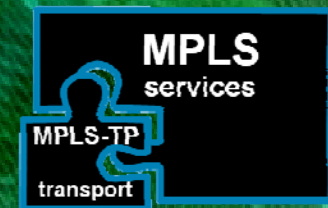




Cisco MPLS-TP Solutions



Moustafa Kattan

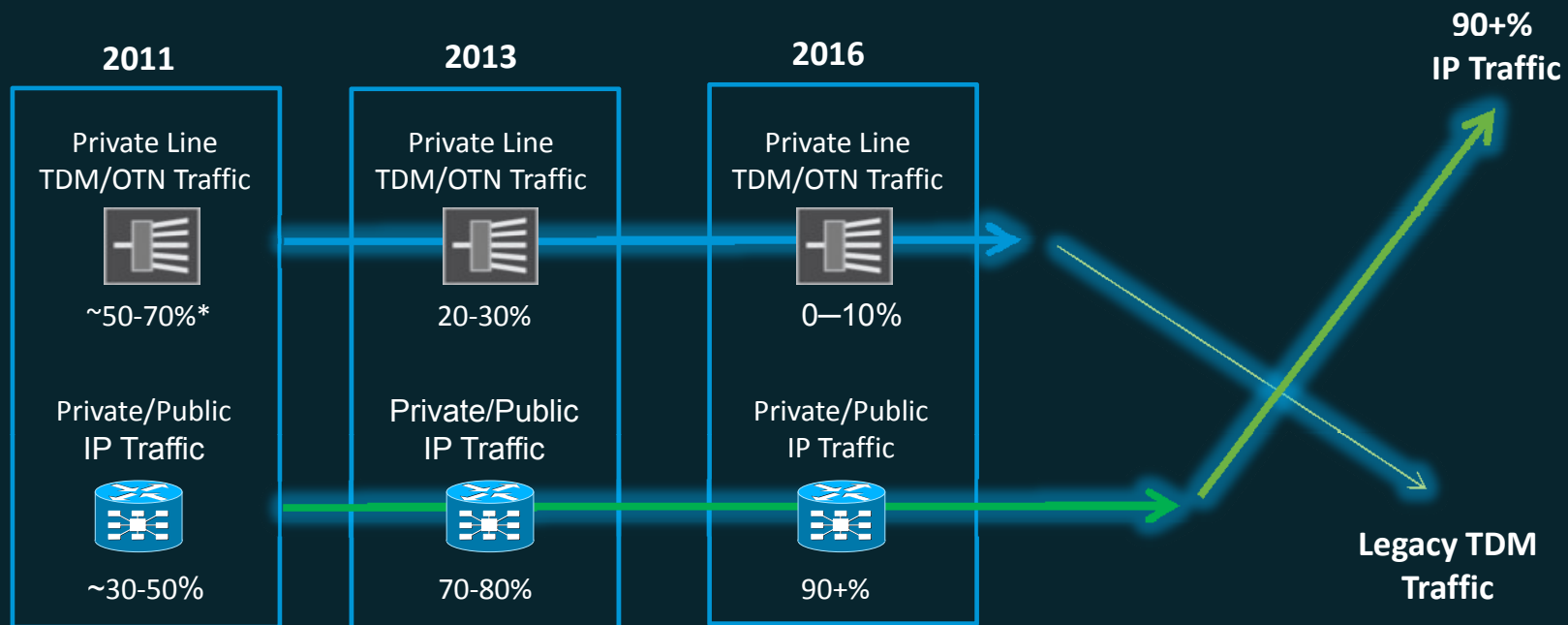
Consulting Systems Engineer, Emerging

Dec 5, 2011

Agenda

- **MPLS-TP Fundamentals**
- **Carrier Packet Transport (CPT)**
- **Control Plane**
- **MPLS-TP Scenarios**

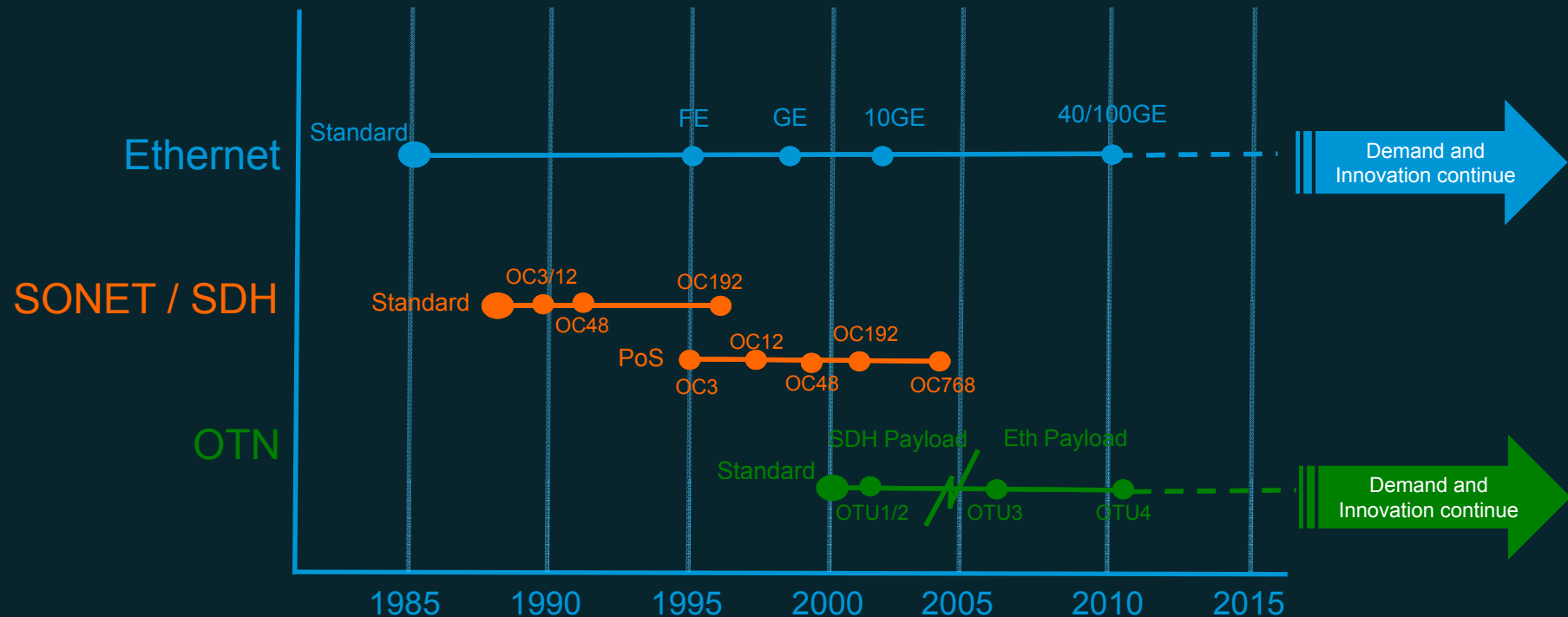
Circuit to Packet Migration



- Massive change in SP traffic make-up in next 5 years*
- SP revenue shifting from circuits to packet services**
5 yrs → ~80% revenue derived from packet services
Packet traffic increasing at 34% CAGR***

*ACG Research 2011, ** Cisco Research 2010, ***Cisco VNI 2011

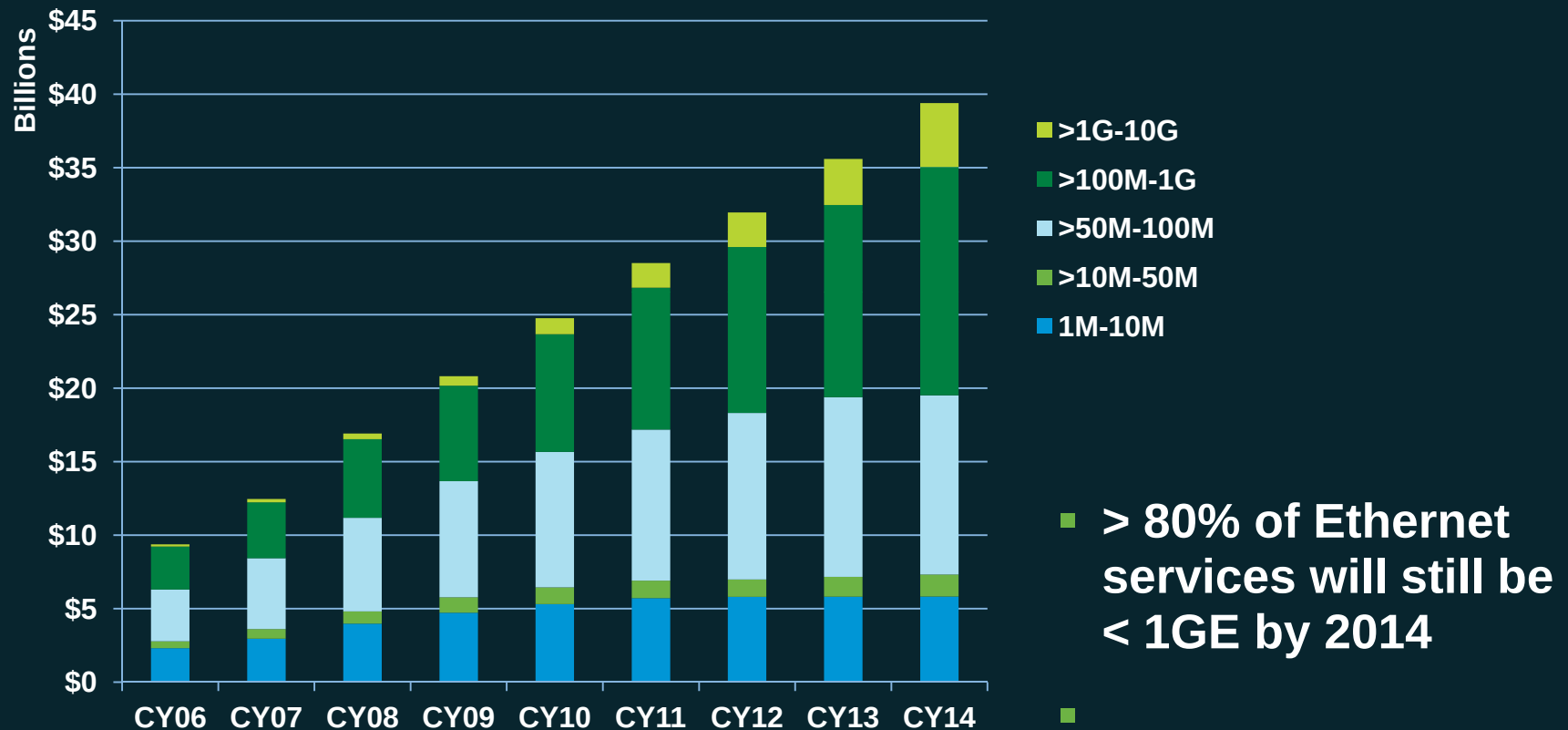
POS / Ethernet / OTN Migration



- POS and SDH R&D / Innovation caps 1995 / 2004
- Ethernet has undergone continual innovation since standardization
- OTN transitions in 2004/5 from SDH hierarchy to Ethernet payloads

SPs are making transition from SDH / POS to Ethernet

Worldwide Ethernet Services Market



Wholesale and retail Ethernet services: E-Line, E-Tree and E-LAN

Why is Transport Moving Toward Packet?

- **Market drivers:**

Fast deployment of new packet applications and services in recent years

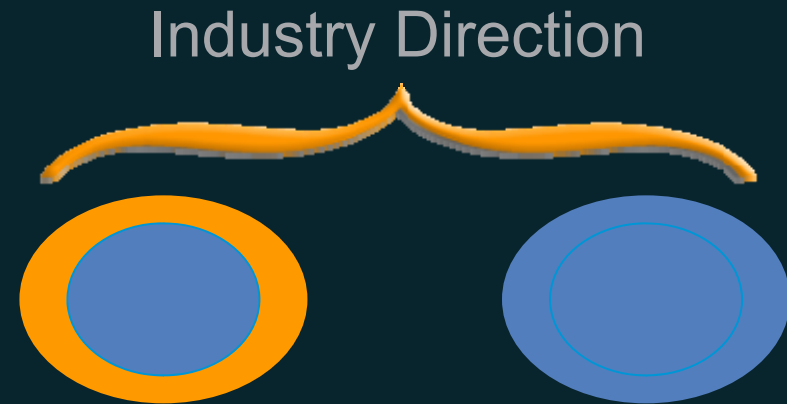
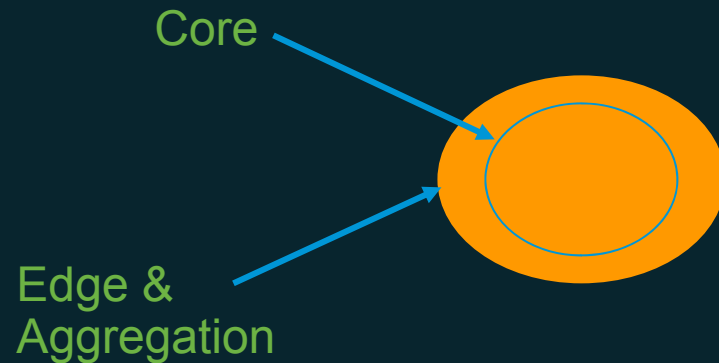
- *IP Video, Mobile data (smart phone apps)*
- *Triple play, IP and Ethernet VPNs*
- Creates new revenue opportunities for service providers

- **Infrastructure drivers:**

Transport moving to packet becomes inevitable

- Replacing aging legacy networks, end of life devices
- Consolidating networks onto common infrastructure
- Flexible data rates and statistical Multiplexing for efficiency
- Goal: Support growing new services with lower cost

MPLS Options



	Static	Hybrid (Static/Dynamic)	Dynamic
Forwarding Plane	MPLS Label	MPLS Label	MPLS Label
Control Plane	Manual NMS Dynamic NMS	Access/Agg – Manual NMS Agg/Core – Dynamic IP	Dynamic IP
Protection	Manual or NMS Calc and provisioning	Dynamic—core Manual—Agg/Acc	Auto-calculation or explicit route
OAM	MPLS-OAM	MPLS-OAM	MPLS-OAM

Cherry Picking



	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



Poll Response

The properties of MPLS-TP make it most suitable for deployments in what part of the network?

Backbone/core



46%

Metro



56%

Access



51%

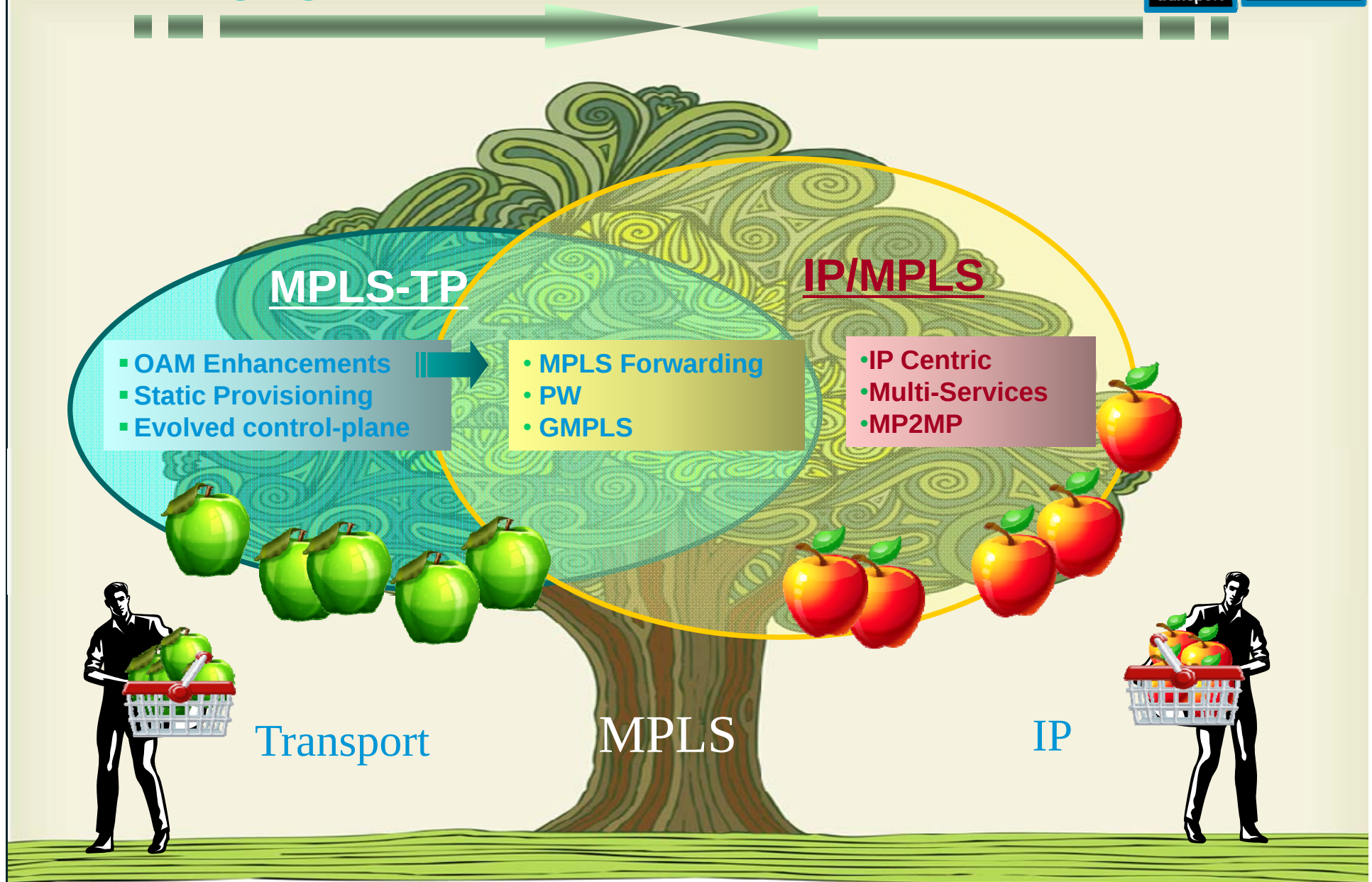
None of the above, MPLS-TP deployments will be minimal



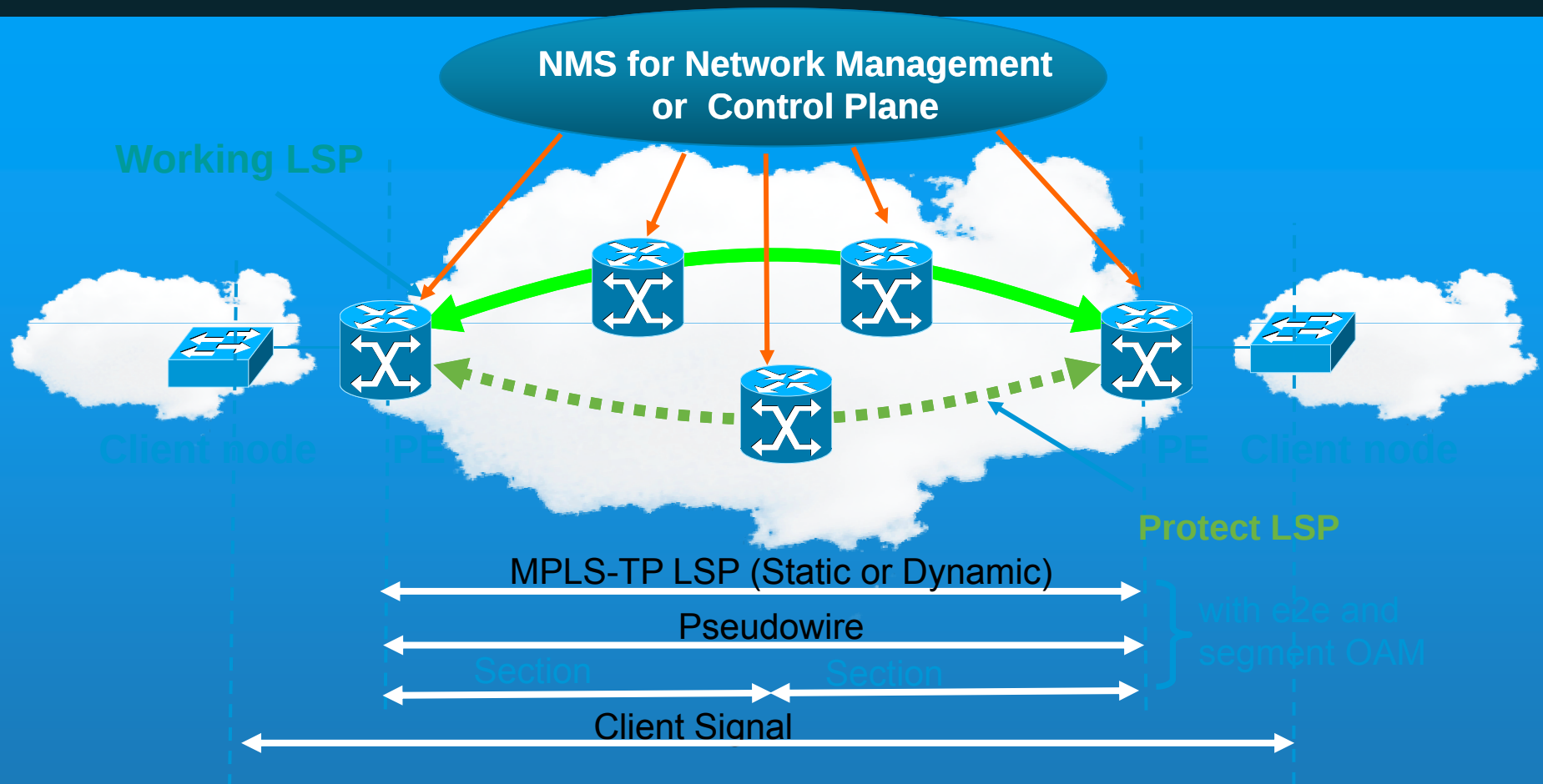
3%

MPLS-TP is a Subset of MPLS

Bridging the Gaps of IP and Transport



MPLS-TP Concept



Connection Oriented, pre-determined working path and protect path
Transport Tunnel 1:1 protection, switching triggered by in-band OAM,
Option with NMS for static provisioning

IETF and ITU-T Joint Work on MPLS-TP

IETF and ITU-T agreed to work together and bring transport requirements into the IETF and extend IETF MPLS forwarding, OAM, survivability, network management, and control plane protocols to meet those requirements through the IETF Standards Process.[RFC5317]¹

ITU-T withdrawal of T-MPLS draft G.8114 in Jan. 2008.



Definition of MPLS “Transport Profile” (MPLS-TP) protocols, based on ITU-T requirements

Note: IETF decided to support single MPLS-TP OAM solution. IETF Chair stated at IETF 79 (11/2010) and IETF 80 (3/2011)

Derive packet transport requirements

Integration of IETF MPLS-TP definition into transport network recommendations

1: [RFC 5317]: Joint Working Team (JWT) Report on MPLS Architectural Considerations for a Transport Profile, Feb. 2009.

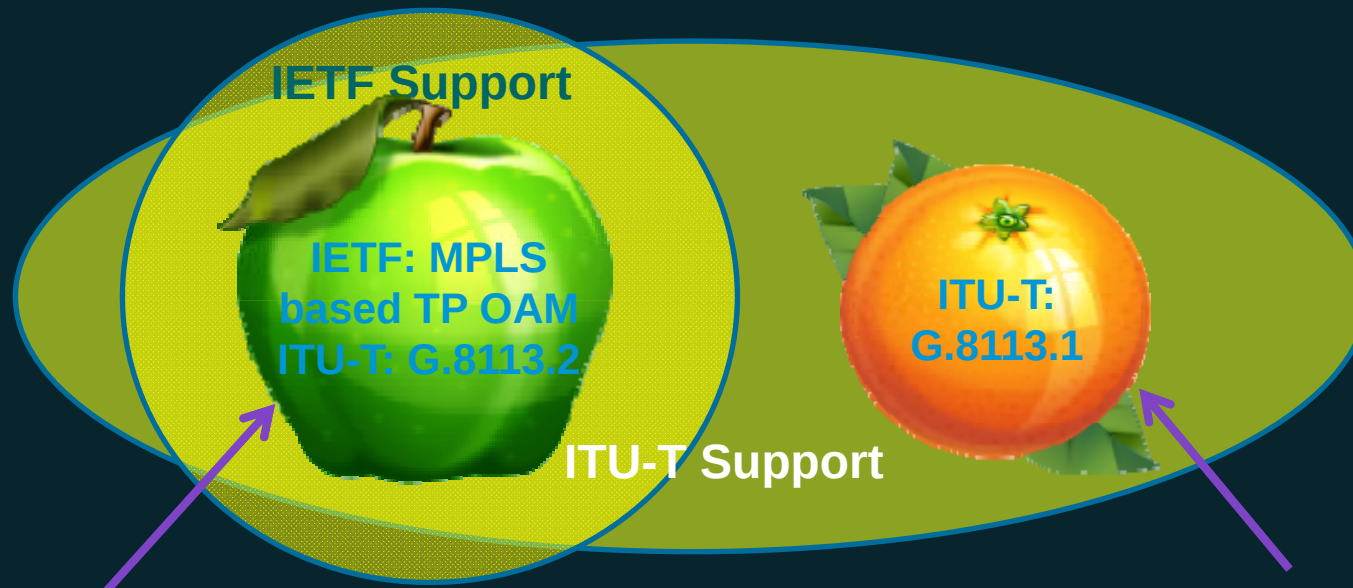
MPLS-TP OAM Standards Status



- Core protocols are under WG last calls to become RFCs
- IETF Chair Russ Housley stated at IETF 79 and IETF 80 meetings: IETF only supports single OAM solution for MPLS-TP



- ITU-T determined in Feb. 2011 for G.8113.1 to enter Traditional Approval Process, contingent on IETF Code Point assignment; and continue work with IETF to standardize MPLS based MPLS-TP OAM.



- Standardizing by IETF and ITU-T

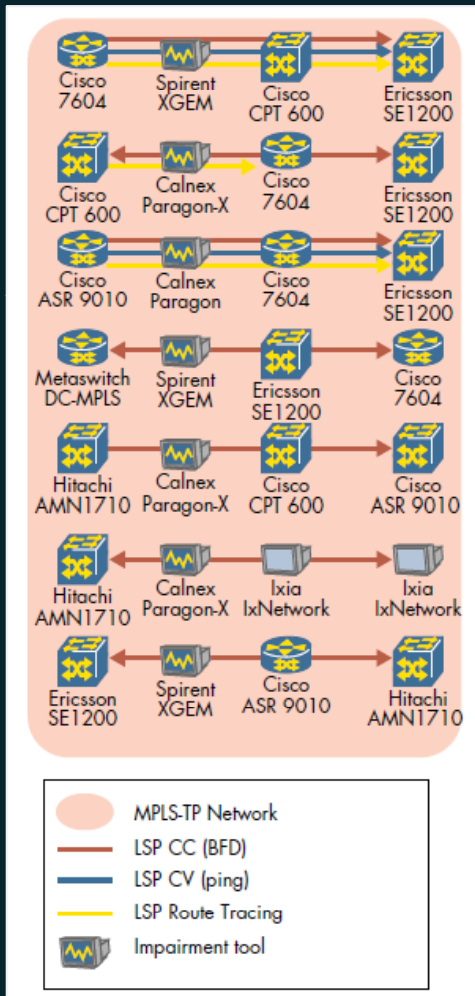
- Pending to approval in ITU-T
- Contingent on IETF Code Point assignment
- Not supported by IETF



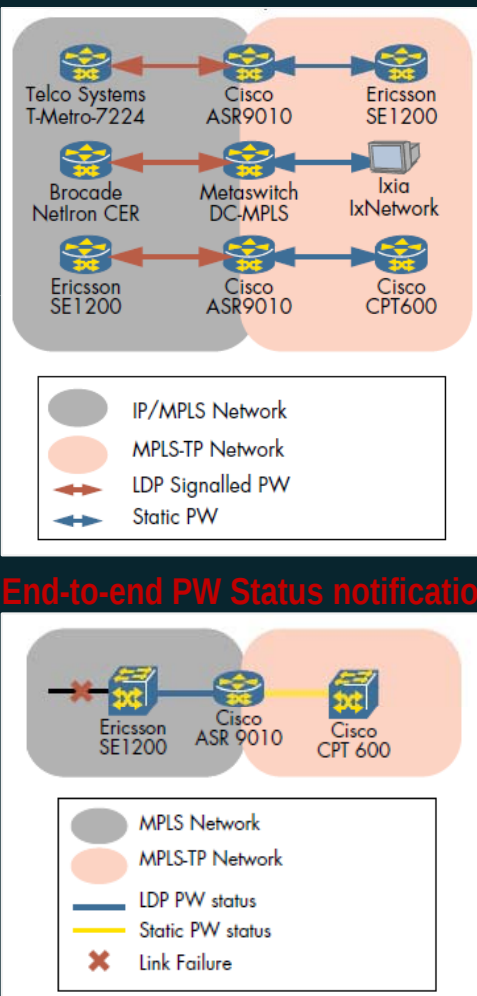
EANTC MPLS World Congress 2011

Actual MPLS-TP Standards Interoperability

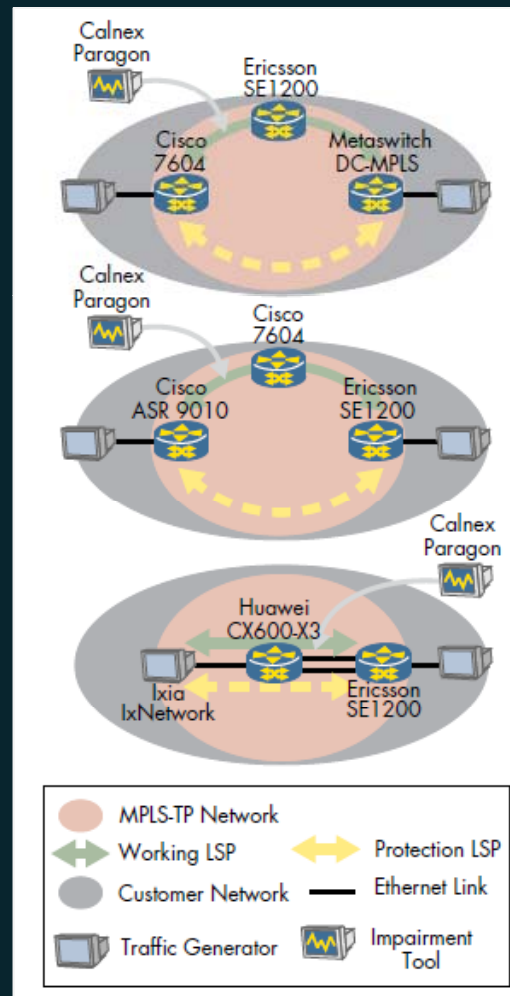
E-LINE / MPLS-TP LSP (CC/RDI)



MPLS-TP IP/MPLS Integration



1:1 Revertive Linear Protection



Support for MPLS-TP Standard Specifications – Nov 2011

Document	Cisco	Ericsson	Hitachi	NEC	Meta switch	Alcatel-Lucent	Huawei
Released product	Yes	No	No	No	Yes	Yes	Yes
Bidirectional, co-routed Forwarding (RFC 5960)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GAL/GACH (RFC 5586)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E-LINE Services (RFC 4448)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E-LAN Services (RFC 4664)	Yes*	No	No	No	No	Yes	No
ATM Services (RFC 4717)	No	No	No	No	No	Yes	Yes
CC/RDI (draft-ietf-mpls-tp-cc-cv-rdi)	Yes	Yes	Yes	Yes	Yes	No	No
LSP Ping/Trace (draft-ietf-mpls-tp-on-demand-cv)	Yes	No	No	No	No	No	No
Fault OAM (draft-ietf-mpls-tp-fault)	Yes	No	No	No	No	No	No
1:1 Linear Protection (draft-ietf-mpls-tp-linear-protection)	Yes*	Yes	No	No	No	No	No
MPLS-TP Integration with IP/MPLS (RFC 5659)	Yes	No	No	No	No	No	No
Static PW Status (draft-ietf-pwe3-static-pw-status)	Yes	No	No	No	No	No	No

* Pre-standard lockout

Transport Services Offerings Comparision

P-OTS Migration from
Metro SDH/SONET to MPLS-TP



	Characteristic	SONET SDH	MPLS-TP	IP/MPLS
Ethernet	Eline (10GE)			
	Eline (GE)			
	Eline (any gran. Sub GE/10GE)			
	E-Tree			
	E-LAN			
Legacy	F/R			
	ATM			
	TDM			
IP	L3VPN			
	L3 Unicast			
	L3 Multicast			
	Content			
General	Traffic Engineering			
	50ms restoration			
	Multiplexing Technology	Time Division	Statistical	Statistical
	UNI processing	Limited	Typically rich	Typically rich
	Granularity	VC-4	Variable	Variable
	Technology Maturity		MPLS w/ OAM & 50ms Protection	

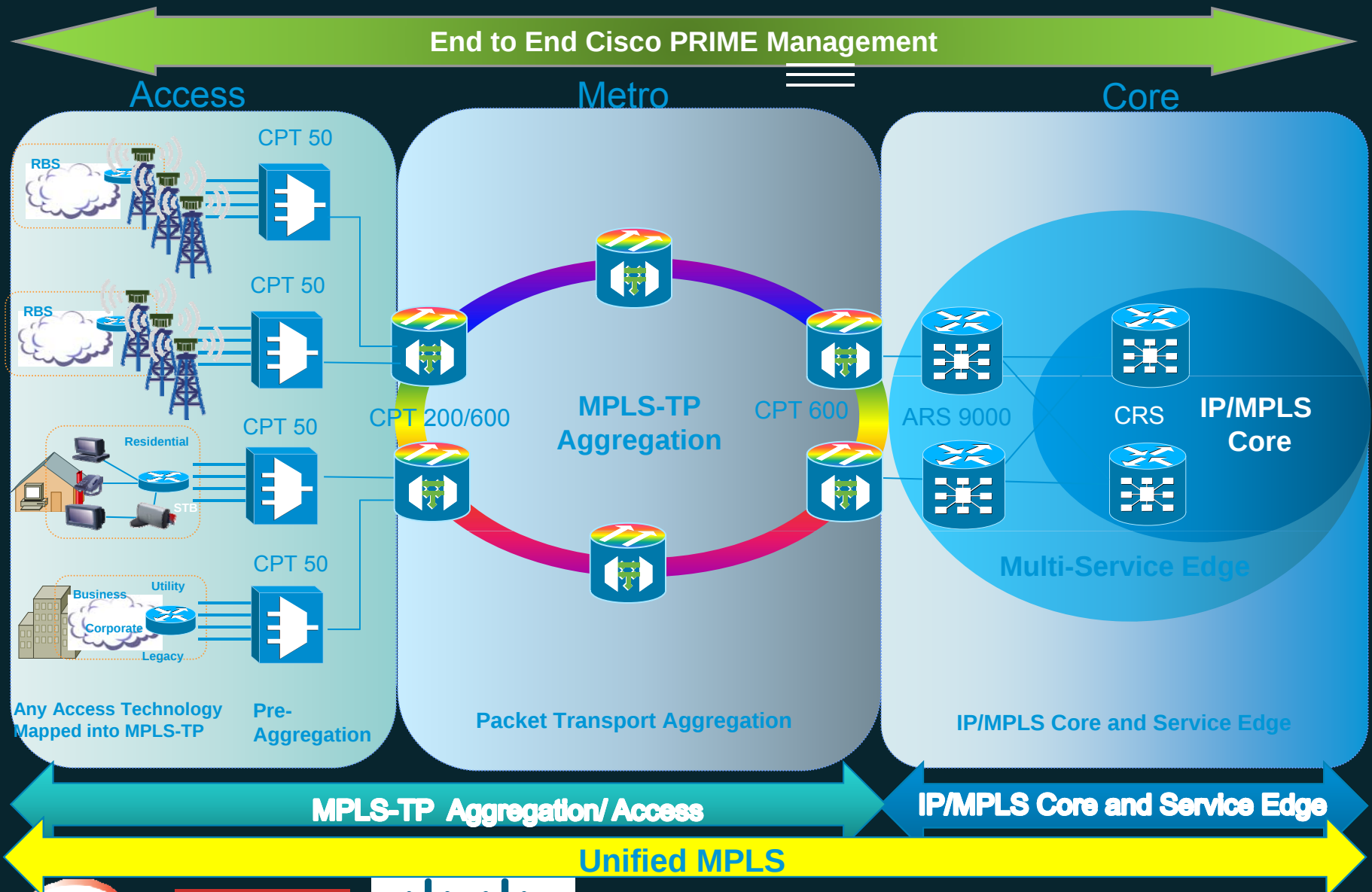
Agenda

- **MPLS-TP Fundamentals**
- **Carrier Packet Transport (CPT)**
- **Control Plane**
- **MPLS-TP Scenarios**

Design Considerations – when to use MPLS-TP?

- When to consider MPLS-TP?
 - Most common use case: replacing SONET/SDH with MPLS-TP
 - Typical applications:
 - Metro aggregation/access
 - Mobile back-haul
- Which MPLS-TP Model?
 - Depending on the operational model and long term planning
 - Dynamic with GMPLS control plane is preferred if ops model allows
 - Static provisioning model may provide easy adaption for the transport ops – most commonly adopted practice today
- Can MPLS-TP be used to replace IP/MPLS?
 - No. MPLS-TP is MPLS focused on transport-only features, it does not provide L2/L3 services functions as IP/MPLS does

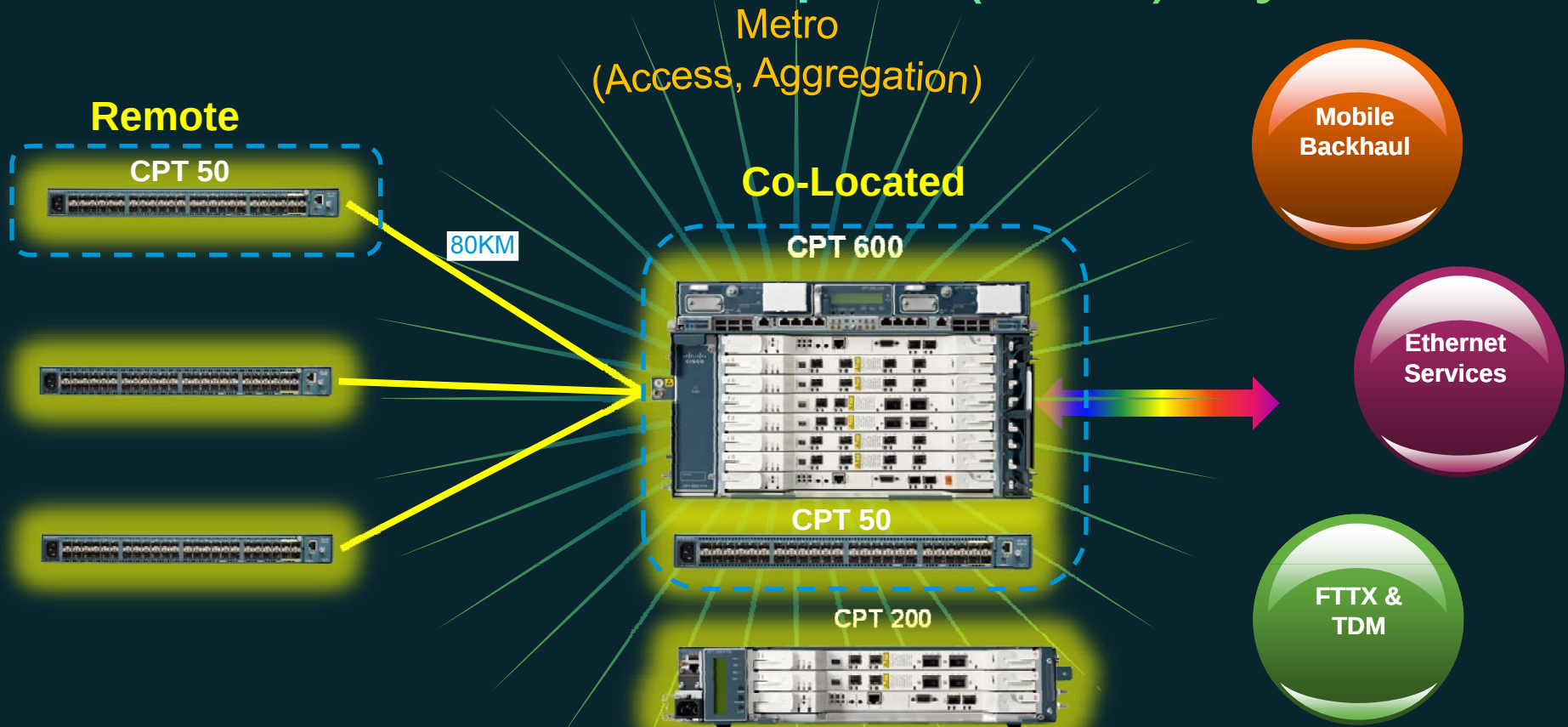
Standards-based Unified MPLS Architecture



HEAVY
READING



Carrier Packet Transport (CPT) System

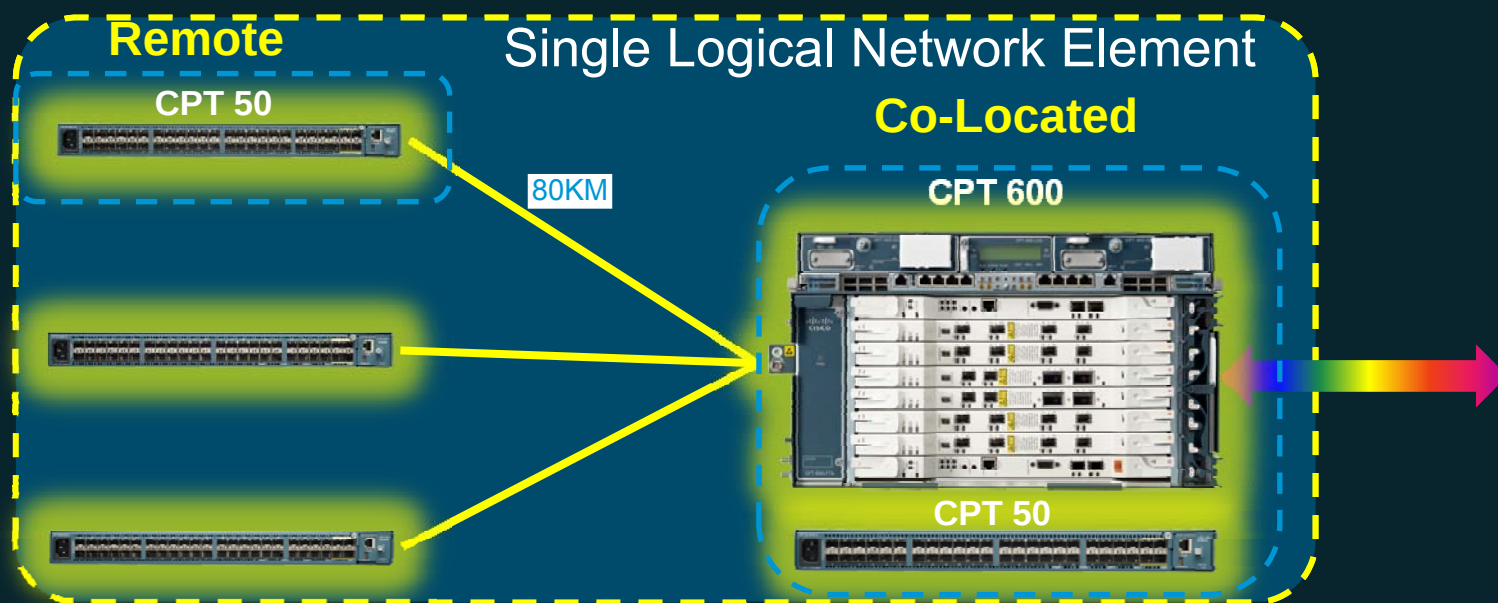


Feature Rich, Carrier Class and Manageability

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

Simplifying Access and Aggregation

CPT Satellite Architecture



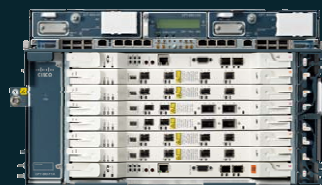
Satellite Architecture Key Benefits:

- Managed as a Single Network Element ($\geq 35\%$ lower TCO)
- Automatic Satellite Discovery (like inserting a linecard)
- Flexible Topologies (Hub & Spoke or Rings (R9.6))
- Scalable Port Density / $\leq 880\text{GE}$
- Supports flexible oversubscription models 4:1 / 3:1 / 2:1 / 1:1
- Single CTC & Prime Management Interface

Simplifying Access and Aggregation

Unprecedented Capacity and Scale in a Small Footprint

Today				
	CPT 600	CPT 200	CPT 50	CPT 50 License
Rack Units	6	2	1	1
# of Slots	8 Slot	3 Slot	Satellite	Satellite
Max. Linecards per Chassis	6 LC	2 LC	Fixed Ports	Fixed Ports
Max. Linecard Bandwidth (Today)	80 Gbps	80 Gbps	44xGE + 4x10GE	11xGE + 4x10GE
Max. Slot Bandwidth (Future)	240 Gbps	240 Gbps	N/A	N/A
Chassis Bandwidth	1.4 Tbps	480 Gbps	80 Gbs	22 Gbs



CPT 600



CPT 200

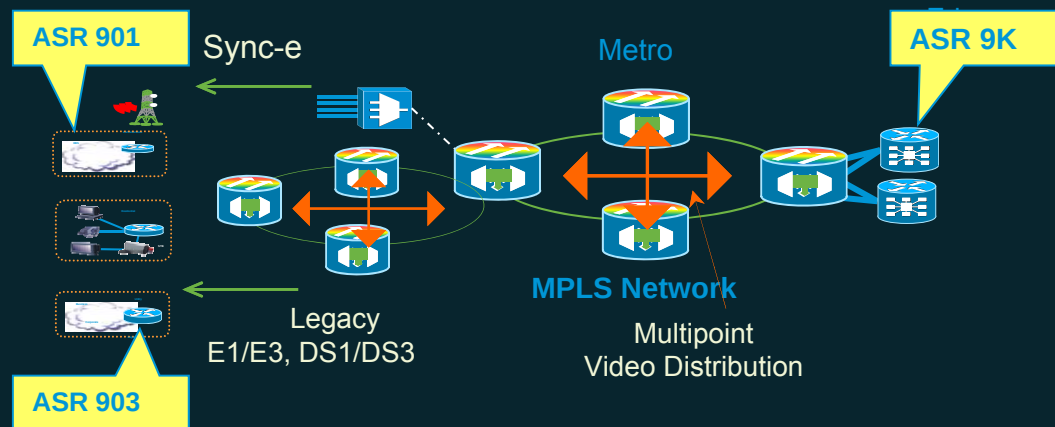


CPT 50



**CPT 50
License**

Simplifying Access and Aggregation Services and Resiliency Flexibility



CPT Service and Resiliency Key Benefits:

- Superior MPLS Service Flexibility

MEF 9 & 14 Certified

- Strict Service SLA <50ms

All MEF Service Type

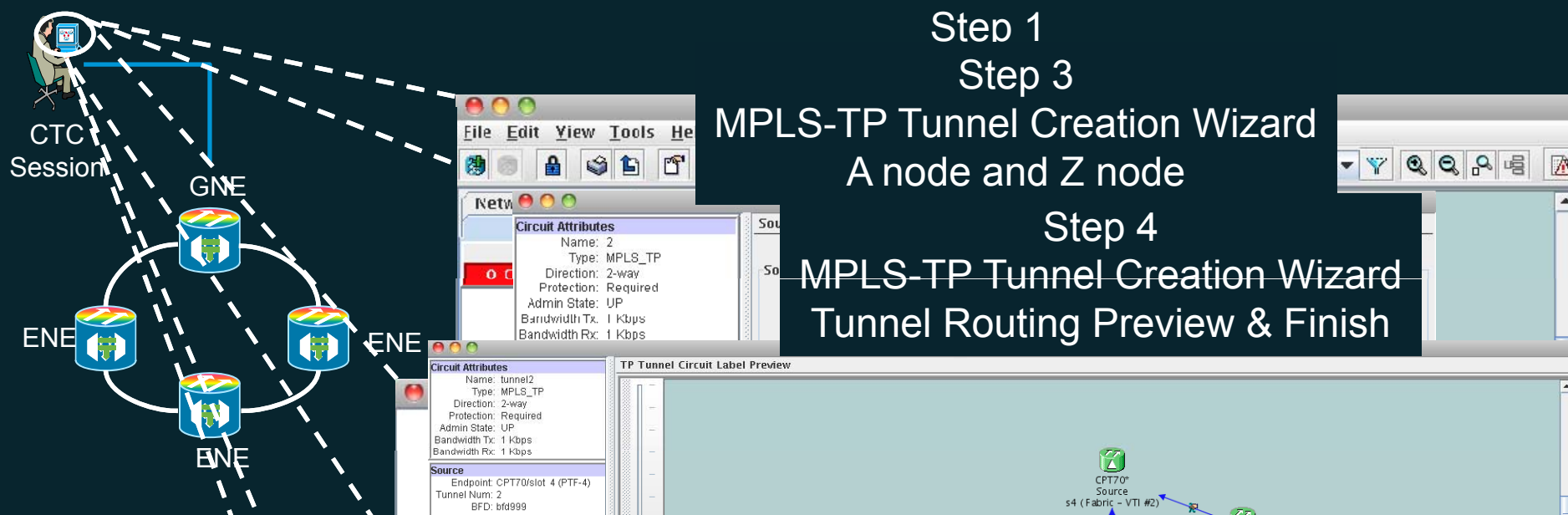
- Integrated G.709 Interfaces

Extended Interfaces Reach over DWDM and Protocol Resiliency



MPLS-TP Services	CPT	Others
ELINE / VPWS	✓	✓
EVPL / VPWS	✓	✓
ELAN / VPLS	✓	✗
EVPLAN / (H)VPLS	✓	✗
ETREE / VPLS (Split H)	✓	✗
IP/MPLS Handoff	✓	✗
MPLS-TP Resiliency	CPT	Others
Ring Topology Resiliency <50ms	✓	✓
Mesh Topology Resiliency <50ms	✓	✗
Single Domain Resiliency <50ms	✓	✗
Multi Domain Resiliency <50ms	✓	✗
Node Resiliency <200ms	✓	✗
Interface Resiliency (OTN)	✓	✗

Simplifying Access and Aggregation CTC Provisioning



Cisco Transport Controller (CTC) Key Benefits:

- GUI based Node and Network Craft Provisioning Tool
- Node and Network Alarm Management and Correlation
- A to Z Circuit Provisioning (EVC, MPLS-TP, & IP/MPLS)
- Multi-Segment MPLS Provisioning (MS-PW between MPLS-TP & IP/MPLS)
- Full Node Maintenance: Software Upgrade/Downgrade & Database Backup/Restore

Poll Question

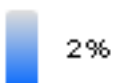
In what timeframe are you considering deployment of MPLS-TP?

- **Within the next 12 Months**
- **Within 12-18 Months**
- **Later**
- **Never**
- **Undecided**

Poll Response

When do you expect to see significant strategic deployment of MPLS-TP by numerous operators?

Before the end of 2011



In 2012



In 2013



In 2014



Unsure / do not expect to see significant deployments of MPLS-TP



Agenda

- **MPLS-TP Fundamentals**
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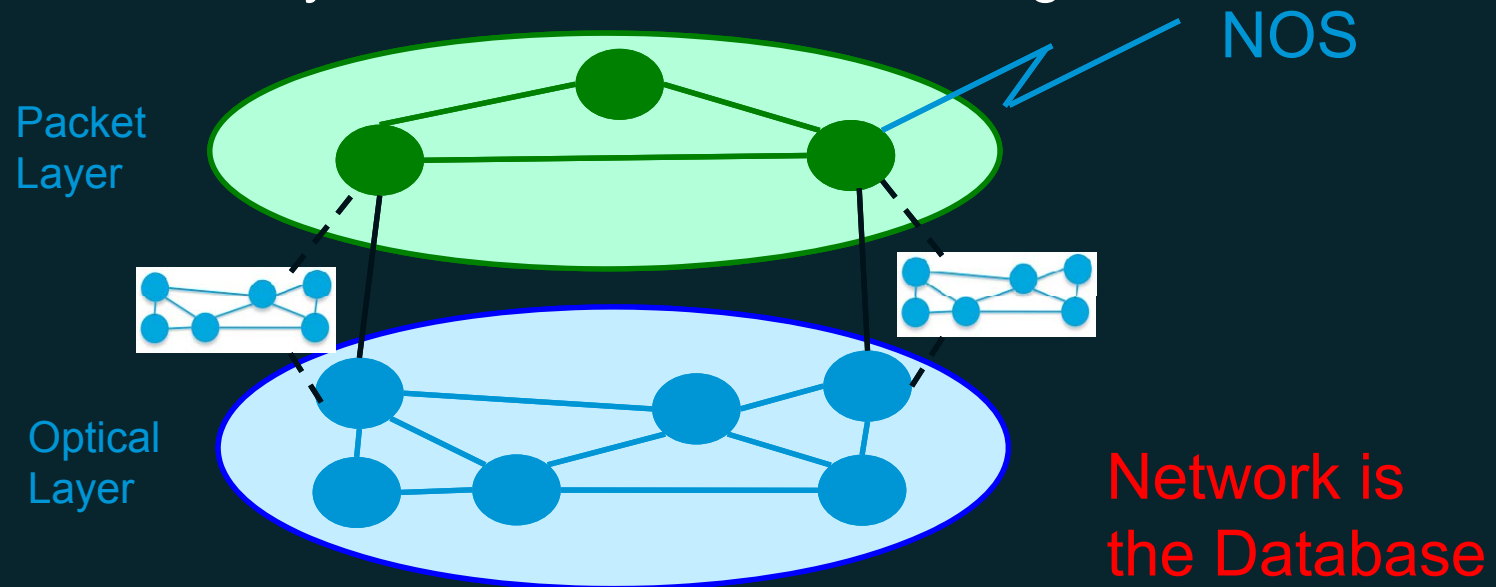
Control Plane - iOverlay

- iOverlay can provide the network knowledge of peering while providing greater scale
- Provide Multi Layer Support while Respecting Organizational Boundaries
- Leverage Expertise across layers
- Share and leverage information across layers



iOverlay: Solving the Multi-layer Control Plane Problem

- Phase 1: Deliver WSON capability in Optical Layer
- Phase 2: Enable interfaces between packet layer and optical layer using G-MPLS UNI
- Phase 3: Extend interfaces to add new capabilities
- Phase 4: In-line fully automated decision making



The Interaction

- Restoration – L3 Protect -> L0 Restores

Today:

Protection is provided via L0 Team

- 1+1, Fiber protection, etc...

- Does not efficiently utilize available BW

- Increases Cost per Bit

Protection is provided via L3 team

- Decrease Interface Utilization based on WC BW

- Does not efficiently Utilize BW

- Increase Cost per Bit

iOverlay:

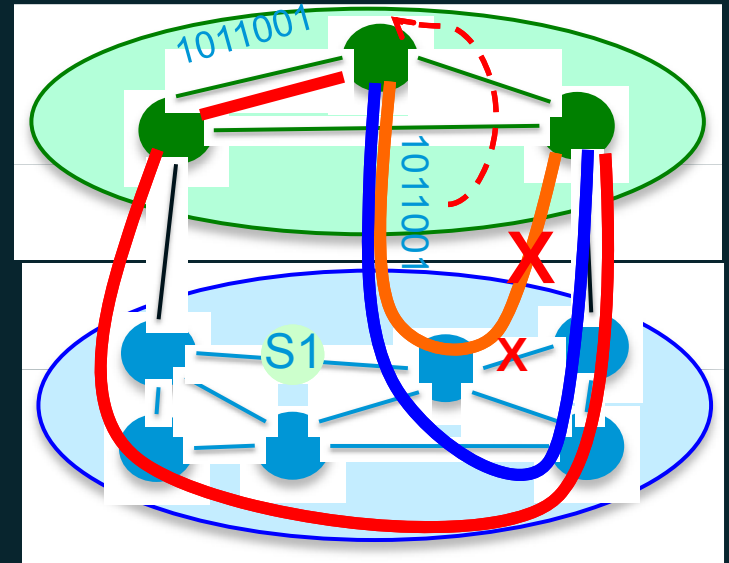
- L3 detects Circuit degradation and initiates Proactive Protection

- L0 Restores capacity back to network and signals existing router port to change if needed

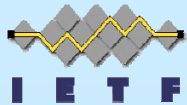
- No SRLG data is propagated and recorded

Packet Layer

Optical Layer



WSON in the Standards Bodies (Wavelength Switched Optical Networks)



*Charter: Evolution of the
Internet (IP) Architecture*
(MPLS, MPLS-TP)

Active Participants:

- Service Providers
- Vendors
- WSON,



*Charter: Global Telecom Architecture and
Standards*

Member Organizations:

- Global Service Providers
- PTTs, ILECs, IXCs
- Telecom equipment vendors
- Governments
- ASON, impairment parameters G.680

- **WSON Optical Impairment Unaware**

<https://datatracker.ietf.org/doc/draft-ietf-ccamp-rwa-wson-framework/>

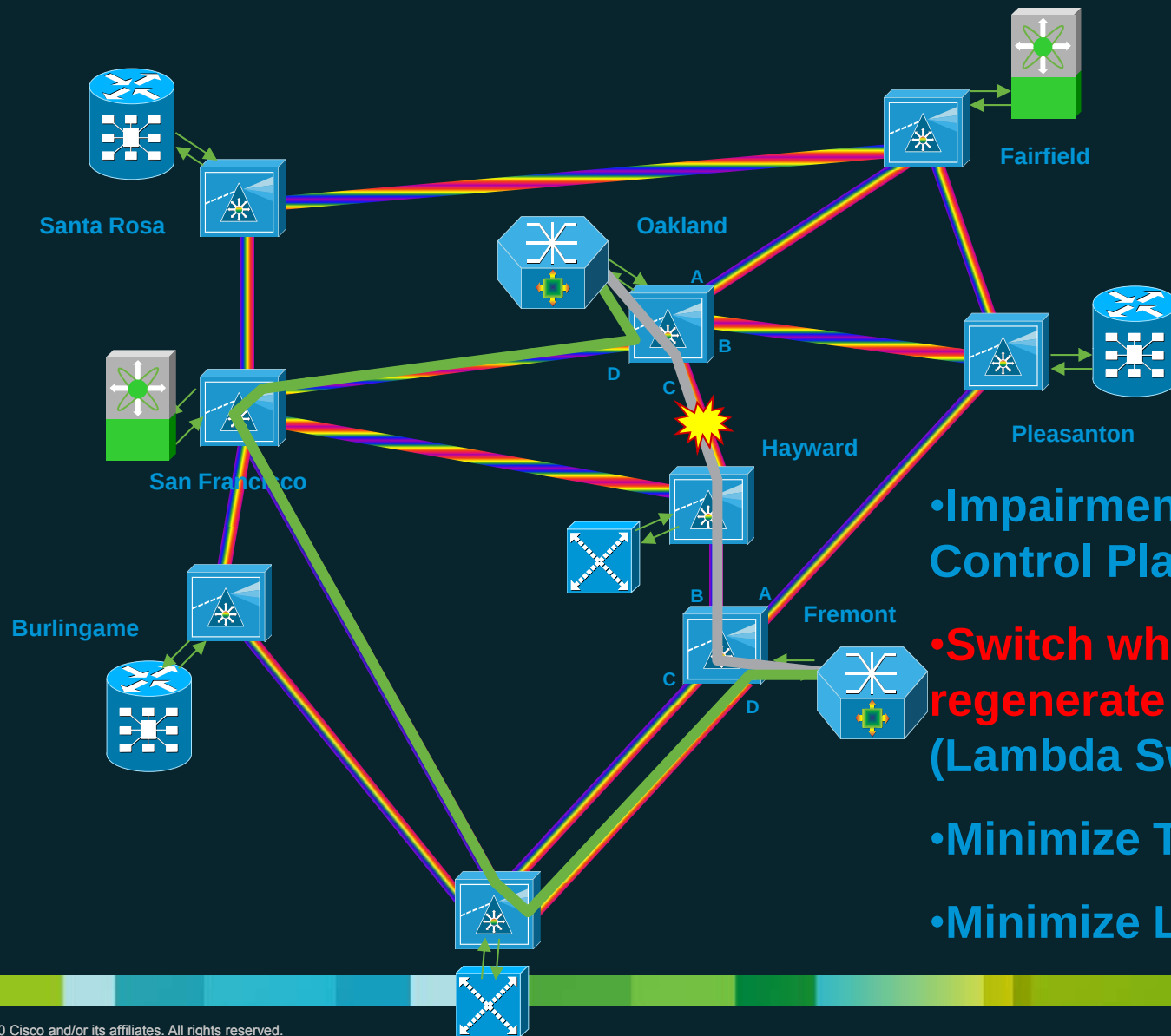
- **WSON Optical Impairment Aware Work Group Document**

<http://www.ietf.org/id/draft-ietf-ccamp-wson-impairments-06.txt>

Why Do We Need WSON ?

- **WSON is an Impairment aware DWDM control plane (ASON is not)**
- **Client interface registration**
 - Alien wavelength (open network)
 - Transponder (closed network)
 - ITU-T interfaces
- **Wavelength on demand**
 - Bandwidth addition between existing S & D Nes (CLI)
- **Optical restoration-NOT protection**
 - Automatic Network failure reaction
 - Multiple SLA options (Bronze 0+1, Super Bronze 0+1+R, Platinum 1+1, Super Platinum 1+1+R)

WSON Restoration Example for AToDWDM

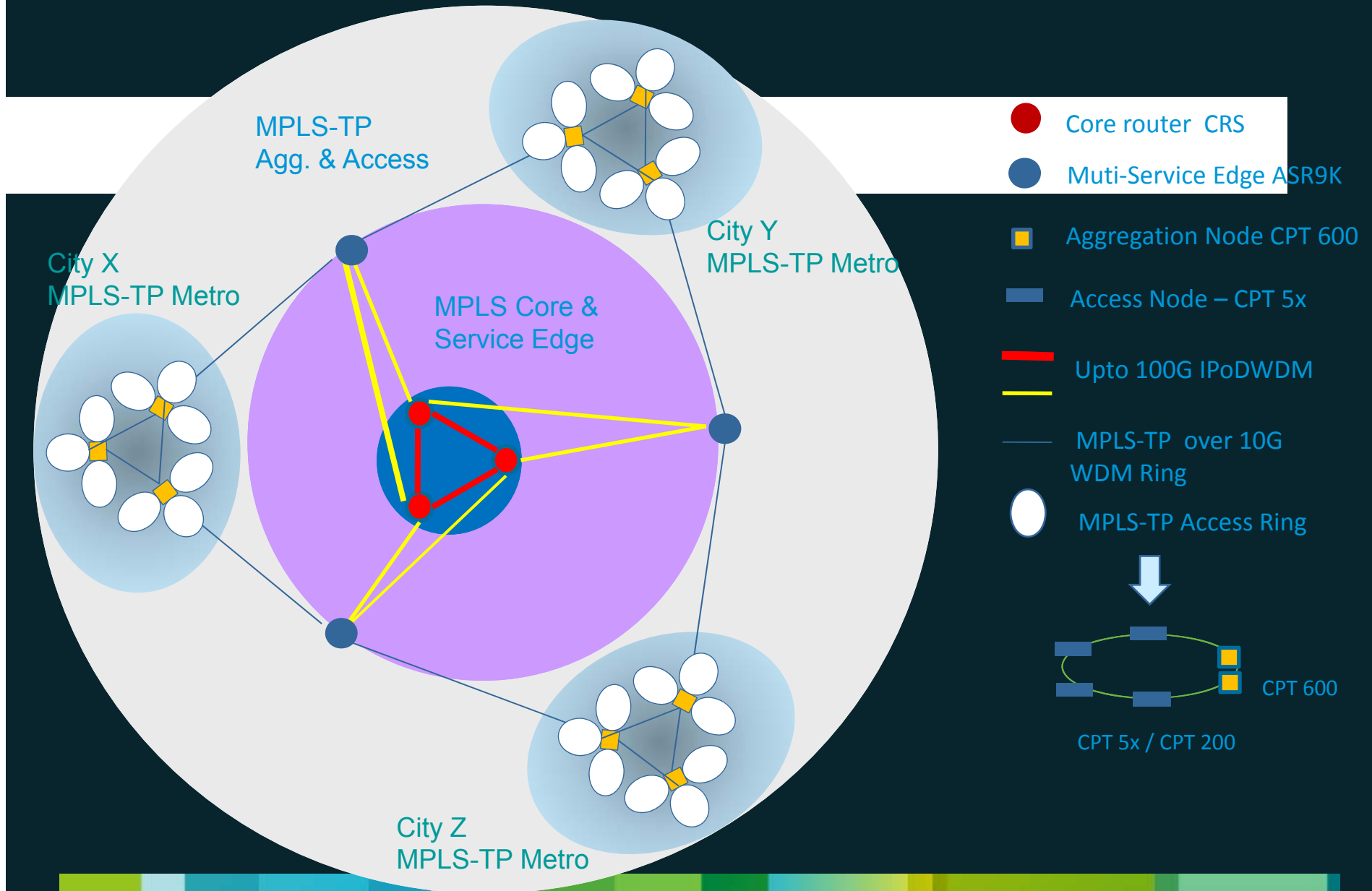


- Impairment Aware DWDM Control Plane
- Switch when you can & regenerate when you must (Lambda Switching)
- Minimize TDM XC/OEO
- Minimize Latency and cost

Agenda

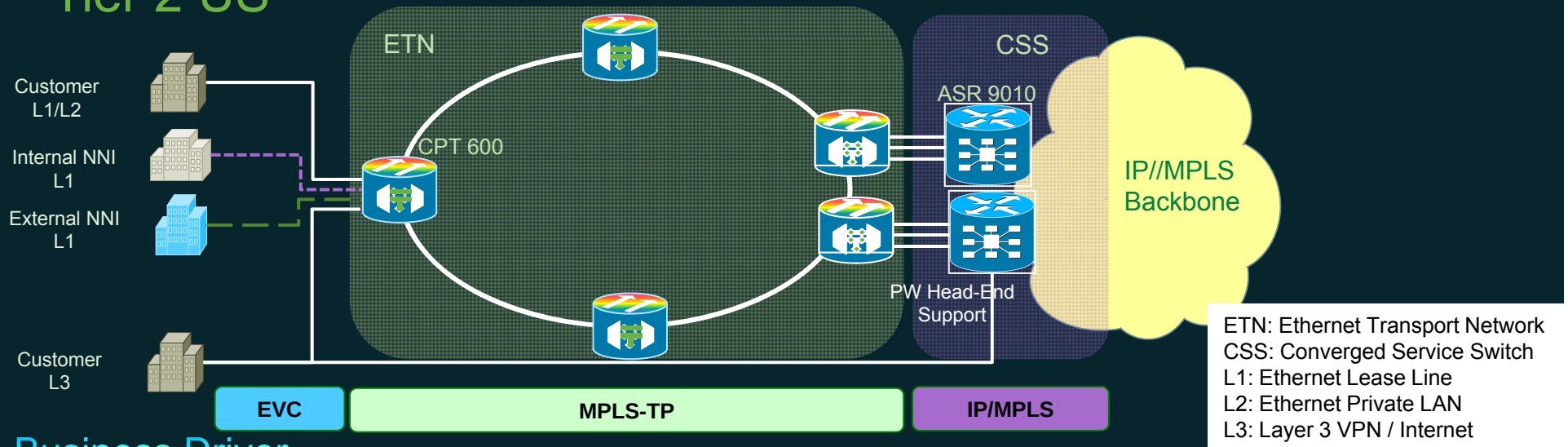
- **MPLS-TP Fundamentals**
- **Carrier Packet Transport (CPT)**
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Use Case 1: MPLS-TP For Metro Aggregation and Access



POTS Use Case

Tier 2 US



Business Driver

- Growth in Ethernet Services leads to Packet Transport migration

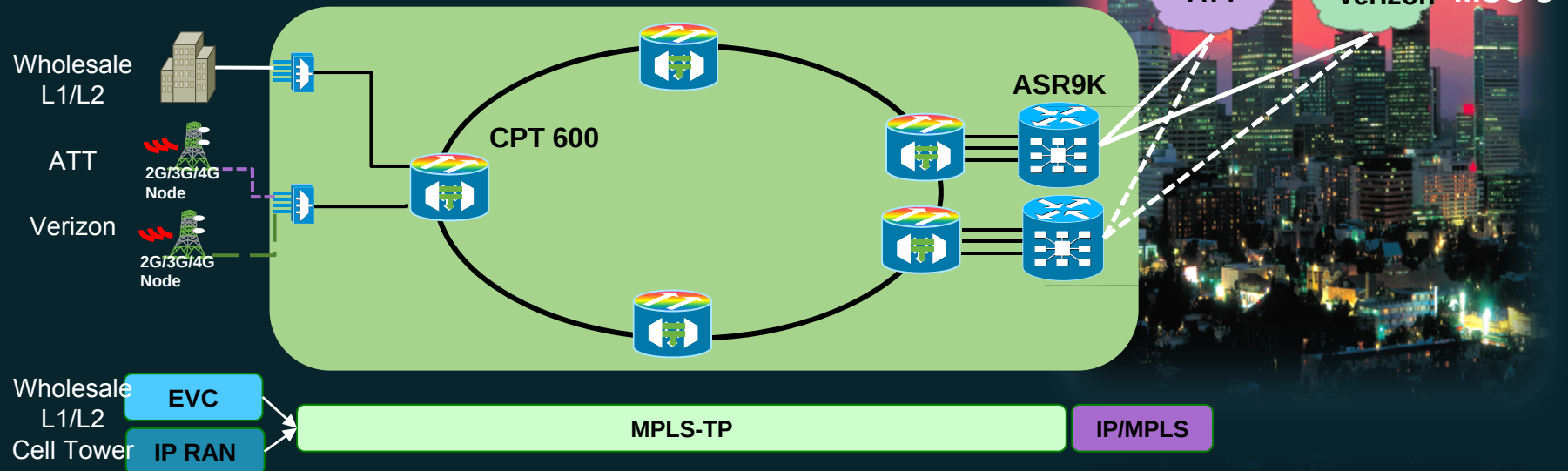
Cisco Solution and Value Solution:

- CPT Provides compact, scalable and pay as your grow architecture
- Strict transport SLAs for L1/L2 services with MPLS-TP
- Unified MPLS w/ CPT & PW Head-End on ASR9K Simplifies Network Design and Enables L3 Services in ETN

Cisco differentiation

Unified MPLS approach with common management and standards based MPLS-TP Solution

North America Mobile Backhaul Tier 2



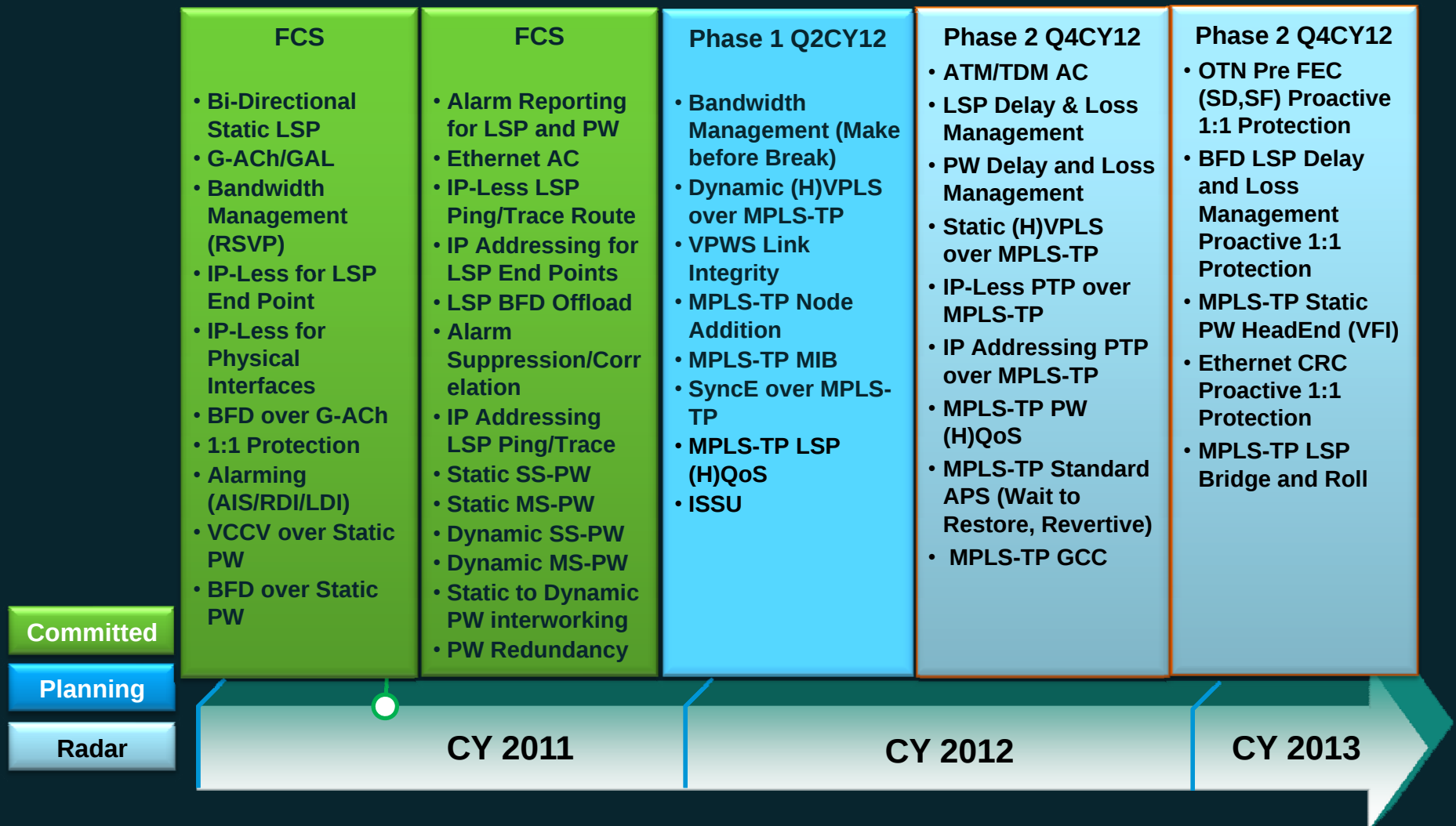
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MPLS-TP Roadmap



Summary

- Transport is evolving toward packet
 - New services driving BW growth
 - Network convergence, technologies refreshes
 - lower OPEX by moving from SONET/SDH/ATM/TDM to MPLS-TP
- Standard status
 - Core set of MPLS-TP definitions are close to finish in IETF
 - IETF supports single, consistent OAM for MPLS and MPLS-TP
 - ITU-T G.tpoam was not consented to become standards, it is pending to long approval process in ITU-T and code point allocation by IETF
 - Using Experimental code point in production network has the risk of code point collision
- Development
 - Cisco participated Inter-op events in 10/2011 and 2/2011.
 - CPT product family is available today with standards based MPLS-TP OAM
- MPLS-TP Use Case
 - End-to-end MPLS: IP/MPLS in the core, MPLS-TP for access
 - Applications of MPLS Based MPLS OAM

References

- **Light Reading MPLS-TP Webinar, June 17, 2011 – *MPLS in Next-Generation Transport Networks*, by Heavy Reading, Cisco, CEI, Ericsson, IXIA**
http://www.lightreading.com/webinar.asp?webinar_id=29688
http://www.lightreading.com/document.asp?doc_id=209360&site=mplstp&
- **Webinar, April 2011, *MPSL-TP Reality Check*, by VZ, Cisco and IXIA**
<http://www.ixiacom.com/ixiatv/webinars/index.php#mpls-tp-reality-check-drivers-development-and-deployment>
- **Cisco white pager**
http://www.cisco.com/en/US/prod/collateral/optical/ps5726/ps11348/white_paper_c11-656286.html
- **Cisco Optical Networking Product Information:**
<http://www.cisco.com/en/US/products/hw/optical/index.html>
- **Cisco Carrier Packet Transport (CPT) System**
<http://www.cisco.com/en/US/products/ps11348/index.html>
- **IETF RFC references:**
 - MPLS-TP Requirements:** <http://datatracker.ietf.org/doc/rfc5654/>
 - MPLS-TP OAM Requirements:** <http://datatracker.ietf.org/doc/rfc5860/>
 - MPLS-TP Framework:** <http://datatracker.ietf.org/doc/rfc5921/>
 - MPLS-TP Data Plane Architecture:** <http://datatracker.ietf.org/doc/rfc5960/>

THANK YOU!



Please fill evaluation sheet and this nice Cisco-Linksys E4200 Dual-Band Wireless-N Router could be yours ...