Leader
PHABRIX®

Pipes are now Packets: What you **really** need to know about QC monitoring & maintenance for IP

Kevin Salvidge – Leader Europe Limited

IP SHOWCASE

Audio Engineering Society · AIMS Alliance for IP Media Solutions · AMWA Networked Media. Working. · EBU · SMPTE · VSF Video Services Forum

Pipes are now Packets

- Just remember that IP is just another I/O interface: A way to get video, audio and data to or from a switch

- It's **how** you do that , that has changed.

Pipes are now Packets

- Although many broadcasters are transitioning to IP, the majority are going to do so in a piecemeal manner.
- With ST-2110, the timing information has been removed from the underlaying hardware layer making the distribution asynchronous.
- With current broadcast formats, video must be frame synchronous at the camera's sensor and at the viewers display device.
- The intermediate IP distribution network is asynchronous but the variance in packet jitter directly affects latency leading to potentially longer video and audio delays than we have come to expect from SDI infrastructures.
- Although uncompressed video such as that provided by ST-2110 does map to the active video parts of SDI, two major changes have occurred;
  - The PTP and SPG reference sources may or may not be the same device
  - Signal distribution in IP is asynchronous and multiplexed.

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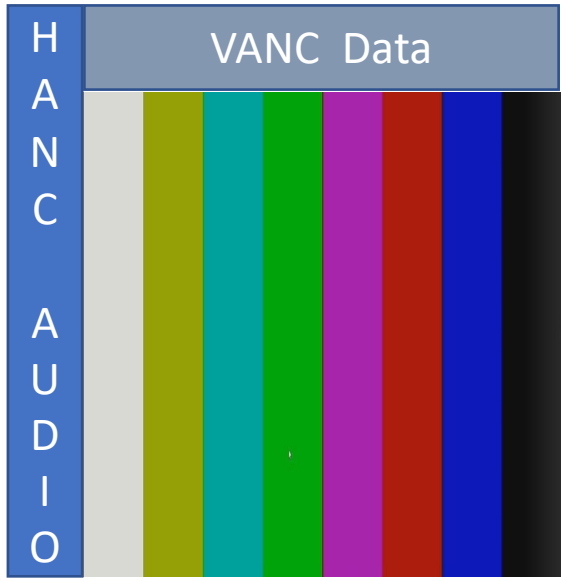
SDI Transmission

- In SDI we send Video, Audio and Data all on the same coaxial cable, line by line.
- We send a Field or Frame of Video, the Audio that goes with each Field or Frame and the ANC data that goes with that Filed or Frame.



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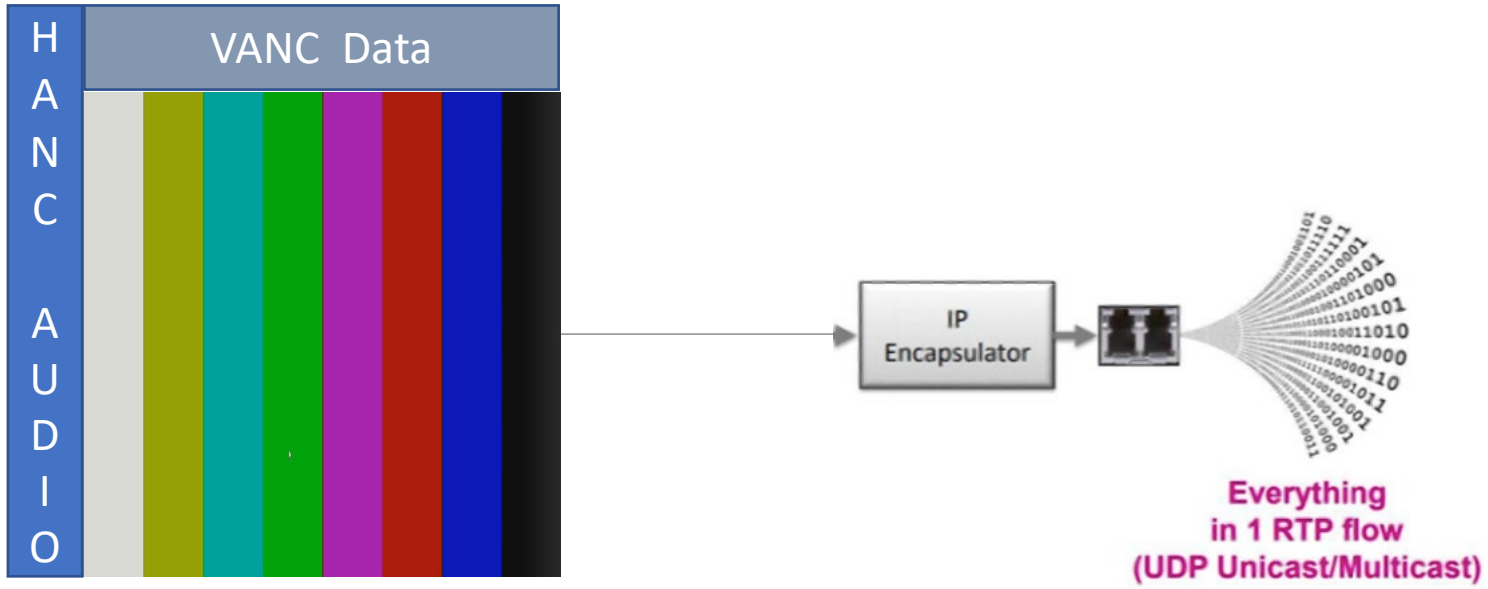
IP Transmission

- SMPTE ST 2022-6 saw us replicate SDI in a single RTP flow, using UDP Unicast/Multicast protocols



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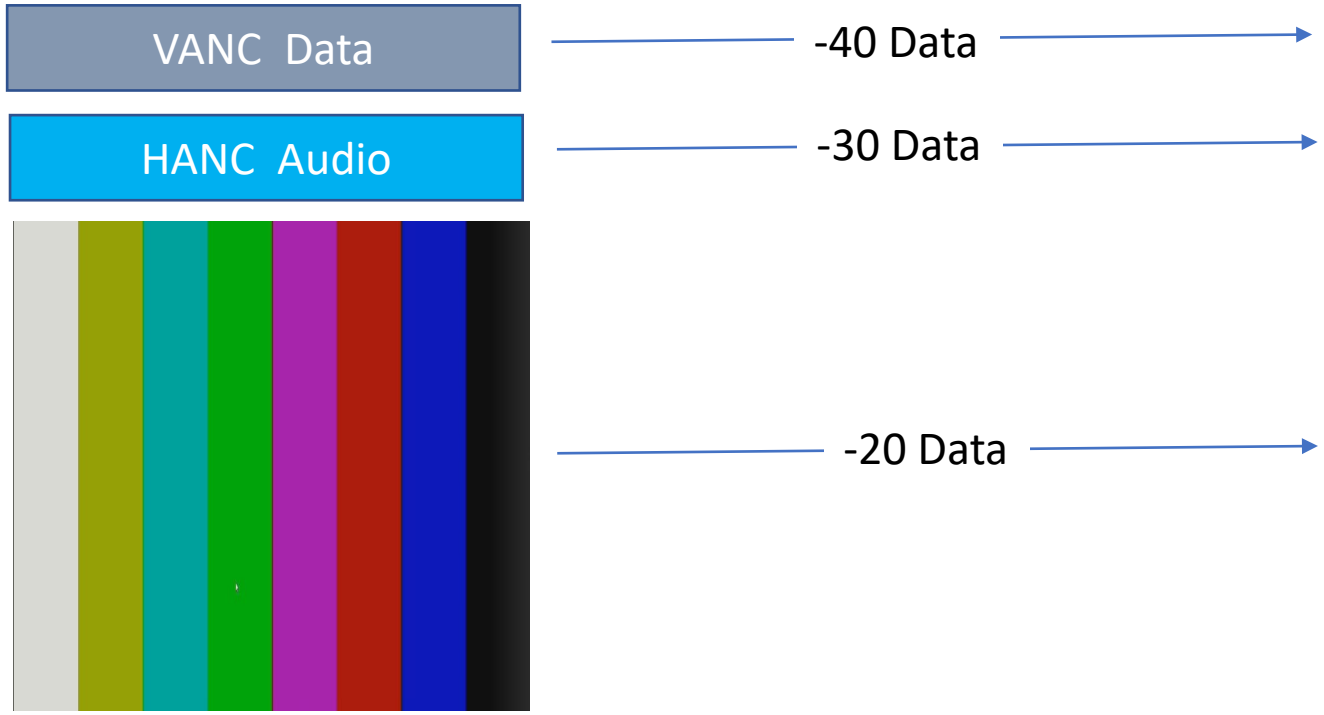
IP Transmission

- In IP we send Video, Audio and Data in (3) three different IP Multicast streams (essences).
- These different multicast streams can be on the same fiber, but they don't have to be.



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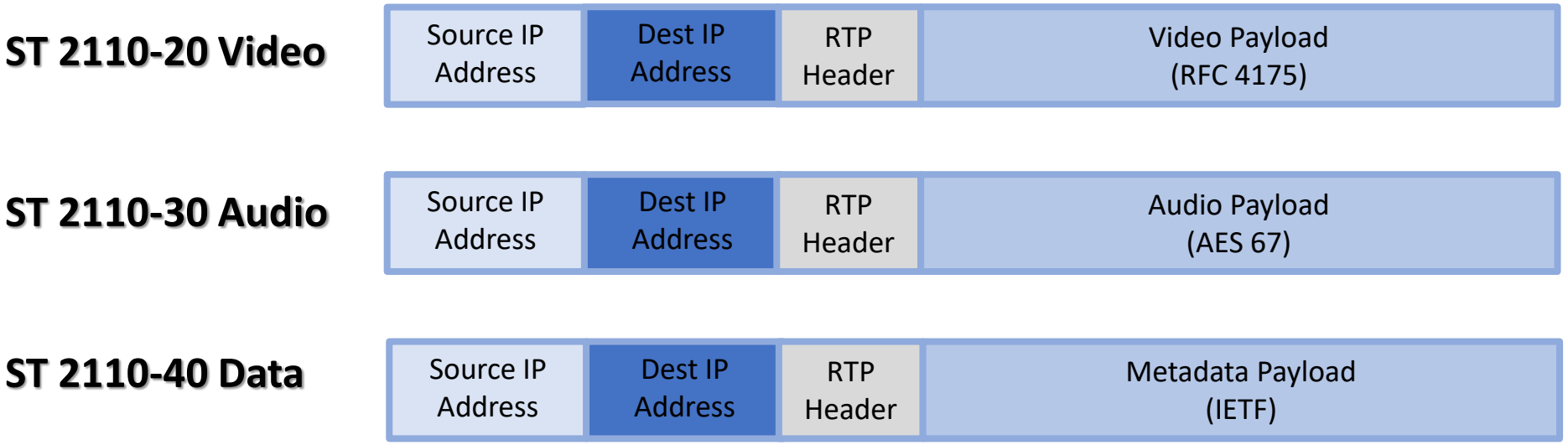
SMPTE ST 2110

- ST 2110 uses separate Video, Audio and Metadata as essence payloads, or Flows.
- Uses essence over RTP/UDP
- Use PTP for synchronization (IEEE 1588 with SMPTE ST 2059-2 Profile.
- These three IP flows (essences) make up your program and are aka as a Service



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Things we used to do – Analogue Video to SDI.

- With Analogue Video, we could hang an Oscilloscope on the video coaxial cable and look at it.
- We had to come up with a way to look at SDI, take 10 bits, make a Pixel out of it put that Pixel on the screen.

- With Analogue Audio, we could put an Oscilloscope on the Audio and see the Audio.
- With SDI we had to come up with a way to grab the channel that we wanted from the data out of the HANC and make an Audio waveform out of it.

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Things we used to do – SDI to IP.

- SDI allowed us to carry the Audio and Captions (and several other things) in the Video payload. New tool sets and new ways were created to look at them.
- Well, we have done it again. We have moved everything around and put it on IP, not just IP but (3) three different IP Multicast flows.
- We need to find / make new tools to look at Video / Audio / Data (Captions) and make sure the Video / Audio / Captions etc., are compatible with being put back to SDI if needed.
- We will look at how to do this and see IP and SDI side-by-side.

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Engineering verses Day to Day Work.

- Engineering IP Trouble shooting:
- You need a deep tool set to trouble shoot the IP layer.
  - IP Flow status, Packet Jitter, PTP timing, Buffers, 2022-7 and more
- But that’s not what you need for day-to-day operations
- Production Day-to-Day operations;
  - Waveform, Vector, Captions, SCTE104, Audio Loudness, comparison of IP to SDI feed.

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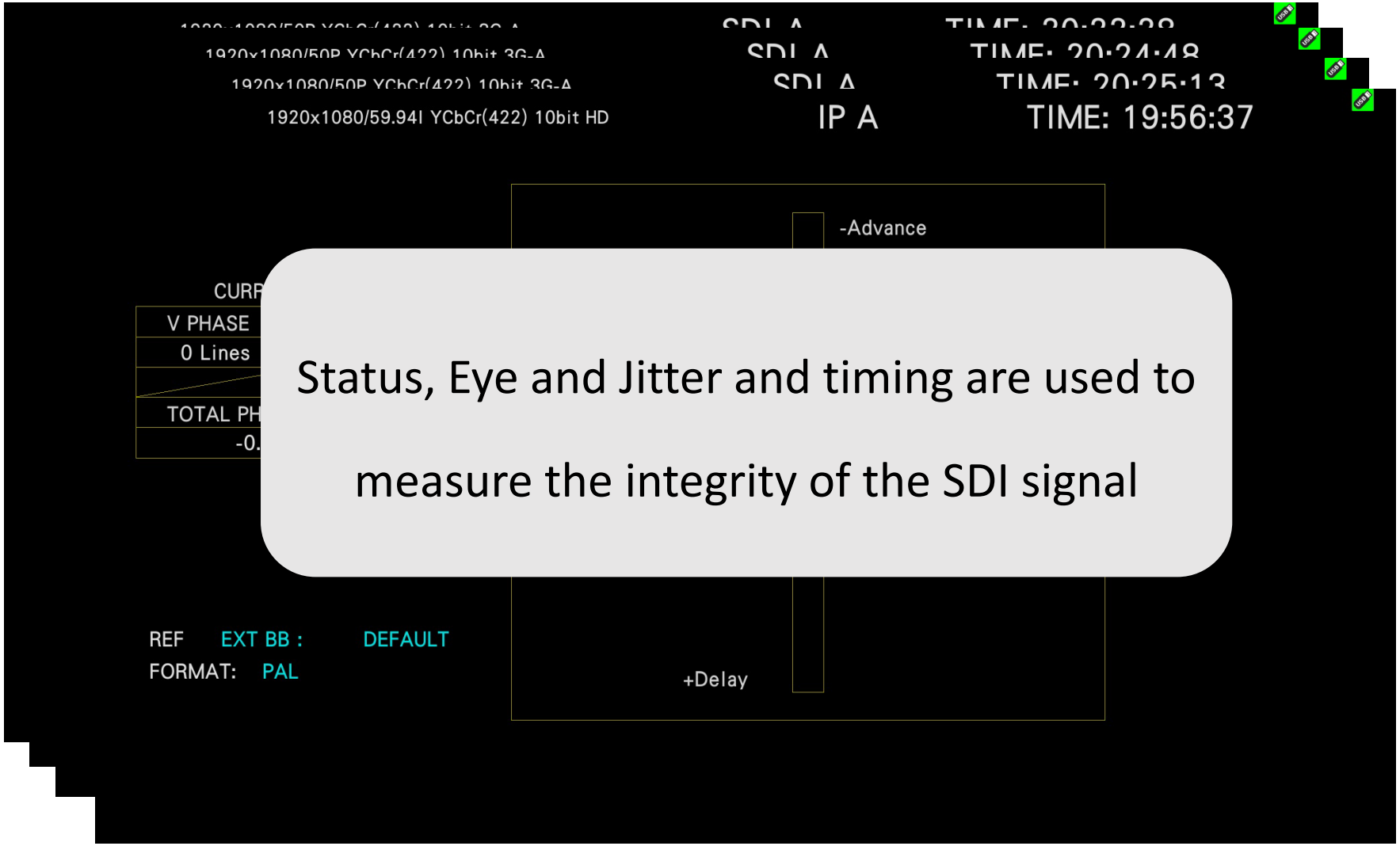
SDI Trouble shooting

- **STATUS**
- **EYE**
- **JITTER**
- **TIMING**



Status, Eye and Jitter and timing are used to measure the integrity of the SDI signal

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IP Trouble shooting

- As IP networks become more complicated, it is important to monitor each service.
- Confirm the protocol, data rate, Src. And Dst. address etc. of the received packets
- Monitor whether errors in packets occur.
- Monitoring traffic on each input IP port, as variations might indicate a network issue.

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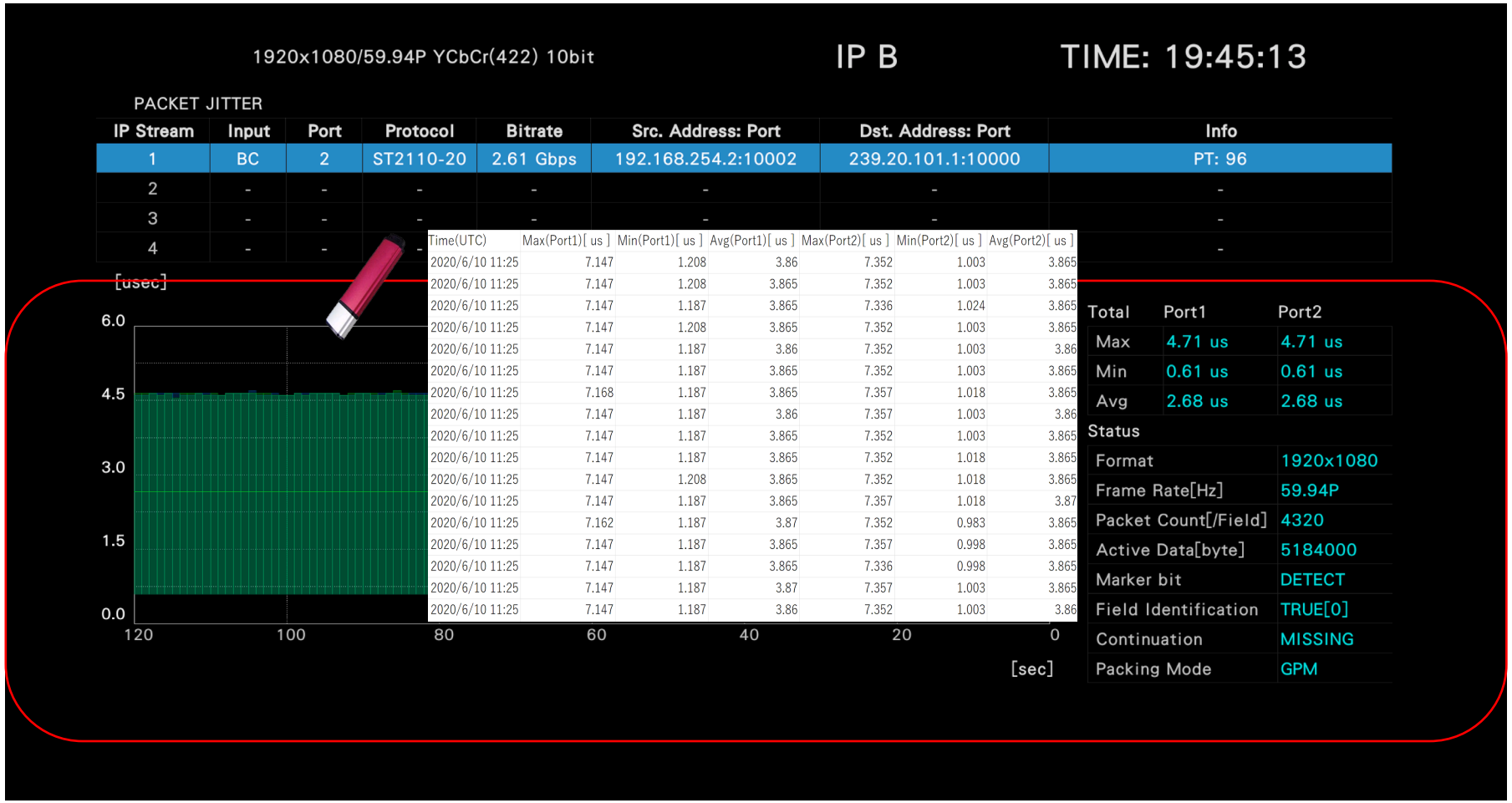
IP Trouble shooting

- Excessive jitter results in large variances in inter packet arrival times.
  - Sustained jitter can mean burst or voids of packets.
- If packets are excessively delayed (a void) the receiver is starved.
  - Receive buffers are drained and the stream cannot be sustained.
- If packets are excessively bunched (a burst) the receiver is overloaded
  - Receive buffers are filled and video data must be discarded.
- Use Inter-Packet Arrival tools to visualize packet jitter.



IP Stream	Input	Port	Protocol	Bitrate	Src. Address: Port	Dst. Address: Port	Info
1	BC	2	ST2110-20	2.61 Gbps	192.168.254.2:10002	239.20.101.1:10000	PT: 96
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-

Time(UTC)	Max(Port1)[us]	Min(Port1)[us]	Avg(Port1)[us]	Max(Port2)[us]	Min(Port2)[us]	Avg(Port2)[us]
2020/6/10 11:25	7.147	1.208	3.86	7.352	1.003	3.865
2020/6/10 11:25	7.147	1.208	3.865	7.352	1.003	3.865
2020/6/10 11:25	7.147	1.187	3.865	7.336	1.024	3.865
2020/6/10 11:25	7.147	1.208	3.865	7.352	1.003	3.865
2020/6/10 11:25	7.147	1.187	3.86	7.352	1.003	3.86
2020/6/10 11:25	7.147	1.187	3.865	7.352	1.003	3.865
2020/6/10 11:25	7.168	1.187	3.865	7.357	1.018	3.865
2020/6/10 11:25	7.147	1.187	3.86	7.357	1.003	3.86
2020/6/10 11:25	7.147	1.187	3.865	7.352	1.003	3.865
2020/6/10 11:25	7.147	1.187	3.865	7.352	1.018	3.865
2020/6/10 11:25	7.147	1.208	3.865	7.352	1.018	3.865
2020/6/10 11:25	7.147	1.187	3.865	7.357	1.018	3.87
2020/6/10 11:25	7.162	1.187	3.87	7.352	0.983	3.865
2020/6/10 11:25	7.147	1.187	3.865	7.357	0.998	3.865
2020/6/10 11:25	7.147	1.187	3.865	7.336	0.998	3.865
2020/6/10 11:25	7.147	1.187	3.87	7.357	1.003	3.865
2020/6/10 11:25	7.147	1.187	3.86	7.352	1.003	3.86

Total	Port1	Port2
Max	4.71 us	4.71 us
Min	0.61 us	0.61 us
Avg	2.68 us	2.68 us

Status	
Format	1920x1080
Frame Rate[Hz]	59.94P
Packet Count[/Field]	4320
Active Data[byte]	5184000
Marker bit	DETECT
Field Identification	TRUE[0]
Continuation	MISSING
Packing Mode	GPM

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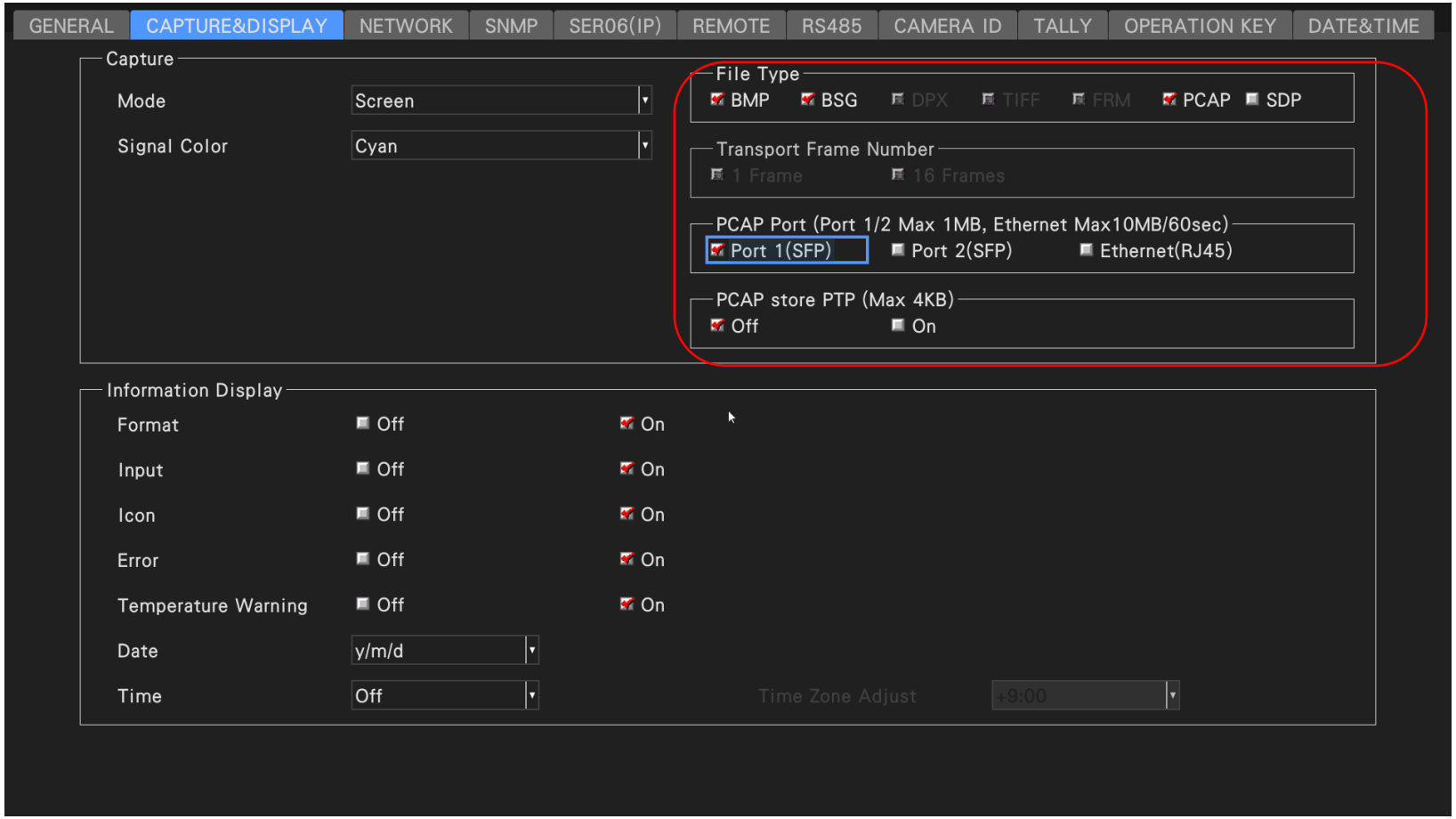

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- With ST-2110, the timing information has been removed from the underlaying hardware layer making the distribution asynchronous.
- BB / TLS reference is replaced by Precision Time Protocol (PTP)
- PTP is time-based, as opposed to phase based like BB / TLS

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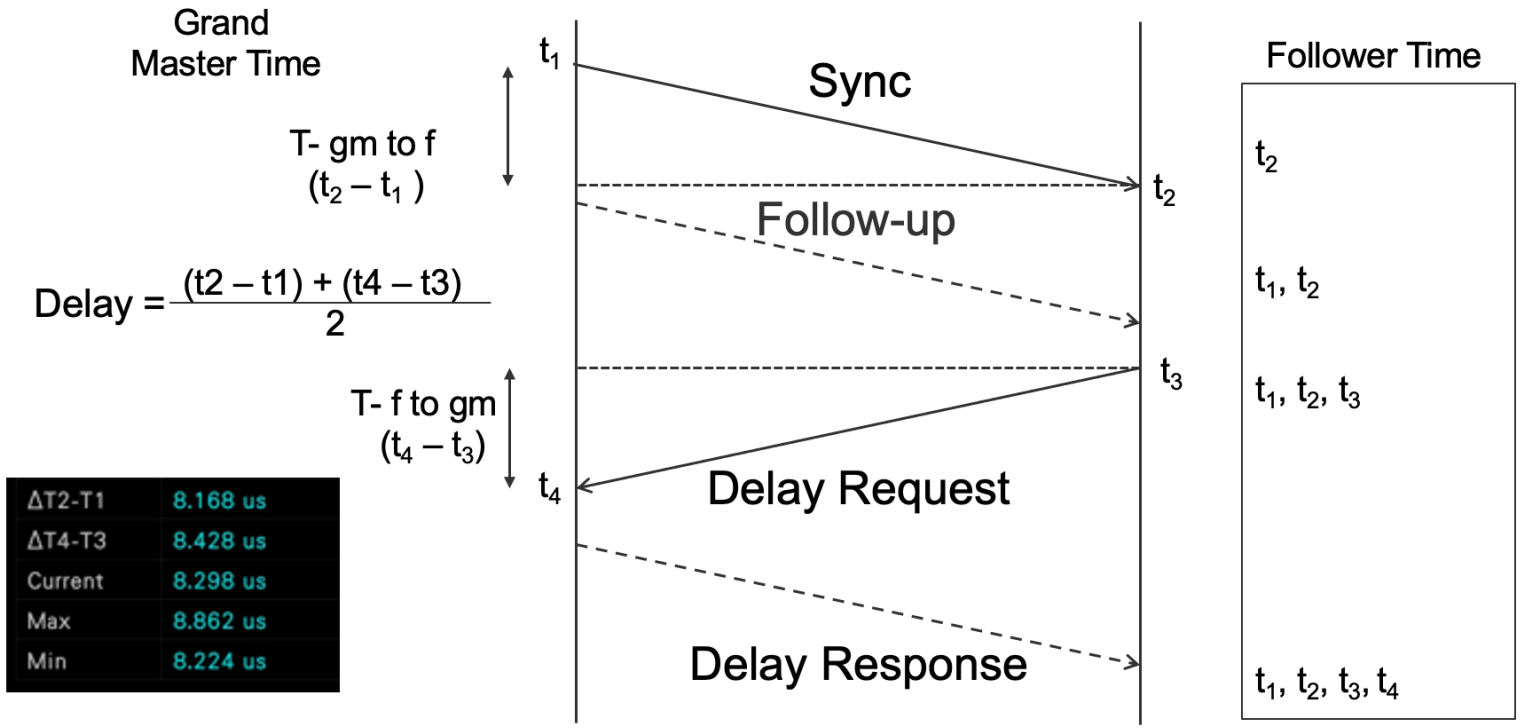
IP SHOWCASE™

IP Trouble shooting

- PTP works by sending messages in both directions between the Grandmaster and Follower clock (device that is being timed) and using timestamps on those messages to determine the delays in the network and the offset in the client.

Used by Followers and Boundary Clocks



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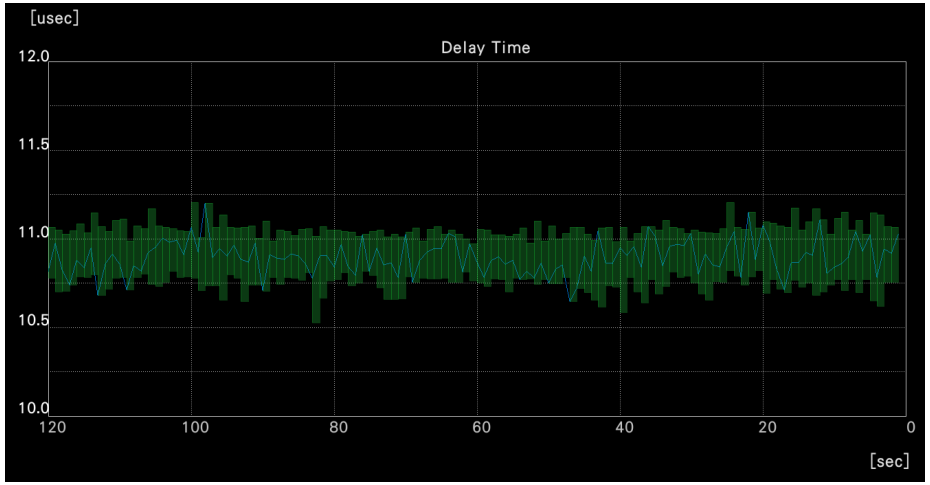
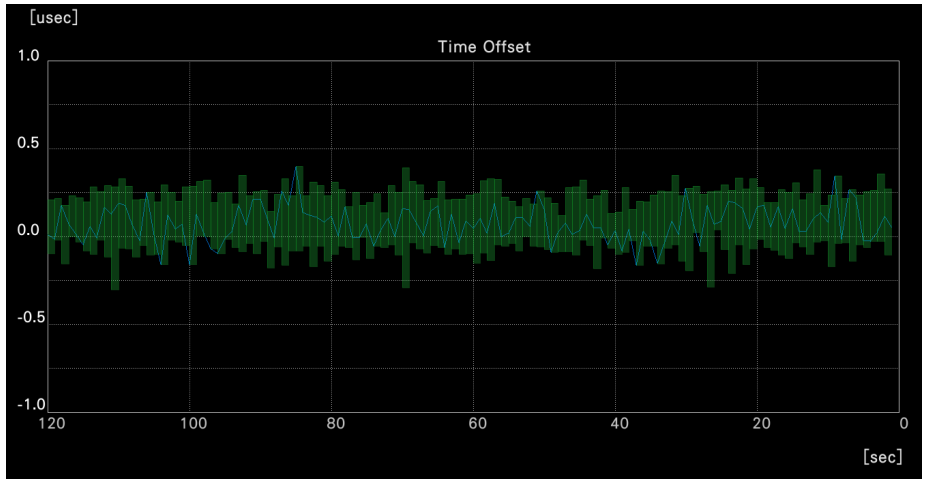
IP SHOWCASE™

IP Trouble shooting

- One way to look at this, is PTP compensates for network delays and will adjust the Follower clock, using the measured difference in time between the Grandmaster and the Follower in time on the upstream and downstream paths.
- So, if the path delay on the two directions of a given path really are equal then the two clocks will be accurately aligned.





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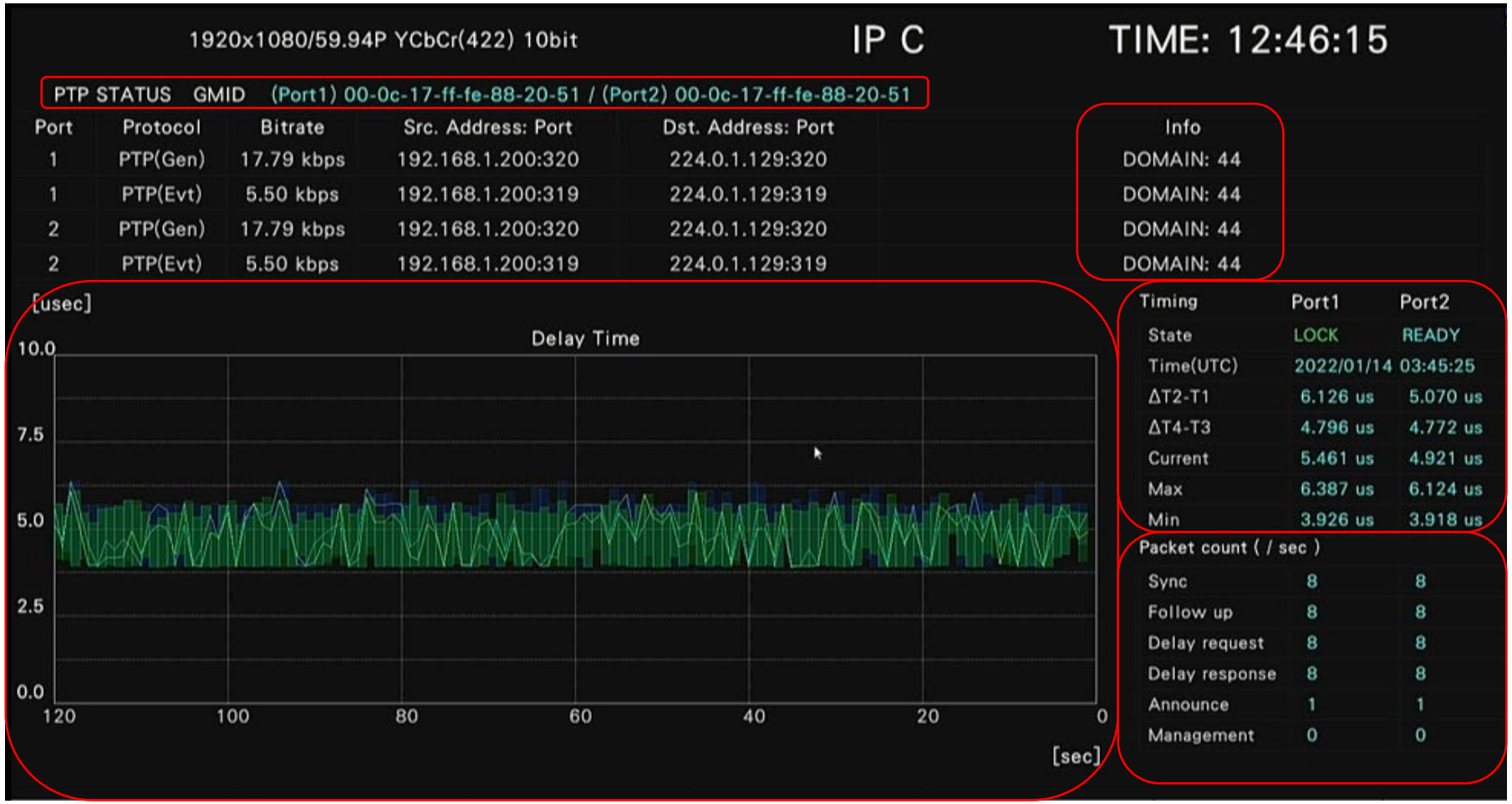
IP Trouble shooting

- Display synchronization status, time information and delay in PTP time synchronization.
- PTP STATUS GMID
- PTP DOMAIN
- Display max, min, measured value per second of PTP lock status, time information, network delay.
- Display PTP Message rates
- Network delay graph.



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- Once we are confident that our PTP reference is stable, we can start to investigate the timing of each of the SMPTE ST 2110 Multicast flows.
- With ST-2110-20 the video stream only contains the active pixels.
- Which brings with it a new series of measurement challenges.

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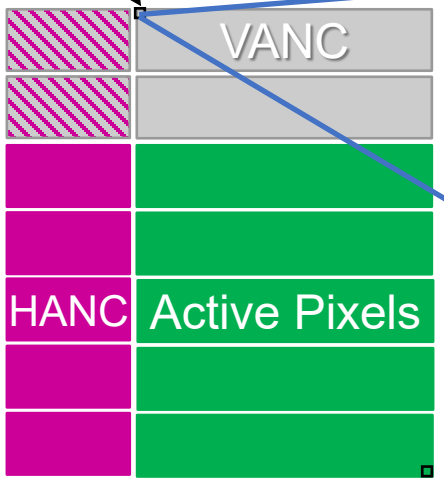
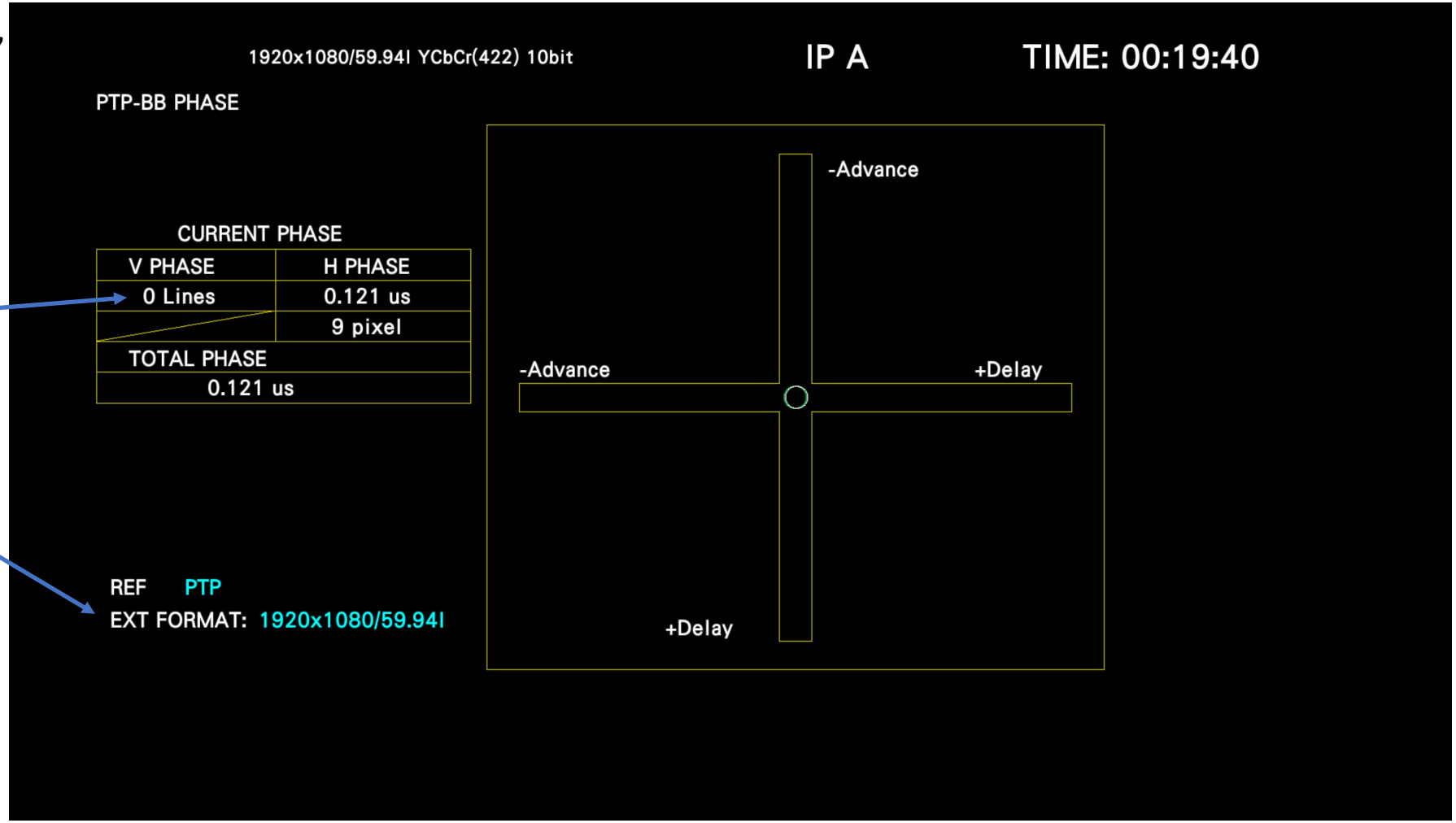
RTP / PTP Timing – ST.2110

The start of PTP is normally the same as the start of Black, Line 0, Pixel 0





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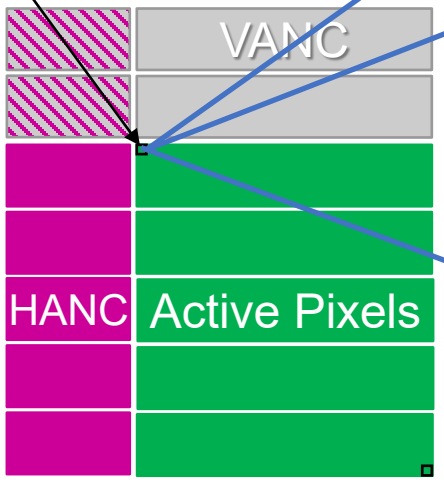
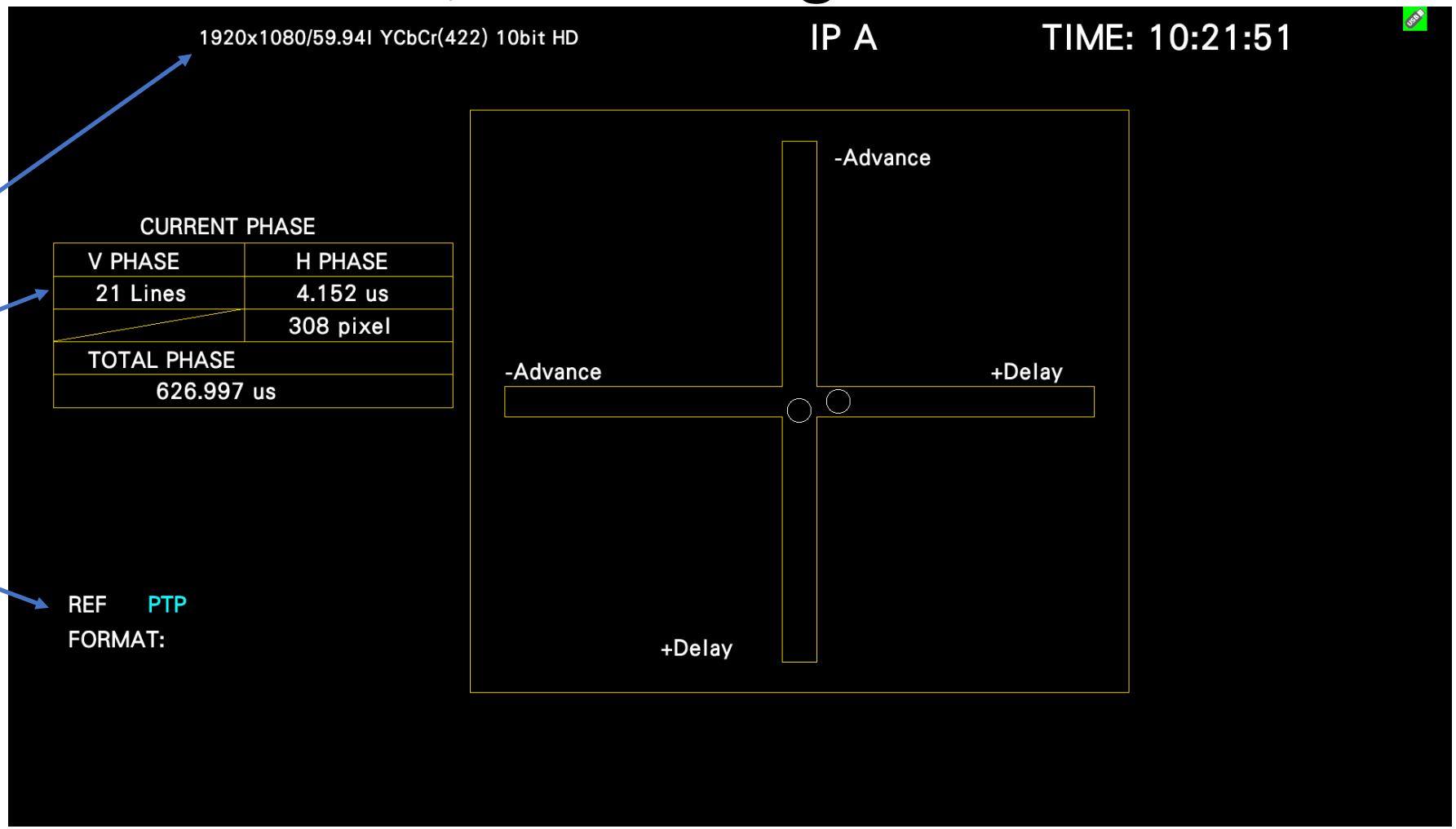
RTP / PTP Timing – ST.2110

The start of PTP is normally the same a the start of Black, Line 0, Pixel 0

But active video starts 21 lines later for 1080i or 42 lines later for 1080p





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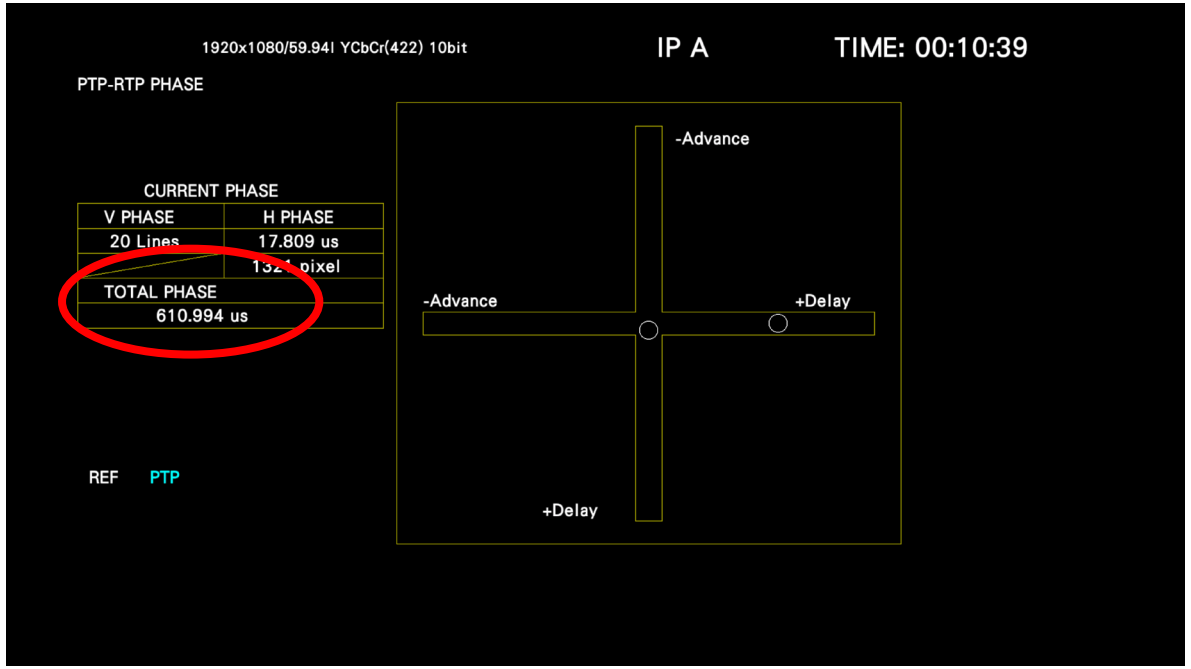
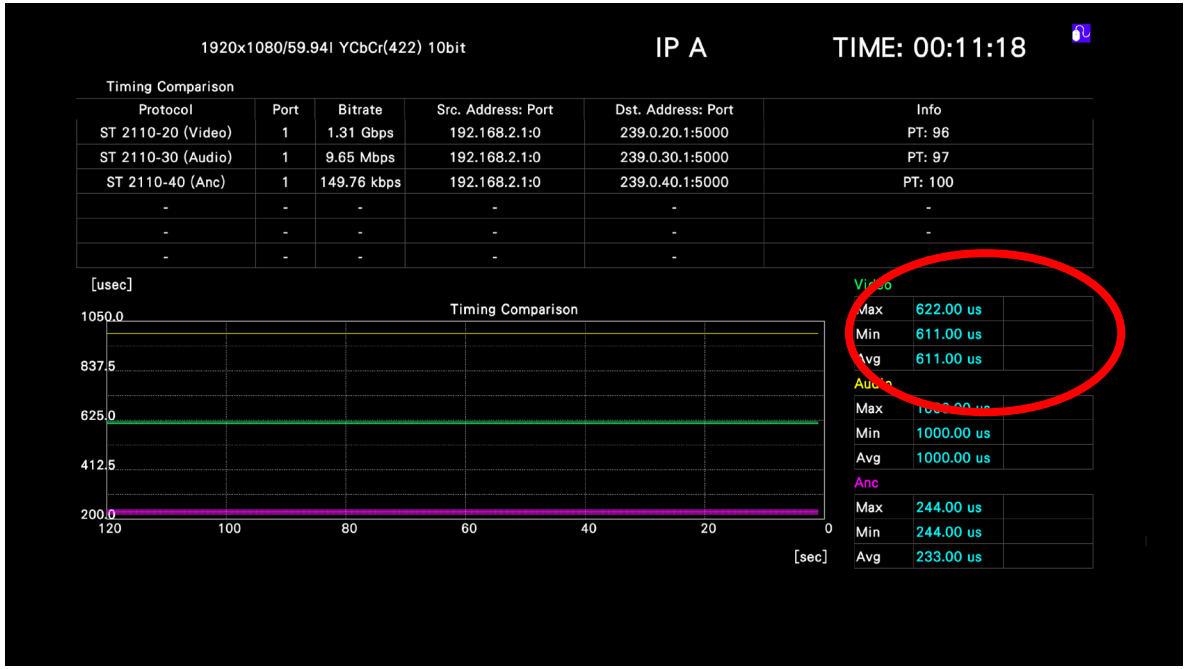
Timing Comparison





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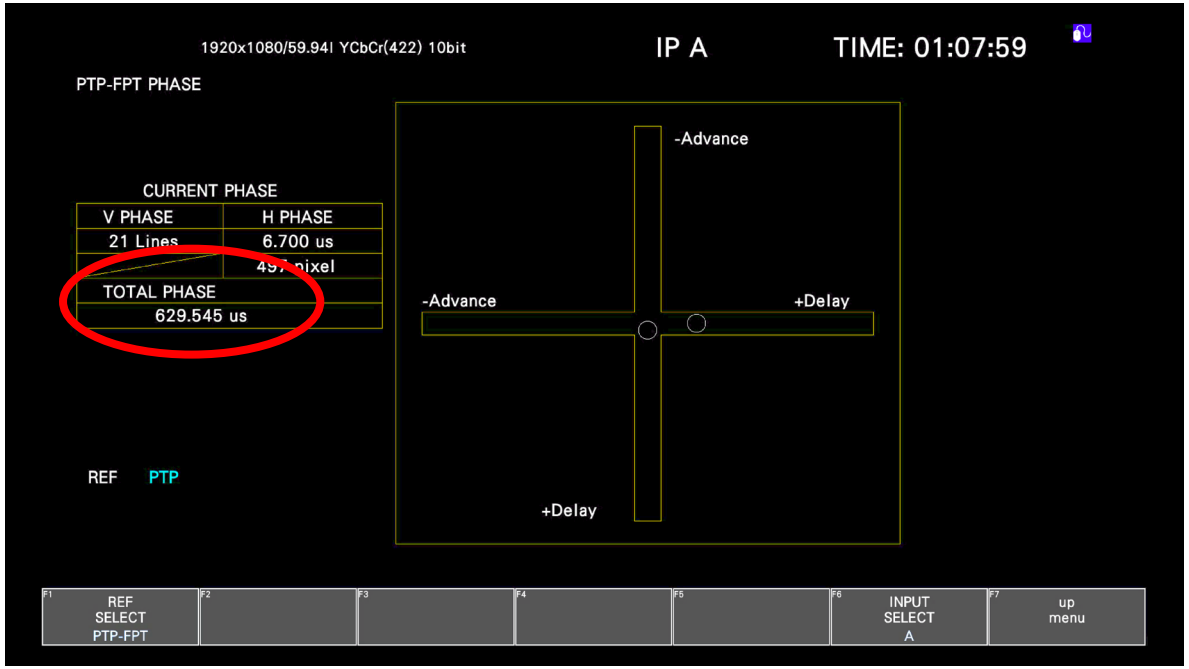
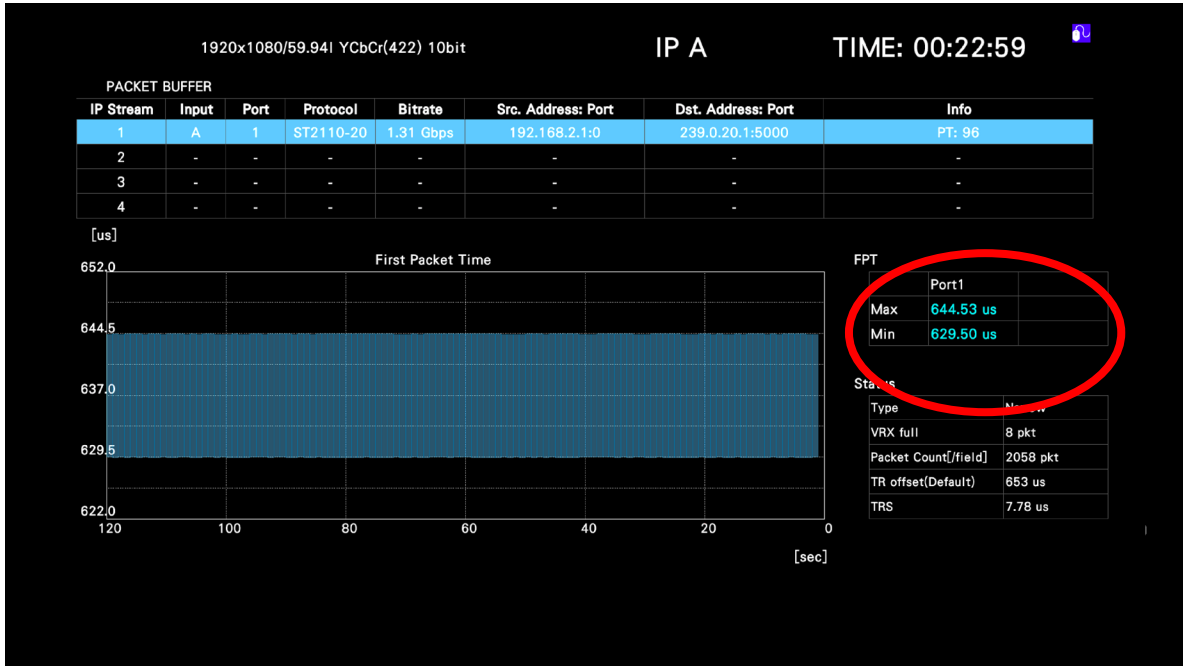
1st Packet Arrival Time





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- If the Timing Comparison displays and the 1st Packet Arrival Time graph are outside the expected timing range and no image is being displayed, there is one further test you can employ.
- On the Leader test and measurement products you can switch the ‘Timestamp Mode’ to OFF.

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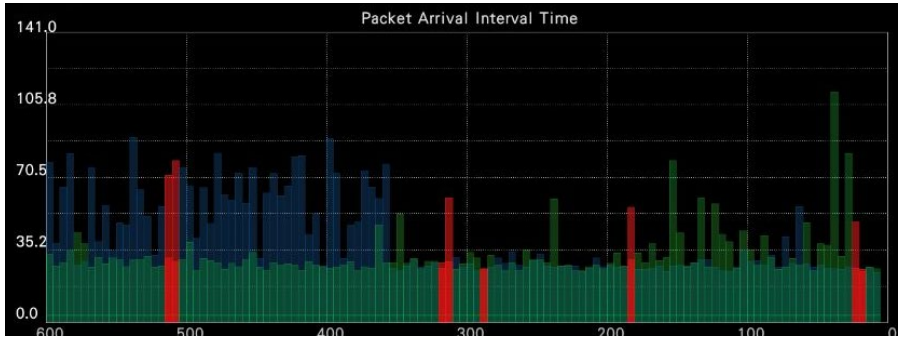
IP Trouble shooting

- Transmission Errors – Dropped Data
- SDI we look at CRC errors
- In IP we look at RTP errors
  - CRC Errors will not pass through an IP Switch

ERROR	
SDI	A CH
CRC	0
TRS Position	0
TRS Code	0
Illegal Code	0
Line Number	0



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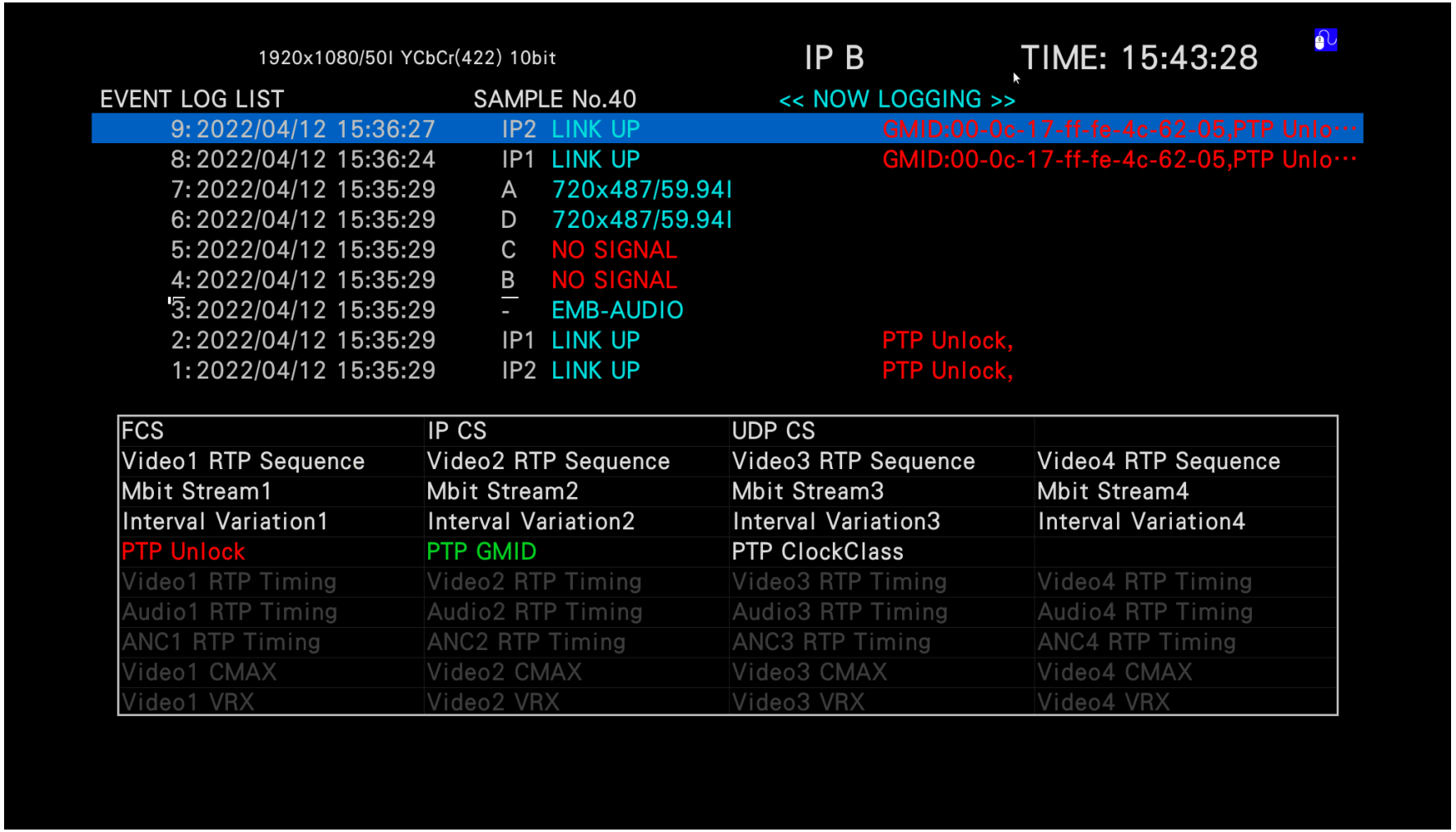
IP Trouble shooting

- The Event Log now contains a completely new set of fault parameters.
  - FCS Error
  - IP CS Error
  - UDP CS Error
  - Video RTP Sequence
  - Mbit Stream 1,2,3,4
  - Interval Variation 1,2,3,4
  - PTP ClockClass
  - Video CMAX
  - Video VRX
  - PTP Unlock Error
  - PTP GMID Exist
  - Video RTP Timing
    - Threshold
  - ANC RTP Timing
    - Threshold



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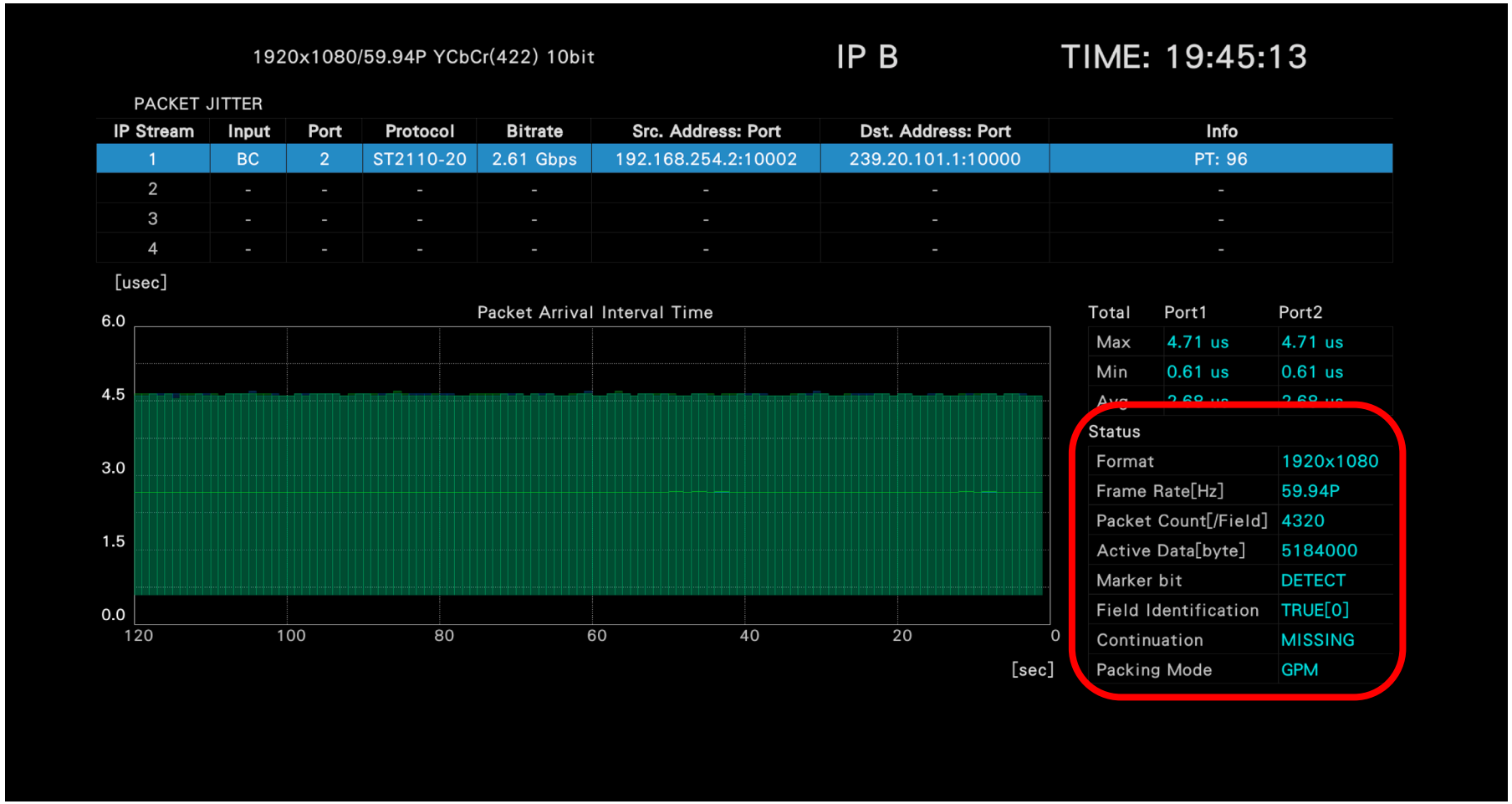
IP Trouble shooting

- ST 2110-20 video stream only contains the active pixels.
- Video frame rate and sampling rate are determined on the STATUS -> Packet Arrival Time display from RTP timestamp.



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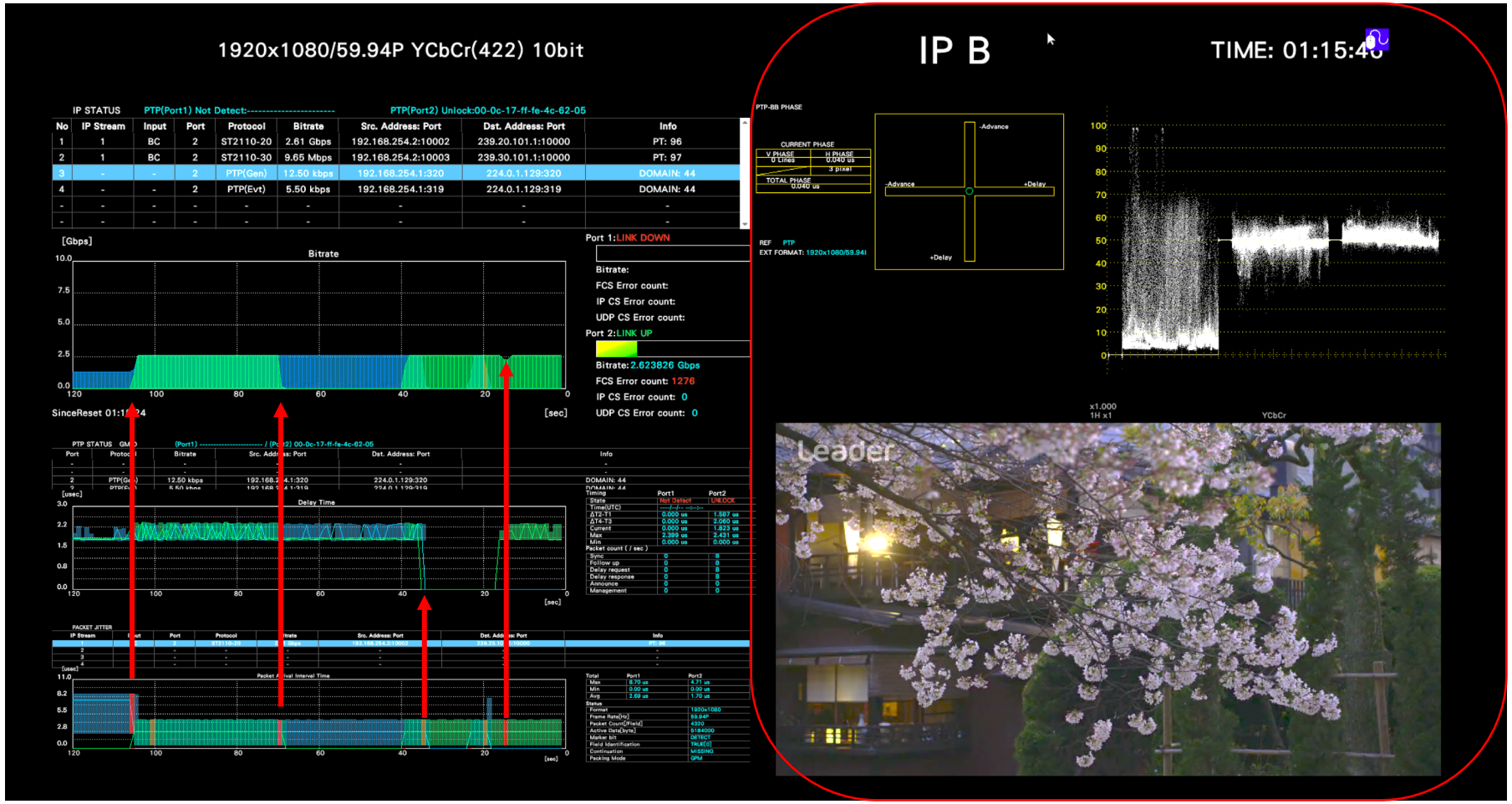
IP Trouble shooting

- By being able to view simultaneously multiple IP analysis tools, engineers can quickly and efficiently identify where the networking issues lies.
- Whilst at the same time still having access to the traditional waveform, timing and picture display tools they are familiar with from SDI based facilities



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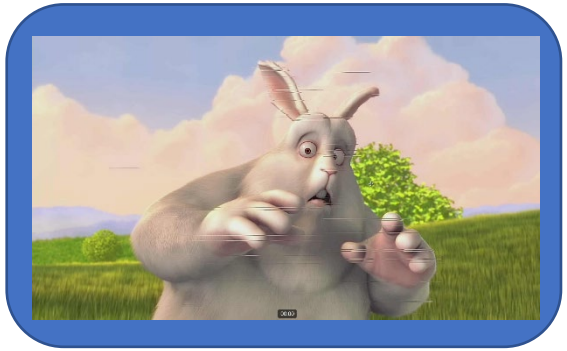
- Every device may show the errors in a picture a little differently, it is all depends on how they build the picture.
- In 1080i one IP packet is about ¼ of a line, that's how much data will be lost for one packet error.
- Some are going break up randomly
- Some will have lines of bad pixels jumping all over the place
- Some will go to black on the error



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IP Trouble shooting

- Picture Breakup
  - Slice

Pipes are now Packets

IP Trouble shooting

- Picture Breakup
  - Pixel Lines

Pipes are now Packets

IP Trouble shooting

- Picture Breakup
  - Blackout

Pipes are now Packets

- So, we've established that our IP network is operating correctly.
- We now need a suite of analysis tools for Day-to-Day production that operate in both IP and SDI infrastructures.
- Remember – IP is just another I/O interface – its how we analysis it.

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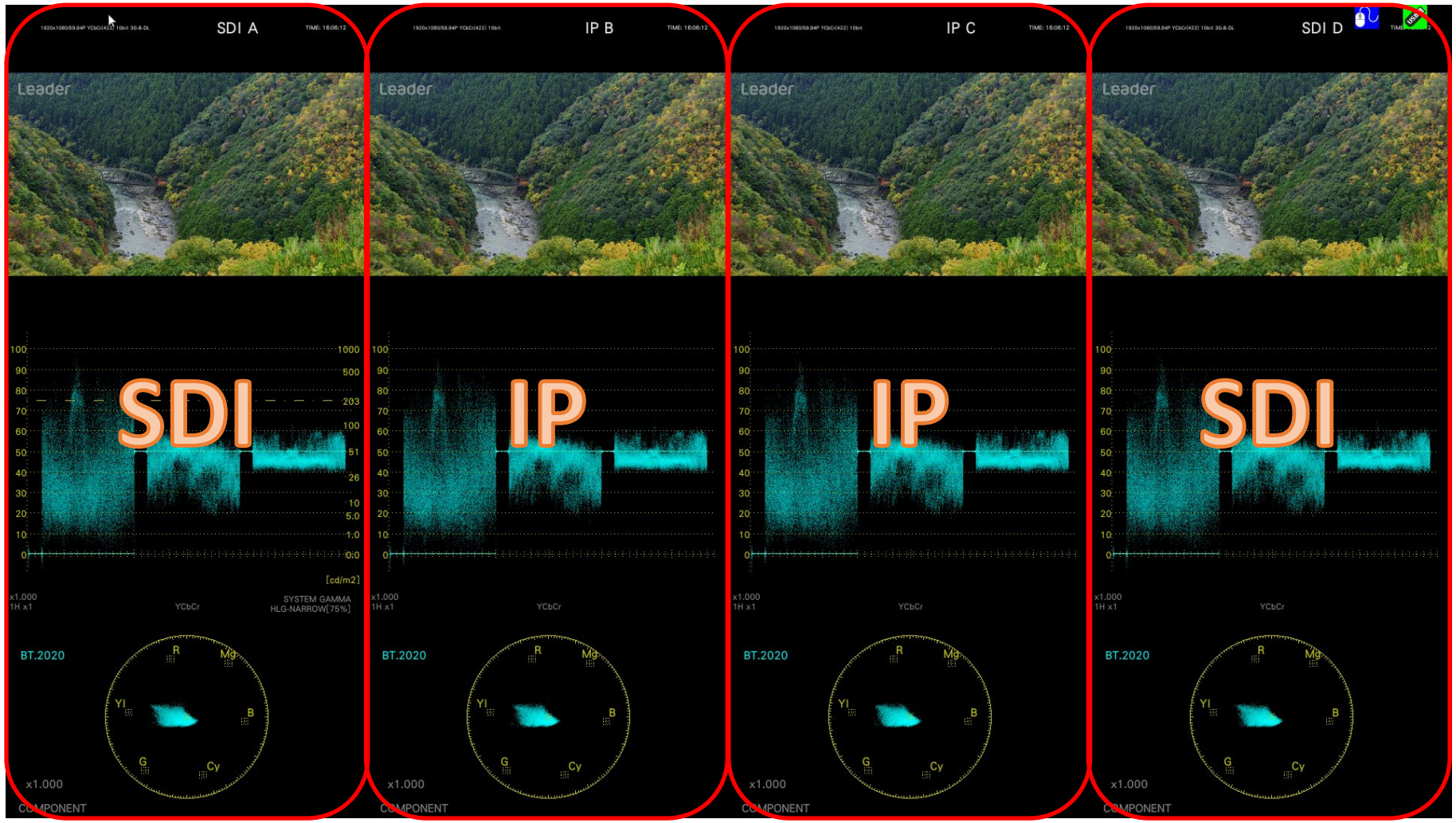
Day-to-Day Operations

- Although the transport layer has changed, color management of images remains the same.
- Camera shaders don't care if the source signal is IP or SDI
- You need test and measurement tools that can display both IP and SDI simultaneously (aka as 'True Hybrid' Operation)



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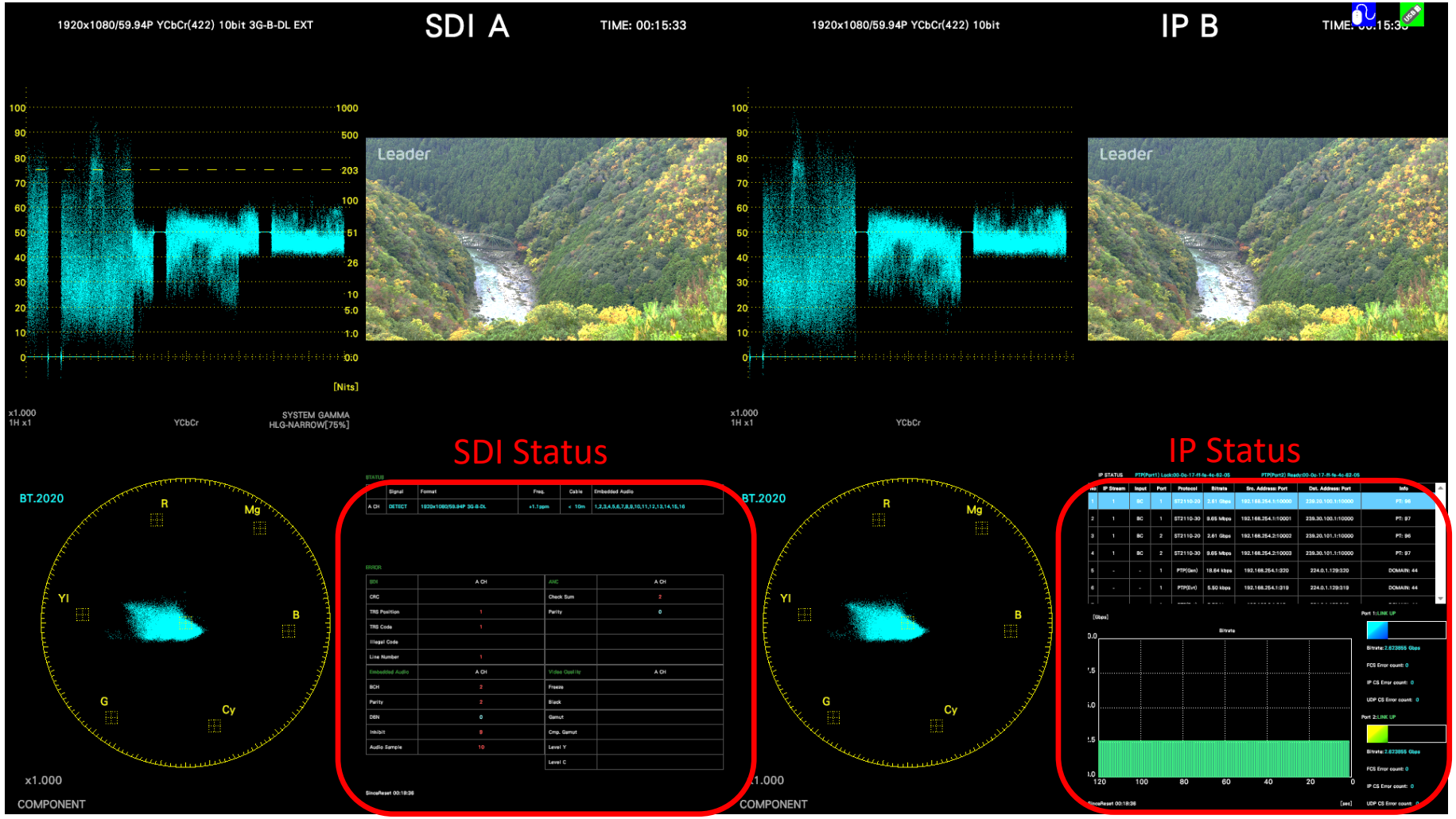
Day-to-Day Operations

- The same applies to the traditional ‘Quad-split’ display.
- Only the STATUS display is different



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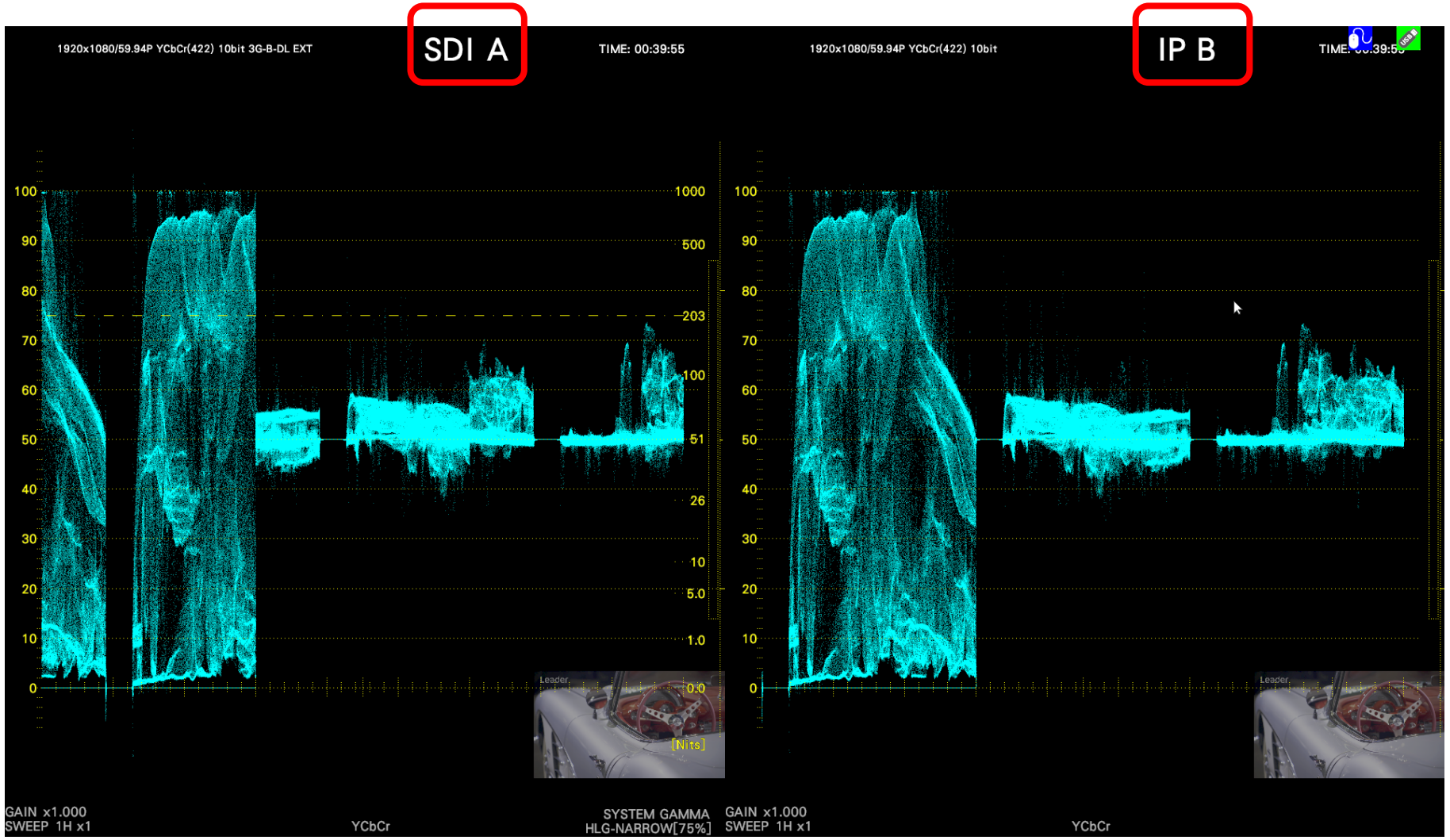
Day-to-Day Operations

- With the customizable layout license, analysis tools can be freely sized, positioned and even overlaid depending on the operator preference.
- Irrespective of whether the video source is IP or SDI



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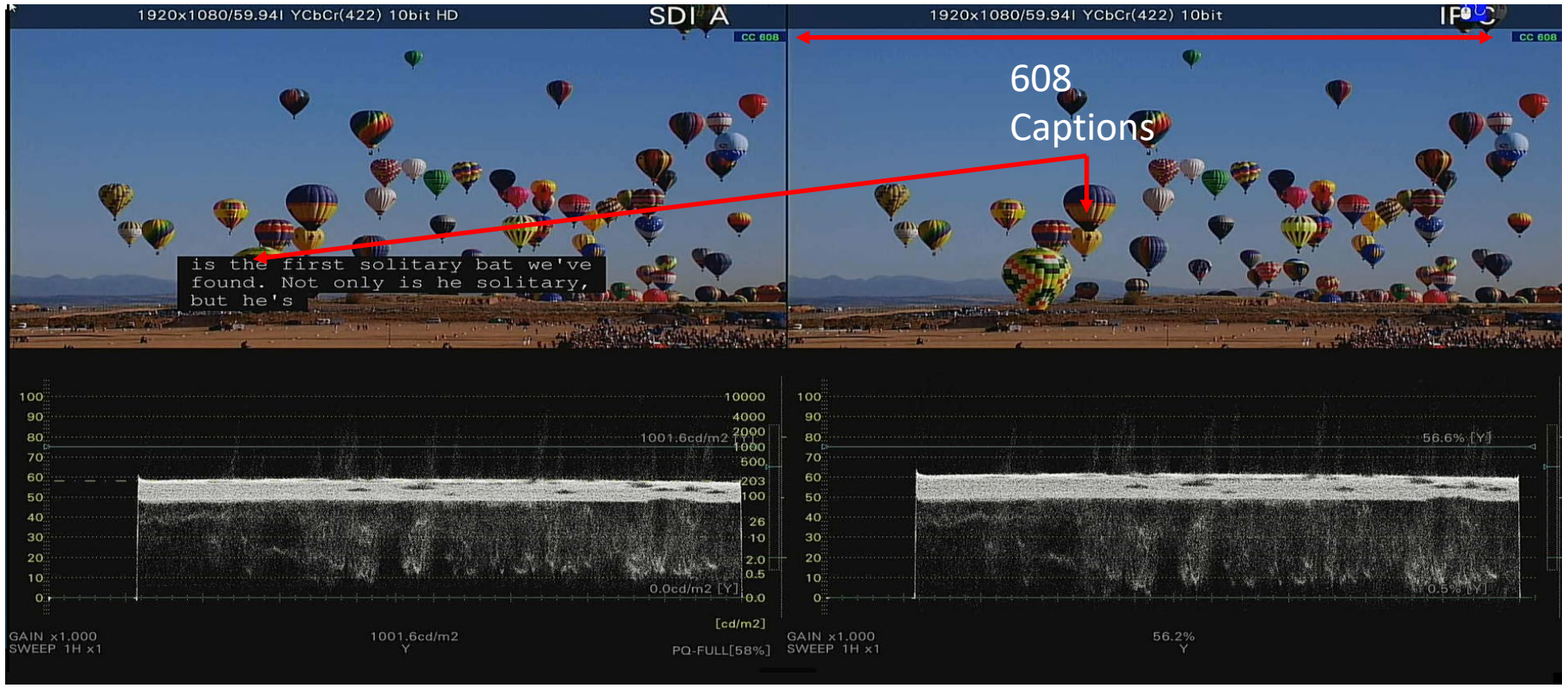
Day-to-Day Operations

- ‘True Hybrid’ operation allows you to ensure ancillary data like closed captions are present.
- Multiple analysis tools like PIC and WFM can be displayed in both IP and SDI.



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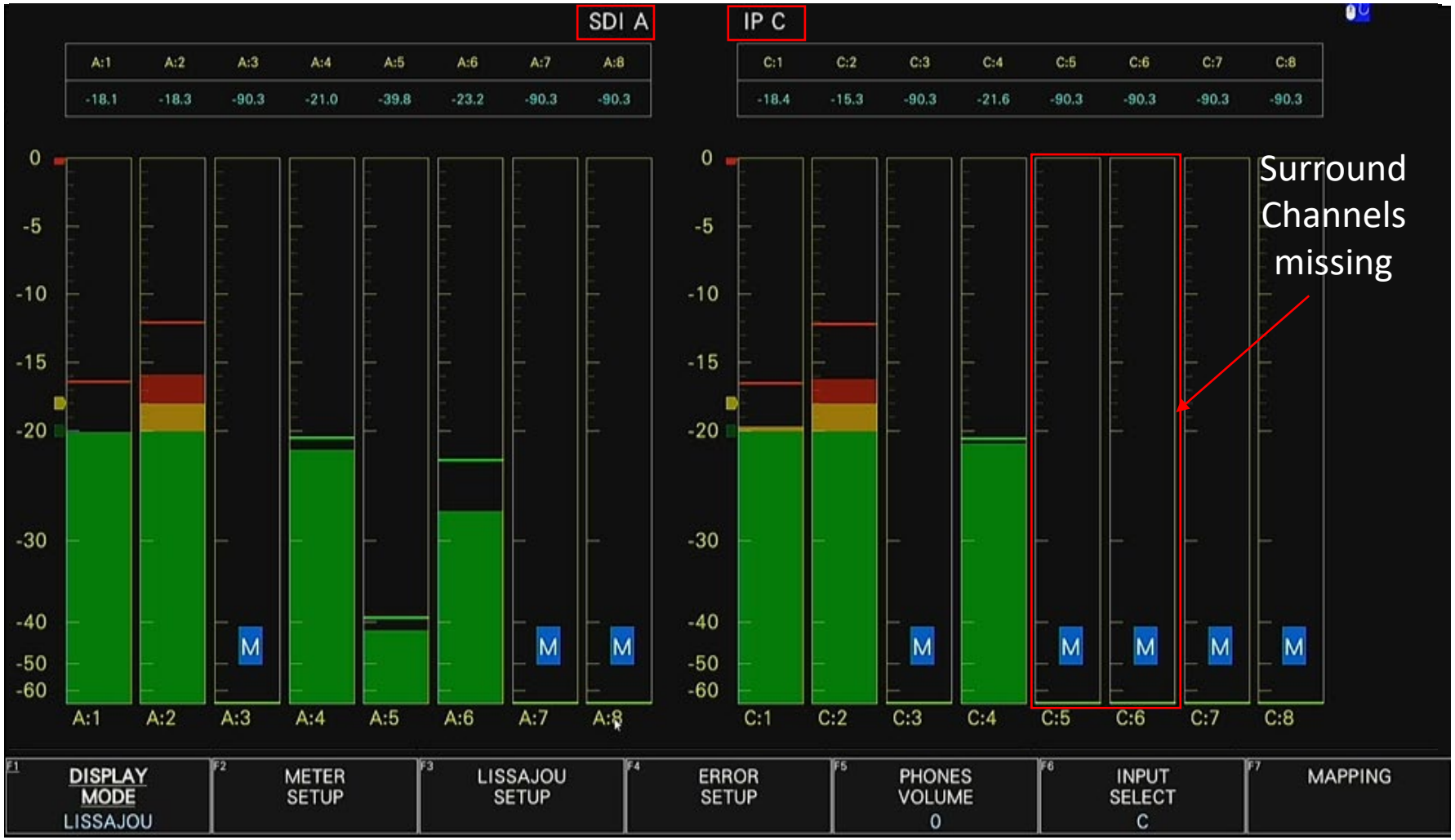
Day-to-Day Operations

- The same applies to Audio Analysis of -30 or -31 audio stream and SDI embedded audio.



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Day-to-Day Operations

- The same applies to ANC Data Analysis of -40 ANC Data stream and SDI embedded audio.

PAYLOAD ID DISPLAY SMPTE ST352		PAYLOAD ID DISPLAY SMPTE ST352	
INTERFACE LINE No.	10	INTERFACE LINE No.	10
BYTE1	10001001 [89]	BYTE1	10000101 [85]
VERSION ID	SMPTE ST352-2011	VERSION ID	SMPTE ST352-2011
PAYLOAD ID	1125(1080) LINE	PAYLOAD ID	1125(1080) LINE
DIGITAL INTERFACE	3Gb/s LEVEL-A	DIGITAL INTERFACE	1.485Gb/s
BYTE2	11001010 [CA]	BYTE2	00001010 [0A]
TRANSPORT STRUCTURE	PROGRESSIVE	TRANSPORT STRUCTURE	INTERLACED
PICTURE STRUCTURE	PROGRESSIVE	PICTURE STRUCTURE	INTERLACED
HDR / SDR	SDR	HDR / SDR	SDR
PICTURE RATE	60/1.001	PICTURE RATE	60/1.001
BYTE3	00000000 [00]	BYTE3	00100000 [20]
ASPECT RATIO	UNKNOWN	ASPECT RATIO	16:9
H SAMPLING	1920	H SAMPLING	1920
COLORIMETRY	REC 709	COLORIMETRY	REC 709
SAMPLING STRUCTURE	4:2:2 YCbCr	SAMPLING STRUCTURE	4:2:2 YCbCr
BYTE4	00000001 [01]	BYTE4	00000001 [01]
CHANNEL ASSIGNMENT	NOT USED	CHANNEL ASSIGNMENT	NOT USED
LUMINANCE / COLOR	YCbCr	LUMINANCE / COLOR	YCbCr
AUDIO EMB MODE	NOT USED	AUDIO EMB MODE	NOT USED
BIT DEPTH	10BIT	BIT DEPTH	10BIT

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- Remember – IP is just another I/O interface – its how we analysis it.
- IP Networks don't typically 'drop off a cliff' and fail, they gradually drift.
  - So having test and measurement products that can monitor your IP network over a prolonged period is vital.
- You need tools that will still show you errors that you can relate back to SDI
  - So having analysis tools that allow you to see Inputs side-by-side, irrespective of whether they are IP or SDI are invaluable.
- You need timing tools to verify that your SDI and IP are locked to the same clock
  - So, connections and analysis of both PTP and BB / TLS are essential.
- You need simple user configurable Multi View screen.
  - The traditional 'Quad-Split' display is no longer sufficient.

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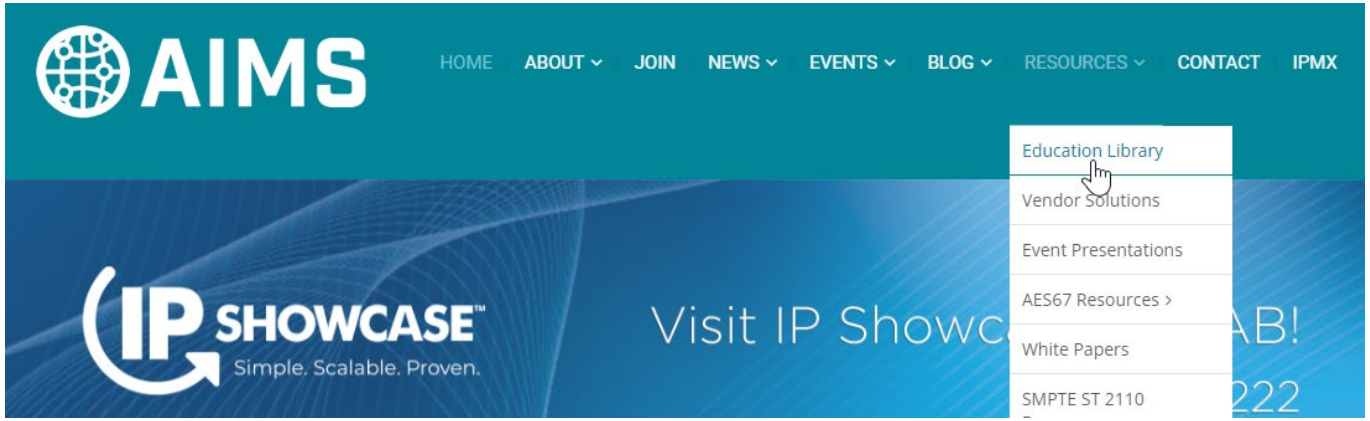
AIMS Education Working Group

Building a foundation of shared knowledge and practical experience in the area of IP media networking

Visit the Education Library at AIMSAlliance.org



Let us know what training and learning opportunities you'd like to see in the field of IP Media Networking

info@aimsalliance.org

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- If you like more information including a copy of this presentation.

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Thank You ..... & ..... Any Questions?

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