Agilent N2X

MPLS Signaling Emulation Software

E7883A
Technical Data Sheet

Agilent N2X MPLS Signaling Emulation Software integrates the most scalable RSVP-TE and LDP/CR-LDP signaling protocol emulations available to deliver unparalleled protocol verification and stress testing of data networking devices.

Agilent Technologies

Key Features

- Verify MPLS protocol implementations over native interfaces and sub-interfaces
- Determine MPLS scalability limitations
- Simulate real world multi-protocol environments
- Test MPLS network manageability

RSVP-TE

- Stress and verify RSVP implementations
- Verification of RSVP signaling and forwarding functions
- Determine RSVP protocol scalability limitations
- Testing RSVP high availability capabilities
- Flexible RSVP Messaging

LDP/CR-LDP

- Stress and verify LDP/CR-LDP implementations
- Verification of LDP/CR-LDP signaling and forwarding functions
- Determine LDP/CR-LDP protocol scalability limitations
- Testing of LDP/CD-LDP high availability capabilities

Product Overview

Agilent N2X is the industry's most comprehensive test solution for testing the development and deployment of network services for converging network infrastructures. Service providers, network equipment manufacturers (NEMs), and component manufacturers can verify service attributes of entire networks end-to-end, while also isolating problems down to individual networking devices and subsystems. Agilent N2X incorporates the strength of the RouterTester 900 to deliver unparalleled test realism to verify the ultimate performance, scalability and resilience of carrier grade services and infrastructure.

Agilent N2X MPLS Signaling Emulation Software integrates powerful RSVP-TE and LDP/CR-LDP protocol emulations into a single, integrated solution that provides comprehensive coverage of the signaling protocols used in MPLS networks.

Each signaling protocol can be emulated independently to deliver protocol interoperability, functional and stress testing.

Signaling protocols can also be emulated concurrently with the BGP-4, OSPF-TE and ISIS-TE protocol emulations in Agilent's IPv4 Routing Emulation Software (E7882A) to simulate large and diverse MPLS network topologies around a switch, router or network. This will allow you to determine its ability to manage multiple protocol engines, databases and forwarding tables simultaneously.

The protocol emulation is dynamic, allowing you to manipulate the number and rate of LSPs being set-up and torn down in the simulated MPLS topology, and measure in real time how this manipulation affects the stability and performance of your device or network.

Key MPLS performance scenarios such as MPLS Fast Reroute, MPLS make-before-break (MBB), MPLS tunnel pre-emption, and RFC 2547 MPLS BGP VPNs can also be configured automatically through the combination of this and the IPv4 Routing Emulation Software.

MPLS Test Scenario

A typical test scenario is depicted in Figure 1 below.

- Using the OSPF emulation software a network topology is simulated behind port 1.
- A LSP tunnel is set up using either RSVP or LDP/CR-LDP between node 1.1 to port 2 via Port 1 and the SUT
- Labeled traffic is forwarded from port 1 with the label 7 over the LSP tunnel.
- The SUT receives the label packet, pops the label 7, pushes label 9 into the packet and forwards the packet to Port 2.
- With the Agilent N2X, performance measurements are made on the traffic forwarded to Port 2.

RSVP-TE Features

Verification of RSVP-TE signaling and forwarding functions

The MPLS Signaling Emulation Software provides the ability to generate RSVP PATH and RESV messages, and to verify that these messages are propagated to other LSRs appropriately. In addition, labeled traffic may be generated and confirmed. This enables you to check for appropriate switching of labeled traffic based on initiated LSPs.

Simulating real world, multi-protocol environments

In real networks, MPLS must interwork with routing protocols. In traffic engineering applications, an IGP such as OSPF or IS-IS will construct a routing topology. The MPLS cloud will provide an overlay on this topology for label-based switching. As a result, simultaneous simulation of OSPF or IS-IS routers with MPLS LSRs is needed to simulate real world conditions.

To achieve this, the IPv4 Routing Emulation Software provides OSPF and IS-IS emulation capabilities with MPLS and TE extensions to allow full multi-protocol routing switching simulation. Using the OSPF and IS-IS emulation capabilities, virtual topologies can be constructed. RSVP LSPs consistent with these virtual topologies can then be established. These can be combined with unlabeled and labeled data packet generation and analysis.

Stress and verify RSVP implementations

Internet routing and switching is a complex task, and the increasing use of the Internet places an even heavier processing load on routers and switches. As a result, stress testing is critical to establishing whether a router, switch or network will be able to sustain the loads expected when deployed.
With Agilent N2X the RSVP emulation capabilities can be used to stress a single router, switch or network. A large number of LSP requests can be initiated, responded to or torn down when simulating edge LSRs. For interior LSRs, virtual topologies can be constructed by using IGPs such as IS-IS or OSPF by advertising Link State PDUs. LSPs consistent with these virtual topologies can then be initiated, responded to or torn down. By varying the advertising Link State PDUs over time, dynamic changes in an MPLS network can be simulated.

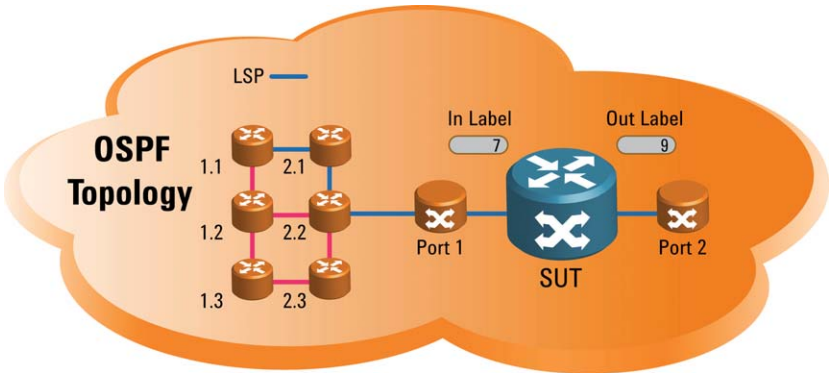

Figure 1: A typical MPLS protocol test scenario

Determine RSVP protocol scalability limitations

MPLS technology is being deployed at a staggering pace, creating a strong need for MPLS protocol stability and scalability testing. As the size of Label Forwarding Information Bases, and the number and rate of LSP requests managed by routing devices continue to increase, it is critical to determine the aggregate number of LSPs the device can successfully support.

Determining the MPLS protocol scalability limitations and robust operation of a router or network requires a test solution that exceeds the scalability of an MPLS protocol implementation. The RSVP protocol emulations in the MPLS Signaling Emulation Software scale to surpass the protocol performance of a router or network, and reliably determine its ultimate protocol scalability limitations.

Testing RSVP high availability capabilities

Network convergence is demanding increased reliability and uptime in MPLS networks. As legacy services (such as ATM, frame relay and leased line data) are migrated onto a single MPLS infrastructure, the robustness of that network is becoming a top priority. High Availability protection and recovery mechanisms have been developed to meet the increased reliability and uptime demanded by the converged network.

RSVP's graceful restart (GR), fast reroute (FRR) and make-before-break (MBB) capabilities are all mechanisms being used today to ensure high availability of the network. Testing and characterizing the behaviour of these features requires a test solution that fully supports the GR/FRR/MBB protocol extensions. Graceful Restart capabilities include emulation of a 'Helper' (cooperating neighbour) to a restarting node, as well as emulation of a restarting node itself to test 'Helper' functionality. The MPLS Signalling Emulation Software can work in conjunction with N2X's comprehensive traffic generation and analysis capabilities to quickly and reliably determine the effectiveness of these high availability mechanisms, validate that traffic continues to flow uninterrupted during a fail-over, measure any packet loss, and verify correct operation under scaled conditions.

Flexible RSVP Messaging

Craft any RSVP PDU and send it over an existing session. This unique feature enables users to:

- Perform negative testing to verify the resiliency of their RSVP implementation.
- Define custom messages specific to their implementation and test product differentiators.
- Keep abreast of new standards without requiring software upgrades.

Furthermore, generic object definition provides for the customization of path messages. This powerful patented feature is XML based, allowing any customer to rapidly and easily extend the PDU definitions.

RSVP Technical Specifications

This section contains the RSVP features of the MPLS Signaling Emulation software that are accessible using the GUI and Tcl/TK scripting environment. Simple point and click actions enable you to dynamically change the environment being tested.

RSVP Emulation

Refresh Period	
L-Timer Constant	
Hello Signaling	
Hello TTL	
Hello Interval	
Hello Timer K	
Reliable Messaging	Enable/Disable Initial Timeout Exponential Backoff Retry Limit Maximum Ack Delay
Summary Refresh	Enable/Disable
Bundle Message Generation	Enable/Disable
GRE Tunneling	Enable/Disable Tunnel End Point Address
Graceful Restart	Enable/Disable
Fast Reroute	Fast Reroute object Detour object
Make-Before-Break	Automatic Manual (Primary/Secondary)

RSVP Messages Supported

PATH
RESV
PATH TEAR
RESV TEAR
HELLO

PATH Message Fields

Common Header	Automatically derived from the objects present
Session	Including the extended Tunnel Id
RSVP Hop	May be automatically derived from the test interface address
Label Request	Protocol and ranges may be specified, including IP, ATM and Frame Relay styles
Session Attributes	Including Setup and Hold priorities, Flag Bits and Name fields Policy Data
Sender TSPEC	QoS and integrated services are supported
Sender Template	LSP-IDs may be specified on a peer/tunnel basis
ADSPEC	QoS and integrated service models are supported

RESV Message Fields

Common Header	Automatically derived from the objects present
Session	Including the Extended Tunnel Id
RSVP Hop	May be automatically derived from the test interface address
Time Val	Upstream refresh interval
RESV-Confirm m	IP Address
Style	Fixed Filter (FF) and Shared Explicit (SE) are supported
FLOWSPEC	QoS and Integrated Services are supported
FILTERSPEC	Derived from the incoming PATH message
Label	A value derived automatically from the Label Manager

Analysis

Statistics can be displayed and saved. Update intervals can be specified in seconds, with a minimum of one second. Numerical, graphical and snapshot save to file representation is available.

Duration	
PATH	Count, rate
PATH TEAR	Count, rate
RESV	Count, rate
RESV ERR	Count, rate
RESV TEAR	Count, rate
Tail End Tunnels	Count, rate
Head End Tunnels	Count, rate
RESV L Timer expirations	Message/s
PATH rate	Message/s
RESV rate	Message/s
HELLO	Count, rate
ACK	Count, rate
NACK	Count, rate
SREFRESH	Count, rate
BUNDLE	Count, rate
RESVCONF	Count, rate
Out of order messages	Count, rate
Message retransmission	Count, rate

Applicable RSVP Standards

- **Resource ReSerVation Protocol, RFC 2205**
- **Multiprotocol Label Switching Architecture, RFC 3031**
- **Extensions to RSVP for LSP Tunnels, RFC 3209**
- **RSVP Refresh Overhead Reduction Extensions, RFC 2961**
- **MPLS Support of Differentiated Services, RFC 3270**
- **Fast Reroute Extensions to RSVP-TE for LSP Tunnels, RFC 4090**
- **RSVP-TE Graceful Restart, RFC 3473 (Section 9)**

LDP Overview

Agilent's MPLS Signaling Emulation Software provides a comprehensive set of capabilities for testing LDP/CR-LDP-based MPLS implementations. It enables the simulation of edge and intermediate/core label switch routers (LSRs).

Each simulated LSR has the ability to initiate Label Request messages to request label switched paths (LSPs) or respond with Label Mapping messages to upstream Label Request messages. It also has the capability to generate unsolicited Label Mapping messages to establish LSPs. With full control of message contents, positive and negative testing can be achieved.

Labeled packets can then be generated to verify appropriate switching. The labels for these packets can be established via the signaling protocol or can be manually provisioned. Up to 8 levels of labels can be generated.

When combined with the OSPF and IS-IS emulation capability of the IPv4 Routing Emulation Software, the LDP/CR-LDP emulation software will allow for comprehensive testing of real world multi-protocol routing and switching applications.

This capability is ideal for testing traffic engineering through MPLS with an underlying internal gateway protocol such as OSPF or IS-IS.

Network reliability and High Availability techniques are now a critical part of MPLS networks. Agilent's N2X supports graceful restart for LDP/CR-LDP allowing users to quantify the robustness of the High Availability mechanisms.

LDP Features

Verification of LDP/CR-LDP signaling and forwarding functions

The MPLS Signaling Emulation Software provides the ability to generate LDP/CR-LDP Label Request and Label Mapping messages, and to verify that these messages are propagated to other LSRs appropriately. It also supports the generation of Label Release/Withdraw and Notification messages to break the LSPs and/or LDP sessions. In addition, labeled traffic may be generated and confirmed.

This enables you to check for appropriate switching of labeled traffic based on initiated LSPs. The MPLS Signaling Emulation Software also supports the LDP Graceful Restart (GR) feature. It is able to set up GR-enabled LDP sessions and trigger the restart mechanism on the device under test to fully test and characterize this important recovery feature.

Simulating real, multi-protocol environments

In real networks, MPLS must interwork with routing protocols. In traffic engineering applications, an IGP such as OSPF or IS-IS will construct a routing topology. The MPLS cloud will provide an overlay on this topology for label-based switching. As a result, simultaneous simulation of OSPF or IS-IS routers with MPLS LSRs is needed to simulate real world conditions.

To achieve this, the IPv4 Routing Emulation Software provides BGP-4, OSPF and IS-IS emulation capabilities with MPLS and TE extensions to allow full multi-protocol routing switching simulation. Using the OSPF and IS-IS emulation capabilities, virtual topologies can be constructed. LDP/CR-LDP LSPs consistent with

these virtual topologies can then be established. These can be combined with unlabeled and labeled data packet generation and analysis.

Stress and verify LDP/CR-LDP implementations

Internet routing and switching is a complex task, and the increasing use of the Internet places an even heavier processing load on routers and switches. As a result, stress testing is critical to establishing whether a router, switch or network will be able to sustain the loads expected when deployed.

With Agilent N2X, the LDP/CR-LDP emulation capabilities can be used to stress a single router, switch or network.

A large number of LSP requests can be initiated, responded to or torn down when simulating edge LSRs. For intermediate LSRs, virtual topologies can be constructed by using IGPs such as IS-IS or OSPF by advertising link state PDUs.

LSPs consistent with these virtual topologies can then be initiated, responded to or torn down. By varying the advertising link state PDUs over time, dynamic changes in an MPLS network can be simulated.

Determine LDP/CR-LDP protocol scalability limitations

MPLS technology is being deployed at a staggering pace, creating a strong need for MPLS protocol stability and scalability testing. As the size of Label Forwarding Information Bases, along with the number and rate of LSP requests managed by routing devices continues to increase, it is critical to determine the aggregate number of LSPs the device can successfully support.

Determining the MPLS protocol scalability limitations and robust operation of a router or network requires a test solution that exceeds the scalability of an MPLS protocol implementation. The LDP/CR-LDP protocol emulations in the MPLS Signaling Emulation Software scale to surpass the protocol performance of a router or network, and reliably determine its ultimate protocol scalability limitations.

Testing LDP High Availability capabilities

Network convergence is demanding increased reliability and uptime in MPLS networks. As legacy services (such as ATM, frame relay and leased line data) are migrated onto a single MPLS infrastructure, the robustness of that network is becoming a top priority. High Availability protection and recovery mechanisms have been developed to meet the increased reliability and uptime demanded by the converged network.

LDP's graceful restart (GR) mechanism is being used today to ensure high availability of the network. Testing and characterizing the behaviour of this feature requires a test solution that fully supports the GR protocol extensions.

The MPLS Signaling Emulation Software can work in conjunction with N2X's comprehensive traffic generation and analysis capabilities to quickly and reliably determine the effectiveness of these high availability mechanisms.

LDP/CR-LDP Technical Specifications

This section contains the LDP/CR-LDP features of the MPLS Signaling Emulation Software that are accessible using the GUI and Tcl/Tk scripting environment. Simple point and click actions enable you to dynamically change the environment being tested.

LDP/CR-LDP Emulation

LDP/CR-LDP Emulation	Hold Timer and Keep Alive Timer for session establishment and maintenance.
Messages Supported	Hello (multicast (link session) and unicast (targeted sessions)) KeepAlive, Address, Address Withdraw Initialization Label Request LDP and CR-LDP) Label Mapping (LDP and CR-LDP) Label Release (LDP and CR-LDP) Label Withdraw (LDP and CR-LDP) Notification (Fatal & Advisory)
Discovery	Basic or Extended
Fault Tolerance Session TLV	Enable/Disable Reconnect Flag Reconnect Timeout Recovery Time
Graceful Restart	Enable/Disable Helper Mode

Ingress LSP TLVs

Common Header	Automatically derived from the interface definition
FEC	User specified values. Supported types: - Host Address - Prefix - CR-LSP
LSPID	(CR-LSP) User specified values
Hop Count	User specified. If Loop detection enabled and no value is specified, then set to a default value
Path Vector	User specified. If Loop detection enabled and no value is specified, then set to a default value
Explicit Route	May be assigned to be a list of Virtual LSRs
Traffic TLV	User specified. Default for CR-LDP are "Best Effort" traffic parameters
Resource Class TLV	User specified
Preemption TLV	User specified
Pinning TLV	User specified
DiffServ TLV	Type E/Type L

Egress LSP TLVs

FEC	User specified values Supported types: - Host Address - Prefix - L2MPLS (VC)
The following TLVs are applicable to Prefix and Host Address FECs	
DiffServ TLV	Type E/Type L
Hop Count	User specified. If Loop detection enabled and no value is specified, then set to a default value
Path Vector	User specified. Set to a default value if Loop detection enabled and no value is specified
The following parameters are applicable to L2MPLS FEC	. VC Type VC ID Group ID C-Bit Interface parameters

Notification Message Fields

Match Criteria	The Notification messages are automatically constructed and sent when the LSPs/LDP Session need to be broken. (Note: these messages are sent in response to the LAST message that was send or received for the LSP/LDP Session).
Status Code	User specified value

Label Withdraw/Release Message Fields

Match Criteria	Match Criteria The Label Withdraw/Release messages are automatically constructed & send when the LSPs need to be broken.
FEC	User specifies values, or can be derived from relevant messages
LSPID	User specifies values, or can be derived from relevant messages

Label TLV	The Label. MAY be specified by the user for "NULL" labels. Else it is a Label that is extracted from the Label Manager

Analysis

Statistics can be displayed and saved. Update intervals can be specified in seconds, with a minimum of one second. Numerical, graphical and snapshot save to file representation is available.

Open LSPs	Count
Label Abort	Count
Number of Egress LSPs	Count
Number of Ingress LSPs	Count
Label Request Messages	Count
Label Mapping messages	Count
Label Release messages	Count
Label Withdraw messages	Count
Notification messages	Count

Applicable LDP/CR-LDP Standards

- **LDP Specification, RFC 3036**
- **MPLS Label Stack Encoding, RFC 3032**
- **Multiprotocol Label Switching Architecture, RFC 3031**
- **Constraint-Based LSP Setup using LDP, RFC 3212**
- **MPLS Support of Differentiated Services, RFC 3270**
- **Fault Tolerance for the Label Distribution Protocol (LDP), RFC 3479**

Additional N2X Features

Easy to use Graphical User Interface

The graphical user interface provides simple point and click features to dynamically define your sessions and generate routes and peers, quickly emulating a RSVP or LDP environment.

Flexible, powerful scripting

Automated scripts are quickly created using the Tcl/TK scripting environment. With only a few lines of code, thousands of networks are easily advertised from simulated peers on any or all ports.

Online Help

An extensive online help system provides complete descriptions and detailed usage instructions. Dialog-level context-sensitive help provides rapid access to the relevant sections of the online help. A technology reference section provides a complete library of background information pertaining to router and switch performance testing.

Generate wire speed traffic

With N2X Packets and Protocols, you can generate a complex, real-world mix of wire speed traffic whilst simultaneously testing the routing and signaling functionality. For example, LSP tunnels can be created and the data forwarding performance of the labeled packets traversing those tunnels can be measured.

Configuration and Ordering Details

To use the E7883A MPLS Signaling Emulation Software, Agilent N2X hardware and software is required.

Hardware

A N2X system is required with:
- System controller
- Chassis
- Interface cards

E7883A MPLS Signaling Emulation Software is supported on all N2X XR/XR-2 cards and XS/XS-2 cards. The N2X XS cards offer up to 2 times the protocol scalability of the XR cards.

E7883A MPLS Signaling Emulation Software is NOT supported on N2X XP or XM cards.

Software

Required software packages are as follows:
- E7881B Packets and Protocols Application Software

Ideally you will also require underlying IGP support to realize the full benefit of the MPLS emulation (recommend E7882A IPv4 Routing Emulation Software and/or E7885A IPv6 Routing Emulation).

Your local Agilent field engineer can provide more details on how to order and configure a test system.

www.agilent.com/find/n2x

Agilent N2X

Agilent's N2X multi-service tester combines leading-edge services with carrier grade infrastructure testing and emulation. The N2X solution set allows network equipment manufacturers and service providers to more comprehensively test new services end-to-end, resulting in higher quality of service and lower network operating costs.

Software and Support Agreement

To protect your investment in the Agilent N2X, every new system includes an initial 12-month comprehensive system-based warranty and Software and Support Agreement (SSA).

Renewing Agilent support services ensures uninterrupted technical support and software upgrades, giving you confidence in N2X throughout the life of your system.

The N2X technical support portion of your SSA includes assistance with product operation and measurements, and verification that the N2X equipment is in correct working order.

Warranty and Support

Hardware Warranty

All N2X hardware is warranted against defects in materials and workmanship for a period of 1 year from the date of shipment.

Software Warranty

All N2X software is warranted for a period of 90 days. The applications are warranted to execute and install properly from the media provided.

This warranty only covers physical defects in the media, whereby the media is replaced at no charge during the warranty period.

Ordering Information

To order and configure the test system, consult your local Agilent field engineer.

Sales, Service and Support

N2X must be serviced by an approved Agilent Technologies service centre, please contact us for more information.

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