Cisco Carrier Packet Transport System

Foundation for Next-Generation Transport

Ramesh Pillutla, OTBU Marketing

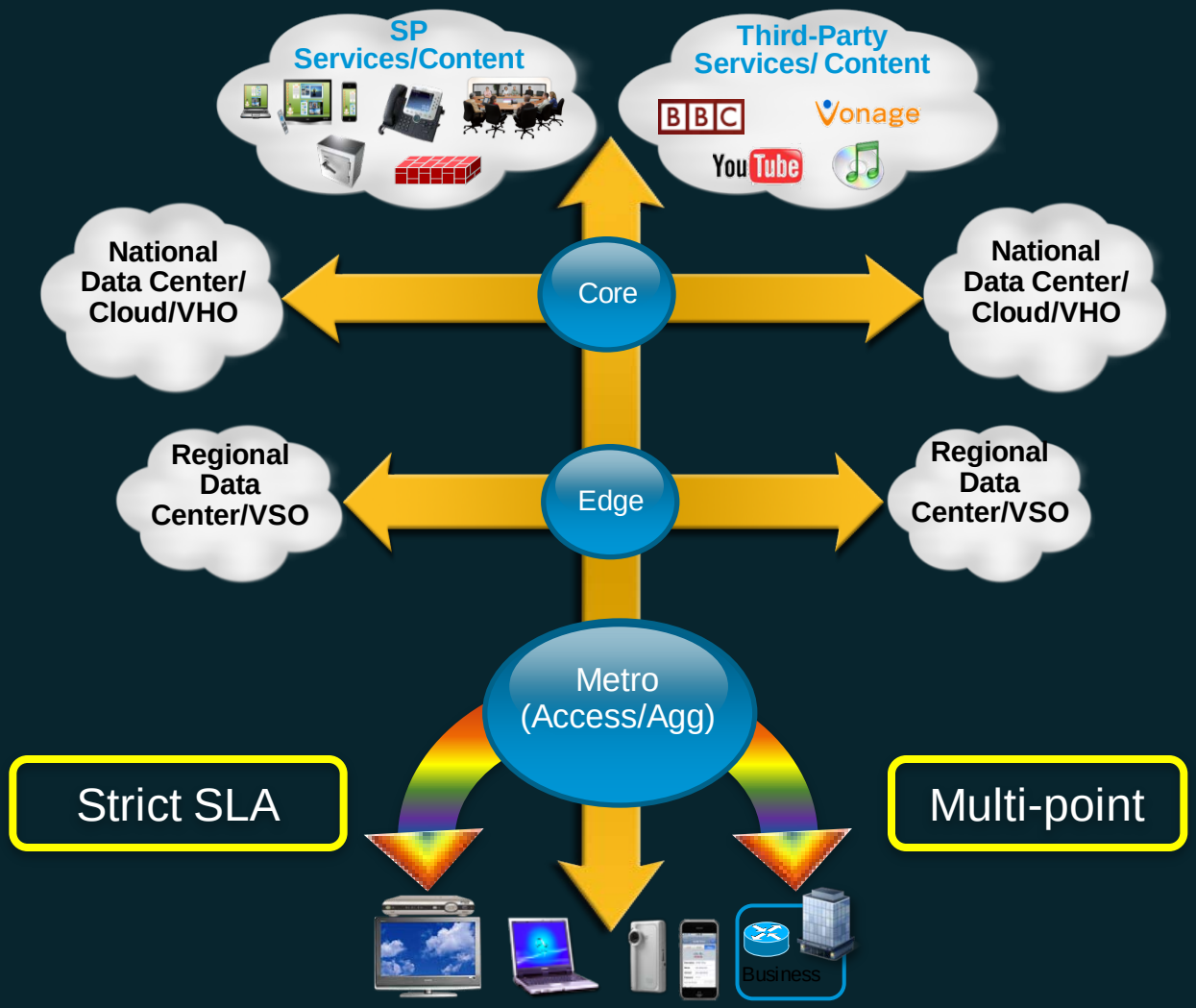
Optical Transport Business Unit

Agenda

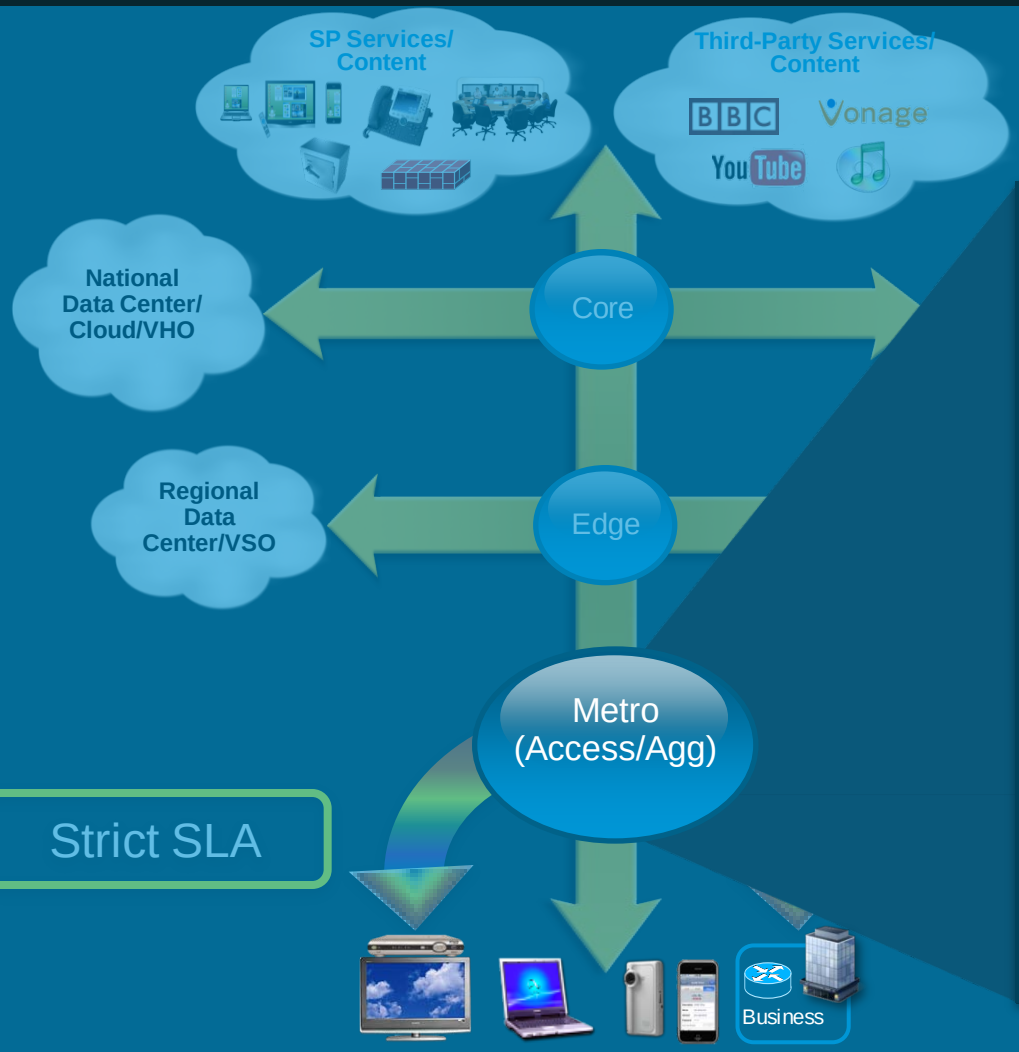
- Carrier Packet Transport
- Carrier Packet Transport Applications
- CPT Platform Introduction
- 40/100 Gig Solution
- 40/100Gig Integration with CPT

Carrier Packet Transport

Dramatic Shifts in Traffic Patterns



Requiring Transport to Evolve



What's Needed?

Trust
- Transport quality
- Familiar Ops

Savings
- CapEx & OpEx reduction
- Green

Agility
- Time-to-revenue
- Adaptable service models

Trust + Savings + Agility

MPLS-TP – The Transport World
MPLS based Transport w/ in band OAM

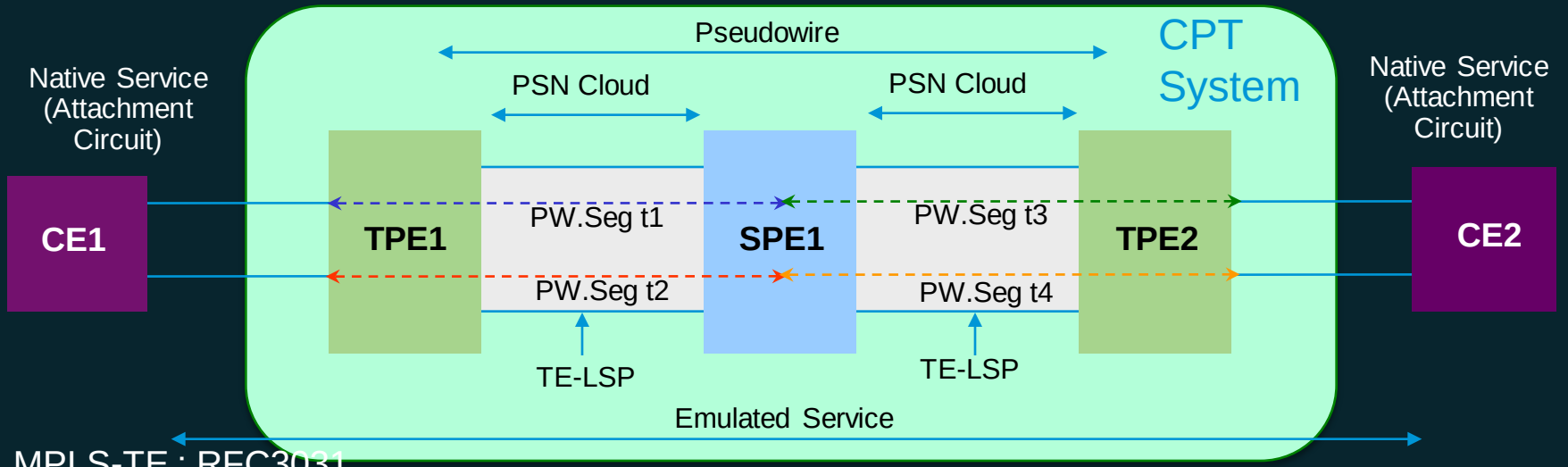
	TDM Transport	Packet Data Network
Connection mode	Connection oriented	Connectionless (except TE)
OAM	In-band OAM	Out-of-band (except PW, TE)
Protection Switching	Data Plane Switching	Control plane dependency
BW efficiency	Fixed Bandwidth	Statistical multiplexing
Data Rate Granularity	Rigid SONET hierarchy	Flexible data rate
QoS	One class only	QoS treatment






Packet Transport

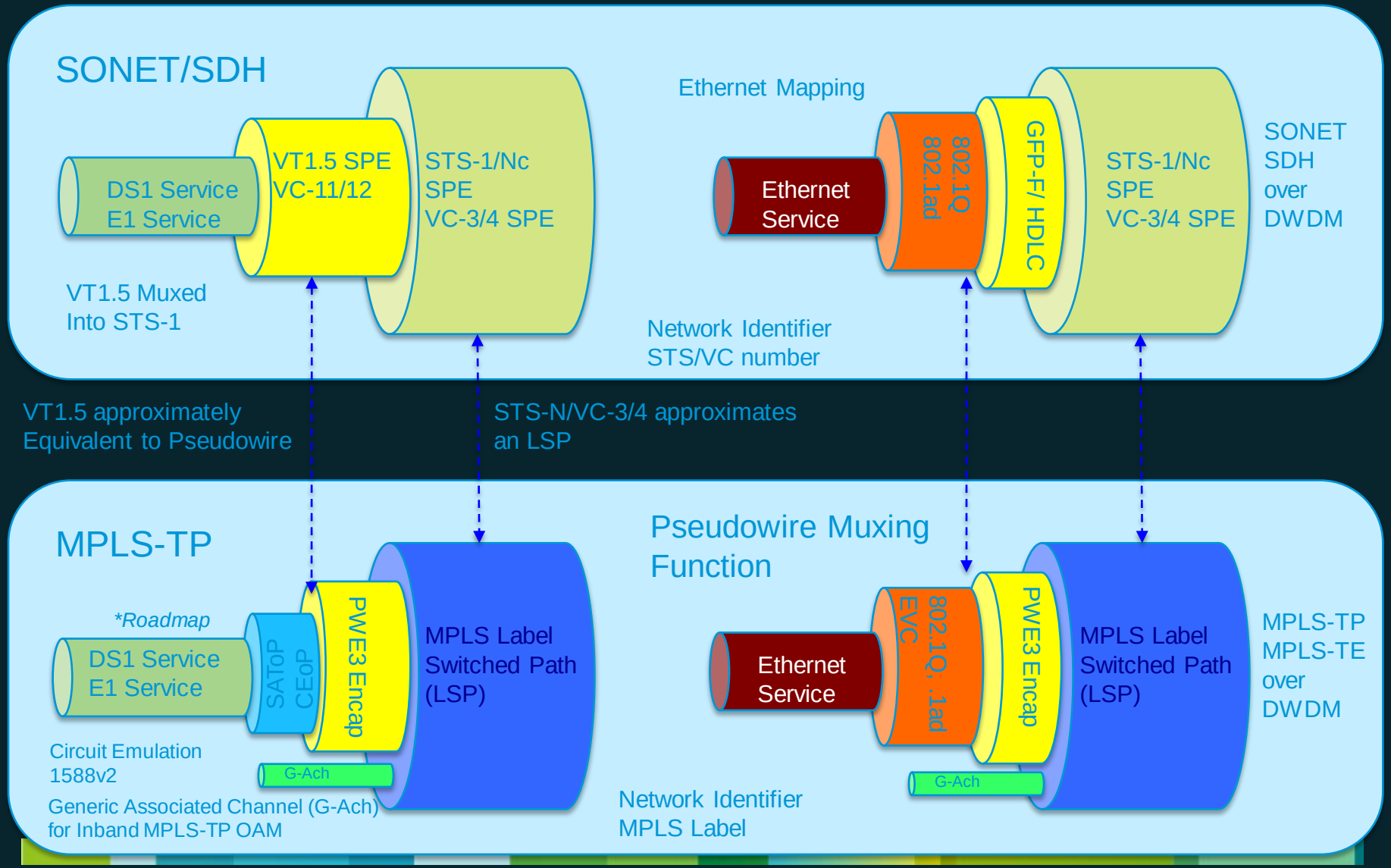
MPLS-TP architecture



- MPLS-TE : RFC3031
- Pseudowires : RFC3985
- Multi-segment pseudo-wires : draft-ietf-pwe3-ms-pw-arch-05
- Comprehensive set of OAM and protection-switching capabilities : SONET/SDH equivalent
- A centralized control plane with or without support of a distributed control plane
- Defines a mechanism to differentiate specific packets (OAM,APS etc) for user packets
- Primary constructs are
  - MPLS LSPs for transportation
  - PWs for the client layer

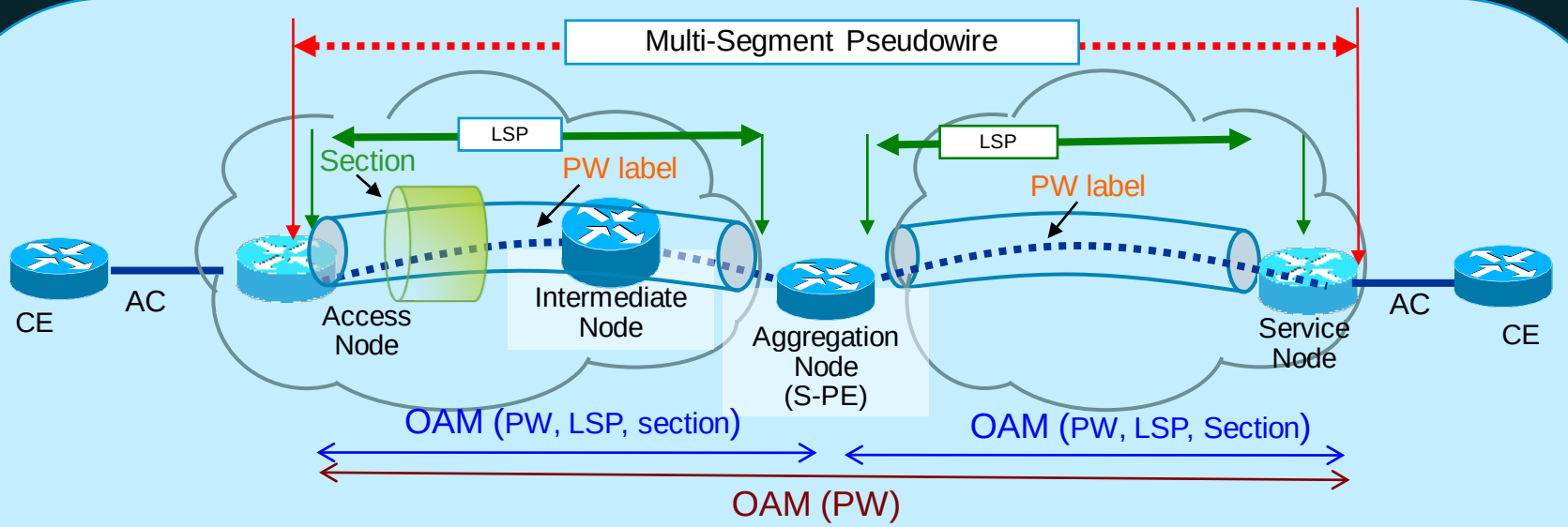
"CE" – Customer Edge
"TPE" – Terminating Provider Edge
"SPE" – Service Provider Edge

MPLS-TP Encapsulation



MPLS-TP building blocks

Creating a Transport DNA



- Circuits - MPLS Pseudowires (PW)
- Nailed down paths - MPLS-TP tunnel or an LSP
- OAM - In Band OAM at PW, LSP and Section level
- Resiliency – path, ring, mesh based, OAM triggered
- Control Plane – NMS based or GMPLS
- Inter-Domain – Multi-segment PW, OAM separation !!!
- BW management – per PW and per LSP

MPLS-TP Extensions

Generic Associated Channel
OAM - BFD, AIS, LDI
LSP Ping Traceroute
Virtual Circuit Connectivity Verification (VCCV)

Introducing the Cisco Carrier Packet Transport (CPT) System

Metro (Access/Agg)

CPT 200

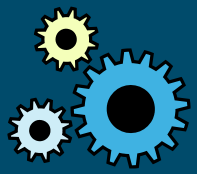
CPT 50 CPT 600

Unmatched Trust

Resilient, Preserves Transport Ops,
Best-in-class A to Z Management

Exceptional Savings

60% reduction in Space / Power,
Industry's greenest POTS platform



Uniquely Agile

Established + New Services,
Industry-first MPLS-TP

Foundation for Next-Generation Transport

10

Carrier Packet Transport (CPT) System

Metro
(Access, Aggregation)

Mobile Backhaul

Ethernet Services

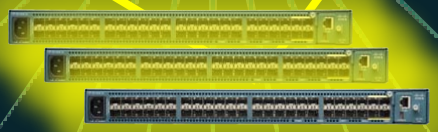
FTTX & TDM

CPT 600

6 slots (480G)
Up to 352 ports

CPT 200

2 slots (160G)
Up to 176 ports



Fixed config satellite
44xGE, 4x10GE

MPLS-TP

Ethernet

OTN

DWDM

IP/MPLS

Hardware
Unique satellite architecture
HA: SSO, ISSU, MDR
Active-Active Data Plane
Active-Standby Control Plane

Software
MPLS-TP, 802.1ad, H-QoS, E-OAM, MPLS OAM, LAG, REP, MVR, IGMPv3, G.709, IP/MPLS-TE

Industry's first, standards-based, unifying 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)

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 Manageability

A to Z Point and Click Provisioning & Maintenance

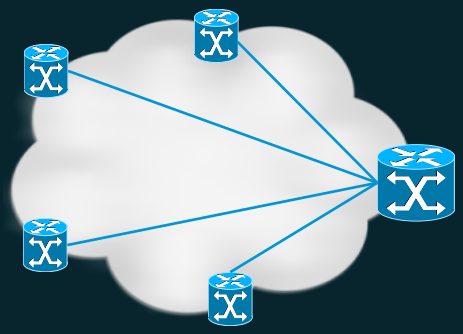
Industry standard CLI

12

Building a Trusted Scalable Green Network
Ethernet Private Line Services

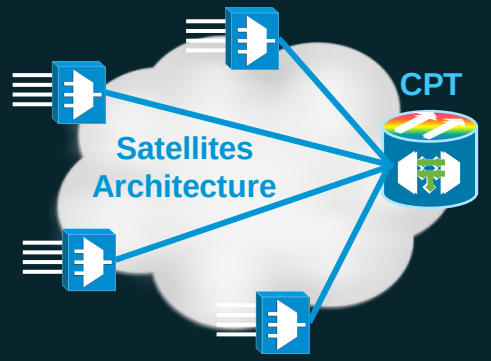
Baseline:
Service Type: EPL
Network Scale: 240G

Traditional MSPP Network



Highlights:
- A single MSPP Network can only handle 20G of EPL.
- Need to replicate MSPP Network Build 12 times to reach 240G
- Equals High CapEx & OpEx
  - Cost Per G ~$28K
  - 708 RU's
  - 41Kwatts

CPT Network Architecture

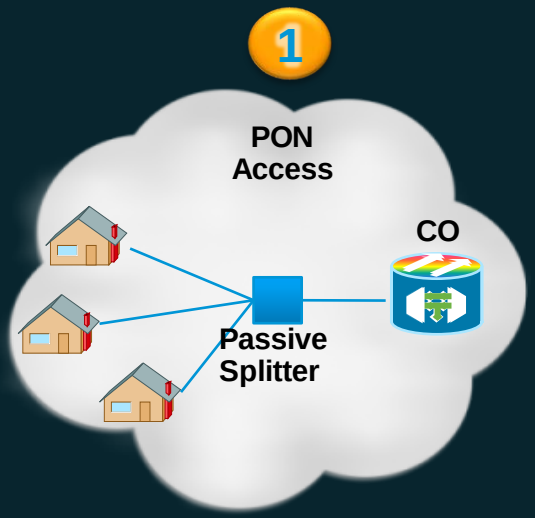


Highlights:
- A Single CPT Architecture
- Optimized CapEx & OpEx
  - Cost Optimized Per G **~$2K**
  - Space Optimized **14 RU's**
  - Power Optimized **3Kwatts**

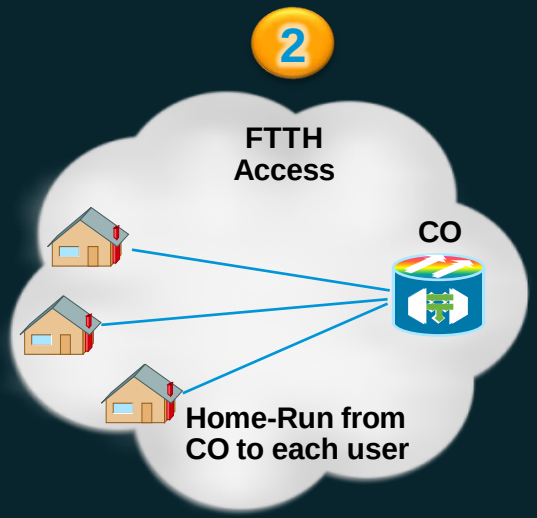
Scaling Services for Growth

13

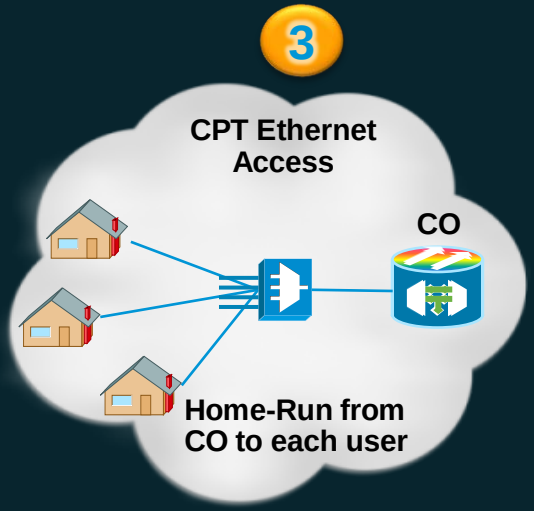
Building a Trusted & Agile Network
Fiber to the Home Services



Pro: Fiber Consolidation
Con: BW Constrained



Pro: Bandwidth Scale
Con: 35% Fiber Mgt. space overhead in CO



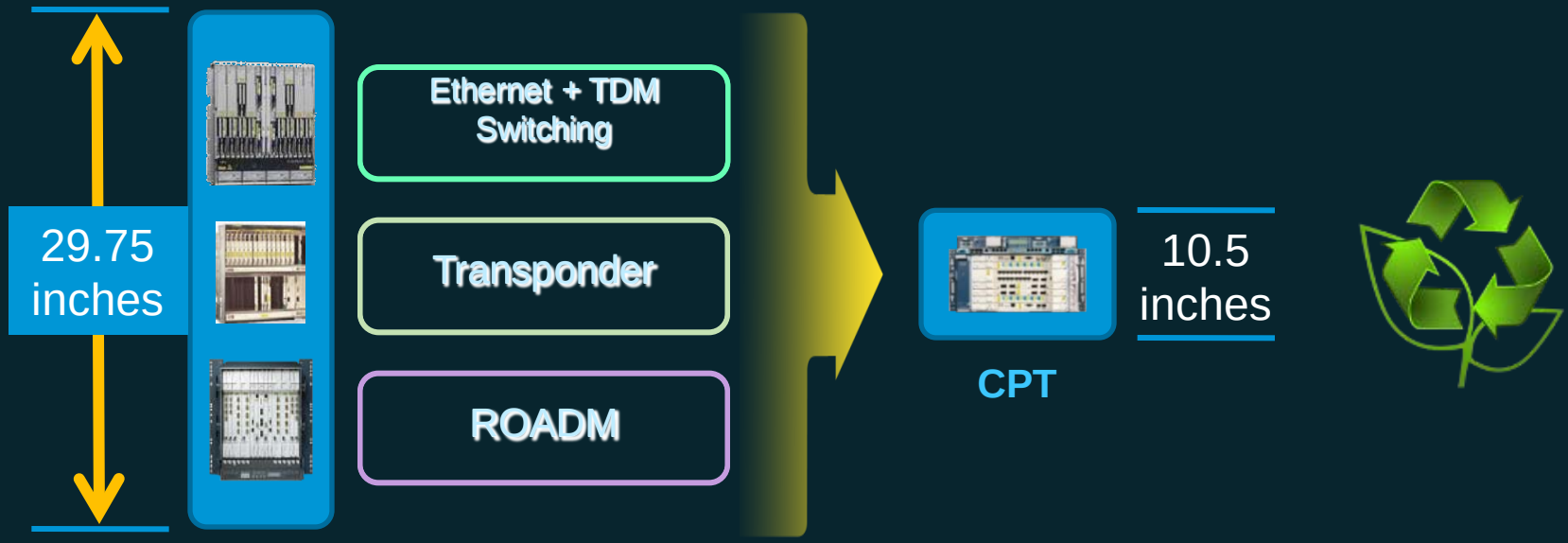
Pro: Fiber Consolidation
Pro : Bandwidth Scale

98% Fiber Space Savings and CO Fiber Management Optimization

Scaling Services for Growth

14

Exceptional Savings



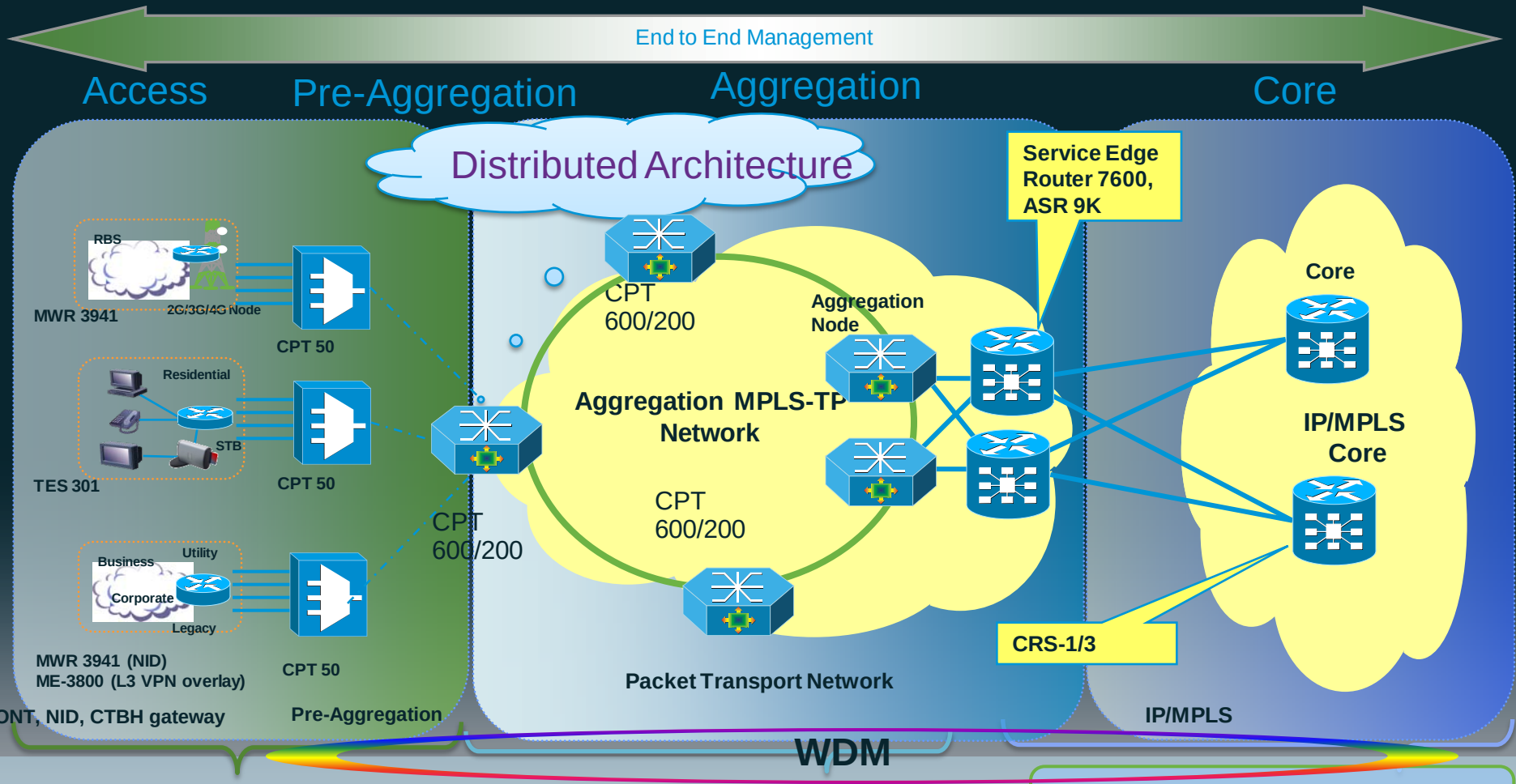
Over 60% Reduction in Rack Space
Over 65% Reduction in Power Consumption

Calculations based on 480G capacity

Powerful Yet Green and Optimized

15

CPT Packet Transport Architecture



Cisco Carrier Packet Transport 600

Field Replaceable LCD

- Viewable Shelf Management
- Redundant Database Backup

Field Replaceable Electronic Connection Unit

- Bits In/Out Timing, External Alarm, USB, EMS, ToD/PSS

6 RU ANSI & ETSI Compliant

Field Replaceable Redundant Power Supplies

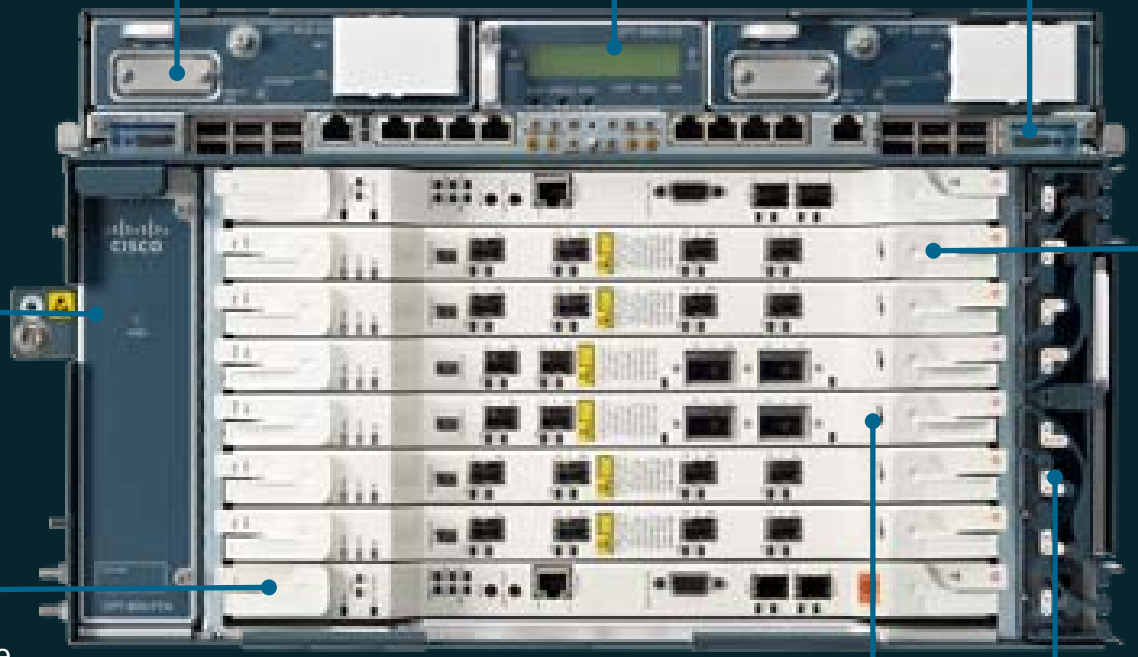
- DC and AC Power Options

Field Replaceable Fan Tray

- Redundant Fans

Redundant Shelf Controller

- Redundant Internal Stratum 3 Timing
- Redundant Database Backup



Packet Transport Module

- 4x10GE UNI/NNI/CPT 50 Inter-Connect
- Full Line Packet Processing and Traffic Management

Cable Guide & AirFilter

- Fiber or Copper Cable Management
- Field Replaceable AirFilter

Packet Transport Fabric

- 2x10GE UNI/NNI/Satellite Inter-Connect
- 2x10GE G.709 Enabled
- 256G Active-Active Switch Fabric
- Full Line Rate Packet Processing and Traffic Management

Cisco Carrier Packet Transport 200

Field Replaceable Electronic Connection Unit

- Bits In/Out Timing, USB, & EMS

Field Replaceable Fan Tray & LCD

- Redundant Fans
- Viewable Shelf Management
- Redundant Database Backup

Cable Guide & AirFilter

- Fiber or Copper Cable Management
- Field Replaceable AirFilter

Field Replaceable Redundant Power Feeds

- DC and AC Power Options

Shelf Controller

- Redundant Internal Stratum 3 Timing
- Redundant Database Backup

Packet Transport Fabric

- 2x10GE UNI/NNI/Satellite Inter-Connect
- 2x10GE G.709 Enabled
- 160G Active-Active Switch Fabric
- Full Line Rate Packet Processing and Traffic Management

2 RU ANSI & ETSI Compliant

18

Cisco Carrier Packet Transport 50

Redundant Power Feeds

- AC, -24vDC, & -48vDC Power Options

1 RU ANSI & ETSI Compliant

LEDs

Field Replaceable Fan Tray

- Redundant Fans
- ToD/PSS Output
- Bits Out

44xGE UNI

- Full Line Rate Packet Processing and Traffic Management
- Pay As You Grow Licensing (11port Increments)

4x10G Inter-Connect Ports

- Plug-n-Play In-Band Management
- Automatic Discovery and Provisioning
- Co-Located or Remote Distribution

Industrial Temp Rated

- -40C to +65C Operational Temperature
- -40C to +70C Storage Temperature

19

Packet Transport Line Cards

- Packet Transport Fabric (PTF)
  - Full Line Rate Packet Processing & Traffic Management
  - 256G Switch Fabric
  - 2x10GE G.709 Enable XFP
  - 2x10GE UNI/NNI/Satellite Interconnect
- Packet Transport Module (PTM)
  - Full Line Rate Packet Processing & Traffic Management
  - 4x10GE UNI/NNI/Satellite Interconnect

- PTF & PTM Service Scale
  - 16K Point-to-Point EVC
  - 4K Point-to-Multipoint EVC
  - 256K MAC Address
  - 4K MPLS Tunnels
  - 7.5K MPLS(TP) Circuits
  - 4K VPLS services
  - 32K Policers (2-Level 2R3C)
  - 64K Queues (3-Level H-QoS)

Packet Transport Fabric

Packet Transport Module

Packet Transport Fabric (PTF) 256G Fabric Card w/ 4x10GE

- 256 Gigabit non-blocking full duplex Switch Fabric
- 2x10 GE Pluggable SFP+ for UNI/NNI/CPT 50 Interconnect
- 2x10 GE G.709 with Standard & Enhanced FEC for transmission OAM
- Single core CPU @ 1.5Ghz speed, 2 GB DDR3 RAM
- Packet Processing

  9K Jumbo frames are support

  64-byte PPS switching capacity
- Traffic Management

  8K policers & 64K queues

  50 Gig bi-directional packet processor engine with external TCAM @ 350MHz

  50 Gig Traffic Manager with 1 GB DDR3 RAM for packet buffering
- Hardware OAM off-load via FPGA for MPLS BFD OAM (sub-50 ms APS)
- Dedicated Control plane, Data plane and Timing Traces to PTF / PTM
- Maximum Power 210 Watts, Nominal Power 147 Watts
- Serial console connection with mini USB

Packet Transport Module (PTM) 4x10GE

- 40 Gigabit non-blocking Switching Capability
- 4x10 GE Pluggable SFP+ for UNI/NNI/CPT 50 Interconnect
- Single core CPU @ 1.3Ghz speed with 1 GB DDR3 RAM
- Packet Processing

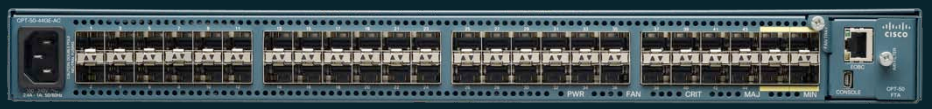
  9K Jumbo frame support
  64-byte PPS capacity
- Traffic Management

  8K policers & 64K queues
  50 Gig bi-directional packet processor engine with external TCAM @ 350MHz
  50 Gig Traffic Manager with 1 GB DDR3 RAM for packet buffering
- Dedicated Control plane, Data plane and Timing Traces to PTF / PTM
- Maximum Power 128 Watts, Nominal Power 89.6 Watts
- Serial console connection with mini USB

Carrier Packet Transport (CPT) 50

- 4x10 GE SFP+ Inter-Connect back to the CPT 600 / CPT 200
- 44x10/100/1000 Mbps SFP based interfaces
- CPT 50 Power supplies

-48v DC ANSI redundant power feeds
-48v DC ETSI redundant power feeds
-24v DC ANSI redundant power feeds
100V – 240V AC single power feed



- Single core CPU @ 1.3Ghz speed with 1 GB RAM
- Packet processing

9K Jumbo frame support
64-byte PPS capacity

- Traffic management

8K policers & 64K queues
50 Gig bi-directional packet processor engine with external TCAM @ 350MHz
50 Gig Traffic Manager with 1 GB DDR3 RAM for packet buffering

- Control Plane uses high priority queuing on Inter-Connect ports
- Maximum Power 210 Watts, Nominal Power 159 Watts.
- Serial console connection with mini USB

CPT Features

CPT Features

Carrier Ethernet

- Cisco EVC 2.0 support
- 16K P2P Services
- 4K MP2MP Services
- 4K P2MP Services w/ split horizon
- Flexible Encapsulation: 0:1, 0:2, 1:1, 1:2, 2:2, 2:1, 2:0 & 1:0
- Resilient Ethernet Protocol
- A to Z provisioning

Unified MPLS

- MPLS-TP
  - 4K Tunnels, 7.5K VPWS & 4K VPLS
  - GAL, GACH, AIS, LDI, Hardware BFD for sub-50ms resiliency, 1:1 Path Protection, Lockout, VCCV, MS-PW, Alarms & Bandwidth Management
  - A to Z Provisioning
- IP/MPLS
  - 4K Tunnels & 7.5K VPWS
  - OSPF-TE, RSVP-TE, LDP, MS-PW & VCCV
  - A to Z Provisioning

CPT Features (contd)

High Availability

- Active-Active Data plane
- Active-Standby Control plane
- SSO, ISSU
- 128 Link Aggregation groups (LAG). Up to 8 Members in a LAG

QoS / H-QoS

- 8K policers (2 level 2R3C)
- 64K queues (3 level H-QoS)
- Remarking
- Priority queues for LLQ traffic
- Shaping
- Pre-allocated QoS for control plane

Multicast

- IGMP V2, V3 Snooping
- Multicast VLAN Registration (MVR)
- 2K Multicast Groups
- H-VPLS optimized for Multicast

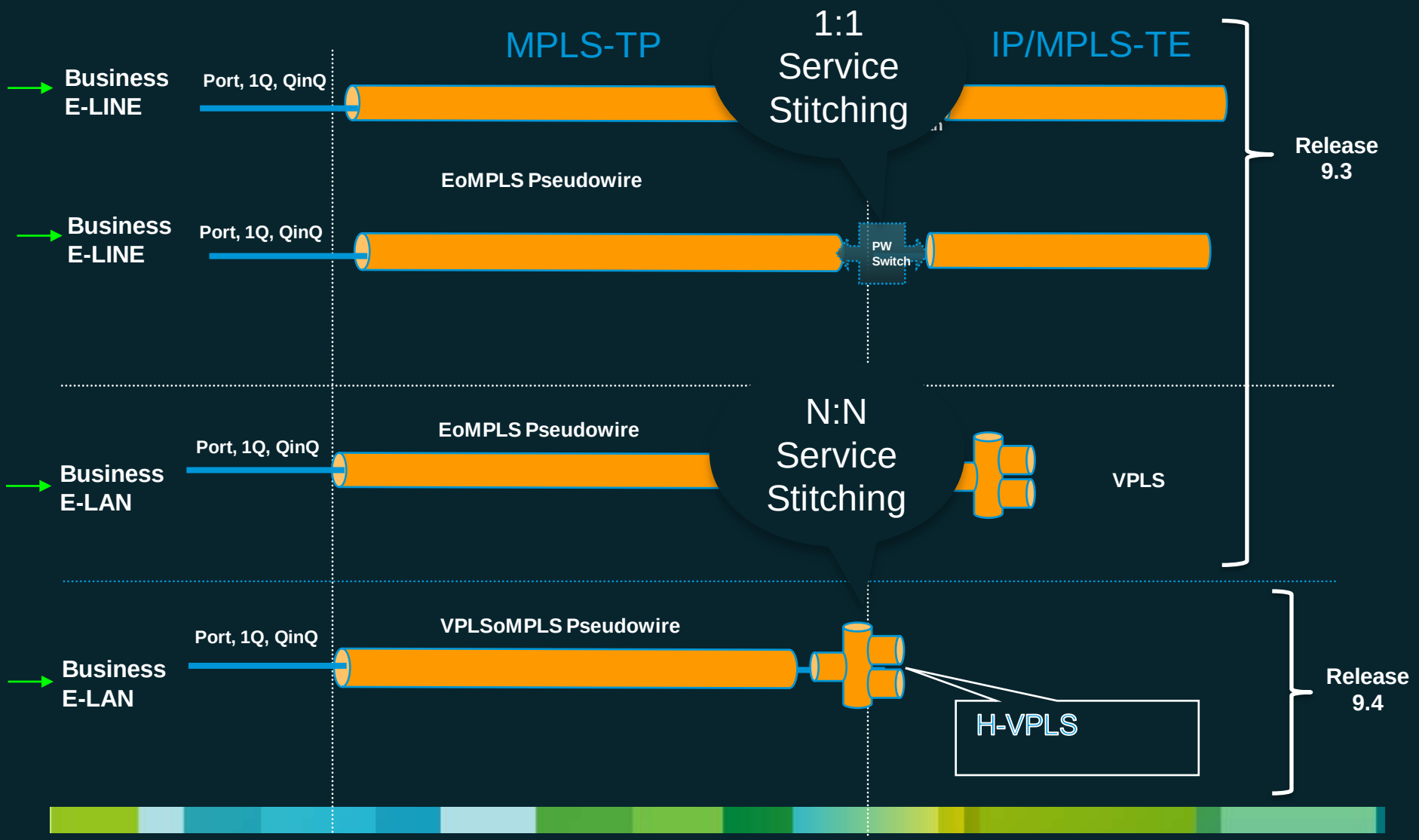
Timing

- (Hardware Ready) Sync E (BITS In/Out) , IEEE 1588v2 PTP ToD/PPS

Management

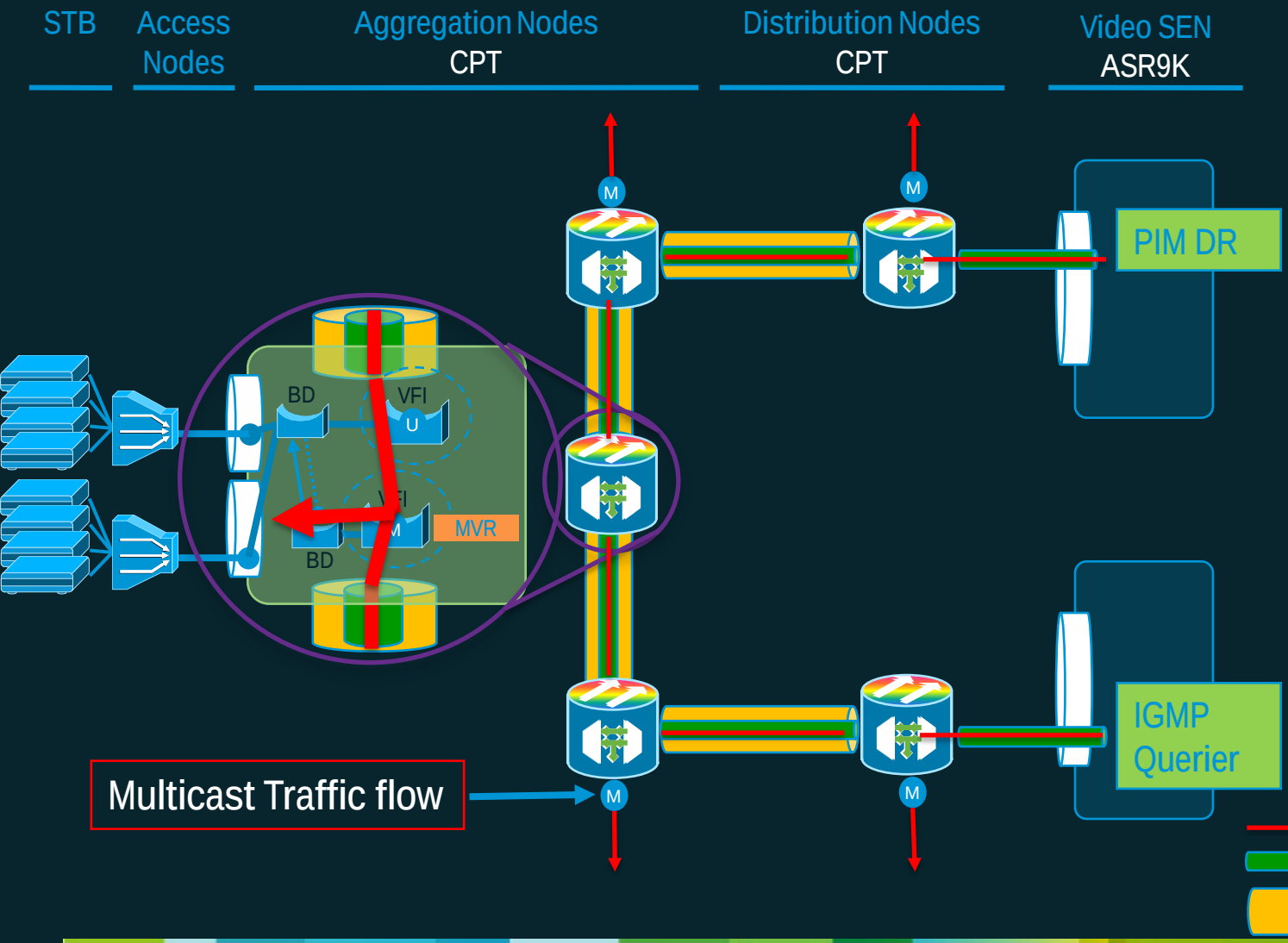
- CTM, CTC, TL1 (Equipment) supported. Cisco CLI support

Unified MPLS Deployment Models



Release 9.4

CPT– Efficient Video Distribution

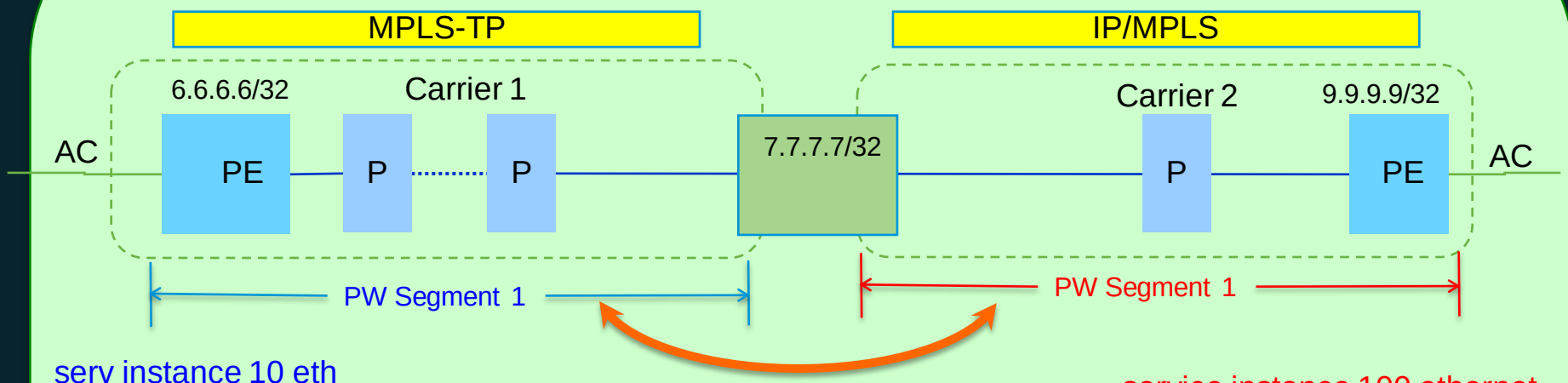


- Each LSP has a Back LSP
- Fiber cuts protected in sub 50 ms via Back up LSP
- Both routers forward on CPT node failure
- PIM router failure protected via backup router

CPT VPWS MS-PW Stitching

MPLS-TP – IP/MPLS

PW's across multiple carriers




```
serv instance 10 eth
encap default
Xconnect 7.7.7.7 99 encapsulation
mpls manual pw-class pw-static
  mpls label 61 42
```

```
l2 vfi PW-SWITCH point-to-point
neighbor 6.6.6.6 99 pw-class mpls_static
     mpls label  42 61
neighbor 9.9.9.9 66 pw-class mpls
```

```
service instance 100 ethernet
encapsulation default
xconnect 7.7.7.7 66 encap
mpls
```

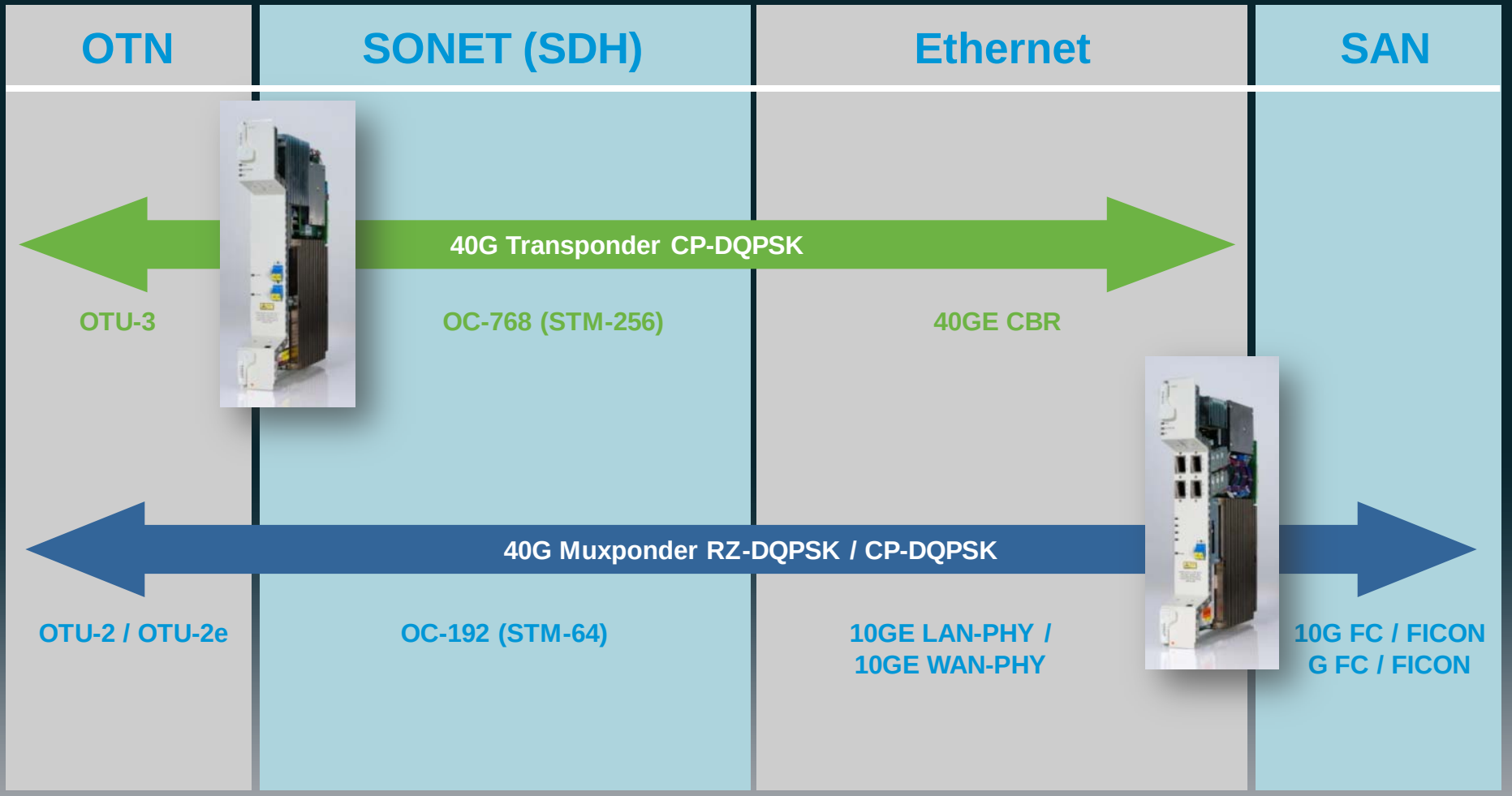
```
pseudowire-class pw-static
 encapsulation mpls
 protocol none
 preferred-path interface tunnel-tp 1
```

```
pseudowire-class mpls_static
 encapsulation  mpls protocol none
```

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

40/100 Gig DWDM Solution

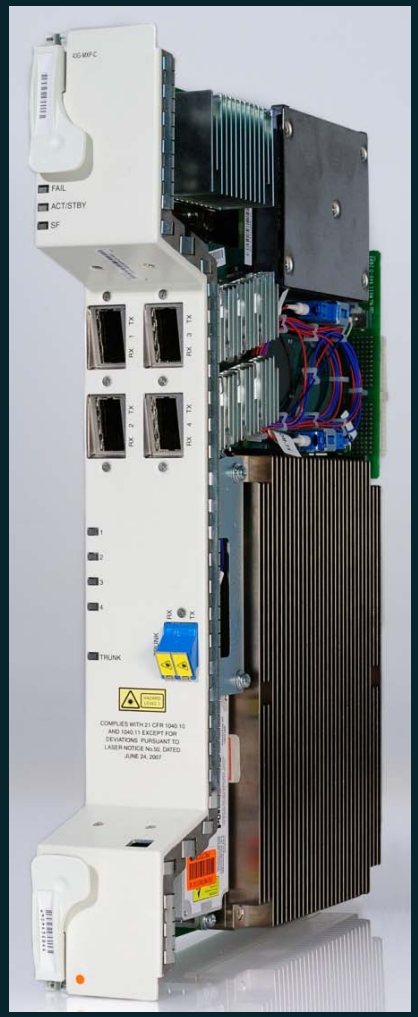
40G Solutions



40G CP-DQPSK Muxponder -
Extended Performance

R9.2

- **Full C-band Tuneable (50GHz stability) DWDM Trunk**
  - CP-DQPSK DWDM Trunk
  - CD Tolerance: +/-29,000 ps/nm
  - PMD robustness: 30ps
  - B2B OSNR: 5dB (0.5nm RBW)
  - Tx Power: 1dBm (minimum)
  - Automatic Laser Shutdown (ITU-T G.664)
  - OTN Standard Performance Monitoring (PM)
  - FEC (ITU-T G.975) / E-FEC (ITU-T G.975.1 I.7) via SW
- **4 XFP-based Clients**
  - 3x Client ports support E-FEC / 4x Client ports support FEC (Wavelength termination)
  - Client Protocols supported with **OTU-3** framed Trunk:
    - OC-192 (STM-64)
    - 10GE LAN-PHY (G.Sup43 - Sub7.3)
    - 10GE WAN-PHY
    - 10GE LAN to WAN Conversion
    - OTU-2
    - OTU-2e (G.Sup43 Sub7.3)
    - 8G FC
  - Client Protocols supported with **OTU-3e** framed Trunk:
    - OTU-2e (G.Sup43 Sub7.1)
    - 10G FC



32

40G CP-DQPSK Transponder - Extended Performance

R9.2

- **Full C-band Tuneable (50GHz stability) DWDM Trunk**
  - CP-DQPSK DWDM Trunk
  - CD Tolerance: +/-29,000 ps/nm
  - PMD robustness: 30ps
  - B2B OSNR: 5dB (0.5nm RBW)
  - Tx Power: 1dBm (minimum)
  - Automatic Laser Shutdown (ITU-T G.664)
  - OTN Standard Performance Monitoring (PM)
  - FEC (ITU-T G.975) / E-FEC (ITU-T G.975.1 I.7) via SW
- **Fixed Client**
  - VSR2000-3R2 (ITU-T G.693/05-2006)
    - OC-768 (STM-256) with Standard PM
    - OTU-3 with Standard PM
    - 40GE CBR (Serial)
  - Automatic Laser Shutdown as per ITU-T G.664

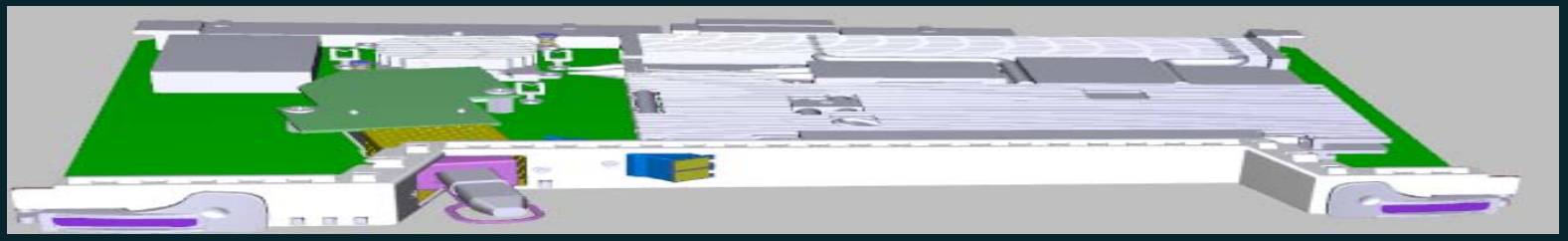
33

100 Gig Overview

- 100Gbps DWDM program includes 4 units:
  - 100GE/OTU-4 Full C band Tuneable Line Card
    Leverages on 100G DWDM Trunk module
  - 10x10G Client Line Card
    Leverages on 10 pluggable ports interfaces
  - 2x100G Client Line Card
    Leverages on 2 x 100G CFP pluggable ports interfaces
  - Mixed 40G/10G Client Line Card
    Leverages on 8 pluggable ports interfaces
- The 4 units can be placed in any slot of the M2 and M6 chassis
- 100G DWDM Trunk module is a common development between DWDM Optical team and CRS Development team to deliver the same DWDM interface over all Cisco platforms supporting 100G DWDM

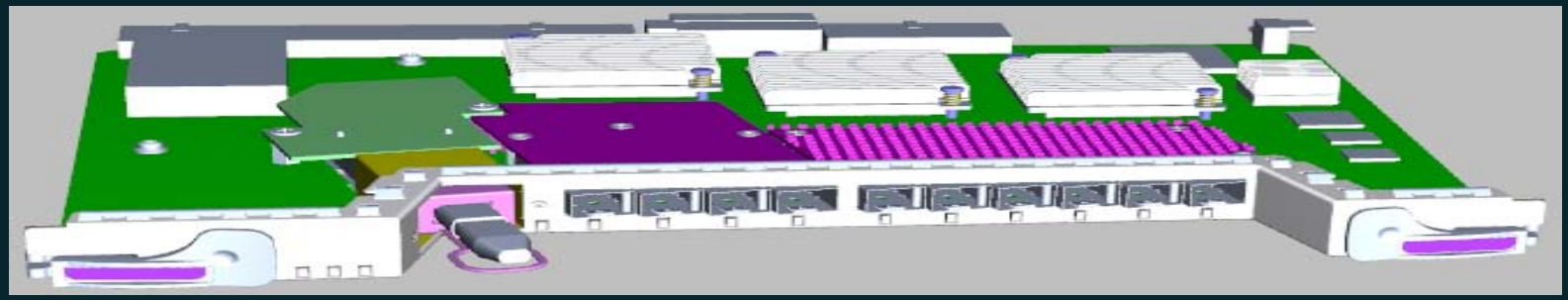
OTU-4 Full C-Band Tunable Line Card

- Same unit supporting **3 working modes** (SW Configurable):
  - **100G TXP** or IPoWDM Interface (CXP as standard 100GE SR10 / OTU4 Client)
  - Trunk Line Card – coupled with Client card for **Muxponder** (CXP Included)
  - Trunk Line Card – coupled with Trunk Line card for Regen (no CXP pluggable needed)
- High performance OTU-4 ITU-T Trunk interface:
  - Full C Band Tunable with 50GHz stability
  - -G.709 PM
- Equipped with 1x DWDM Port and 1x CXP interface to provide a 100G Pluggable Client as well as a cost optimized connection with CRS/ASR/Nexus
  - 100G DWDM Trunk supports EFEC for optimized DWDM Performances
  - CXP allows up to 100m “low cost” connection solution towards external client(e.g. router) equipped with a CXP interface or with a 100GE BASE SR10 Interface
- 150W Maximum Power consumption



10x 10G Multi-Rate Client Line Card

- 3 SW Configurable Modes:
  - **10-ports 10G Multi-Rate Muxponder** – coupled with 100G DWDM Line card
    Any combination of 10G signals (SONET/SDH, 10GE, 10G FC and 8G FC)
  - **5x 10G Transponder** – Standalone configuration with DWDM SFP+, supporting FEC/E-FEC (no CXP pluggable needed)
    Can be configured to support Low Latency 10G Transport for SAN / High-Speed Trading
  - **100G Fan-Out** – Standalone configuration leveraging on CXP for interconnecting with an external Client and allowing split into 10G streams
- 80W Max Power consumption

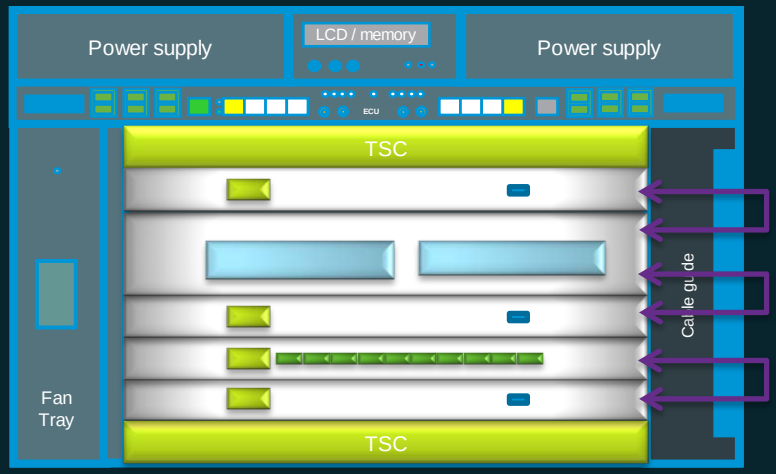


2 x CFP 100G Line Card

- Same unit supporting 3 working modes (SW Configurable):
  - **1-port 100G CFP based Transponder** – coupled with 100G DWDM Line card
  - **2-port 40G CFP Muxponder** – coupled with 100G DWDM Line card
- HW ready for:
  - **1-port Metro 100G Transponder** – Standalone configuration leveraging on CFP to CFP connection leveraging on WDM CFP availability
  - **40GE Serial Transponder** – coupled with new Single Slot 40G Transponder card

100G CFP Card connection

- M6 or M2 100Gbps Back-panel connections to support Muxponder or Regeneration functionality:



2 x 100G CFP based TXP

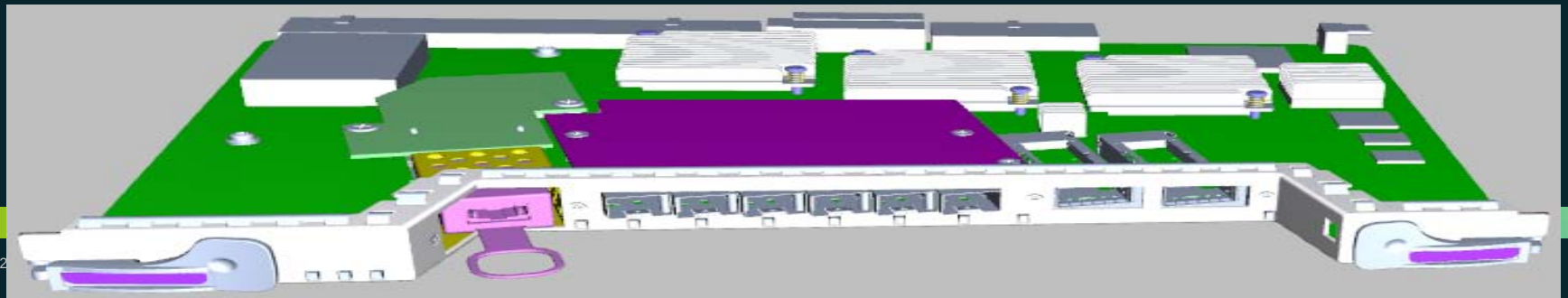
10x10G 100G Muxponder

Mixed 10G/40G Multi-Rate Client Line Card

Two SW configurable:

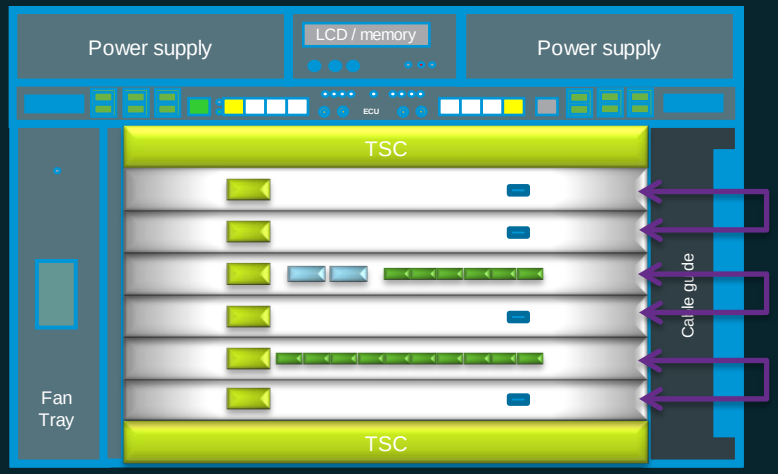
- **10-ports 10G Multi-Rate Muxponder** – coupled with 100G DWDM Line card
- **100G Fan-Out** – Standalone configuration leveraging on CXP for interconnecting with an external Client and allowing split into 10G and 40G streams

- Muxponder Configuration details:
  - Able to support any combination of 10G signals (SONET/SDH, 10GE, 10G FC and 8G FC)
  - Able to support a mix of 2x 40G (Ethernet / OTN) and 2x 10G mix of signals
  - Able to support 1x 40G and 6x 10G mix of signals
- 80W Max Power consumption



100G Transport Options

- M6 or M2 100Gbps Back-panel connections to support Muxponder or Regeneration functionality:

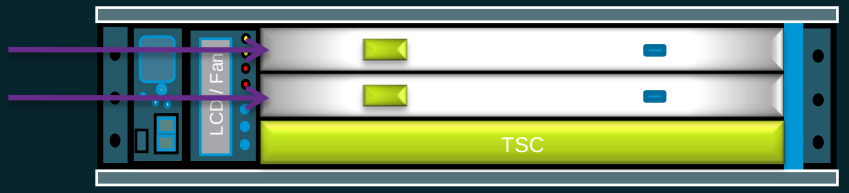


100G Regeneration

10G/40G 100G Muxponder

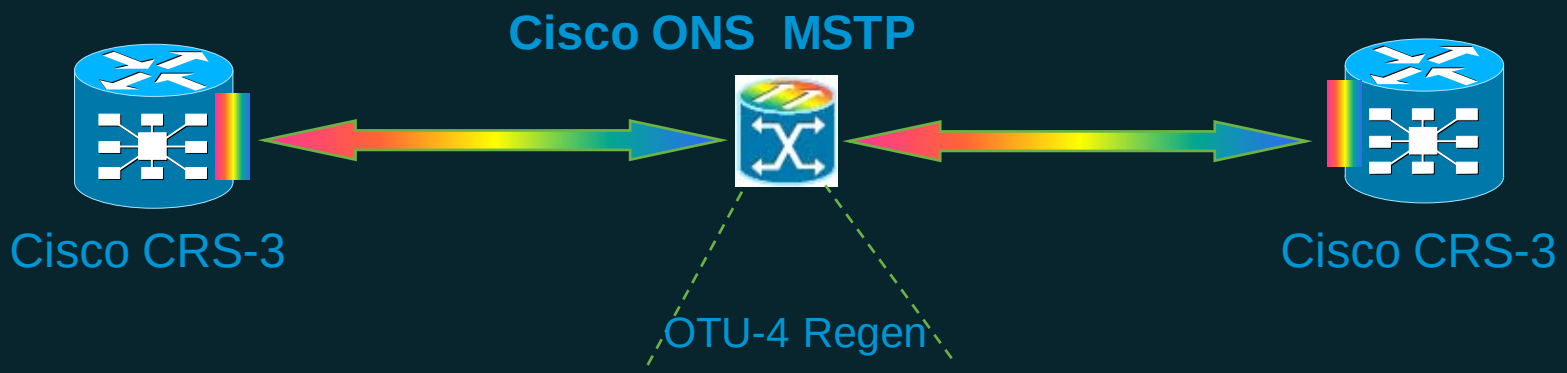
10x10G 100G Muxponder

2x 100G Transponder in 2RU



IPoWDM 100G Interoperability – CRS-3

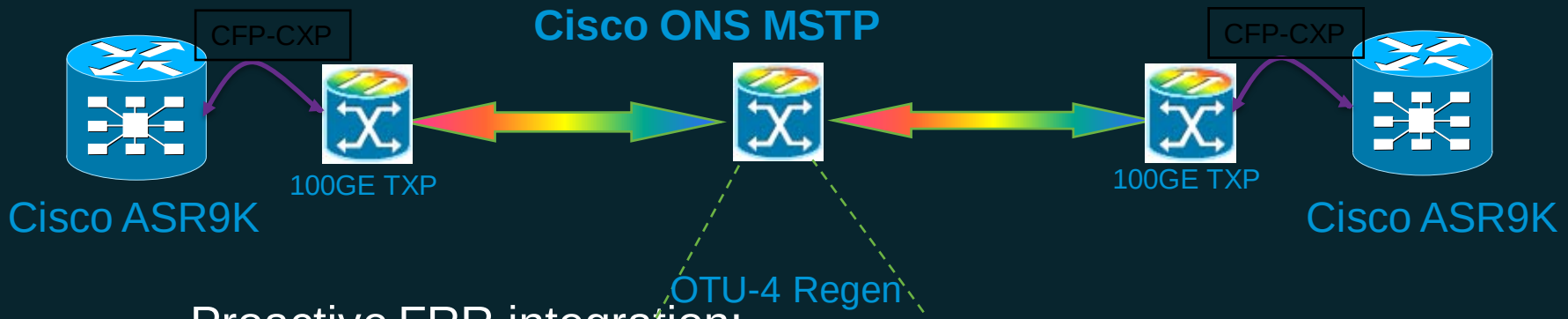
- Same Interface used on CRS-1 Line Card and ONS 15454 boards
- Capability to use ONS15454 Boards and chassis to Regenerate CRS-3 100G signals.



- OAM integration:
  - Proactive FRR messaging supported by OTU-4 Regen (Degrade detection generate a FDI to the Router)

I00G Interoperability – ASR9K

- Cisco only solution supporting Proactive FRR with ASR-9K 100GE Line Card and 100G TXP
- Connection between CXP of 100G TXP and CFP SR10 of ASR-9K.



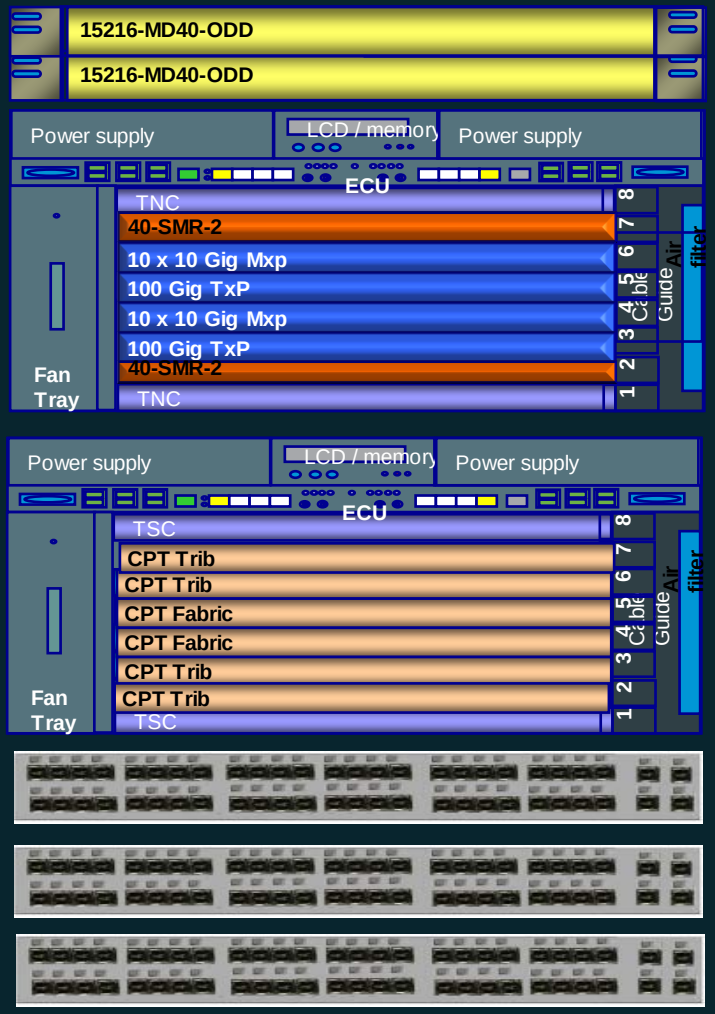
- Proactive FRR integration:
  - Cisco proactive FRR solution where 100G TXP will trigger a protection message to ASR-9K, through a proprietary signal between CXP and CFP, in case PRE FEC BER will cross a define TCA.

CPT Integration with 40/100 Gig

CPT Transport Configuration

12 RU
2 x Fabric Redundancy
132 Linerate GigE

3 x CPT-50 (4 x 10 Gig) to 3 x Trib
1 x 100 Gig Wavelength East/West



Thank you.