Cisco Canada Plus

Cisco Packet Transport Network – MPLS-TP

cisco

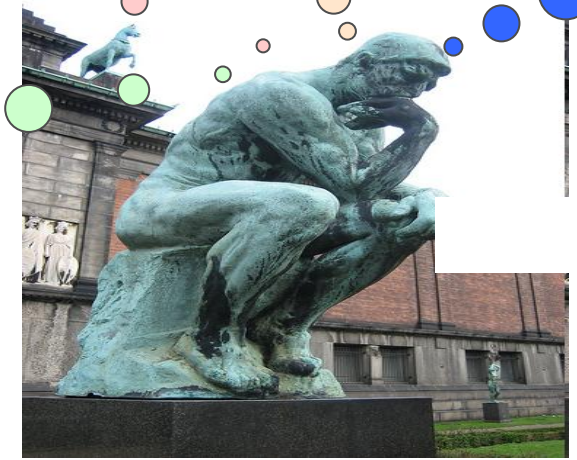
The Challenge

Packet is Growing…
Grow SONET/SDH ?
Transport Reliability

IPTV
EVPL
EPL
L3 VPN
Need Services
VoD
HSI
Business Ethernet
Mobile Backhaul
E-LAN

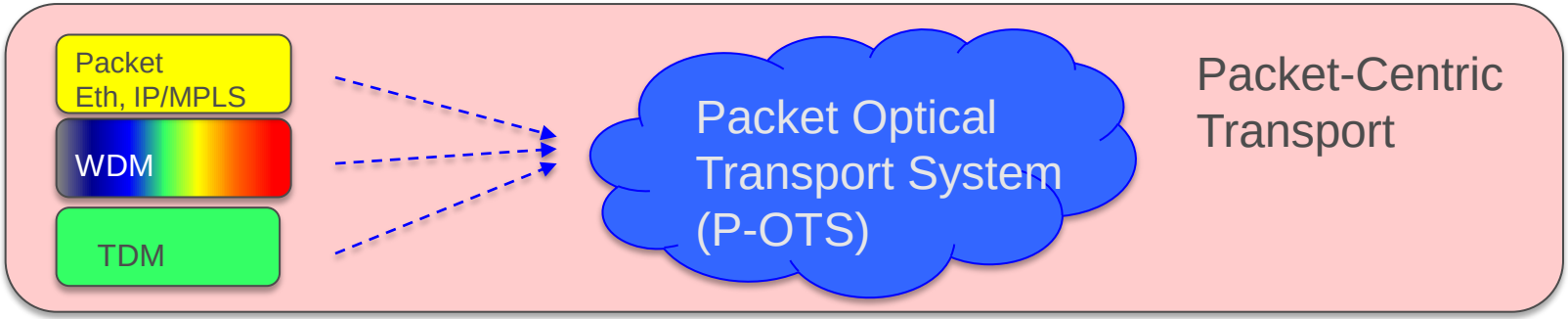
SONET/SDH
PBB
IP/MPLS
WDM
Which Technology ?
OTN
MPLS-TP
PBB-TE
ASON
T-MPLS

ARPU
CapEx
Financials
OpEx
Revenue
Expenses



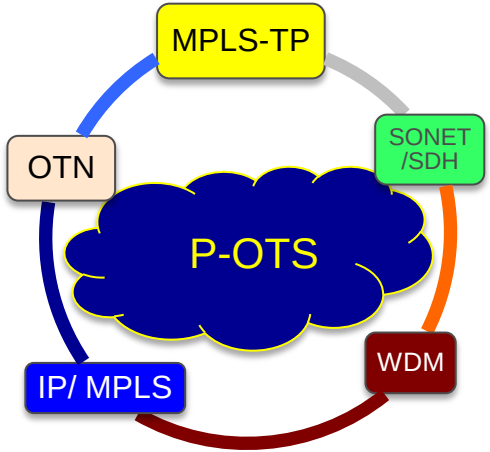
Packet Optical Transport System

(P-OTS)

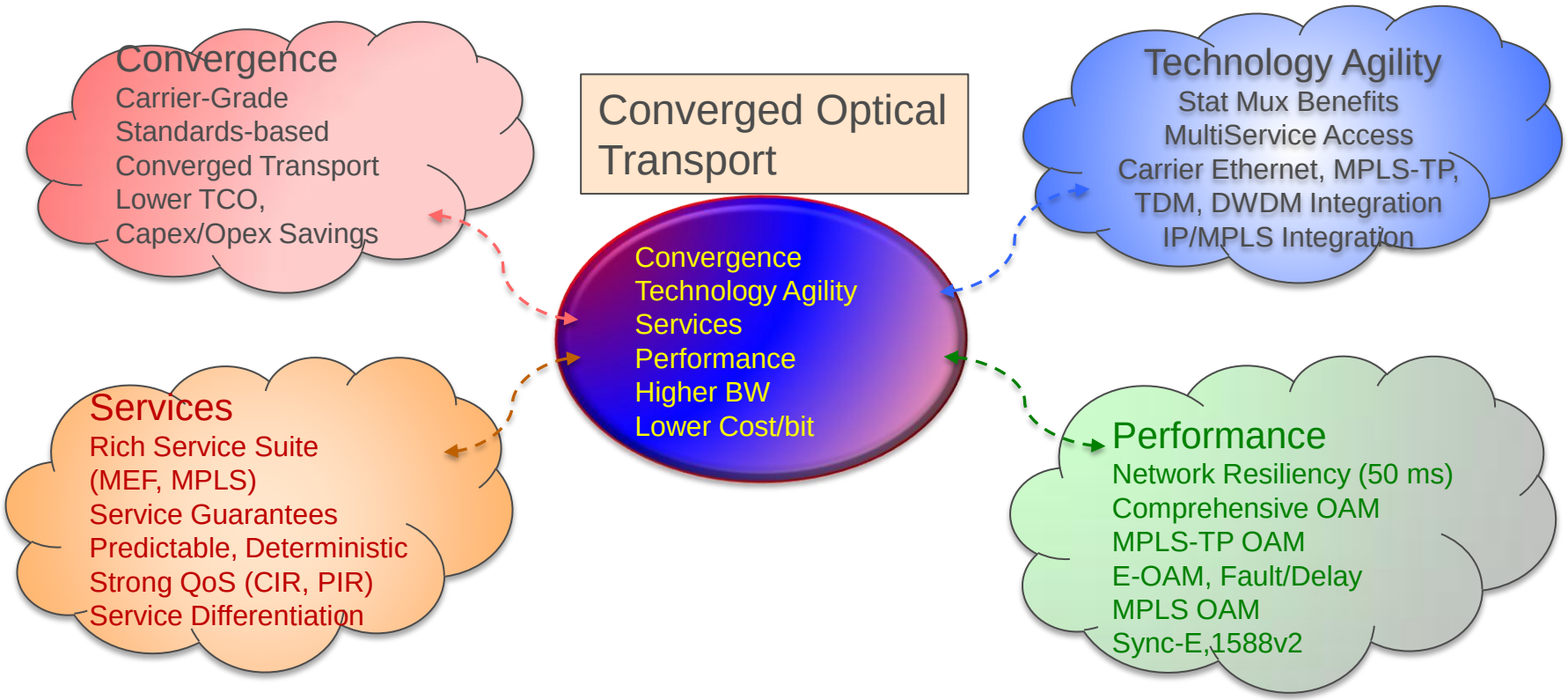


Metro P-OTS Keys

- Predictable, Deterministic
- Resiliency – 50-msec
- Bandwidth Efficiency
- Legacy Support (TDM)
- Integrated ROADM
- Service Scalability
- Granular Service Differentiation
- Network Management
- Higher BW (Tbps), Lower Cost/bit



Cisco Packet Transport



Why MPLS-TP ?

Bringing proven technology to Transport

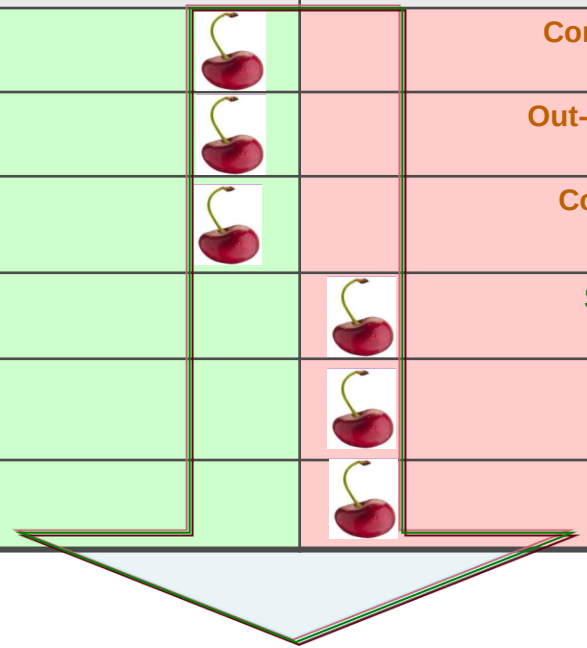
MPLS-TP leverages flexibility of scale of MPLS and adapts it to transport space:

- Transport operational model
- Addresses growth in packet traffic and services
- Service flexibility - P2P private lines, Video transport, Multipoint, best effort traffic as wells as legacy services
- SONET/SDH like SLA and OAM with granular BW provisioning
- High network utilization of transport network
- Capex/Opex Savings as Bandwidth increases
- Efficient Access & Aggregation saves $$$$ in Core

MPLS Transport Profile (TP)

- Converge Data/Transport

Attribute	TDM Transport	Packet Data Network
Connection Mode	**Connection Oriented**	**Connectionless (Except TE)**
OAM	**In-Band OAM**	**Out-of-Band (Except PW, TE)**
Protection Switching	**Data Plane Switching**	**Control Plane Dependency**
BW Efficiency	Fixed Bandwidth	**Statistical Multiplexing**
Data Rate Granularity	Rigid SONET Hierarchy	**Flexible Data Rate**
QoS	One Class Only	**QoS Treatment**



Packet Transport

MPLS Transport Profile (TP)

- Components

Data Plane

- MPLS Forwarding
- Bidirectional P2P and
- Unidirectional P2MP LSPs
- No LSP merging
- No Penultimate hop popping (PHP)
- PW (SS-PW, MS-PW)
- No Routing Required

Control Plane

- NMS provisioning option
- GMPLS control plane option

OAM

- In-band OAM channel (GACH)
- Connectivity Check (CC): proactive (ext. BFD)
- Connectivity verification (CV): reactive (ext. LSP Ping)
- Alarm Suppression and Fault Indication with AIS (new tool), RDI (ext. BFD), and Client Fault Indication (CFI)
- Performance monitoring, proactive and reactive (new tools)

Resiliency

- Sub-50ms protection switch over without IGP
- 1:1, 1+1, 1:N path protection
- Linear protection
- Ring protection

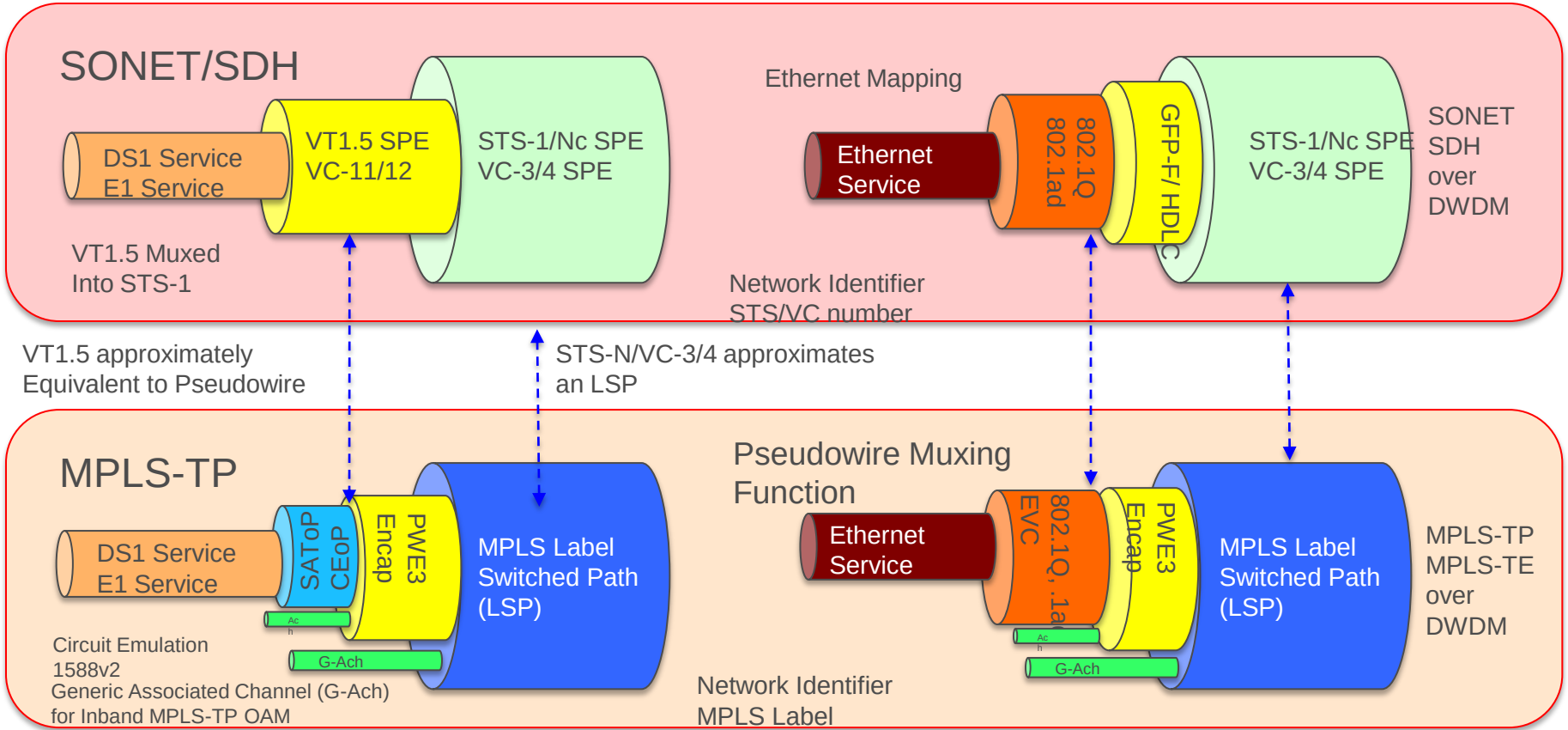
MPLS Transport Profile (TP)

Characteristics

- **Connection-oriented** packet switching model
- **No** modifications to **MPLS** data plane
- **No** IPv4/v6 needed for **packet forwarding**
- Interoperates/interworks with **existing MPLS** and pseudowire control and data planes
- **No** LSP **merging**
- **LSPs** may be point to point (unidirectional, co-routed **bidirectional** or associated bidirectional)
- LSPs may be point to multipoint (unidirectional)
- **Networks** can be created and maintained using **static provisioning** or a **dynamic** control plane: LDP for PWs and RSVP-TE (GMPLS) for LSPs
- **In-band OAM** (fate sharing)
- **Protection** options: 1:1, 1+1,1:N, Ring-Protection (Achieve GR-253 detection and switching times)
- Network operation equivalent to existing transport networks

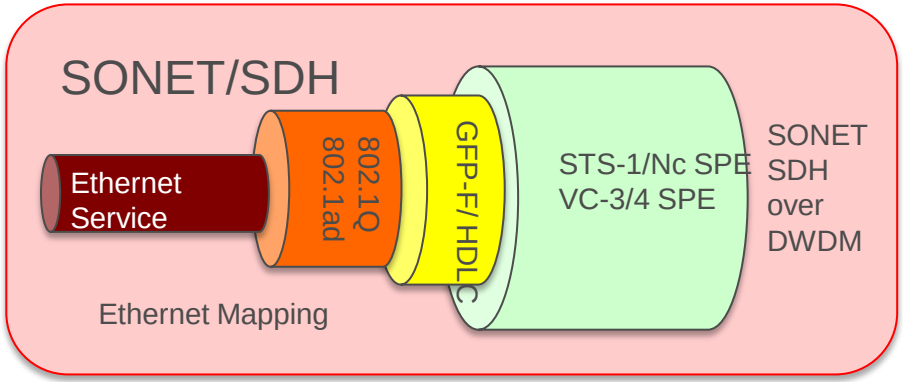
MPLS Transport Profile (TP)

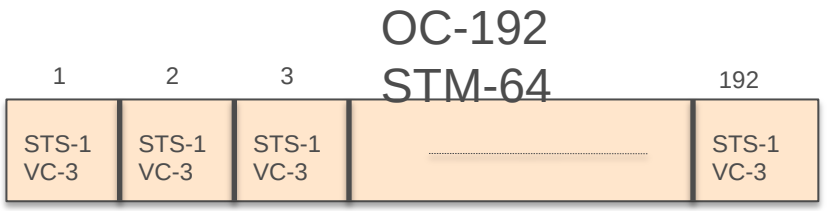
- Encapsulation



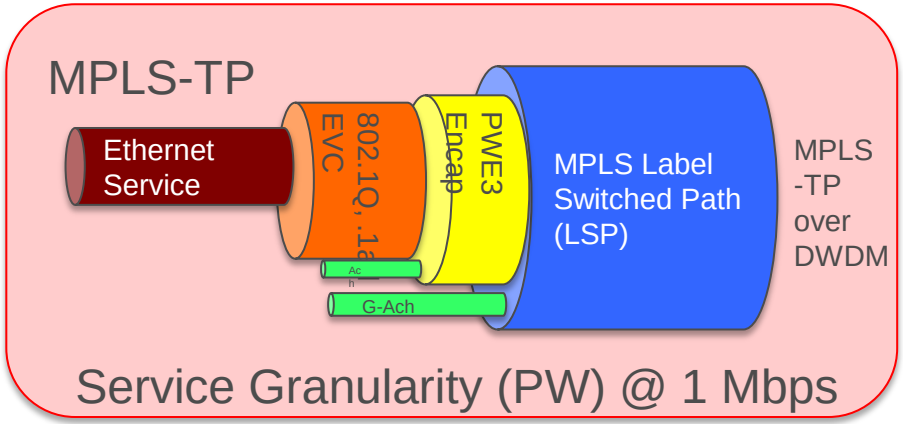
MPLS Transport Profile (TP)

- SONET/SDH Analogy

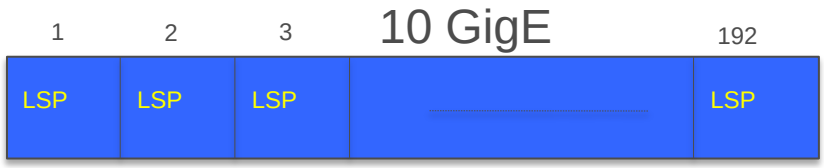




192 STS-1/VC-3 @ 51 Mbps
Fixed SPE
Capped at 10 Gig



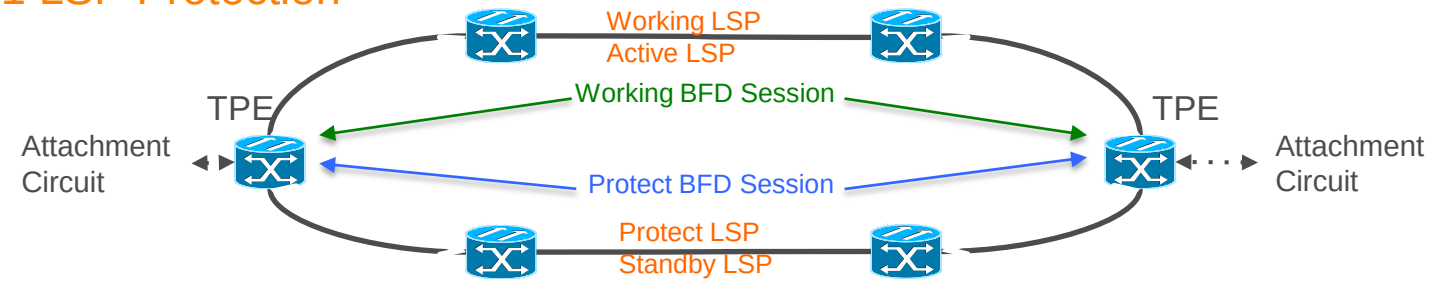
Service Granularity (PW) @ 1 Mbps



192 LSP's @ 51 Mbps CIR
Bandwidth Efficient
Service Scalability & Flexibility
Statistical Multiplexing

MPLS-TP Resiliency

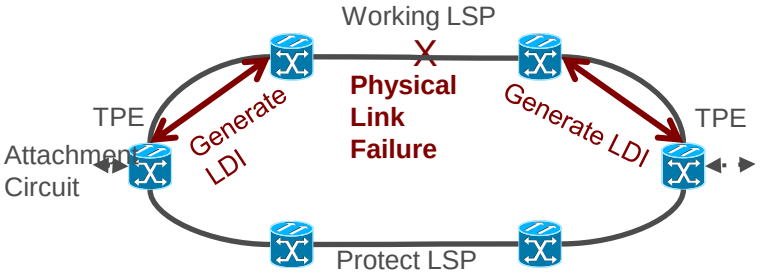
1:1 LSP Protection

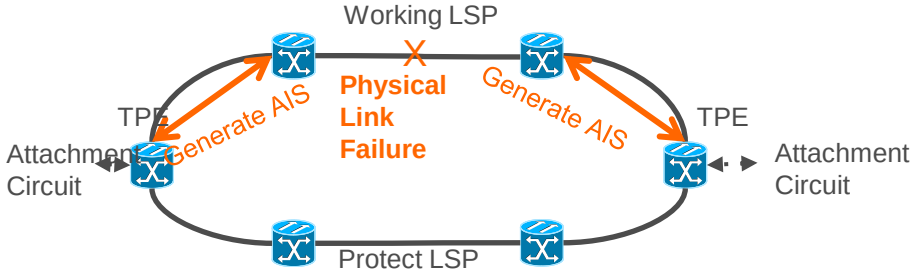


- Working LSP provisioned as Active Path between two TPE's
- Protect LSP provisioned as Standby Path between two TPE's
- Active/Standby home in on same node but different interfaces – Network redundancy
- MIP's are agnostic to Active/Standby Designations
- LSP Fault Detection via BFD, LDI, & Manual APS Switching
- **In 1:1 Protection the Standby Path is idle until APS**

MPLS-TP Resiliency

Link Down Indication (LDI) Fault Detection & AIS



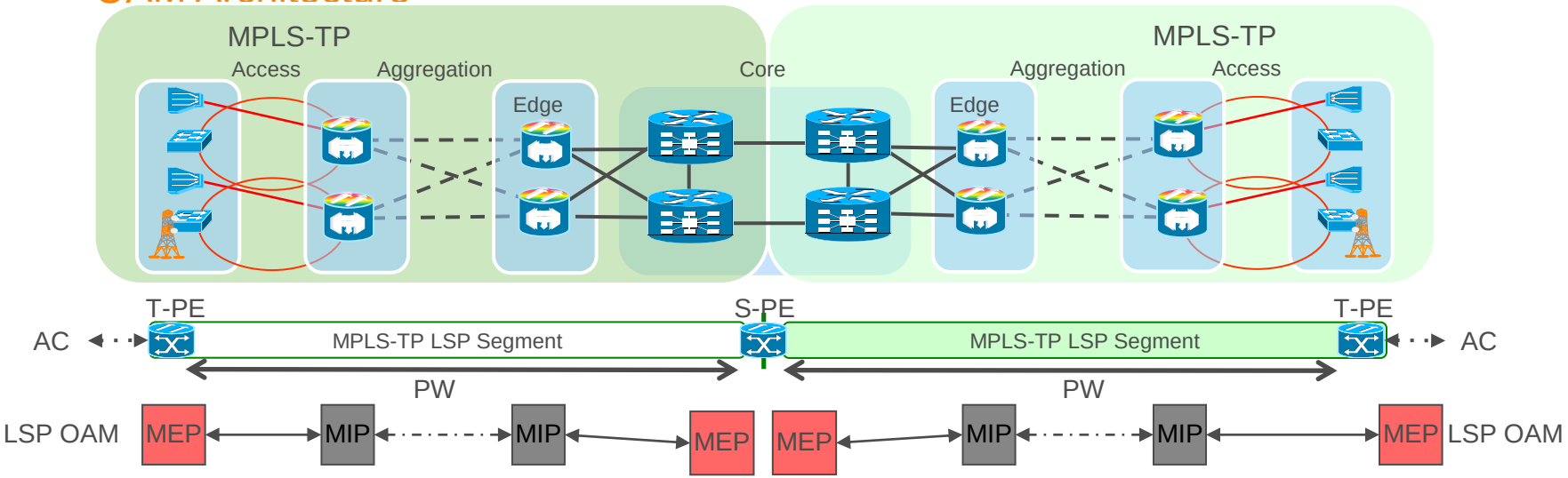


- LSP LDI Generated from MIP
- LSP MEP/TPE receives LDI and triggers protection switching
- MPLS-TP LDI Packet will have GAL Label, GE-ACH Header
- **LDI is equivalent to SONET/SDH AIS**

- LSP AIS Generated from MEP or MIP
- AIS is a transient, If persistent BFD will detect failure, IF LDI is disabled or between MPLS-TP domains
- MPLS-TP AIS Packet will have GAL Label, GE-ACH Header
- **AIS is transient with no consequent APS actions. This is different from SONET/SDH AIS. MPLS-TP LDI is equivalent to SONET/SDH AIS**

MPLS-TP OAM

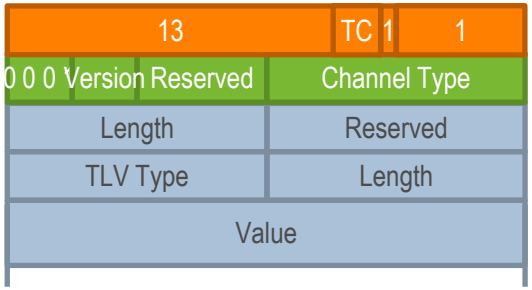
OAM Architecture



- Based on Maintenance Entities
  - Maintenance End Points (MEPs) and Maintenance Intermediate Points (MIPs)
  - Multiple levels
- Maintenance Entities
  - Association of two MEPs
  - Zero or more intermediate MIPs
  - MEPs source and sink OAM flow
  - MIPs can only sink or respond to an OAM flow

MPLS-TP OAM

- MPLS-TP LSP/PW G-ACh Packet Structure



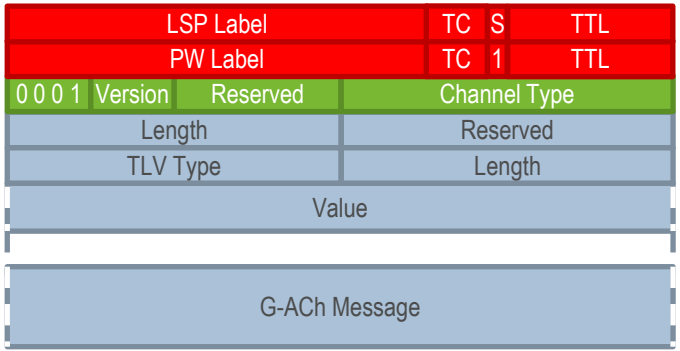
Generic Associated Channel Label (GAL)

Associated Channel Header (ACH)

ACH TLV Header

ACH TLV (e.g Source, Destination, LSP ID, PW ID)

G-ACh Message



LSP Shim Header

Pseudowire Shim Header

Associated Channel Header (ACH)

ACH TLV Header

ACH TLV (e.g Source, Destination, LSP ID, PW ID)

G-ACh Message

MPLS-TP section defined as link connecting two adjacent T-PE

GAL as label stack

Same ACH structure

Existing VCCV ACH (RFC)

Use of GAL not required, but allowed

ACH TLV header defines length of ACH TLV list

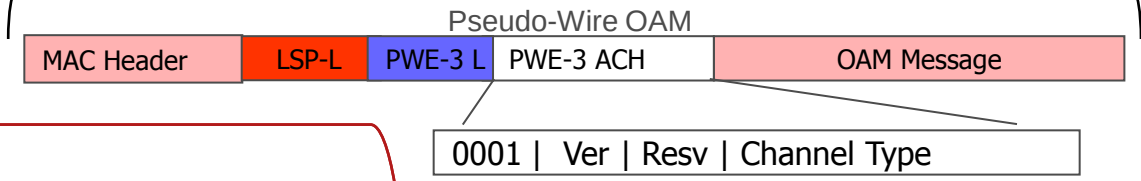
ACH TLVs provide additional context for processing of G-ACH message

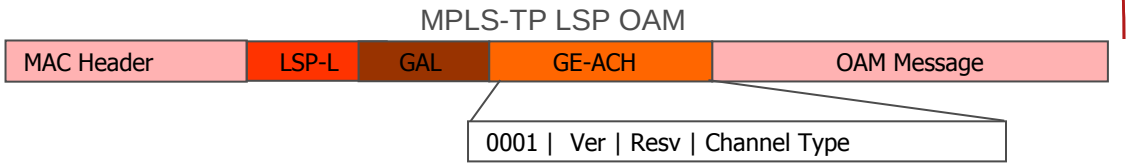
G-ACH message may not require ACH TLVs

MPLS-TP OAM

Associated Channel (A-CH) Processing

- Pseudo-Wire (PW) OAM in MPLS-TP is exactly the same as PW OAM in IP/MPLS
- PW OAM is only processed between MEP's
- PW OAM is defined by the 1st nibble 0001 in the PW control word

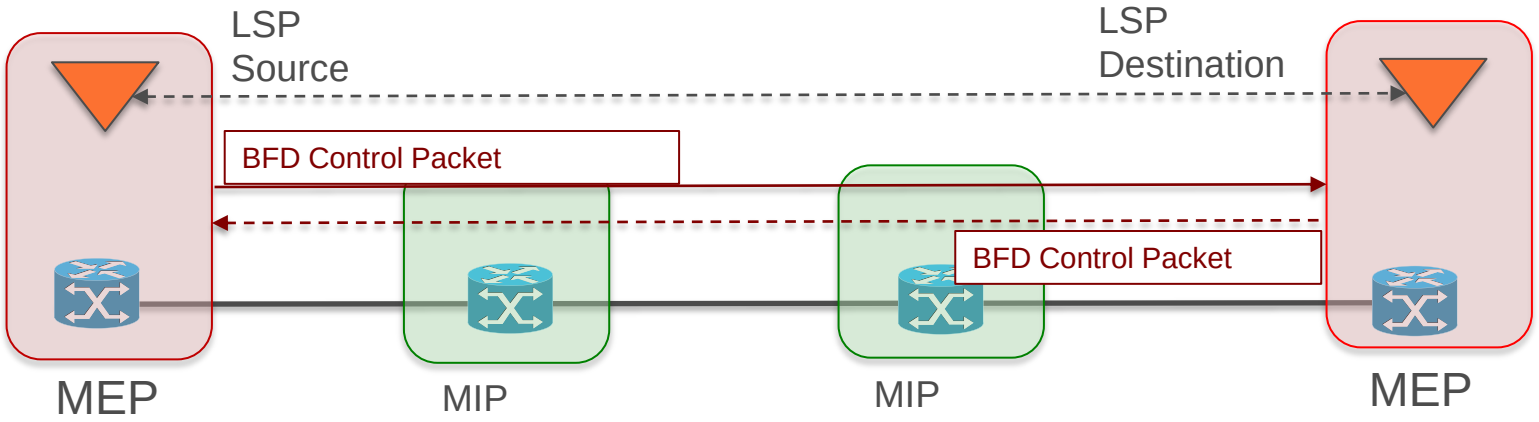




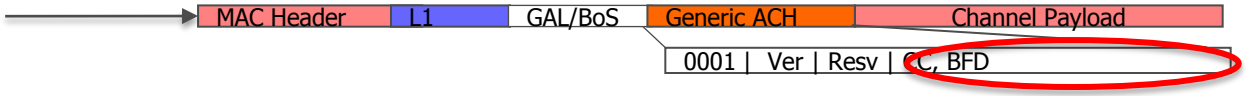
- LSP OAM in-band designated by label 13
- LSP OAM can be processed between MEP's and MIP's

MPLS-TP OAM

LSP Continuity Check (CC) Bidirectional Forwarding Detection (BFD)

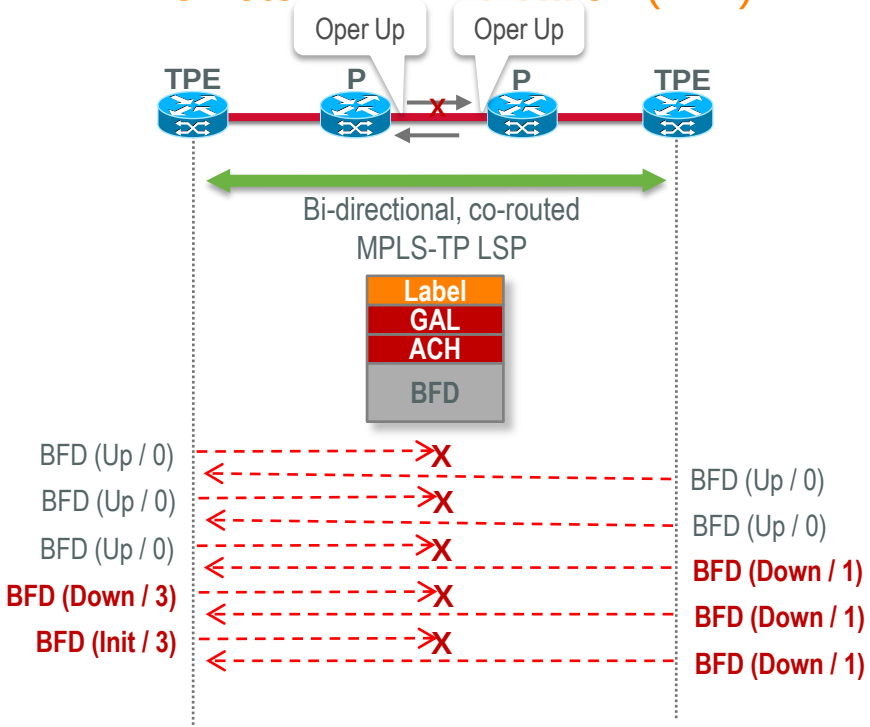


LSP OAM - GAL Label = 13
G-ACH Control Word = 0x01
CC Type = 0x1
Channel Type = 0x7 – BFD



MPLS-TP OAM

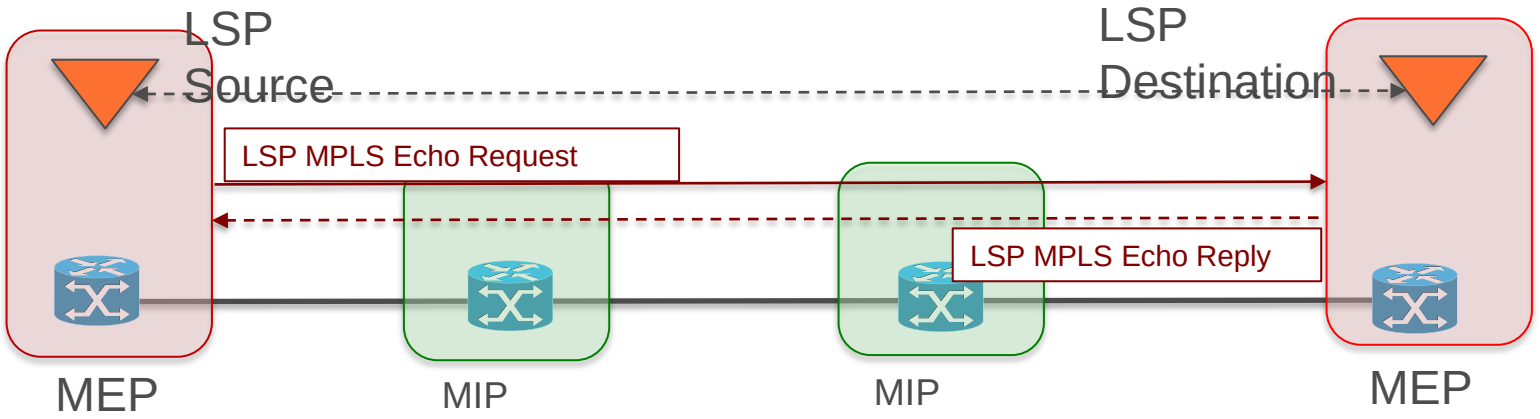
BFD Remote Down Indication (RDI)



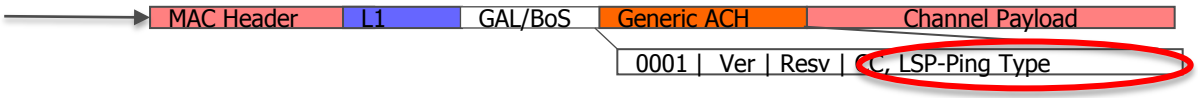
- Failure indication sent by local end point to remote end point
- Sent on direction opposite to failure
- Uses existing BFD diagnostics field
  - 0 - No Diagnostic
  - 1 - Control Detection Time Expired
  - 3 - Neighbor Signaled Session Down
  - 4 - Forwarding Plane Reset
  - 5 - Path Down
  - 7 - Administratively Down
- Diagnostics field indicates reason for last change in session state on an end point

MPLS-TP OAM

LSP Continuity Verification (CV) LSP-Ping

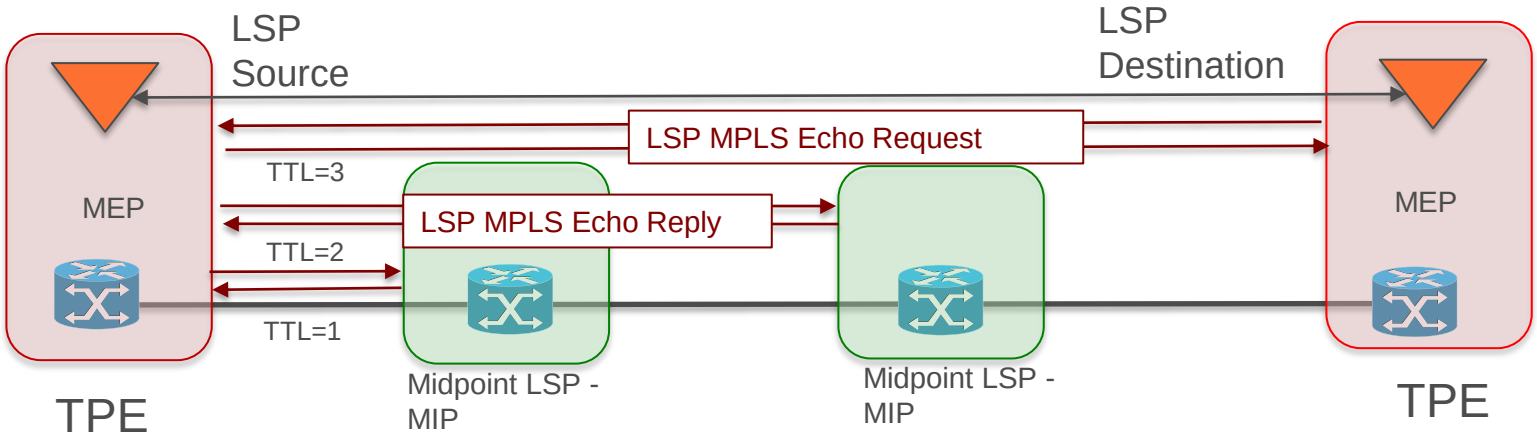


LSP OAM - GAL Label = 13
G-ACH Control Word = 0x01
CC Type = 0x1
Channel Type = 0x1 – MPLS LSP Ping

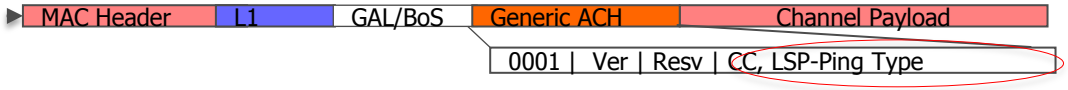


MPLS-TP OAM

LSP Continuity Verification (CV) – Fault Isolation

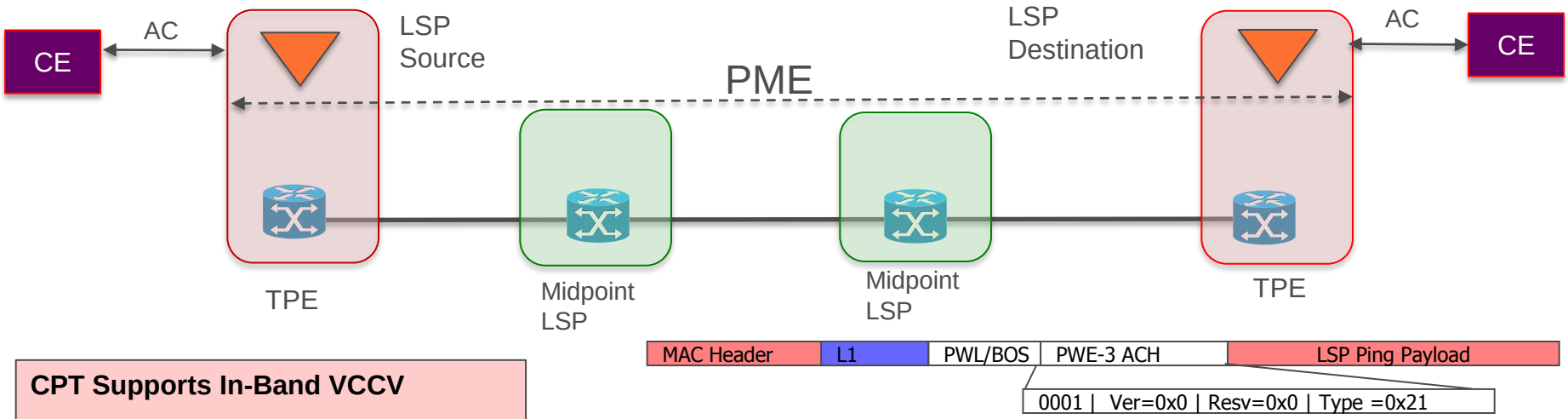


LSP OAM - GAL Label = 13
G-ACH Control Word = 0x01
CC Type = 0x1
Channel Type = 0x4 – MPLS LSP Echo Request



MPLS-TP OAM

Pseudowire Maintenance Entity (PME) – VCCV RFC 5085



CPT Supports In-Band VCCV

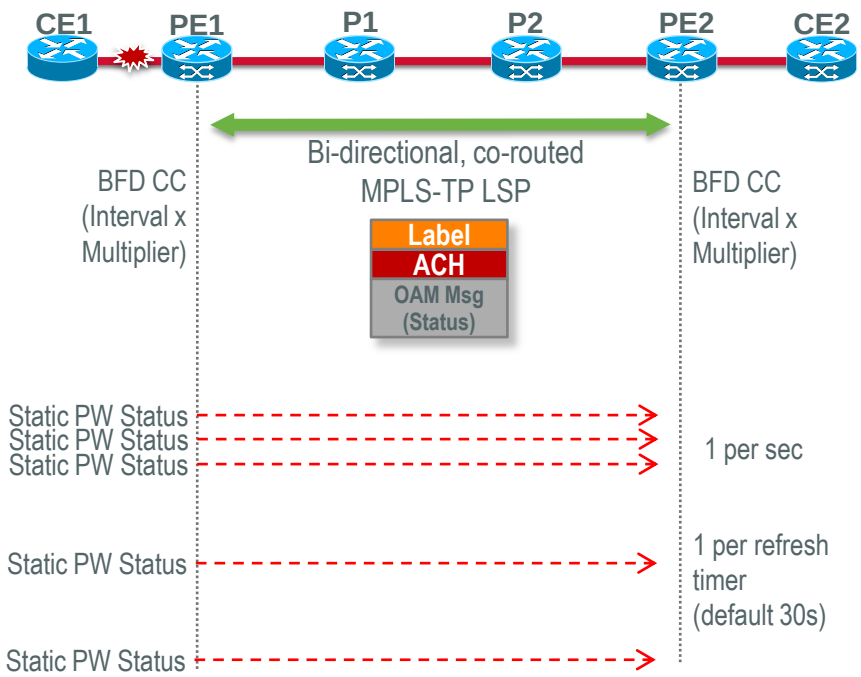
Ethernet PW-ACH (IPv4) = 0x21
Ethernet PW-ACH (IPv6) = **0x57**

PWE3 Control Word (1st nibbles) = 0x1
Channel Type = 0x21 or 0x57
MPLS LSP Ping Payload

On-Demand Continuity Check Between MEPs and MIPs
NMS Retrieval of PW Path to Populate the Global ID of MIPs/MEPs

MPLS-TP OAM

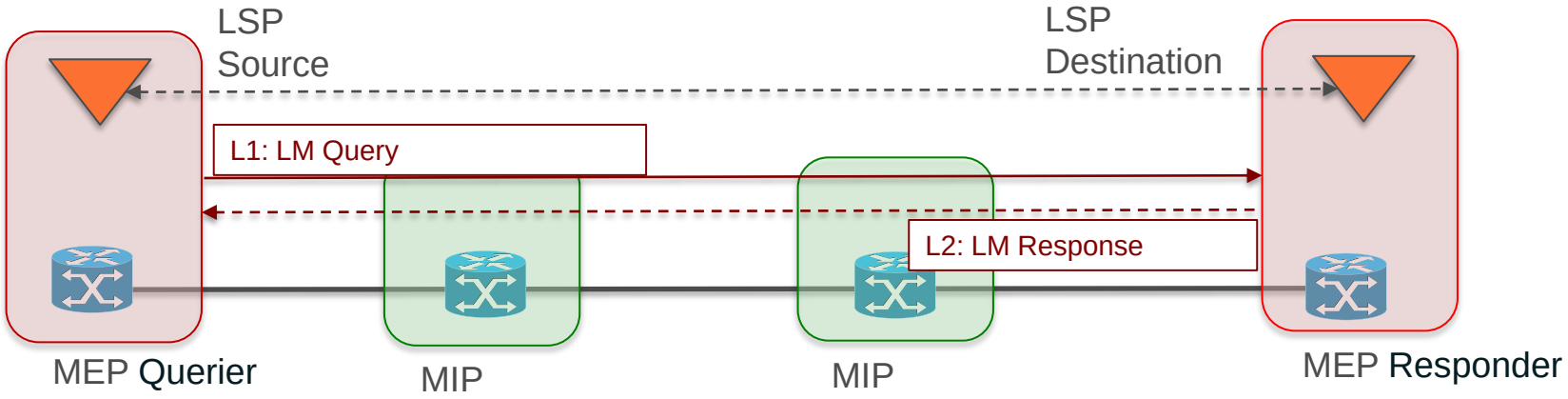
Static Pseudowire Status Notification



- Static PWs require in-band status notification (no LDP notification)
- Existing PW Status TLV sent over G-ACh
- Three messages sent at 1 per sec to set/clear fault then continuous messages sent at a longer interval
- Native service OAM or port shutdown can propagate failure to remote CE

MPLS-TP OAM

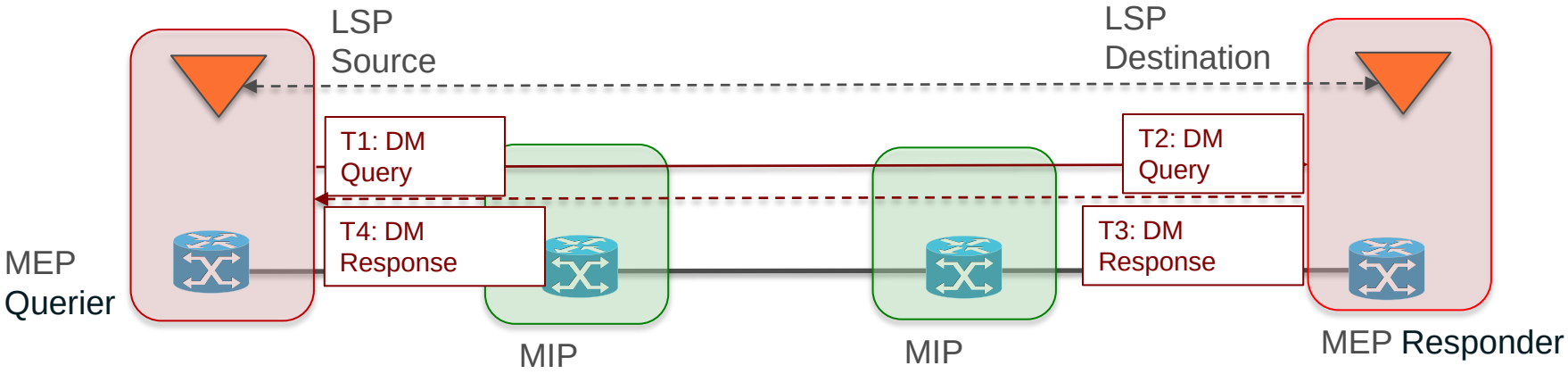
LSP Loss Measurement (LM)



- For LM, each “counterstamp” records the count of packets or octets sent or received over the channel prior to the time this message is sent or received
- For LM, loss is measured as a delta between successive messages. For example, a loss measurement in the forward direction is computed as (Q_TxCount[n] – Q_TxCount[n-1]) – (R_RxCount[n] – R_RxCount[n-1])
- Thus LM requires a small amount of state at the querier: it retains the counter values in the most recently received response

MPLS-TP OAM

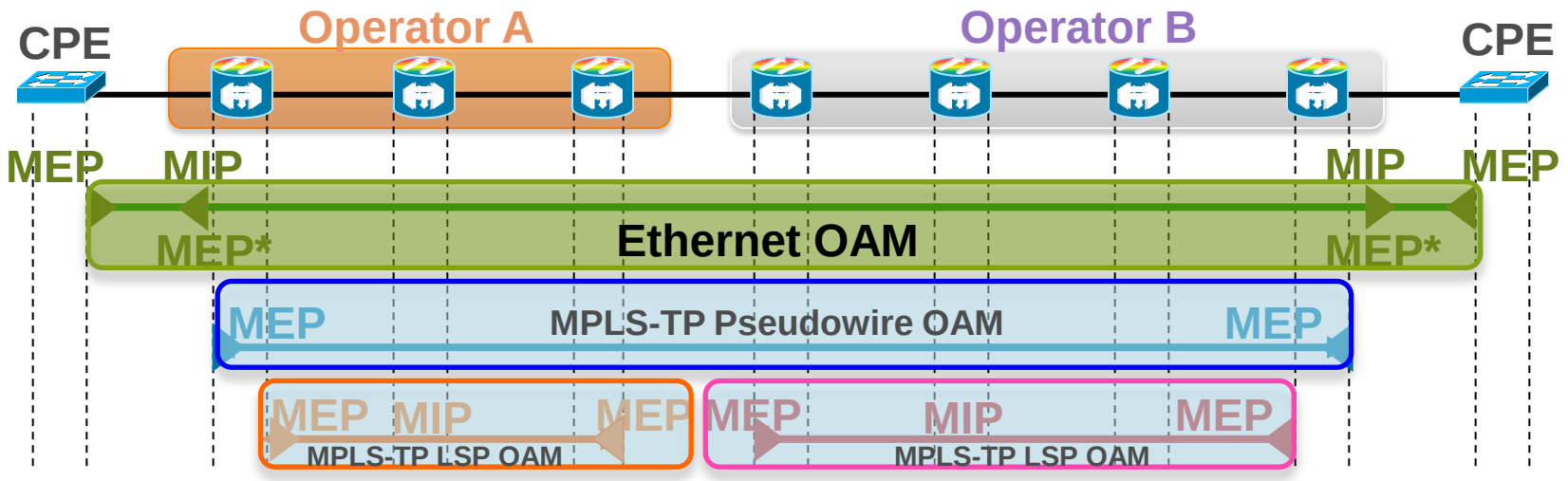
LSP Delay Measurement (DM)



1. The querier begins a measurement session by initiating a stream of query messages at a specific rate
2. Time T1: Query message exits the Querier TX port and is stamped with a time or counter value
3. Time T2: Query message enters the Responder RX port and is time- or counter-stamped
4. Responder inspects and processes the query and generates a response message, which is a copy of the Query with the Response flag set
5. Time T3: Response message exits the Responder TX port and is time- or counter-stamped
6. Time T4: Response message enters the Querier RX port and is time- or counter-stamped
7. Querier now has all four data values and can compute a measurement

MPLS-TP OAM

Overlay Model Ethernet OAM and MPLS-TP OAM



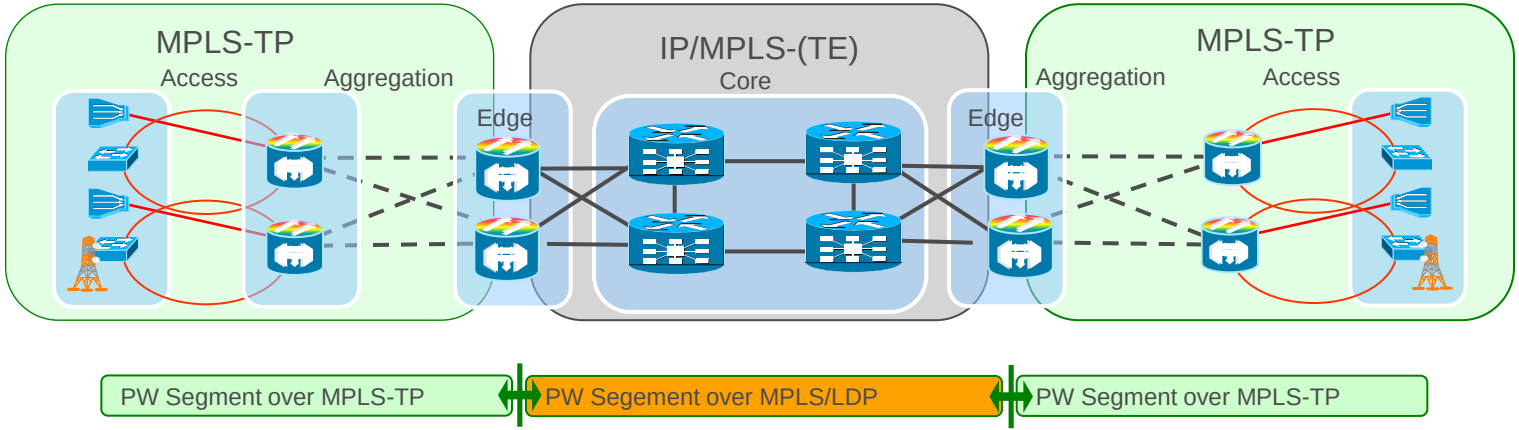
Notes:

All E-OAM Sessions Will Transparently Traverse the MPLS-TP Network Domain

The E-OAM Session Will Start at the Attachment Circuit When the Services Starts on the MPLS-TP TPE

MPLS Interworking

Pseudo-Wires Form a Natural Bridge



- The MPLS PW works over both MPLS-TP and IP/MPLS-(TE).
- The PW OAM Header is replaced with the LDP Header when going from static to dynamic
- This enables End to End Service Visibility and Management
- MPLS-TP PW is a standard MPLS PW

New IGP Label
Change VC ID symmetric
TTL Decremented by 1
EXP Bits copied
L2 Encapsulation

S-PE

Cisco Carrier Packet Transport

Cisco CPT 600, 200, & 50 System

Cisco CPT 600

Cisco CPT 200

Cisco CPT 50

Feature Rich, Carrier Class and Manageability

- Advanced Standard Based MPLS-TP
- Innovative Distributed Satellite Architecture
- Fully Carrier Ethernet and IP/MPLS supported
- Runs CTC, over 10 years of Network Management Experience

Based on over 10 years of Cisco Optical Transport Experience

Green Packet Transport

Space & Power Optimized

Standard Base MPLS-TP

Rich Service Features (Video Optimization)

DWDM =10/40/100 Gig

TDM – T1/T3, E1/E3, Ocn/STMn

Carrier Class

Fully Redundant Power Architecture

Fully Redundant Software Architecture

Fully Redundant Fan Architecture

Resiliency

> 50ms Link Protection

> 50ms Node Protection

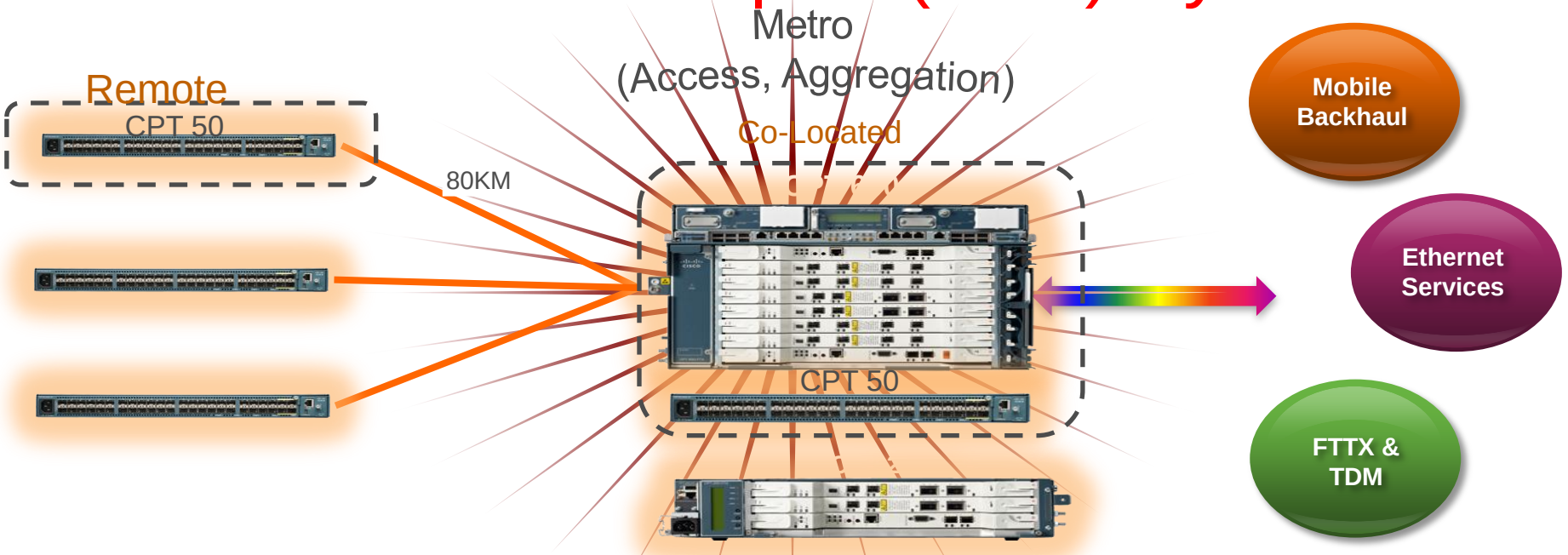
> 50ms Network Protection

End-to-End

A to Z Point and Click Provisioning & Maintenance

Industry standard CLI

Carrier Packet Transport (CPT) System



Feature Rich, Carrier Class and Manageability

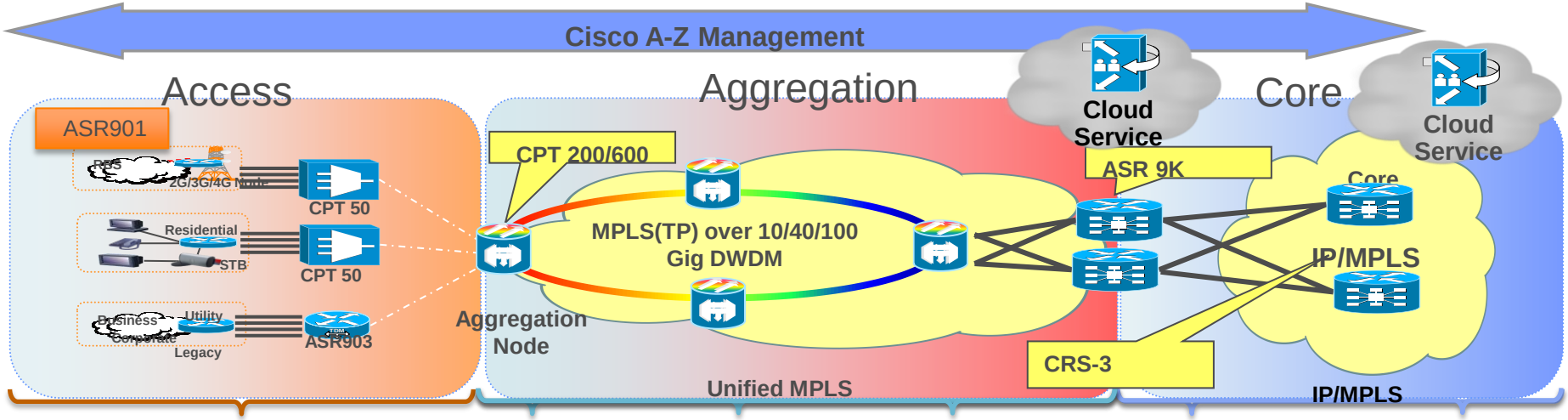
- Advanced Standard Based MPLS-TP
- Innovative Distributed Satellite Architecture
- Fully CE and IP/MPLS support (**Unified-MPLS**)
- Common Packet + Optical Network Management

IP/MPLS | MPLS-TP | Ethernet | OTN | DWDM

Cisco POTS Architecture

Applications – TDM Lease Line, Ethernet Lease Line, Mobile Back-Haul, Residential, Smart Grid Utility, Data Center Interconnect & Cloud Based

Architectural Elements- Unified MPLS, E2E Management, Integrated Packet Transport, TDM, & DWDM



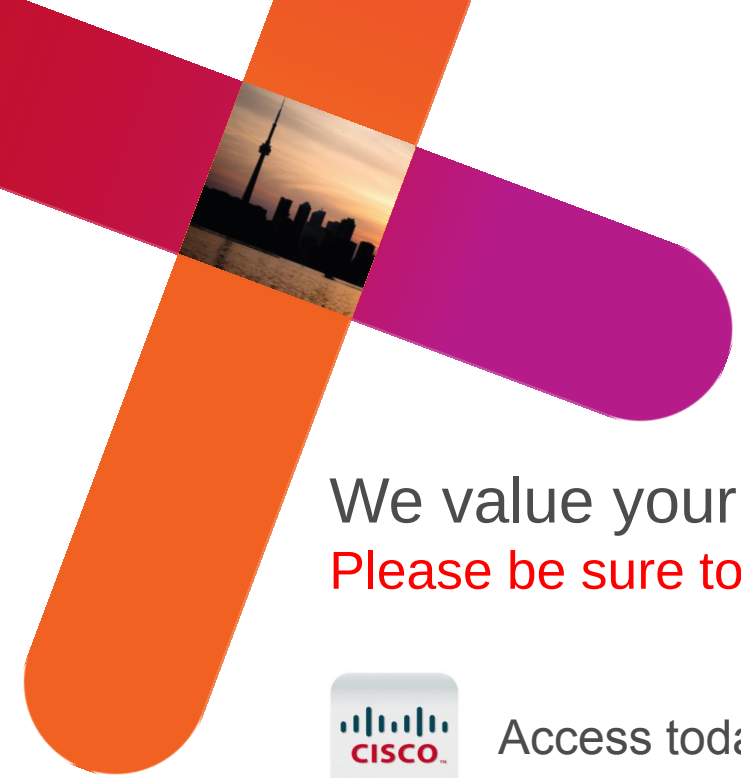
CPE	Transport Pre-Aggregation	Transport Aggregation	PE Edge	Core	Cloud
• ASR901 • ASR903	• CPT 50 w/Edge DWDM • ASR903	• CPT 200 w/MSTP • CPT 600 w/MSTP	• ASR9k w/MSTP	• CRS 3 w/MSTP	• EOS • Umi • Webex

Enabling Next-Generation Transport

www.cisco.com/go/cpt

Begin the Transformation with CPT

Q&A



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