Foundation for Next-Generation Transport
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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

- National Data Center/Cloud/VHO
- Regional Data Center/VSO
- Core
- Edge
- Metro (Access/Agg)
- Third-Party Services/Content
- SP Services/Content
- Strict SLA
- Multi-point
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**

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**Packet Transport**

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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

SONET/SDH
- VT1.5 SPE
- VC-11/12
- DS1 Service
- E1 Service
- VT1.5 Muxed Into STS-1

Ethernet Mapping
- STS-1/Nc SPE
- VC-3/4 SPE
- STS-N/VC-3/4 approximates an LSP
- Network Identifier
- STS/VC number

Ethernet Mapping
- SONET SDH over DWDM

MPLS-TP
- PWE3 Encap
- MPLS Label Switched Path (LSP)
- MPLS-TP MPLS-TE over DWDM

Pseudowire Muxing Function
- PWE3 Encap
- G-Ach
- Circuit Emulation 1588v2
- Generic Associated Channel (G-Ach) for Inband MPLS-TP OAM

*Roadmap
- DS1 Service
- E1 Service
- MPLS-TP
- MPLS Label
- Ethernet Service
- SONET/SDH over DWDM
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
Introducing the Cisco Carrier Packet Transport (CPT) System

**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
Carrier Packet Transport (CPT) System

Metro
(Access, Aggregation)

Mobile Backhaul

Ethernet Services

FTTX & TDM

CPT 600

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

2 slots (160G)
Up to 176 ports

Fixed config satellite
44xGE, 4x10GE

CPT 200

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

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
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
Building a Trusted & Agile Network
Fiber to the Home Services

1. PON Access
   - Passive Splitter
   - Pro: Fiber Consolidation
   - Con: BW Constrained

2. FTTH Access
   - Home-Run from CO to each user
   - Pro: Bandwidth Scale
   - Con: 35% Fiber Mgt. space overhead in CO

3. CPT Ethernet Access
   - Home-Run from CO to each user
   - Pro: Fiber Consolidation
   - Pro: Bandwidth Scale

98% Fiber Space Savings and CO Fiber Management Optimization

Scaling Services for Growth
Exceptional Savings

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

Calculations based on 480G capacity

Powerful Yet Green and Optimized
CPT Packet Transport Architecture

End to End Management

Access Pre-Aggregation Aggregation Core

Distributed Architecture

Service Edge Router 7600, ASR 9K

Core

IP/MPLS

IP/MPLS Domain

L2/L3VPN

EoMPLS Pseudowire

MPLS-TP

.W1q, PW

.W1q, MPLS

Packet Transport Network

Aggregation MPLS-TP Network

Aggregation Node

CPT 600/200

CPT 50

CPT 600/200

CPT 50

Pre-Aggregation

Aggregation

Core

IP/MPLS

CRS-1/3

2G/3G/4G Node

RBS

CPT 50

MWR 3941

MWR 3941 (NID)

ME-3800 (L3 VPN overlay)

OMT, NID, CTBH gateway

Residential

STB

Business

Utility

Corporate

Legacy

MPLS-TP

L2/L3VPN
Cisco Carrier Packet Transport 600

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

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

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

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Cisco Carrier Packet Transport 200

Field Replaceable Electronic Connection Unit
- Bits In/Out Timing, USB, & EMS

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

Field Replaceable Fan Tray & LCD
- Redundant Fans
- Viewable Shelf Management
- Redundant Database Backup

Cable Guide & AirFilter
- Fiber or Copper Cable Management
- Field Replaceable AirFilter

2 RU ANSI & ETSI Compliant
Cisco Carrier Packet Transport 50

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

44xGE UNI
- Full Line Rate Packet Processing and Traffic Management
- Pay As You Grow Licensing (11port Increments)

Field Replaceable Fan Tray
- Redundant Fans
- ToD/PSS Output
- Bits Out

LEDs

1 RU ANSI & ETSI Compliant

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
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 (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
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

- **MPLS-TP**
  - 1:1 Service Stitching
  - EoMPLS Pseudowire
  - Port, 1Q, QinQ

- **IP/MPLS-TE**
  - Release 9.3

- **EoMPLS PW Switch**

- **N:N Service Stitching**
  - VPLS
  - Release 9.4

- **VPLSoMPLS Pseudowire**

- **H-VPLS**

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**CPT— Efficient Video Distribution**

- **STB**: Access Nodes
- **Aggregation Nodes**: CPT
- **Distribution Nodes**: CPT
- **Video SEN**: ASR9K

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- 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

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**Multicast Traffic flow**

- Multicast VLAN Traffic
- PW for Multicast Video
- LSP for Multicast Video

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PW’s across multiple carriers

MPLS-TP

6.6.6.6/32

Carrier 1

PE

P

P

IP/MPLS

7.7.7.7/32

Carrier 2

P

PE

9.9.9.9/32

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

I2 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

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

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<td>40G Muxponder RZ-DQPSK / CP-DQPSK</td>
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40G CP-DQPSK Muxponder - Extended Performance

- **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
40G CP-DQPSK Transponder - Extended Performance

- 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
**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:

![Diagram showing connections]

- 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)
### 100G 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.