

## Next-Gen Mobile Backhaul

# Prove Ethernet Sync and OAM



CESoP • SAToP • 1588 • SyncE • Y.1731 • 802.1ag • G.8031/2 • 802.3ah

### Ethernet OAM Performance Summary

- Prove Connectivity Fault Management (CFM) and Performance Monitoring (PM) for Y.1731, 802.1ag and 802.3ah
- Add latency, jitter, errors, dropped packets to prove OAM implementation
- Prove G.8031/2 protection
- Support for 1000s of MEGs

### SyncE Performance Summary

- Prove SyncE Jitter and Wander to G.8262
- MTIE/TDEV Pass/Fail evaluation
- 1 nanosecond accuracy
- ESMC (SSM) message testing and proving to G.8264
- Full hybrid SyncE/PTP test suite

### 1588 and CES Performance Summary

- One-box testing for Master Clock, Slave Clock, Boundary Clock and Transparent Clock devices
- Emulate two PTP masters for BMCA and G.8265 conformance test
- Capture and replay PDV stress profiles
- Run G.8261 and MEF-18 test cases


# All the measurements you need in one box

## For complete analysis of mobile backhaul devices and networks

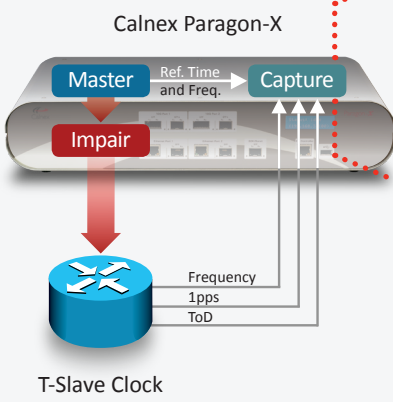
As Ethernet sweeps in to address the huge capacity expansion requirements for mobile backhaul, it brings with it completely new methods of synchronisation. Today, network performance depends on proving overall synchronisation quality, and probing its underlying packet-layer and physical-layer mechanisms.

Giving you direct insight to actual device and service behavior, the Calnex Paragon products are the definitive one-box testers for SyncE, PTP and NTP synchronisation mechanisms, as well as E1/T1/ToD sync interfaces and Ethernet OAM. Moreover, the Paragon-X brings together all the measurements you need for the design and verification of Ethernet backhaul synchronisation devices and networks. With the Paragon-X, proving synchronisation performance and quality is now truly effortless.

### Applications

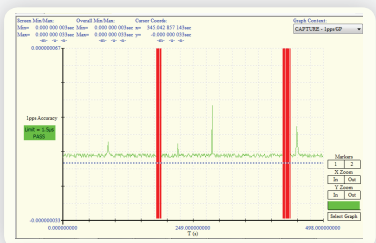


**1588**  
Hybrid  
PTP/SyncE

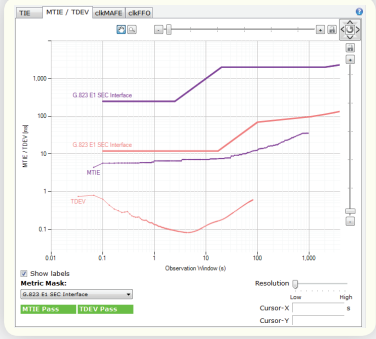


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T-Slave Clock




◀ Assess T-Slave Clock timing accuracy with 1 pps and Time of Day (ToD) measurements

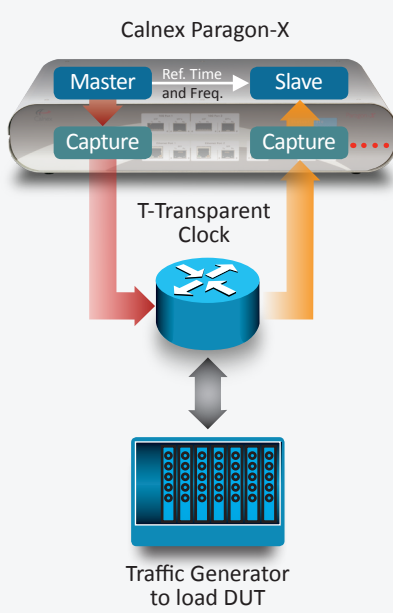
  


◀ Check T-Slave Clock output wander to the latest standards

Test hybrid devices simultaneously with 1588 G.8261 PDV profiles and SyncE wander



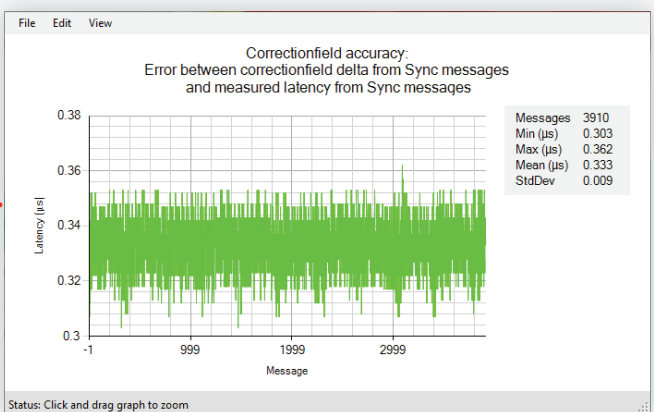
**1588**



Calnex Paragon-X

T-Transparent Clock

Traffic Generator to load DUT

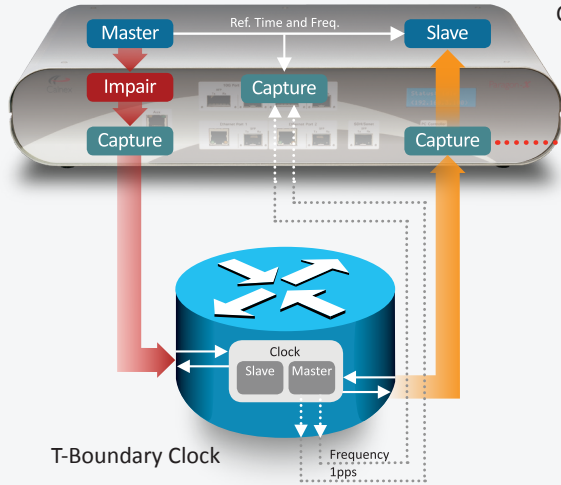


▲ Measure the accuracy of a T-Transparent Clock's correction field packet-by-packet.

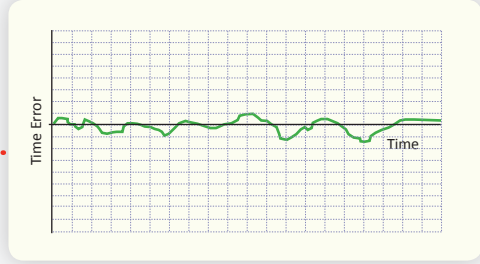


1588

Test hybrid devices simultaneously with 1588 PDV/SyncE wander and measure output packet timing, recovered clocks and SyncE wander



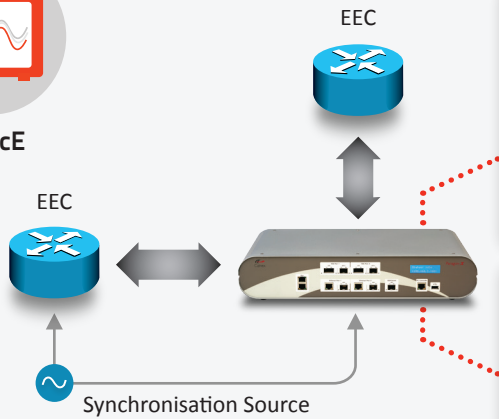
Calnex Paragon-X



Analyze the time accuracy of T-Boundary Clocks between ingress and egress

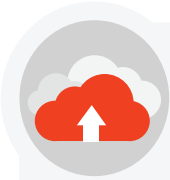


SyncE



Prove SyncE wander transfer, jitter/wander tolerance and jitter/wander generation to ITU-T G.8262

Test ESMC (SSM) to ITU-T G.8264

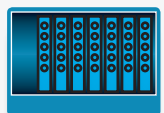


Ethernet OAM

Port	Packet #	Arrival Time	Eth Dst	Eth Src	OAM Type	MEP ID	RDI	Period tps	TransID/Seq/Num	TxFCl	TxFCb
0	0	0.000000000	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	24	38482382	18382902
1	1	1.000022315	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	25	38482382	18382902
2	2	2.000044640	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	26	38482382	18382902
3	3	2.040043850	10:11:12:13:14:15	01:11:21:31:41:51	LBM	-	-	-	1181	-	-
4	4	2.080043060	01:11:21:31:41:51	10:11:12:13:14:15	LBR	-	-	-	1181	-	-
5	5	3.000066960	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	27	38482382	18382902
6	6	4.000089280	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	28	38482382	18382902
7	7	5.000111600	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	29	38482382	18382902
8	8	6.000133915	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	30	38482382	18382902
9	9	7.000156235	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	31	38482382	18382902
10	10	8.000178545	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	32	38482382	18382902
11	11	8.040177755	10:11:12:13:14:15	01:11:21:31:41:51	LBM	-	-	-	1182	-	-
12	12	8.08009380	01:11:21:31:41:51	10:11:12:13:14:15	LBR	-	-	-	1182	-	-
13	13	9.080178965	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	33	38482382	18382902
14	14	10.00023185	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	34	38482382	18382902
15	15	11.000245505	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	1	1s	35	38482382	18382902
16	16	12.000267815	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	36	38482382	18382902
17	17	13.000290135	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	37	38482382	18382902
18	18	14.000312450	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	38	38482382	18382902
19	19	14.040311660	10:11:12:13:14:15	01:11:21:31:41:51	LBM	-	-	-	1183	-	-
20	20	14.080310870	01:11:21:31:41:51	10:11:12:13:14:15	LBR	-	-	-	1183	-	-
21	21	15.000334770	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	39	38482382	18382902
22	22	16.000357080	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	40	38482382	18382902
23	23	17.000379400	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	41	38482382	18382902
24	24	18.000401715	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	42	38482382	18382902
25	25	19.000424035	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	43	38482382	18382902
26	26	20.000446355	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	44	38482382	18382902
27	27	20.040445565	10:11:12:13:14:15	01:11:21:31:41:51	LBM	-	-	-	1184	-	-
28	28	20.080444775	01:11:21:31:41:51	10:11:12:13:14:15	LBR	-	-	-	1184	-	-
29	29	21.000468675	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	45	38482382	18382902
30	30	22.000490990	10:11:12:13:14:15	01:11:21:31:41:51	CCM	323	0	1s	46	38482382	18382902

Capture and analyze OAM messages and flows. Introduce controlled impairments to stress-test OAM.

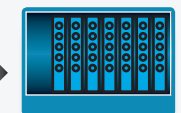
Prove and troubleshoot OAM more rapidly and more thoroughly than using a traffic generator alone.



Traffic Generator



Calnex Paragon-X



Traffic Generator

**1588 (option 201) and CES (option 202)**

<b>Packet Sync Rates</b>	<b>1588</b> Any packet rate.	<b>CES</b> T1, E1, T3, E3 or Any.
<b>Protocols</b>	PTP (1588).	SAToP, CESoPSN, TDMoIP.
<b>Header Capture and Alarms</b>	MessageType, TransportSpecific, VersionPTP, MessageLength, DomainNo, Flags, CorrectionField, SourcePortIdentity, SequenceID (errors highlighted), ControlField, LogMessageInterval, OriginTimestamp.	L, R, M, FRG, Length and Sequence # (errors highlighted). L, R, M Alarm Injection.
<b>Graphs Displayed</b>	Inter-Packet (SYNC, DEL_REQ, DEL_RESP, pDELAY_REQ, pDELAY_RESP, FOLLOW-UP, ALL), Sync PDV ( <b>Master-to-Slave PDV</b> ), Delay_Req PDV ( <b>Slave-to-Master PDV</b> ), Slave Clock Wander (T3), Follow-up PDV, Delay_Resp PDV, PDelay_Req PDV, PDelay_Resp PDV, Asymmetry Variation, RTD Variation. (Include or Exclude Correction Factor in PDV Calculation.) Delay Distribution Curve/Histogram.	TIE vs Nominal, TIE vs Measured Average, Delay vs Packet #, Inter-packet Time (vs Time and vs Packet #), Delay Distribution Curve/Histogram.
<b>Standards</b>	G.8261 (Test Cases 1 – 17), G.8273.2 and MEF-18	
<b>PDV Editor Suite</b>	Edit any PDV file from the graphs. Profile Edits: Extract, Repeat, Copy, Paste (Replace or Insert); Modulate, Scale (%), Banding (Deplete or Concentrate); Adjust Delay Floor.	
<b>Measurement Accuracy</b>	5 ns.	
<b>Metrics</b>	ITU-T metrics will be implemented as ratified incl. MTIE, MAFE, ZTIE, PktMTIE, etc.	
<b>Master/Slave Emulation (Option 250)</b>	Emulate up to two 1588 masters with full parametric control and PDV/protocol anomaly addition. Each master can have up to 8 attached slaves. Emulate one 1588 slave. Calculate and display: slave wander, 1 pps/ToD accuracy, TC correction field accuracy, BC time error.	

**SyncE (options 213, 207, 208, 223)**

<b>Jitter/Wander Measurement</b>	To ITU-T G.8262 and O.174 - jitter/wander generation, wander transfer, jitter/wander tolerance, phase transient. Built-in frequency offset plus sinusoidal, MTIE and TDEV wander generation.	
<b>MTIE/TDEV Analysis</b>	Built-in software with ITU-T masks and Pass/Fail indication.	
<b>SyncE Master</b>	Accuracy traceable to Reference source used (refer to Reference Clocks).	
<b>Measurement Accuracy</b>	1 ns.	
<b>ESMC (SSM) Features to G.8264, G.781, etc</b>	Decode ESMC messages to ITU-T G.8264 and plot Quality Level (QL) changes graphically (bi-directional). QLs: PRS, PRC, INV3, SSU-A/TNC, INV5, INV6, ST2, SSU-B, INV9, EEC2/ST3, EEC1/SEC, SMC, ST3E, PROV, STU/UKN, DNU/DUS. Overwrite ESMC Message to change QL status. Support for ESMC Decode and SyncE in 1588 mode (for concurrent SyncE and 1588 implementations). Integrated decode using industry-standard tool, Wireshark.	
<b>ESMC Generation</b>	Generate ESMC (SSM) packets per ITU-T G.8264 QLs: PRS, PRC, INV3, SSU-A/TNC, INV5, INV6, ST2, SSU-B, INV9, EEC2/ST3, EEC1/SEC, SMC, ST3E, PROV, STU/UKN, DNU/DUS. Generate ESMC messages, change QL value and measure impact on wander.	

**Ethernet OAM (option 301)**

<b>Capture and Decode</b>	Packet Number, Arrival Time, Ethernet Destination Address, Ethernet Source Address, OAM Message Type, MEP ID, RDI, Period fps, TransID, TxFCf, RxFCf, TxFCb, Tx Timestamp(f), Rx Timestamp(f), Tx Timestamp(b), Rx Timestamp(b), Maintenance Domain Length, Maintenance Domain Name, Short MA Name Format, Short MA Name Length, Short MA Name, Time To Live, Origin MAC, Target MAC, Relay Action, OUI, TLV Offset, TLVs.
<b>Round-trip Delay</b>	Based on DMM/DMR messages. Displayed in table and graph. MEF and ITU-T delay methods supported.
<b>View Filtering</b>	MAC addresses and OAM Message types.
<b>Standards Supported</b>	ITU-T Y.1731, IEEE 802.1ag, IEEE 802.3ah, ITU-T G.8031, ITU-T G.8032.
<b>Message Filters for Corruption and Delay</b>	CCM, LBM, LBR, LTM, LTR, AIS, LCK, TST, APS, MCC, LMM, LMR, 1DM, DMM, DMR, EXM, EXR, VSM, VSR. Any combination of above messages. CCM at 1 s and 3.33 ms both supported.
<b>Impairments and Delay</b>	Lost, Misordered, Repeated, Errored, AIS/LCK/RDI Generation, Fixed Delay, Variable Delay.
<b>Header Overwrite</b>	Ethernet Header or OAM Header – overwrite any bit (first 128 bytes) with hex or binary value or invert.
<b>Multi-MEG Mode</b>	Capture information for 1000s of MEGs including Eth Dest, Eth Src, SVID, CVID, MEL, MEP ID, OAM Message Count, AIS, RDI, CCM, CCM fps, etc.

## Product Specifications

<b>Physical Interfaces</b>	<b>Ethernet</b> 100 M Electrical, 100 M Optical (SGMII). * 1 G Electrical (optional), 1 G Optical (optional) – SFP. 10 G Optical (optional) – XFP or SFP+ (LAN-PHY).	(*) PTP, NTP, CES, Services
<b>Reference Clocks</b>	Lock internal timing reference to external reference. Reference Lock soft LED indication. External reference inputs: 64 kHz, 2.048 MHz, 10 MHz; T1 BITS clock; E1 MTS, SyncE, GPS. Internal reference Stratum-3, ±4.6 ppm.	
<b>PC Control Interface</b>	Any standard PC or laptop running Windows XP, Vista or 7. RJ45 LAN connection to instrument.	
<b>TCP/IP Settings</b>	TCP Port, IP Address and Gateway settable.	
<b>Automatic flow-selection in multi-flow environment</b>	Automatic detection of OAM (MEGs), 1588, CES and other flows and filter setup using FlowWizard.  Filter: (1 to 64 bytes): Setup messages for capture and replay Select OAM type within a MEG flow Select 1588 Message type(s) or groups  Integrated decode using industry-standard tool, Wireshark.	
<b>Packet Capture Memory</b>	Capture complete packet and display contents. The filters can specify the packet types to be captured. Internal (2 Gb) or External (via USB).	
<b>Graph Manipulation</b>	Zoom in (X and Y), Zoom out (X and Y), Marker 1, Marker 2, Min/Max display in nanoseconds.	
<b>Impairments – Delay</b>		
<b>Fixed Delay</b>	6 μs to 10 s.	
<b>Variable Delays</b>	(a) Gaussian, Gamma (b) User Defined – stored PDV profiles or captures from networks (c) G.8261 and MEF-18 Test Cases (d) Sawtooth – Systematic, Beating (F) and Beating (S) (e) Step Function (f) Latency Ramp	
<b>1588 Delays applied to:</b>	Packet Sending Time, Correction Field or Both.	
<b>Impairments - Corruption</b>	Misordered, Lost, Repeated or Errored Packets.	
<b>Control</b>	Single, Burst (1 to 10000), Duration (0.1s to 10s), Rate (0.00001% to 99.99999%), Ratio ( $1 \times 10^{-7}$ to $9 \times 10^{-1}$ ) or Constant.	
<b>Overwrite Header</b>	Any bytes with any value in first 128 bytes.	
<b>Switch Simulation</b>	Independently set (a) Latency (b) Buffer Depth (1 byte to 256 kbytes) (c) Bandwidth (0% to 100%)	
<b>Timing Measurements</b> (Options 205, 206)	E1/T1 wander – TIE, MTIE, TDEV analysis with ITU-T masks - sample rate 0.1 Hz to 100 Hz. 1 pps accuracy – recovered slave clock 1 pps vs reference.	
<b>Simultaneous Measurements</b>	1588/CES PDV and IPG, E1/T1/2.048 MHz TIE/MTIE/TDEV, 1 pps wander/accuracy.	
<b>Remote control</b>	Scripting via TCL.	
<b>Operation and Regulatory</b>	Temperature 5 - 50°C, Humidity 0 - 95%, CE and EMC (incl. EN-61010, EN-61326, etc.) certified. Voltage 85 - 246 VAC, 100 - 240 VAC (Nominal) @ 50/60 Hz.	
<b>GPS Antenna, Receiver and Rubidium Reference</b> (Option 132)	PRS/Stratum 1 (GPS-locked): typical $1 \times 10^{-12}$ Outputs: 10 MHz, 1 pps.	

Specification is subject to change without notice.

## Related Products



### Calnex Paragon-t

- Speed up test time and reduce test complexity with multi-clock measurements
- Measure multiple outputs from a chain of Boundary Clocks and Slave Clocks
- 4 x Frequency (SyncE/E1/T1/2.048 M/10 M Wander) measurements
- 4 x Phase (1 pps accuracy) measurements
- 4 x ToD display measurements



### Calnex Paragon-m

- All capture and measurement features of Paragon-X
- PTP and NTP PDV and Standards and Vendor Metrics (Pass/Fail evaluation)
- SyncE Wander measurement to ITU-T limits
- Clock measurements – 1 pps, ToD, E1/T1, including MTIE/TDEV to ITU-T limits
- Thru-mode network capture and analysis

### Calnex Sentinel

- PTP, NTP, SyncE and TDM in one portable box
- Measure ALL parameters at the SAME time
- Test networks for Frequency and Phase
- Test networks with Boundary Clocks and Transparent Clock
- Standard industry masks and packet metrics, with built-in Pass/Fail limits when measuring the network
- Measurement reports in pdf format
- Embedded GPS receiver and Rubidium (Rb)



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Calnex Solutions is a global leader in Test and Measurement solutions for next-generation telecom networks. Our products help to prove new technologies for Mobile Backhaul and Carrier Ethernet networks.

For more information on the Calnex Paragon platform, and to take advantage of Calnex's extensive experience in Packet Sync and OAM testing technologies, contact Calnex Solutions today:

tel: +44 (0) 1506 671 416  
email: [info@calnexsol.com](mailto:info@calnexsol.com)

[calnexsol.com](http://calnexsol.com)

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Insight and Innovation