Calnex Paragon-X

Prove Ethernet Sync to 10GbE

1588 (PTP) • SyncE • NTP • CES • E-OAM

All the Measurements You Need in One Box

The timing performance of today's Ethernet networks depends on proving overall synchronization quality, and probing the underlying packet-layer and physical-layer timing mechanisms.

For technologies up to 10 Gb/s, the Calnex Paragon-X offers direct insight to actual device and service behaviour, and the ability to generate a broad range of real-world disruption scenarios to validate the operation of your network devices and systems to industry standards.

The Paragon-X is the definitive one-box solution to rigorously test SyncE, PTP and NTP synchronization mechanisms, as well as E1/T1 sync interfaces and Ethernet OAM. It brings together all the measurements you need – from jitter and wander through to measuring the accuracy of the recovered Time of Day (ToD), Phase (1pps) and Frequency (MTIE/TDEV) – to ensure your products will work reliably in the complex world of Ethernet switches, routers and gateways.

The Paragon-X also offers Network Emulation so you can fully stress-test the transport of real-time services like video and VoIP over next-gen IP platforms and networks. While powerful, fully-integrated traffic filtering targets the effect of impairments on particular packets or particular types of traffic.

For design through to evaluation, it's for good reason that the Paragon-X is the tester of choice for proving Ethernet sync up to 10 Gb/s.



Calnex Paragon-X

Control

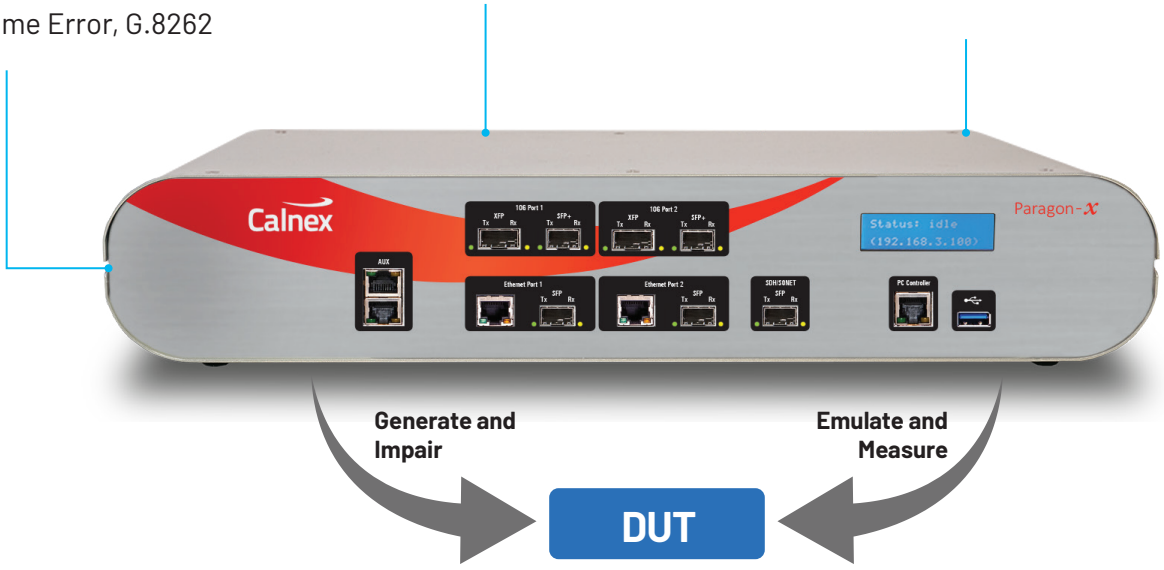
- Generate industry standard and custom physical and packet timing signals.
- Drop-down Master Slave emulation setting for fast and easy profile conformance test
- Generate ESMC messages
- Automatic test configurations for Boundary Clocks (BCs), Transparent Clocks (TCs), Bridge Time Error, G.8262

Precision

- Fully integrated test bed aligns test stimulus and measurement for increased accuracy and repeatability.
- No additional equipment necessary
- Fully scriptable
- Simultaneous measurement and visualisation of all signals

Flexibility

- Time Error and PDV Profiles, with custom editing
- Hybrid testing – combine input/output types: PTP, SyncE, 1pps, Time of Day
- User-defined wander/jitter
- Total control of generated PTP fields
- Signalling impairments
- Message suppression



1588 and CES

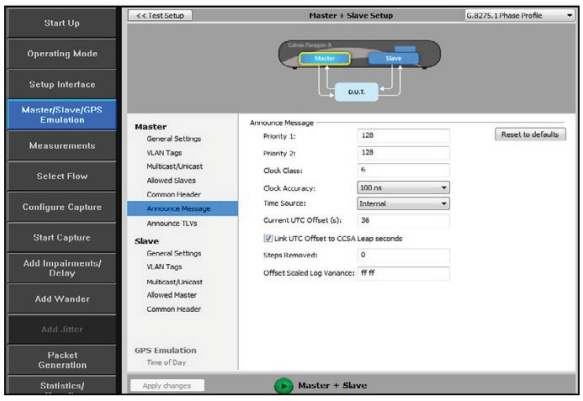
- One-box PTP testing for Master Clock, Slave Clock, Boundary Clock and Transparent Clock devices
- Emulate two PTP masters for BMCA and G.8265 conformance test
- Capture and replay PDV stress profiles
- Run ITU-T and MEF-18 test cases G.8262

SyncE

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

Ethernet OAM

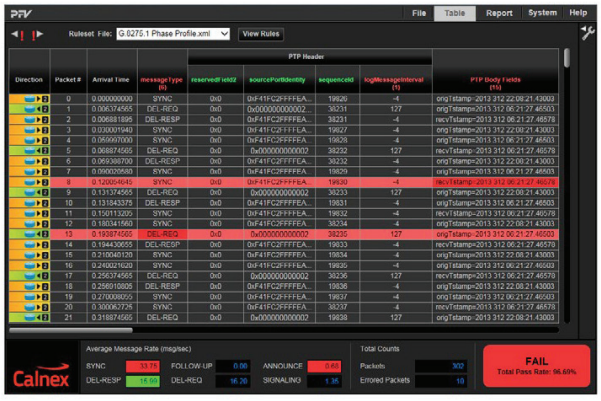
- Prove Connectivity Fault Management and Performance Monitoring for Y.1731, 802.1ag and 802.3ah
- Add latency, jitter, errors, dropped packets to prove OAM implementation
- Prove G.8031/2 protection
- Support for 1000s of MEGs



Master and Slave Emulation

PTP Master and Slave emulation (with optional SyncE support) allows fully controllable protocol and timing test – no additional network equipment required and no Command Line Interface.

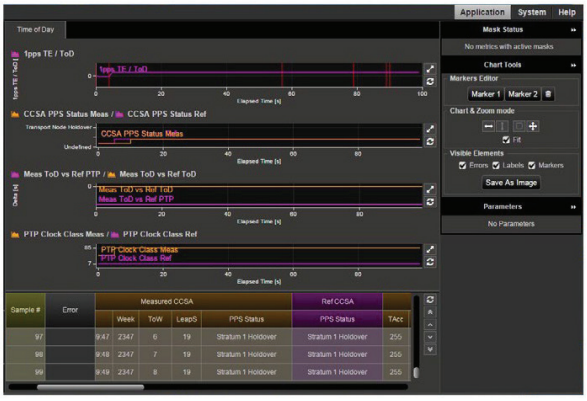
- Generate PTP to defined/custom profiles with easy drop-down menus and total control of fields
- Manipulate PTP messages in controlled ways – ideal for Negative testing and troubleshooting
- Generate high-accuracy timing: no external equipment, no uncertainty
- Impair timing signals including Time Error/Packet Delay Variation and SyncE Jitter/Wander



PTP Field Verifier

Analyze PTP protocol for conformance to standards or user-defined profiles with the PTP Field Verifier (PFV).

- Automatic Pass/Fail indication – check captured PTP messages against a predefined set of rules, with clear Pass/Fail alerts
- Check transmitted PTP messages for compliance with ITU-T, IEEE and userdefined standards and rules – areas of non-conformance immediately visible
- Flexible XML rules allow full customization of pass criteria
- Full report generation capability



Advanced Time of Day (ToD)

Generate industry-standard ToD event and information messages with full control of message format and alarms.

Full decode of significant fields in ToD messages lets you rapidly identify and pin down timing errors

- Generate ToD signals simultaneously to PTP and SyncE
- Check device response to controlled manipulation of all timing inputs
- Combine with CAT visualization to easily see the effects of status transitions
- Align ToD results with other simultaneous measurements for complete performance analysis

The Calnex Analysis Tool (CAT) provides powerful insight into network and device performance. All your measurement results are now in one place, and you can view multiple graphs simultaneously for easier correlation of your results.

- Enhanced graphics makes it easy to evaluate ITU-T metrics such as Time Error (cTE, dTE), MTIE and TDEV against ITU-T masks
- Import live and archived measurement data
- Customisable multi-graph window lets you rapidly select measurements and channels for detailed analysis
- One button generation of reports in PDF format: Pass/Fail statistics and details of failures



Meeting Industry Standards

Verify your products and devices meet relevant standards including:

- ITU-T G.8262x/7x
- IEEE 802.1AS/AS-REV
- IEC/IEEE 61850-9-3
- IEEE C 37 238
- SMPTE 2059-2

Elevate your testing with greater accuracy, deeper measurement insight, and with repeatability you can rely on. The Paragon-X gives you all the tools you need to ensure your network devices and network topologies are not only thoroughly tested but truly meet industry standards.

Ethernet Network Emulation

Calnex Paragon-X lets you emulate 'the Cloud' for real-world testing of your Ethernet devices or topology. It offers both comprehensive and ultra-high precision network emulation, enabling you to test:

- Video/voice applications (IPTV, VoIP, etc.)
- Mobile subscriber networks (VoLTE, eMBMS, etc.)
- Content delivery networks
- Cloud computing/migration
- CoS/QoS levels
- WAN acceleration/network optimization
- LAN/WAN enterprise networks
- ADSL/FTTH
- SLA verification
- ITU-T Y.1731/IEEE 802.1ag operations and maintenance
- Satellite links
- Storage networks
- Telecom/Federal network applications
- Carrier WiFi
- Cable/broadband network

Don't Emulate Just Any Network, Re-Create Your Actual Network

With Real Capture + Replay you're neither limited to capturing pings, nor restricted with capacity. Now you can capture IPG and PDV traffic from live networks for long periods of time and replay these back in the lab to test your devices for absolute proof of performance.

Impair Eight CoS/QoS Levels Up To 10GbE

Class of Service (CoS)/Quality of Service (QoS) levels have to be independently impaired during testing. Paragon-X allows eight CoS/QoS levels to be uniquely impaired at the same time, even at 10GbE

Related Products



Pre-deployment

Calnex Paragon-neo

PTP Master and Slave emulation (with optional SyncE support) allows fully controllable protocol and timing test – no additional network equipment required and no Command Line Interface.

- Delivers high accuracy sub-nanosecond timing measurements at rates up to 100GbE
- Capture and decode PTP packets for analysis and Time Error testing
- Prove SyncE jitter and wander performance to ITU-T G.8262.1/G.8262
- Evaluate MTIE/TDEV pass/fail results to ITU-T G.8262.1/G.8262 masks Control ESMC (SSM) message generation for testing to ITU-T G.8264



Deep Analysis

Calnex Analysis Tool (CAT)

- Analyzes the Time Error and Frequency performance of devices and networks
- Evaluates metrics such as MTIE and TDEV against O-RAN and ITU-T masks
- Displays multiple graphs simultaneously for easy correlation of results



Network Deployment

Calnex Sentinel

- Tests PTP, NTP, SyncE and TDM in one portable box
- Measure ALL parameters at the SAME time
- Over-the-Air Time Error analysis
- For LTE-A, TDD LTE and small cell deployment – test network phase accuracy and validate network performance to ITU-T limits
- Measure and analyze metrics: PDV, FPP, TE/max|TE|/dTE, MTIE/TDEV
- Best-in-class internal Rubidium and measurement accuracy

Technical Specifications

1588 (PTP) (options 25x and 201, option PFV)	
Master/Slave Emulation (Option 25x)	Emulate up to two 1588 masters with full parametric control and Time Error/PDV/protocol anomaly impairment functions. (Option 25x) Each master can have up to 8 attached slaves.
	Emulate 1588 slave; calculate and display: PTP Time Error, 1 pps Time Error/ToD accuracy, TC CorrectionField accuracy, BC Time Error.
Additional features for End-to-End (Option 250/253)	Automatic configuration for e.g., ITU-T Phase Profile, 2-Way Time Error metrics, plus flexible user configuration
Additional features for Peer-to-Peer (Option 252/253)	Automatic configuration for e.g., IEEE 802.1AS gPTP, Turnaround Time and Rate Ratio metrics
Header Capture and Alarms	MessageType, TransportSpecific, VersionPTP, MessageLength, DomainNo, Flags, CorrectionField, SourcePortIdentity, SequenceID (errors highlighted), ControlField, LogMessageInterval, OriginTimestamp
Graphs Displayed (Calnex Analysis Tool, CAT)	PTP Time Error (dTE, cTE, Max|TE|), Transparent Clock accuracy, latency
	Packet Delay Distribution
	PacketMTIE/TDEV, MAFE, MATIE
	Sync PDV **(Master-to-Slave PDV)**, Delay_Req PDV **(Slave-to-Master PDV)**, Slave Clock Wander (T3), Follow-up PDV, Delay_Resp PDV
	PDelay_Req PDV, PDelay_Resp PDV, Delay Distribution Curve/Histogram
Standards Supported	ITU-T G.826x/7x, MEF-18, IEEE/IEC 61850-9-3, IEEE C 37 238, IEEE 802.1AS
PTP Field Verifier (PFV)	Decode and display PTP Fields
	Display Pass/Fail to standards-based or user-defined rules
	Report Generation capability
PDV Editor Suite	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
Measurement Accuracy	5 ns
SyncE (options 213, 207, 208, 223)	
Jitter/Wander Measurement	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
MTIE/TDEV Analysis	Built-in Calnex Analysis Tool (CAT) software with ITU-T and masks with Pass/Fail indication
SyncE Master	Accuracy traceable to Reference source used (refer to Reference Clocks)
Measurement Accuracy	1 ns

Technical Specifications continued

SyncE (options 213, 207, 208, 223) continued	
ESMC (SSM) Features to G.8264, G.781, etc.	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 display in Calnex Analysis Tool (CAT)
ESMC Generation	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)	
Capture and Decode	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.
Round-trip Delay	Based on DMM/DMR messages. Displayed in table and graph. MEF and ITU-T delay methods supported.
View Filtering	MAC addresses and OAM Message types
Standards Supported	ITU-T Y.1731, IEEE 802.1ag, IEEE 802.3ah, ITU-T G.8031, ITU-T G.8032
Message Filters for Corruption and Delay	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
Impairments and Delay	Lost, Misordered, Repeated, Errored, AIS/LCK/RDI Generation, Fixed Delay, Variable Delay
Header Overwrite	Ethernet Header or OAM Header – overwrite any bit (first 128 bytes) with hex or binary value or invert
Multi-MEG Mode	Capture information for 1000s of MEGs including Eth Dest, Eth Src, SVID, CVID, MEL, MEP ID, OAM Message Count, AIS, RDI

Technical Specifications continued

NTP (option 404) and CES (option 202)		
	NTP	*CES*
Packet Sync Rates	Any packet rate	T1, E1, T3, E3 or Any
Protocols	NTP (up to v4)	SAToP, CESoPSN, TDMoIP
Header Capture and Alarms	Version, Mode, Stratum, Poll, Precision, Root Delay, Root Dispersion, ReferenceId, Reference Time, Origin, Receive, Transmit	L, R, M, FRG, Length and Sequence # (errors highlighted) L, R, M Alarm Injection
Graphs Displayed	Inter-Packet (Reserved_0, Sim_ Active, Sim_Passive, Client, Server, Broadcast, Control, Reserved_7, all), Client PDV (Client-to-Server PDV), Server PDV (Server-to-Client PDV), RTD Variation. 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
Standards Supported	G.8261 (Test Cases 1 – 17), G.8273.2 and MEF-18	
PDV Editor Suite	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	
Advanced Time of Day (option 230)		
Time of Day (ToD) Emulation	Generate ToD messages to CCSA, NMEA and ITU-T standards	
	Control Fields/Values: • Event Message: TimeSource Type, TimeSource Status, TimeSource Alarms • Information Message: Leap Seconds, PPS Status, TAcc	
Time of Day Measurement	Decode and display ToD fields	
	Highlight errors e.g., CRC, Second jumps	
	Validate ToD alignment to 1 pps	
	Compare ToD and PTP message and status	
Measurement Accuracy	1 ns	
Wander Measurement on Other Frequencies (option 205)		
Software Option 205	For E1/T1/2 MHz Wander measurement including TIE/MTIE/TDEV and ITU-T Masks	
Phase and Time Measurement (option 206)		
Software Option 206	For 1 pps Time Error measurement (1 pps accuracy) in nanoseconds – measure 1 pps Time Error relative to 1 pps reference	
Network Emulation (options 708, 709, 710)		
Selection of flow from multi-flow environment	Automatic detection of flows and filter setup using Flow Wizard	
	Filters: any 1 to 64 bytes within the first 256 bytes of the frame.	
	Integrated Wireshark decode	

Technical Specifications continued

Network Emulation (options 708, 709, 710) continued	
Impairment Profiles	Select at time of purchase – 4, 8 or 16 Profiles (optional) • 4 Profiles allows all impairments to be configured individually for up to 4 Flows (up to 2 bi-directional profiles) • 8 Profiles allows all impairments to be configured individually for up to 8 Flows (up to 4 bi-directional profiles) • 16 Profiles allows all impairments to be configured individually
Packet Corruption	Errored packets, Lost packets, Repeated packets (1 to 10000), Mis-ordered packets (1 to 32)
	Corruption modes: single, burst, rate (%), ratio (xE-y), constant
Latency/Delay and PDV/Jitter	(a) Step waveform profile
	(b) Gamma distribution of delays
	(c) Gaussian distribution of delays
	(d) Apply fixed delay to the filtered packets
Maximum Delay	8 seconds at 1 G (100 M: 80 s, 10 G: 0.8 s)
Bandwidth Control	Control bandwidth throttle and buffer depth per profile
	Preset and user-defined bandwidths
	Basic mode and advanced policing and shaping mode
General	
Physical Interfaces	Ethernet • 100 M Electrical (RJ45), 100 M Optical – SGMII* • 1 G Electrical (RJ45), 1 G Optical – SFP • 10 G Optical (if option 111 fitted) – XFP or SFP+ (LAN-PHY)
Reference Clocks	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
	Internal reference Stratum-3, ±4.6 ppm
PC Control Interface	Any standard PC or laptop running Windows 8 or 10. RJ45 LAN connection to instrument
TCP/IP Settings	TCP Port, IP Address and Gateway settable
Automatic Flow-selection in Multi-flow Environment	Automatic filter setting for 1588 in Master/Slave Emulation mode. 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. Additional PTP analysis capability with PFV
Packet Capture	Capture complete packet and display contents. The filters can specify the packet types to be captured.
Memory	Internal (2 Gb) or External (via USB)
Graph Manipulation	Zoom in (X and Y), Zoom out (X and Y), Marker 1, Marker 2, Min/Max display in nanoseconds

*PTP PDV, NTP, CES, Services

Technical Specifications continued

General continued	
Impairments – Delay	
Fixed Delay	6 µs to 10 s
Variable Delays	Gaussian, Gamma, User Defined – stored PDV profiles or captures from networks, G.8261 and MEF-18 Test Cases, Sawtooth – Systematic, Beating (F) and Beating (S), Step Function, Latency Ramp
1588 Delays applied to:	Packet Sending Time, CorrectionField or Both
Impairments – Corruption	Misordered, Lost, Repeated or Errored Packets
Control	Single, Burst (1 to 10000), Duration (0.1 s to 10 s), Rate (0.00001% to 99.99999%), Ratio (1x10-7 to 9x10-1) or Constant
Overwrite Header	Any bytes with any value in first 128 bytes
Switch Simulation	Independently set: Latency, Buffer Depth (1 byte to 256 kbytes), Bandwidth (0% to 100%)
Timing Measurements (Options 205, 206, 230)	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
	ToD analysis
Simultaneous Measurements	Chosen packet measurements can be performed simultaneously with all timing measurements (SyncE and Clock wander, 1 pps Accuracy, ToD analysis)
Remote Control	Scripting via TCL, Perl and Python
Operation and Regulatory	CE and EMC (incl. EN-61010, EN-61326, etc.) certified
	Voltage 85 - 246 VAC, 100 - 240 VAC (Nominal) @ 50/60 Hz
GPS Antenna, Receiver and Rb Ref. (Option 132)	PRS/Stratum 1 (GPS-locked): typical $1x10^{-12}$
	Outputs: 10 MHz, 1 pps

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