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MetaWatch tested with STAC-TS

STAC-TS.NTE2: Ultra-high frequency reference capture
and
STAC-TS.PSE1: Port-sync error (same device)

Dr Dave Snowdon, Matthew Knight

Simplifying networks
Reducing latency
Increasing flexibility

www.metamako.com

MetaWatch

Metamako's network monitoring solution

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MetaWatch

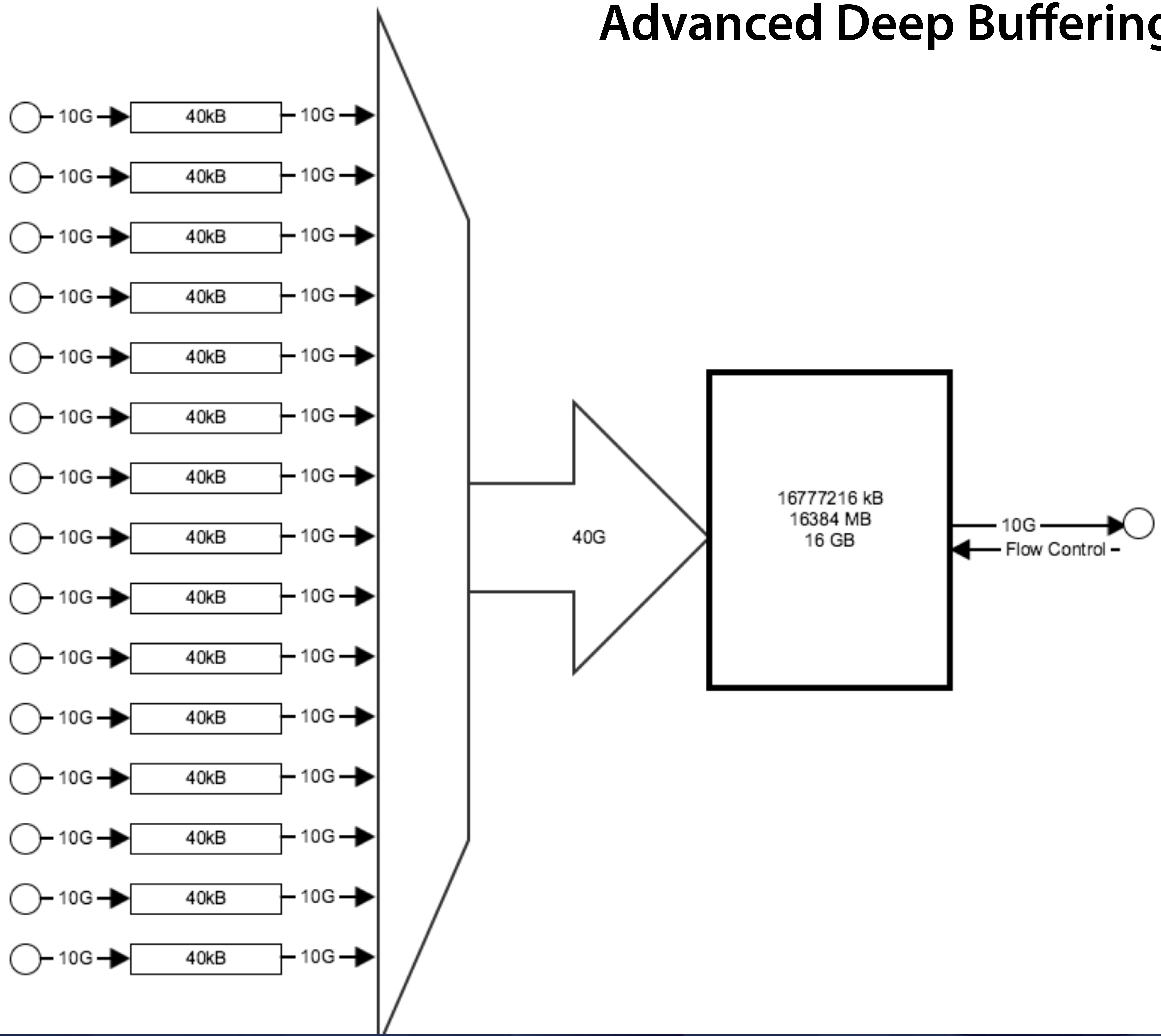
Combine traditional network monitoring into one powerful device:

- Tapping
- Aggregation
- Deep Buffering
- Nanosecond Timestamping
- Time Synchronisation

MetaWatch replaces:

- 30 passive optical taps
- an aggregation and timestamping switch
- media converters, patch panels, and all other Layer 1 switch use cases
- Wiring mess

Advanced Deep Buffering



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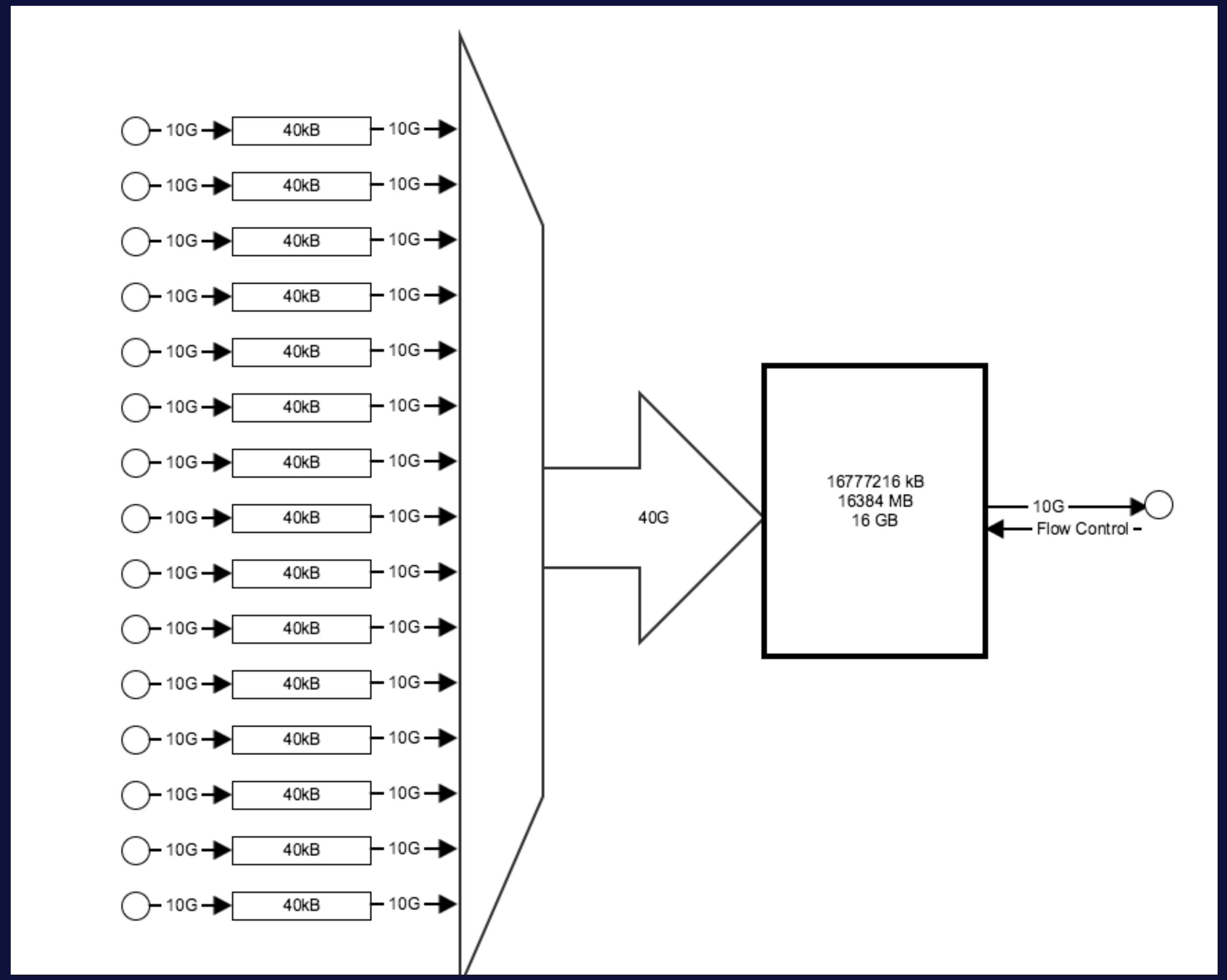
Advanced Deep Buffering

- Data is buffered in up to 32GB
- Aggregate 300G ingress to 20G egress
- ‘Lossless Ethernet’ - using industry-standard IEEE flow control



What this means: Don’t Drop Packets

- **absorb microbursts** and over-subscription;
- monitor **more connections** with the same device;
- analytics consumes packets as fast as it is capable;
- aggregate multiple devices further.

STAC-TS Network Error Tests

Step 1: How accurate are the ports relative to each other?
STAC-TS.PSE1

Step 2: How accurate is one port relative to a time source?
STAC-TS.NTE2

Step 3: Combine to determine accuracy of all ports.

STAC-TS.PSE1*

Port Synchronisation Error (Same Device)

Percentile	μs
100%	0.001 ± 0.003
99.99%	0.001 ± 0.002

*Preliminary results, subject to confirmation

STAC-TS.NTE2

Network Time Error

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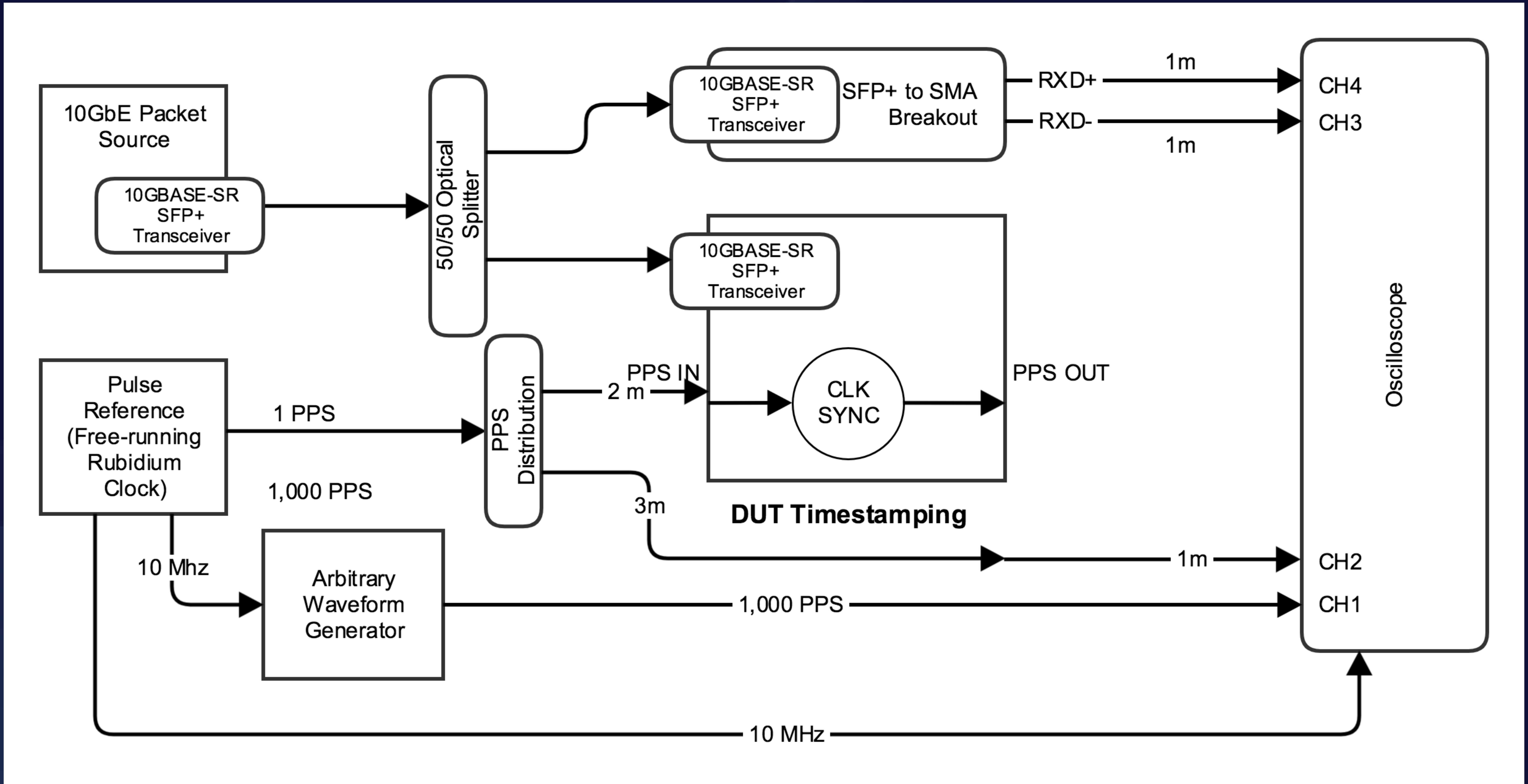
STAC-TS.NTE2



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STAC-TS.NTE2

How we measured

- A stream of 1 PPS pulses from the Rubidium Frequency Standard was split and sent to both the DUT and the Oscilloscope
  - The Oscilloscope was used to measure and characterize the skew and jitter between the two pulses
- A stream of 10GbE frames from the Packet Source was split using an optical splitter before being send to the DUT and a breakout board converting the electrical signals from the SFP+ cage to a pair of 1 m 50Ω Coax cables
  - A second breakout board and pair of Coax cables was used to measure and characterize any skew from the optical splitter, the fibre cables and the transceivers
- Immediately following each run, the oscilloscope was configured to measure the 1,000 PPS period jitter and the relative position in time between the 1,000 PPS and 1 PPS channels

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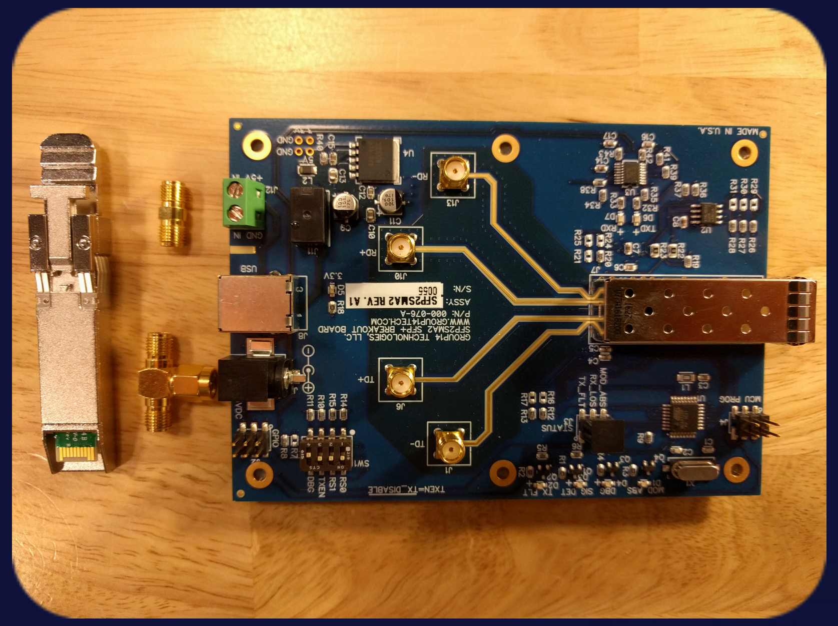
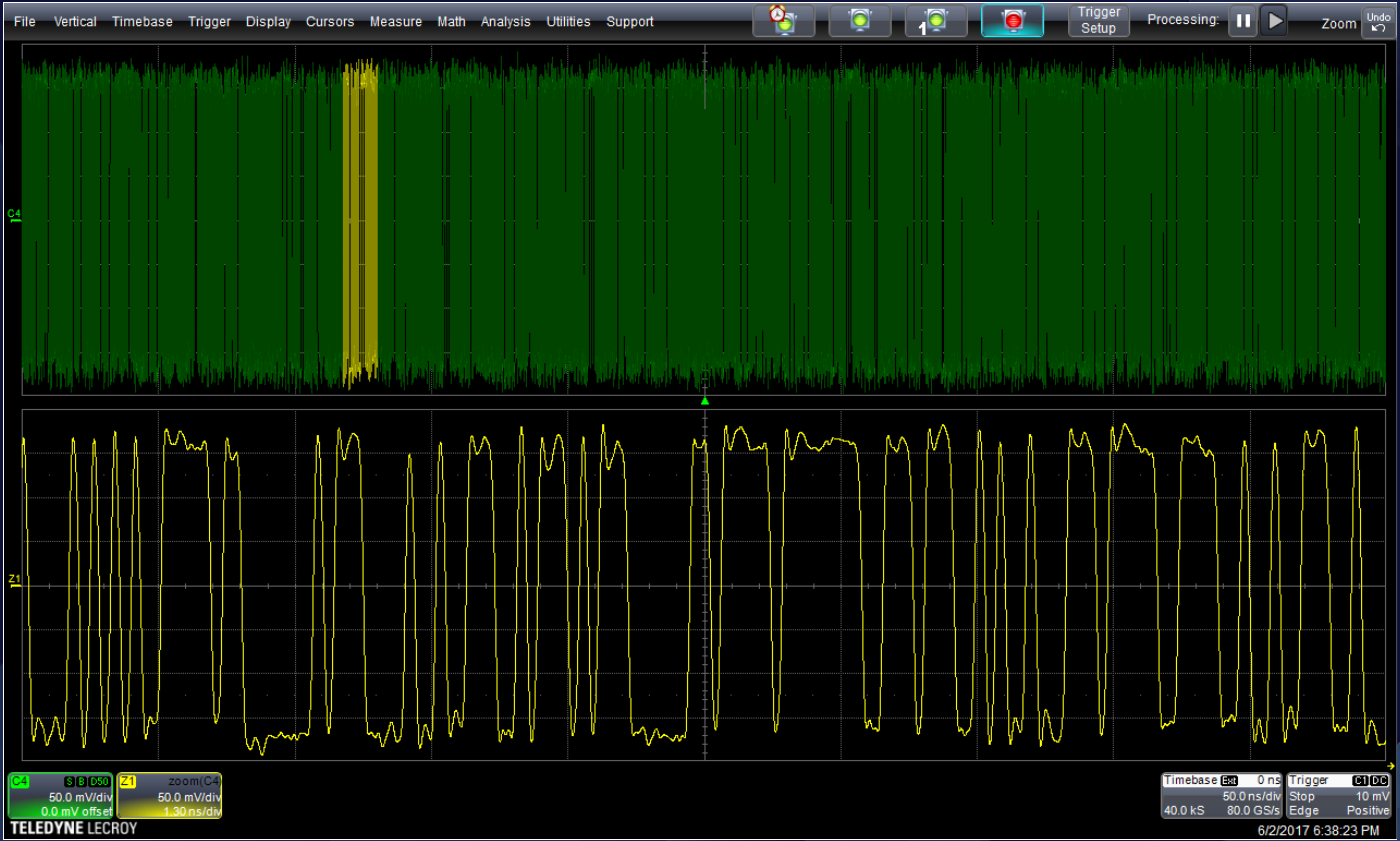
STAC-TS.NTE2





Key Elements of Interest

- **Time Standard:** Free running rubidium standard
- **Oscilloscope sampling accuracy:**
  - Sampling frequency: 80 GS/s
  - Resolution: 12.5 ps
- **Measurement accuracy (10G to PPS):** 50 ps
  - 1 ps is the latency of 0.24 mm of coax



File
Vertical
Timebase
Trigger
Display
Cursors
Measure
Math
Analysis
Utilities
Support
Trigger Setup
Processing:
Zoom
Undo
C4
Z1
C4
50.0 mV/div
0.0 mV offset
Z1
zoom(C4)
50.0 mV/div
1.30 ns/div
TELEDYNE LECROY
Timebase
0 ns
50.0 ns/div
40.0 kS
80.0 GS/s
Trigger
Stop
10 mV
Edge
Positive
6/2/2017 6:38:23 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Support
Trigger Setup
Processing:
Zoom
Undo
C4
DataWord
Terminate+Idle(7)
Idle(4)+Start+Data(3)
DataWord
Z1
64B66B Time(us) BlockType TypeField Primitive Block Payload
18 -0.132907 Control Block 0x87 Terminate+Idle(7) 0x87 0x0 0x0 0x0 0x0 0x0 0x0 0x0
19 -0.126507 Control Block 0x33 Idle(4)+Start+Data(3) 0x33 0x0 0x0 0x0 0x0 0x55 0x55 0x55
20 -0.1201 Data Block 0x55 0x55 0x55 0xd5 0x0 0x1 0x2 0x3
21 -0.113711 Data Block 0x4 0x5 0x6 0x7 0x8 0x9 0xa 0xb
22 -0.107305 Data Block 0x92 0x0 0x1 0xab 0xd7 0xc5 0x42 0x75
C4 S B D50
50.0 mV/div
0.0 mV offset
Z1 zoom(C4)
50.0 mV/div
1.94 ns/div
TELEDYNE LECROY
Timebase 0 ns
50.0 ns/div
40.0 kS 80.0 GS/s
Trigger C1 DC
Stop 10 mV
Edge Positive
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STAC-TS.NTE2

It was not all smooth sailing…

- The oscilloscope's 64b/66b Decode table in Sequence Mode only exports with nanosecond precision
- The alternative was to manually extract the table from the oscilloscope memory via VBScript at picosecond resolution
- A larger than standard oscilloscope acquisition buffer is required to capture 1,000's of segments over multiple seconds


File
Vertical
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Math
Analysis
Utilities
Support
Trigger Setup
Processing:
Zoom
Undo
C1
C2
C3
Z2
Measure
P1:dtrig(C1)
P2:ddelay(C2,C1)
P3:setup(C1,C1)
P4:ddelay(C1,C2)
P5:- - -
P6:rise(C1)
P7:- - -
P8:- - -
P9:- - -
P10:- - -
P11:- - -
P12:- - -
value 1.0000000 ms ---
mean 1.00000000 ms 48.250786 ns
min 1.0000000 ms 48.24506 ns
max 1.0000000 ms 48.25709 ns
sdev 0 s 4.927 ps
num 2.999e+3 3
status
64B66B
Time
BlockType
TypeField
Primitive
Block Payload
231... 2.99900022 s Data Block 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0
231... 2.99900023 s Data Block 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0
231... 2.99900023 s Control Block 0xcc Data(4)+Terminate+Idle(3) 0xcc 0xe9 0xfc 0xa0 0xd7 0x0 0x0 0x0
231... 2.99900024 s Control Block 0x1e Idle+Idle 0x1e 0x0 0x0 0x0 0x0 0x0 0x0 0x0
C1 S B D50 500 mV/div 0 mV offset 3.000 kSeg
C2 S B D50 500 mV/div -1.300 V ofst 3.000 kSeg
C3 S B D50 50.0 mV/div 0.0 mV offset 3.000 kSeg
Z2 zoom(C2) 440 mV/div 50.0 ns/div [899] 1 Seg
Timebase Ext 0 ns
Seq: 3000 50.0 ns
40.0 kS 80.0 GS/s
Trigger C1 DC
Stop 10 mV
Edge Positive
Zoom
Z1
Z2
Z3
Z4
Z5
Z6
Z7
Z8
Z9
Z10
Z11
Z12
MultiZoom
Close
Trace On
Source
C2
Segments
First
899
Num
1
Horizontal
Scale / div
50.0 ns
Center
0.0 ns
x 1.00
out
in
Var.
Vertical
Scale / div
440 mV
Center
1.252 V
x 1.14
out
in
Var.
Preview
Measure
Store
Next
Label
Reset Zoom
Script running; please wait.
5/31/2017 9:05:43 AM

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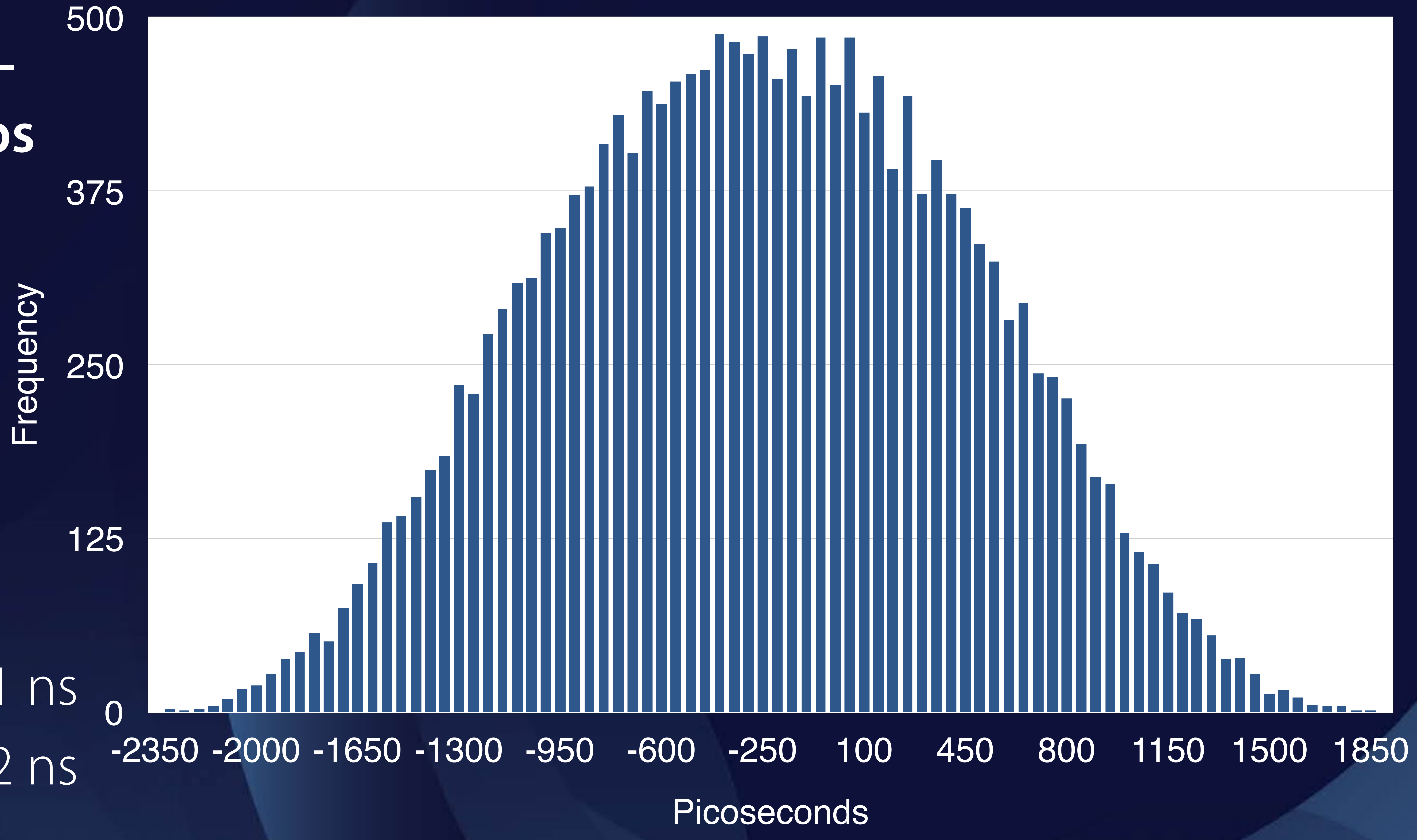
STAC-TS.NTE2

Results from one of the STAC-audited runs re-analyzed in ps

- 19,152 samples over 3,000 Segments
  - Min: -2.334 ns
  - Mean: -0.257 ns
  - Max: 1.829 ns
  - Range: 4.163 ns
- 78.5% of samples lie within ±1 ns
- 99.7% of samples lie within ±2 ns



Picoseconds not audited or reported in STAC-TS.NTE2

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STAC-TS.NTE2

Accuracy confidence?

- At least 1,000 samples of each measurement were taken with picosecond resolution
- Combining the errors (max - min) into the calculation gave us an overall measurement uncertainty of 50ps

Conclusions

What has been achieved?

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Conclusions

- The first official STAC-TS tests in conjunction with STAC;
- MetaWatch was calibrated for skew;
- Can be compared with other devices using STAC-TS.PSE.2
- MetaWatch was proven to be very accurate, to a regulatory standard.

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Reducing latency
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