MPLS Architectural Considerations for OAM MPLS Japan

Monique Morrow
mmorrow@cisco.com

Motivation

- **Overview of MPLS OAM Issues**
- **Structure tools to focus in strength areas**

Agenda

- Challenges
- MPLS Architecture
- ITU defined OAM
- LSP Ping
- Application Specific OAM
- MIB Overview
- Cisco Network Health Monitor
- Summary

Challenges

- One tool does not fit all
- Fault monitoring
- Fault detection
- Service Level Agreement Management
- Quality of Service
- Tools that are appropriate

Challenges: An Example

Virtual Circuits	Label Switched Paths
Established via ATM Signaling or Management	Establishment tied closely to control planes
Bi-directional	Usually Uni-directional
Connection oriented	Can be “connectionless”
Single route	May use ECMP
No penultimate popping	Penultimate hop popping
Fixed hierarchy VP/VC	Variable Label Stack

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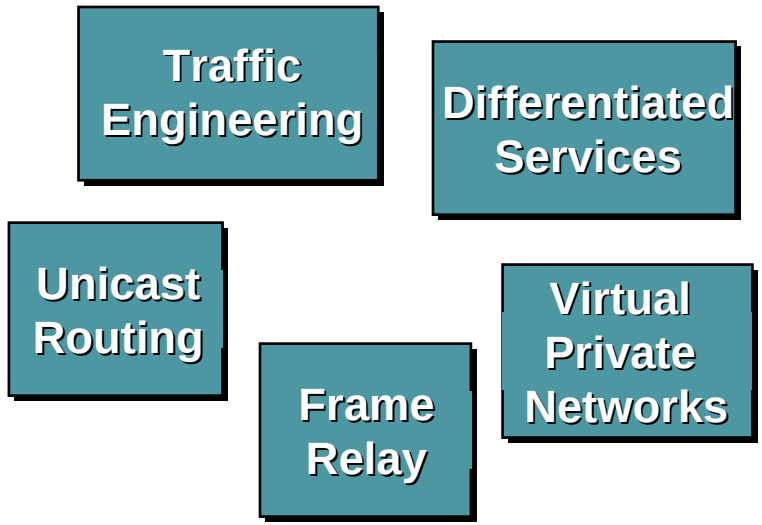
Applications & Labels

- **Applications can directly manipulate label bindings**



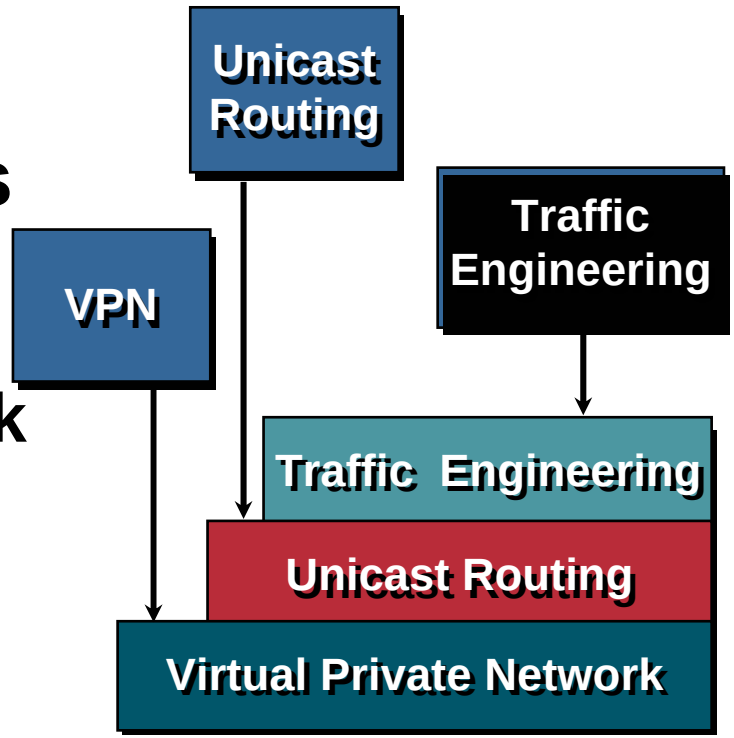
- **Forwarding component**

  Simple label-swapping paradigm

- **Separation allows flexibility**

Label Stack

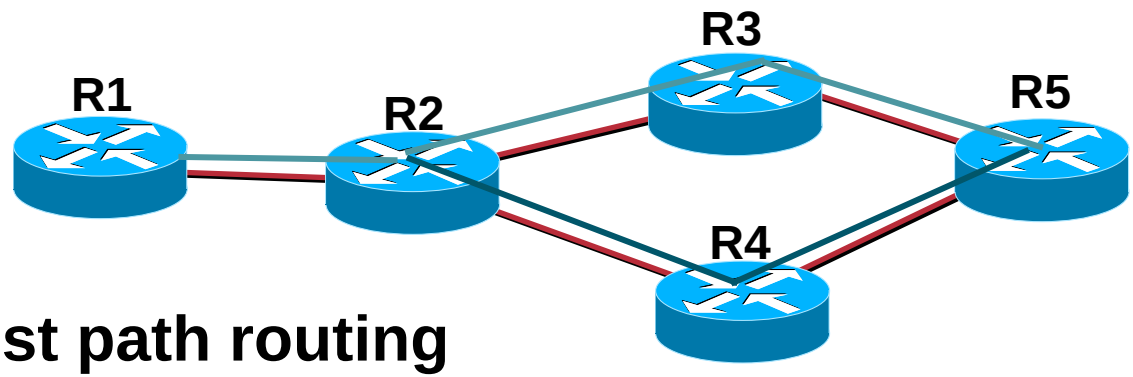
- Arbitrary number of labels
- Label Stack Operations
  - Push- add a label to the stack
  - Swap - replace the top label
  - Pop - remove the top label
- Allows multiple control planes to act on a packet
- Eases the integration of applications



MPLS & IP Routing

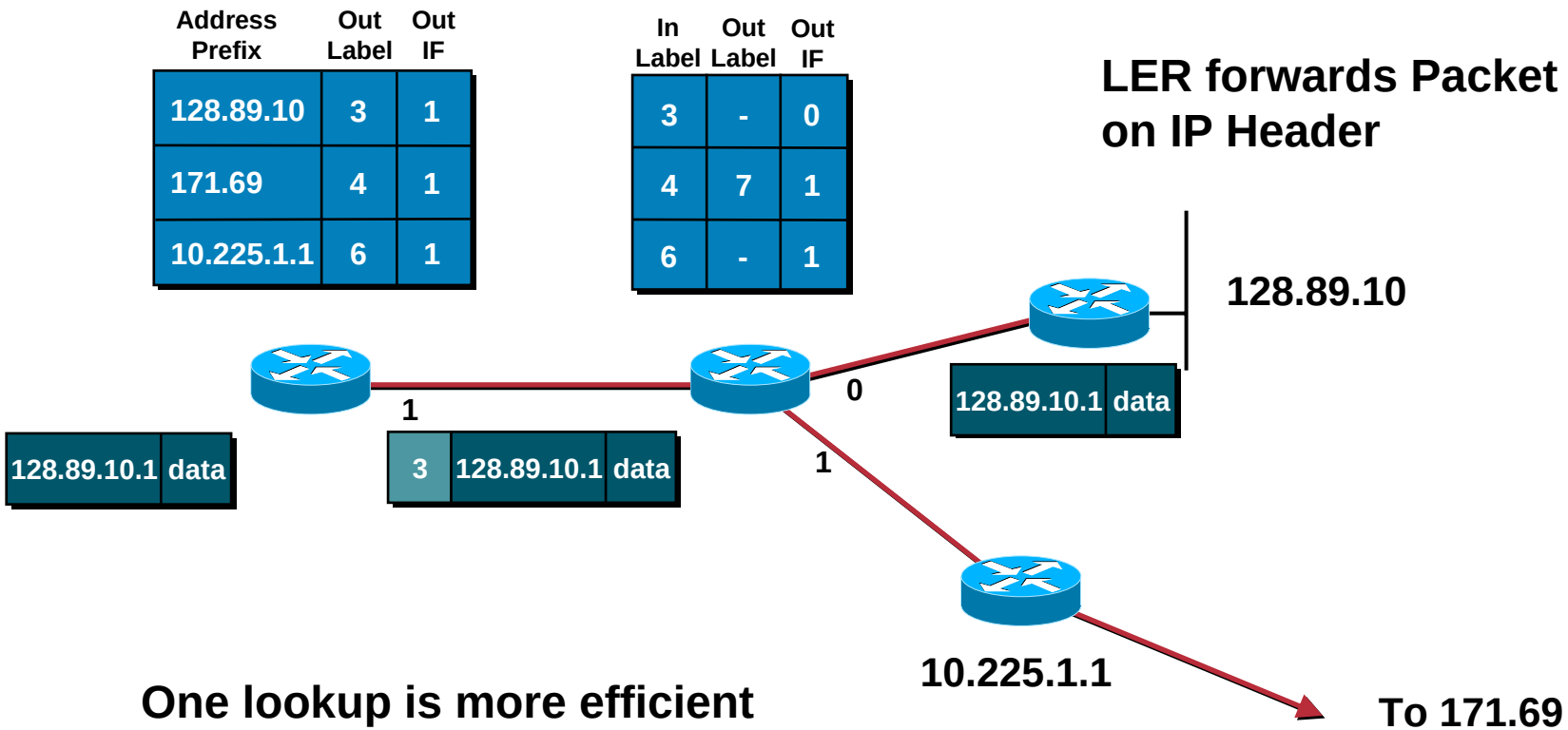
- IP offers a connectionless service
- The primary function of LDP is to distribute labels to support IP routing
- Labels distributed by LDP are under control of the IGP
- IGP LSPs are not static entities
- These LSPs may be rerouted at any node at any time

Equal Cost Multi-Path (ECMP)



- IP uses shortest path routing
- Traffic can be split across multiple shortest paths
- Most deployed label switching boxes use the bottom most label in their ECMP algorithm
- Adding an OAM label at the bottom may change the behavior that is being measured

Penultimate hop popping



One lookup is more efficient than two

Label is no longer available for LSP identification

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ITU MPLS OAM - Y.1711

- Follows closely ATM OAM (I.610)
- Three functions defined
  - Connectivity Verification (CV)
  - Forward Defect Indication (FDI)
  - Reverse Defect Indication (RDI)
- OAM Alert Label
  - Reserved label value (14)
  - Added at bottom of stack to identify OAM packet

Y.1711 OAM Format

44 byte Payload

- Function Type (1 byte)
- Trail Termination Source ID (20 bytes)
  - IPv6 Node ID (16 bytes)
  - LSP ID (4 bytes)
- BIP-16 (2 bytes)
- Other bytes specific to function type

Drawbacks of Y.1711

- LSP Identification (TTSI)
- Equal cost multi-path
- Penultimate hop popping
- Assumption of a fixed path
- Requirement for a reverse path
- Fixed interval between CV Packets

LSP Identification (TTSI)

- LSP ID is not a well defined term
- Each application manages its LSPs independently – no coordination of LSP identification across applications
- Only point of commonality is a low level label database to ensure uniqueness
- 4 byte LSP ID field defined in Y.1711 is too small to use application's native identification
- Use of this field would require a unique space to be managed across applications and that LSP IDs be added to all forms of MPLS signaling

Requirement for a reverse path

- Some OAM functions assume that a reverse LSP exists which can be associated with the forward path
- This kind of association is the exception rather than the rule for most MPLS applications

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Rationales for IP based OAM

- **MPLS is IP-based**
- **All MPLS control protocols are based on the IP protocol suite**

  LDP / BGP / RSVP / PIM

Rationales for IP based OAM (2)

- **The majority of MPLS applications carry IP traffic**
  - **Even most Frame Relay & ATM traffic has IP as its payload**
- **The primary goal of OAM is to ensure the customer is receiving the expected service**

LSP Ping

- **Similar to ICMP (IP) Ping**
  - **Sequence Number**
  - **Timestamps**
  - **Sender Identification**
- **Full identification of FEC based on syntax and semantics of the application**
- **Variable length for MTU discovery**
- **Support for tunnel tracing**

LSP Ping

- Destination address in local host range (127.0.0/24)
  - Detects lack of MPLS connectivity even if there is IP connectivity
  - Range allows coverage of Equal Cost Multi-Paths
- Reply can be via IP or control plane or no reply
- IP reply uses Router Alert to avoid LSPs
- Extensions to support recursive traceroute
  - GTTP – Generalized Tunnel Trace Protocol

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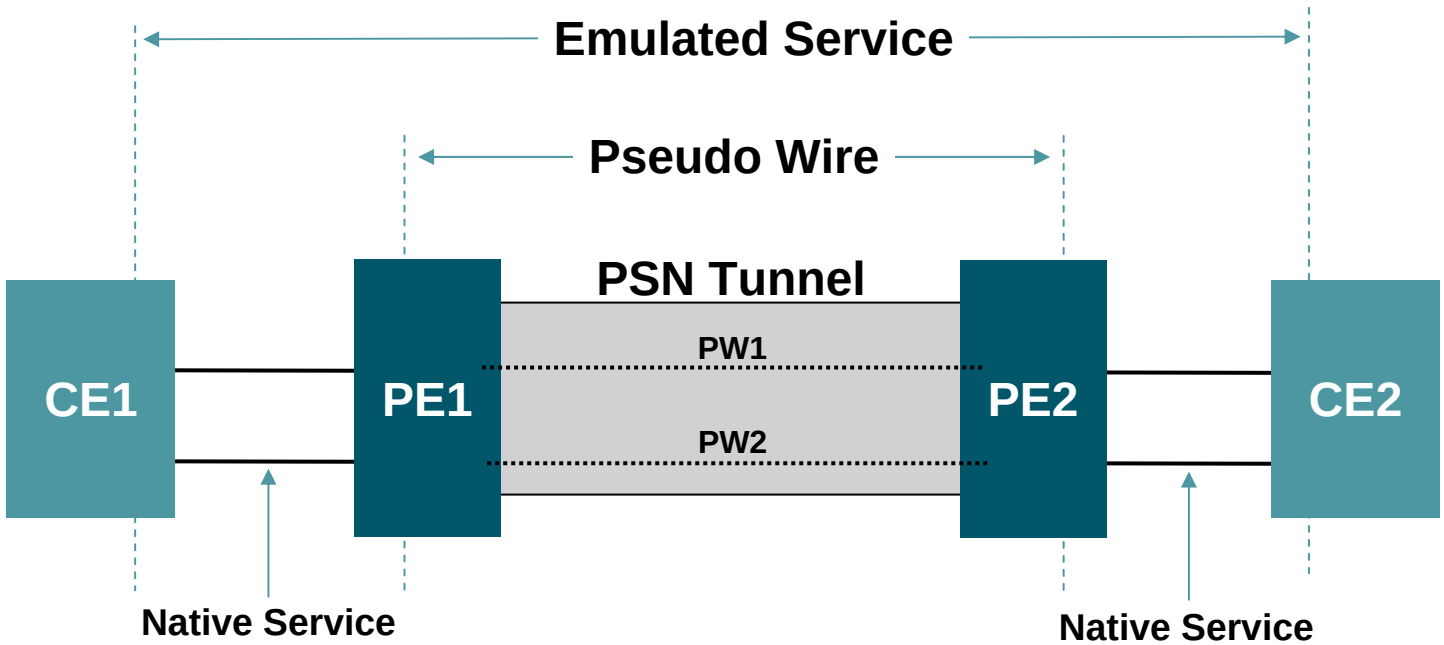
One Size does not Fit All

- **OAM is trying to measure application performance**
- **Most MPLS applications are IP related like MPLS BGP VPN, RSVP-TE**
- **However, some of the services targeted for PWE3 have OAM requirements beyond those provided by the current IP OAM suite**

PWE3 Network Reference Model

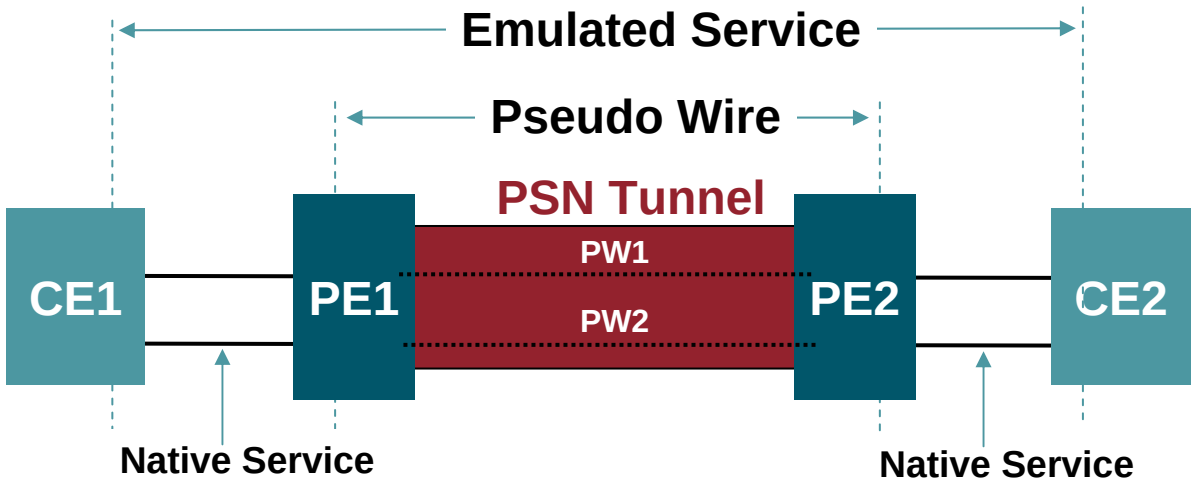


PWE3 does not run exclusively over MPLS

PSN Tunnel may be MPLS, IPSEC, L2TP, GRE,…

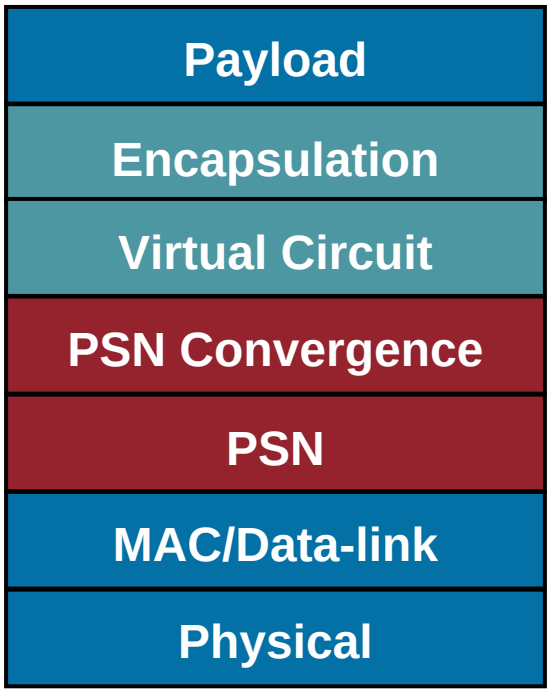
Should PWE3 OAM be tied closely to MPLS?

Monitoring the tunnel



- Tunnels may be MPLS, IPSEC, L2TP, GRE,…
- One tunnel can serve many pseudo-wires
- IP based tools (including MPLS ping) are sufficient to monitor the PSN tunnel
- Verifies PE to PE connectivity
- Frequent monitoring may be appropriate

Pseudo-Wire Protocol Layers



May be null

Pseudo-Wire Demux

Usually null

MPLS, L2TP, IPSEC, etc.

- **Encapsulation could be used to flag OAM**
- **Alert label before or after Virtual Circuit could also be used**

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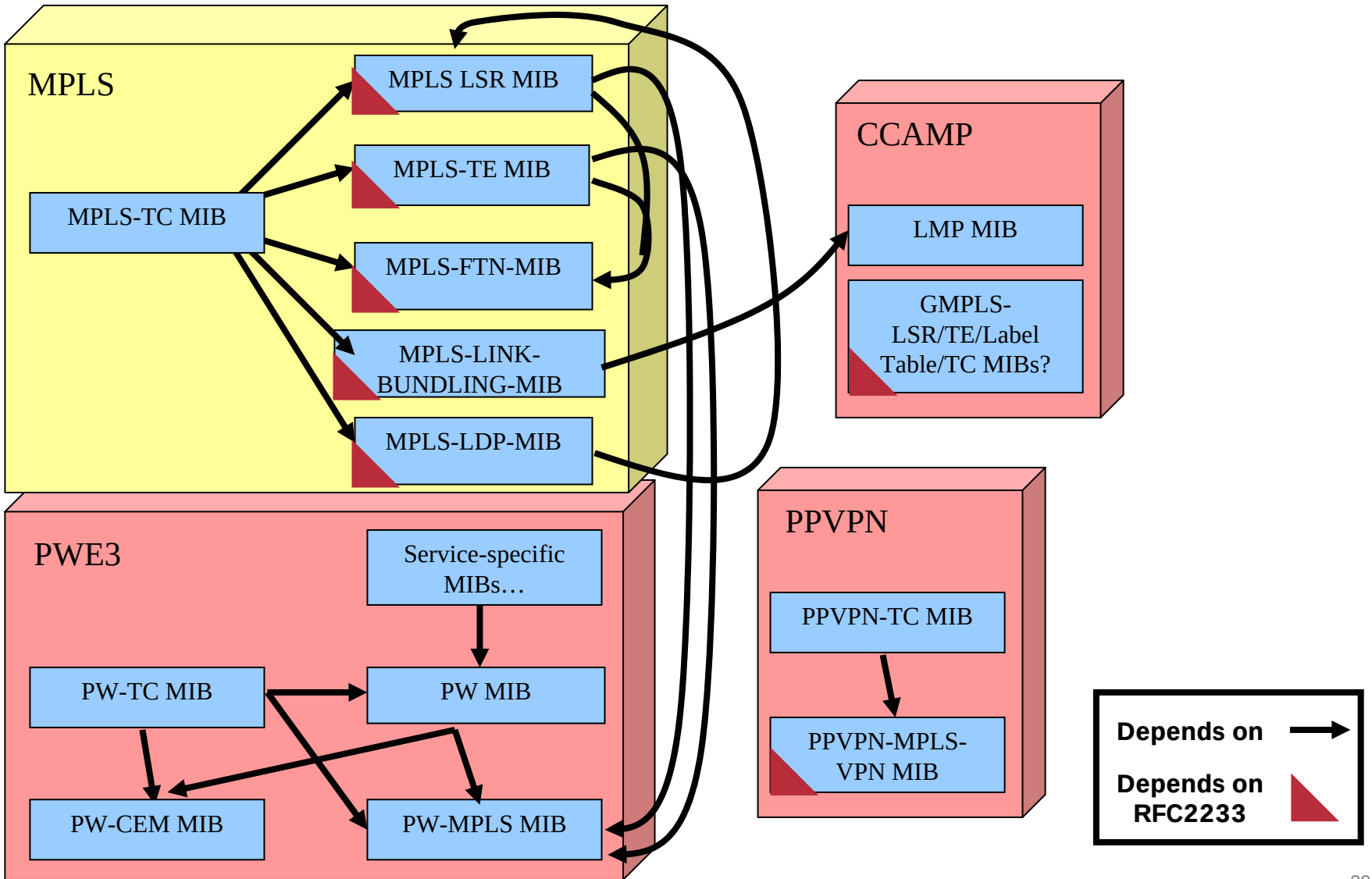
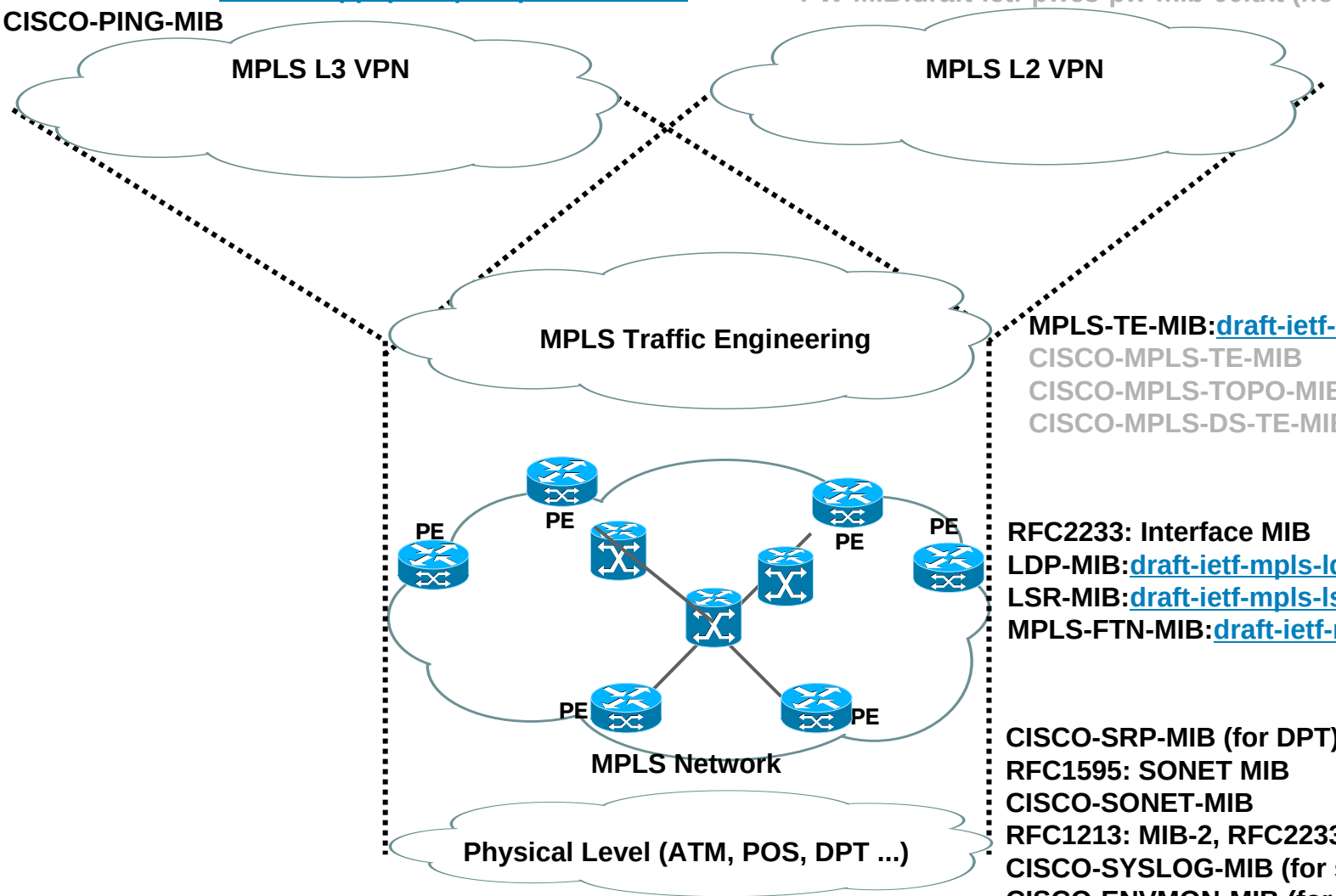
MPLS MIB Overview at a Glance



MPLS based services - MIB

MPLS-VPN-MIB: draft-ietf-ppvpn-mpls-vpn-mib-04.txt
CISCO-PING-MIB

PW-MIB:draft-ietf-pwe3-pw-mib-00.txt (not implemented yet)



MPLS-TE-MIB:draft-ietf-mpls-te-mib-08.txt
CISCO-MPLS-TE-MIB
CISCO-MPLS-TOPO-MIB
CISCO-MPLS-DS-TE-MIB

RFC2233: Interface MIB
LDP-MIB:draft-ietf-mpls-ldp-mib-08.txt
LSR-MIB:draft-ietf-mpls-lsr-mib-08.txt
MPLS-FTN-MIB:draft-ietf-mpls-ftn-mib-04.txt

CISCO-SRP-MIB (for DPT)
RFC1595: SONET MIB
CISCO-SONET-MIB
RFC1213: MIB-2, RFC2233
CISCO-SYSLOG-MIB (for syslog)
CISCO-ENVMON-MIB (for env. monitor)

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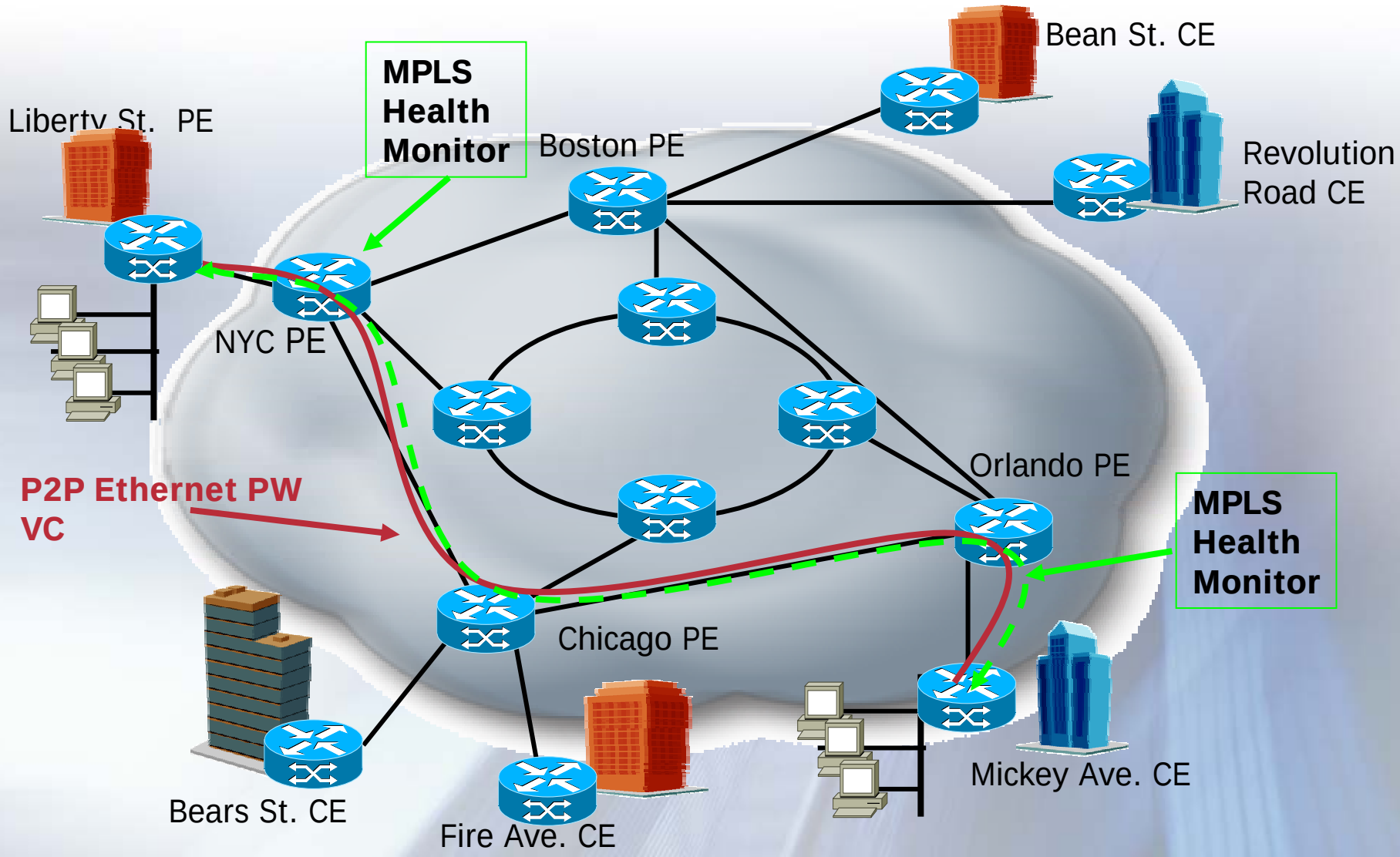
Cisco Health Monitor Application

- **Application residing in IOS that is responsible for:**
  - **Periodically verifying PW VC connection status using MPLS LSP Ping/GTTP.**
  - **Continually monitoring the quality of a VC (e.g.: packet loss, jitter, etc…)**
  - **Automatically take user-programmed corrective actions under curtain circumstances (e.g.: notify tunnel manager to choose alternative tunnel that meets user requirements).**
  - **Significantly automates health monitoring tasks!**

Putting it All Together



Summary

Solution must address MPLS needs

- **Independence of control planes**
- **Uni-directional LSPs**
- **Penultimate hop popping**
- **Equal Cost Multi-Path**
- **Flexible binding up & down label stack**

Summary (2)

- Most current applications offer an IP related service
- IP is the basis of MPLS control planes
- IP based tools make sense

Summary (3)

- Applications vary widely in their OAM requirements
- Adaptable & tunable to application needs
- One size does not fit all
- MIBs enhance tool box
- Cisco Network Health Monitor
- Progress continues!

Thank You