



Jitter, Wander, and Time Lock of ST 2110 Video Streams

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Introduction



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Who I am

- **Koji Oyama**

- Working for Business Development over 10+ yrs, Used to be an LSI design engineer for 10 yrs

- **M3L Inc.** (株式会社メディアリンクスエルエスアイラボ)

<http://www.m3l.co.jp/en/>

- Found : April 1997
- President : Kenji Fukuda
- Office : Kawasaki, Japan
- Employees : 10
- SMPTE and VSF member

- **Independent IP-Core Design Company**

IP Core: Reusable logic design blocks ([See Wiki](#))

- Mission: Speedy & High Quality, Vision: Pursue ideal IP cores

- Value: **15+ years Experience** with Professional Video Over IP technology

IP : Internet Protocol ([See Wiki](#)), Professional Video Over IP ([See Wiki](#))



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This Presentation Helps You

- know what happens inside your ST 2110 and ST 2059 function cores
- understand your ST 2110 and ST 2059 features, characteristics, and performance
- know what the difference between SDI and ST 2110 + ST 2059 IP-based technology

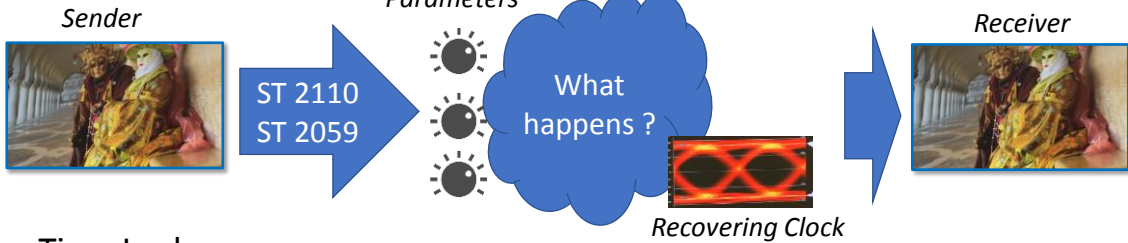


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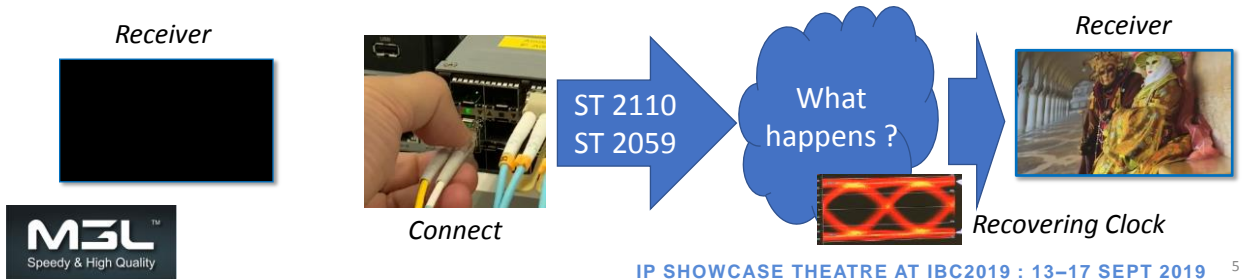


You can know them w/videos and numbers

1. Jitter / Wander



2. Time Lock



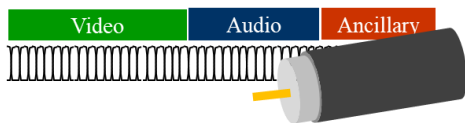
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SDI and ST 2110 + ST 2059

SDI-based Network

- Shorter distance because of coax cables
- Peer to peer connection
- Timing Jitter Requirement
3G-SDI/12G-SDI: < 2UI

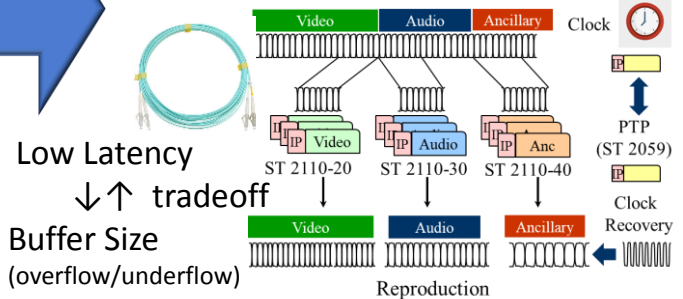


UI := minimum time interval between condition changes of a data transmission signal
 UI = 0.333 ns / baud @ 3Gb/s (3G-SDI)
 UI = 0.083 ns / baud @ 12Gb/s (12G-SDI)



IP-based Network

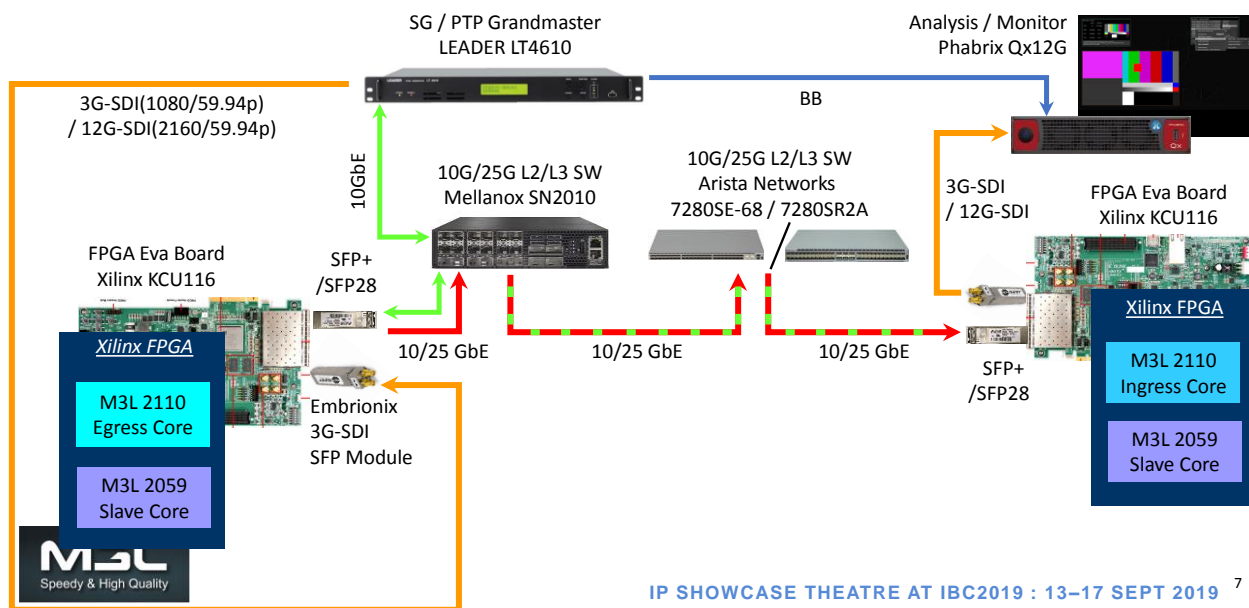
- Longer distance because of optical cables
- n to n connection
- Lock-time Requirement
5 sec @ 1 uS PTP offset



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Evaluation Environment Example



Advance Information

- So that you don't get confused
- The jitter and wander I mention are NOT PTP jitter and wander
 - But timing jitter and phase shift of a reproduced video and SDI signals
- These jitter and wander depend on each implementation
 - Numbers in this presentation are just an example of our implementation
 - ST 2110 and ST 2059 standards have no numbers regarding jitter, wander, and lock time
- Such numbers may be criteria for network system reliability



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Jitter / Wander

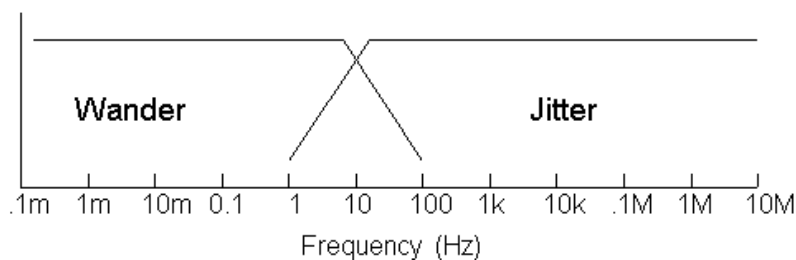


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What Jitter and Wander are

- What's Jitter?
 - the *short-term* (<1sec) variations of the significant instants of a digital signal from their ideal positions in time
- What's Wander?
 - the *long-term* (>=1sec) variations of the significant instants of a digital signal from their ideal positions in time



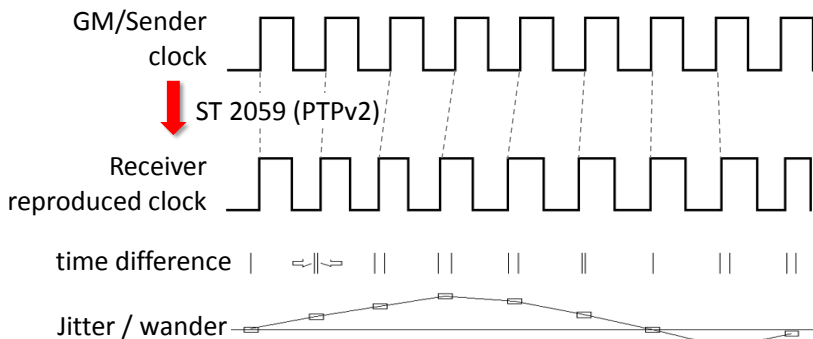
Quoted from <http://users.rcn.com/wpacino/jitwtutr/jitwtutr.htm>

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What is ST 2059 PTP synchronization for?

- To achieve less data buffering → **Low Latency**
 - Reasonable adjustment by feedback control
 - Some jitter and wander are good to prevent resonance
 - Basically, lower jitter and wander, better quality of reproduction on a receiver

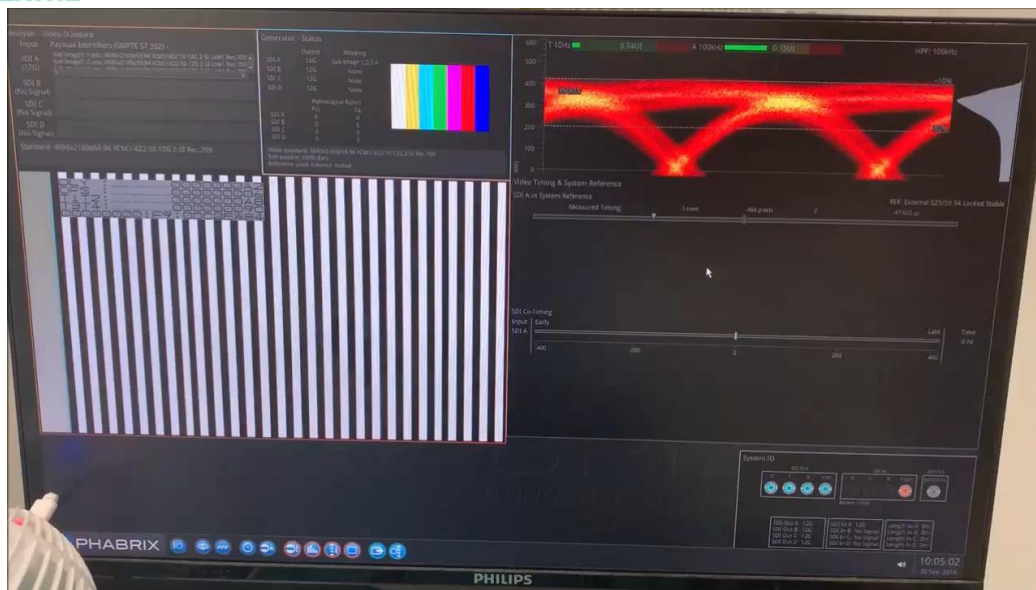


Quoted from <http://users.rcn.com/wpacino/jitwtutr/jitwtutr.htm>

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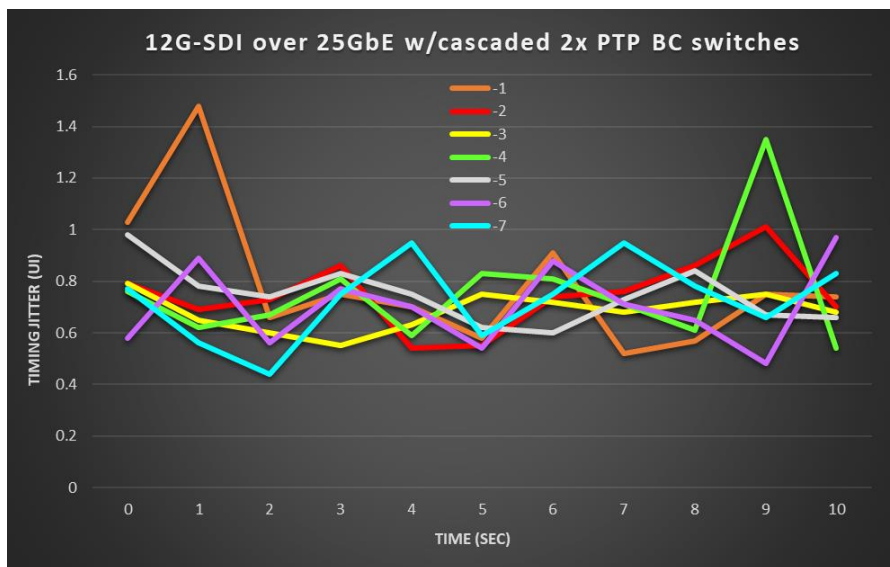
Video: 4K/UHD ST-2110 over 25GbE transmission



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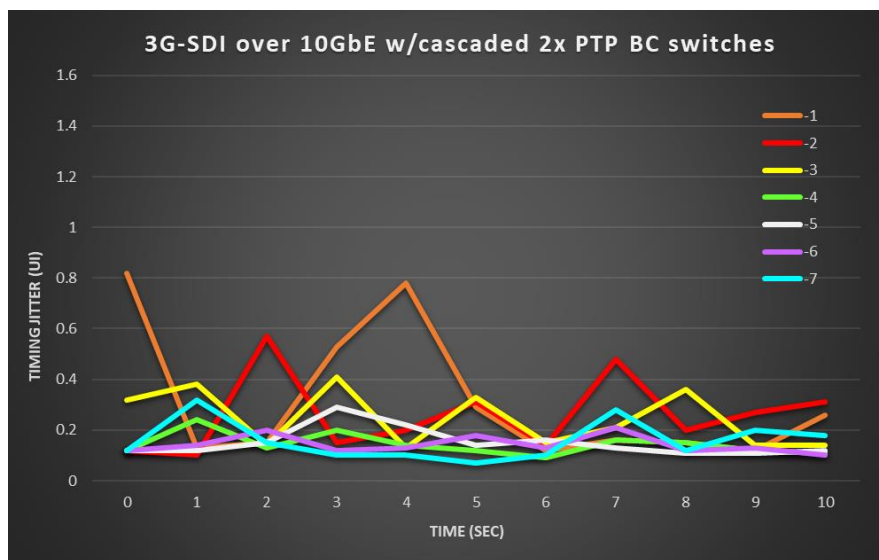
Timing Jitter for 12G-SDI over 25GbE



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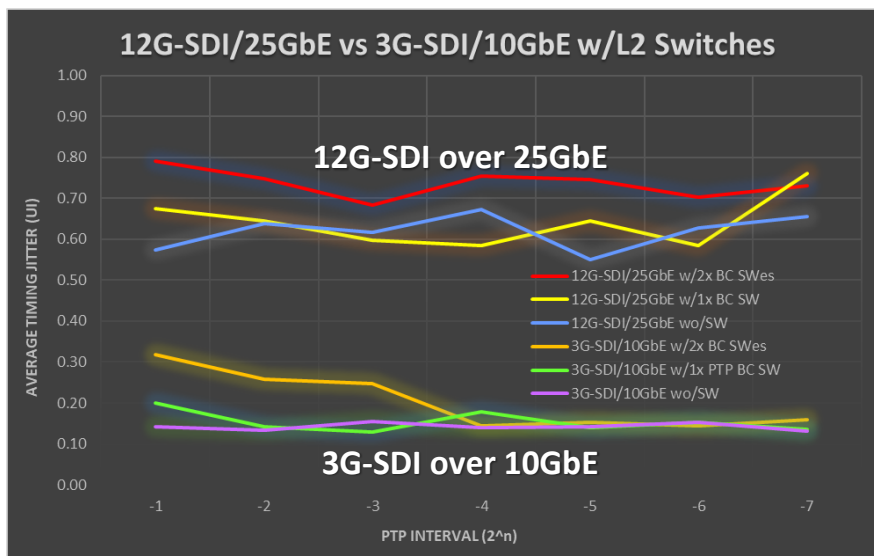
Timing Jitter for 3G-SDI over 10GbE



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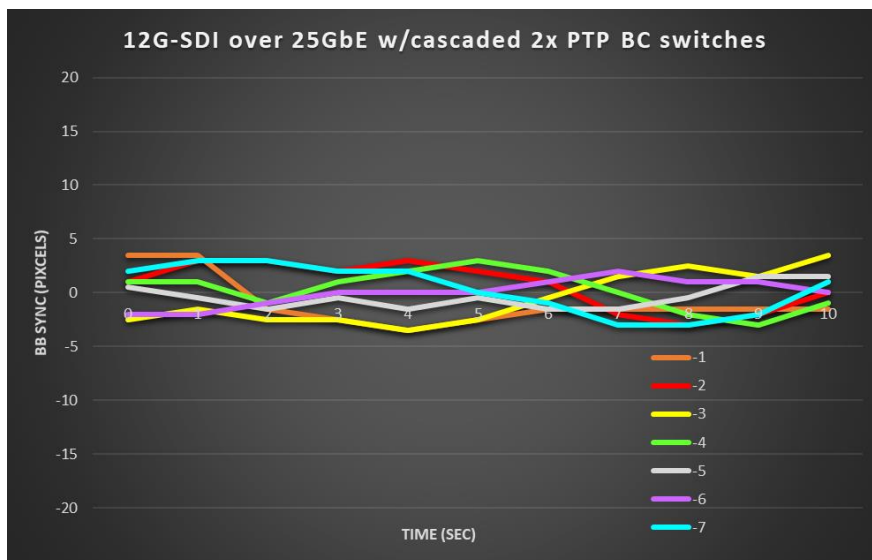
Timing Jitter Comparison



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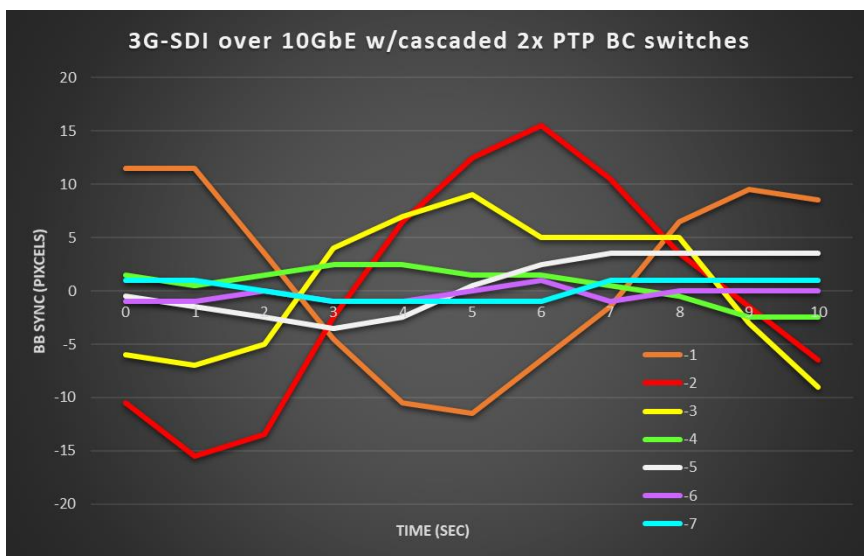
Wander for 12G-SDI over 25GbE



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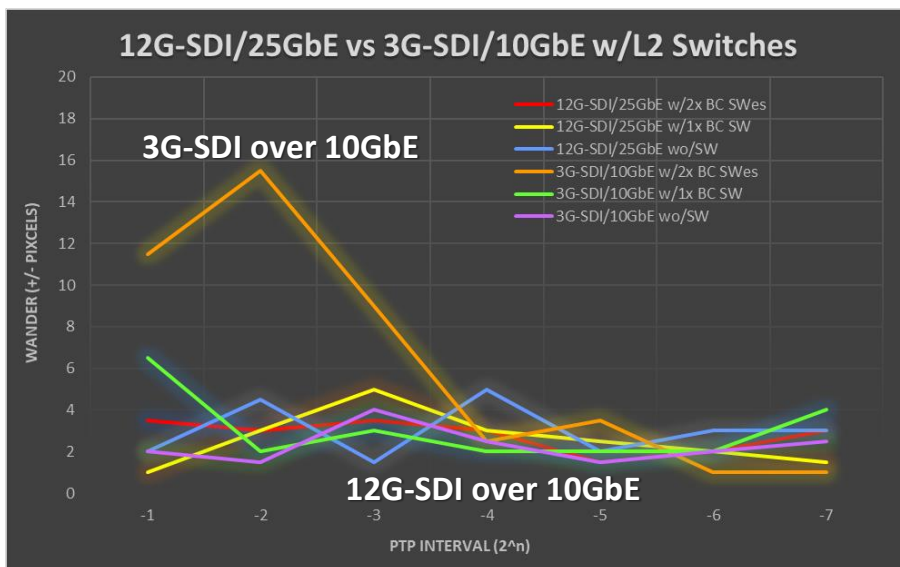
Wander for 3G-SDI over 10GbE



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Wander Comparison

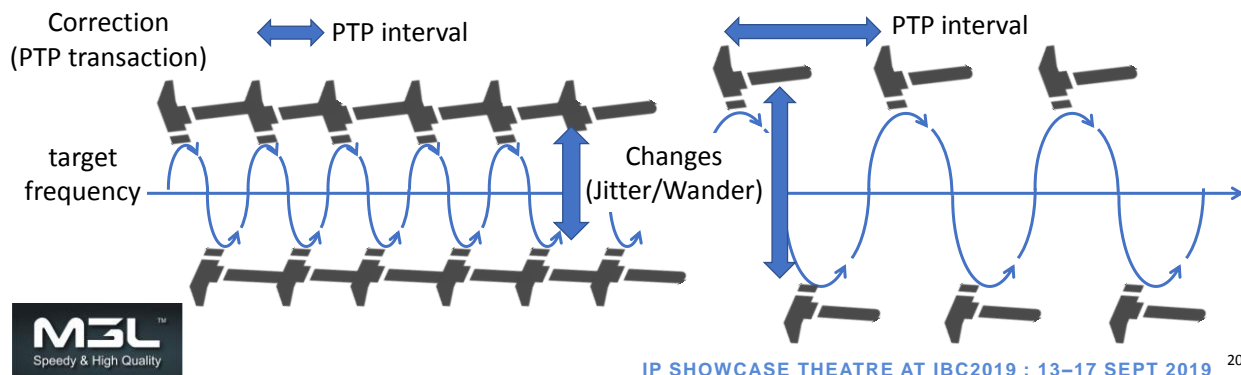


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Jitter and Wander Results

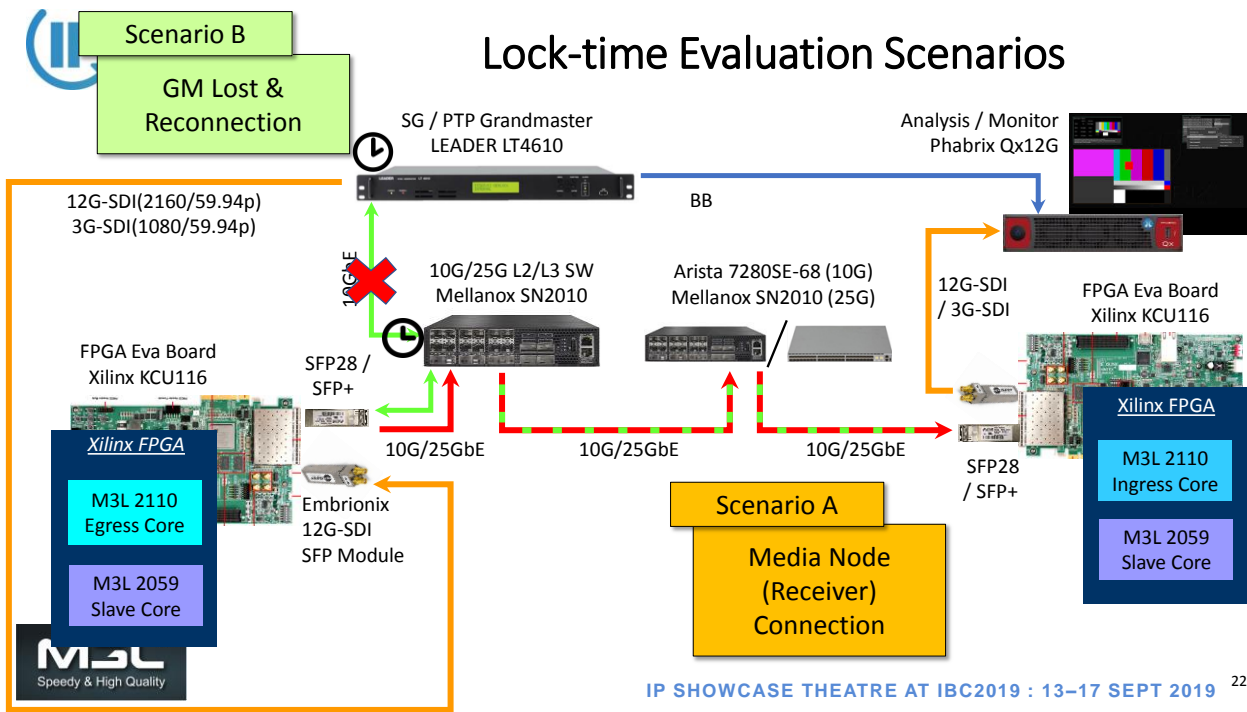
- Too few PTP interval could make jitter and wander worse
- The default value of PTP interval 2[^]3 (8Hz) in ST 2059 would be good
 - Most vendors would adjust the default value to be optimal
- It has 15-sec period of phase shift btw sending SDI and received SDI signal



Time Lock



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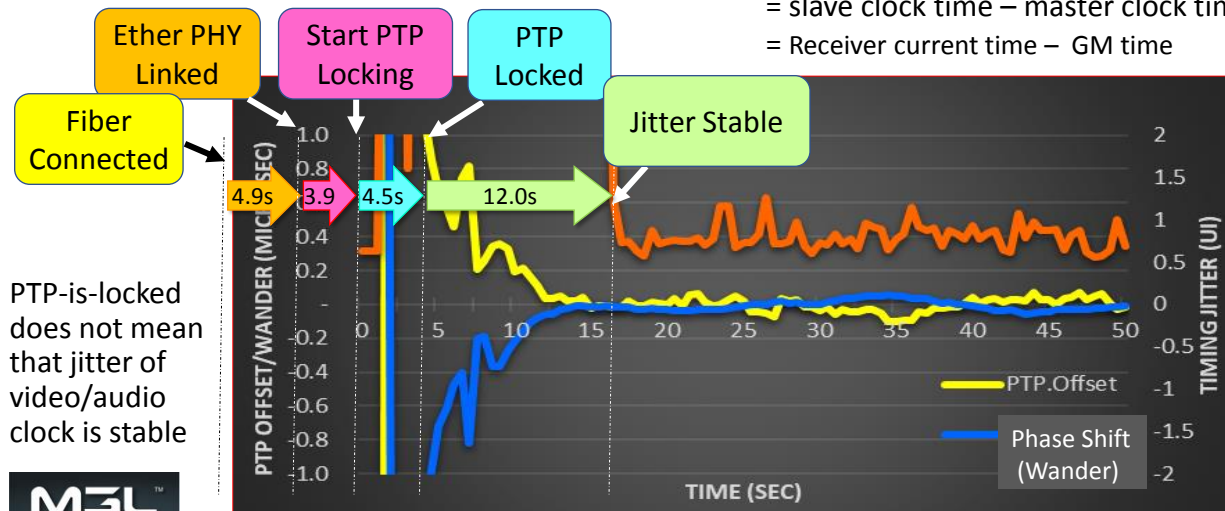
Video: Lock-time Scenario A example





Lock-time for 12G-SDI over 25GbE w/8Hz PTP

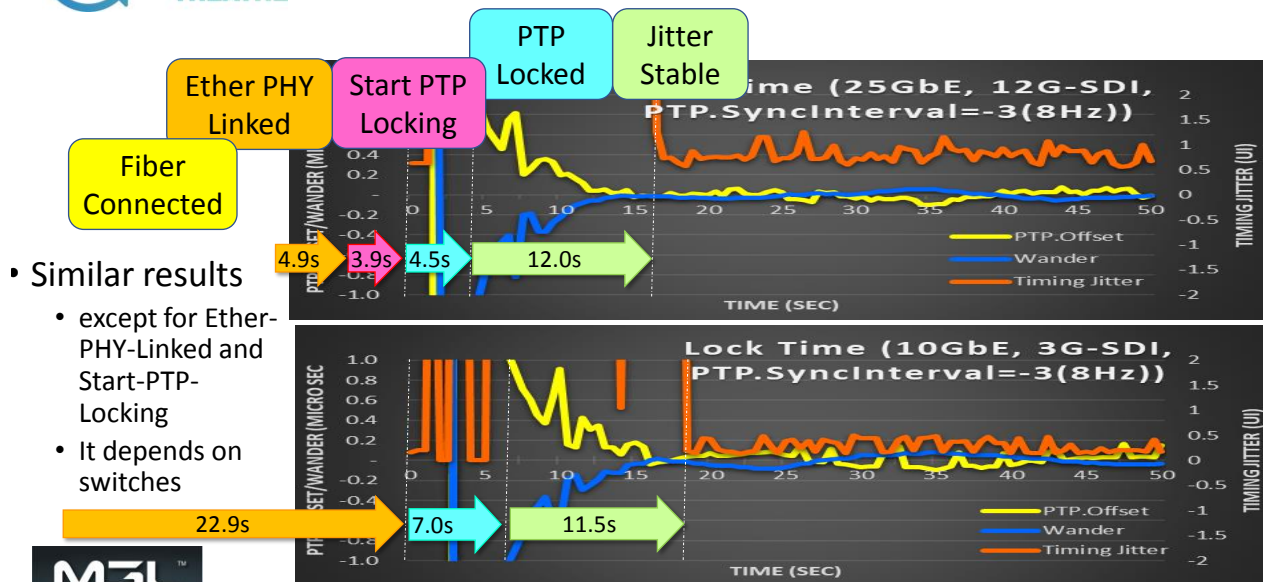
PTP offset
 = slave clock time – master clock time
 = Receiver current time – GM time



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Scenario A Comparison: 25GbE vs 10GbE



- Similar results
 - except for Ether-PHY-Linked and Start-PTP-Locking
 - It depends on switches

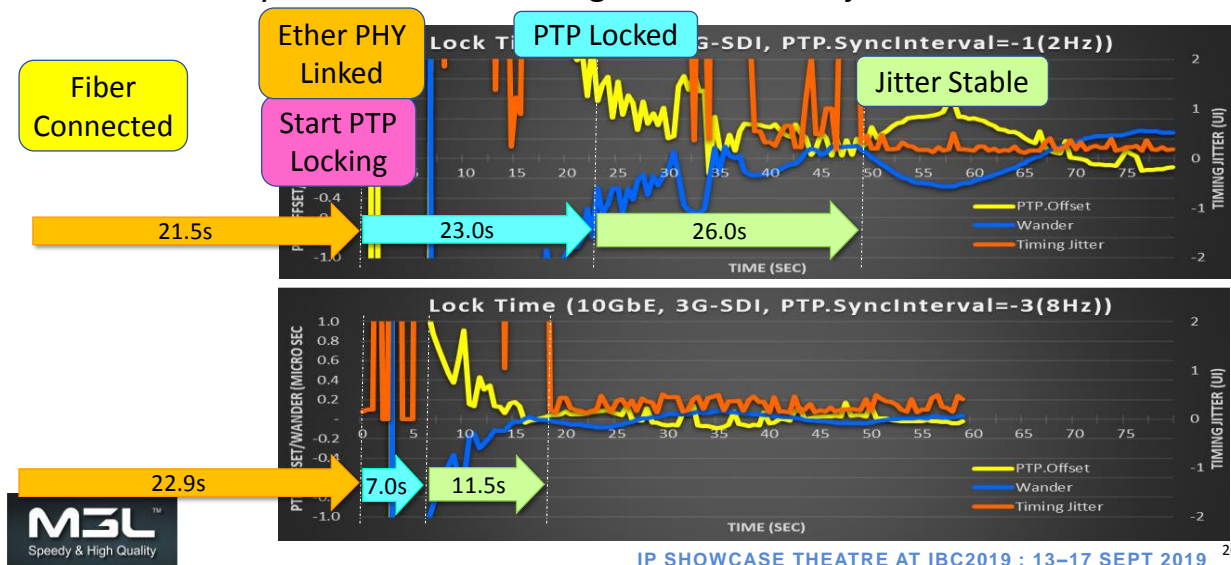


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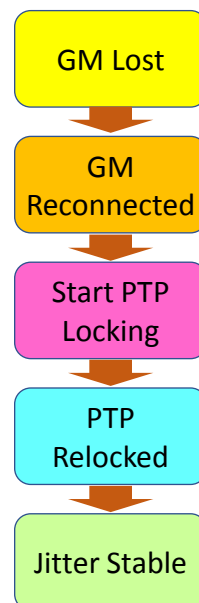
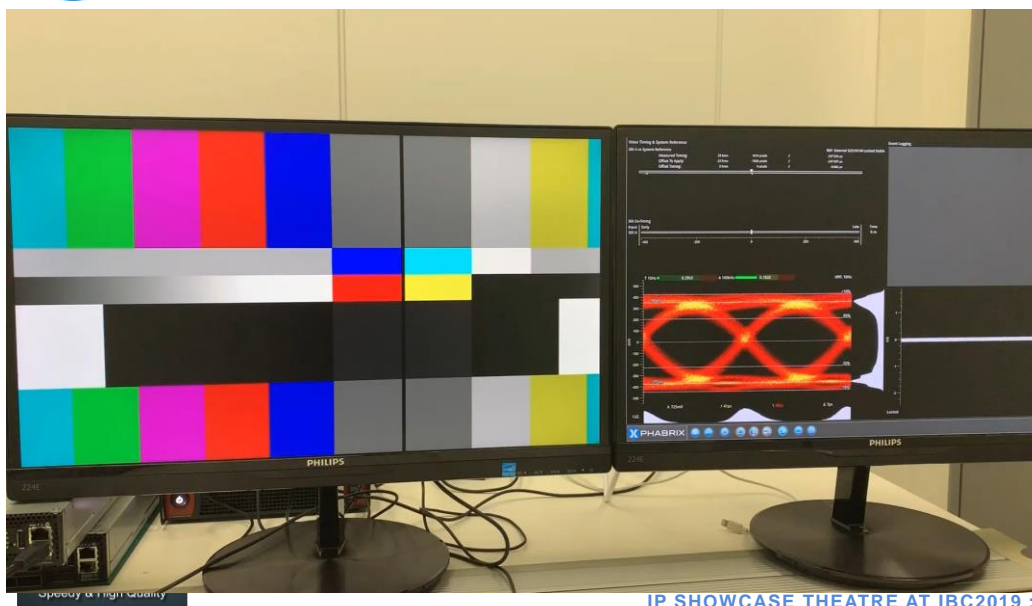


Scenario A Comparison: PTP Sync Interval

- Less PTP sync interval needs longer PTP lock and jitter stable time

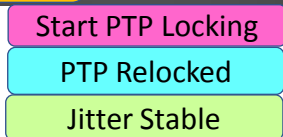
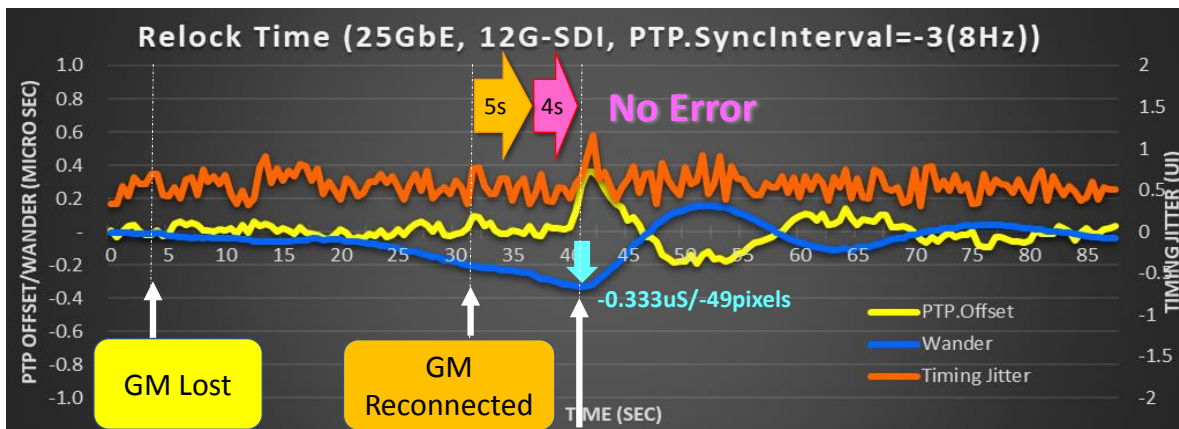


Video: Lock-time Scenario B example #1





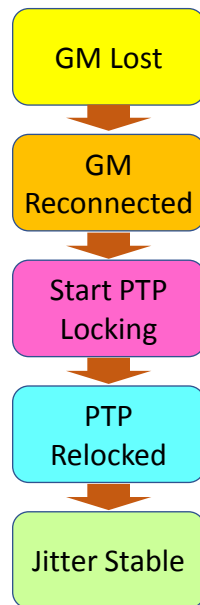
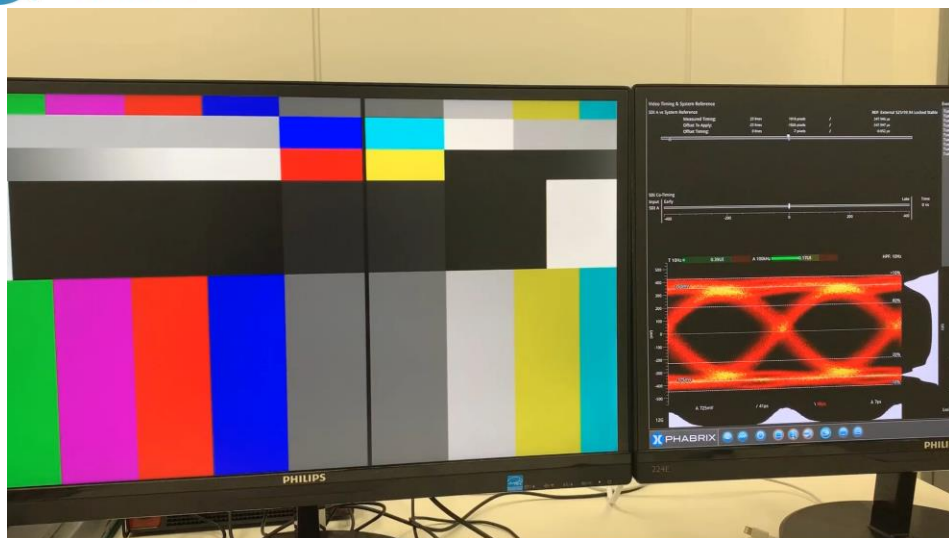
Lock-time Scenario B result #1



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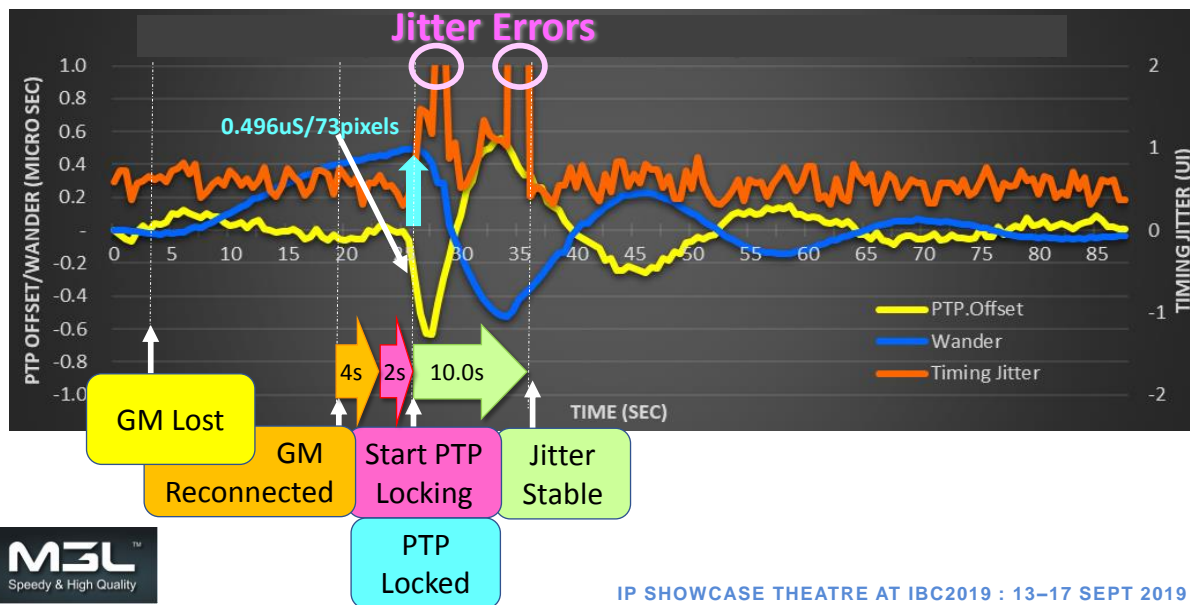
Video: Lock-time Scenario B example #2



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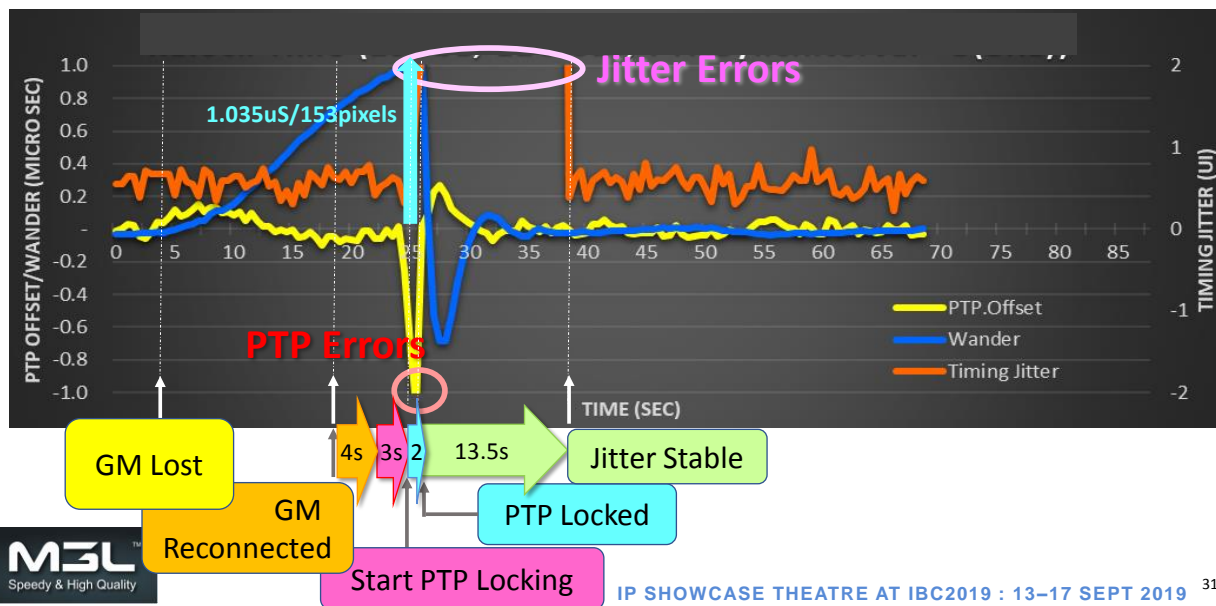
Lock-time Scenario B result #2



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Lock-time Scenario B result #3



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Time Lock Results

- Scenario A: New Media-Node Connection:
 - PTP-is-locked does not mean that jitter of video/audio clock is stable
 - Jitter-stable times for 10GbE and 25GbE are similar
 - Less PTP sync interval needs longer PTP-lock and Jitter-stable time
- Scenario B: GM-lost & Reconnection:
 - There are 3 types of recovery for GM-lost & Reconnection
 1. Recover without an error
 2. Reconnect with jitter errors
 3. Reconnect with PTP and jitter errors



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Conclusion

- You saw some examples for jitter/wander and time lock
- You understood more of ST 2110 and ST 2059 features
- I highly recommend measuring the actual number of your own products because it depends of their implementations
- Knowing the actual number of signal qualities will be better knowledge for controlling the reliability of your IP-based networks
- Hope this presentation helps your work



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Thank you

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