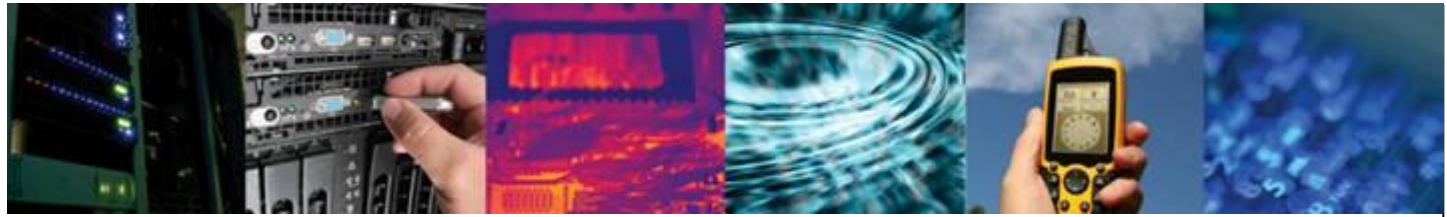


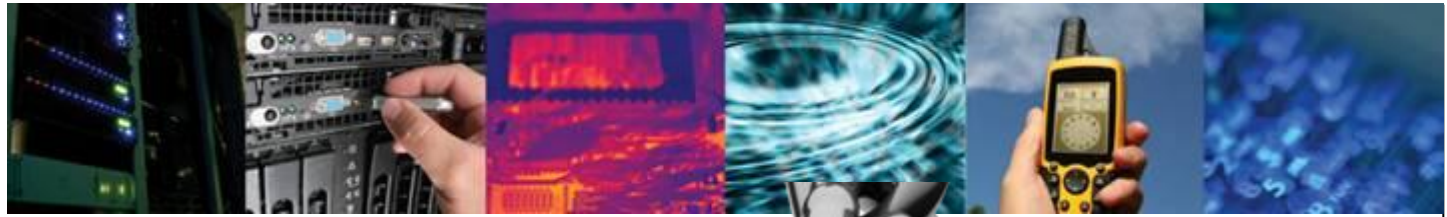
Using a Transportable Synchronisation Testing Facility to capture Real World Measurements

Chris Farrow - Technical Services Manager,
Chronos Technology Ltd
chris.farrow@chronos.co.uk



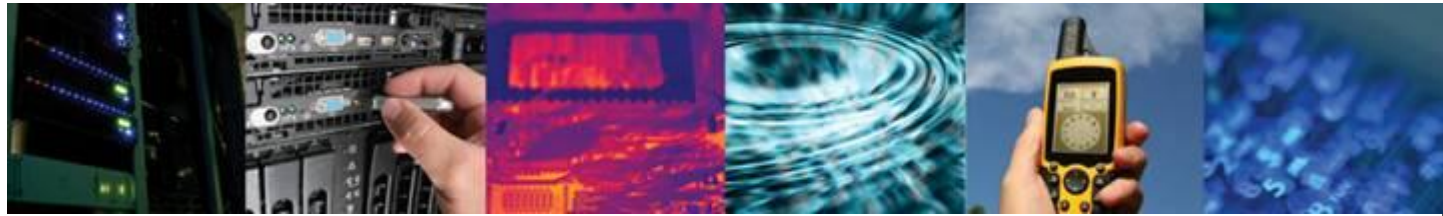
This Presentation

- Introduction & Background
- Assembling the components
- Real World Captures
- Conclusions



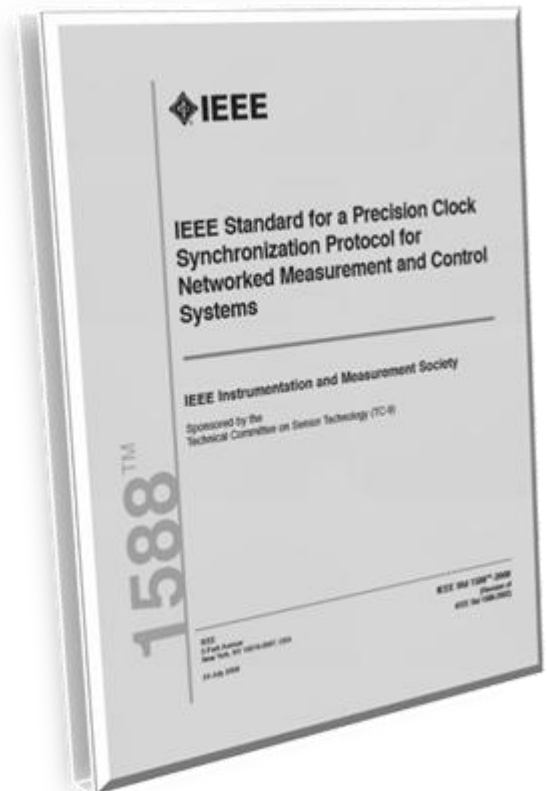
The Problem

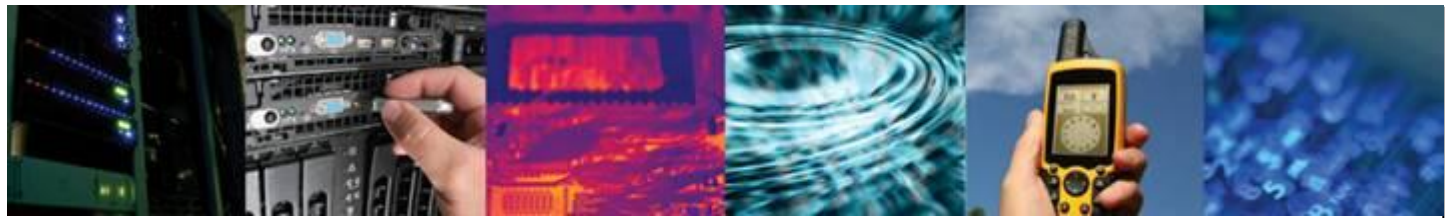
- Issues of scalability for operators to packet based (backhaul, network)
- Applications still need & timing



Possible Solutions:

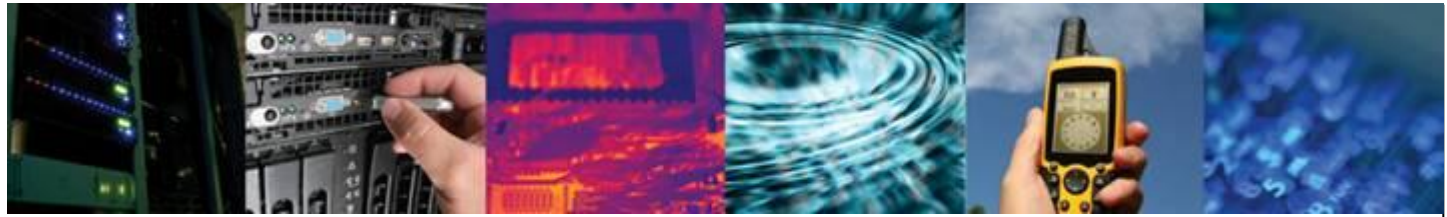
- 2 standardised solutions





More Problems:

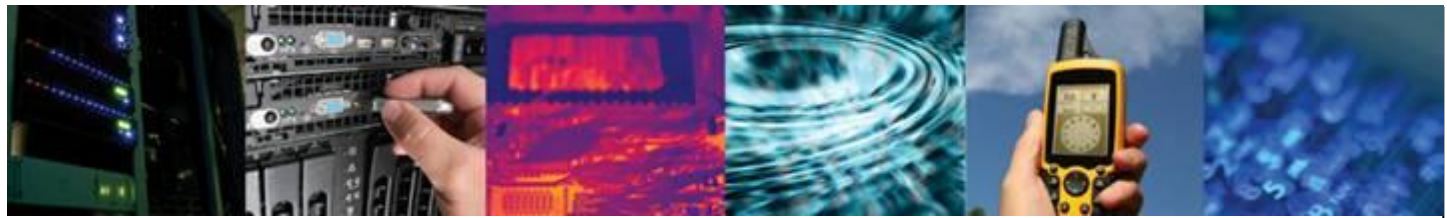
- But... quantifying the ability of a packet network to transport time & timing is not trivial!
- Existing metrics (MTIE, TDEV etc.) not adequate for characterising PDV
 - TIE looks like Noise, MTIE is one dimensional
- ITU SG15/Q13 have been considering this for some time
 - minTDEV, bandTDEV, MATIE & MAFE...
- Building large scale model networks is not always feasible



To progress work on the metrics...

- Capture Real World Data
 - Both Physical Layer AND Packet Layer
- Replay under controlled (lab) conditions
- Test Algorithms, refine metrics





Where to start...?



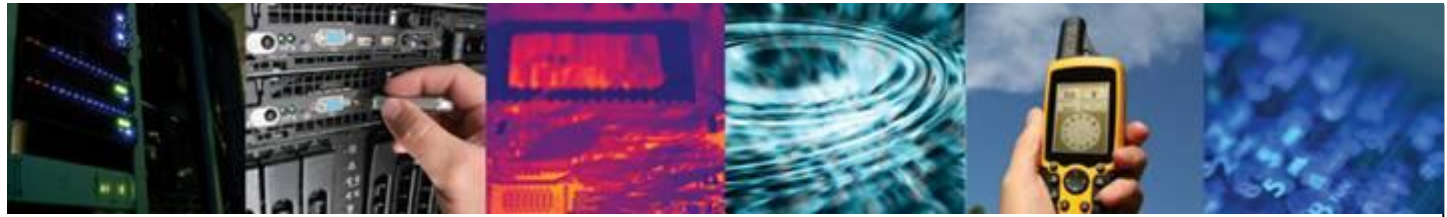






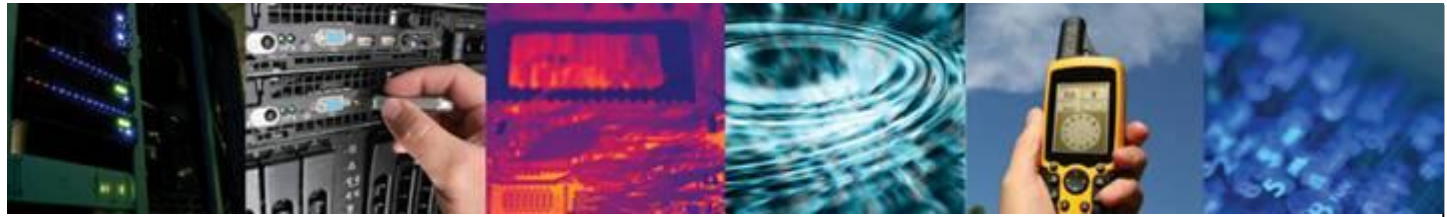






Transportable Test Facility - Project Great

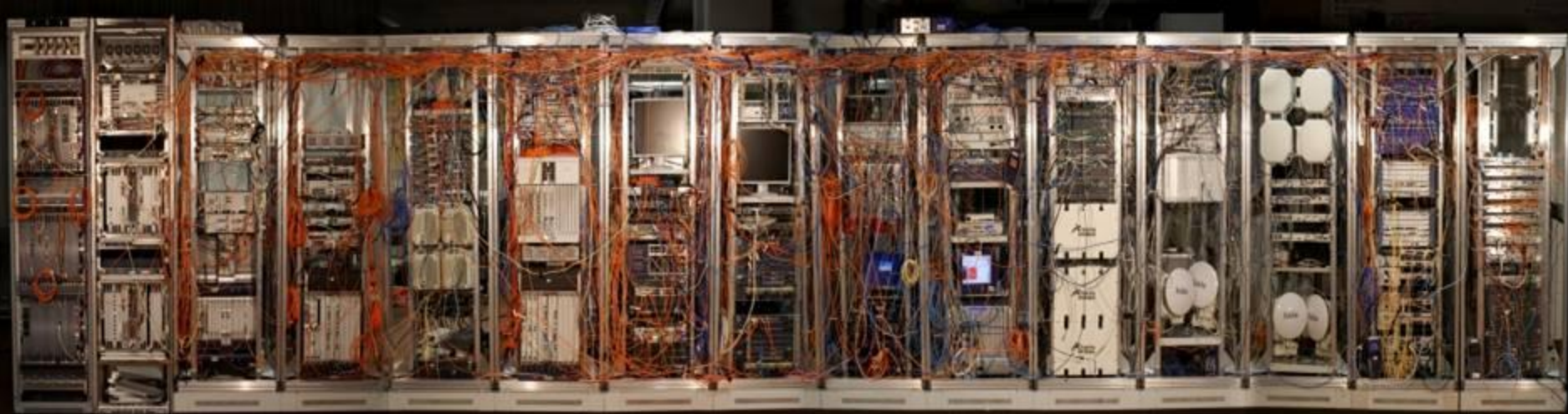
- Photos used with permission
- Tom Van Baak
- [Project GREAT](#)
 - **General Relativity Einstein / Essen Anniversary Test**
 - Took 3 atomic clocks up to 5400ft/1646m for 2 days
 - Lower gravitational field = clocks run faster
- <http://www.leapsecond.com/>
- Time-Nuts mailing list
<http://www.leapsecond.com/time-nuts.htm>

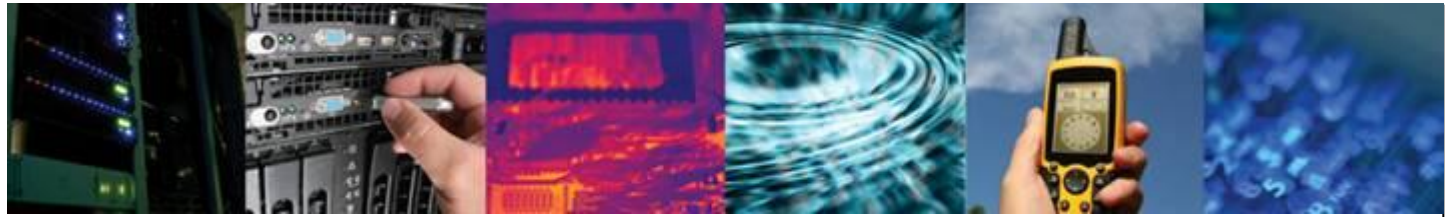


Transportable Rack

■ The Challenges:

- Space
- Weight
- Power



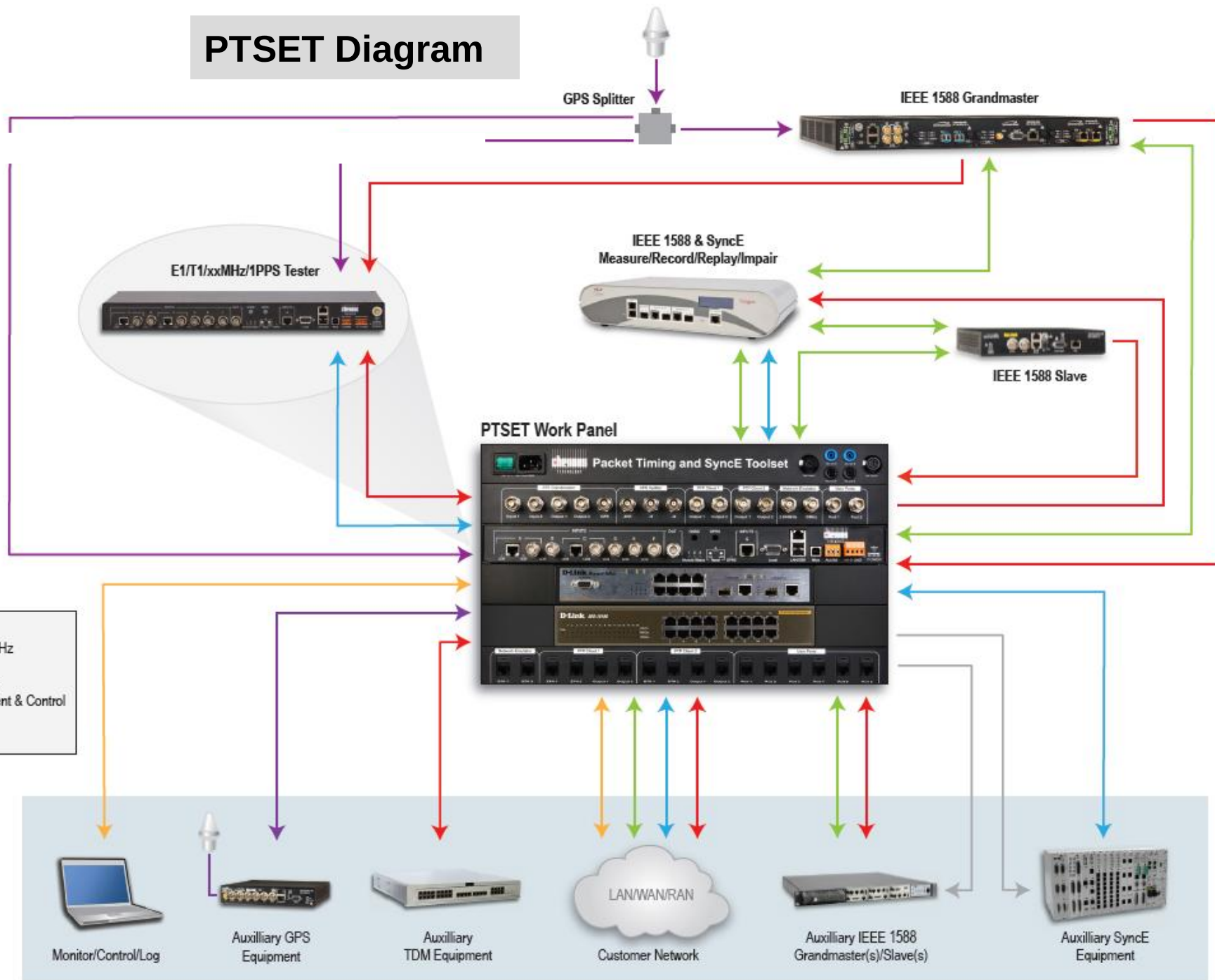


Packet Timing & SyncE Toolset

- PTSET - Developed by Chronos as a portable solution for 1588 / TDM / SyncE environments
- **Applications and Use Cases**
 - PTPv2 Technology Demonstrator
 - Test and qualify IEEE 1588 (PTPv2) Grandmasters and PTPv2 Slave Clocks
 - Simultaneously measure performance between different 1588 Slave Clocks
 - Prove interoperability between IEEE 1588 elements
 - Measure SyncE frequencies
 - Network PDV Measurement, Capture and Emulation
 - Field and Lab Testing of PTPv2 and SyncE Applications



PTSET Diagram



■ PTPv2 Grandmaster



- 1 RU Package
- 2x E1 or 2048MHz Inputs
- 2x E1 or 2048MHz Outputs
- 2x GigE PTP Ports
- 1x L1 GPS Input
- Optical/Electrical SFPs

■ PTPv2 to E1 Translator



- 2x E1/2.048 Outputs
- 1PPS + 10 MHz Outputs
- 120 Ω or 75 Ω Impedance

1588 & SyncE Test Set



- Measure PDV ▪ Record PDV ▪ Replay PDV ▪ Impair PDV
- IEEE 1588 ▪ SyncE ▪ Optical / Electrical SFP

■ Sync Tester

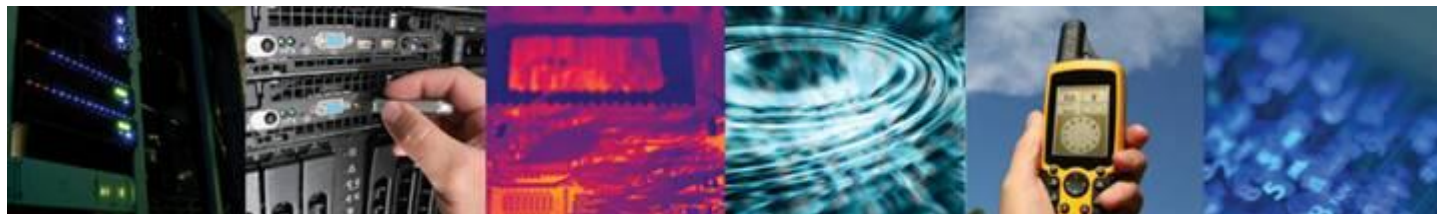


- 2x E1/2.048 Inputs ▪ 1PPS Input ▪ 120Ω or 75Ω Impedance ▪ xxMHz Variable Frequency Input
- L1 GPS Input ▪ Internal Rubidium Reference



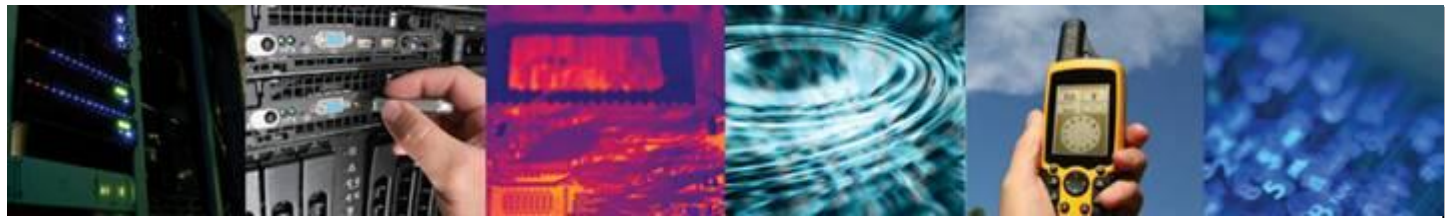
PTSET – Infrastructure Eqpt

- **Chronos PTSET PSU**
 - Dual 250W DC power source
 - 2x -48v Auxiliary power ports for external equipment
- **2x Independent Ethernet Switches**
 - Isolates service traffic to eliminate spurious PDV
 - D-Link DGS-3200-10
 - Managed switch with 1GB ports + 2 SFP
 - D-Link DES-1016
 - Unmanaged 10/100Mbps switch
- **2 Way GPS Signal Splitter**
 - Allows single GPS antenna to be used for multiple equipment



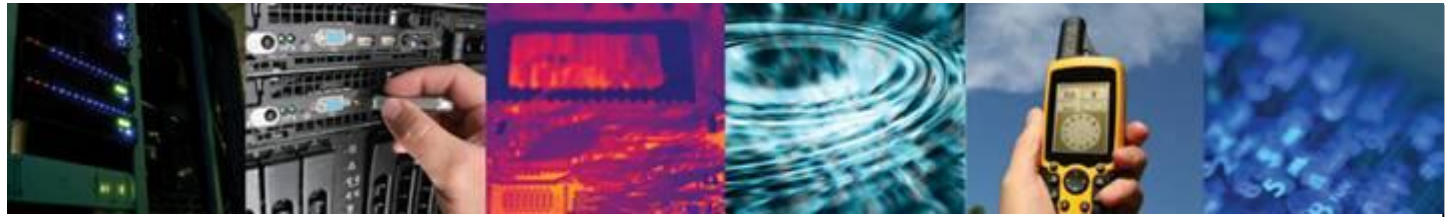
PTSET – The Work Panel





PTSET – The Equipment Panel

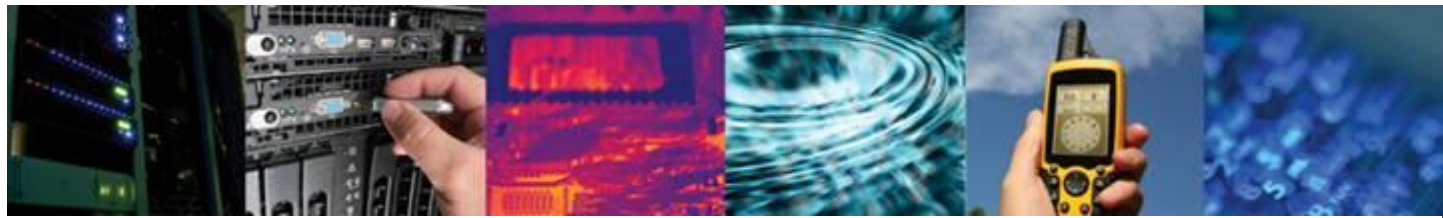




Real World Captures

- 1588 - PDV over microwave
 - 2 microwave radio hops
 - 2 x Native ETH and (EoPDH + Native ETH)
 - Approx. 7km per hop
 - Live site – 20%-30% traffic, 2G/3G mix

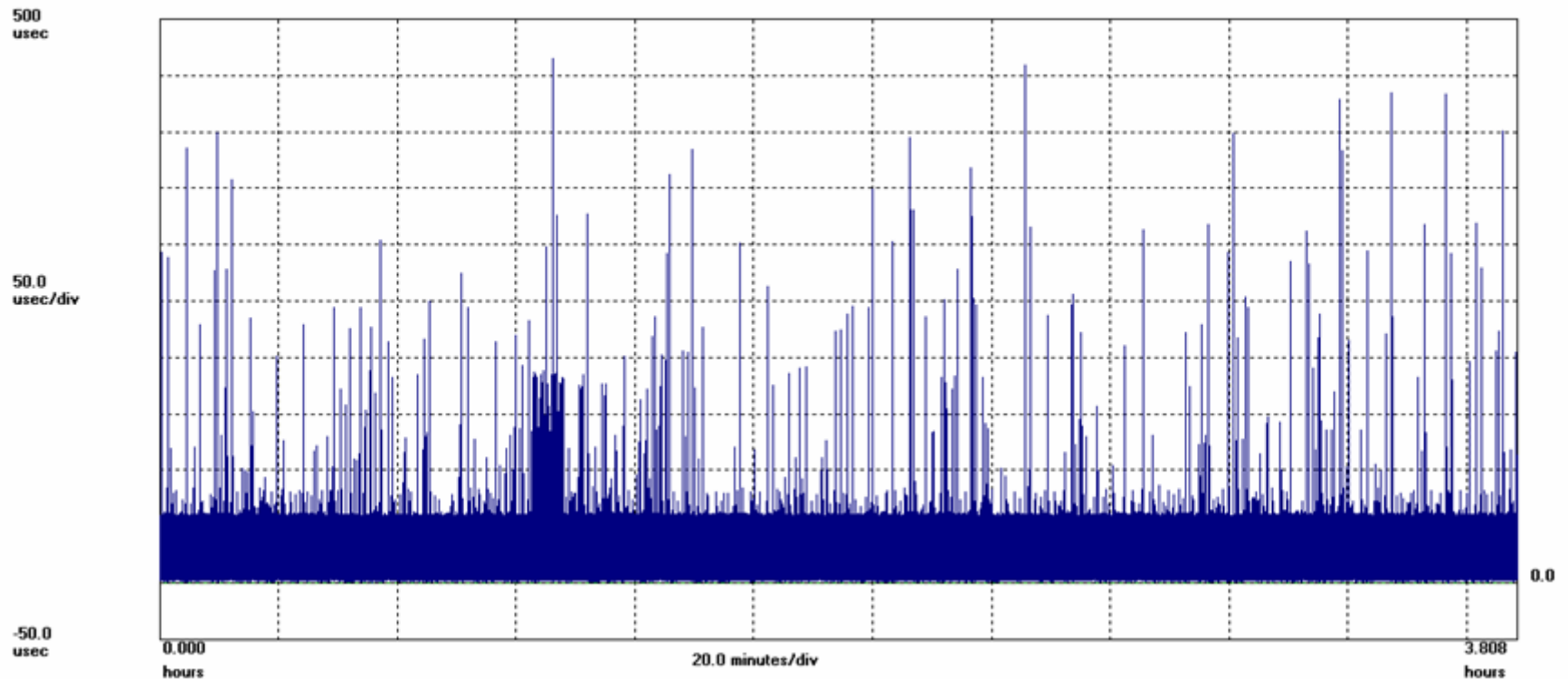
- TIE/MTIE
 - E1 derived from 1588 client

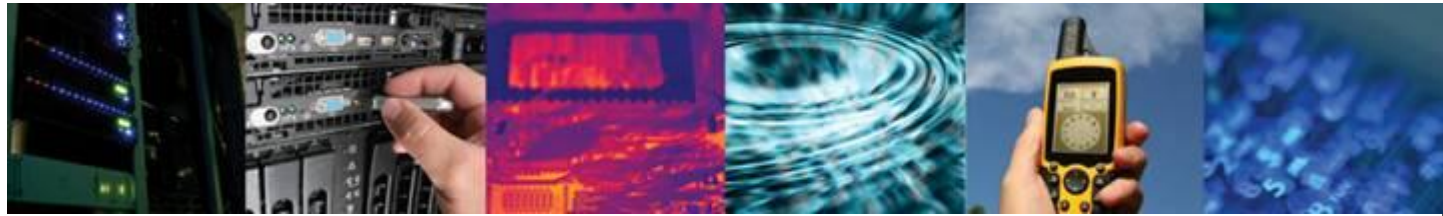


Results - PDV

■ 1588 SYNC message (forward pdv)

Symmetricom TimeMonitor Analyzer
Phase deviation in units of time; Fs=64.00 Hz; Fo=10.000000 MHz; 2009/09/25 08:46:03
Phase; Samples: 877412
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp [5ns clocks]





Symmetricom TimeMonitor Analyzer

Phase deviation in units of time; $F_s=64.00$ Hz; $F_0=10.000000$ MHz; 2009/09/25 08:46:03

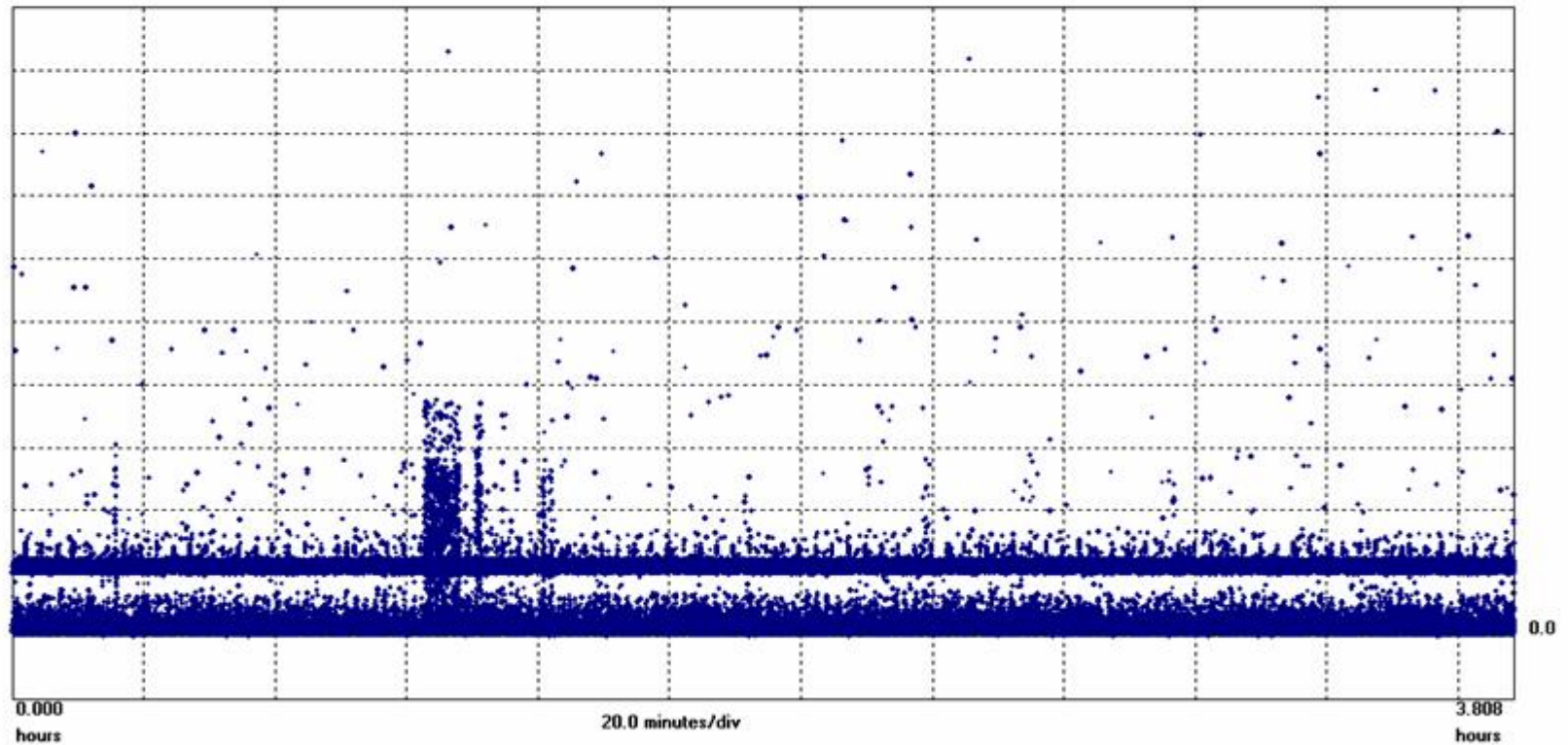
Phase; Samples: 877412

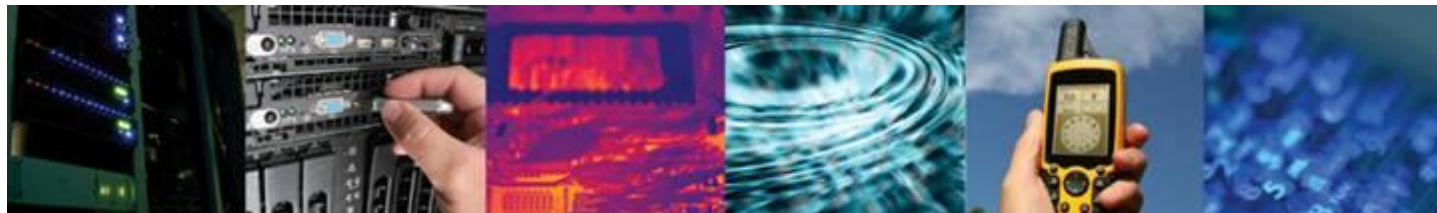
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp [5ns clocks]

500
usec

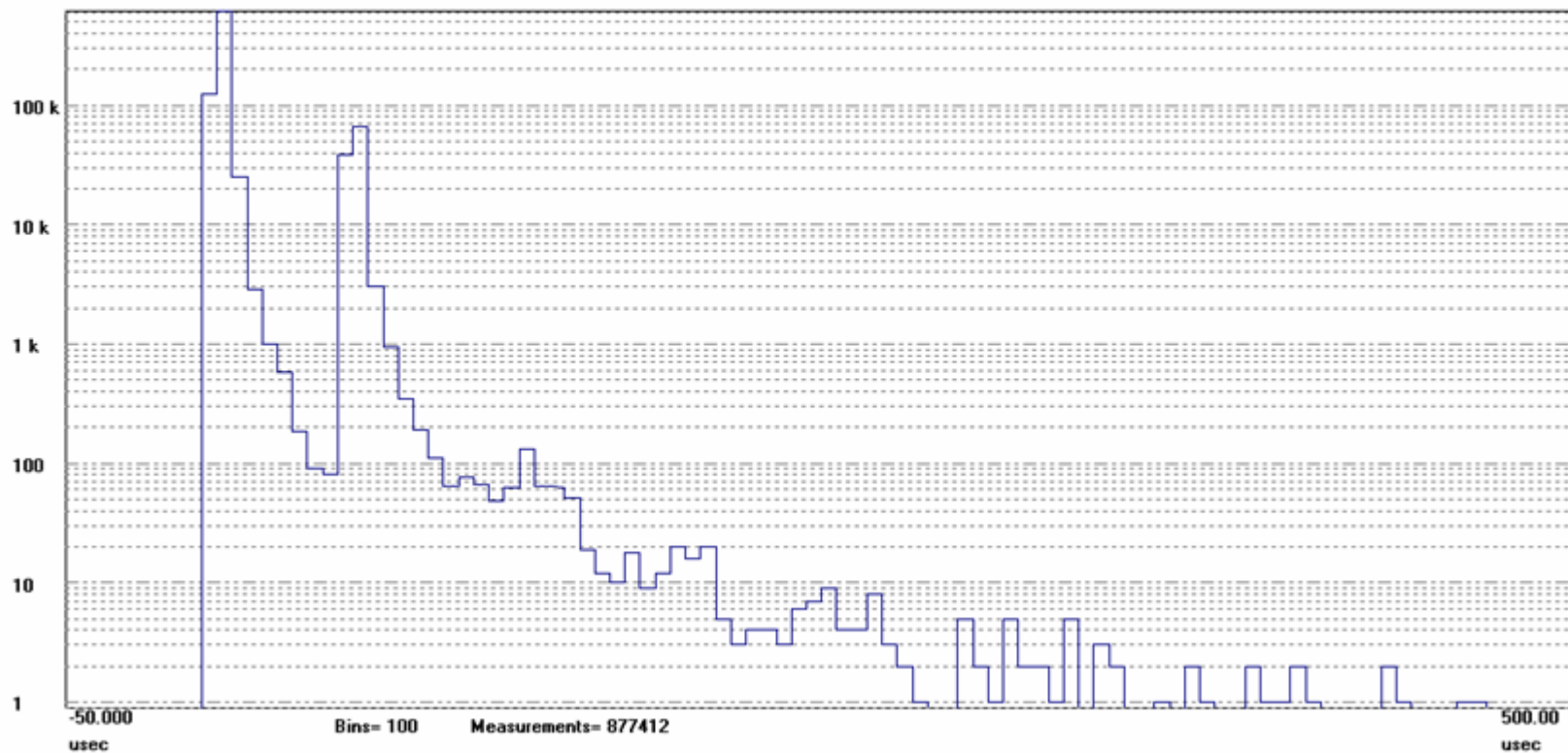
50.0
usec/div

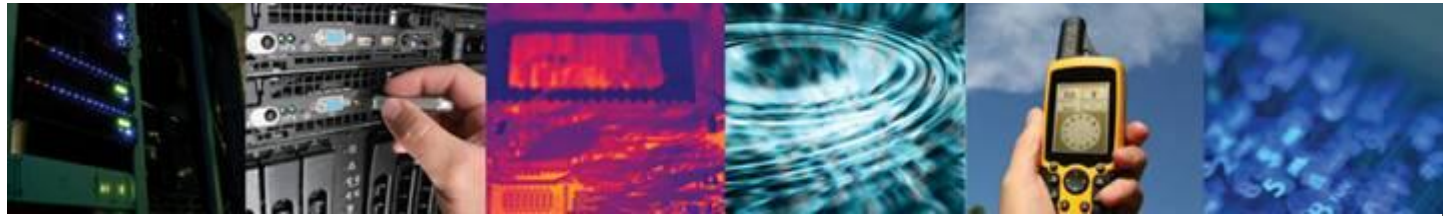
-50.0
usec



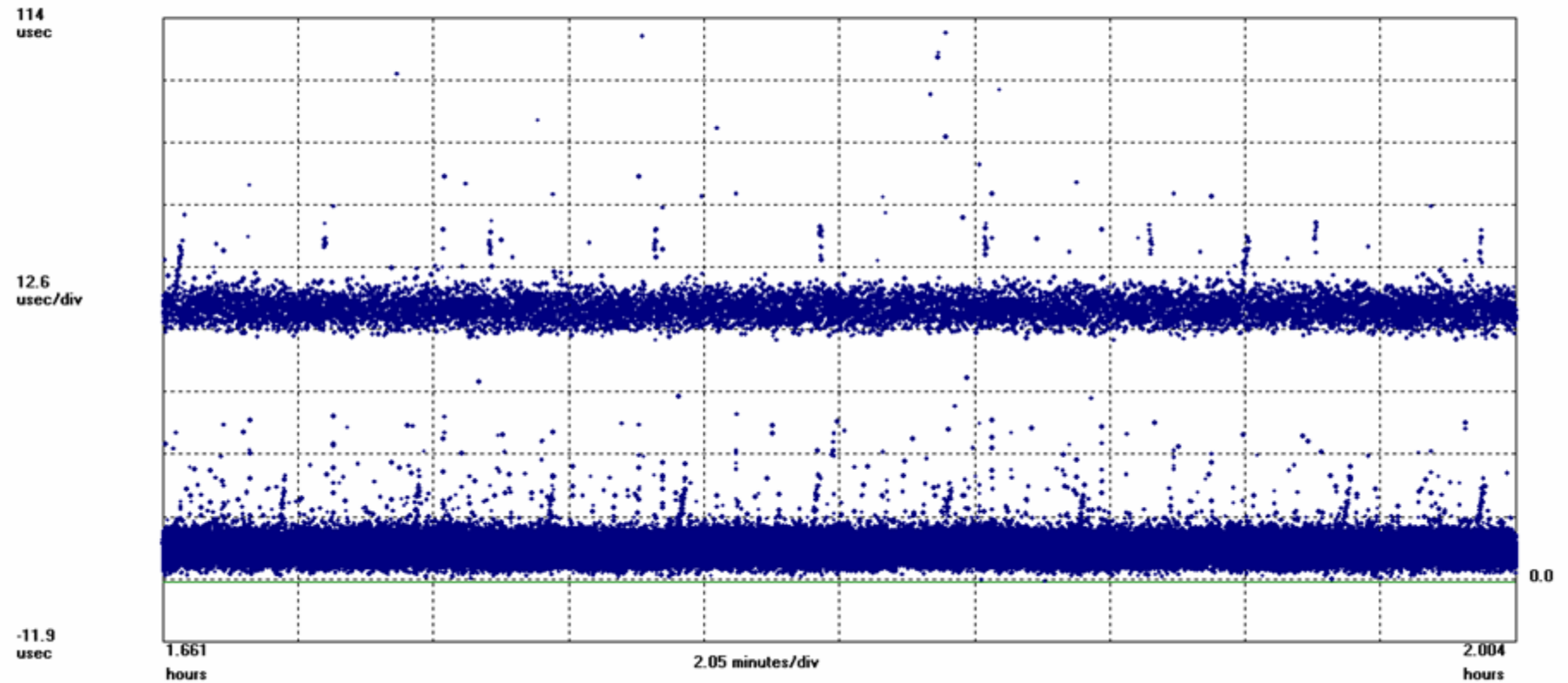


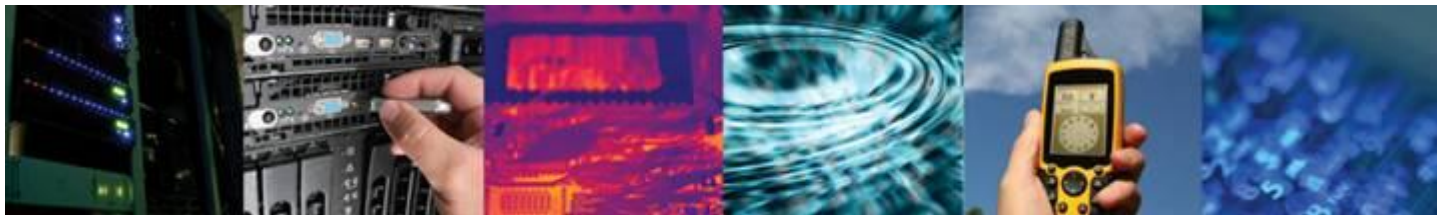
Symmetricom TimeMonitor Analyzer
Phase Deviation Histogram: Fs=64.00 Hz; Fo=10.00 MHz; 2009/09/25 08:46:03
Phase: Samples: 877412
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp (5ns clocks)





Symmetricon TimeMonitor Analyzer
Phase deviation in units of time: $F_s=64.00$ Hz; $F_o=10.000000$ MHz; 2009/09/25 08:46:03
Phase: Samples: 877412
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp (5ns clocks)





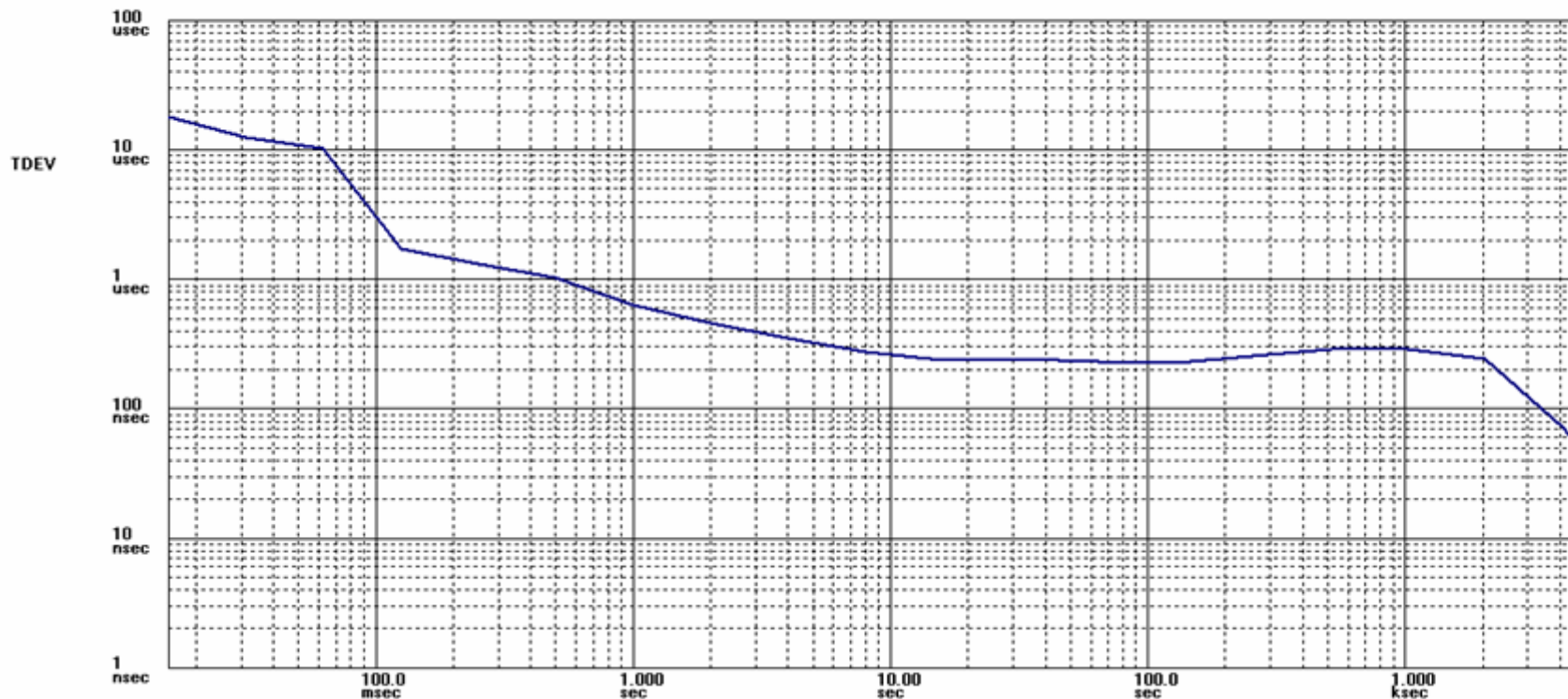
minTDEV

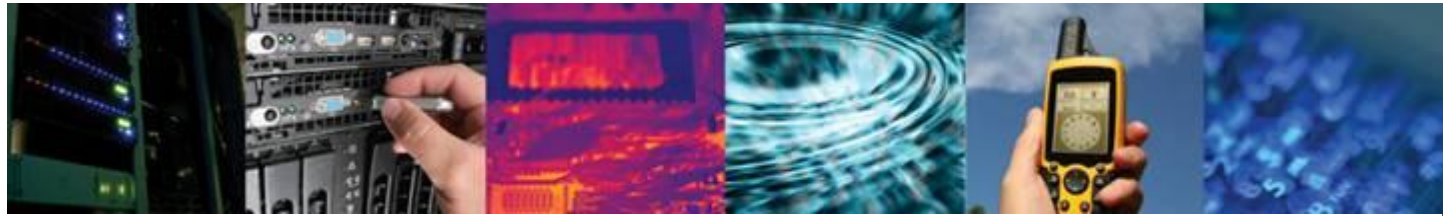
Symmetricon TimeMonitor Analyzer

TDEV: F₀=10.00 MHz; F_s=64.00 Hz; 2009/09/25 08:46:03

Phase: Samples: 877412

Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp [5ns clocks]

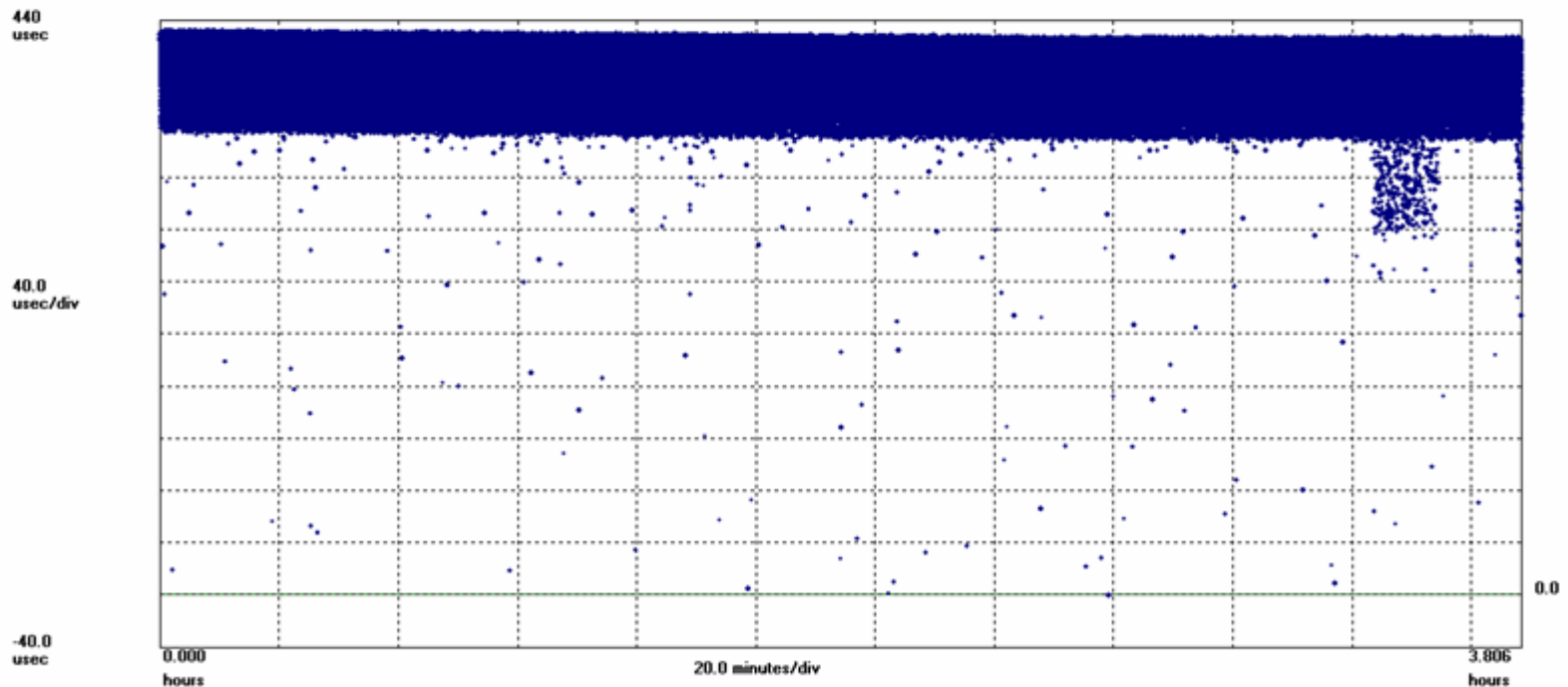


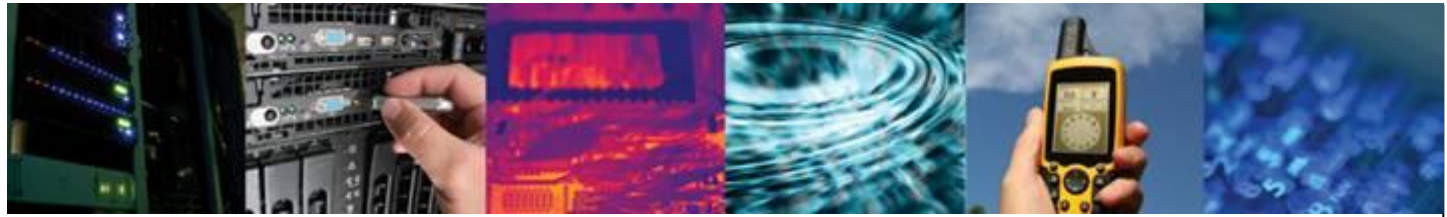


Results - PDV

■ 1588 DEL_REQ message (reverse flow)

Symmetricom TimeMonitor Analyzer
Phase deviation in units of time; Fs=64.00 Hz; Fo=10.000000 MHz; 2009/09/25 08:46:03
Phase; Samples: 876941
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp (5ns clocks)



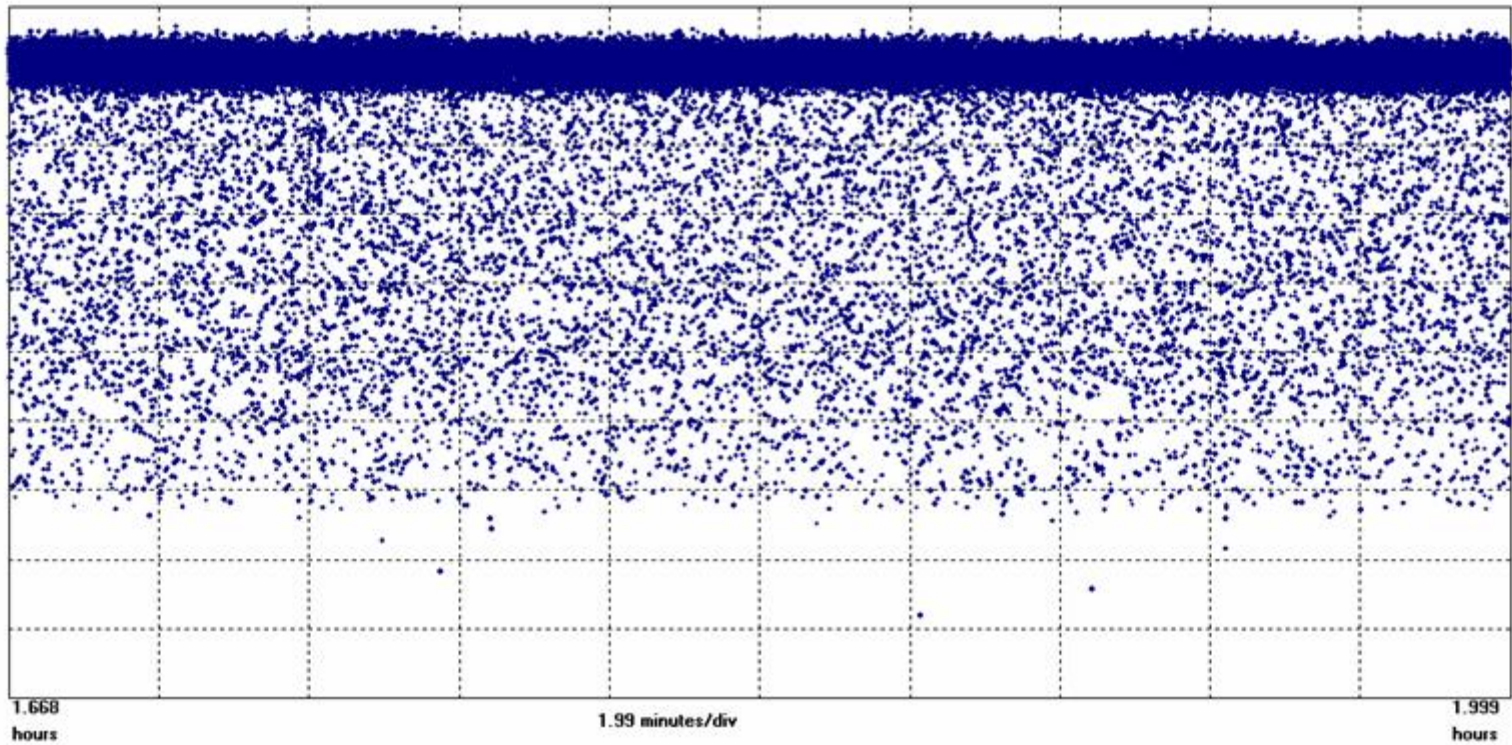


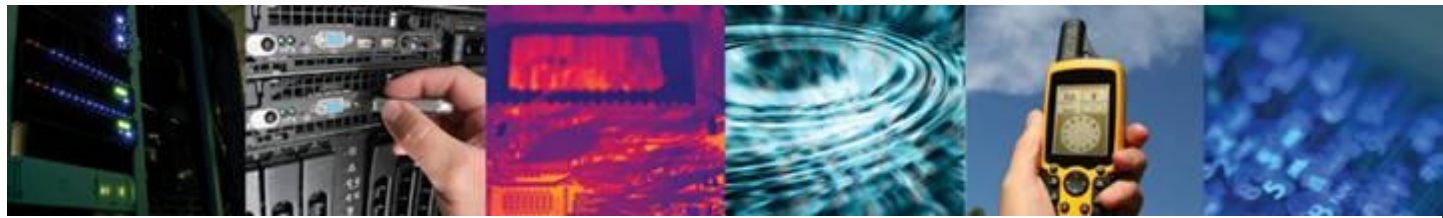
Symmetricon TimeMonitor Analyzer
Phase deviation in units of time: $F_s=64.00$ Hz; $F_o=10.000000$ MHz; 2009/09/25 08:46:03
Phase: Samples: 876941
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp (5ns clocks)

433
usec

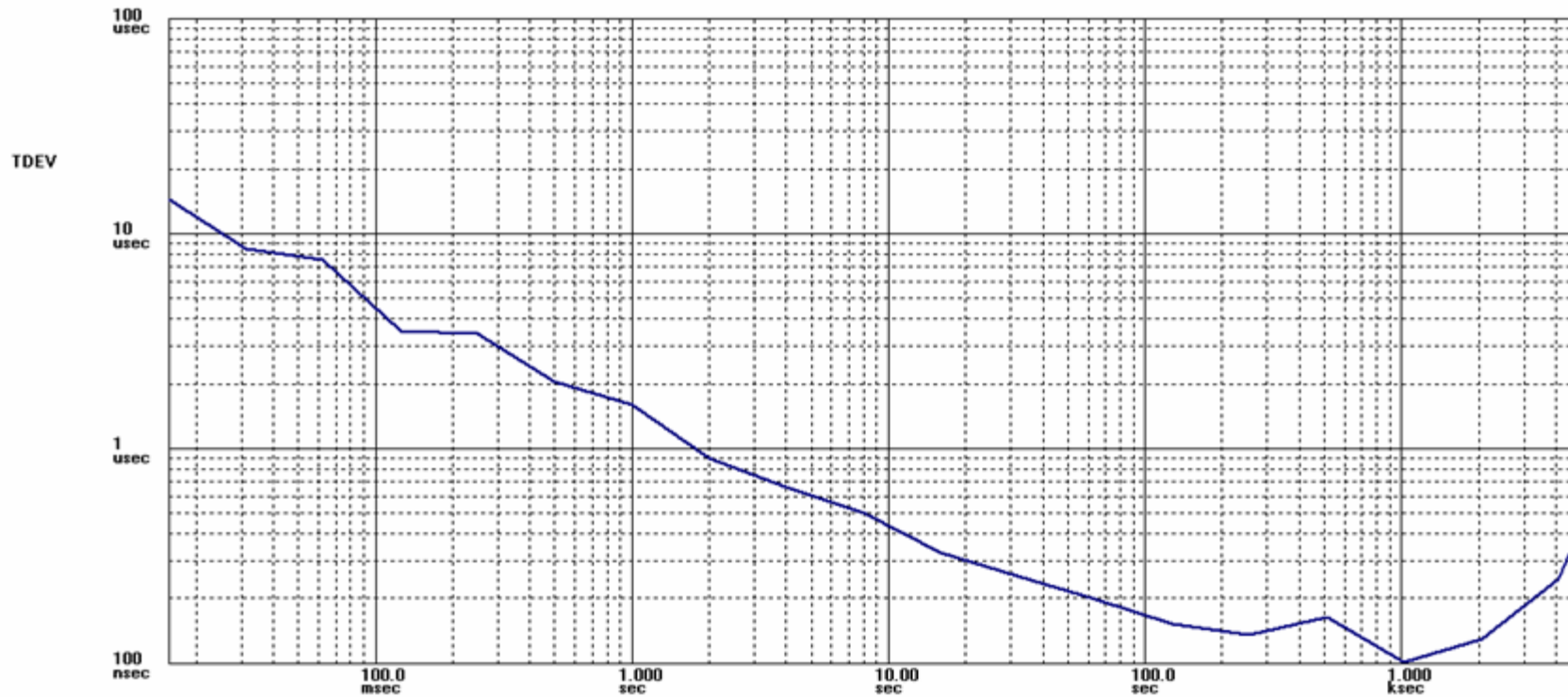
11.3
usec/div

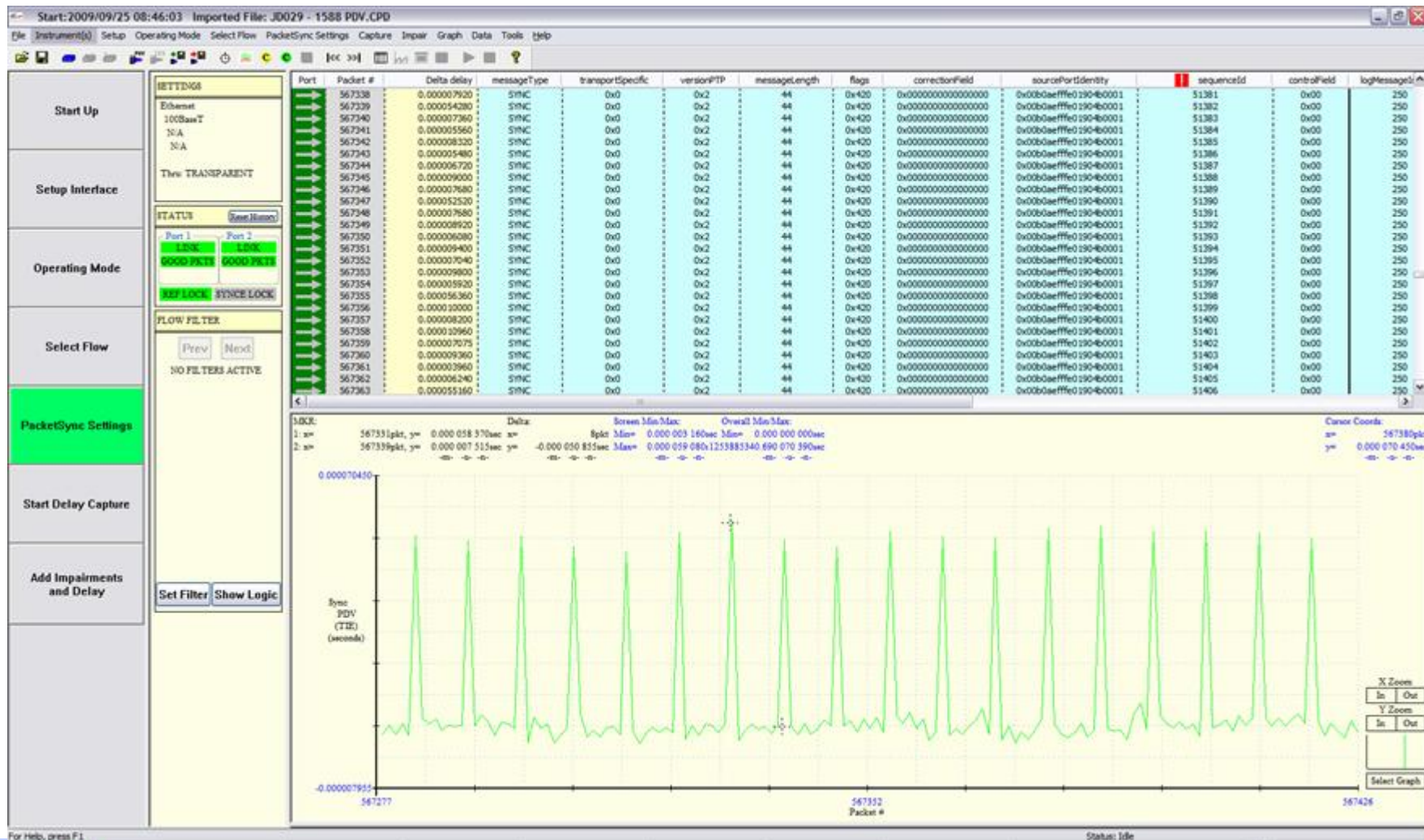
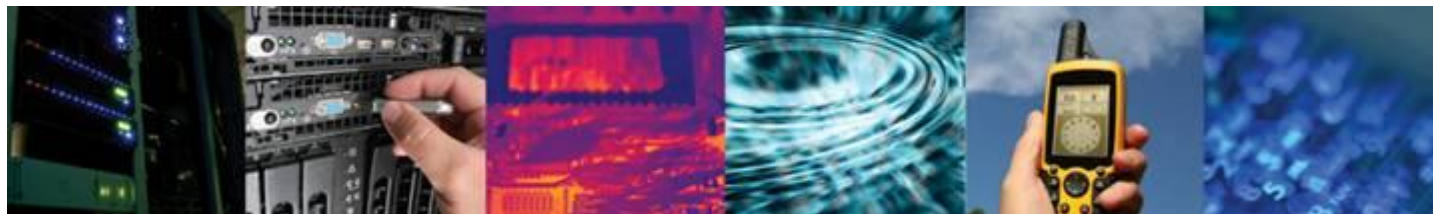
320
usec

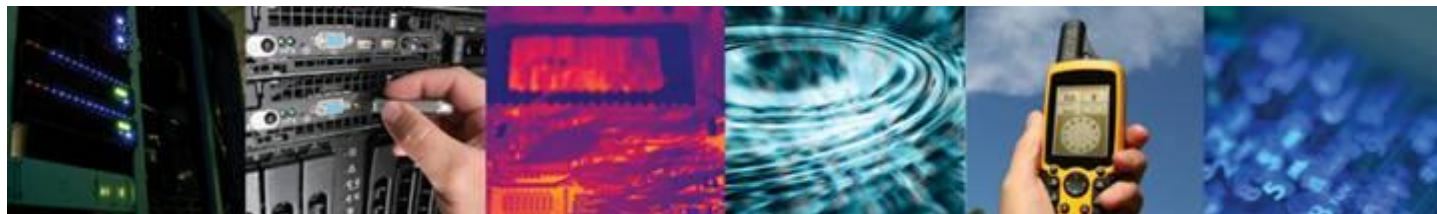




Symmetricom TimeMonitor Analyzer
TDEV: Fo=10.00 MHz; Fs=64.00 Hz; 2009/09/25 08:46:03
Phase: Samples: 876941
Paragon Test Probe/1588 Timestamp Data/Inter-packet Timestamp (5ns clocks)







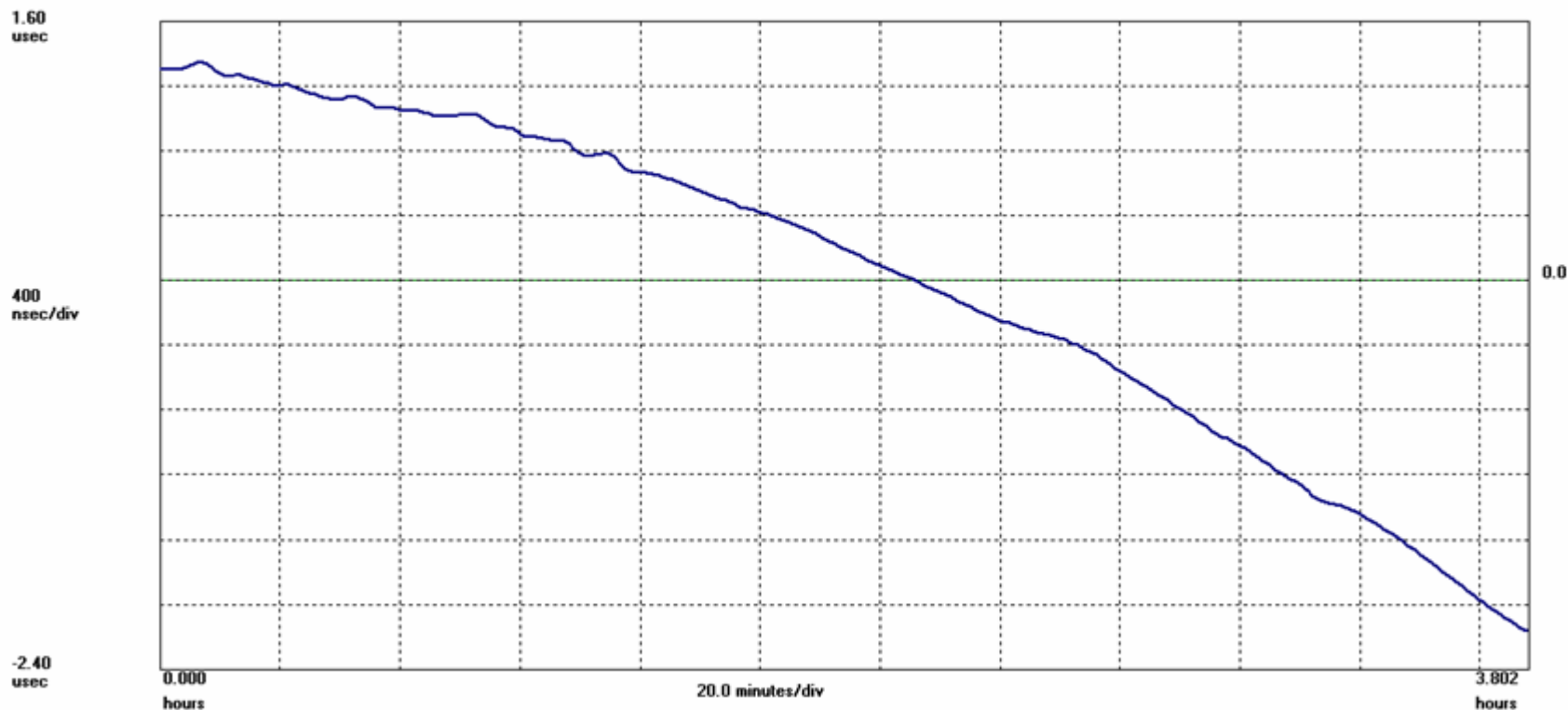
Results – Physical layer

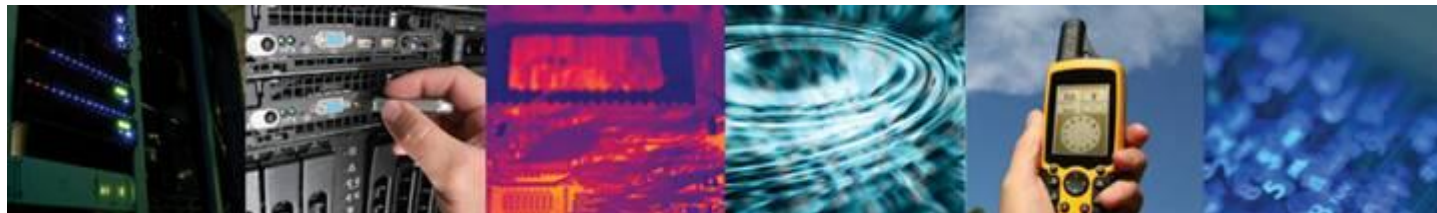
Symmetricon TimeMonitor Analyzer

Phase deviation in units of time; $F_s=1.001$ Hz; $F_o=2.0480000$ MHz; 1980/01/01 00:15:39

SyncWatch Phase; Samples: 13697; StartPC: 2009/09/25 08:44:47; MeasChan: 2M; RefChan: 2M

TP500-JD029





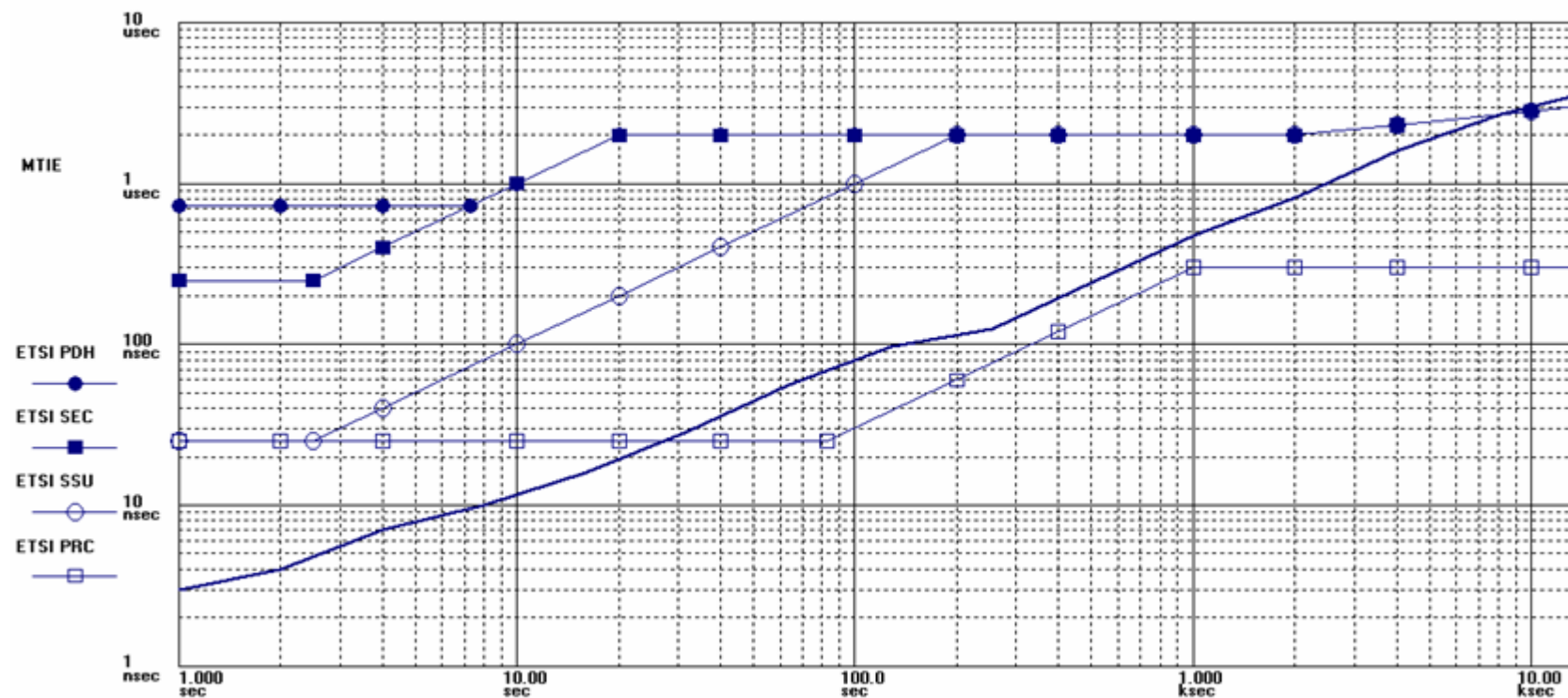
Results – Physical layer

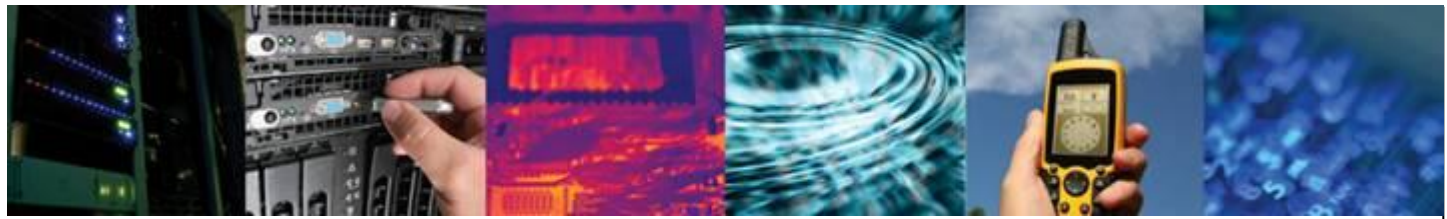
Symmetricom TimeMonitor Analyzer

MTIE: $F_0=2.048$ MHz; $F_s=1.001$ Hz; 1980/01/01 00:15:39

SyncWatch Phase; Samples: 13697; StartPC: 2009/09/25 08:44:47; MeasChan: 2M; RefChan: 2M

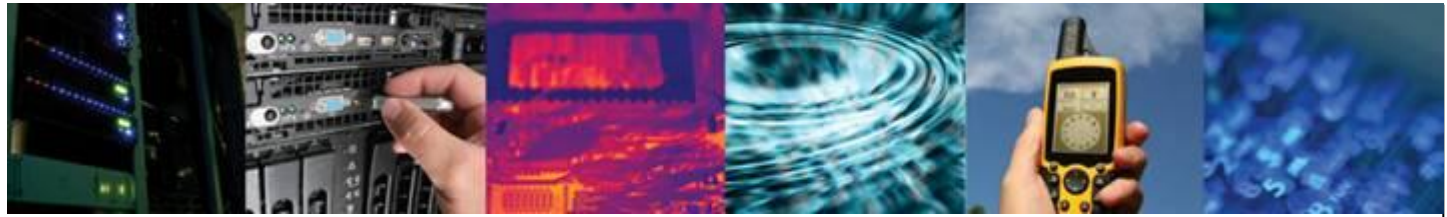
TP500-JD029





Conclusions

- In the transition to Packet Networks both Packet **AND** Physical layer measurements/metrics are key
 - Both for R&D – Algorithm development, and Customer Trials – Technology & Service Assurance
- Sound Engineering practice:
 - Benchmark before a change
 - Measure during the change
 - Monitor after the change
- Transportable rack can be taken from lab → trial → network → lab
- Has the flexibility to capture Packet **AND** Physical layer performance
- Without the use of a minivan/SUV/People Carrier 😊



Thank You.

- With thanks to:
 - Billy Marshall - Chronos