



# Using IEEE-1588™ Hardware as a PDV Measurement Tool

Conference on IEEE-1588

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**Sync**University

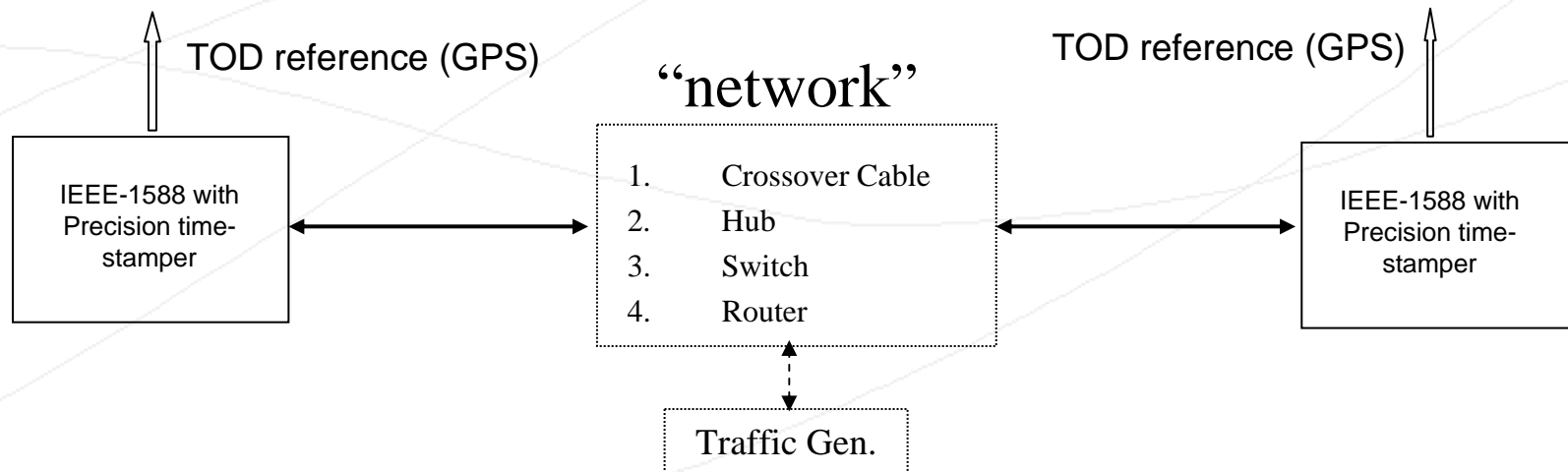
**Symmetricom**®

- ▶ **Measurement Set-Up**
  - Network configurations
- ▶ **Performance Metrics**
  - Phase data, sequential Time Interval Error data
  - Maximum Time Interval Error, MTIE
  - Time Deviation, TDEV
  - Standard Deviation of the Time Error
- ▶ **Observations**

# SET-UP



- ▶ Measurement equipment that has a precise hardware time-stamping feature on each 1588 port
- ▶ GPS time-of-day reference in each unit
  - Required for sub-microsecond end-to-end analysis
  - Log-files of the time-stamp data is post-processed
- ▶ Network configurations
  - Baseline, e.g. no traffic
  - With traffic load, based upon G.8261 “Data” profile

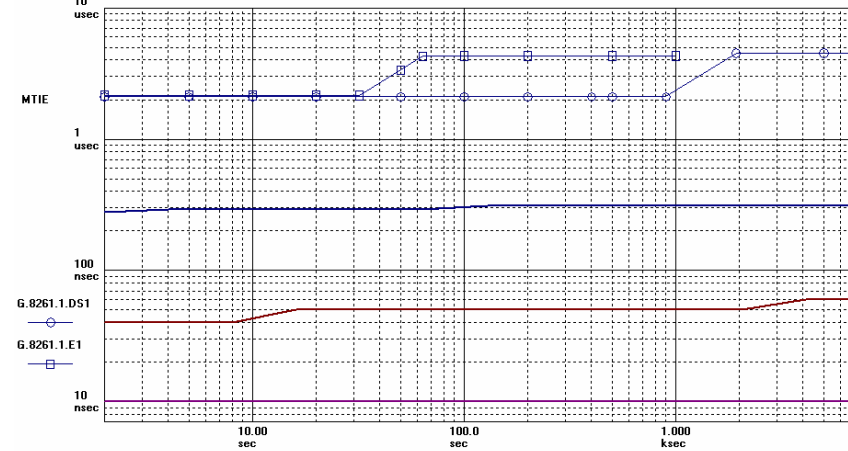


# Performance Metrics



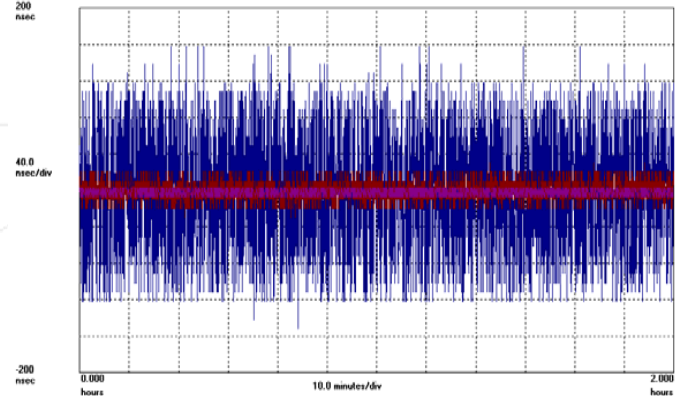
- Time Interval Error, TIE or Phase
  - Basis for all PM data sets
- Maximum Time Interval Error
  - defined in G.8261
- Time Deviation, TDEV
  - Defined in ANSI T1.101

Symmetricom TimeMonitor Analyzer (file=switch2h.tsh)  
 MTIE: Fo=10.00 MHz; Fs=500.0 mHz; 2006/01/31; 19:10:06  
 1. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 16.7500 usec; 2006/01/31; 19:10:06  
 2. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 660.000 nsec; 2005/12/24; 15:34:08  
 3. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 290.000 nsec; 2006/01/31; 16:10:21



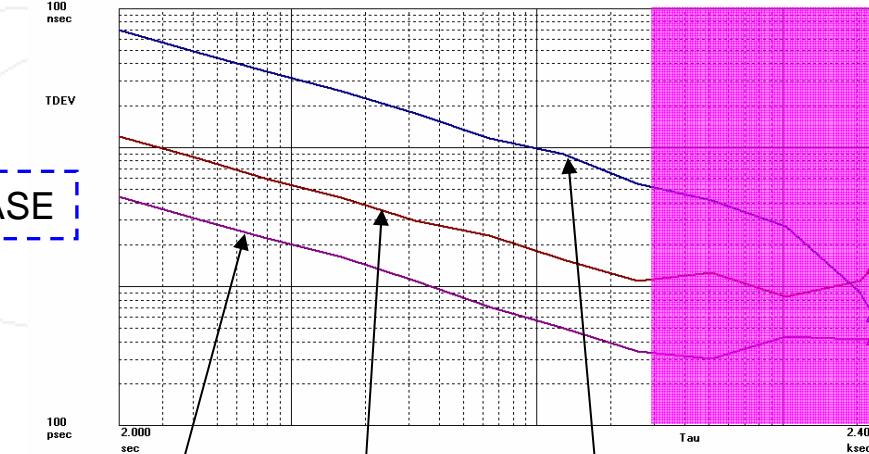
MTIE

Symmetricom TimeMonitor Analyzer (file=crossover2h.tsh)  
 Phase deviation in units of time: Fs=500.0 mHz; Fo=10.000000 MHz; 01/31/06; 19:10:06  
 1. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 16.7500 usec; 01/31/06; 19:10:06  
 2. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 660.000 nsec; 12/24/05; 15:34:08  
 3. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 290.000 nsec; 01/31/06; 16:10:21



PHASE

Symmetricom TimeMonitor Analyzer (file=crossover2h.tsh)  
 TDEV: No. Avg=1; Fo=10.00 MHz; Fs=500.0 mHz; 01/31/06; 19:10:06  
 1. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 16.7500 usec; 01/31/06; 19:10:06  
 2. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 660.000 nsec; 12/24/05; 15:34:08  
 3. Tahiti Phase; Samples: 3601; UUID: 00A0690BC1A4; Initial phase offset: 290.000 nsec; 01/31/06; 16:10:21



TDEV

Crossover      Hub      Switch

# Performance Metrics Con't



- Statistics
- Mean Deviation
- Peak to Peak Deviation
- Standard Deviation

Statistics

*Crossover cable:*

Mean: 287.2818 nsec

Peak to Peak: 10.01 nsec

Standard Deviation: 4.450 nsec

*Hub:*

Mean: 659.7955 nsec

Peak to Peak: 60.01 nsec

Standard Deviation: 12.13 nsec

*Switch:*

Mean: 16.75112  $\mu$ sec

Peak to Peak: 310.0 nsec

Standard Deviation: 70.10 nsec

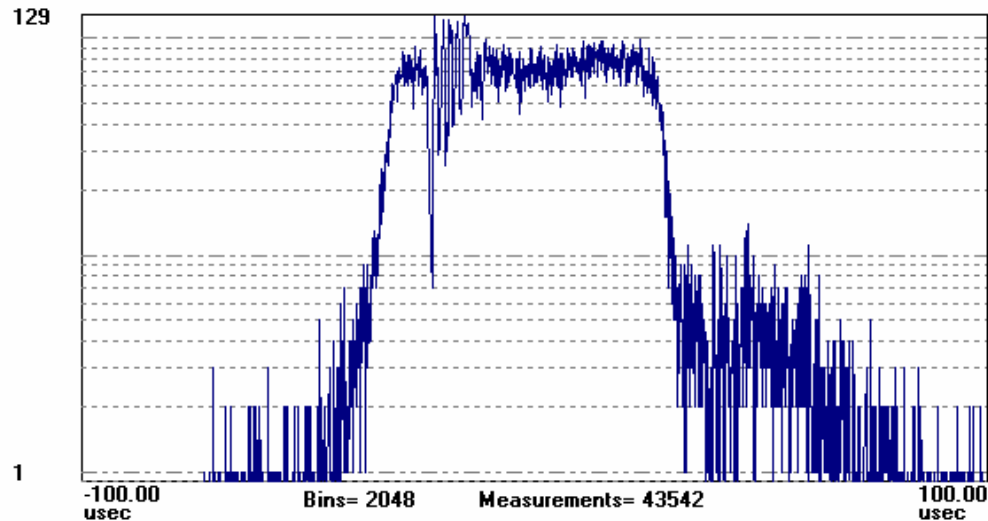
*Router:*

Mean: 277.6874 usec

Peak to Peak: 212.5 usec

Standard Deviation: 20.64 usec

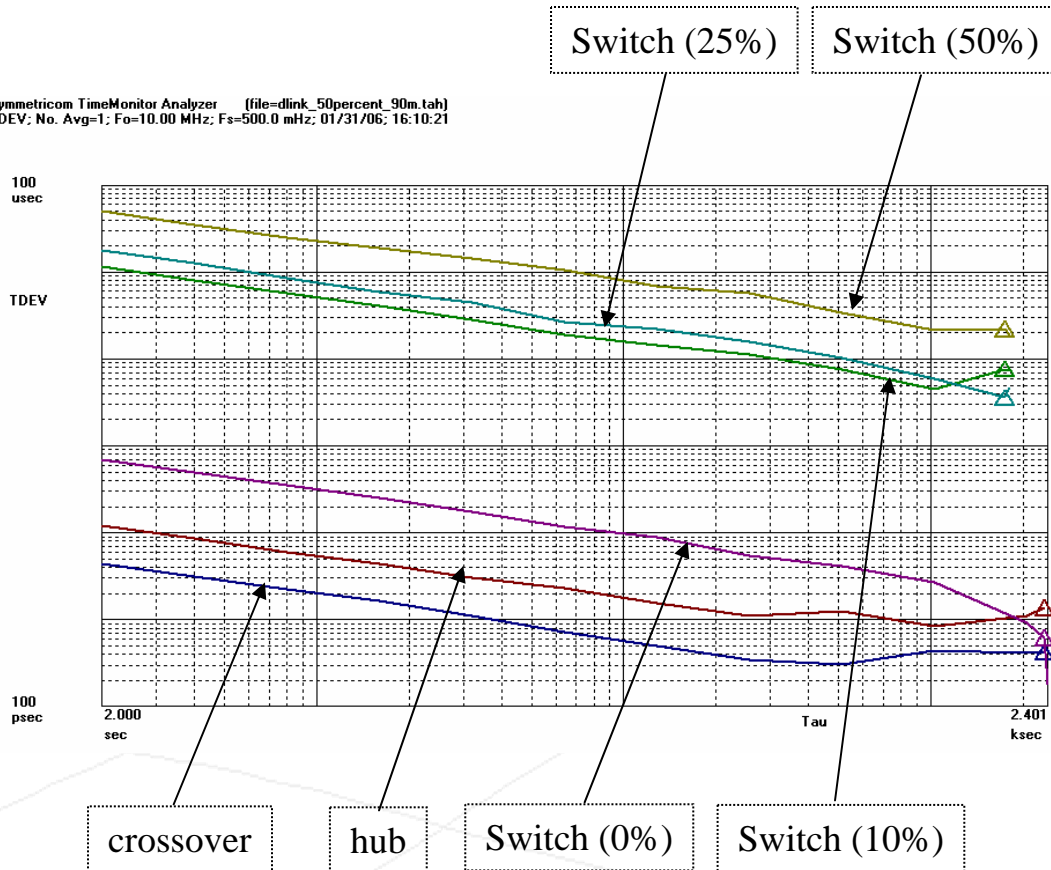
Symmetricom TimeMonitor Analyzer  
PDV Software Router; Mean: 277.6874 usec; Standard Deviation: 20.64 usec



# Performance as a Function of Load



Symmetricom TimeMonitor Analyzer (file=dlink\_50percent\_90m.tah)  
 TDEV: No. Avg=1; Fo=10.00 MHz; Fs=500.0 mHz; 01/31/06; 16:10:21



## Statistics

*No traffic:*  
 Mean: 16.75112  $\mu$ sec  
 Peak to Peak: 310.0 nsec  
**Standard Deviation: 70.10 nsec**

*10% BW Utilization:*  
 Mean: 17.93500  $\mu$ sec  
 Peak to Peak: 121.4  $\mu$ sec  
**Standard Deviation: 11.53  $\mu$ sec**

*25% BW Utilization:*  
 Mean: 19.62525  $\mu$ sec  
 Peak to Peak: 122.6  $\mu$ sec  
**Standard Deviation: 17.61  $\mu$ sec**

*50% BW Utilization:*  
 Mean: 47.99551  $\mu$ sec  
 Peak to Peak: 122.8  $\mu$ sec  
**Standard Deviation: 50.90  $\mu$ sec**

# Not All Elements are *Equal*

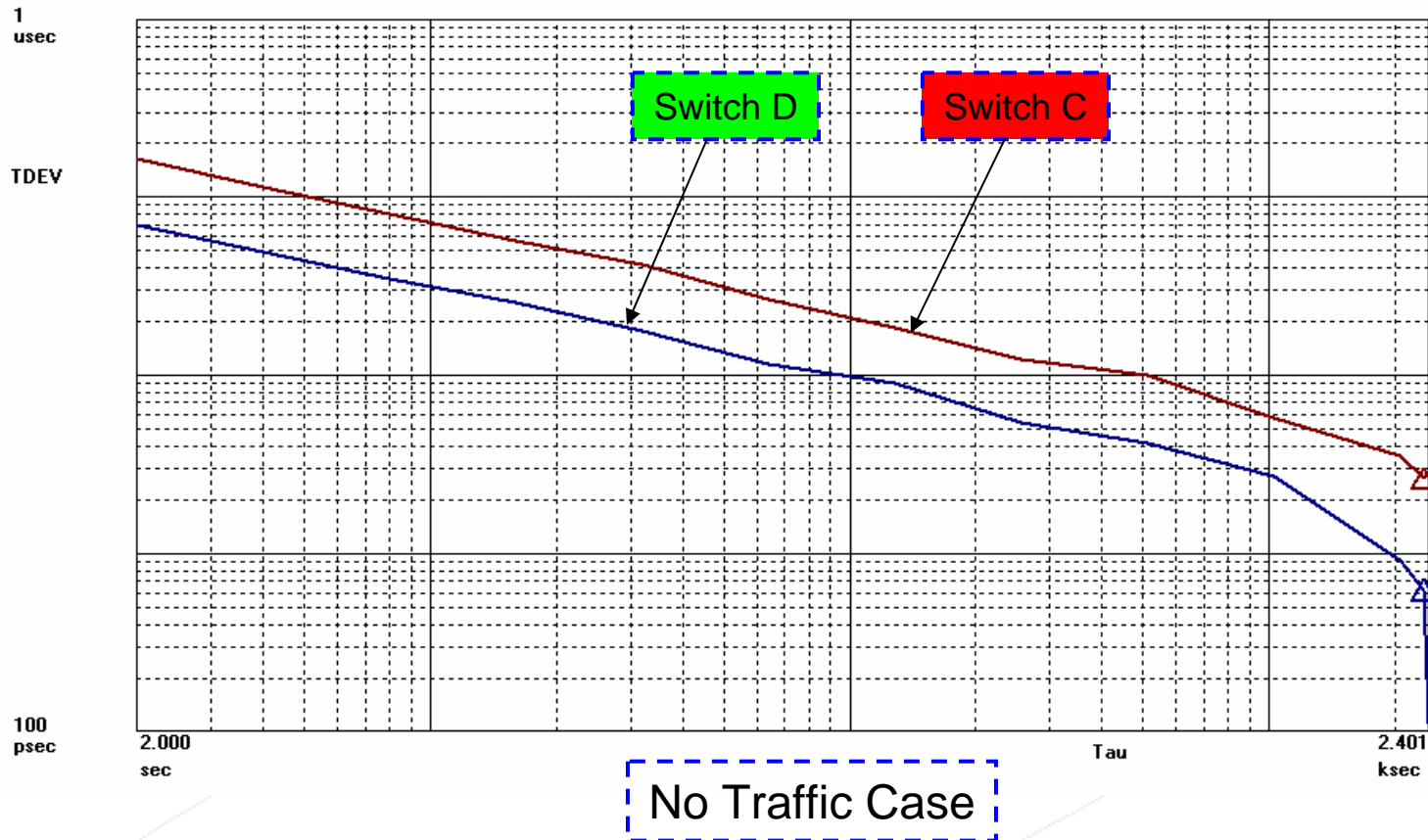


Symmetricom TimeMonitor Analyzer (file=switch2h.tah)

TDEV; No. Avg=1; Fo=10.00 MHz; Fs=500.0 mHz; 01/31/06; 19:10:06

1: Tahiti Phase; Samples: 3600; Stop: 3600; UUID: 00A0690BC1A4; Initial phase offset: 16.7500 usec; 01/31/06; 19:10:06

2: Tahiti Phase; Samples: 3600; Stop: 3600; UUID: 00A0690BC1A4; Initial phase offset: 21.1400 usec; 02/07/06; 00:21:21

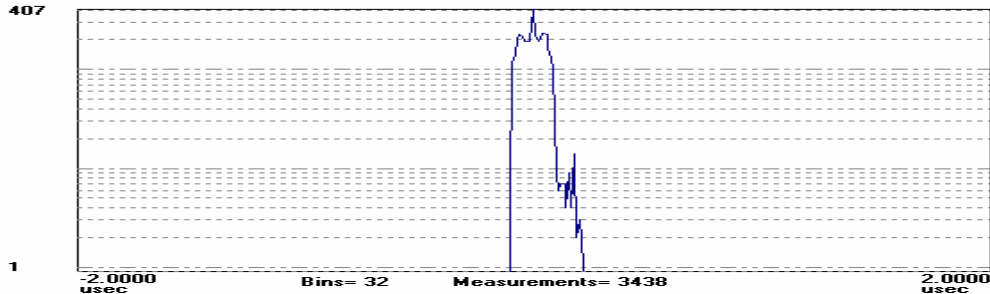


# Not All Elements are *Equal* Con't



## Switch vs. Wire-speed router vs. Software router

Symmetricom TimeMonitor Analyzer  
PDV Switch; Mean: 24.41855 usec; Standard Deviation: 52.85 nsec



### Statistics

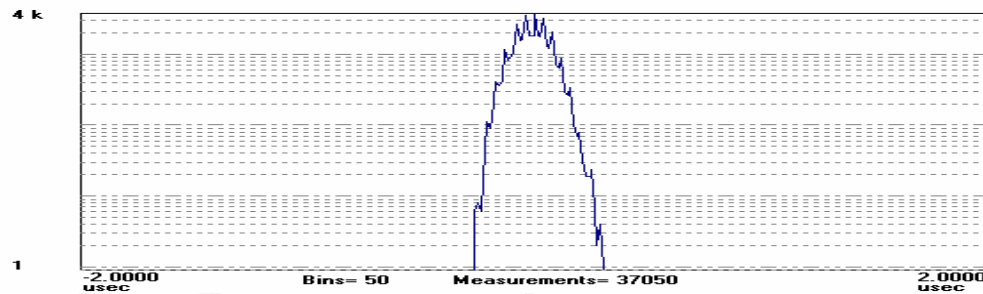
*Switch:*

Mean: 24.41855  $\mu$ sec

Peak to Peak: 334.8 nsec

**Standard Deviation: 52.85 nsec**

Symmetricom TimeMonitor Analyzer  
PDV Wire-speed Router; Mean: 27.02728 usec; Standard Deviation: 76.19 nsec



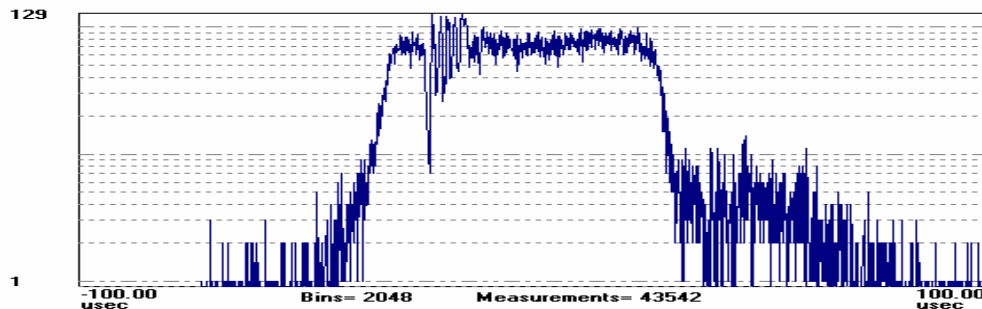
*Wire-speed router:*

Mean: 27.02728  $\mu$ sec

Peak to Peak: 576.0 nsec

**Standard Deviation: 76.19 nsec**

Symmetricom TimeMonitor Analyzer  
PDV Software Router; Mean: 277.6874 usec; Standard Deviation: 20.64 usec



*Software router:*

Mean: 277.6874  $\mu$ sec

Peak to Peak: 212.5  $\mu$ sec

**Standard Deviation: 20.64  $\mu$ sec**



- ▶ For constrained networks (few elements):
  - TDEV or Standard Deviation metrics for PDV provide network characterization and can be used in addition to existing QoS elements such as packet delay and loss
  - Hypotheses for TDEV or StDEV
    - Can be used to “compare” network element performance
    - Can be used to specify packet network performance (in conjunction with delay, loss, etc.)
    - Can be used to define network performance under load
    - Can be used to “tune” the network

Thank You



Questions?

Suggestions?