



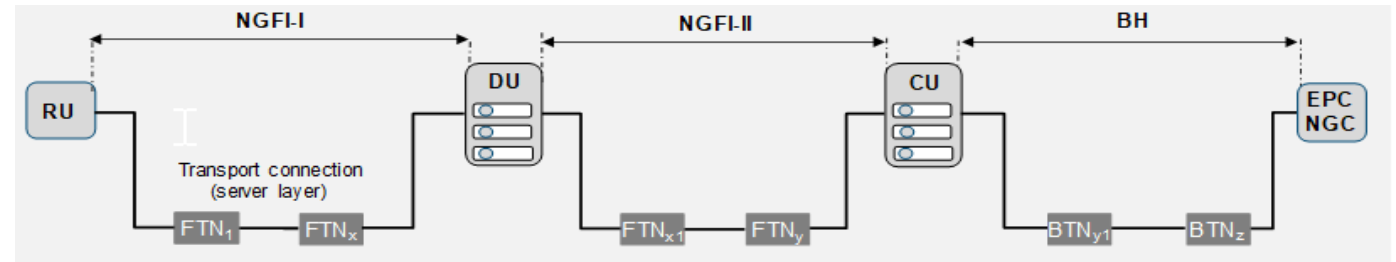
a  MICROCHIP company

Does PTP Synchronization Get Easier When Network Speed Increases?

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Science and Technology
Microchip/Microsemi Frequency and Time Division

10 Years of PTP deployments

- 2008: Wide deployment of IEEE 1588 PTP for frequency
 - Debates on whether PTP will work or not ?
 - How many hops ?
 - Metrics ?
 - Will it work for phase/time ? G.8275.1 vs G.8275.2 ?
 - GPS primary source, PTP as back-up ?
- 2018: 5G
 - RRUs connected to BBUs using new network segment (Fronthaul network)
 - Network technology changes due to bandwidth scalability issues
 - Synchronization going from pure physical technology (CPRI) -> Packet based technology (Ethernet)
 - **PTP is becoming preferred primary synchronization source for 5G**
 - **Sync phase/time reqs are getting tighter (3GPP wants to lower 1.5 us phase req)**
 - **Fronthaul speed: 10G/25G/100G**
 - RU interfaces @ 10G and 25G



ITU-T G.8261 Test case 14 (ramp test)

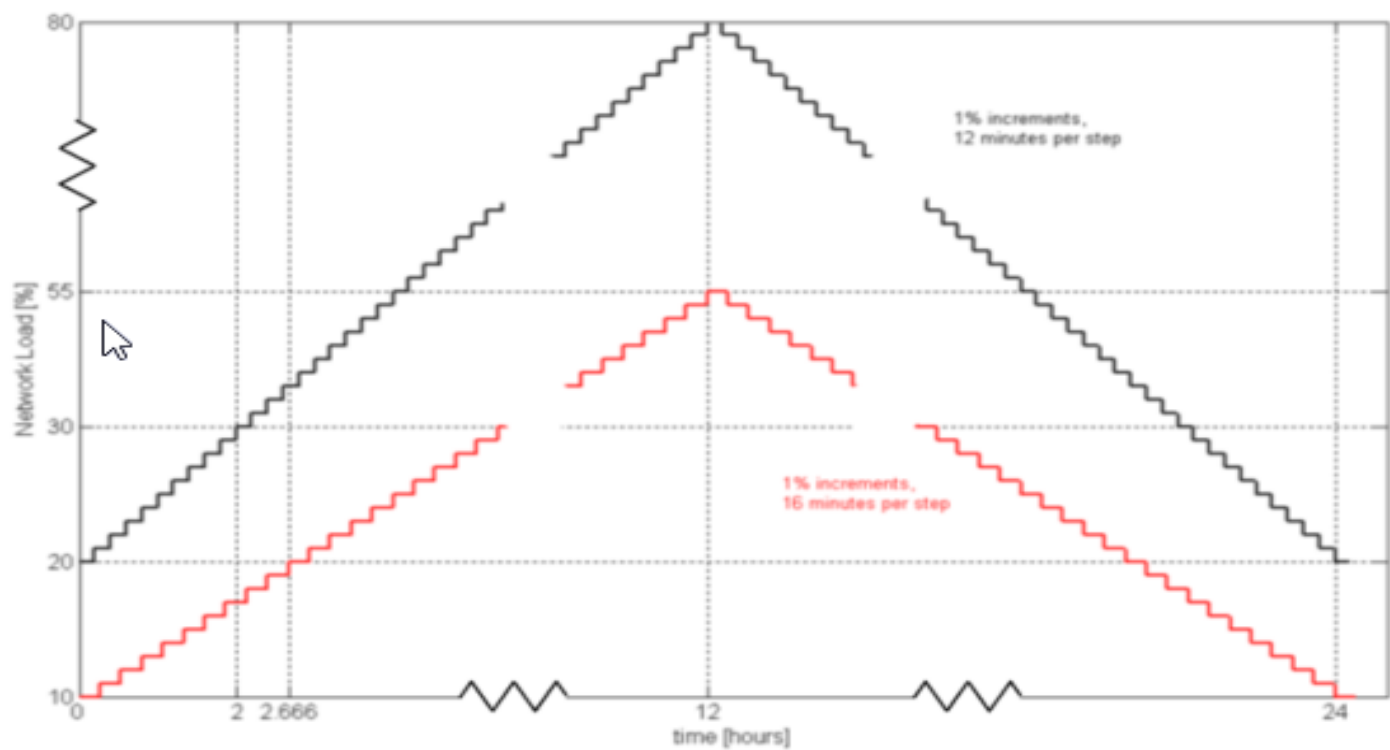
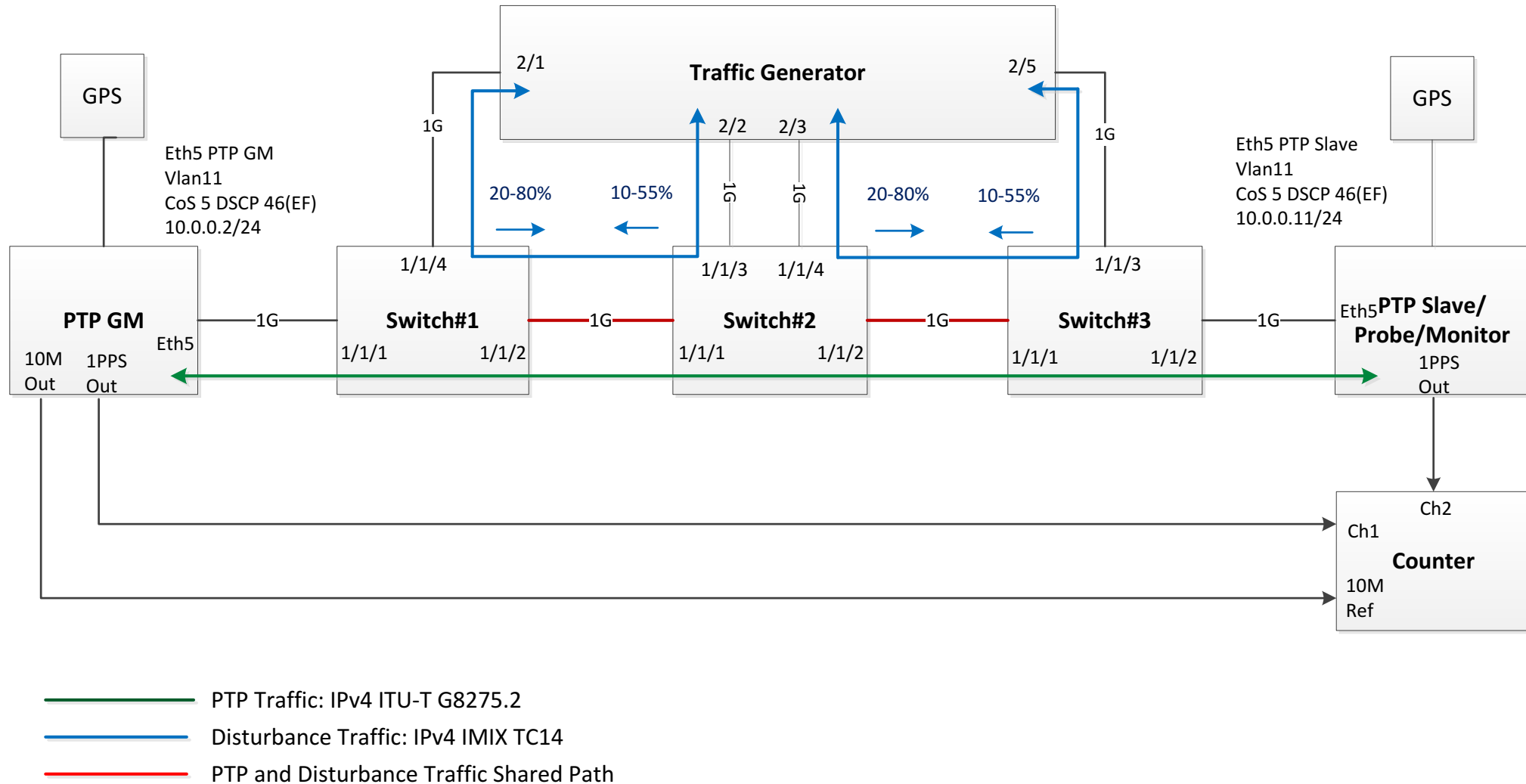
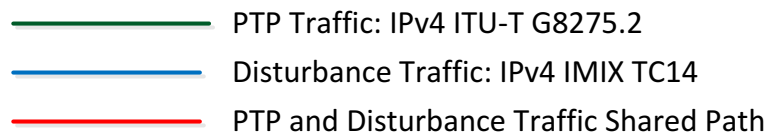


Figure VI.12/G.8261 - Slow Network Load Modulation for two-way

Dynamic Time Error Network Setup – 1G





PDV Overlay 1G vs 10G

TC14 FW

- Blue: 1G, Red: 10G

Microsemi TimeMonitor Analyzer

Phase deviation in units of time; $F_s=63.96$ Hz; $F_o=10.000000$ MHz; 2018/09/14; 00:20:11

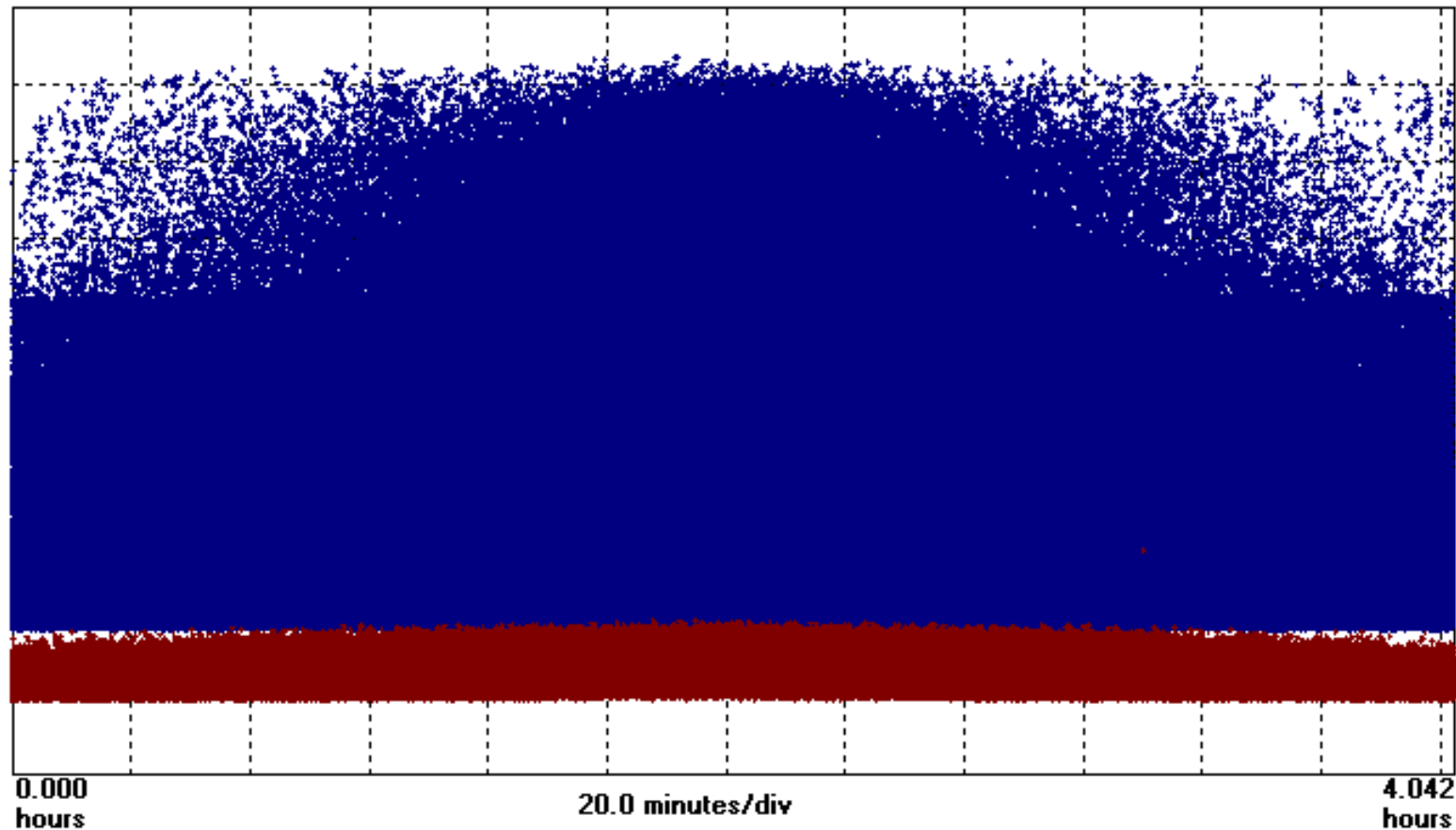
1 (blue): Two-Way Fwd PDV Phase; Samples: 929679; Upper Thresh: 60.0000 us; Initial phase offset: 15.7180 usec; 2018/09/14; 00:1

2 (red): Two-Way Fwd PDV Phase; Samples: 930784; Initial phase offset: 12.2280 usec; 2018/09/14; 18:26:30

48.0
usec

4.00
usec/div

8.00
usec



PDV Overlay 1G vs 10G

TC14 RV

- Blue: 1G, Red: 10G

Microsemi TimeMonitor Analyzer

Phase deviation in units of time; $F_s=63.96$ Hz; $F_o=10.000000$ MHz; 2018/09/14; 00:20:11

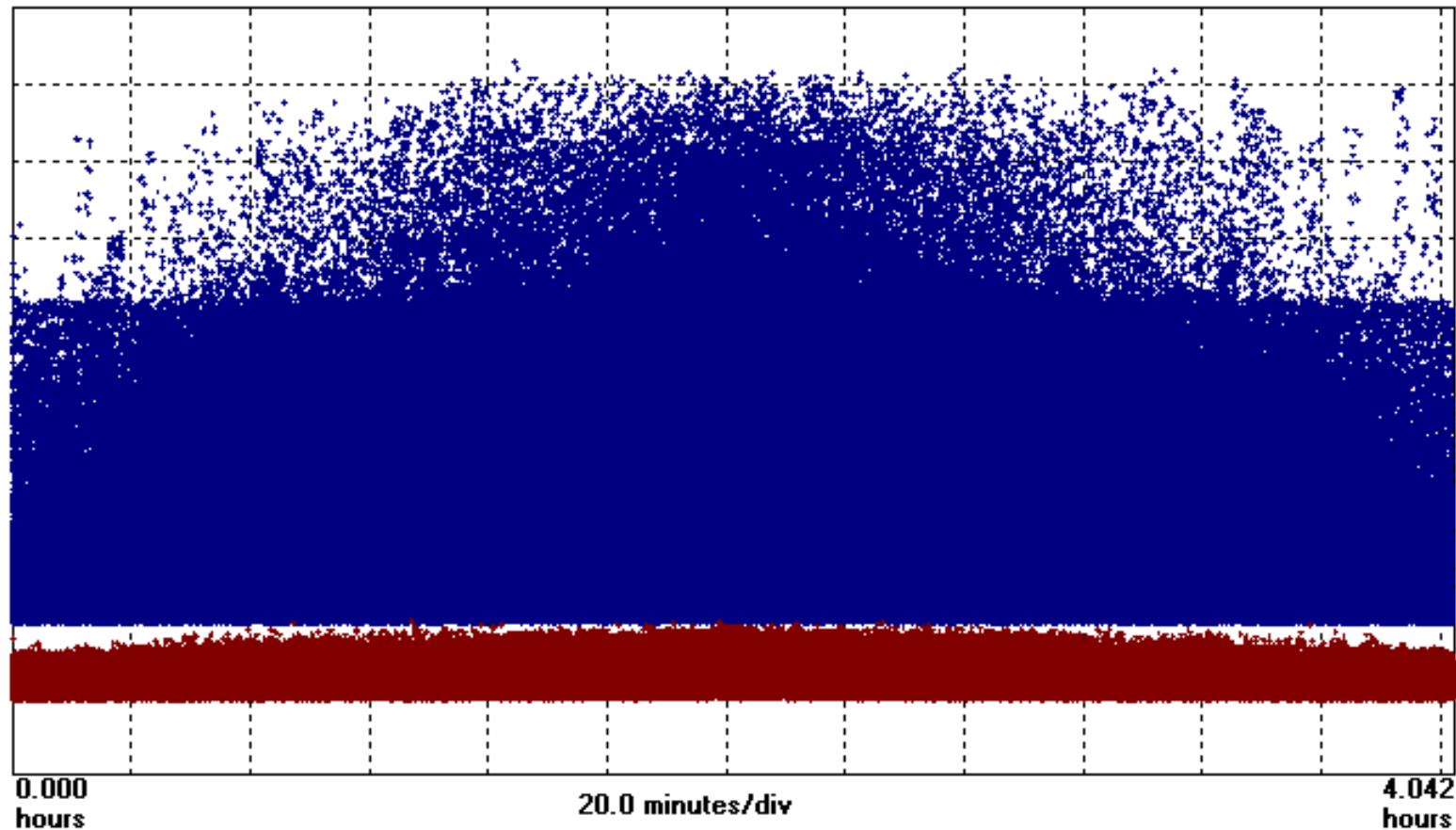
1 (blue): Two-Way Rev PDV Phase; Samples: 929680; Initial phase offset: 16.4390 usec; 2018/09/14; 00:20:11

2 (red): Two-Way Rev PDV Phase; Samples: 930784; Initial phase offset: 12.4460 usec; 2018/09/14; 18:26:30

48.0
usec

4.00
usec/div

8.00
usec



PTP Monitor TE CDF Overlay

TC14 (cumulative distribution function)

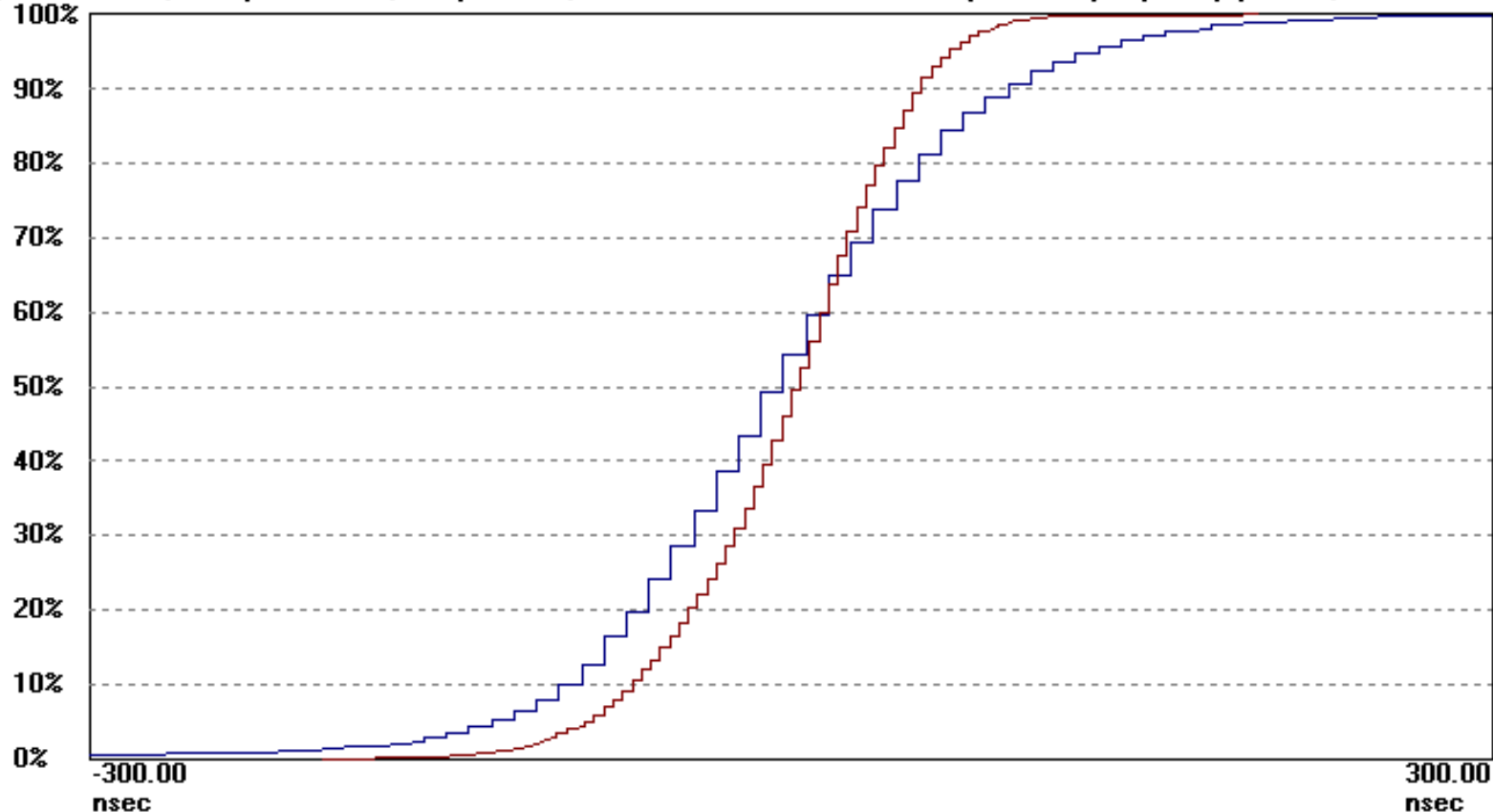
- Blue: 1G, 90pct: 92.80 ns; 95pct: 121.6 ns; 99pct: 198.4 ns; 99.9pct: 284.8 ns;
- Red: 10G, 90pct: 52.00 ns; 95pct: 68.00 ns; 99pct: 92.00 ns; 99.9pct: 116.0 ns;

Microsemi TimeMonitor Analyzer

Phase Deviation CDF; $F_s=999.9$ MHz; $F_o=1.000$ Hz; 2018/09/26; 21:53:54

1 (blue): Time Phase; Samples: 57600; Stop: 57600; TP4100 Performance Monitor (time-error): Input = ptp-client, Reference = gnss, Tim

2 (red): Time Phase; Samples: 57600; Stop: 57600; TP4100 Performance Monitor (time-error): Input = ptp-client, Reference = gnss, Tim



PTP Monitor TE Overlay TC14

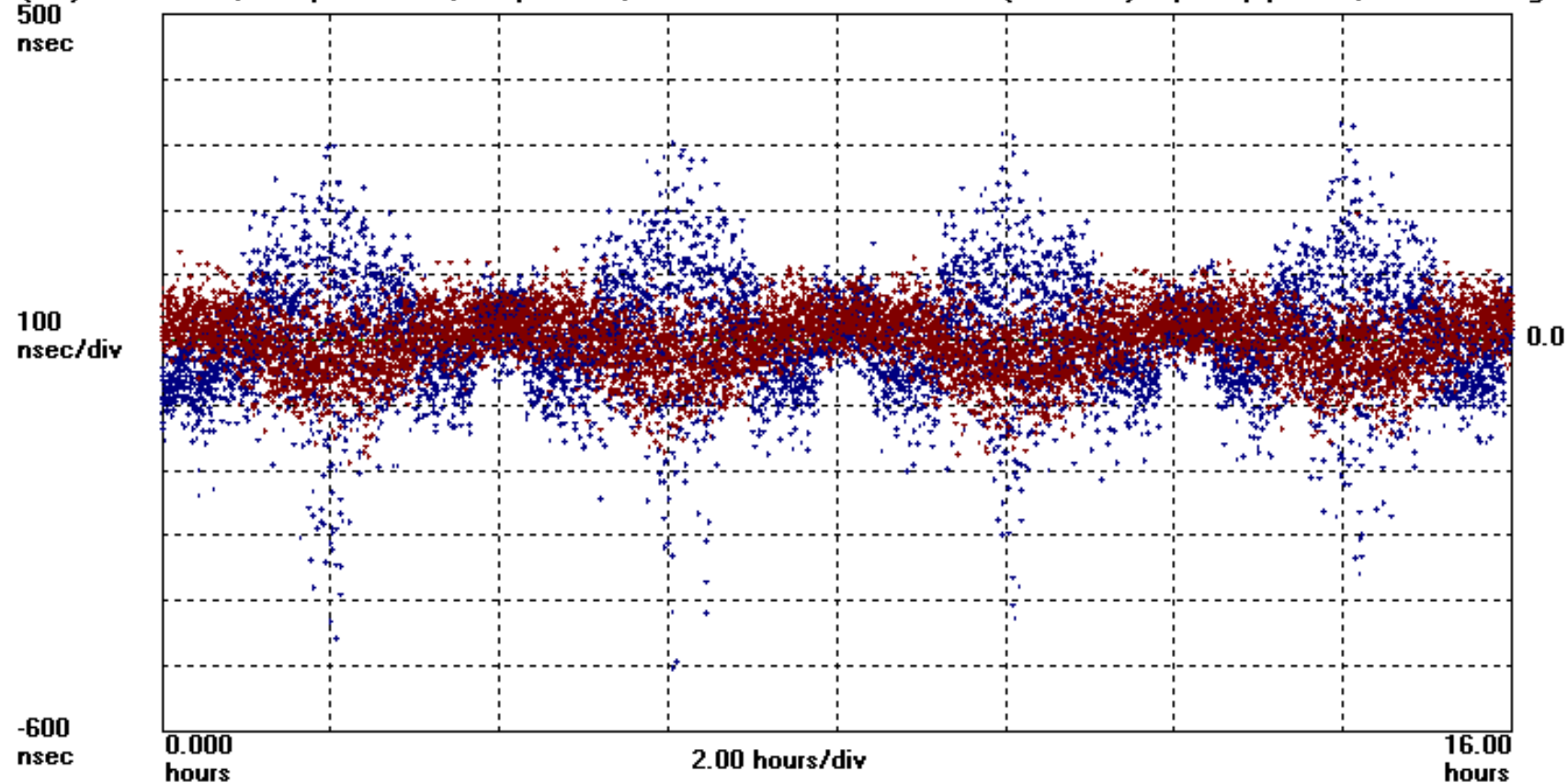
- Blue: 1G, Red: 10G

Microsemi TimeMonitor Analyzer

Phase deviation in units of time; Fs=999.9 mHz; Fo=1.0000000 Hz; 2018/09/26; 21:53:54

1 (blue): Time Phase; Samples: 57600; Stop: 57600; TP4100 Performance Monitor (time-error): Input = ptp-client, Reference = gnss, Tim

2 (red): Time Phase; Samples: 57600; Stop: 57600; TP4100 Performance Monitor (time-error): Input = ptp-client, Reference = gnss, Tim



Simulator PDV

5-Switch PDV 1G vs 10G

IMIX Ramp 20% to 80%

- Magenta: 1G, Green: 10G

Microsemi TimeMonitor Analyzer

Phase deviation in units of time; Fs=1.000 Hz; Fo=10.000000 MHz; 2018/10/01; 11:34:00

3 (magenta): Simulated Phase; Samples: 57600; Link: 1G; Hops: 4; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000

4 (green): Simulated Phase; Samples: 57600; Link: 10G; Hops: 4; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000;

64.0

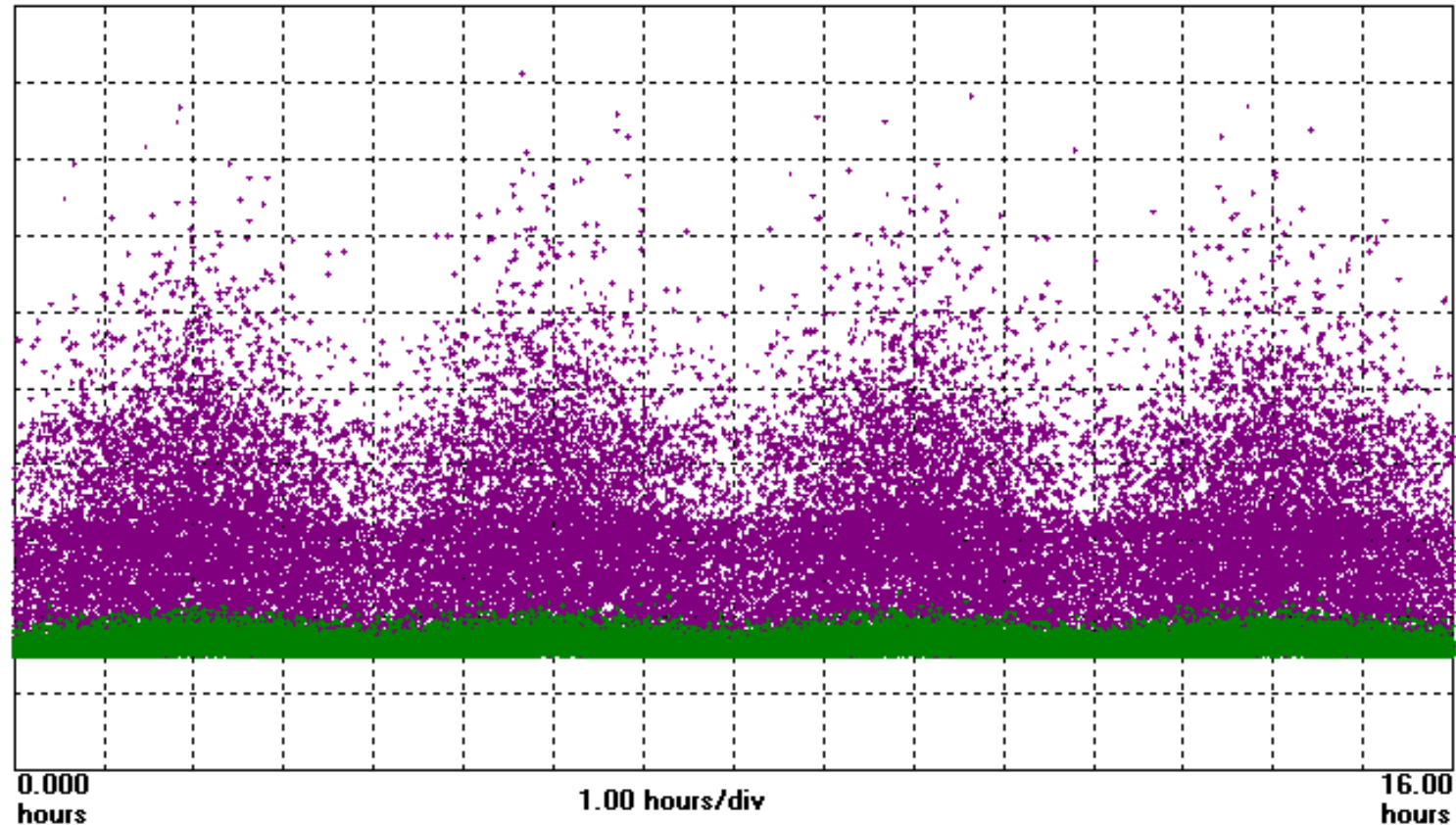
usec

4.00

usec/div

24.0

usec



5-Switch PDV CDF 1G vs 10G

IMIX Ramp 20% to 80%

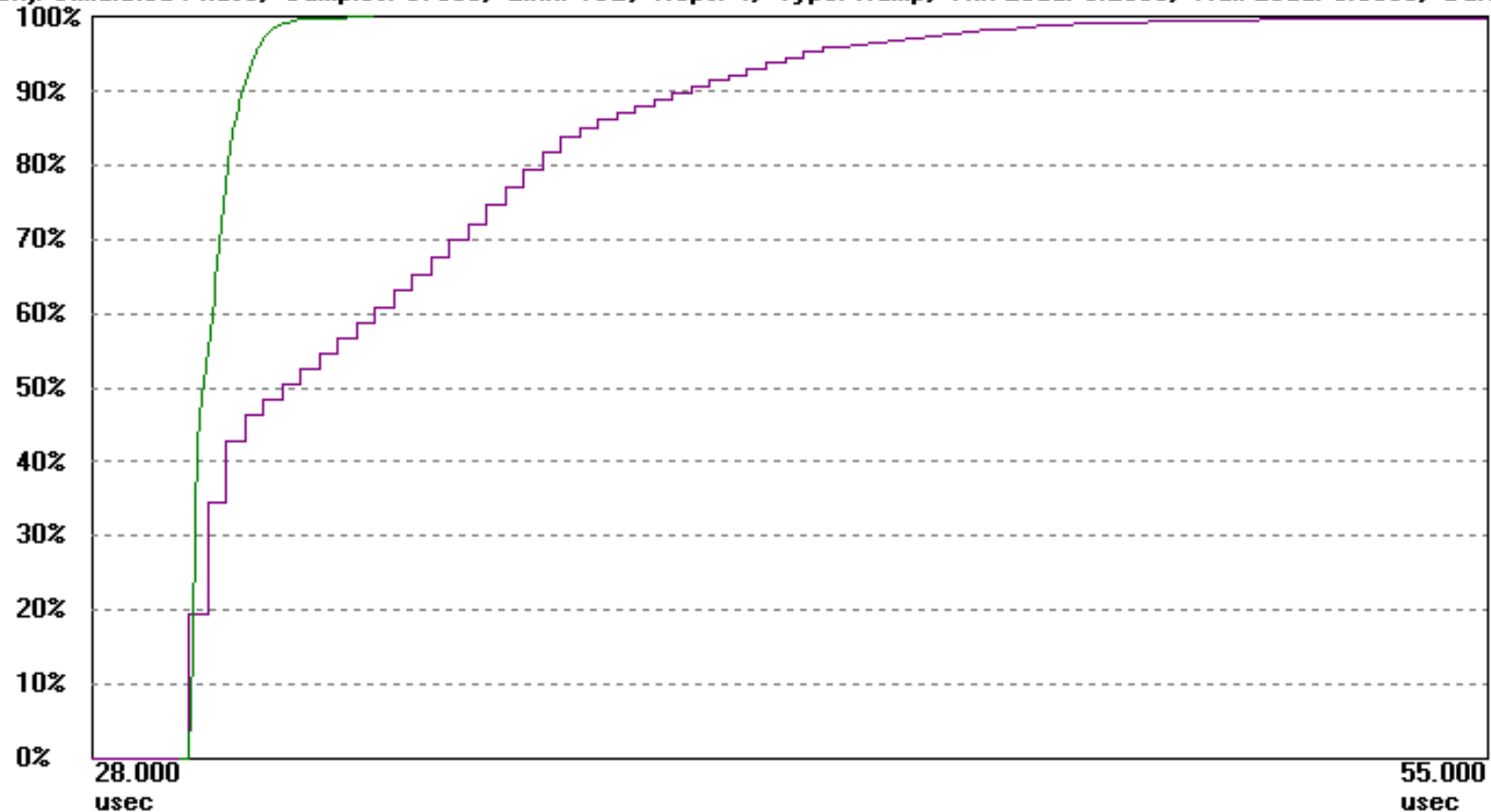
- Magenta: 1G, Green: 10G

Microsemi TimeMonitor Analyzer

Phase Deviation CDF; Fs=1.000 Hz; Fo=10.00 MHz; 2018/10/01; 11:34:00

3 (magenta): Simulated Phase; Samples: 57600; Link: 1G; Hops: 4; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000

4 (green): Simulated Phase; Samples: 57600; Link: 10G; Hops: 4; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000;



10-Switch PDV 1G vs 10G

IMIX Ramp 20% to 80%

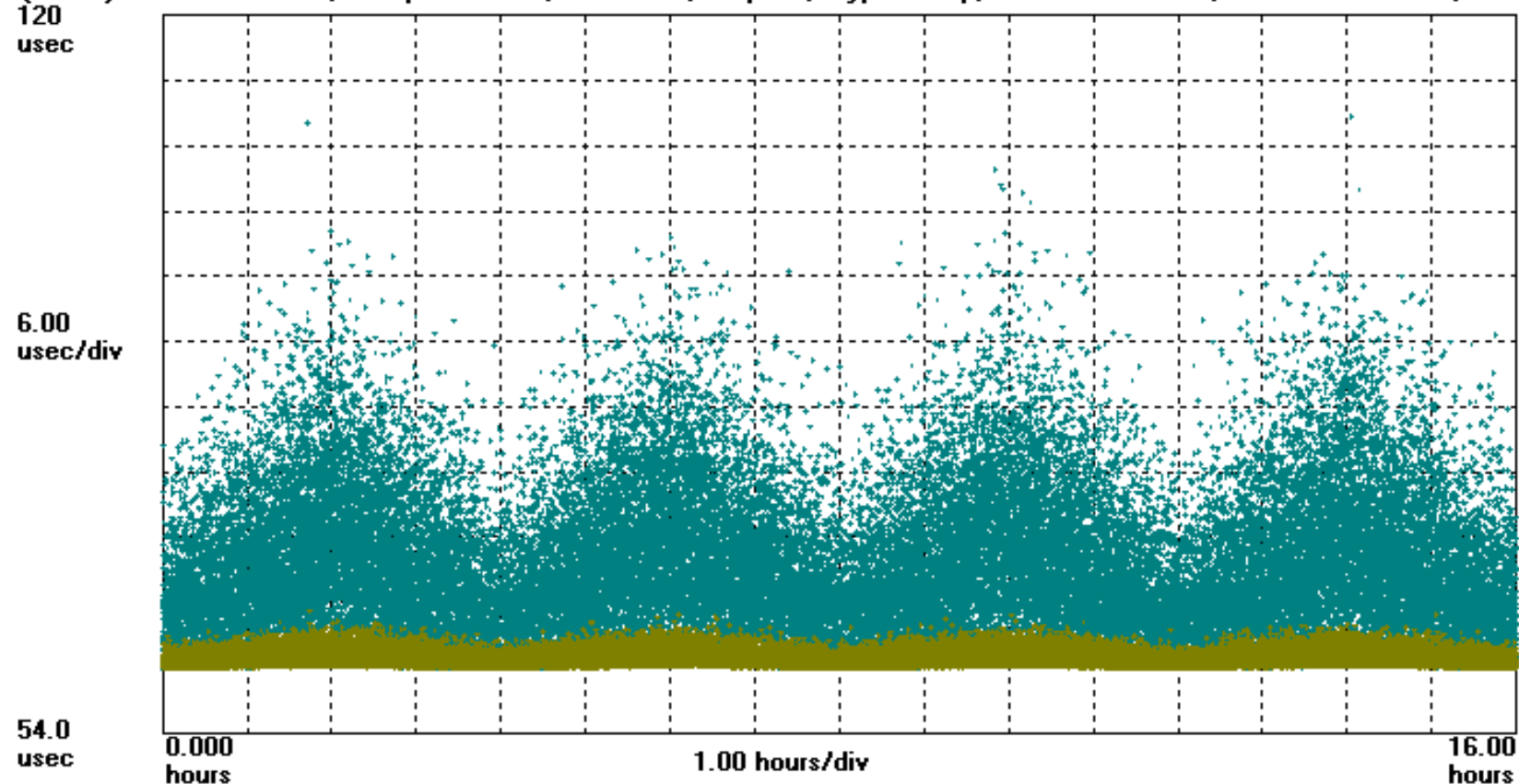
- Cyan: 1G, Brown: 10G

Microsemi TimeMonitor Analyzer

Phase deviation in units of time; Fs=1.000 Hz; Fo=10.000000 MHz; 2018/10/01; 11:41:58

5 (cyan): Simulated Phase; Samples: 57600; Link: 1G; Hops: 9; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000; Ir

6 (brown): Simulated Phase; Samples: 57600; Link: 10G; Hops: 9; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000;



10-Switch PDV CDF 1G vs 10G

IMIX Ramp 20% to 80%

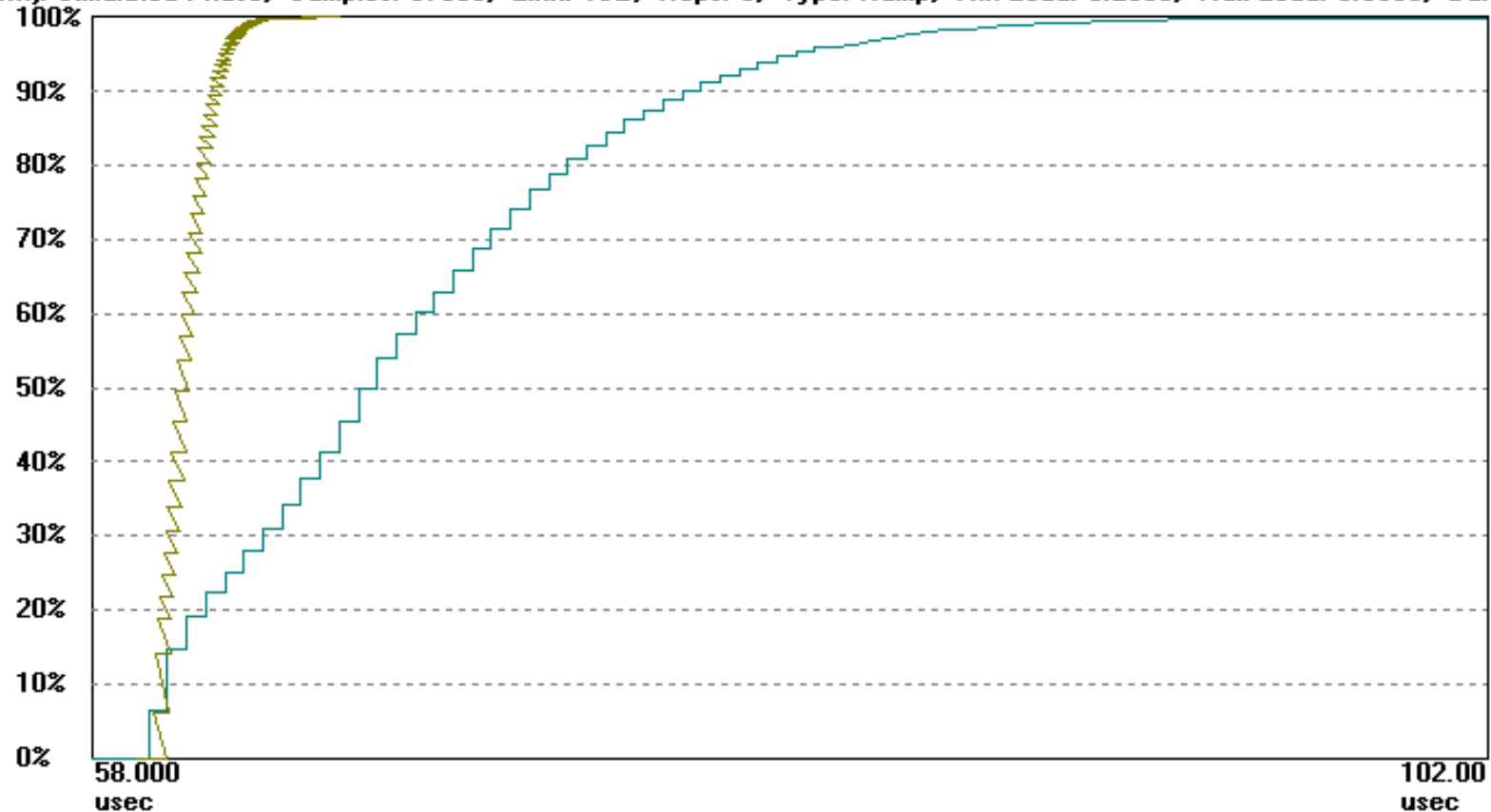
- Magenta: 1G, Green: 10G

Microsemi TimeMonitor Analyzer

Phase Deviation CDF; Fs=1.000 Hz; Fo=10.00 MHz; 2018/10/01; 11:41:58

5 (cyan): Simulated Phase; Samples: 57600; Link: 1G; Hops: 9; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000; Ir

6 (brown): Simulated Phase; Samples: 57600; Link: 10G; Hops: 9; Type: Ramp; Min Load: 0.2000; Max Load: 0.8000; Burst: 0.0000;



Summary

- Fronthaul @ 100Gbps in future
 - PTP transport over 10G/25G/100G
 - Asymmetry errors
 - Traffic profile (70% to 90% of 5G traffic is video)
- Fronthaul latency reqs (URLLC services) limits distance between RUs and DUs/CUs
 - Strictest one-way latency: 50 usec between RU and DU (0.5 ms between PDCP layers)
 - 2 to 3 hops
- Time to re-establish a new requirement frontier for phase/time
- Good indications that servo algorithms can take advantage of fronthaul speed

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