Verifying MPLS

OC-192,VPN, 10GbE
What You Need to Know Before You Start

Foreword

Service providers are rapidly upgrading their core optical networks to OC-192c/STM-64c speeds. 10 Gb Ethernet is being hailed as a ground-breaking transport technology for access and metro networks. MPLS is becoming the tool of choice to increase the manageability and reliability of these networks, including providing services such as Virtual Private Networks (VPNs). As a result, it has become imperative that network equipment manufacturers and service providers test MPLS functions and performance over Internet transport technologies at speeds of up to 10 Gb/s.

Regardless of whether your interest lies in implementing MPLS over OC-192, OC-48, 10 Gb Ethernet, or in conjunction with services like VPNs, there are a few basics you need to be aware of. This article identifies the fundamental test capabilities that are essential in order to obtain a realistic verification of your MPLS implementation.

Overview

Even the most basic MPLS test scenario requires a test tool that can quickly and easily accomplish the following tasks:

1. Establish a network topology (the more realistic the better), and ensure that the System Under Test (SUT) can learn that topology.

   This requires an integrated IGP (Interior Gateway Protocol), such as OSPF-TE or ISIS-TE, to advertise a simulated network topology. In a real network, the MPLS signaling protocols (RSVP-TE or LDP/CR-LDP) will rarely operate without an accompanying IGP.

2. Dynamically establish Label Switched Paths (LSPs) through the topology.

   This feature is also crucial, since static LSPs are not supported by most routers.

3. Generate traffic over those LSPs.

   The test tool needs the ability to specify and generate realistic traffic flows of labeled packets over dynamically established paths, then integrate the flows with signaling and routing protocols over the same port. In MPLS testing, this also includes the automatic insertion of labels exchanged through signaling protocols. Manual configuration of the ingress and egress labels on a router is difficult, slow, and not representative of real network scenarios.

4. Measure key performance indicators under a variety of conditions.

   This last key component requires comprehensive capture and analysis tools so you can diagnose performance issues to a level of granularity that allows you to identify and fix the problem.

How these Fundamentals Deliver more Realistic Results

1. Establish a network topology — the more realistic the better

The most fundamental traffic measurements for layer-2 frames or layer-3 packets traversing a SUT are throughput, latency, and loss. For any traffic stream, the SUT needs know the correct destination for test traffic received on its input interfaces.

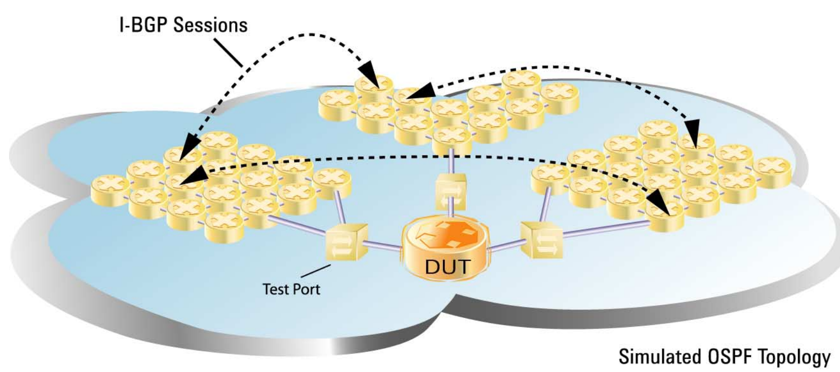
Different protocols employ various means of accomplishing this. For example, Ethernet sends 'learning frames' (ARP requests) to the SUT, ATM or Frame Relay manually configure PVCs or use a routing and signaling protocol to establish a set of SVCs, and IP manually configures static routes or uses a routing protocol, such as BGP-4 or OSPF/IS-IS, to automatically advertise routes. In MPLS, either RSVP-TE or LDP/CR-LDP are used to dynamically establish paths.

The MPLS architecture in a network is complex. The TE-related reachability information used by LDP/CR-LDP or RSVP-TE is installed in the router's link state database by an IGP, such as OSPF or IS-IS (with new traffic engineering extensions). Without this TE information, the router will reject the signaling protocol requests. Therefore, it is essential for the tester to have an automatic routing protocol emulation, and it must be integrated with the signaling protocol emulation.

OSPF itself is a complex routing protocol. A router uses Link State Advertisements (LSAs) to exchange information to peers about its network topology. Traffic engineering LSAs are used to advertise link bandwidth information used by RSVP. The LSAs received by a router must be accurate and consistent for the router to construct a correct link state database. It is difficult and time consuming to manually create the set of LSAs needed to describe the kind of network topologies useful for MPLS test cases.

MPLS signaling protocols create paths through the network, utilizing state information carried by the routing protocols. The signaling protocols assign labels for use between routers. To ensure that MPLS software implementations function correctly, engineers need to simultaneously test both MPLS signaling and routing protocols with TE extensions. To obtain realistic results, protocols need to interact as they would in a 'real world' network.

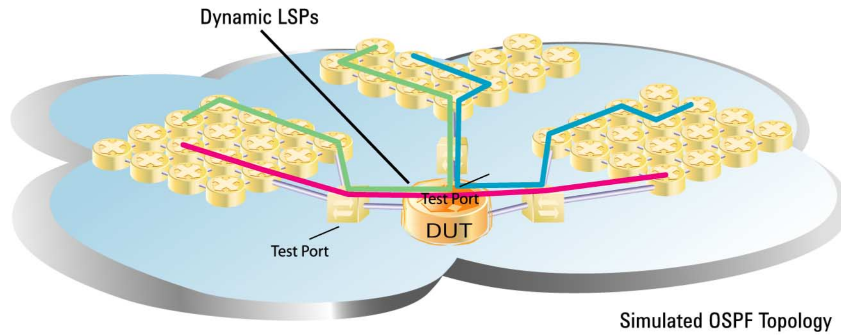
Ideally, an automatic routing protocol emulation with TE extensions should be used to set up a simulated network topology for each test port. The routing protocol will also automatically exchange LSAs with the SUT to quickly and accurately build the link state database(s).



Simulated OSPF network utilizing BGP-4 to advertise topology and establish I-BGP Sessions

2. Dynamically Establish Label Switched Paths (LSPs) through the simulated topology

When establishing paths for MPLS, there is really only one viable option. Most routers do not support static LSPs (Label Switched Paths), so manual configuration is difficult at best, and usually not even possible. A signaling protocol such as RSVP-TE or LDP/CR-LDP must be used to set up paths through the SUT. Ideally you want each test port connected to your SUT to source many ingress tunnels and terminate many egress tunnels. The term 'many' represents whatever real numbers of LSPs your network of devices is expected to handle.



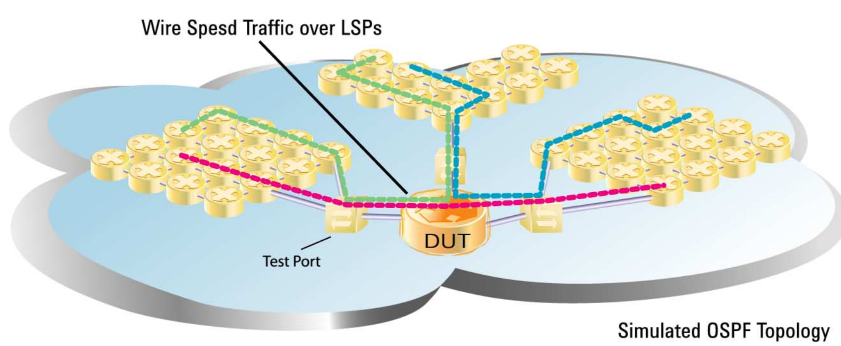
Dynamic Label Switch Paths can be established and torn down.

3. Specify and generate realistic traffic flows of labeled packets over dynamically established paths

A minimal MPLS implementation in a test system would merely support MPLS label encapsulation for transmitted packets. However, this implementation would only be useful for the simplest of MPLS test scenarios. After configuring one or more LSPs, you would need to know the label(s) used by each LSP and manually build the MPLS headers for test traffic.

A better approach would be for the test system to automatically insert the correct label values into each transmitted packet. Once each test port is aware of the respective label assignments from the signaling exchange, the label values will automatically be used for transmitted traffic. By integrating protocol emulation with the traffic generation, the test can actually configure itself. This exactly replicates a real network scenario.

The tester must include IGP emulation (such as OSPF-TE) that shares topology and traffic engineering information with the signaling protocol. In turn, label assignments received by the signaling emulation should be used to configure the traffic generator and measurement system.



Specify and generate wire-speed traffic over dynamic LSPs.

4. Information capture and analysis

Once realistic, labeled data streams can be exchanged between the test interfaces and the SUT, it is important to focus on throughput, jitter, latency, and loss measurements. The test tool needs the capability to log every packet exchanged with the SUT to correctly assess the SUT's forwarding performance. These measurements must be made at realistic data flow rates up to 10 Gb/s for today's networks and devices.

The data measurements will reveal the QoS characteristics of each LSP. This is especially important when looking at more complex MPLS features, such as rerouting and preemption, where data streams are expected to change physical and logical paths in real time.

Agilent Technologies' RouterTester integrates traffic engineering extensions to the OSPF/IS-IS routing protocols to simulate large network topologies into the SUT. RouterTester can then utilize its RSVP-TE MPLS signaling protocol to establish LSPs between any combination of simulated routers. Together, these industry leading capabilities assist test engineers to rapidly validate the traffic engineering capabilities of an SUT.

Closing

In order to achieve this level of realism, even the simplest MPLS test requires a significant amount of protocol intelligence in the test system. So before your next set of MPLS implementation tests, ask yourself these five questions:

- Does my test bed support RSVP to dynamically establish and release LSPs?
- Does my test bed support an IGP (OSPF and/or IS-IS) that can automatically populate the link state database of the router with a realistic topology?
- Can I specify and generate realistic traffic flows of labeled packets over dynamically established paths?
- Are the labels automatically inserted into the headers of transmitted traffic as they would be in a real network?
- Do I have the ability to drill down into test results to identify and debug performance and conformance issues?

Agilent Technologies has been showcasing its comprehensive array of Multi Protocol Label Switching (MPLS) testing capabilities at Supercomm 2001, including industry-first integrated testing of MPLS Traffic Engineering (TE) over OC-192 links and Virtual Private Network (VPN) implementations.

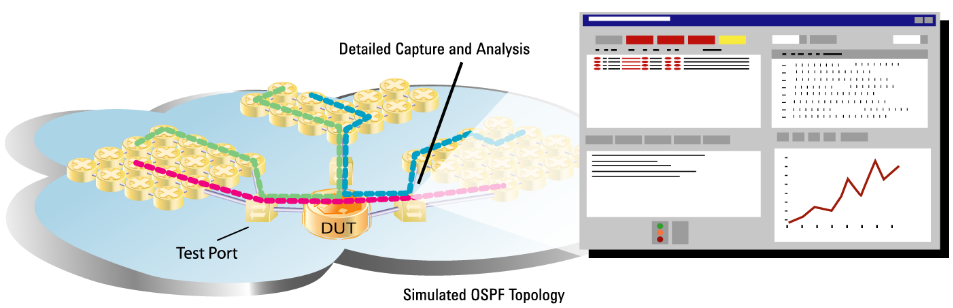
Agilent has been an industry leader in the delivery of test solutions, including the MPLS TE and VPN protocols that increase the reliability and efficiency of next-generation IP networks.

For more information on how Agilent can help verify your MPLS implementation please email:

IPTest@Agilent.com

Or visit

www.Agilent.com/comms/IPTest



In depth analysis is essential to diagnose and rectify implementation issues

June 8,2001
5988-3284EN

Agilent Technologies