Home Volume Pro	esets Settings Capture	O		C: 2018-03-22 14:49:58	onix Messages

ST2110-21: Video Timing

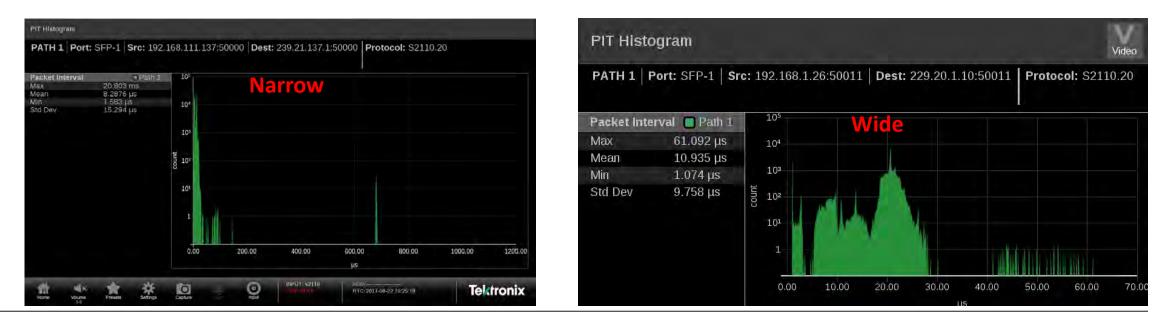
Needs to be Supported

ST2110-21: Video Timing

- Describes required transmitter performance for streams
 - Packet pacing
 - Bursts
 - Gaps
- Considers expected network behavior and link/fabric loading
- Accommodates SDI-like HW sources (with V and H blanking gaps) gapped mode.
- Accommodates full-frame-time rasters (no gaps): linear mode
- Accommodates software senders: wide linear

ST2110-21: video timing-transmission

- 'Narrow' transmission for SDI like sources, i.e. Hardware Sources
- 'Wide' transmission intended for support of softwarebased signal sources



ST2110-21: video timing-transmission

- 'Narrow' transmission for SDI like sources, i.e. Hardware Sources
- 'Wide' transmission intended for support of softwarebased signal sources

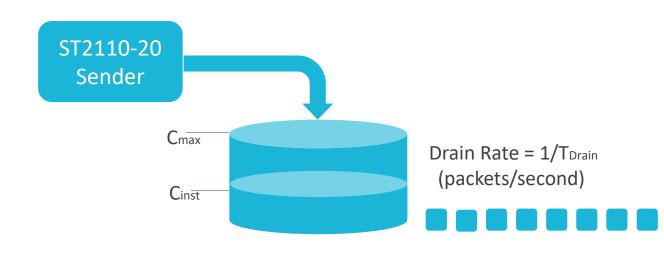
N sender is supported by both W and N receivers

W sender is supported by only W receivers



S2110-21: Transmission Traffic Shape Models

- Network Compatibility Model: Tested directly at the output of the sender, packets from the sender enter a buffer that drains every Tdrain seconds if a packet is available.
- Cinst represents the instantaneous number of packets in the buffer.
- Cmax represents the max value the buffer cannot exceed.





S2110-21: Buffer Models

- For VRXFull, 8 packets is the minimum for narrow senders, which is approximately 2 lines of data in 4:2:2, 1920*1080.
- For VRXFull, 720 packets is the minimum for wide senders, which is approximately 20% of a frame at 4:2:2, 1920*1080.



Make sure it equipment will support you design

- AES67 format used to send uncompressed PCM audio
- Full implementation of AES67 not supported
 - 48KHz, 96KHz
 - 24 bit linear encoding
- Check Audio level Support of Devices in the System

- *Level A:
 - Reception of 48 kHz streams with from 1 to 8 channels at packet times of 1 ms
- Level AX:
 - Reception of 48 kHz streams with from 1 to 8 audio channels at packet times of 1 ms.
 - Reception of 96 kHz streams with from 1 to 4 channels at packet times of 1ms

- *Level B:
 - Reception of 48 kHz streams with
 - from 1 to 8 channels at packet times of 1 ms or 1 to 8 channels at packet times of 125 μs
- Level BX:
 - Reception of 48 kHz streams with from 1 to 8 channels at packet times of 1 ms or 1 to 8 channels at packet times of 125 $\mu s.$
 - Reception of 96 kHz streams with from 1 to 4 channels at packet times of 1ms or 1 to 8 channels at packet times of 125 μs.

- Level C:
 - Reception of 48 kHz streams with
 - from 1 to 8 channels at packet times of 1 ms or 1 to 64 channels at packet times of 125 μs
- Level CX:
 - Reception of 48 kHz streams with from 1 to 8 channels at packet times of 1 ms or 1 to 64 channels at packet times of 125 $\mu s.$
 - Reception of 96 kHz streams with from 1 to 4 channels at packet times of 1ms or 1 to 32 channels at packet times of 125 μs.

2110-30 Bit Rate

WILL INDICATE THE NUMBER OF CHANNELS

Channels	Bit Rate
1	1.616 Mb/s
2	2.768 Mb/s
3	3.92 Mb/s
4	5.072 Mb/s
5	6.224 Mb/s
6	7.376 Mb/s
7	8.528 Mb/s
8	9.68 Mb/s

- 48kHz sampling support is required for all devices
- Support for 1ms packet time is required for all devices
- Support 1..8 channels per stream is required for all devices

dBFS			True Peak							
0 –10					m]mlm	mhuilim	ալալա			
-20										
-30										
-40 -50 -60										
-70				4	5	6	7	8		
	1 Status Port 1:	ок					d, 00:01:22	100		
	Status Port 1: Total:	ок 2.868 Gb/9	5	2	Ru	in Time: 0	d, 00:01:22	100		
0	Status Port 1: Total: ID	OK 2.868 Gb/9 PORT	s PROTOCOL	2 BITRATE	Ru Source	n Time: 0	d, 00:01:22 DEST IP	2 5		
0	Status Port 1: Total: ID 1	OK 2.868 Gb/: PORT 1	s PROTOCOL S2022.6	BITRATE 1.555 Gb/s	Ru source 192.168.0	n Time: 0	od, 00:01:22 DEST IP 239,0,1,2:	20000		
0	Status Port 1: Total: ID	OK 2.868 Gb/9 PORT	s 1 PROTOCOL S2022.6 S2110.20	2 BITRATE 1.555 Gb/s 1.311 Gb/s	Ru source 192.168.0	n Time: 0	od, 00:01:22 DEST IP 239,0,1,2: 239,0,1,4:	20000		
8 8 8	Status Port 1: Total: ID 1 2	OK 2.868 Gb/s PORT 1 1	s PROTOCOL S2022.6 S2110.20 S2110.30	BITRATE 1.555 Gb/s	Ru source 192,168.0 192,168.0	n Time: 0	od, 00:01:22 DEST IP 239,0,1,2:	20000 20000 20001		
0 0 8	Status Port 1: Total: ID 1 2 3	OK 2.868 Gb/s PORT 1 1 1	s 1 PROTOCOL S2022.6 S2110.20	2 BITRATE 1.555 Gb/s 1.311 Gb/s 1.616 Mb/s	Ru source 192,168.0 192,168.0	n Time: 0	DEST IP 239.0.1.2: 239.0.1.4: 239.0.1.6:	2 5 20000 20000 20001 2:20000		
S S S S	Status Port 1: Total: ID 1 2 3 4	OK 2.868 Gb/s PORT 1 1 1 1	s PROTOCOL S2022.6 S2110.20 S2110.30 Other UDP	BITRATE 1.555 Gb/s 1.311 Gb/s 1.616 Mb/s 31.12 kb/s	Ru source 192.168.0 192.168.0 192.168.0	n Time: 0	DEST IP 239.0.1.2: 239.0.1.4: 239.0.1.6: 239.0.1.12	2 5 20000 20000 20001 2:20000		
S S S S	Status Port 1: Total: ID 1 2 3 4	OK 2.868 Gb/s PORT 1 1 1 1 1 1	s PROTOCOL S2022.6 S2110.20 S2110.30 Other UDP Other UDP	2 BITRATE 1.555 Gb/s 1.311 Gb/s 1.616 Mb/s 31.12 kb/s 527.5 b/s	Ru source 192.168.0 192.168.0 192.168.0	n Time: 0	DEST IP 239.0.1.2: 239.0.1.4: 239.0.1.6: 239.0.1.12	2 5 20000 20000 20001 2:20000		

AMWA and NMOS

AMWA and NMOS

- Advanced Media Workflow Association
 - "The AMWA is an open, community-driven forum, advancing business-driven solutions for Networked Media workflows."
 - <u>http://www.amwa.tv</u>
 - <u>https://github.com/AMWA-TV</u>
 - BBC, Fox, Ericsson, PBS, AJA, Arista, AVID, Cisco, Dalet, enbrionix, evertz, Grass Valley, Harmonic, Nevion, Panasonic, Macnica, Sony, SAM, Tektronix, Streampunk, Coveloz
- Networked Media Open Specifications (not a Standard)
 - <u>http://www.nmos.tv</u>
 - <u>https://github.com/AMWA-TV/nmos</u>
 - "NMOS is a family name for specifications produced by the Advanced Media Workflow Association related to networked media for professional applications."

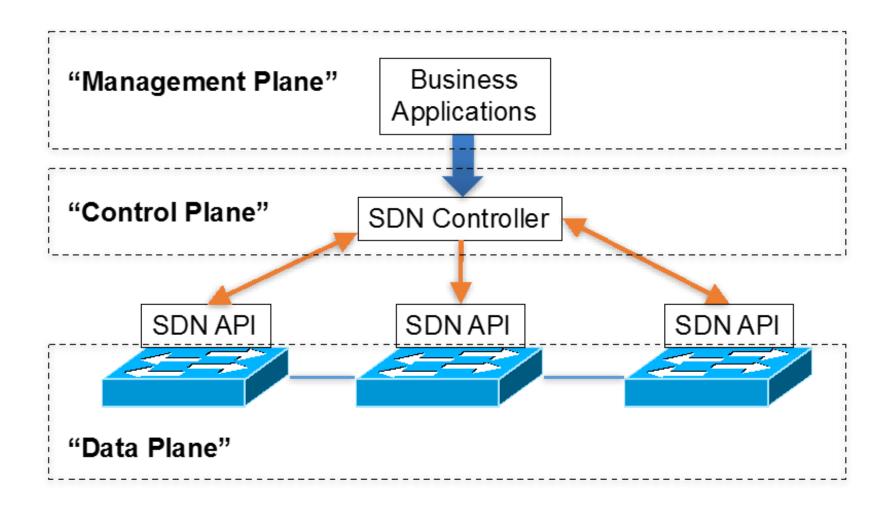




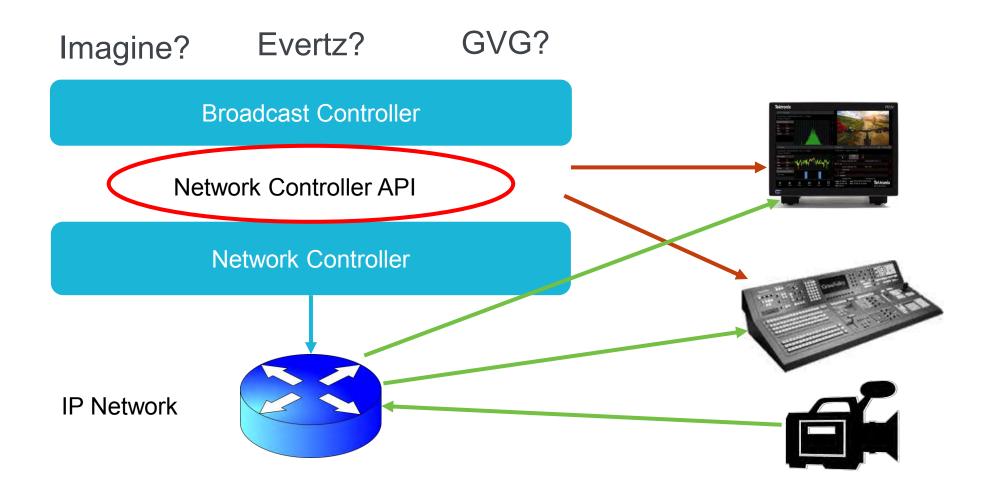
• Simplifying this:

Settings > Inputs			IP Status		Run Time: 0d, 00:01:18 [
IP	SI	IC	 Port 1: OK Total: 952.01 b/s 					
ST2022-6	ASPEN	ST2110	ID PORT	PROTOCOL BITRATE	SOURCE IP	DEST IP		
		II TOWNER	Ĺ	Other Level 3 491.6 b/s				
Video	Âu ntsj							
Enable Video		Enabled						
Source Address	XXX.XXX.XXX.XXX	Masked						
			IP Session	Run Time	: 0d, 00:01:18 [Running		
Source Port	XXXXXX	Masked	LAYER 1/2					
Destination Address	229.1.1.1	Unmasked	LAYER 1					
			10GbE Link SFP Loss Of Sign	OK nal (LOS) OK				
Destination Port	50000	Unmasked	LAYER 2	STATUS	ERR SECS			
			🔗 Lock	OK	2			
RTP Payload Type	96		CRC Error	оĸ	Q			
			LAYER 2 METRI					
Cancel	Save		Rx Bytes Rx BER High	4,865 0				
Home Volume Presets	Settings	Input	INPUT: SDI-SFP+ 2 Unlocked	AUD: RTC:2017-08-22 09:34:44	3	Tektronix		

Software Defined Network



NMOS is the Heart of SDN



Getting Documentation

- High Level Documentation and diagrams accompany the formal RAML definitions of NMOS Standards on AMWA's Github account in the "docs" directory (and its very good):
 - IS-04 Discovery / Registration:
 - https://github.com/AMWA-TV/nmos-discovery-registration/tree/master/docs
 - IS-05 Connection Management:
 - https://github.com/AMWA-TV/nmos-device-connection-management/tree/master/docs
 - IS-06 Network Control (In-progress):
 - https://github.com/AMWA-TV/nmos-network-control



Specifications of Interest:

- IS-04 Discovery and Registration
 - Finding NMOS Devices on the Network
 - Describing their capabilities
 - Advertising the locations of other (IS-05) APIs
- IS-05 Device Connection Management
 - HTTP APIs for telling senders where to send content
 - HTTP APIs for telling receivers where to get content
 - Trading SDP Files from Senders to Receivers
- IS-06 Network Control (In-progress)
 - Describe Network Topology
 - Allocate Bandwidth to streams

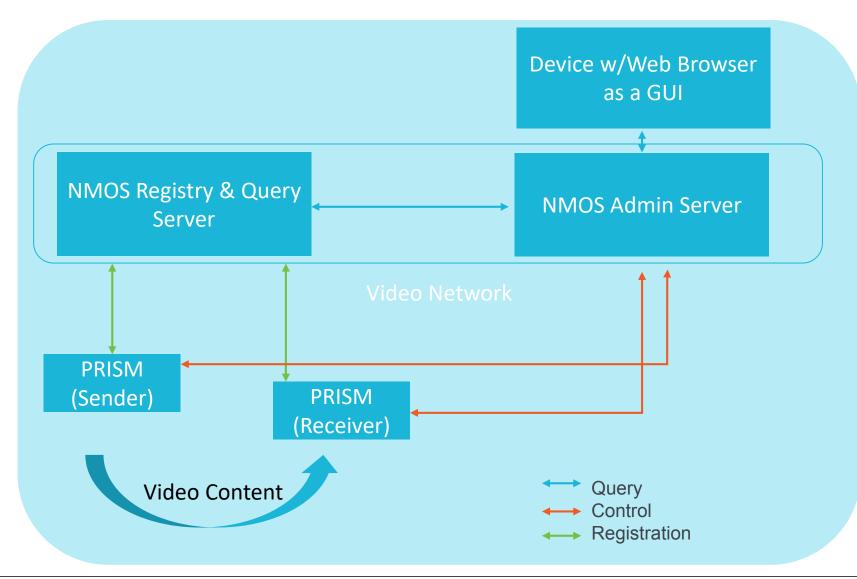


What NMOS is and isn't :

- Is a mechanism to:
 - Find sources / senders
 - Make / break connections
 - Report connection status
 - Eliminate need for UI on senders / receivers
 - Allow 3rd party management UI through standardized, unified API
- Is not a mechanism to:
 - Encode / Encapsulate video, audio (payload agnostic)
 - Actively sniff out non-NMOS devices



Plugging into a simple NMOS Network



Precision Time Protocol (PTP) System Timing

PTP Terms and Definitions

PTP Domain

 Logical grouping of clocks that are synchronised to each other using PTP, but may not be synchronised to other clocks in another domain

Grandmaster Clock

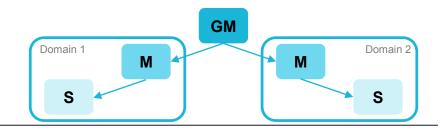
- Ultimate source of time for clock synchronisation using PTP
 - In broadcast applications, these are usually synchronised to GPS, GLONASS or both

Master Clock

 A clock that is the source of time to which all other clocks in that domain are synchronised

Slave Clock

• A clock that is synchronised to another clock





Relevant Standards



IEEE 1588-2008 (PTP V2)

 Standard for a Precision Clock Synchronisation Protocol for Networked Measurement and Control Systems

SMPTE ST 2059-1 2015 (PTP V2)

• Generation and Alignment of Interface Signals to the SMPTE Epoch

SMPTE ST 2059-2 2015 (PTP V2)

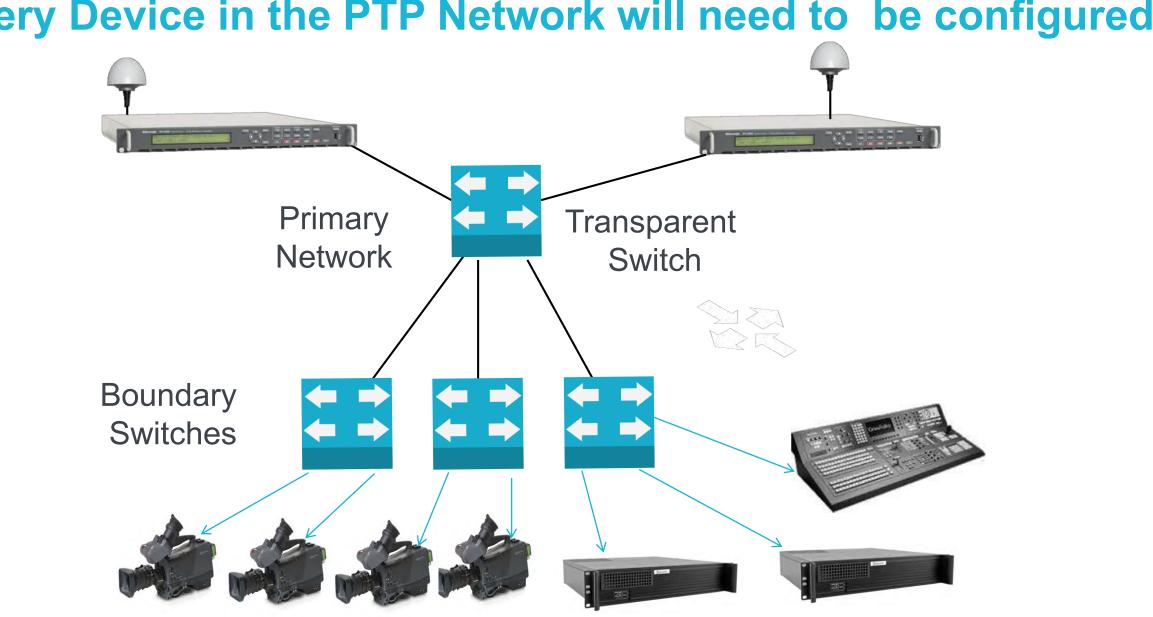
• Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications

AES67-2015 (PTP V2)

AES standard for audio applications of networks - High-performance streaming audio-over-IP interoperability

DANTE (PTP V1) (DIGITAL AUDIO NETWORK THROUGH ETHERNET)

 Proprietary system used in digital audio over a standard Ethernet network Developed in 2006 by Audinate

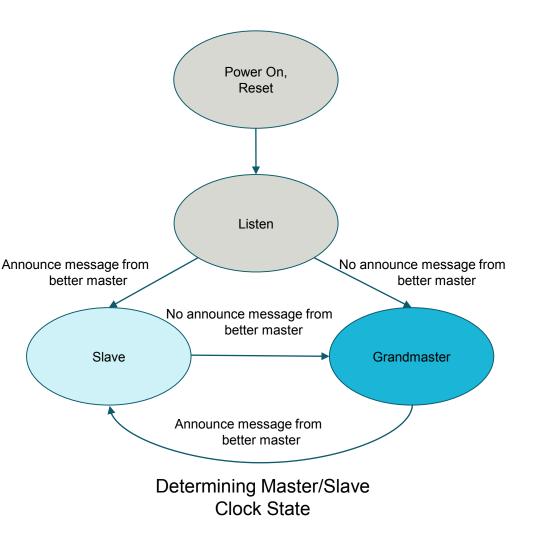


Every Device in the PTP Network will need to be configured

PTP Clocks

BEST MASTER CLOCK ALGORITHM (BMCA)

- BMCA runs on all devices
- Master based on several parameters
 - Priority 1 defaultDS.priority1 Default Value 128
 - Lowest value wins (Range 0-255)
 - Clock Class
 - Clock Accuracy
- How good is my clock
- Clock Variance
- Priority 2 defaultDS.priority2 Default Value 128
 - Lowest value wins (Range 0-255)
- Final tie breaker
 - Clock ID usually MAC address



PTP Message Types

ANNOUNCE

- Used to establish the synchronization hierarchy
- Provides the clock status and clock criteria used to determine which clock becomes the Grandmaster

SYNC AND FOLLOW UP

• Transmitted by the Grandmaster and used by the Slaves to derive the time

DELAY REQUEST

 Request for timing information sent from Slave to the Grandmaster in order to determine the propagation delay between the Slave and the Grandmaster

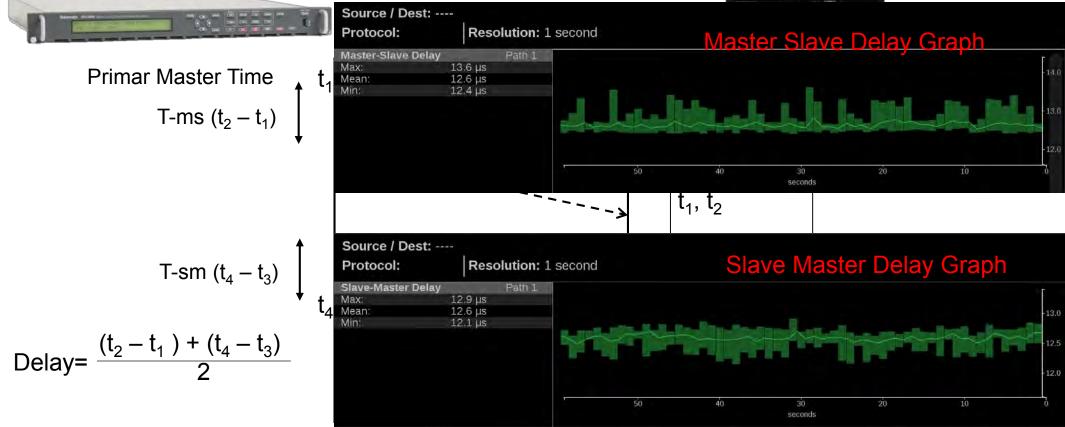
DELAY RESPONSE

• Time of receipt of the Delay Request message sent by the Grandmaster back to the Slave

Synchronization Message Exchange

Used by Ordinary and Boundary Clocks





PTP Clock Types - 2

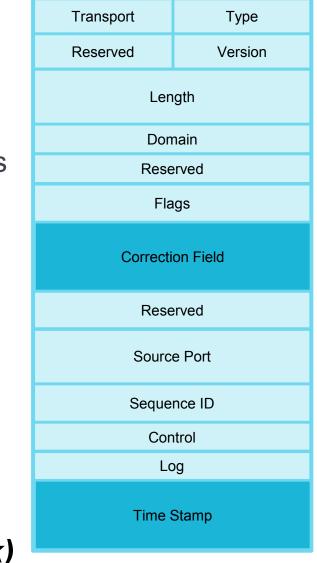
TRANSPARENT CLOCK

- Accounts for queueing delays in switches or routers
- Hardware time stamps Sync and Delay Request messages on arrival and departure and adds the difference to a correction field in the message header

BOUNDARY CLOCK

- Receives time from a Master on one Slave port
- Provides Multiple Master (not Grandmaster) ports to downstream Slaves in a domain
- Removes the effect of its own queue

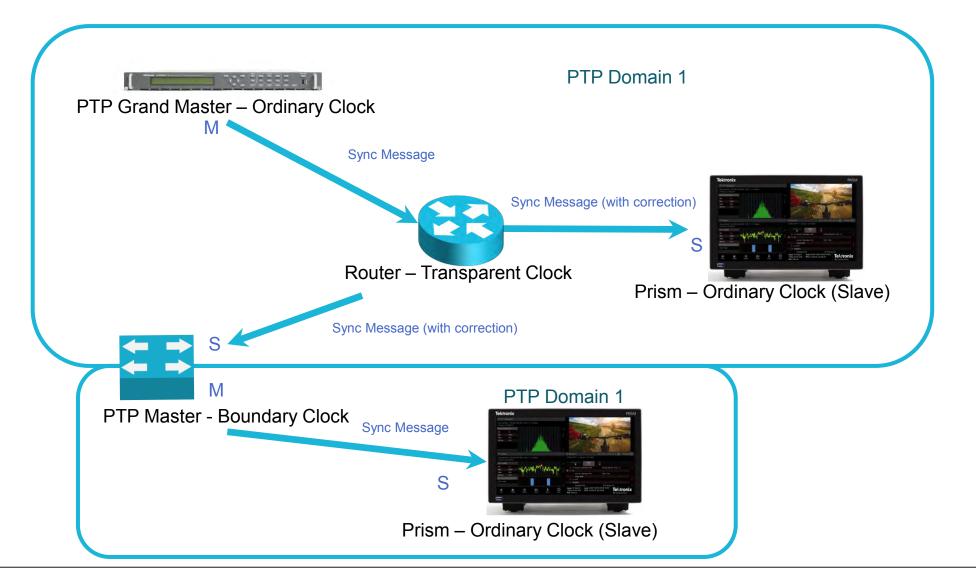
Switches/Routers in a PTP network <u>must</u> be PTP aware (Must be either a Transparent Clock or a Boundary Clock)



Sync/Delay Request Message Format



PTP Clock Types In A Network



PTP Network

QUESTION TO ASK

• Does the IP Switch support the SMPTE Profile (ST2059)

- Can it be a Boundary Clock
 - Receives time from a Master on one Slave port
 - Provides Multiple Master (not Grandmaster) ports to downstream Slaves in a domain
 - Removes the effect of its own queue

What Domain should be used?

- Range is from 0 to 127
- Dante uses PTP Version 1 which is not compatible with V2
 - Some Dante devices can act as a Boundary Clock for PTP V1 when in the AES mode
 - Some Dante devices can only use domain 0
 - Default Values for ST2059-2 =127
 - Default Values for AES and IEEE1588 = 0

PTP ST 2059-2 Interoperability (AES-R16-2016)

Interoperability between Default, AES and SMPTE Profiles	Min	Max	Proposed	Further info
Domain Number	0	127	0	Must be same for all ports
Log Announce Interval*	0	1	1	Must be same for all ports
Announce Receipt Timeout	2	10	3	Must be same for all ports
Log Sync Interval*	-1	-1	-1	
Interoperability between AES and SMPTE Profiles	Min	Max	Proposed	Further info
- ·	Min 0	Max 127	Proposed 0	Further info Must be same for all ports
and SMPTE Profiles				
and SMPTE Profiles Domain Number	0	127	0	Must be same for all ports

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Choosing Your Grandmaster Clock (GM)

THE KEY HERE IS YOU CHOOSE THE GM, DON'T LET IT BE CHOSEN FOR YOU

- Each Domain needs a Grandmaster Clock
- Priority 1 is used to select the devices you want to be able to be the GM
 - Lowest Value wins (Range 0 255)
 - Make the Priority 1 value very low for the GM devices.
 - If Priority 1 is zero then there is less chance of a rogue device becoming the GM
 - Remember if all the BMCA values are equal then the MAC address is used to pick the GM
- Clock class, accuracy and variance are quality of lock values
 - Which will select the best and most stable PTP source
 - Selects from the devices with the lowest Priority 1 value.
 - If all the quality values are equal then Priority 2 will select the GM.
- Priority 2 is used to select which of the devices with the lowest Priority 1 value you would prefer to be the GM
 - Lowest Value win (Range 0 255)
 - Also making the Priority 2 value low would be safer

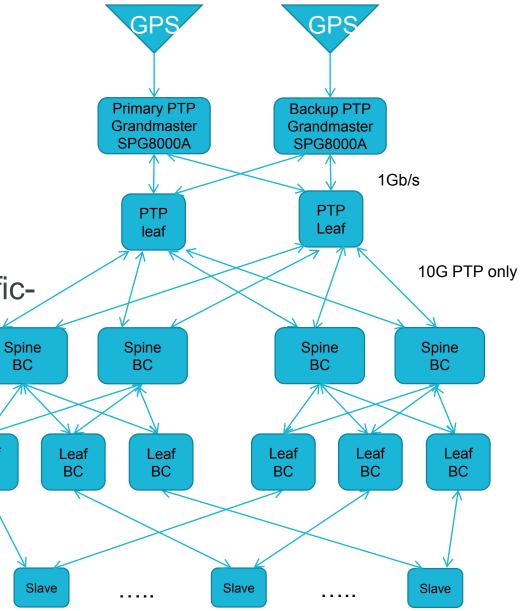
Leaf Spine

- Redundant System
- PTP Leaf
- Single output master OK
- PTP leaf should not see video traffic-

Leaf

BC

need to block out video



PTP message congestion

Multicast

- All messages go from all devices to all devices
- Large load for slaves 1000 slaves @ 8 Hz rate -> 16020 message/sec
- Larger load for Switch, scales with N squared -> 16,017,000 message per sec
- Mixed- Not many devices support yet
 - Delay Request and Response are unicast so route explicitly
 - Slave load for 1000 slaves at 8 Hz rate -> 36 message a sec
 - Switch load is 36,000 per sec.
 - Mixed with Negation– Preferred -Master Regulates Rate/Load 250 Sec Duration of Session then slave needs to ask again

Unicast- Master Needs to Know all Slaves

- Announce, Sync and Follow up are routed explicitly instead of common. So larger load on master.
- Same load on Slaves
- Similar load on Switch depending on effort for multicast vs unicast

Verifying Video Lock in the IP world

JUST LIKE BASEBAND VIDEO YOU NEED THE SIGNALS TO SYNCHRONIZED TO A



Many challenges still lie ahead

IT'S NOT FOR THE FAINT OF HEART

- Manufacturers ST2110 products are getting more stable
 - The implementation of the standards is improving
- As we start to deploy NMOS servers then control will become easier
- The user and the market will need help define audio interoperability
 Number of Channels pre Streams
- Future System will be 25g instead of 10g. (To support 4K)
- PTP with Boundary Clock for best results.
 - Check configuration
- Once we move to an IP based system, it will open future possibilities



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