Prove Ethernet Sync to 10GbE

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

**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

**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

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.
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 pre-defined set of rules, with clear Pass/Fail alerts
- Check transmitted PTP messages for compliance with ITU-T, IEEE and user-defined standards and rules – areas of non-conformance immediately visible
- Flexible XML rules allow full customisation of pass criteria
- Full report generation capability

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

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

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-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/broadcast networks

**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.

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**Related Products**

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<th>Calnex Paragon-neo</th>
<th>Calnex Paragon-t</th>
<th>Calnex Sentinel</th>
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<tr>
<td>Delivers high accuracy sub-nanosecond timing measurements at rates up to 100GbE</td>
<td>Speed up test time and reduce test complexity with multi-clock measurements</td>
<td>Tests PTP, NTP, SyncE and TDM in one portable box</td>
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<tr>
<td>Capture and decode PTP packets for analysis and Time Error testing</td>
<td>Measure multiple outputs from a chain of Boundary Clocks and Slave Clocks</td>
<td>Measure ALL parameters at the SAME time</td>
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<tr>
<td>Prove SyncE jitter and wander performance to ITU-T G.8262.1/G.8262</td>
<td>4 x Frequency (SyncE/E1/T1/2.048 M/10 M Wander) measurements</td>
<td>Over-the-Air Time Error analysis</td>
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<td>Evaluate MTIE/TDEV pass/fail results to ITU-T G.8262.1/G.8262 masks</td>
<td>4 x Phase (1 pps accuracy) measurements</td>
<td>For LTE-A, TDD LTE and small cell deployment – test network phase accuracy and validate network performance to ITU-T limits</td>
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<tr>
<td>Control ESMC (SSM) message generation for testing to ITU-T G.8264</td>
<td>4 x ToD display measurements</td>
<td>Measure and analyze metrics: PDV, FPP, TE/max</td>
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<td></td>
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<td>Best-in-class internal Rubidium and measurement accuracy</td>
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For more information on Calnex’s Paragon and Sentinel products, and to take advantage of our extensive experience in Packet Sync, OAM and Ethernet testing technologies, contact Calnex Solutions today:
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CX2008 v3.5
Calnex Paragon-X

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/PTP/protocol anomaly impairment functions. 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, ConnectionField, SourcePortIdentity, SequenceID (errors highlighted), ControlField, LogMessageInterval, OriginTimestamp. |
| Graphs Displayed (Calnex Analysis Tool, CAT) | PTP Time Error (dTE, cTE, Max(TIE)), 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 Y.1731, IEEE 802.1ag, IEEE 802.3ah, ITU-T G.8031, ITU-T G.8032 |

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


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. |

ESMC (SSM) Features to G.8264, G.781, etc


ESMC Generation

| Generate ESMC (SSM) packets per ITU-T G.8264 OQLs: PRS, PRC, INV3, SSU-A/TNC, INV5, INV6, ST2, SSU-B, INV9, EE2/ST3, EE1/SEC, SMC, ST3E, PROV, STU/UKN, DNU/DUS. Generate ESMC messages, change QL 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 tps, TransID, TxFCI, RxFCI, TxFCb, RxFCb, Tx Timestamp(p), Rx Timestamp(p), 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

| 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, CCM, CCM fps, etc. |

NTP (option 404) and CES (option 202)

Packet Sync Rates

| NTP (up to v4). |

Protocols


Graphs Displayed

| Inter-Packet (Reserved, 0, Sim_Active, Sim_Passive, Client, Server, Broadcast, Control, Reserved, 7), Client PDV (Client-to-Server PDV), Server PDV (Server-to-Client PDV), RTD Variation. 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); ModulateScale (%), Banding (Deplete or Concentrate); Adjust Delay Floor. |

Measurement Accuracy

| 5 ns. |
Calnex Paragon-X Specifications

**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)**
For E1/T1/2 MHz Wander measurement including TIE/MTIE/TDEV and ITU-T Masks.

**Phase and Time Measurement (option 206)**
For 1 pps Time Error measurement (1 pps accuracy) in nanoseconds – measure 1 pps Time Error relative to 1 ppps reference.

**Network Emulation**
- 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.
- 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
  - Error packets, Lost packets, Repeated packets (1 to 10000), Mis-ordered packets (1 to 32).
  - Corruption modes: single, burst, rate (%), ratio (x-E-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).
  - *PTP PDV, NTP, CES, Services
- Reference Clocks
  - 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
  - TCP Port, IP Address and Gateway settable.
- TCP/IP Settings
  - Any standard PC or laptop running Windows 8 or 10. RJ45 LAN connection to instrument.
- 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.
- 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
  - 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, 1pps 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.

Specification is subject to change without notice.