Emerging MPLS OAM mechanisms

Answering the interoperability and scalability question

Data Networks Operation

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October 2006

Agenda

Introduction – The Need for MPLS OAM

Comparison: OAM in Legacy & MPLS Networks

Emerging MPLS OAM Mechanisms

- Review
- Development & Deployment Challenges

New Test Methods to help you ensure MPLS Scalability and High Availability

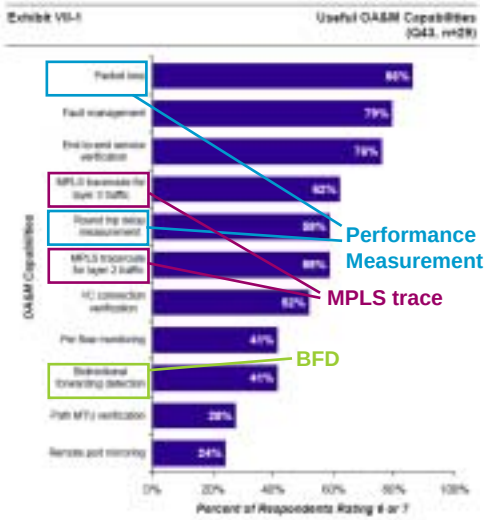
Introduction – The Need for MPLS OAM

MPLS has emerged as the technology of choice for the deployment of next generation converged networks

MPLS-specific operations, administration and maintenance (OAM) mechanisms are being developed to help Carriers support and maintain their MPLS networks

What is OAM?

A collection of mechanisms & processes used to monitor the health of a network and to diagnose problems that might occur within the network



Source: "*Service Provider Plans for IP, MPLS, and ATM: North America, Europe, and Asia Pacific 2005*" – Infonetics Research, December 2005

Comparison of Legacy and MPLS OAM

	SONET & SDH	ATM	MPLS	Carrier Ethernet
Failure Detection and Diagnostics	• Alarms & event indications (LOS, OOF, LOF, LOP, AIS, RDI, LOM…) • Loopback • Path & Section Trace	• Alarm Indication Signal AIS • Remote Defect Indication RDI • F4 (VP) & F5 (VC) end-to-end and segment Continuity Check & Loopback Test	• Bidirectional Forwarding Detection (BFD) • LSP Ping • VCCV • LSR Self-Test	• 802.3 Clause 57 (was 802.3ah) Link Monitoring, Remote Failure Indication, Remote Loopback • 802.1ag CFM for end-end services • ITU Y.1730, Y.1731 • MEF Service needs
Recovery	• APS (50 ms) • LCAS for virtual concatenation	• ATM Protection Switching (I.630) • IMA	• Fast Reroute • Make-before-break	• EAPS (RFC3619), EAPSv2, G.8031 • LACP, RPR • STP, RSTP, MSTP
Performance Monitoring	• BIP-N parity error • Path status	• Performance Monitoring (I.610) (round-trip delay, inter-arrival jitter)	• LSP Ping	• 802.3 Clause 57 Link performance monitoring

MPLS OAM Data Plane Mechanisms

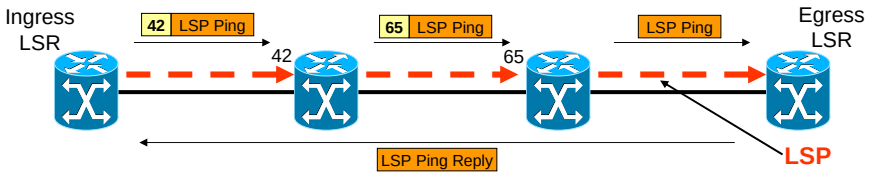
Data plane & LSP tunnel connectivity:

- **LSP Ping** – Ping and Traceroute mechanism customized for operation within MPLS LSP tunnels
- **Virtual Circuit Connectivity Verification (VCCV)** – Used for verifying the connectivity status of MPLS pseudo wires

Link & path connectivity:

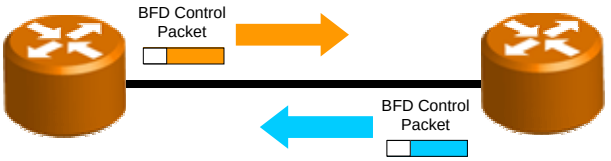
- **Bidirectional Forwarding Detection (BFD)** – Generic lightweight hello protocol use to detect link & path failures between adjacent nodes

LSP Ping Overview



- LSP Ping provides a mechanism for detecting data plane failures in MPLS LSP tunnels
- It can be used to monitor the status of active LSP tunnels by performing connectivity checks
- It can diagnose and isolate LSP faults by performing hop-by-hop path tracing
- LSP Ping is a MPLS-specific variation of traditional IP/ICMP Ping
- LSP Ping Echo packets are encapsulated with the same label stack as used by the LSP. Therefore the Echo packet travels along the exact same path as the LSP
- LSP Ping can operate in two modes:
  - Ping mode is a simple end-to-end loopback
  - Traceroute incrementally verifies each node along the LSP path
- LSP Ping is specified in IETF RFC 4379

Bidirectional Forwarding Detection (BFD) Overview



- Simple, lightweight "hello" protocol used to detect path failures between nodes
- Each node periodically transmits BFD Control Packets across a specific path
- If a node stops receiving BFD packets then some component of the path is assumed to have failed
- IETF BFD working group
  - `draft-ietf-bfd-`**`base`**`-05.txt`
  - `draft-ietf-bfd-`**`mpls`**`-03.txt`
- The participating nodes negotiate how quickly they can send & receive BFD control packets. This negotiated timer will determine how quickly a path failure can be detected
- A BFD path can be any of the following:
  - Direct physical link
  - Multi-hop routed path
  - Virtual circuit
  - MPLS LSP tunnel

Other MPLS OAM Mechanisms

ITU-T Study Group 13

- **Y.1710** – Specifies requirements for MPLS OAM
- **Y.1711** & **Y.1713** – Equivalent to BFD
- **Y.17fw** – Specifies and leverages IETF VCCV and LSP-Ping for LSP tunnel connectivity verification
- **Y.1720** – "Protection switching for MPLS networks" (Nov 2002).

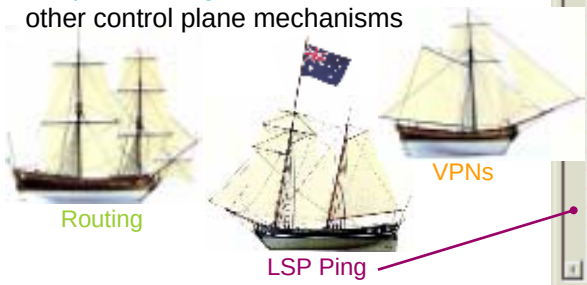
IETF

- **LSR Self-Test** – A mechanism to allow a router to test its own label forwarding engine by using an upstream and downstream LSR neighbor

MPLS OAM Challenges

MPLS OAM is new but unproven… need to test latest devices

- Interoperability: Multiple vendor devices
- Scalability: Stability & performance in large carrier networks, with thousands of tunnels
- "Ships in the night": No interference with other control plane mechanisms



Testing LSP Ping (1)

Validate router LSP Ping implementations

Functionality

- Ping response accuracy
- Trace response data

Negative test (abnormal conditions)

- Inactive and non-existent LSPs
- Incorrectly formed packets
- Unexpected messages (echo reply)

Scalability

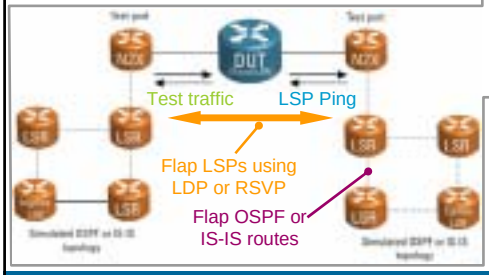
- Stability under load (high ping rate, large meshes of active tunnels)
- Measure performance limits

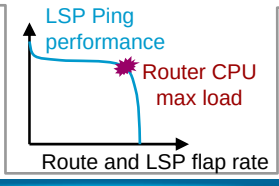
Impact on data plane performance

- Generate LSP traffic; measure packet loss, latency during a LSP Ping "storm"

Impact on control plane performance

- Stress **routing**, **signaling**, **OAM** and **traffic** capabilities simultaneously





Testing LSP Ping (2)

Monitor LSPs and diagnose faults in testbeds and live networks

Switching and Signalling

- Look for LER & LSR faults – during LSP flapping, check LSP setup and teardown
- Using RSVP & LDP, measure LSP setup time and characterize MPLS scalability

High Availability

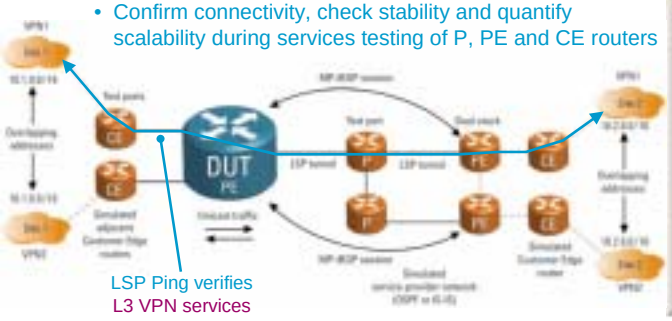
- Gauge MPLS FRR / LSP Switchover time, Make-Before-Break and tunnel pre-emption

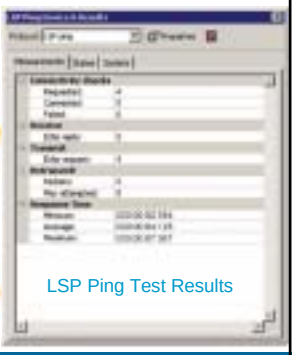
IPv6 Transition

- Test IPV6 BGP/MPLS tunnelling operation

Pseudo-wire and VPN Services

- Confirm connectivity, check stability and quantify scalability during services testing of P, PE and CE routers

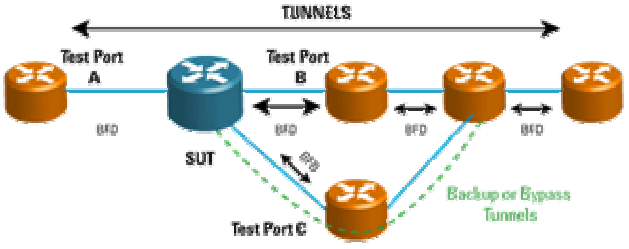




Testing BFD and Fast ReRoute

Verify LSP reroute after BFD goes down

Test that BFD fault detection triggers MPLS Fast ReRoute, and verify service restoration



Test scenario

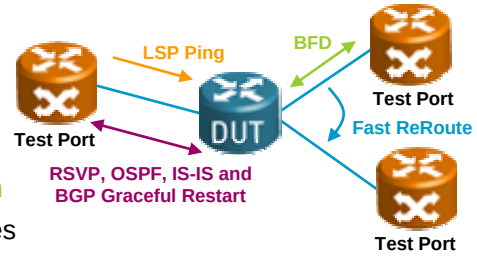
1. Emulate MPLS Routers with BFD; setup multiple tunnels and backup tunnels; use LSP Ping between Test Port A and Test Port B to verify tunnel connectivity
2. Initiate BFD down at Port B, forcing reroute to backup tunnels at Port C
3. Use LSP Ping/Trace to verify connectivity and path (for each tunnel) at Port C, measure fast reroute time, and measure impact of reroute on ping echo delay

High Availability

MPLS OAM complements existing HA technologies

LSP Ping is a **proactive** mechanism that complements other HA technologies, to build confidence in MPLS networks

- Fast ReRoute
- Make Before Break
- Tunnel pre-emption
- RSVP Graceful Restart
- Bidirectional Forwarding Detection
- IP-layer and hardware technologies
  - BGP/IS-IS/OSPF Graceful Restart
  - Non-stop routing



These must be tested together

Creating and Implementing MPLS Test Plans

What to look for in a test solution?

- Comprehensive coverage of MPLS, VPNs, routing, HA, and Multicast
- MPLS OAM protocol emulation
  - Fully integrated software application
- High protocol performance to verify device scalability and stability
  - MPLS: 1,800 LDP sessions or 400,000 LSP tunnels per port
  - Routing: 4,000 BGP sessions/port

VPLS over MPLS Scalability Test

Fast ReRoute / LSP Switchover Time Test

- A complementary guide-book on test methodologies to save time during test plan creation
- Automated tests to save time during test plan implementation

Summary

OAM mechanisms will make MPLS truly carrier-class and ready for real-time services

This introduces new challenges

- Interoperability
- Scalability
- Interference with other control-plane mechanisms

Testing MPLS OAM and other HA mechanisms together will give you confidence in your MPLS network devices, and let you sleep easy!

Questions?