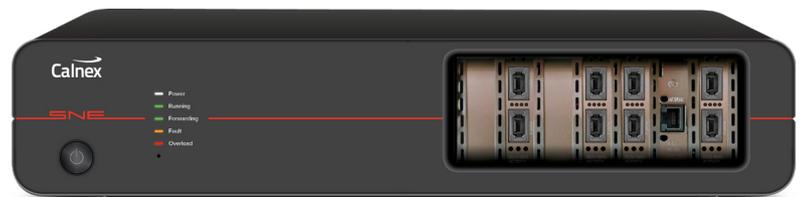


Get predictable infrastructure performance

**Multi-port, multi-user network
emulation and simulation**



**Calnex SNE offers industry's
highest port density with
interfaces from 1GbE to 100GbE**

Key Highlights

- 100GbE, 50GbE, 25GbE, 10GbE and 1GbE interfaces supported
- Web-based user interface (Web UI)
- RESTful API for easy remote control in your automation environment
- Multi-user
- Multi-port — best-in-class port density with up to 8 ports 100GbE/50GbE/25GbE, up to 16 10GbE/1GbE
- Timeline feature for easy automation via the WebUI
- Connect any-port to any-port without limitations
- Delay emulation up to 30 seconds
- Over 55+ impairments and tools
- Audio and video MPEG (H.264 & H.265) modification and corruption
- Packet fragmentation and reordering
- Includes generic full packet inspection and filtering
- Packet modification; change any bits or bytes of any packet
- Load generators
- Non-volatile capture and replay
- Link flapping
- Markov random packet drop
- 20Mbyte bandwidth throttle buffer for video applications
- Automated 5G network model
- Personalised User Annotations

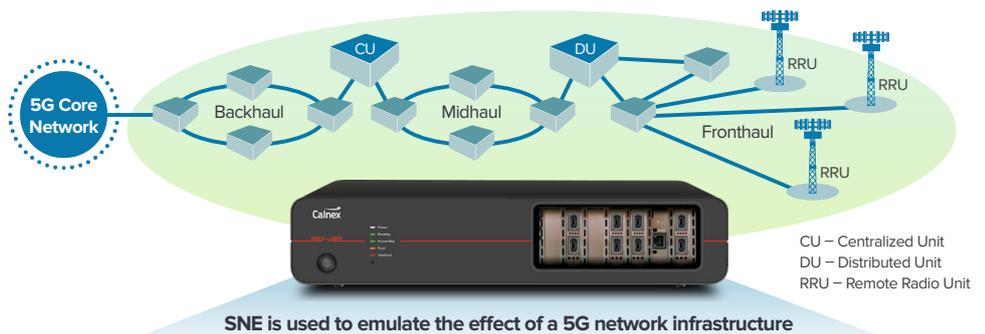
Test with real-world network conditions in your lab with the Calnex SNE network emulator

Real-life networks are a complex system of changing conditions, flexible routes and competing applications. And the only way to get predictable infrastructure performance is to test before deployment.

The Calnex SNE provides industry-leading flexibility in building and modelling these complex real-life systems enabling you to simulate networks and emulate the real world conditions under which applications and platforms need to perform.

Automated tests with a real 5G transport network model

5G networks will be used to support numerous new applications and these need to be tested under realistic test conditions. The SNE has a 5G dataset modelled from real data collected by major carriers to enable fast and accurate application testing using common real-world 5G conditions



Easy-to-use visual graphics via web user interface

The Calnex SNE now has a Web User Interface (Web UI). You can simply control your Network Emulator from your web browser on your PC or tablet. No longer do you need a separate client GUI to be downloaded onto your PC and of course you no longer need to worry if the client GUI on your PC is compatible with the instrument software on your Network Emulator.

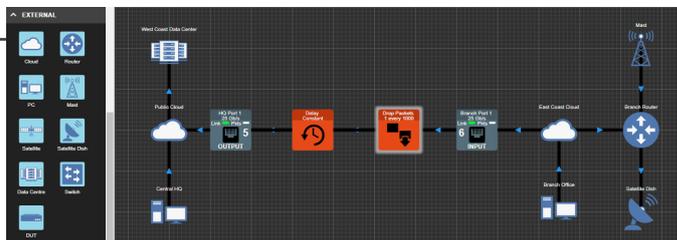
The SNE's Web UI utilises the same unique graphical design that's used to build network emulation "maps" in the previous GUI. So, if you know how to use the previous Calnex SNE user interface then you will know how to use the new Web UI. If you've never used Calnex SNE before then you will still find the Web UI very easy to use. The SNE Web UI provides a unique visual graphical means of building network emulations. You can take full control by linking together impairments in the order required and directly controlling the flow of packets around the simulated network.



The flexible Web UI enables you to drag and drop from the extensive list of impairments into your network "map" to create specific impairment scenarios to meet your testing needs.

Same Intuitive Drag and Drop functionality

All tools are housed in sidebar menus. Simply drag what you need onto the map area to build your test scenario. Copy and Paste enables whole sections of maps to be replicated easily.

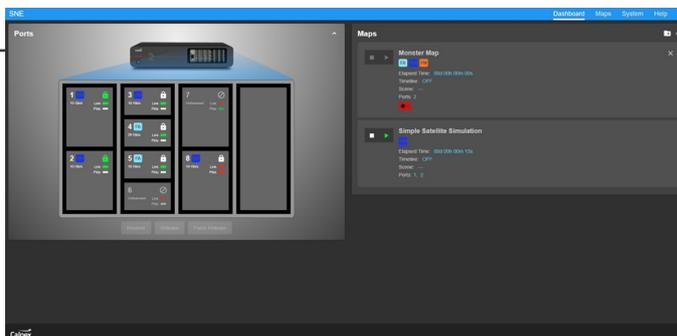


New User Annotations

Users can now personalise their Maps by adding Annotations to the Map end points. Multiple Annotations can be added and named to represent the users' own devices or locations.

Dashboard view - with Ports & Map Summary

Lets you view and reserve ports and run/stop selected maps.



Ports view provides information on port configuration, active ports, data rates and link status as well as information on which ports are assigned to which user.

Map Summary lists user selected maps and enables user to run/stop selected maps for the dashboard view.

Use Calnex SNE to test:

- SD-WAN
- Cloud computing/data center migration
- Broadcast quality video networks – SMPTE
- AV/Video conferencing
- Video/voice applications (IPTV, VoIP, etc.)
- Mobile subscriber networks (VoLTE, eMBMS, etc.)
- Content delivery networks
- CoS/QoS levels
- WAN acceleration/network optimisation
- 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 Wi-Fi
- Cable/broadband networks
- Microwave
- Wifi and Wimax
- RoIP
- GPRS, 3G, 4G and 5G
- Dial Up
- DSL, ADSL and XDSL

Extreme flexibility – multi-port and multi-user

The Calnex SNE is a highly flexible solution for both network emulation and network simulation. Whether you want to emulate point to point links, simulate complex data-centers with multiple gateways or extract out analytical information on video systems, with the SNE you can build your network in seconds.

And because every network and project requirement is different – depending on factors such as location, connectivity, quality of service, number of services and the applications being used across it – reaching beyond simple delay, jitter and bandwidth emulation is essential for any business.

Further, the SNE offers a multi-user, multi-port environment. Each user can be allocated a pair of ports, or a number of ports for their own exclusive use. This ensures a very cost effective and flexible means of providing test resources to a team or department.

Applications

The Calnex SNE is a total solution to the problem of real-world Ethernet testing. It combines comprehensive and highly-accurate network emulation to enable you to:

Troubleshoot

Investigate reported problems and test resolutions without disrupting production traffic. Moreover, test specific scenarios and gain insight and data about where and when problems arise to identify effective resolutions before they become live issues.

Design networks

Create ‘what if?’ scenarios to evaluate network changes; evaluate different topologies and technologies before expensive implementation. For example, evaluate WAN Acceleration Technology by determining how different WAN optimisation products will perform under the best/average/worst conditions of your network.

Test application performance

Determine how your software will perform for the end user on their network before deployment; troubleshoot and resolve issues before the need for re-work, release delay or failure.

Optimise performance

Adjust application and software settings under replicated network characteristics to optimise performance for different user groups.

Emulate Real Network Conditions

- Busy peak times
- Long distance
- Jittery connections
- Duplication of data
- Fragmentation of data
- Traffic re-routing
- Limited bandwidth
- Packet corruption
- De-sequencing of data
- Network traffic bursts
- Partial or total outage
- Back-up switchovers
- Network congestion

Key features

Calnex SNE is available with the following:

- Multi-port — market leading port density with up to 8 ports 100GbE/50GbE/25GbE, up to 16 ports 10GbE/1GbE.
- Flexible configuration — mix and match interface cards to meet your needs
- Flexible interfaces; QSFP28, SFP28, SFP+ or RJ-45 (or a mixture)
- Timeline feature for easy automation via the Web UI without scripting or the need to learn Remote Control commands
- Wireshark integration
- Easy automation via remote control using RESTful API
- Flow packets between any port, no limitations
- Up to 12 minutes of storage for wire-rate recording at 10Gbps
- Delay emulation up to 4 seconds at 10GbE; up to 10 seconds at 1GbE
- Fast visual emulation design creates networks in seconds

Wire rate

The SNE supports wire rate performance. All 10GbE ports are dual rate, supporting 10GbE and 1GbE operation. All 25GbE ports are multi-rate, supporting 25GbE, 10GbE and 1GbE operation. This makes the SNE very flexible and can be tailored to your individual throughput needs.

“Any port to any port”™ capabilities

The SNE comes with true “Any Port to Any Port”™ capabilities. Whether you are using 4, 8 or 16 ports they will all communicate with each other without limitation.

Many emulate products may state you are buying a ‘4 port emulator’ but often what you actually get is two ‘emulators’ each with two ports inside a single box. There may be four ports on the outside, but the reality is that you have two independent emulators and you won’t be able to send packets between each. So effectively you have got two emulators with two ports, not the four ports you need.

Fragmentation and reordering

When packets cross network boundaries they can become fragmented. The SNE can fragment packets to simulate MTU changes down to 68 bytes. Packets can also be reordered either by displacing the packets “X” number of frames or time into the future.

Load generation

Very few networks are silent as there is always a certain amount of background traffic. Whether it is file servers, printers or other devices generating traffic, it is important to model this correctly.

The SNE provides a number of ways of generating this traffic including background traffic generation (contention), TCP load generators, PCAP file replay, etc.

Video and audio

Dedicated impairments allow smart degradation of video (H.264 and H.265), audio streaming, RTP, RTCP and much more. Understand how robust your AV equipment is to corruption of video or audio framing and view analytics information on video format internals.

Impairments

The SNE provides all the common impairments including delay, jitter, throttle, and so on. Furthermore, it also provides advanced impairments including fragmentation, video corruption, BER corruption, reordering and many more.

Switchover and back-up circuits

Built on top of our powerful filtering system, you can easily simulate multiple paths in any network and switch between them in real-time (or using an external trigger). This allows you to model a “good” and “poor” network and switch between them in real time, plus you can create an unlimited number of paths.

Comprehensive settings

Not only are there 55+ impairments, but each one of those impairments has extensive options and settings to uniquely control their operation. This gives you an unparalleled level of fine tuning such as buffer and burst management on bandwidth throttles, or affecting only B-Frames in H.264 video streams.

Filtering

It’s very important to be able to identify and target certain streams of data on an emulated network. The SNE provides a host of built-in filters to identify packets for impairment or analysis. Moreover, you can join filters together to create more complex filters (for example, you could find HTTP traffic going to Port 8080 on VLAN ID 90 with only two filters).

Key features (cont'd)

Easy automation

We understand that everyone's automation environments are different. The SNE can be controlled externally through a variety of methods. A RESTful API is provided offering powerful and efficient web-based automation. The RESTful API provides an easy automation and scripting environment via remote control.

The RESTful API provides the ability to start / stop maps, change impairment settings on-the-fly, link flapping and much more.

RESTful API - for easy automation and scripting

- GET /api/physical/ports
- GET /api/physical/ports/{port}
- PUT /api/physical/ports/reserve
- PUT /api/physical/ports/release

The SNE also comes with a very useful and easy to use timeline (auto-change) feature which allows the user to easily automate emulation via the Web UI without having to learn or develop scripts.

The screenshot displays the SNE Web UI interface. On the left is the 'CONFIGURATION' panel, and on the right is the 'Timeline' view.

CONFIGURATION Panel:

- Timeline:** Mode: Autostop after 5 loop(s). Loop Duration: 00m 50.0s. Loop: 1.
- SCENES Table:**

Name	Duration	Progress
Base Map	00m 10.0s	100%
Apply 50ms Delay	00m 10.0s	0%
Add Drop 1% Packets	00m 10.0s	0%
Add 5ms Jitter	00m 10.0s	0%
Increase to 100ms Delay	00m 10.0s	0%

Timeline View:

- Elapsed Time:** 00d 00h 00m 11s
- Timeline:** On (toggle)
- Loop:** 1
- Progress:** 100%
- Stop Map:** Scene: Apply 50ms Delay
- Input Port 5:** 25 Gb/s Link, 0 Pkts
- Delay Constant:** (Icon: Clock)
- Drop Packets:** 0 every 100
- Jitter:** 0.01 ms
- Output Port 6:** 25 Gb/s Link, 0 Pkts

Technical Specifications	PRODUCT RANGE				
	1G	10G	25G	50G	100G
Physical					
Network Interfaces	up to 16	up to 16	up to 8	up to 8	up to 8
Standard Network Interfaces	GbE Copper	SFP+	SFP28	QSFP28	QSFP28
Optional Network Interfaces	RJ45	SFP+	SFP28	QSFP28	QSFP28
Max. Packet Rate Per Port (bi-directional)	2.96 million	29.6 million	37.2 million	62.5 million	62.5 million
Dimensions	2u Rack	2u Rack	2u Rack	2u Rack	2u Rack
Intrinsic Latency	<20µs	<20µs	<20µs	<20µs	<20µs
Max. Frame Size — Jumbo Mode 9219 bytes; Non-jumbo Mode 1542 bytes	✓	✓	✓	✓	✓
General					
Timing Precision	10µs	10µs	10µs	10µs	10µs
Any Port to Any Port™ packets can be sent between any port for complete flexibility	✓	✓	✓	✓	✓
Live Changes — Real-time modification of any impairment setting	✓	✓	✓	✓	✓
Traffic Capture and Replay with Looping Option					
Volatile Storage (20G RAM)	✓	✓	✓	✓	✓
Non-volatile Storage (1TB SSD)*	optional	optional	optional	optional	optional
*Max Traffic Capture Rate 1Gb/s					
Bi-directional, Independent Emulations	✓	✓	✓	✓	✓
Timeline — Schedule changes to emulation settings with no manual intervention required. Option: loop timeline for continuous playback	✓	✓	✓	✓	✓
Link Flap	✓	✓	✓	✓	✓
Delay Emulation — up to 4s at 25GbE; up to 4s at 10GbE; up to 10s at 1GbE; up to 30s (all rates at reduced bandwidth)					
1GbE Delay Emulation — up to 1.25secs	✓	✓	✓	✓	✓
10GbE Delay Emulation — up to 0.5secs	n/a	✓	✓	✓	✓
25GbE Delay Emulation — up to 0.5secs	n/a	n/a	✓	✓	✓
50GbE Delay Emulation — up to 0.339secs	n/a	n/a	n/a	✓	✓
100GbE Delay Emulation — up to 0.339secs	n/a	n/a	n/a	n/a	✓
Delay Emulation (at reduced bandwidth) — up to 30secs	✓	✓	✓	✓	✓
1GbE Extended Delay Emulation — up to 10secs	optional	optional	optional	optional	optional
10GbE Extended Delay Emulation — up to 4secs	n/a	optional	optional	optional	optional
25GbE Extended Delay Emulation — up to 4secs	n/a	n/a	optional	optional	optional
50GbE Extended Delay Emulation — up to 2.714secs	n/a	n/a	n/a	optional	optional
100GbE Extended Delay Emulation — up to 2.714secs	n/a	n/a	n/a	n/a	optional
Fixed Latency	✓	✓	✓	✓	✓
Variable Latency	✓	✓	✓	✓	✓
Ramp	✓	✓	✓	✓	✓
Normal / Gaussian	✓	✓	✓	✓	✓
Sinusoidal Wave	✓	✓	✓	✓	✓
Jitter — 0.1ms to 100ms or 0.1 to 100% of constant delay	✓	✓	✓	✓	✓
Timing Constraints (specify start and duration of impairments activity) Start / Duration 0.01ms to 360,000ms (in 0.01ms increments)	✓	✓	✓	✓	✓

✓ Provided as Standard

Technical Specifications (cont'd)	PRODUCT RANGE				
	1G	10G	25G	50G	100G
Bandwidth Emulation (with user configurable buffer size up to 20Mbytes for video)					
Constant Throttle	128bits/sec to 1G	128bits/sec to 10G	128bits/sec to 25G	128bits/sec to 25G	128bits/sec to 25G
Random Range (min to max with time constraints)	128bits/sec to 1G	128bits/sec to 10G	128bits/sec to 25G	128bits/sec to 25G	128bits/sec to 25G
Random Range Duration — 1000ms to 60 minutes (in 0.1ms increments)	✓	✓	✓	✓	✓
Background Traffic Generation					
Fixed Data Rate Generate broadcast packets Range (min to max with time constraints)	500byte/sec to 1G	500byte/sec to 10G	500byte/sec to 25G	500byte/sec to 50G	500byte/sec to 100G
Range Duration 1000ms to 360,000ms (in 1ms increments)	✓	✓	✓	✓	✓
Reordering					
Time Based Re-order Displace packet from 0.1ms to 500 ms	✓	✓	✓	✓	✓
Position Base Re-order Displace packet up to 10,000 places	✓	✓	✓	✓	✓
Corruption					
Bitflips Start and end position (first byte to last byte), 1 to 100%	✓	✓	✓	✓	✓
Byte Overwrites Start and end position (first byte to last byte), 1 to 100%	✓	✓	✓	✓	✓
Ethernet Fragmentation MTU: 68 to 9000	✓	✓	✓	✓	✓
Bit Error Rate (Per) Simulation x bits in y received (1 bit to 1E+15)	✓	✓	✓	✓	✓
Enable/Disable FCS	✓	✓	x	x	x
Duplication					
Simple (single duplication) Packets received on link will be immediately duplicated once	✓	✓	✓	✓	✓
Timed (duplicated every x seconds) Single duplication after specified delay (1ms to 10,000ms)	✓	✓	✓	✓	✓
Complex (multiple, timed duplication) Specified multiple duplications after specified time delay (1ms to 1,000ms)	✓	✓	✓	✓	✓
Loss					
Standard — Drop x packets in y received	✓	✓	✓	✓	✓
Percentage — Drop 1% to 100% (in increments of 1%)	✓	✓	✓	✓	✓
Markov — 2 state random packet drop (as per ITU-T G.1050 Appendix II - Gilbert-Elliott model)	✓	✓	✓	✓	✓
Outage — Drop all packets received on specified link	✓	✓	✓	✓	✓
Drop Evenly — Packets will be dropped regularly throughout emulation	✓	✓	✓	✓	✓
Drops in Bursts — Packets will be dropped in continuous groups	✓	✓	✓	✓	✓
Timing Constraints — Start / Duration 0.01ms to 360,000ms (in 0.01ms increments)	✓	✓	✓	✓	✓

✓ Provided as Standard

Technical Specifications (cont'd)	PRODUCT RANGE
Modification	
Generic Packet Modifier Modify up to 6 bit / byte sections per packet	✓
Analysis (Extract analysis information from any part of the emulation)	
Bandwidth Graph Show bandwidth utilization — export, clipboard, peak and averaging, etc.	✓
Packet Rates Show packet utilization, Inter Packet Gap	✓
RTP Analyser Output detailed information on RTP streams	optional
Stateless load generation with multiple load distribution models	
TCP Client Simulate clients with data streams	optional
TCP Server Simulate servers with data streams	optional
DDOS Simulation Simulate extremely stressful DDOS environments	optional
Audio Visual (AV) Pack	
RTP Filter	optional
MPEG H.264 and H.265 Corruptor	optional
Management	
Drag and Drop User Interface Simple User Interface, allowing user to draw out their target network on screen, drop impairments as required and visualise the network-under-test	✓
RESTful API for Test Automation	✓
Smart Start-up Automatically launch previous map on boot	✓
Multi-user Support Unlimited users, share maps, assign ports to individual users	✓
Hardware NTP Time Stamping Lock hardware and packet timings to accurate internal / external clocks	✓

Technical Specifications (cont'd)	PRODUCT RANGE All interfaces: 1G, 10G, 25G, 50G, 100G
Filtering (UDP, TCP, Packet count)	
Maximum Filter — Connect multiple filters in any way to create complex filter rules	unlimited
IP Source / destination address filtering (impair specific traffic flows)	✓
TCP — Advanced: Source and destination port filtering (including range) TCP Packet length filtering	✓
UDP — Advanced: Source and destination port filtering (including range) UDP Packet length filtering	✓
MAC Address — Src / Dst single or range	✓
Ethernet Payload	✓
Packet Counting — Fail or Pass packets based on packet count or percentage	✓
Advanced Filtering	
Generic Filter — Filter on multiple bit / byte values with logic operations	✓
IP Protocol — Payload Type and Value	✓
MPLS — MPLS Label, QoS Value, TTL Value	✓
VLAN — VLAN ID, User Priority	✓
MPEG Video	optional
RTP A/V	optional
Reporting	
Live Monitoring — Bandwidth monitoring, packets per second, interpacket gap, export to CSV max / average values, etc.	✓
Wireshark Integration (on up to 200 protocols) Allows for live traffic capture and root cause analysis; replay third-party traffic streams under impairments, record traffic and replay at a later date	✓

✓ Provided as Standard

SNE Configuration

SNE has 4 slots available for interface cards. The following interfaces are available:

1G	1GRJ*	1GbE card, 2 or 4 ports of 1GbE Electrical (RJ45)
10G	10G*	10GbE card, 2 or 4 ports ¹ of 10GbE/1GbE Optical (SFP+)
25G	25G	25GbE card, 2 ports ² of 25G/10G/1G Optical (SFP28)
	25G	25GbE card, 2 ports ² of 25G Optical (QSFP28)
50G	50G	50GbE card, 2 ports of 50/25G Optical (QSFP28)
100G	100G	100GbE card, 2 ports of 100/50/25G Optical (QSFP28)

Note: cards marked* can be configured with 2 or 4 ports enabled

¹ Two variants of 10G card exist. There is the 2 port STD card and the 4 port HPC card. Refer to STD and HPC spec below for further details.

² Two variants of 25G card exist. There is the 2 port SFP28 card and the 2 port QSFP28 card. Refer to 25G SFP28 spec and 25G QSFP28 spec below for further details.

STD* (10GbE/1GbE Standard Specification)

- Wire Rate with 128 byte traffic on all ports (up to eight 10GbE ports)
- Wire Rate with 64 byte traffic on any four 10GbE ports or all 1GbE ports

HPC* (10GbE/1GbE High Port Count Performance)

- Wire Rate with iMix traffic on all ports (up to sixteen 10GbE ports)
- Wire Rate with 64 byte traffic on any two 10GbE ports or all 1GbE ports

(*) DOES NOT INCLUDE mixing 4 port 10G HPC modules and 2 port 10G STD modules — NOT CURRENTLY PERMITTED

Calnex Solutions is a global leader in Test and Measurement solutions for next-generation telecom networks. Our products help to prove new technologies for applications such as SD-WAN, DataCenters, Cloud/OTT, Broadcast Video, and AV/Video conferencing.

For more information on Calnex's network emulation products, and to take advantage of our extensive experience in network emulation test, contact Calnex Solutions today:

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