IP SHOWCASE THEATRE

CURATED BY VSF VIDEO SERVICES FORUM

ST 2110 Test and Measurement Super Session

EBU Tektronix PacketStorm Communications, Inc. BRIDGE TECHNOLOGIES Leader Video Clarity Tools for Video Analysis

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

IP SHOWCASE THEATRE

Presenters

- EBU – Willem Vermost
  - Introduction
  - What problems are we trying to solve?
- Tektronix – Mike Waidson
  - Precision Time Protocol (PTP)
- PacketStorm – Jack Douglass
  - Network Emulation and ST 2110-21 Measurements
- Bridge Technologies – Ståle Kristoffersen
  - Live Performance Monitoring In a ST2110 Network
- Leader – Kevin Salvidge
  - Will I be able to do traditional SDI testing / monitoring after I make the transition to an all-IP facility?
- Video Clarity – Adam Schadle
  - Video/Audio Performance and Quality Methods

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Introduction
What problems are we trying to solve?

Willem Vermost
EBU

Questions That Will be Answered

- Types of testing / monitoring
- Setting up and running tests / monitoring
- Understanding test / monitoring results
- What do I need to test when I transition to an all-IP facility that I am not testing in an SDI facility?
- Will I be able to do traditional SDI testing/monitoring after I make the transition to an all-IP facility?

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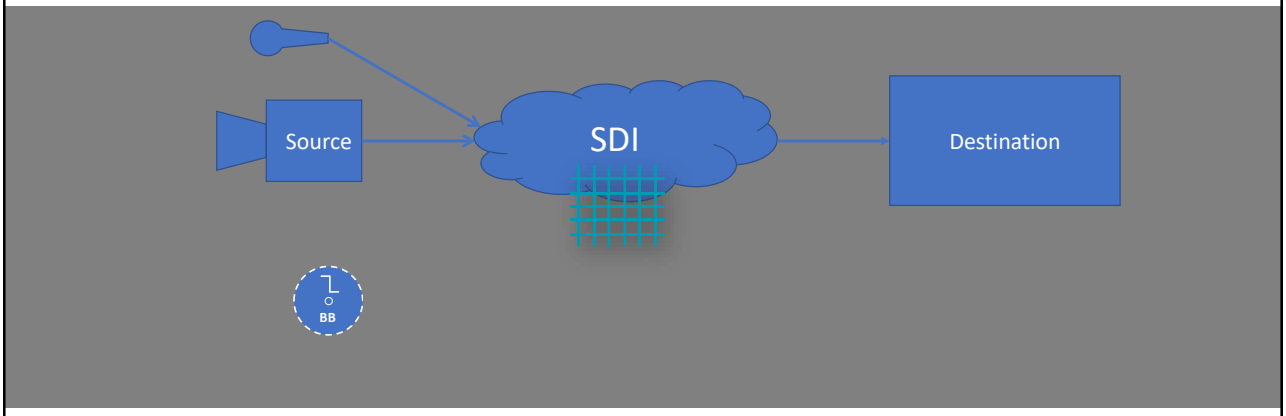
Traditional SDI Network



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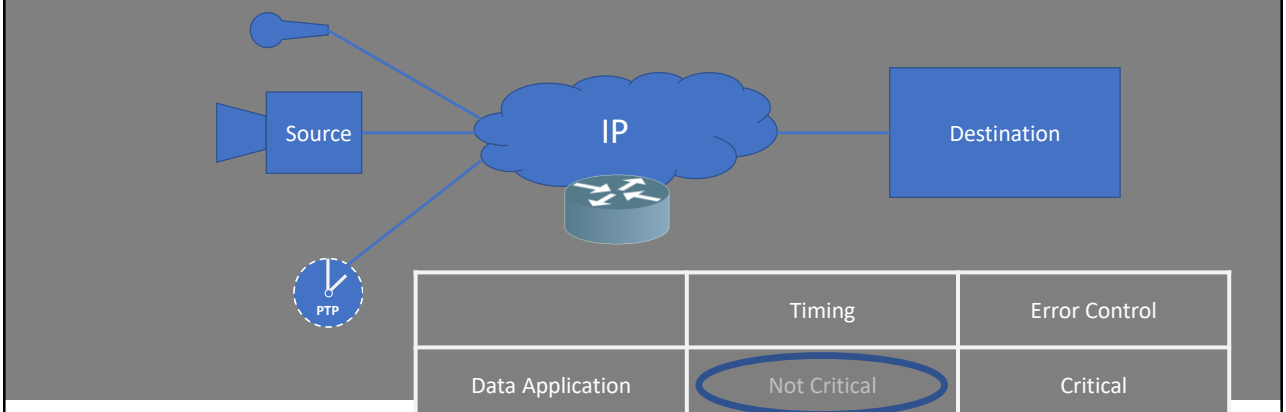
Simple IP Network



	Timing	Error Control
Data Application	Not Critical	Critical
Isochronous Application	Critical	Not Critical

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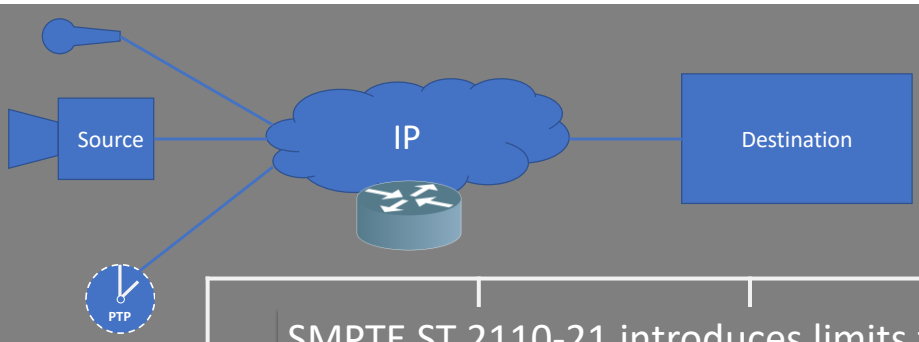
Simple IP Network



SMPTE ST 2110-21 introduces limits to packet delay variation. These values are known as *Cmax* and VRX*full*.
fibre optics: laser budget

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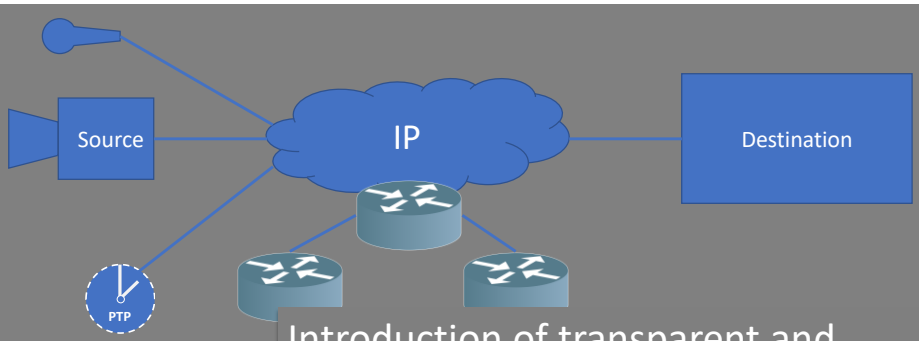
Simple Spine-Leaf IP Network



Introduction of transparent and boundary switches. How to measure for PTP, accuracy, what are the limits?

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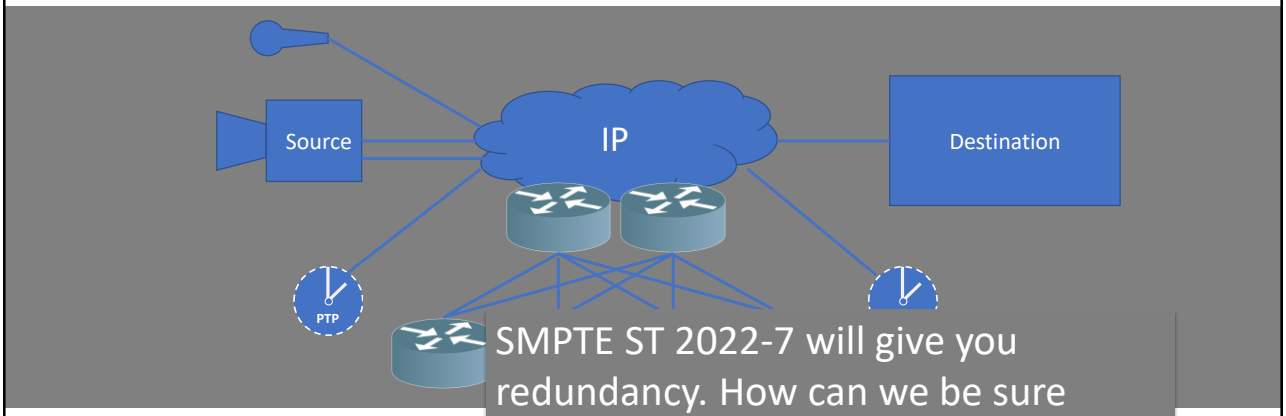
Spine-Leaf IP Network



SMPTE ST 2022-7 will give you redundancy. How can we be sure redundancy is still in place or broken? How to test this?

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Thank You

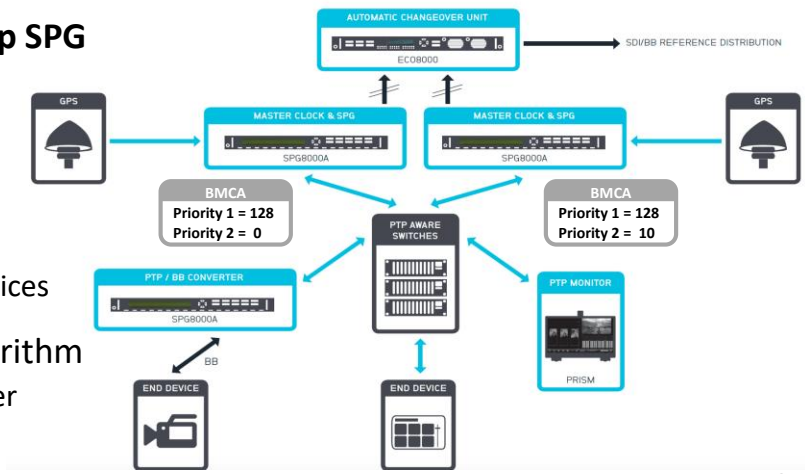
Willem Vermost, EBU
vermost@ebu.ch

Precision Time Protocol (PTP)

Michael Waidson
Tektronix

Precision Time Protocol (PTP)

- **Hybrid Primary/Backup SPG**
- Clock Types
  - Boundary
  - Transparent
- Domain
  - Logical grouping of devices
- Best Master Clock Algorithm
  - Determine Grandmaster



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Precision Time Protocol (PTP) Protocol Messages

- Categorized into
  - Event Messages (Timestamped) Port 319
  - General Messages (non-Timestamped) Port 320

Message Types	SMPTE ST 2059-2 Domain = 127 (0-127)	AES 67 Domain = 0	AES R16 (AES67-ST2059) Domain = 0
Announce	-2 = 4 per second Announce Timeout 3	1 = one every two seconds Announce Timeout 3	0 = once per second Announce Timeout 3
Sync	-3 = 8 per second	-3 = 8 per second	-3 = 8 per second
Follow-Up	-3 = 8 per second	-3 = 8 per second	-3 = 8 per second
Delay Request	-3 = 8 per second	-3 = 8 per second	-3 = 8 per second
Delay Response	-3 = 8 per second	-3 = 8 per second	-3 = 8 per second
Management	0 = once per second	0 = once per second	0 = once per second

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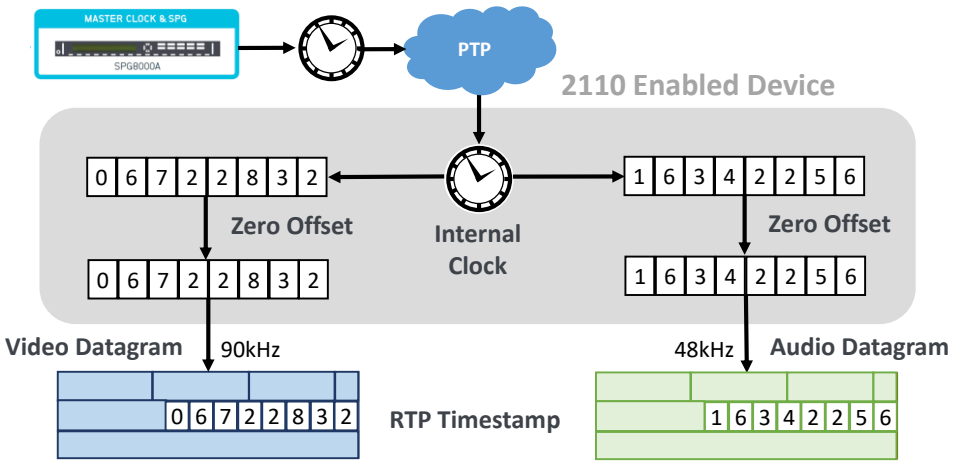
PTP Synchronization across the Network



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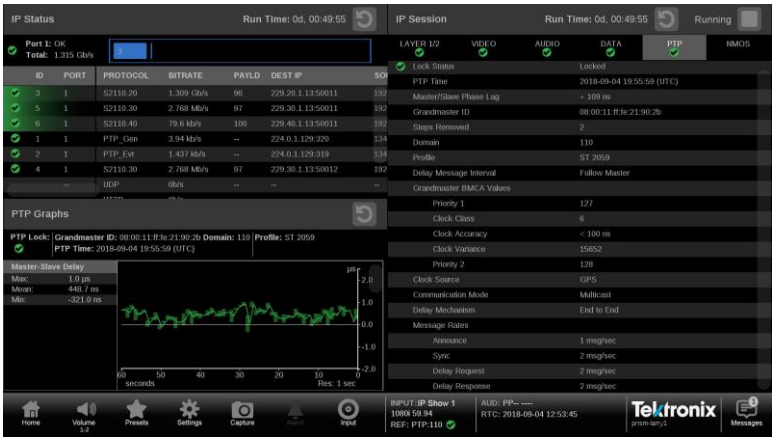
Monitoring & Troubleshooting PTP

- Check Domain
- Check Message Rates
- Check Master ID
- Check switch configuration of ports
- Check QoS



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Monitoring Timing and Synchronization

- Check PTP Lock
- Check Source is locked to PTP
- Check Master ID
- Check switch configuration of ports
- Check QoS

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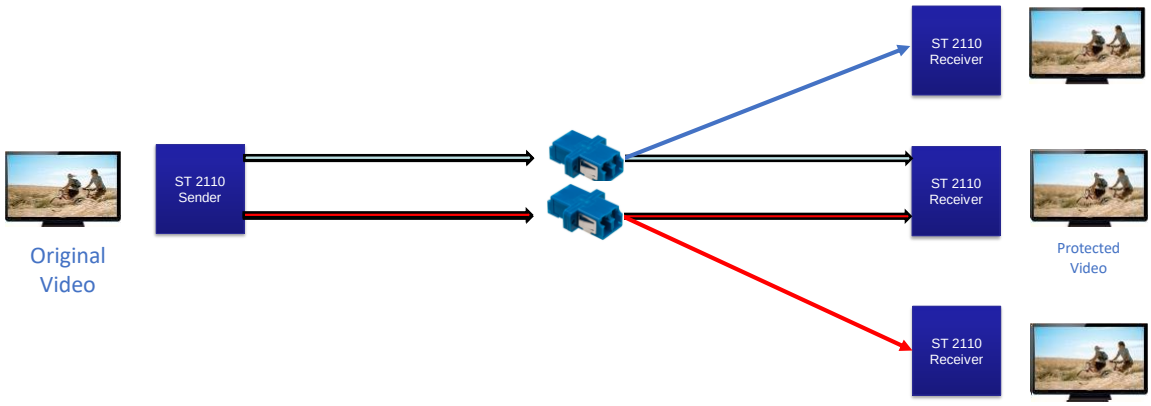
Thank You

Michael Waidson, Tektronix
michael.h.waidson@tektronix.com

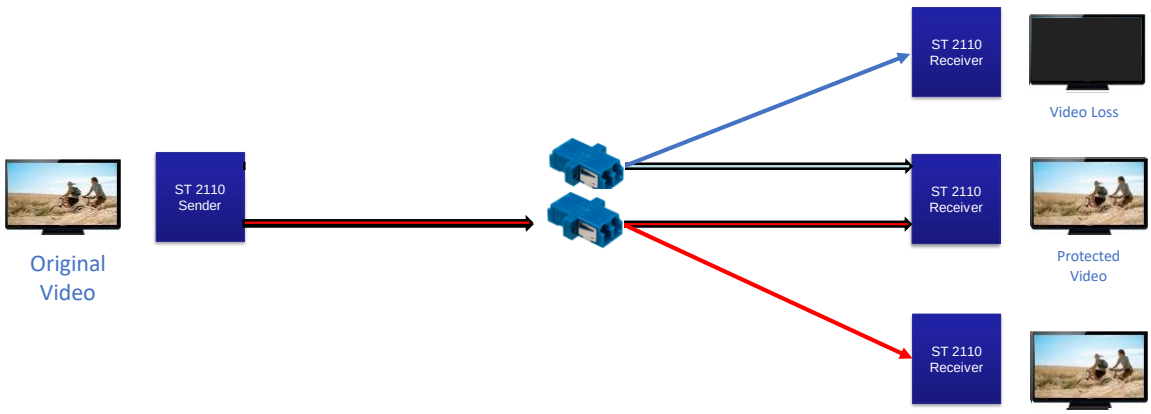
Network Emulation and ST 2110-21 Measurements

Jack Douglass
PacketStorm Communications

ST 2022-7 – Link Redundancy



ST 2022-7 – Link Redundancy



ST 2022-7 – Link Redundancy

Original Video

ST 2110 Sender

ST 2110 Receiver

Video Loss

ST 2110 Receiver

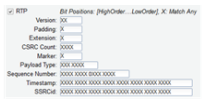
Video Loss

ST 2110 Receiver

Video Loss

ST 2022-7 Hitless Data Loss Protection

Synchronized Network Emulator



Repeat (W) Gap (Z) Burst Loss (X) Gap (Y)

Side A

Original Video

ST 2110 Sender

Sync Burst Drop | Latency | PDV | Packet Loss / BER

Path 1

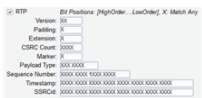
Sync Burst Drop | Latency | PDV | Packet Loss / BER

Path 2

Switch

Switch

Repeat (W) Gap (Z) Burst Loss (X) Gap (Y)



Side B

ST 2110 Receiver

Video with Errors

ST 2110 Receiver

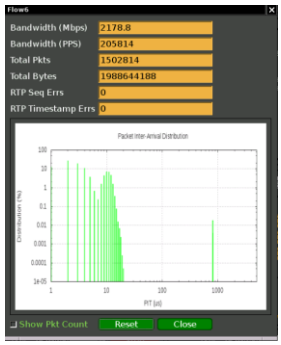
Protected Decoded Video No Errors

ST 2110 Receiver

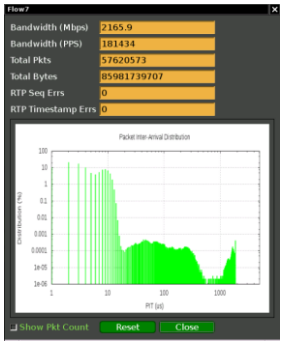
Video with Errors

Type of Senders

Types of Senders
- Narrow Senders (Type N)
- Narrow Linear Senders (Type NL)
- Wide Senders (Type W)

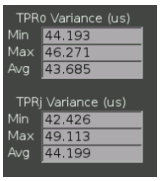


Narrow Gapped Sender

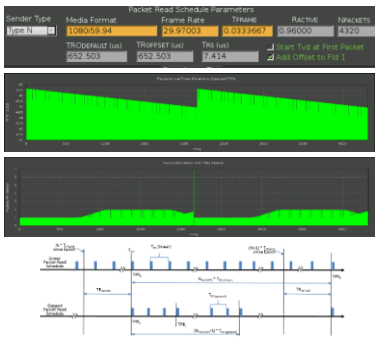


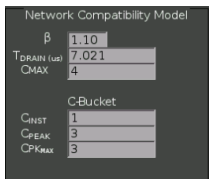
Wide Sender

ST 2110-21 Measurements

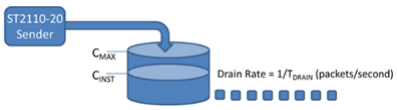


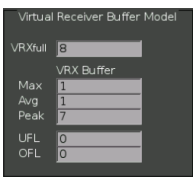
Packet Read Schedule





Network Compatibility Model





Virtual Receive Model

Types of Senders
- Narrow Senders (Type N)
- Narrow Linear (Type NL)
- Wide Senders (Type W)

Types of Receivers
- Narrow (Type N)
- Wide (Type W)
- Asynchronous Receivers (Type A)

Thank You

Jack Douglass, PacketStorm
jack@packetstorm.com

Live Performance Monitoring In a ST2110 Network

Ståle Kristoffersen
Bridge Technologies

Problem Areas

- Does the signal make sense?
- Do all of the signals arrive?
- Does the signal arrive on time?

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Does the signal make sense?

- IP Headers
- RTP Headers
- ST2110-20/30/40 (The essences)
  - Resolution
  - Number of audio channels
  - Specific ancillary type present

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Do all of the signals arrive?

- Packet loss
- 2022-7 combined loss vs single link failure

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Does the signal arrive on time?

- Late can be just as bad as a loss
- Early can be bad depending on receivers
  - Depends on the “wideness” of the receiver

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TRANSPORT FORMAT	SIGNAL	IP ADDRESS	INTERFACE
ST 2110 Video	22 hours	239.0.20.3:50020	Primary up
ERRORS	**PACKET LOSS**	**MALFORMED HEADERS**	**QUEUE OVERFLOWS**
0	–	–	–

TRANSPORT FORMAT	SIGNAL	IP ADDRESS	INTERFACE
ST 2110 Video	22 hours	239.0.20.1:50020	Primary up
ERRORS	**PACKET LOSS**	**MALFORMED HEADERS**	**QUEUE OVERFLOWS**
0	–	155125	–

TRANSPORT FORMAT	ERRORS	BITRATE	PACKET RATE
ST 2110 Video	0	2.18 Gbps	205.70 kpps
RESOLUTION	**FRAMERATE**	**SAMPLING**	**COLORIMETRY**
1920x1080p (16:9)	50 frames/s	YCbCr-4:2:2 10-bit	Rec. 709 (SDR)

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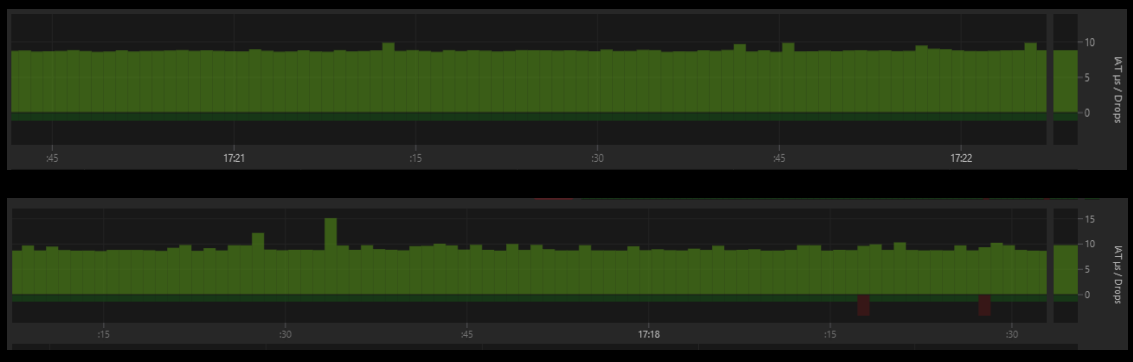

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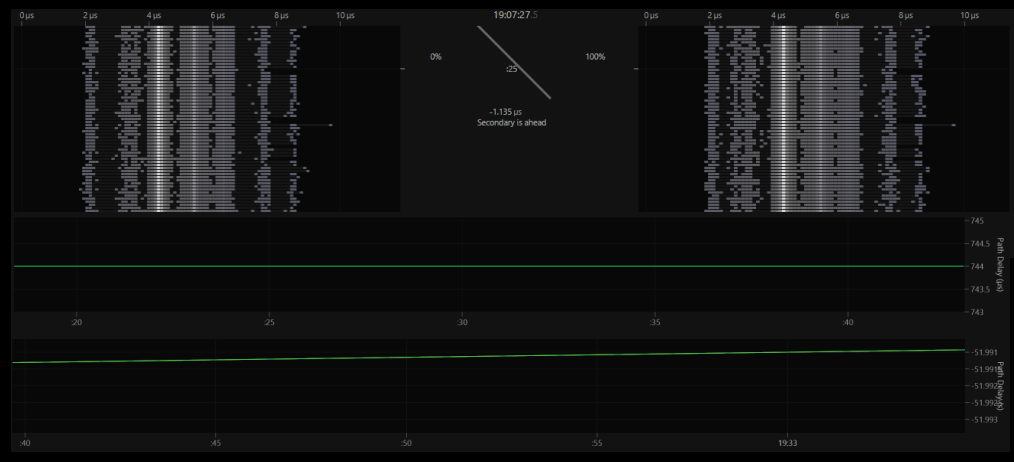

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When should I run the test?

- All the time?
- Periodically?
- During system acceptance testing?
- All of the above!
  - Depending on needs

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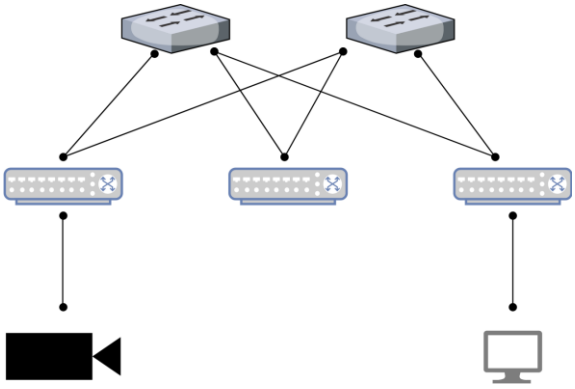
How to connect it



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Thank You

Ståle Kristoffersen, Bridge Technologies
stalk@bridgetech.tv

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Leader

Will I be able to do traditional SDI testing / monitoring after I make the transition to an all-IP facility?

Kevin Salvidge
Leader

IP SHOWCASE THEATRE

SDI to IP transition – the Test and Measurement challenge

- Physical Layer
- Coding
- Baseband

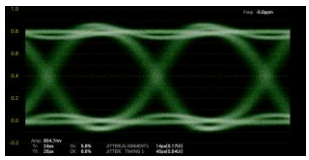
BNC = 1x 1080p60

Half Duplex

- Single essence per BNC
- Direct measurement
- Synchronous transport

- Cause of error occurrence
  Cable loss, connector contact failure, impedance mismatch, jitter and increase in rise time.

- Measurement method
  Monitoring CRC & TRS errors



100Gbe > 75x1080P60

Full Duplex

- 7 layer OSI model

More to keep an eye on

- Multiple essence per Fiber
- Indirect measurements
- Asynchronous transport

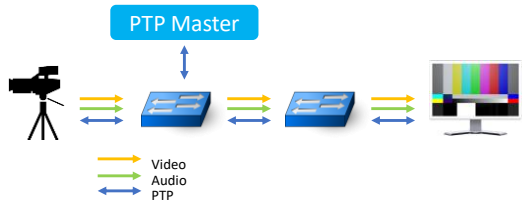
- Cause of error occurrence
  Packet loss due to network overload, error frame discard, bandwidth compression due to concentration of traffic.

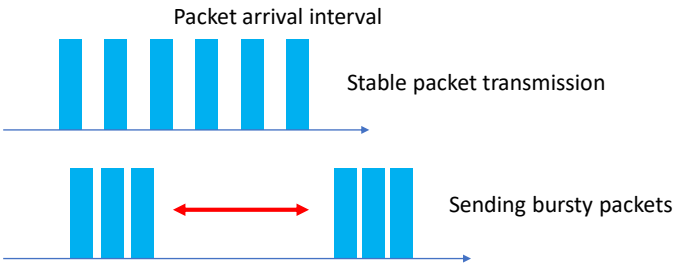
- Measurement method
  Monitoring FCS, CRC errors

SDI to IP transition – the test and measurement challenge

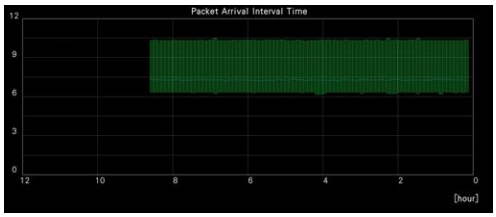
There is a possibility that the buffer of the receiver is insufficient due to excessive delay of the packet and the stream can not be reproduced.

Measure the packet arrival interval as to whether the packet is sent stably.



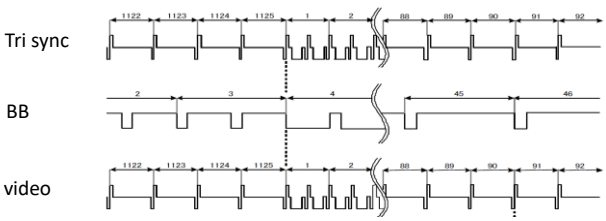


Packet arrival interval time

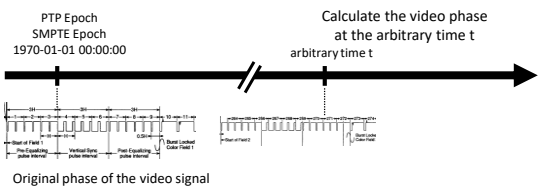


SDI to IP transition – the test and measurement challenge

- SDI
  - ・Synchronization with the video signal of SDI based on the synchronization signal of BB (black burst).
  - ・Use sync pulse (TRS) in the blanking period for video playback.
  - ・Phase measurement of BB and SDI



- IP
  - ・Synchronization with IP video signal, audio signal, auxiliary data signal based on PTP time.
  - ・Play video and audio using RTP time stamp.
  - ・Phase measurement of PTP and video, audio, ancillary data.
  - ・Measurement of time synchronization accuracy of PTP.



SDI to IP transition – the test and measurement challenge

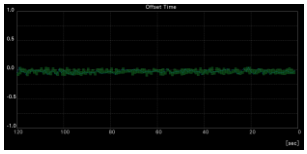
PTP synchronization

・Time synchronization of PTP is done with Sync, Follow up, Delay Request, Delay Response.

・Calculate the offset of the time difference under the assumption that the time the message is transmitted from the master to the slave and the time transmitted from the slave to the master are the same.

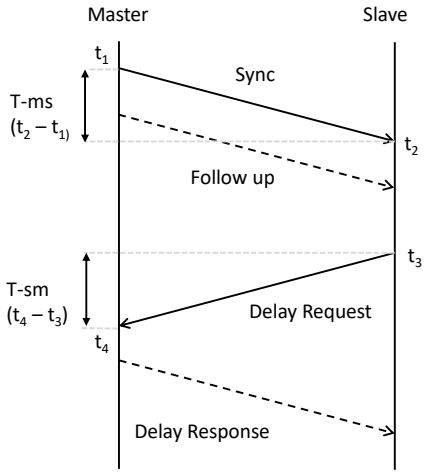
・Since asymmetric packet delay time can occur due to packet transfer time in the switch, network routing change, etc., the average transmission time fluctuates.

・When time synchronization accuracy of less than 1 us is maintained.
・Phase of PTP and video, Phase of PTP and audio are stable.



Measurement of Time Offset

Measurement of Delay Time



Time Offset = $((t_2-t_1) - (t_4-t_3)) /2$

Delay Time = $((t_2-t_1) + (t_4-t_3)) /2$

Leader

Thank You

Kevin Salvidge, Leader
salvidge@leadereurope.com

Video/Audio Performance and Quality Methods

Adam Schadle
Video Clarity

Video/Audio Performance and Quality Methods

- Picture and Sound Quality Objective Tests Are Very Useful to Understand Network Behavior
- Methods to Apply Objective Quality Tests to Audio and Video
  - No Reference
  - Reduced reference
  - Full reference
  - These are generally applied to uncompressed video and audio
- ST 2110 Networks Are Currently Designed for Uncompressed Media
  - Does this mean media is always transmitted perfectly across the network or through to other networks in the delivery path?

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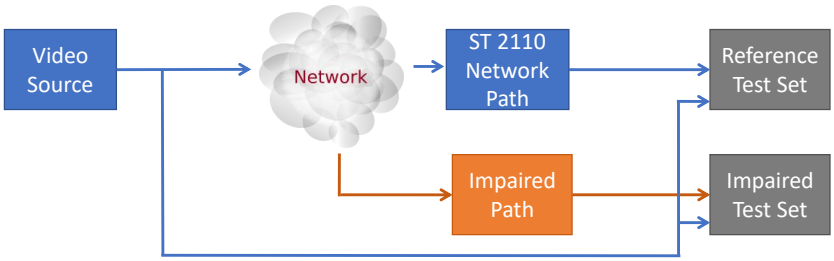
Full Reference Media Performance Testing



Metric Scale

Metric Examples:
- **Video - PSNR**
- **Audio - AFREQ**
- **Lip Sync -AFREQ**
- **Loudness - LKFS**

Score of reference path

versus

Score of impaired path with threshold

Recorded sequence length with logging for failed frames or continuous, real-time test with error segment recordings

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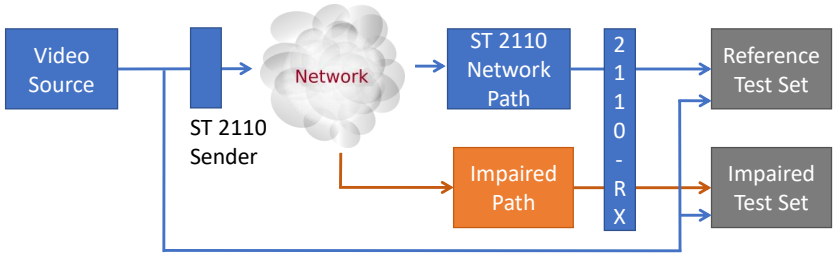
Full Reference Media Performance Testing - with SDI Applied



Metric Scale

Metric Examples:
- **Video - PSNR**
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- **Loudness - LKFS**

Score of reference path

versus

Score of impaired path with threshold

Recorded sequence length with logging for failed frames or continuous, real-time test with error segment recordings

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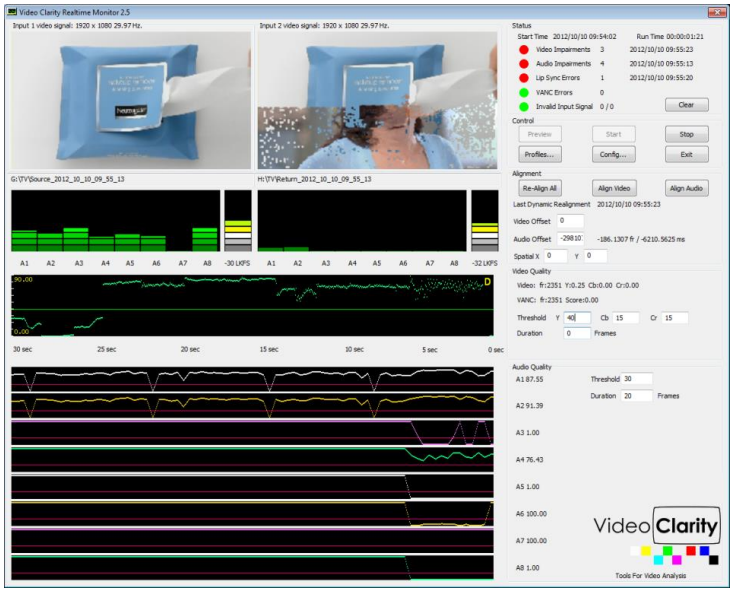
Real-time uncompressed media quality assessment



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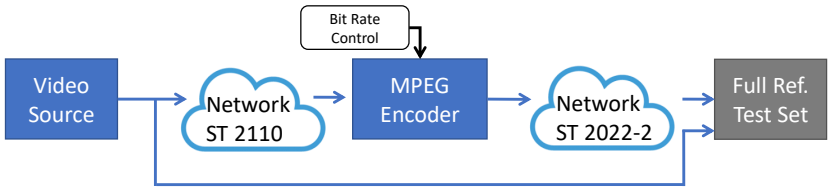
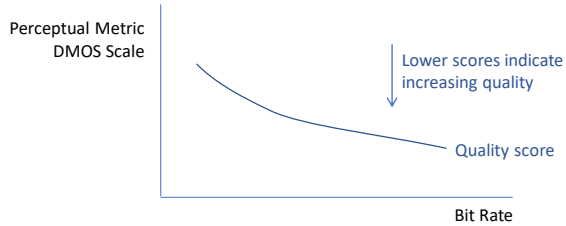
Content Delivery Quality Assessment Using a Perceptual Metric



Expected Results: Video Quality Improves With Increasing Bit Rate



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Full Reference Uncompressed Test Recordings are Generally Compared Visually for Final Assessment

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Thank You

Adam Schadle, Video Clarity
adams@videoclarity.com

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Panel Discussion

Q & A

EBU Tektronix PacketStorm Communications, Inc. BRIDGE TECHNOLOGIES Leader Video Clarity Tools for Video Analysis

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Thank You

EBU Tektronix PacketStorm Communications, Inc. BRIDGE TECHNOLOGIES Leader Video Clarity Tools for Video Analysis

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