SD-WAN
Test Guide

For Service Providers, Vendors and Enterprises

Calnex **SNE**

Calnex
Insight and Innovation

Contents

This test guide provides an insight into some examples of how SD-WAN tests can be carried out using the Calnex SNE. The test examples are focused on validating conformance to policies when SLA's are violated. The guide explores how this can be done on both a basic SD-WAN architecture and a complex mesh network architecture.

Click on the buttons below to learn more.

Basic SD-WAN Architecture

Complex Mesh Network Architecture

What to expect

This eBook is intended to guide anyone evaluating or deploying SD-WAN whether you work for an OEM/Vendor, Managed Service Provider or Enterprise End User.

The key question it addresses is "how can I test SD-WAN fully when I don't have a WAN?" The tests here use a WAN Emulator (or 'WAN-in-a-Box') to enable comprehensive testing of SD-WAN to be done so that:

OEMs/Vendors

- Can prove the solution works correctly under different WAN conditions
- Can perform a convincing demo of the system to customers

Managed Service Providers

- Can evaluate and benchmark solutions from different vendors
- Can check and verify interop between different systems and vendors
- Can perform a convincing demo of the system to enterprise customers

Enterprise End Users

- Can confirm that migrating to SD-WAN will not impact services negatively
- Can evaluate and benchmark solutions from different vendors

This guide provides a framework for how SD-WAN vendors, managed service providers and end users can test service performance using WAN emulators as part of their larger testing methodology.

Comprehensive testing of new technologies is a proven way to avoid performance or quality issues once a solution has been deployed in a production environment. SD-WAN technologies are increasingly prevalent in modern networks as users endeavour to take advantage of the additional agility, security and cost savings such services offer. It therefore stands to reason that comprehensive testing is part of the development of all SD-WAN offerings.
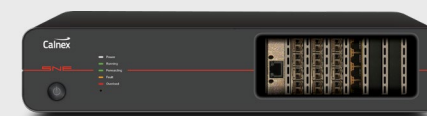
The Calnex SNE is designed to add realistic network conditions to a test environment. As a WAN emulator, it provides realism by adding impairments such as delay, jitter and packet loss which are found commonly in WANs. Moreover, because SD-WAN policies are set to route or switch network traffic when certain thresholds for e.g. latency or packet loss are reached or exceeded, testing using network impairments is a fundamental part of any SD-WAN test methodology given that policy violation is key to understanding the effective function of the SD-WAN solution.

Where are your customers on the SD-WAN journey?

Converting potential SD-WAN enterprise customers and successfully deploying a new complex hybrid network across their business can be challenging for a number of reasons.

Whether its barriers to adoption limiting Managed SD-WAN service growth, or the complexity and unique characteristics of large enterprise networks causing deployment problems and slowing a project down, WAN Emulation can help overcome these challenges and accelerate your go-to-market plans.

Proving solution viability

- How can I prove to my customer that our solution is a viable option for them and give them confidence in our ability to manage their data?
- How can I show them how our solution can be deployed without impacting their business operations?
- Is there a way to prove service quality and ROI to customers considering our solution?
- How can we grow our market share in our SD-WAN provision?

Designing optimal customer solutions

- How can I test a network design to ensure that it will perform as we need it to and meet our customers unique requests prior to deployment?
- Which topology will be most effective for this customer – transport methods, switches, routers?
- Can we ensure SLA enforcement with this design?
- Can we check that traffic is prioritised as we are designing it to once it's on a live system?

Managing the live service

- How can we improve our customer satisfaction scores for our managed service?
- How can we troubleshoot problems on the live environment to ensure we continue to meet SLA's and avoid any service downtimes?
- How can we increase the profitability and performance of our service to meet internal KPI's?
- If we want to change the design now its live is there a way to test changes before deployment?

Enabling customer deployment and adoption

- How can we get our customers hands-on experience and train them to manage their new network architecture?
- How can I show our customer the business resilience across the new network design?
- How can we help customers to implement operational processes which are adapted to reflect a move towards more automation and less manual network troubleshooting?
- Can we help our customers design organisational structures that will reflect their new networks to ensure the right resources are in place to manage it at deployment?

What is your challenge?

- Proving solution viability
- Designing optimal customer solutions
- Managing the live service
- Enabling customer deployment and adoption

Designing and testing customer projects prior to any work being carried out on the live network can help open up new markets, save you time on project delivery and increase customer satisfaction.

For many customers 'digital transformation' is the current business focus and the adoption of SD-WAN is an integral part of this transformation. However, each enterprise business is different and their challenges differ depending where they are on the SD-WAN journey. WAN Emulation can be utilised to support your customers and address their unique challenges whether they are in the planning, deployment or optimization phase of their SD-WAN journey.

From a test perspective, there are essentially three groups that users fall into. Much of the testing methodology of groups is the same, although the group into which a user falls will ultimately determine which tests are most appropriate. For clarity we define these groups as follows:

OEM / Vendor
This group of organisations develop and build the initial solutions which will be sold either directly to end users or in partnership with a managed service provider.

Managed Service Provider
This group does not build native solutions. Instead they use an existing OEM service which is bundled with additional value-added services such as administration or security. This larger bundle is sold to end-users as a total service.

End User
This group may buy a solution either direct from the OEM or as a managed service. Ultimately they use the solution in their own network typically intending to improve connectivity or agility across all locations within the network, improve security across all locations, reduce costs or any combination of these factors.

The End User Challenge – Rightsizing the Organisation

Much of this guide focuses on the steps that vendors and service providers should undertake to ensure successful development and roll out of their solutions. This section focuses specifically on the end-user; for certain organisations 'rightsizing' is a challenge that many end-users may face.

Rightsizing is the process of ensuring that the most efficient amount of resources are allocated in the most effective way. In essence, not too much and not too little. To illustrate this best let's look at the following customer case study to examine this in operation.

Customer Case Study

A large healthcare provider was in the early stages of an SD-WAN roll out across their organisation. In spite of this, and specifically when considering that cost reduction is one of the key drivers for adoption, this organisation found that their WAN costs were still the second largest cost after employee salaries. It was felt (i.e. not clearly understood) that certain critical applications required no more than 6ms of latency to sustain their performance. The IT Director suspected that at least some of these applications could operate effectively at higher latencies, and wanted to undertake some testing to understand the limits. However, WAN emulation was not an embedded process within their test environment.

Following a process of consultation, certain critical questions were highlighted and testing undertaken to answer them.

- Which applications work best on which circuits?
- What are the tolerances in terms of latency and loss that applications can sustain?
- Can the organisation offload bandwidth on high cost circuits and reduce costs?

The net result of this process was identification of the performance limitations of the critical applications, optimised configuration of the SD-WAN, and significant cost reduction to the organisation.

The following series of tests address the following challenges:

OEM / Vendor
- How do I ensure my solution correctly and accurately applies policies?
- How do I effectively demo it to customers?
- My customer needs support. Can I recreate their issue in my lab?

Managed Service Provider
- How do we ensure the highest level of customer satisfaction in our managed SD-WAN service?
- Can we trouble shoot any flagged issues?
- How do I effectively demo my solution to a prospective customer?
- My customer needs to fine tune the deployment. How do I do this?
- How do I convince customers that this solution is right for them?

End User
- How do I ensure minimum disruption to QoS if I adopt this service?
- How do I know which SD-WAN vendor is best for me?
- How do I improve connectivity to remote branches in my network without adding cost?
- Can I reduce my reliance on high-cost dedicated links?
- What bandwidth do my critical applications need?
- Where is their point of failure?
- Which applications work best on what circuits?
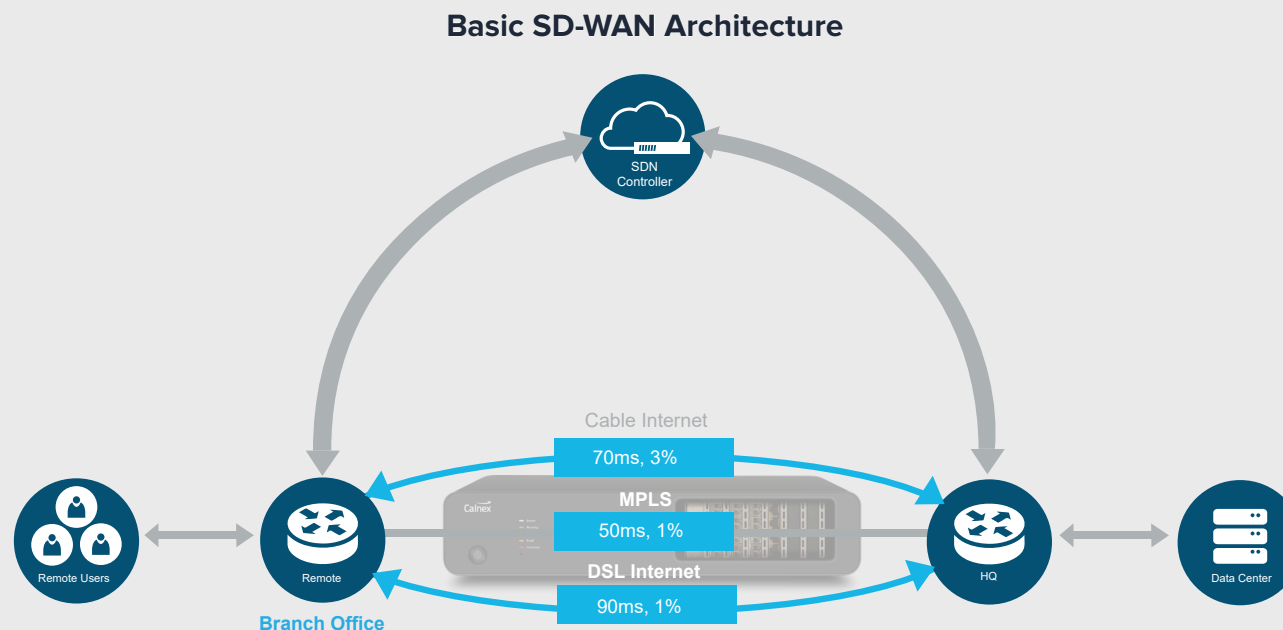
Testing Basic SD-WAN Architecture

A fundamental element of any SD-WAN solution is that before it can apply any policies it must first be able to monitor the network conditions. It is a given that if a policy is set to switch certain traffic from one pathway to another is set once a network condition is reached or exceeded, then accurate network analysis is a critical part of this process. For example if the policy is such that certain traffic should switch if there is 3% packet loss and the SD-WAN controller measures only 2% and fails to execute the policy correctly then the system is fundamentally flawed.

In terms of the test set up a simple point to point architecture can be set up with the customer CPE sitting either side of the SNE representing two locations in the network. Traffic is sent from one side to the other. Impairments such as latency and packet loss can be introduced. This will validate that the SD-WAN controller which applies policy can accurately measure different conditions upon which it will apply policy decisions.

One of the most common tests carried out is validating conformance to policies when SLAs are violated. The graphic below shows the basic architecture whereby there are two links – a dedicated MPLS connection and a public internet connection. This could be between a branch office and corporate HQ or datacentre.

Impairments will be introduced that violate the policy set for traffic along a specific link. In the main example delay will be introduced. If this exceeds the value set within the SLA the expected behaviour would be that some or all of the traffic switches to the next best path, in this case the internet connection. The test validates whether the expected behaviour is observed.

In the following tests, we show how you can run test scenarios for validating conformance policies and determine whether your controller accurately measures the precise network conditions to accurately apply policies.

Basic SD-WAN Architecture

SDN Controller

Cable Internet
70ms, 3%

MPLS
50ms, 1%

DSL Internet
90ms, 1%

Remote Users

Remote
Branch Office

HQ

Data Center

Testing Basic SD-WAN Architecture

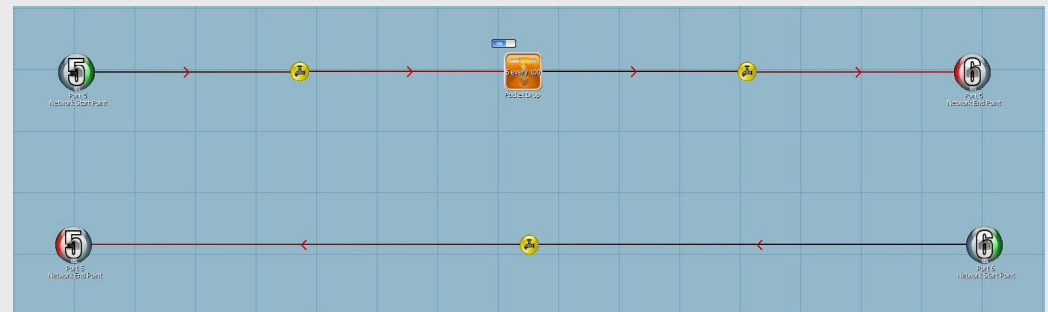## 1. Policy violation of a static SLA with delay

The service should be able to detect and report network KPI violations and upon a violation detection, should be able to intelligently reroute the affected paths to maintain service performance.

Calnex SNE single link map with delay packet.

Additional tests include:

- **Policy violation of static SLA with packet loss**
- **Policy violation of static SLA with limited bandwidth**

Calnex SNE single link map with packet loss.

Testing Basic SD-WAN Architecture

2. Policy violation of a dynamic SLA with delay

The rationale for this test is the same for the series of tests with static SLAs. The service should be able to detect and report network KPI violations and upon a violation detection, should be able to intelligently reroute the affected paths to maintain service performance. What differs is that a number of SD-WAN platforms will operate with dynamic SLAs. In other words, values set for permissible levels of latency, loss, etc. may change at different times. In this case the architecture and basic emulation map design will remain the same. What the test requires is the ability to automate changes to impairment values.

Calnex SNE has a feature called "Timeline". This enables you to preset values which will automatically change at a point in time. Therefore, when running the test, if the SLA changes to a higher/lower value then SNE can equally change values without manual intervention. As before, multiple variations of the test with delay can be set up in the same manner using different impairments.
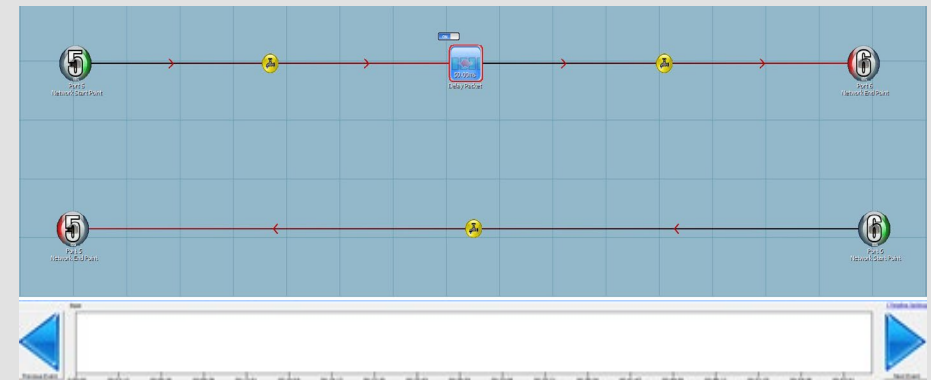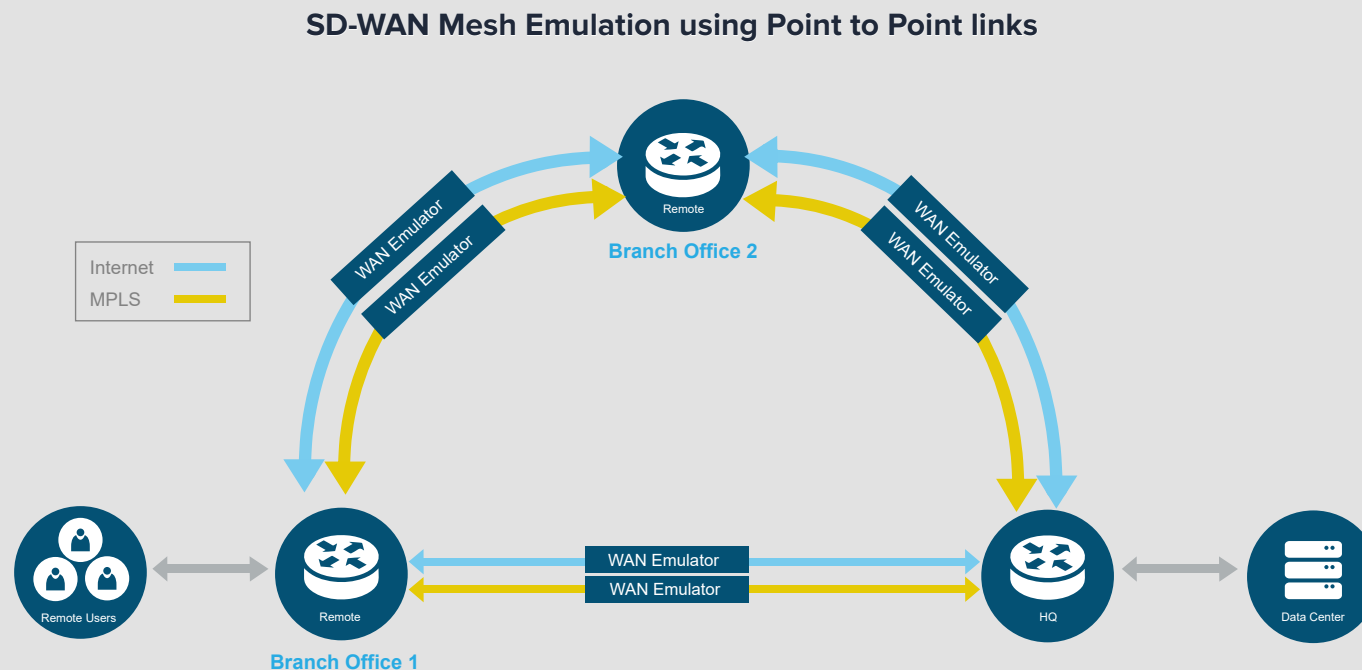
Testing Complex Mesh Network Architecture

Complex mesh networks can have a wide range of design options, with multiple MPLS and Internet link combinations between various locations such as a datacentre, HQ office and branch offices.

Regardless of where customers are on the SD-WAN journey, being able to mimic their real-world network topology and run various scenario tests can enable you to test the real-world conditions under which your SD-WAN solution will perform and validate its performance.

The example below displays a mesh architecture between a datacentre, HQ office, Branch office 1 and Branch office 2. In the following test scenarios we explore how using Calnex SNE you can test scenarios such as validation of conformance to policies when SLAs are violated across one or multiple links in the network.

SD-WAN Mesh Emulation using Point to Point links

Policy Violation — Complex Mesh Network Architecture

The flexibility of the Calnex SNE means that you can design a map to emulate your exact architecture and introduce impairments on the network to meet your testing needs. In this test case we are going to look at policy violations.

Example of the types of tests you can carry out under this scenario are:

- **Policy violation of a static SLA with delay**
- **Policy violation of static SLA with packet loss**
- **Policy violation of static SLA with limited bandwidth**
- **Policy violation of a dynamic SLA with delay**

In the following use case we use 'Policy Violation of a static SLA with delay'. To test a simple link to link we introduce Delay that violates the policy set for traffic along this specific link.

If this exceeds the value set within the SLA the expected behaviour is that some or all of the traffic switches to the next best path. This test validates whether the expected behaviour is observed.

Calnex SNE single link map with delay packet.

Taking this approach we can then explore how you can to do this test within our example complex mesh network with multiple links.

Policy Violation of a static SLA with delay — Complex Mesh Network Architecture

For policy violation testing, each link in our network may have a different SLA value and so a test plan for the full network would need to include options for testing the violation behaviour on each of these.

Using the SNE core capabilities, the exact topology can be recreated and values set rather breaking it down and creating multiple single link tests. The map example below shows both the MPLS and internet links on our example network mapped on the emulator. Each of these has impairments that are used to exceed the value set within the SLA to initiate the expected behaviour that some or all of the traffic switches to the next best path. The test validates whether the expected behaviour is then observed across all the links.

Ports 1 - 3 MPLS links
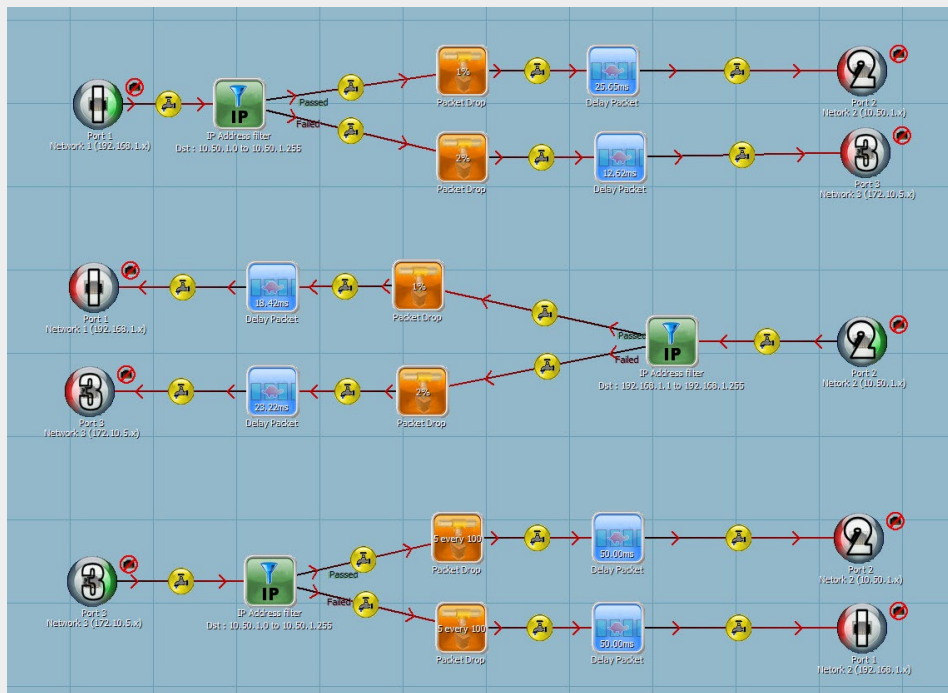
Calnex SNE complex multi-link map with multiple impairments.
For each of these links the values and impairment types can be adjusted to suit the testing needs.

Ports 4 - 6 Internet

Calnex SNE complex multi-link map with multiple impairments.

# Policy Violation of a static SLA with delay — Complex Mesh Network Architecture

With complex architectures, the link configurations between HQ, branch offices, datacentres and cloud based applications can create extensive testing requirements due to the number of potential scenarios that can arise.

Flexibility is essential when testing these and key features in emulation can enable testing to be carried out effectively and efficiently. For example:

- Ability to route traffic from any port to any port on the emulator
- Port density that scales up to 16 1GbE ports to enable greater interconnectivity
- Virtual routing meaning that test traffic sent to the unit can take an intelligent routing decision at the ingress port

Acting as a 'Network-in-a-Box' the Calnex SNE can perfectly mimic the real-world conditions under which your SD-WAN solution will perform. This live environment testing can enable you to:

- **Design and test network architecture to find optimal customer solutions**
- **Evaluate the network performance benchmarked against customer requirements, SLAs and QoS agreements**
- **Answer customer questions and queries**
- **Prove service viability**
- **Identify optimal design changes without having to touch the live network**
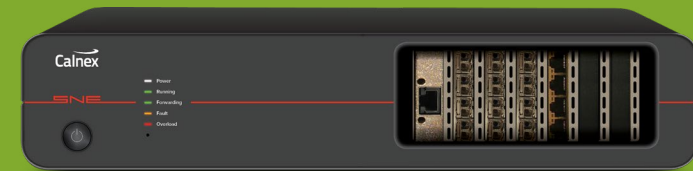
For more information on how the Calnex SNE can help make your transition to SD-WAN as seamless as possible, **click on the button below:**

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 WAN Emulation products, and to take advantage of our extensive experience in WAN Emulation test, contact Calnex Solutions today:

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