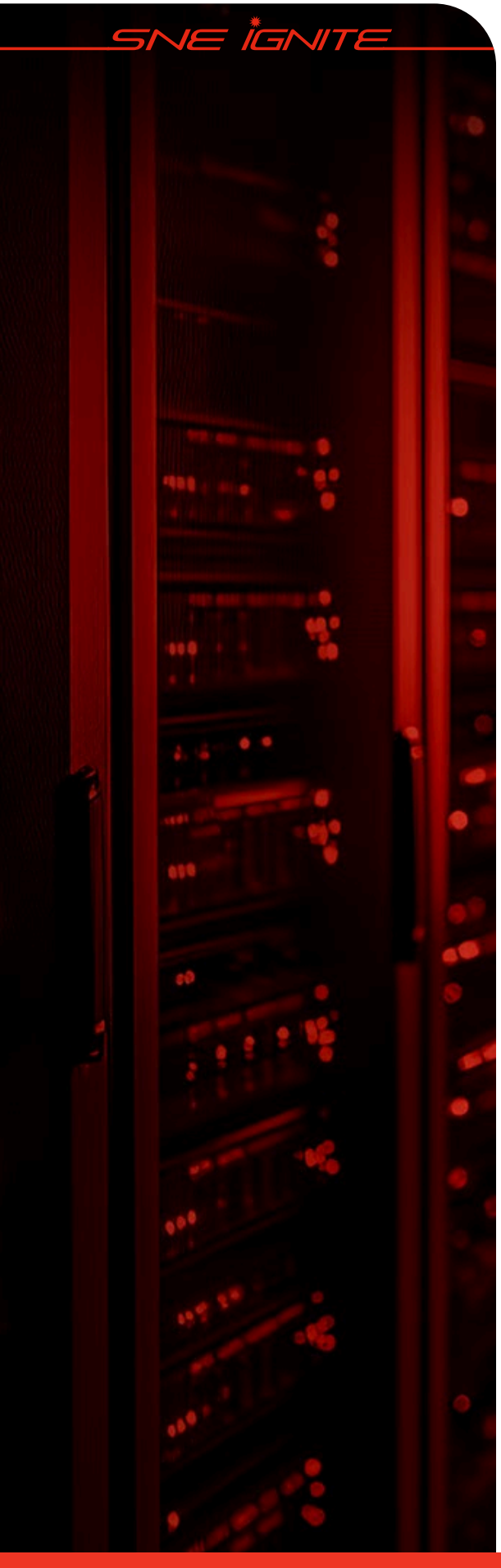
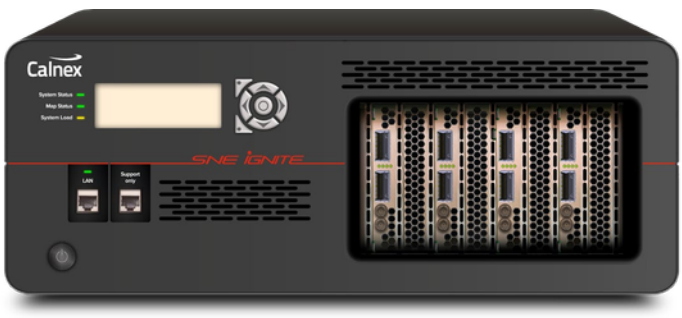


Precision Network Emulation

From400GbEto10GbE, create real networkbehaviorat fullline rate

FPGA-based, designed to validate O-RAN, 5G, AI applications and DCI networks



Calnex SNE Ignite

Key Highlights

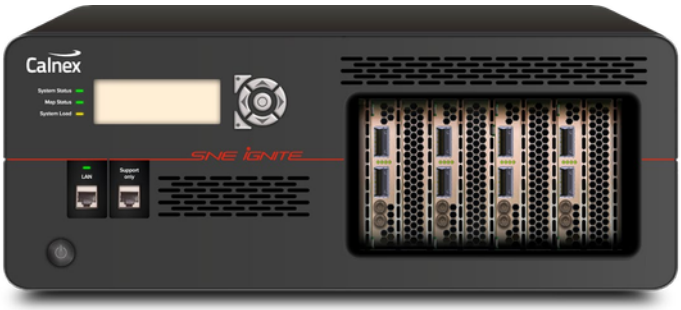
- **Full line-rate network emulation:** prove 400GbE, 100GbE, 50GbE, 25GbE and 10GbE device and infrastructure performance with full line-rate network simulation.
- **Precision emulation:** delivers high accuracy with nanosecond resolution and repeatability, ensuring faithful reproduction of network conditions.
- **Delay at line-rate**: of up to 280ms at 400GbE and up to 42 seconds at reduced bandwidth with Extended Delay Option.
- **SyncE Pass-Thru mode**: maintains SyncE clock link between devices.
- **PTP Transparent Clock (TC)**: integrated one-step TC means that data flows can be separated and impaired independently without affecting synchronization, regardless of packet size.
- **Software upgradeable**: to 400GbE interface speed option — protecting your investment.
- **Configurable**: as two, four, six or eight 100GbE/50GbE/25GbE/10GbE ports, or four 400GbE ports — scale as/when needed.
- **Cost-efficient**: supports multiple concurrent users with isolation through port reservation.
- **Automation**: using Local Timeline Option or RESTful API.

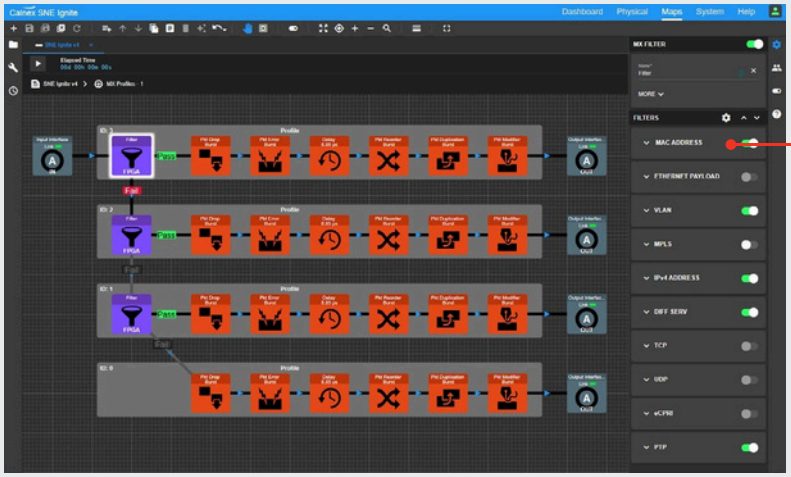
High Precision Network Emulation

Test 5G O-RAN with real-world network conditions in the lab

The SNE Ignite is a multi-port, FPGA-based, precision network emulator designed to meet the stringent requirements associated with applications requiring high accuracy, such as O-RAN fronthaul testing. The network emulator can apply line-rate network impairments on Ethernet links at 400GbE, 100GbE, 50GbE, 25GbE, and 10GbE. The SNE Ignite features:

- **Low intrinsic latency**: many fronthaul links, depending on O-RAN device classification, can be intolerant to delays as low as 8 µs.
- **Low Packet Delay Variation (PDV)**: preserves precise synchronization, enabling accurate validation of timing-sensitive networks
- **Low Maximum Time Interval Error (MTIE)**: guaranteed clock stability and precise synchronization.
- **PTP Transparent Clock (TC)**: integrated one-step TC means that data flows can be separated and impaired independently without affecting synchronization, regardless of packet size.
- **Nanosecond accuracy**: means precise, repeatable testing.
- **SyncE and External Clock input**: maintain Ethernet frequency synchronisation using either recovered SyncE or an external reference..
- **Multi-port**: enabling testing of multiple devices or links simultaneously; supports up to eight 100GbE/50GbE/25GbE/10GbE or four 400GbE ports.





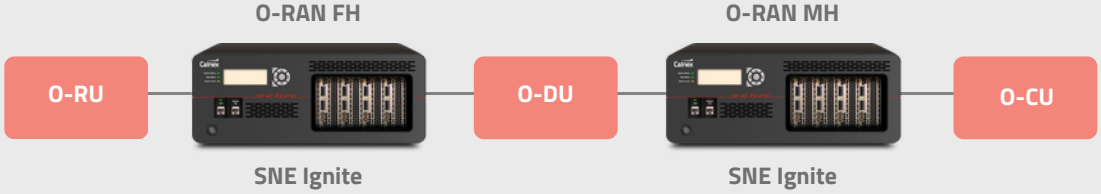
SNE Ignite's graphical map-based WebUI interface feels instantly familiar, intuitive, and simple to navigate.

O-RAN ALLIANCE

Applications

Test Categories	Tests	How SNE Ignite Enables Testing
O-FH Cybersecurity Tests O-RAN WG11 Cybersecurity, robustness tests	O-RAN Alliance Working Group 11 (WG11) focuses on security requirements and security testing in O-RAN networks. The WG11 defines how O-RAN equipment should be robust against malicious actors and unauthorized access. The group specifies security architectures, encryption requirements, authentication methods, and security validation procedures.	SNE Ignite enables manufacturers, operators, and system integrators to perform security resilience testing on O-RAN C/M/S Planes using Packet Modification, Fuzzing, Protocol Corruption by recreating adverse network conditions to stress the protocol implementation. Testing against WG11 builds more secure, resilient, and trustworthy open radio access networks.
O-RAN End-to-End Tests O-RAN TIFG.E2E - FH/MH throughput tests	O-RAN's Test and Integration Focus Group End-to-End (TIFG.E2E) defines complete end-to-end test scenarios across the entire O-RAN network. In simple terms, it checks whether all the different network components work together properly as one system. These tests simulate realistic operator environments involving O-RUs, O-DUs, O-CUs, transport networks, timing systems, and management platforms.	SNE Ignite enables manufacturers, operators, and system integrators to introduce controlled network problems so engineers can verify system stability, recovery behavior, and service quality under stress. Validating against TIFG.E2E scenarios help operators reduce deployment risk and ensure predictable performance in large-scale live networks.
O-RAN MH Behavioral Tests O-RAN WG5 - MH F1 error handling tests	Working Group 5 (WG5) defines how O-RAN equipment should be tested to prove that it meets performance and interoperability requirements. The WG5 creates the official "exam questions" that vendors must pass before deployment by specifying the test methods for areas such as latency, synchronization, throughput, resilience, and fault handling.	SNE Ignite enables manufacturers, operators, and system integrators to recreate difficult real-world network conditions such as jitter, congestion, delay variation, and packet loss during these tests. By testing against WG5 specifications, operators gain confidence that multi-vendor O-RAN equipment will behave reliably in live networks.
O-RAN Interoperability Tests O-RAN WG4 - FH delay management tests	Working Group 4 (WG4) defines how the Radio Unit (O-RU) and Distributed Unit (O-DU) in an O-RAN network should communicate with each other. The Working Group creates the "rules of the road" so equipment from different vendors can be verified to work together reliably by specifying requirements for timing, synchronization, latency, packet handling, and interoperability across the fronthaul network.	By using SNE Ignite to validate against WG4 scenarios, operators and equipment vendors can reduce deployment risk, improve interoperability, and ensure stable cellular network performance to maximize ROI.

O-RAN components under test



SNE Ignite enables manufacturers to test whether their equipment still performs correctly when real-world network problems such as delay, jitter, packet loss, or erroring occurs.

Technical Specifications

Ports	
Optical Interfaces	400GbE: QSFP-DD (DR4/FR4/LR4/SR4/SR8/LR8/ER8) – 4 ports, 1 bidirectional path (optional) 100GbE: QSFP28 (LR4/SR4) – 2, 4, 6 or 8 ports (optional) 50GbE: SFP56 (LR4/SR4) – 2, 4, 6 or 8 ports (optional) 25GbE: SFP28 (SR/LR) – 2, 4, 6 or 8 ports (optional) 10GbE: SFP+ (SR/LR) – 2, 4, 6 or 8 ports (optional) Optical Adapters are provided to convert QSFP28 to SFP28 for 25GbE, and QSFP28 to SFP+ for 10GbE.
Forward Error Correction (FEC)	400GbE PAM4: RS (544,514) KP4 100GbE NRZ: RS (528,514) KR4 50GbE PAM4: RS (544,514) KP4 25GbE NRZ: RS (528,514) KR4 FEC can be disabled at 100GbE and 25GbE
Clock Reference	Internal or External (10 MHz)
SyncE Pass Thru	Clock can be recovered on one port and passed transparently to another.
Passthrough Pause Frames	As per IEEE 802.3x.
Passthrough PFC Frames	As per 802.1Qbb.

Flows	
Impairment Profiles	25GbE/10GbE: 16 profiles allowing 8 flows of impaired packets in each direction. Each profile can be configured independently.
Filtering	Powerful user-configurable filters including ranges and wildcards: ▪ MAC Source and Destination Address, Length/Type ▪ VLAN (Priority, VLAN ID & Type), Custom VLAN ▪ Custom VLAN Length, Offset, Mask, Value ▪ MPLS Label, CustomMPLS ▪ Custom MPLS Length, Offset, Mask, Value ▪ IPv4 Source and Destination Address ▪ IPv4 Version No, DiffServ/ToS, Protocol ▪ IPv6 Source and Destination Address ▪ UDP/TCP Source port, Destination port ▪ Custom L3 Length, Offset, Mask, Value ▪ Custom L4 Length, Offset, Mask, Value ▪ Custom L5 Length, Offset, Mask, Value
GTP Filter	▪ Targeted GTP control message impairments (e.g. create session request, modify bearer request, etc.) ▪ GTP Version (v1, v2), Type, Tunnel EndPoint ID

continued overleaf

Technical Specifications cont'd.

Flows *(cont'd)*	
eCPRI Filter	Targeted eCPRI impairments ▪ eCPRI Revision, Concatenation Indicator, Message Type, Encapsulation and Custom
RoE Filter	Targeted RoE (Radio over Ethernet) impairments ▪ Message Type, Flow ID, Length, Ordering Info
PTP Filter	Layer 2 Ethernet, Layer 3/4 UDP IPv4
PTP Transparent Clock	1-step Transparent Clock ▪ The residence time is measured and added directly into the correction field of the outgoing PTP event message.

General	
Web Browser User Interface	Intuitive drag and drop user interface. Intuitive user interface allowing user to draw out their target network on screen, add impairments as required and visualize the network-under-test.
Local Automation	Local automation Timeline Option enables local automation to a 1s resolution.
Remote Control	RESTful API enables full remote control.
Smart Start-up	Automatically launch previous map on boot.
Multi-user Support	Multiple users, share maps, assign ports to individual users.

continued overleaf

Technical Specifications cont'd.

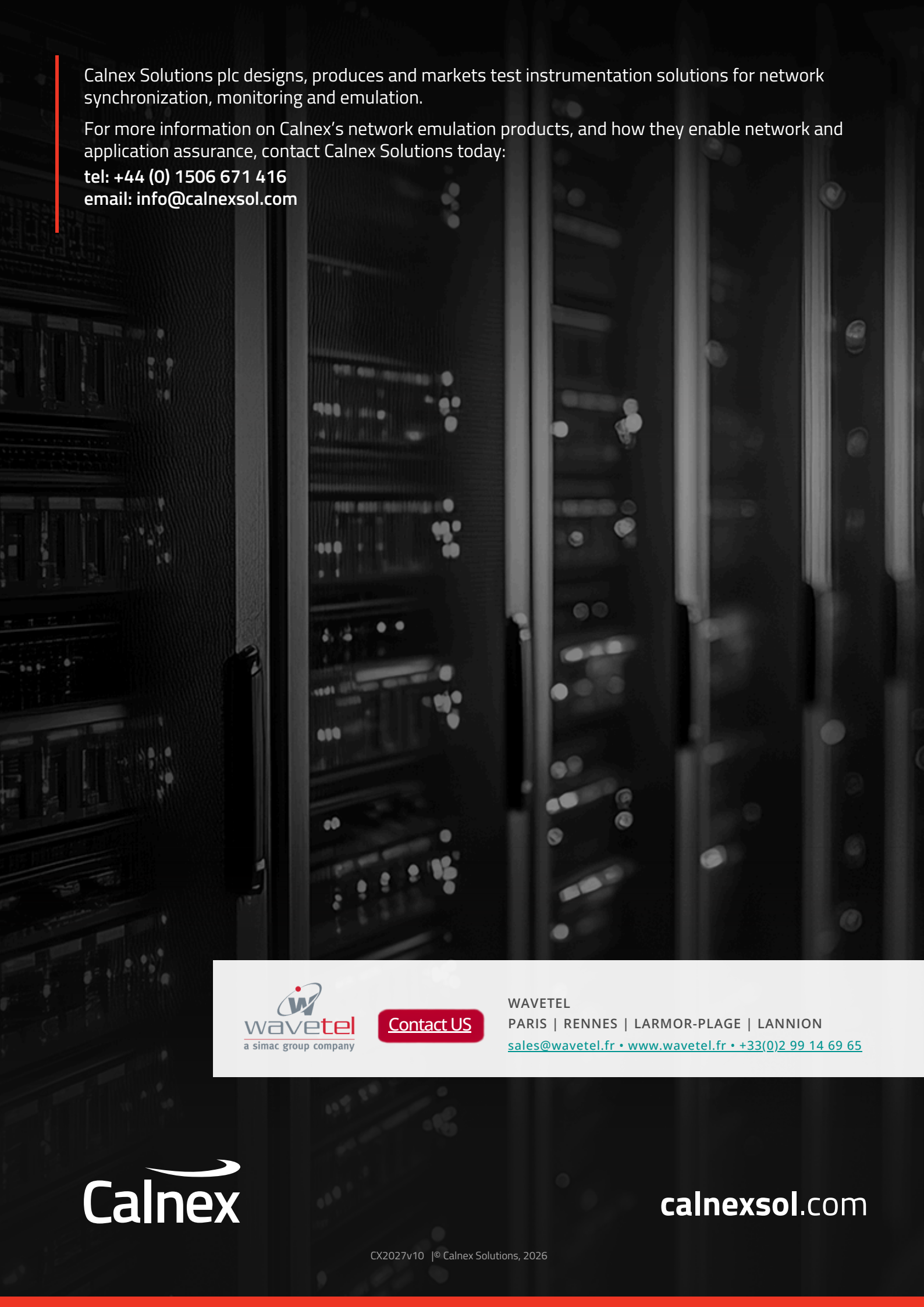
Impairments	
Packet Modification	▪ Select from byte 0 to byte 127 within the frame. ▪ With optional Layer 2, Layer 3, Layer 4 checksum regeneration. ▪ Granular from 1 bit to 4 bytes of modification can be applied. ▪ Any combination of 1 – 4 packet modifier types can be applied in any order to each Profile. ▪ Packet modifier types: ▪ Overwrite ▪ Invert ▪ Increment ▪ Decrement ▪ Fuzz (PRBS with a user defined seed value) Mode (applies to all packet modification impairments): burst (1–10,000), rate (0.00001 to 100%). Continuous or On/Off/Repeat (applies to all packet types) based on time or number of packets.
Delay and Jitter	▪ Constant Delay ▪ Gaussian distribution of jitter ▪ Gamma (internet) distribution of jitter ▪ Uniform distribution of jitter ▪ Step distribution of jitter ▪ Import from an external file ▪ Jitter range from 1 µs to 400 ms; step size is 1 ns ▪ Add independent delay/jitter distribution to each profile simultaneously ▪ Readout of Max, Min Jitter and Max Delay for the applied distribution
Timeline	Easy automation via the Web UI without scripting or the need to learn Remote Control commands. This (auto-change) feature allows the user to easily automate emulation and schedule changes to emulation settings via the user interface with no manual intervention required. Users can loop the timeline for continuous playback.
Minimum Delay Emulation (Intrinsic Delay)	▪ 6.8 µs at 10GbE/25GbE/50GbE/100GbE/400GbE ▪ 14 µs at 10GbE (Jumbo Frame Mode) ▪ 8.85 µs at 25GbE/50GbE/100GbE (Jumbo Frame Mode) ▪ 6.8 µs at 400GbE (Jumbo Frame Mode)
Delay Emulation	Line rate delay: Full line-rate delay of 40ms at 400GbE, 80 ms at 100GbE, 160 ms at 50GbE, 320 ms at 25GbE, and 750 ms at 10GbE. Delay resolution: 1 ns.
Extended Delay Emulation	Extends line-rate delay to 280ms at 400GbE, 320 ms at 100GbE, 640 ms at 50GbE, 1280 ms at 25GbE, and 3200 ms at 10GbE. Extended Delay: up to 22 s (all rates at 1G reduced bandwidth). Extended Delay: up to 42 s (all rates at 500M reduced bandwidth). Delay resolution: 1 ns.
Link Flap	Enables the port administrative state to be cycled up/down, down/up, available via the RESTful API.

Technical Specifications cont'd.

Monitor/Analysis	
Map Statistics	▪ Port and impairment node level packet statistics. ▪ Statistics can automatically refresh every 1s or are available on demand. ▪ Downloadable via the UI in .csv format. ▪ Downloadable via the API in .json format.

Physical Dimensions	
RU Height	3.7RU in height
Height	Metric: 170 mm, Imperial: 6.7"
Width	Metric: 440 mm, Imperial: 17.32"
Depth	Metric: 550 mm, Imperial: 21.65"
Weight	Metric: 14 kg, Imperial: 30 lb 13.8 oz
Active Chassis Cooling	Front to rear
Active PSU Cooling	Side to rear, self-contained
Total Chassis Airflow	Maximum 452 CFM

Specification is subject to change without notice.



Calnex Solutions plc designs, produces and markets test instrumentation solutions for network synchronization, monitoring and emulation.

For more information on Calnex's network emulation products, and how they enable network and application assurance, contact Calnex Solutions today:

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