The bridge to possible

Converge Layers with a New Paradigm

Routed Optical Networking for Simplified Operations and Lifecycle Management

Lorenzo Ghioni – Director, Product Management

Rana D. Kazamel – Leader, Product Management

Stefano Colombo – Leader, Technical Marketing

Phil Bedard – Principal Engineer

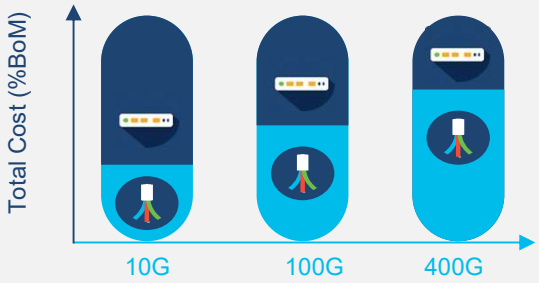
April 27th, 2021

Agenda

1. Routed Optical Networking – The Architecture Transition
2. Customer Journey & Portfolio Mapping
3. Technology Innovation & Enablers
4. Demo

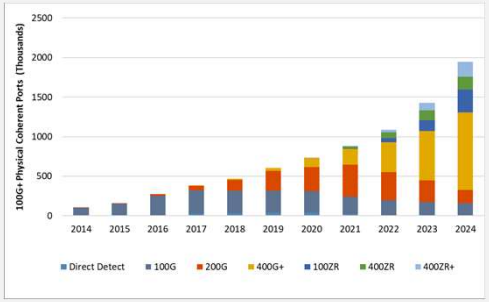
Key Market Trends

Port Price Breakdown



Host port costs are decreasing FASTER than optics

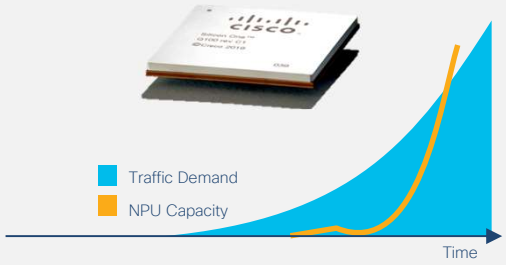
Growth in Coherent 100–400GE Ports



Source: CignalAI Optical Applications Report 3Q20

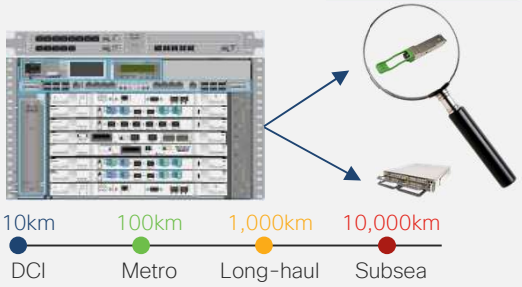
Increasing coherent high volume market

NPU Bandwidth versus Traffic Demand



Enables IP & Optical layers to merge in a H2H architecture

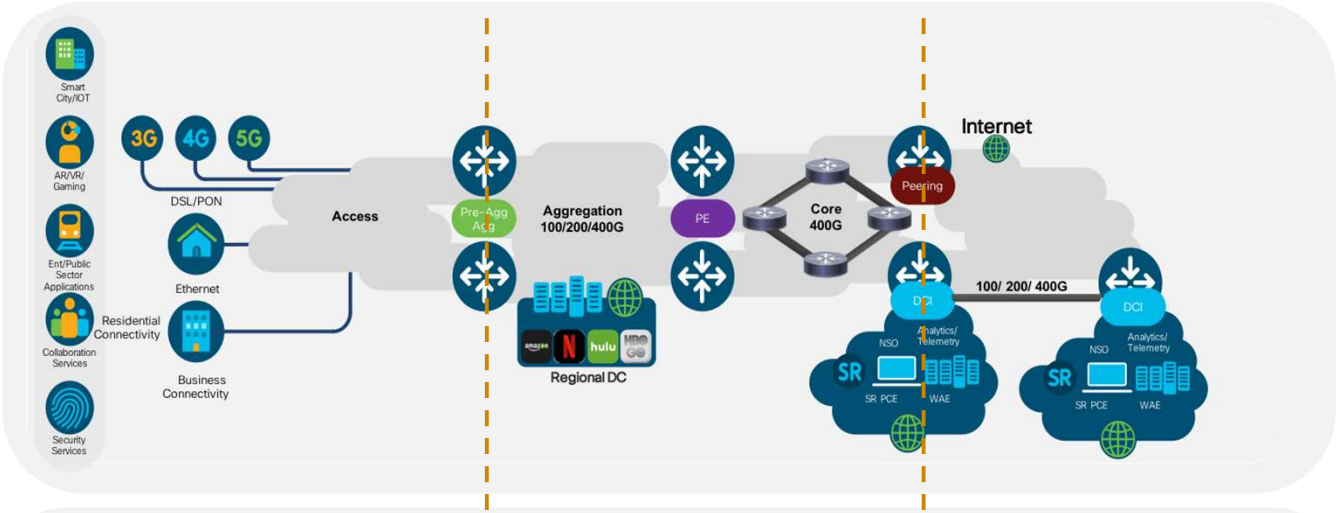
IP & Optics Integration



Chassis-based solutions replaced by pluggable optics with DSPs

IP and Optical Networks Today

IP Routing Layer



Services

Business
L3VPN, L2VPN

Residential
Highspeed Internet, IPTV, Voice, Content

Mobile
eMBB, URLLC, MMTC

Smart Cities, IoT, Gaming
Peering, Transit

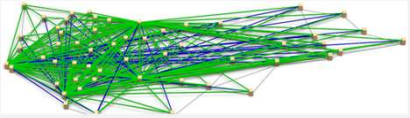
Optical Layer

No ROADM switching due to cost

Low-cost amplifier if longer distance than optics can support

Passive mux/ de-mux

ROADM switching
Hub-and-spoke architecture



Metro/ Regional <1000km
Long-Haul >1000 km

DCI point-to-point traffic

>1Tbps+ capacity
Up to 120 km for near DR
>2,500 km for far DR

Services

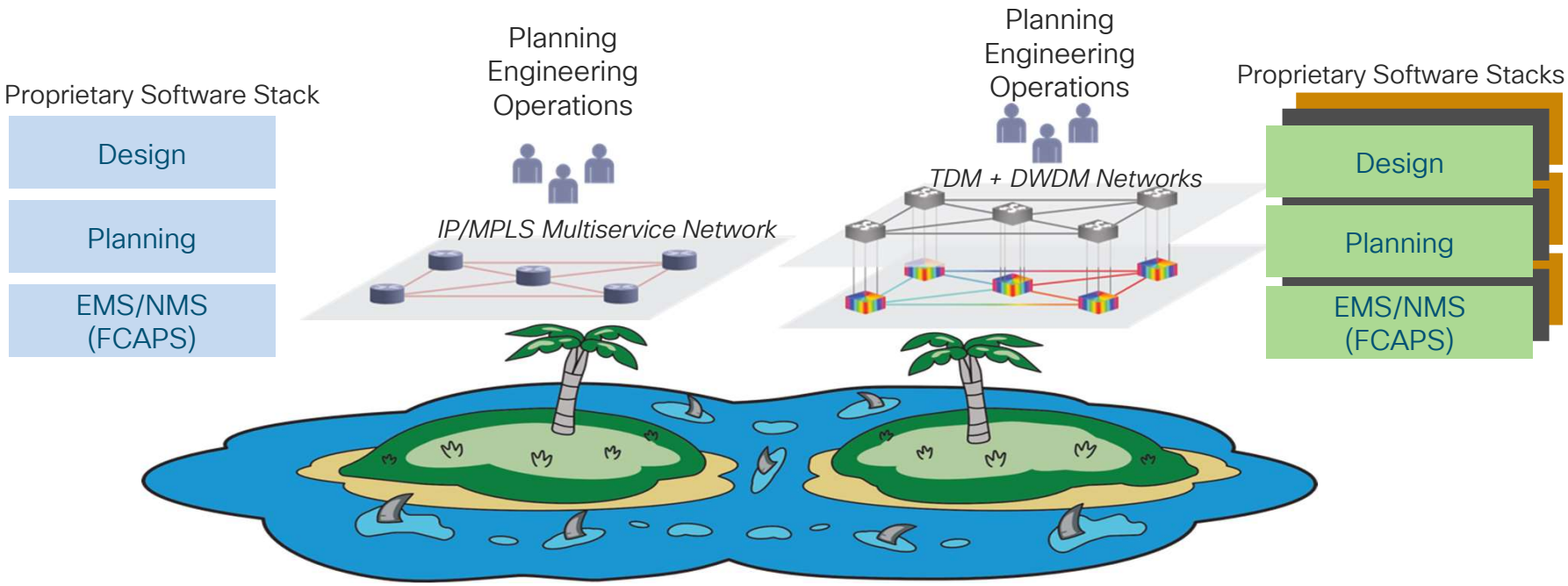
Private Line OTN
Wavelength Services
TDM Services
Optical Restoration
Backup Replication

Challenges of Isolated IP & Optical Network Layers

Inefficient Capacity Planning

Complex Operations Silo'ed Layers

No e2e Service Optimization



What we've learned about IP+Optical Integration

	Speed and Scale	Operations	Cost
Pros	Allows more efficient use of interfaces	Routers get direct visibility of optical performance	Savings driven by Hardware integration
		Better risk management (SRLGs), Signaling (UNI)	Savings driven by Software: Global View & Control (SDN), ML Planning, Global TE, Coordinated Protection
		Brings IP and Optical teams closer	
Cons	Port-density trade-offs with module integration	IP and Optical differences lead to Organizational silos	Different router (faster) and optical (slower) technology renewal lifecycles
	Optical always ahead in Interface Speed and Bandwidth vs. Performance	Complex layered architectures lead to complex software	Dedicated hardware on routers – harder to reuse
		Hard to automate	Hard to optimize network in real-time

What we've learned about IP+Optical Integration

	Speed and Scale	Operations	Cost
Pros	Allows more efficient use of interfaces	Routers get direct visibility of optical performance Better risk management (SRLGs), Signaling (UNI) Brings IP and Optical teams closer	Savings driven by Hardware integration Savings driven by Software: Global View & Control (SDN), ML Planning, Global TE, Coordinated Protection
Cons	Port-density/rate differentiation module integration Optical always ahead in Interface Speed and Bandwidth vs. Performance	IP and Optical differences lead to Organizational silos Complex layered architectures lead to complex software Hard to automate	Different router (faster) and optical (slower) technology renewal lifecycles Dedicated hardware on routers – harder to reuse Hard to optimize network in real-time

In the long term,
we'll need a different approach

Changing the Economics of Networking

Incremental Improvements: Important but not enough

Build faster networks (Moore's Law)

Higher chassis capacities

Higher interface speeds

More capacity at lower cost

Improve network utilization

Better traffic engineering

Telemetry + Analytics

Maximize use of assets

Disruptive Changes: Critical to the future of networks

Transform Network Operations

Consistent operations

Automation + Orchestration

Services agility, speed

Re-architect end-to-end network

Simplify, collapse layers

Remove functional overlaps

Remove complexity

Routed Optical Networking Goals

Converge Services: L1, L2 and L3 services

Using Private Line Emulation for for bit transparent services over packet switching

Mass-scale Routing Platforms

- Multi Tbps NPUs and line cards
- Less space/power per bit
- Cost-effective for all services (Port + Optics, OTN + IP)

Common Hardware

- No dedicated hardware
- Zero port density trade-offs
- No hidden hardware costs

Standardized Optics

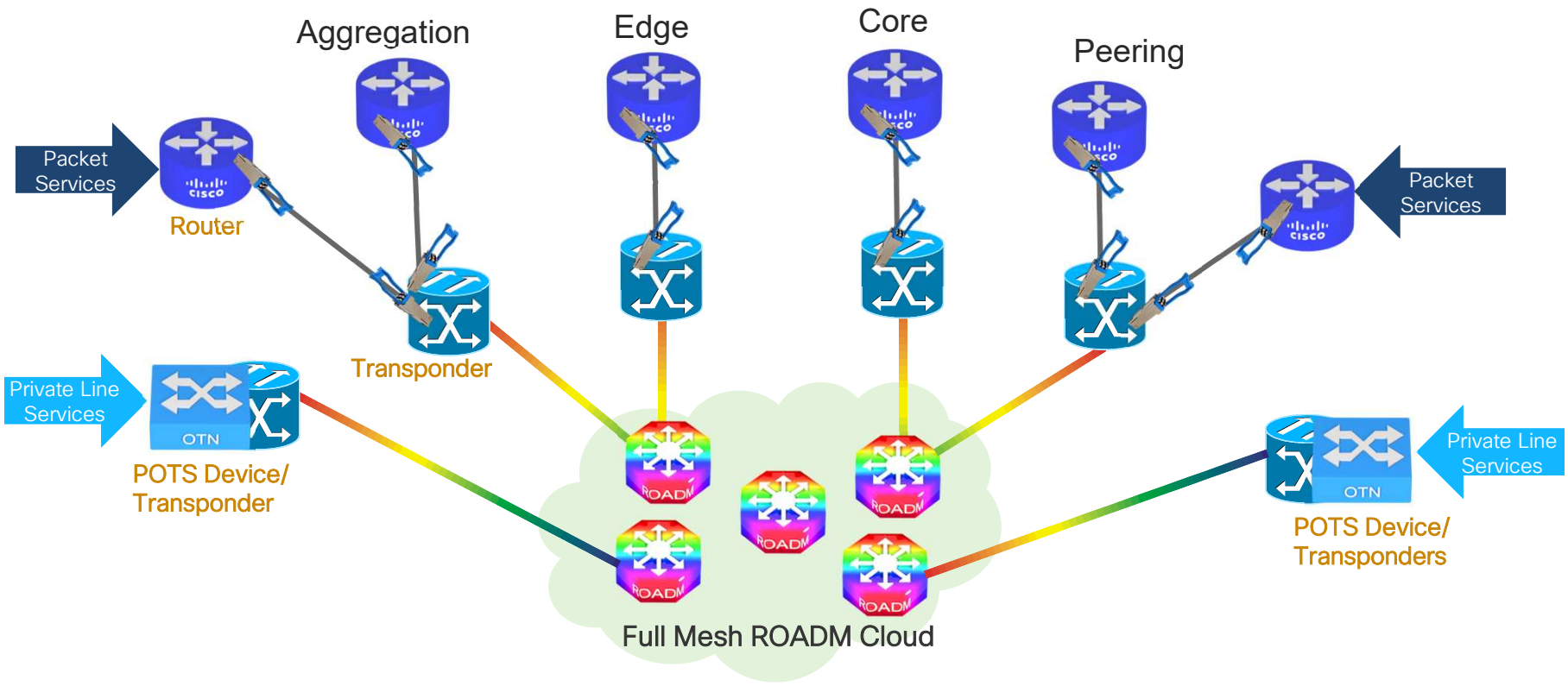
- Multi-vendor ecosystem
- Gains of scale
- QSFP-DD form factor
  - large industry
  - Re-usable

Simplified Operations

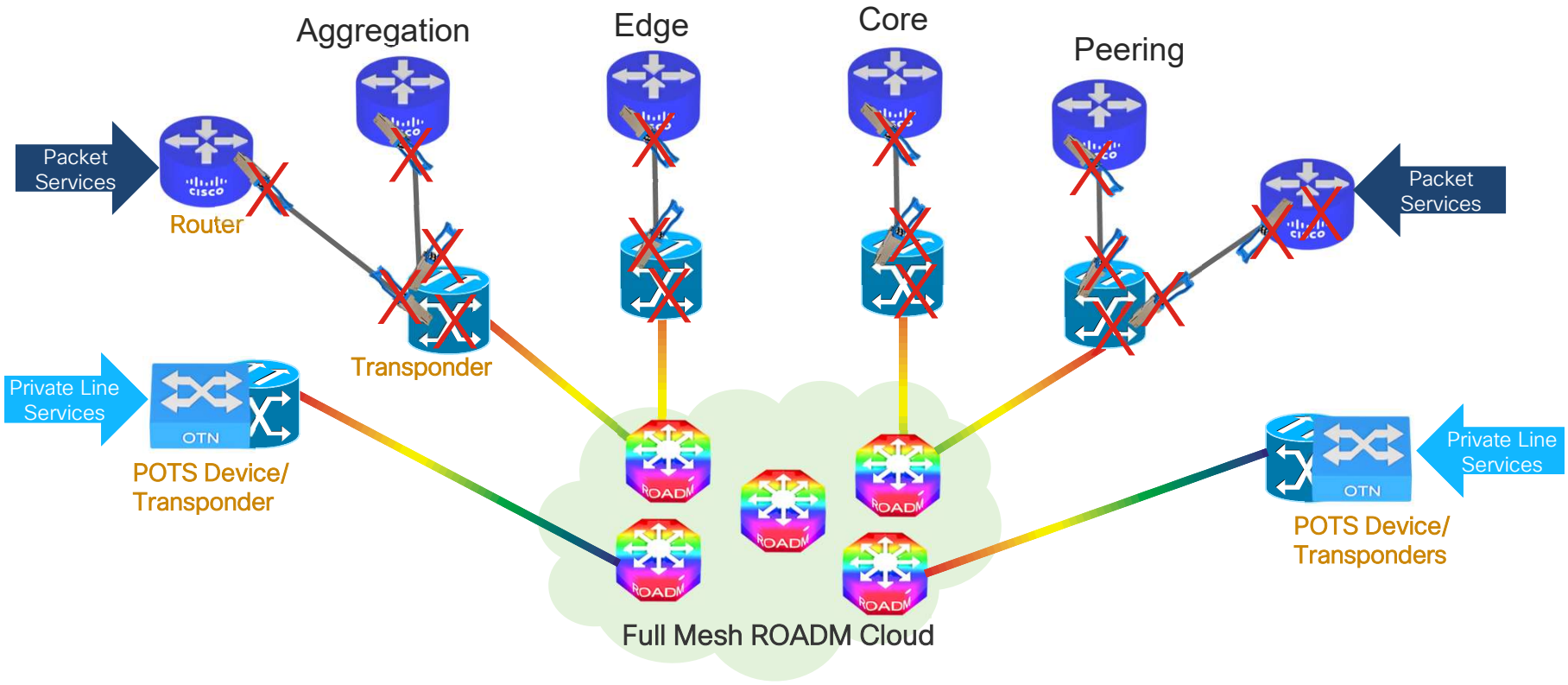
- IP/MPLS control plane
- Model-driven, programmable
- Flexible management models (Silo or converged orgs)

What if you can spend and operate a single network instead?

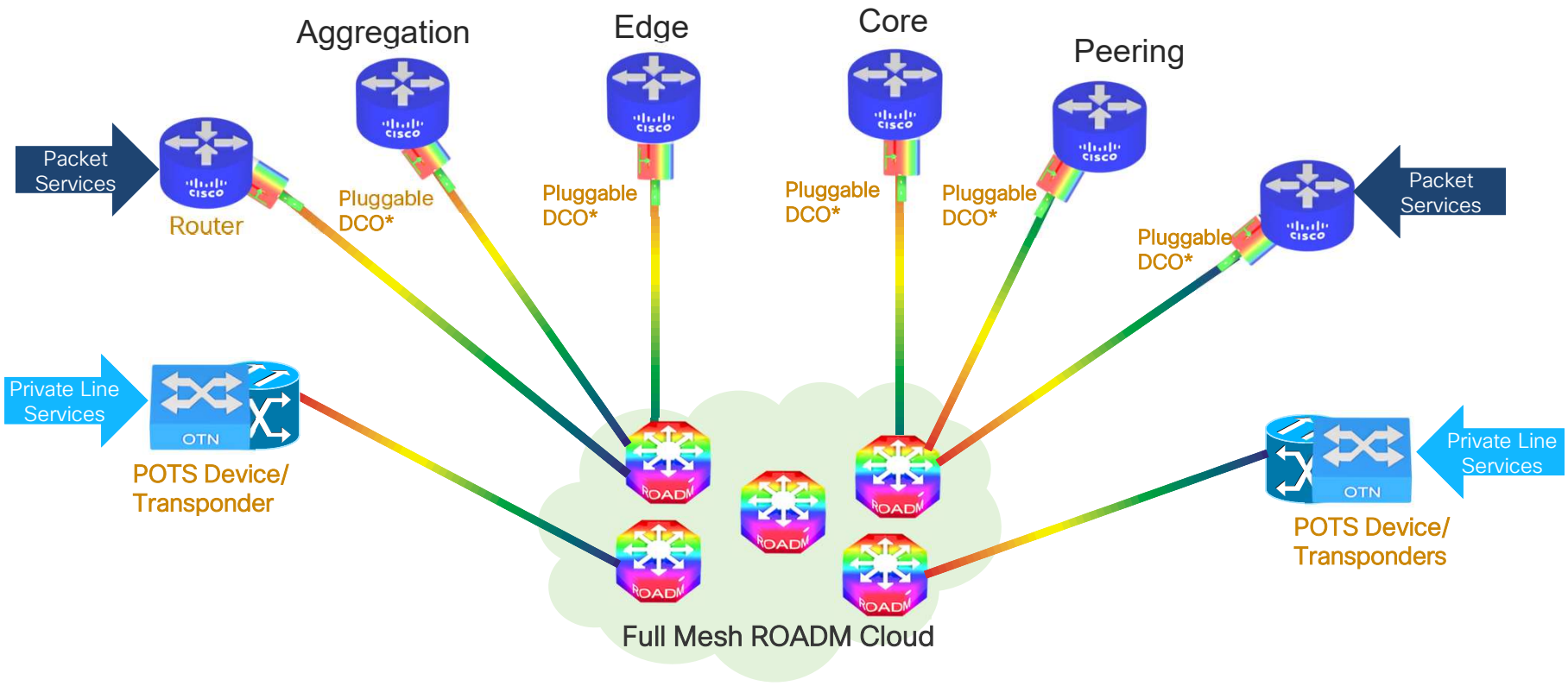
IP and Optical Network Connectivity Today



IP and Optical Networks Evolution
Integrate Transponders

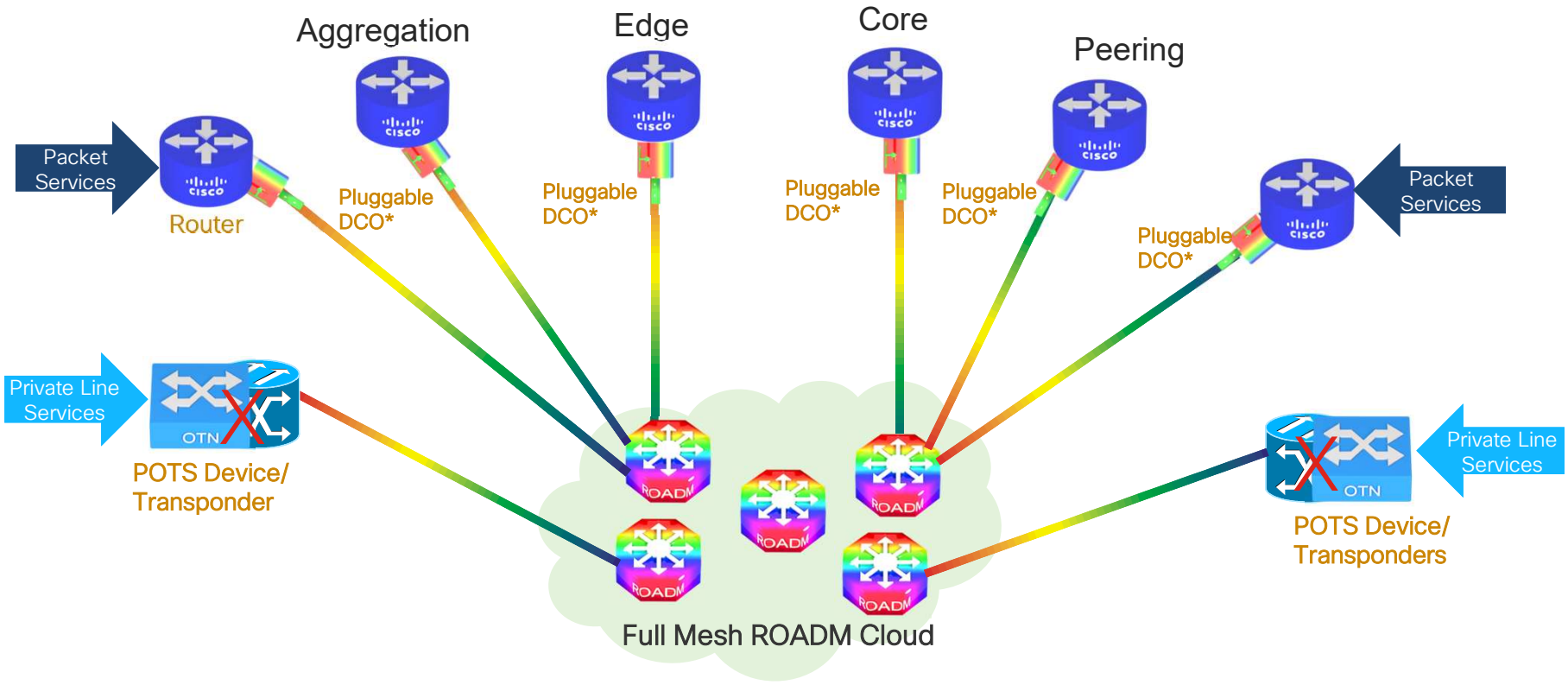


IP and Optical Networks Evolution
Integrate Transponders



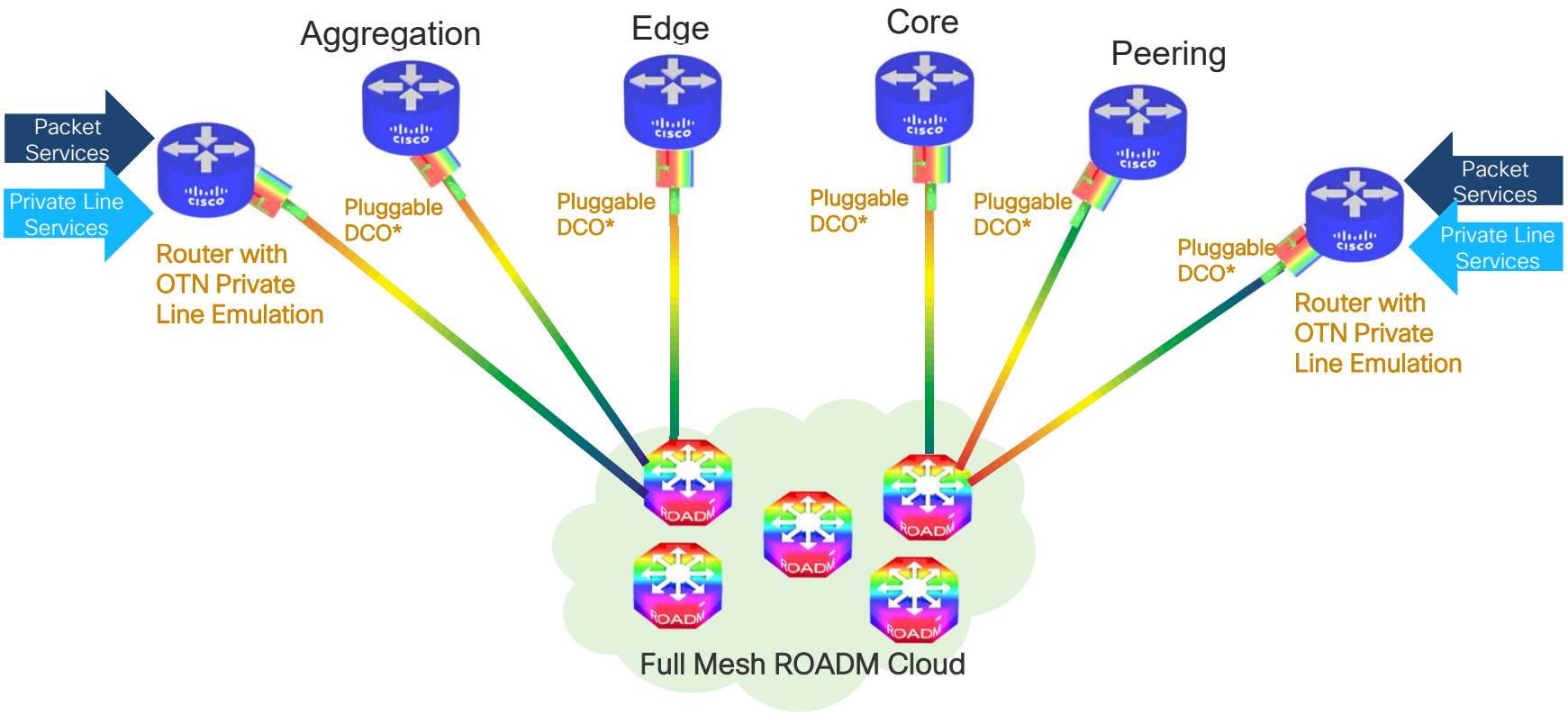
DCO*: Digital Coherent Optic

IP and Optical Networks Evolution
Integrate OTN Services

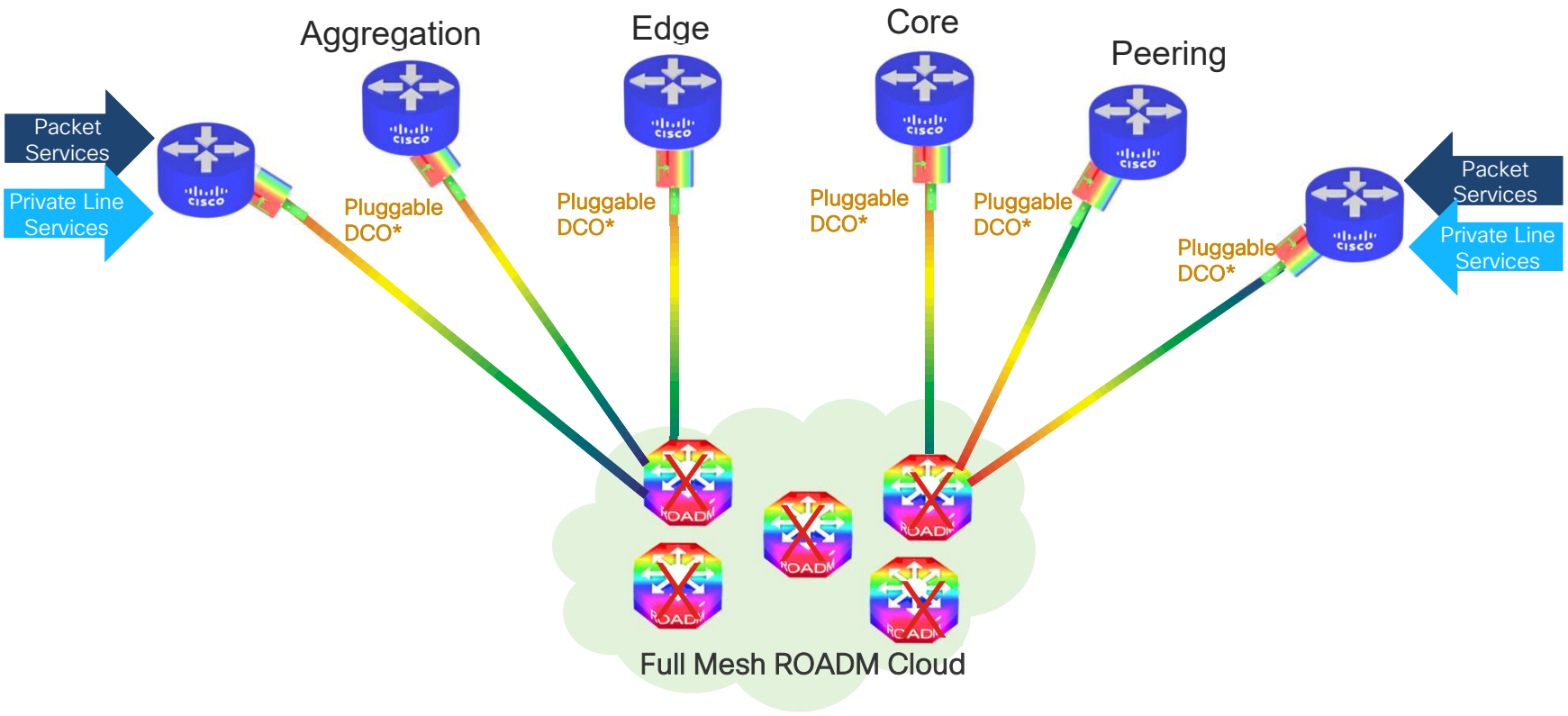


DCO*: Digital Coherent Optic

IP and Optical Networks Evolution
Integrate OTN Services



IP and Optical Networks Evolution
Integrate ROADMs



IP and Optical Networks Evolution
Converged SDN Transport

High Density Routers Up to 260 Tbps

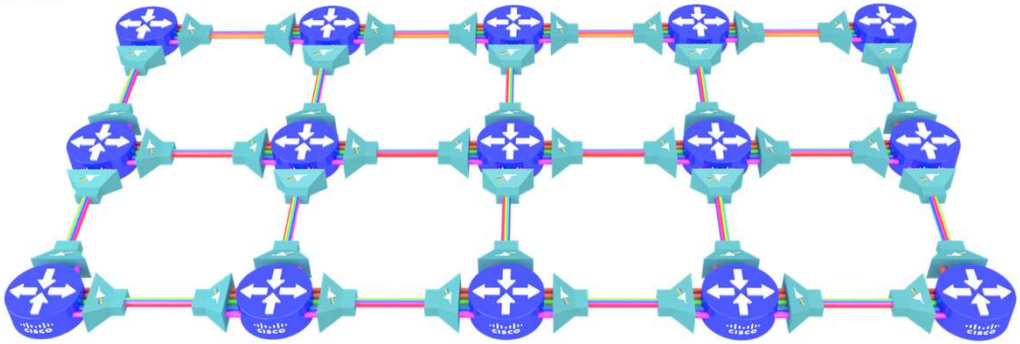
400GE ZR/ZR+

Simpler WDM Line System

Automation

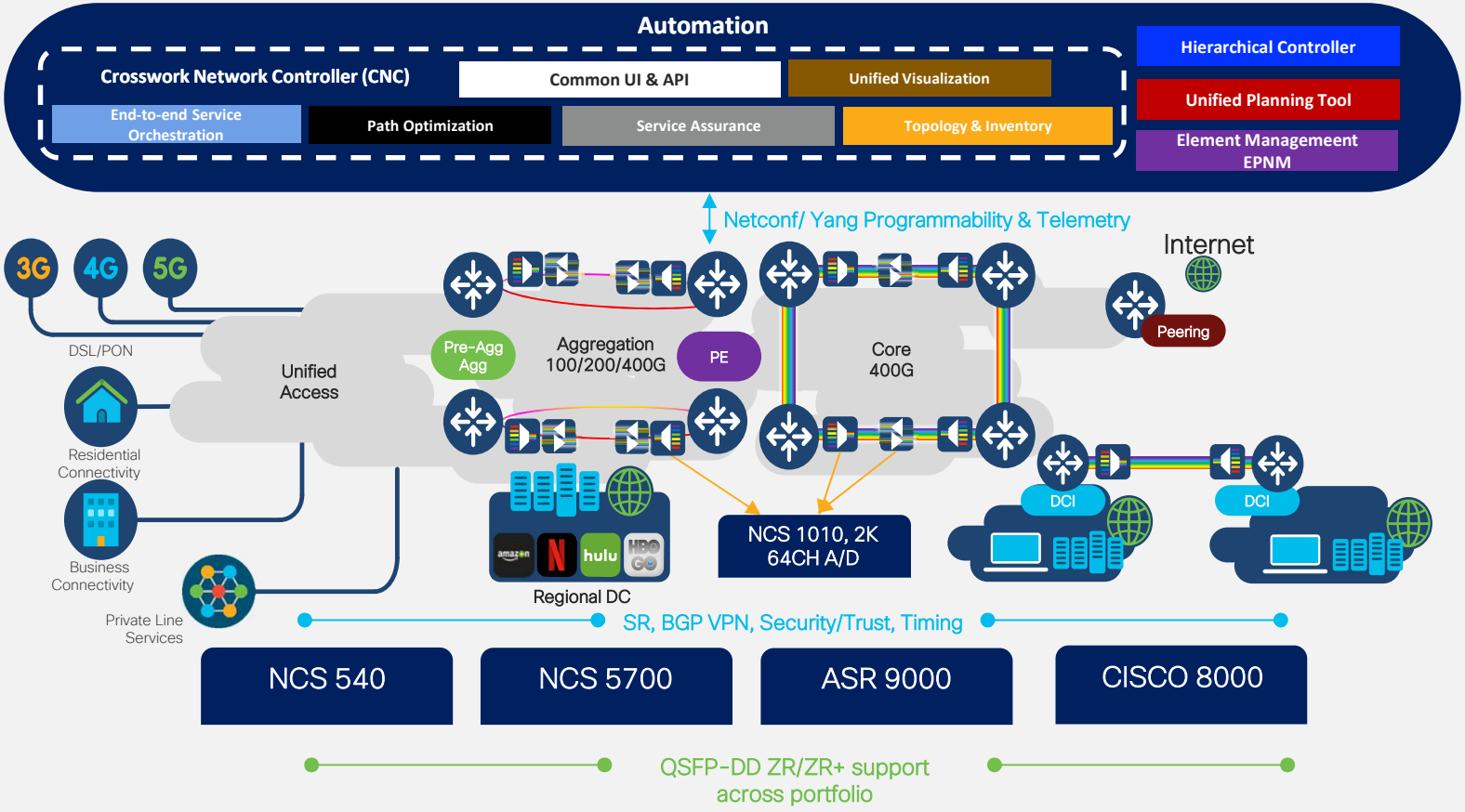
Single Layer Hop-by-hop Design

- Unified Capacity Planning
- Unified Path Optimization
- Orchestration & Assurance
- Unified EMS



- Converged Secure Infrastructure for All Services
- Single Technology End-to-end: SR and BGP VPN
- Secure, Open, Programmable, SDN Based

Routed Optical Network Architecture



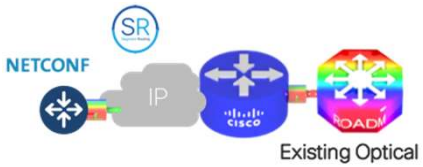
Routed Optical Networking Customer Journey

1 Integrate Transponders & Automate

Hierarchical Controller

Unified Planning Tool | Unified IP & Optical Controller CNC ONC

Unified Element Manager EPNM



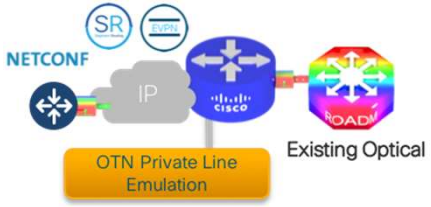
- 400G ZR/ZR+ pluggable optics enable multivendor implementations. Network architecture evolution to open DWDM networks optimized for alien wavelengths with standardized DCO optics.
- SDN controllers to simplify end-to-end network lifecycle management

2 Converge Private Line Services

Hierarchical Controller

Unified Planning Tool | Unified IP & Optical Controller CNC ONC

Unified Element Manager EPNM



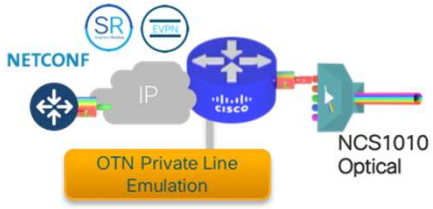
- IP/MPLS used as cost-effective alternative to transport private line services via Private Line Emulation technology innovation.
- Private Line Emulation automation via bandwidth reservation, path optimization, service assurance and orchestration

3 Simplify Optical

Hierarchical Controller

Unified Planning Tool | Unified IP & Optical Controller CNC ONC

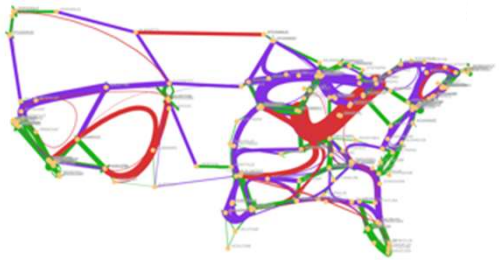
Unified Element Manager EPNM



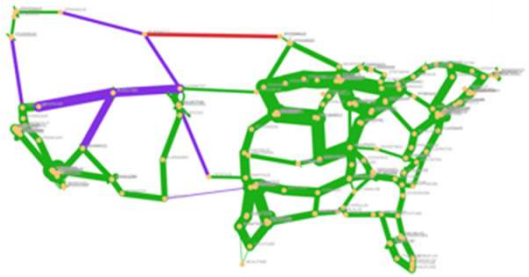
- Fully converged IP/Optical architecture over a simplified DWDM network.
- IP/MPLS network for all services allowing OTN switching to be phased out.
- CAPEX under control with simpler network architecture. Reduced OPEX due to leaner operations

Nationwide Core Network

Routed Optical Network Reduces Cost of Ownership and Improves Resiliency



Present mode of operation has capacity constraints



400G
300G
200G

Routed Optical Network increases capacity

Relative Comparisons

Large Core Network Comparison

Lifecycle Savings

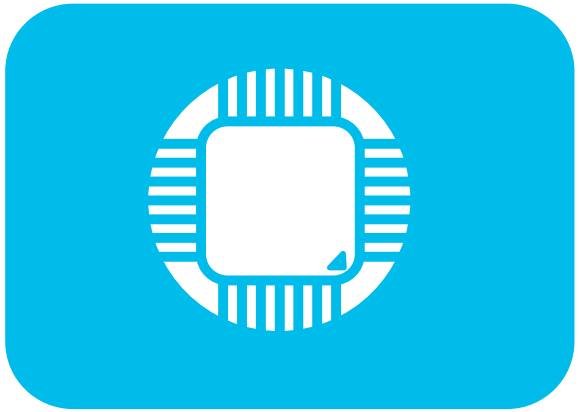
Today's typical node vs. a Routed Optical Network:

- 74% less power
- 58% less rack space
- 35% CapEx reduction
- 60% OpEx reduction

- Eliminates siloed IP & Optical operations
- Integrates transponders & eliminates "grey" optics
- Eliminates the OTN Switching layer
- Integrates ROADMs

Why now and what's different this time?

Key Technology Innovation Areas



Silicon

Optics

Software

Cisco 8000 Routers

Service Provider Scale & Flexibility with Cisco Silicon ONE ASIC

Coherent Optics Integration

OIF ZR & OpenZR+ Standardization

OIF 400ZR
Campus, Metro, DCI

Client: *400GE* → Line: *400ZR*

Simplified functionality
Edge optimized FEC (C-FEC)

OpenROADM
SP Metro, Regional, LH

Client: *100G, 200G, 300G, 400G Ethernet, OTN, FlexO* → Line: *100G, 200G, 300G, 400G OpenROADM*

Flexible Client Mapping +
High Performance FEC (oFEC)

Combination of two standardization efforts

OpenZR+
Metro, Regional, LH

Client: *100GE, 200GE, 400GE* → Line: *100G, 200G, 300G, 400G*

Simplified functionality +
High performance FEC (oFEC)

Enables high performance pluggable modules that provide multi-vendor interoperability

Software Innovations

Segment Routing (SR) & EVPN

- Programmable transport adapting in real-time to network conditions & application requirements
- SR circuit-style converging circuit services by enabling characteristics like bandwidth reservation for guaranteed bandwidth services.
- SR & EVPN enable unification of all services onto a single Converged SDN Transport architecture.
- 50 ms convergence with enhanced redundancy and protection.

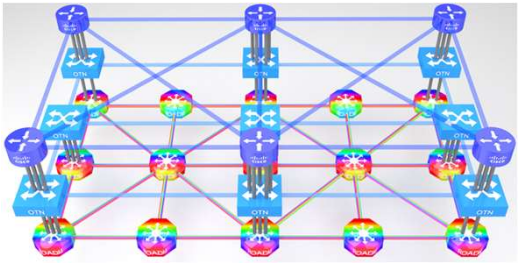
Programmability & Analytics

- Network programmability interfaces (NC/YANG, PCEP, RPC, etc)
- Streaming Telemetry
- AI Ops tools

Network Automation & Orchestration

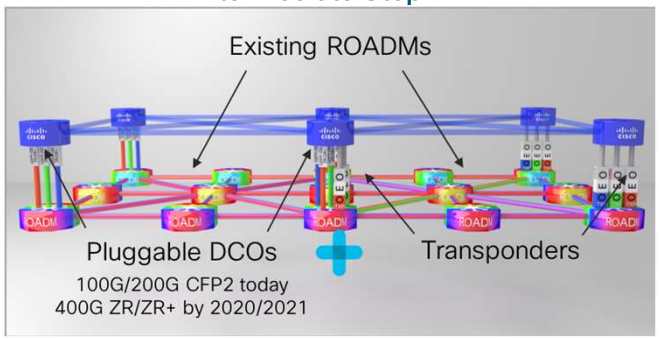
- Controllers with northbound/southbound APIs
- Zero-Touch Provisioning (ZTP)
- Workflow & closed-loop automation
- Standardized/open data models for operational and configuration data

IP and Optical Convergence
Why now? What's the evolution journey?

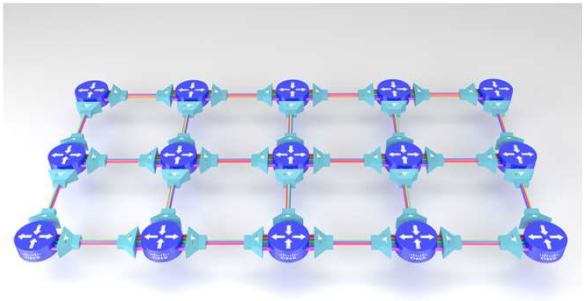


3 control planes
IP/MPLS+ GMPLS + WSON/SSON

Intermediate Step



Integrate Transponders & OTN Switching



Single control plane
Converged hop-by-hop IP+Optical architecture

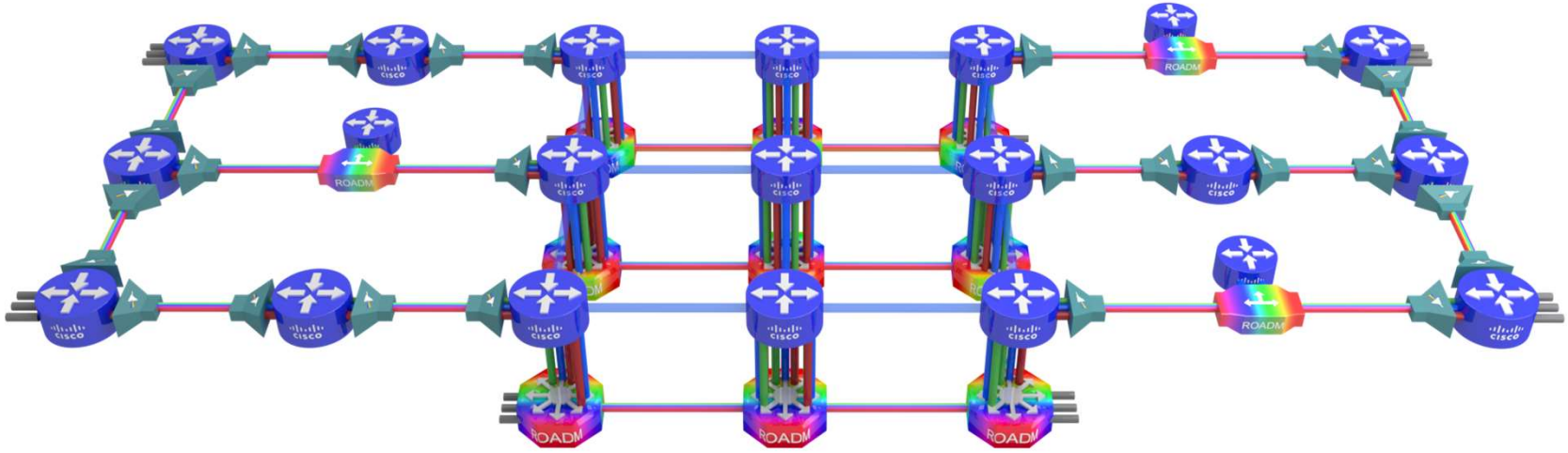
Integrate ROADMs

Why would 400GE achieve the full vision?

- **Grey = DWDM With QSFP-DD**
- **No special router cards for DWDM**
- **Industry standardization & interop**
- **Price points of optics vs router ports**
- **Organizations evolving**
- **Manageability of IP+Optical**

Do You Need a New Network?

Routed Optical Networking deployable in these three different scenarios



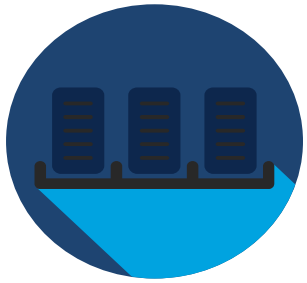
Greenfield

Existing DWDM Layer with NCS 2000

Cisco optics over Existing DWDM Layer

Time for a Live Demo!

Routed Optical Networking Demo



Use Cases:

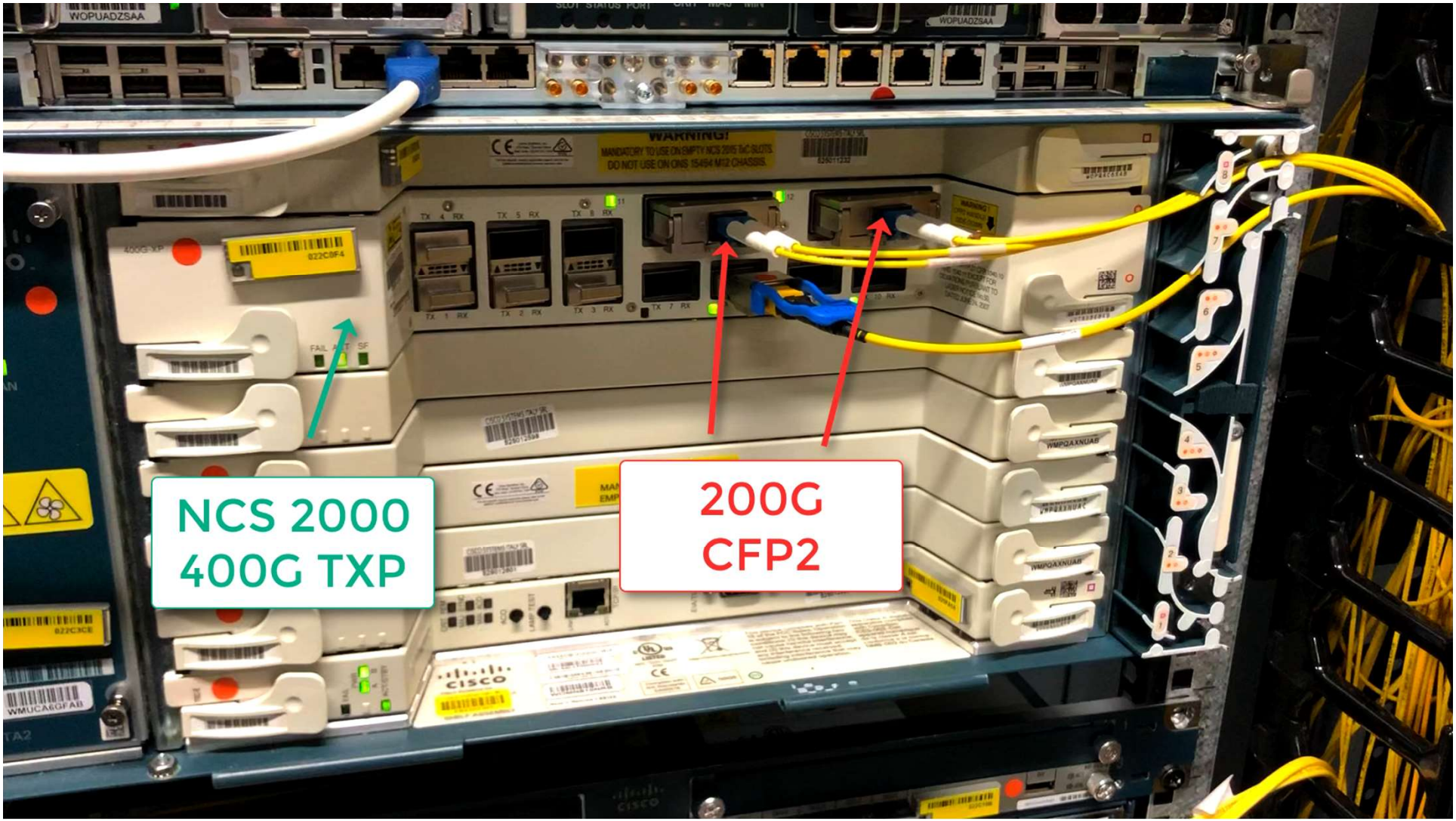
- ✓ Seamless management between services terminated on routers 400G QSFP ZR+ interfaces and traditional services terminated on transponders
- ✓ 400G QSFP ZR+ transmission over 1200 Km
- ✓ Open automation stack

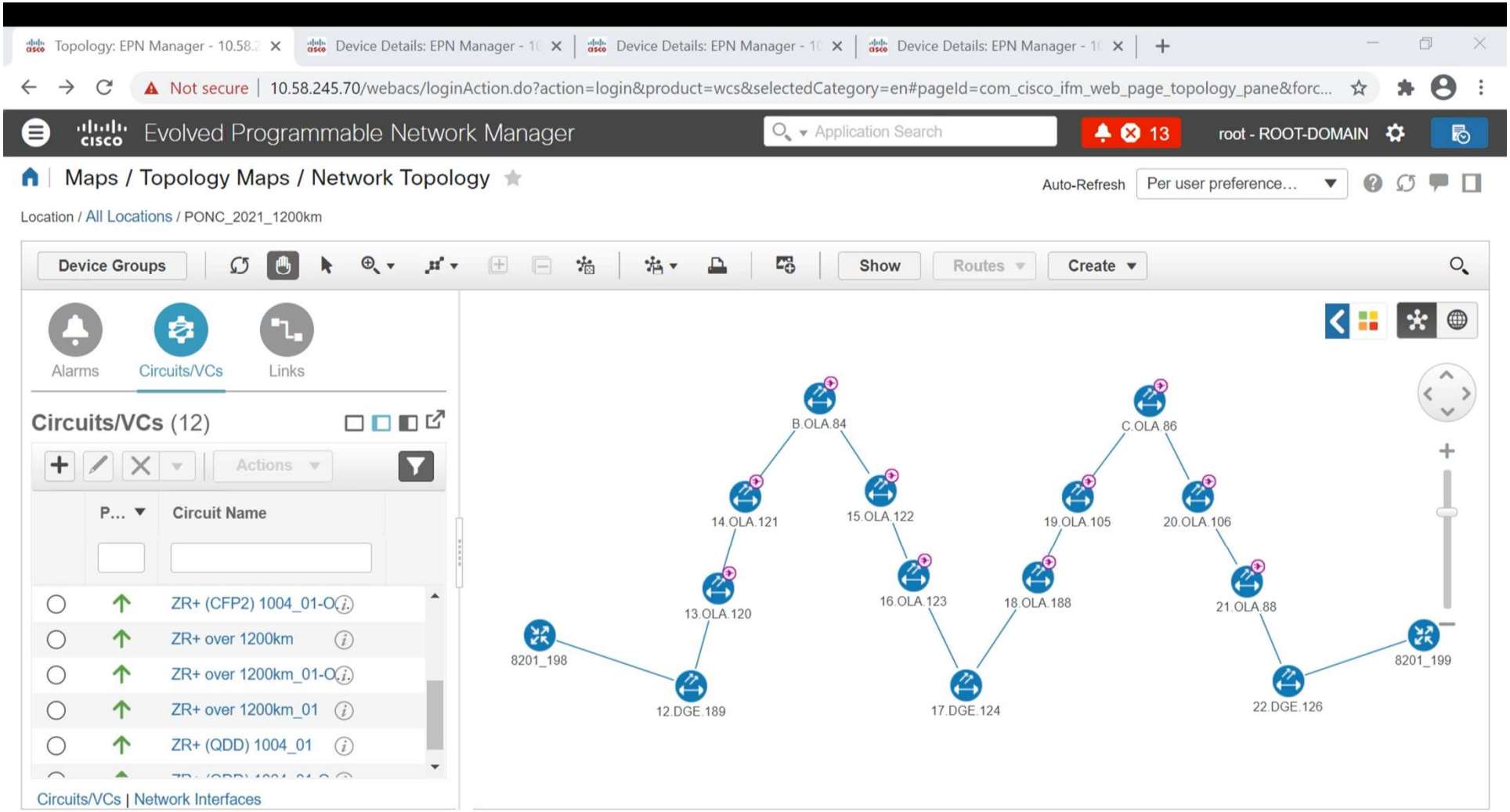
Products used in demo:

Cisco 8201, NCS 5508, NCS 2000, QSFP-DD-ZR+, EPNM, CNC, ONC, Netfusion

Benefits of Routed Optical Networking:

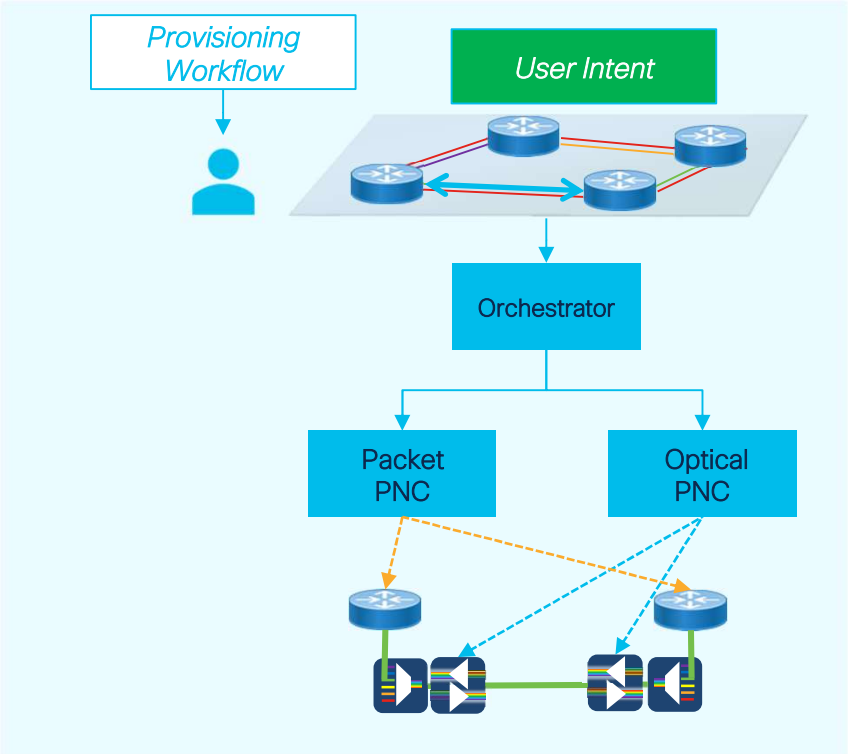
- Improved Operational Efficiencies and Simplicity
- End-to-End automation
- Lower cost per bit


NCS 2000
400G TXP
200G
CFP2


Topology: EPN Manager - 10.58.
Device Details: EPN Manager - 1
Device Details: EPN Manager - 1
Device Details: EPN Manager - 1
Not secure | 10.58.245.70/webacs/loginAction.do?action=login&product=wcs&selectedCategory=en#pageId=com_cisco_ifm_web_page_topology_pane&forc...
Evolved Programmable Network Manager
Application Search
13
root - ROOT-DOMAIN
Maps / Topology Maps / Network Topology
Auto-Refresh
Per user preference...
Location / All Locations / PONC_2021_1200km
Device Groups
Show
Routes
Create
Alarms
Circuits/VCs
Links
Circuits/VCs (12)
Actions
P...
Circuit Name
ZR+ (CFP2) 1004_01-O
ZR+ over 1200km
ZR+ over 1200km_01-O
ZR+ over 1200km_01
ZR+ (QDD) 1004_01
Circuits/VCs | Network Interfaces
B.OLA.84
C.OLA.86
14.OLA.121
15.OLA.122
19.OLA.105
20.OLA.106
13.OLA.120
16.OLA.123
18.OLA.188
21.OLA.88
8201_198
12.DGE.189
17.DGE.124
22.DGE.126
8201_199

Routed Optical Network Link Provisioning

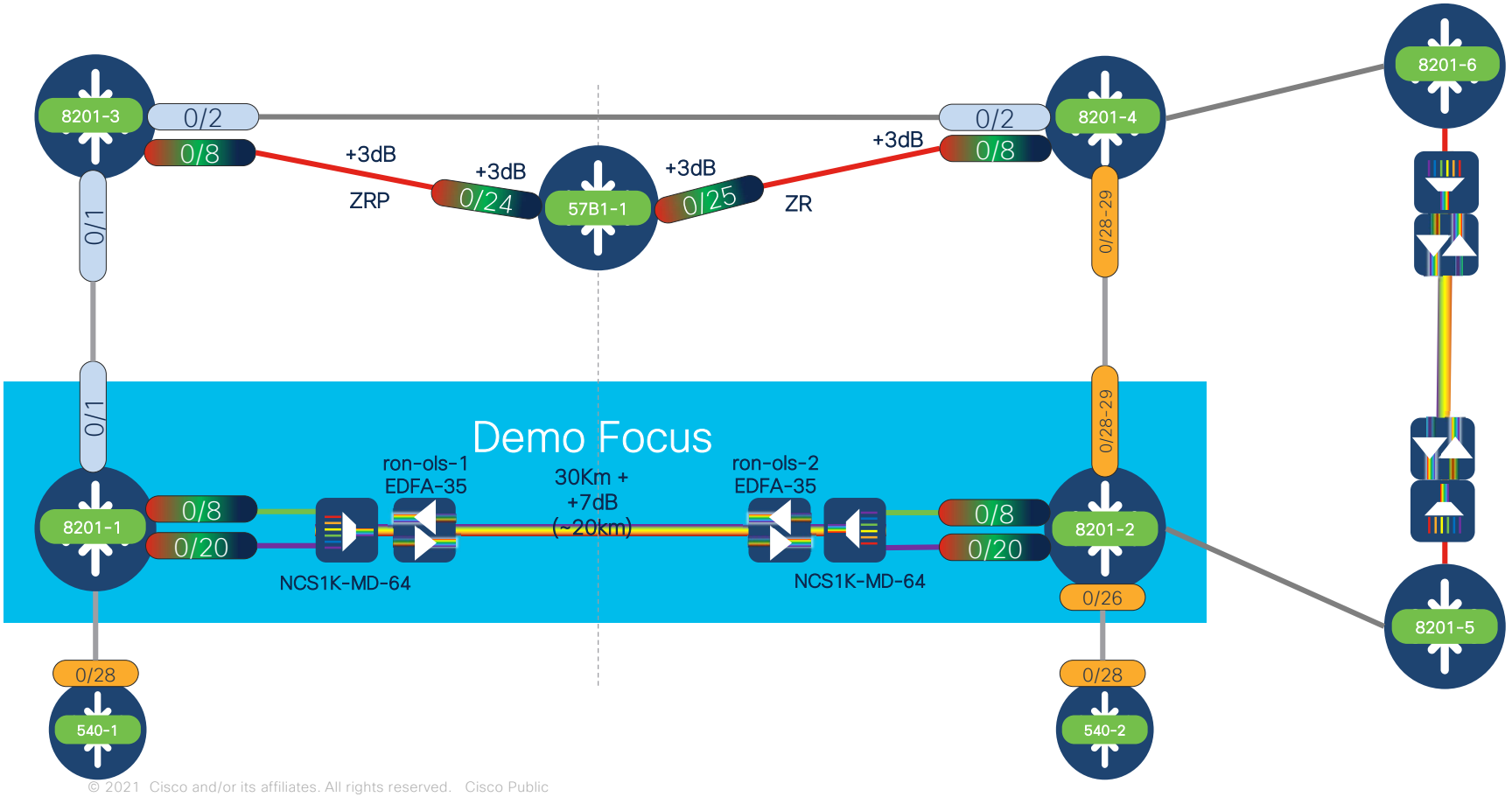
Provision L2/L3 and L1 in a single unified workflow



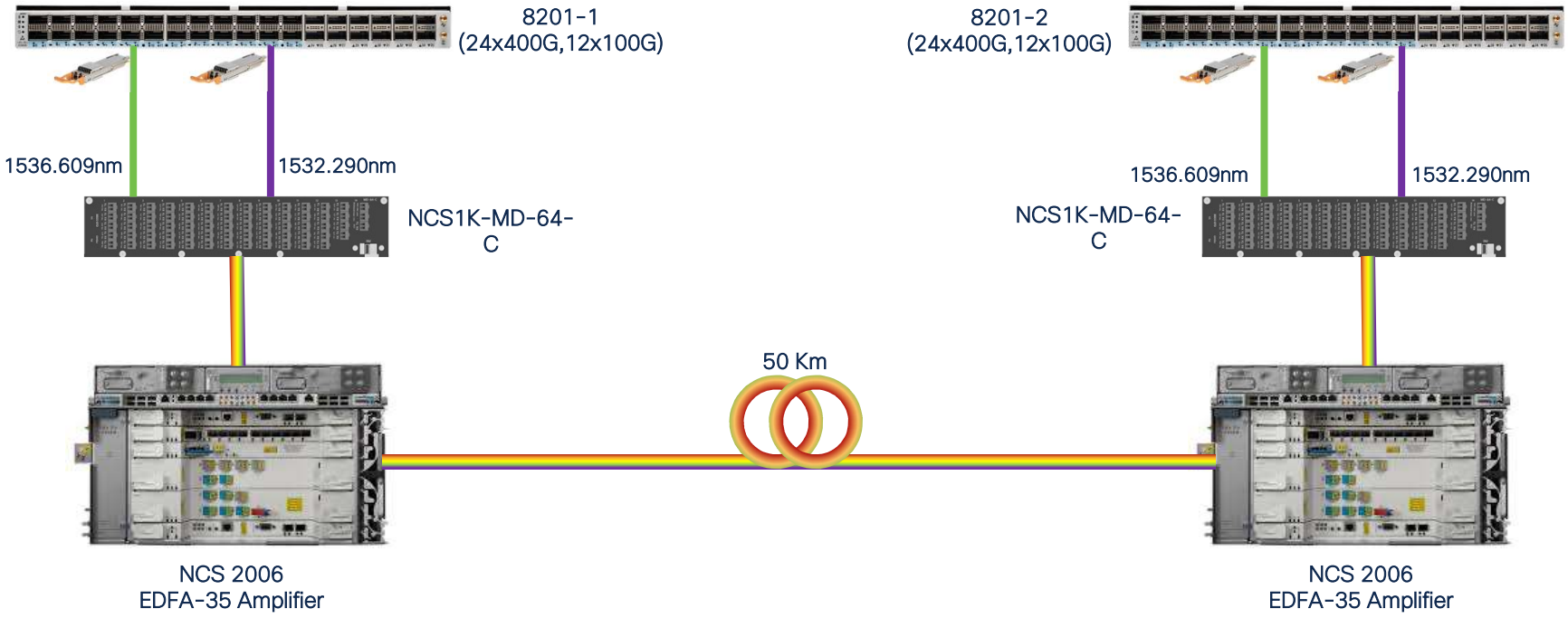
- Convergence of IP interface and optical service turn-up in a single workflow, eliminating redundant operations
- L3 IP, L2 Ethernet, and Optical service configuration
- Cisco optical: Plug and play operation with connection discovery, verification, and auto tuning.

33

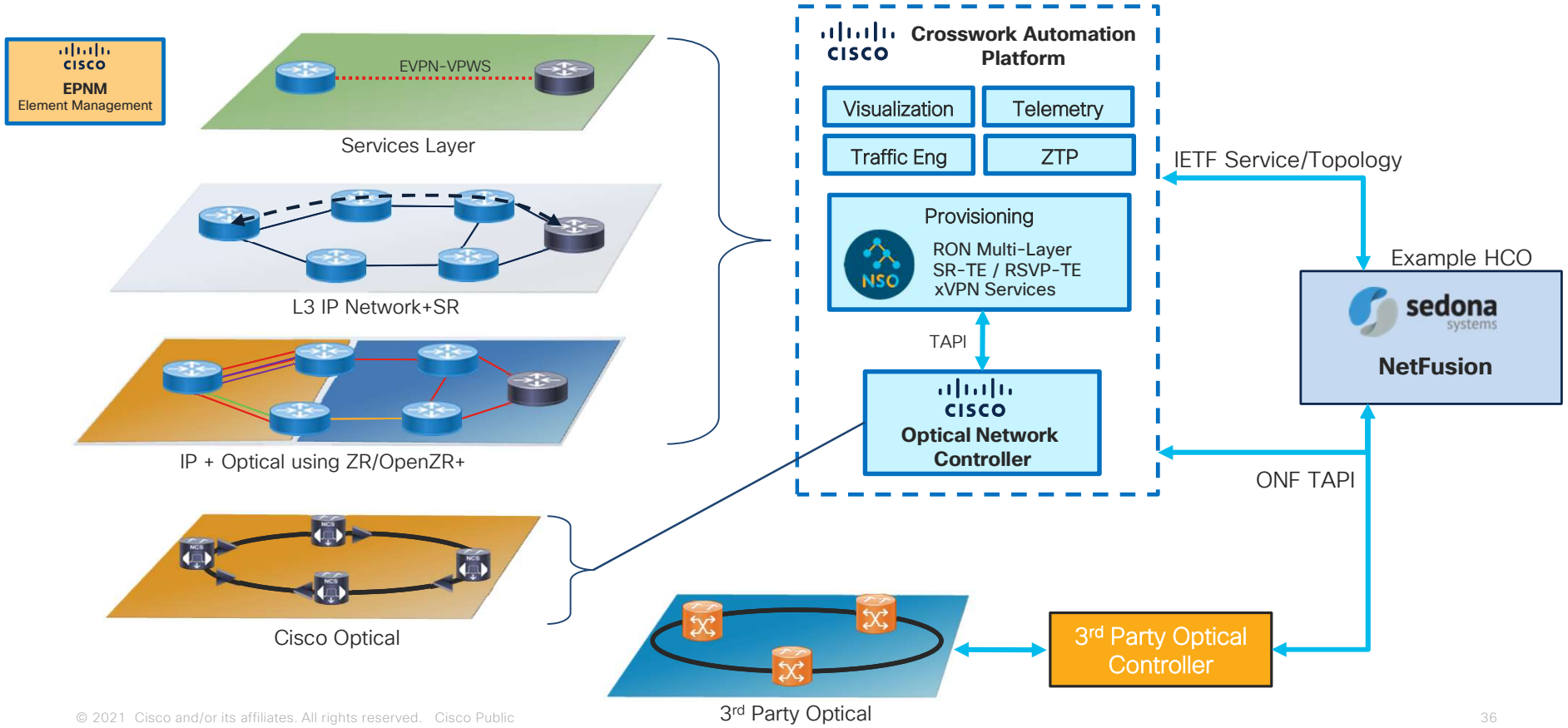
Demo Lab – Full Topology

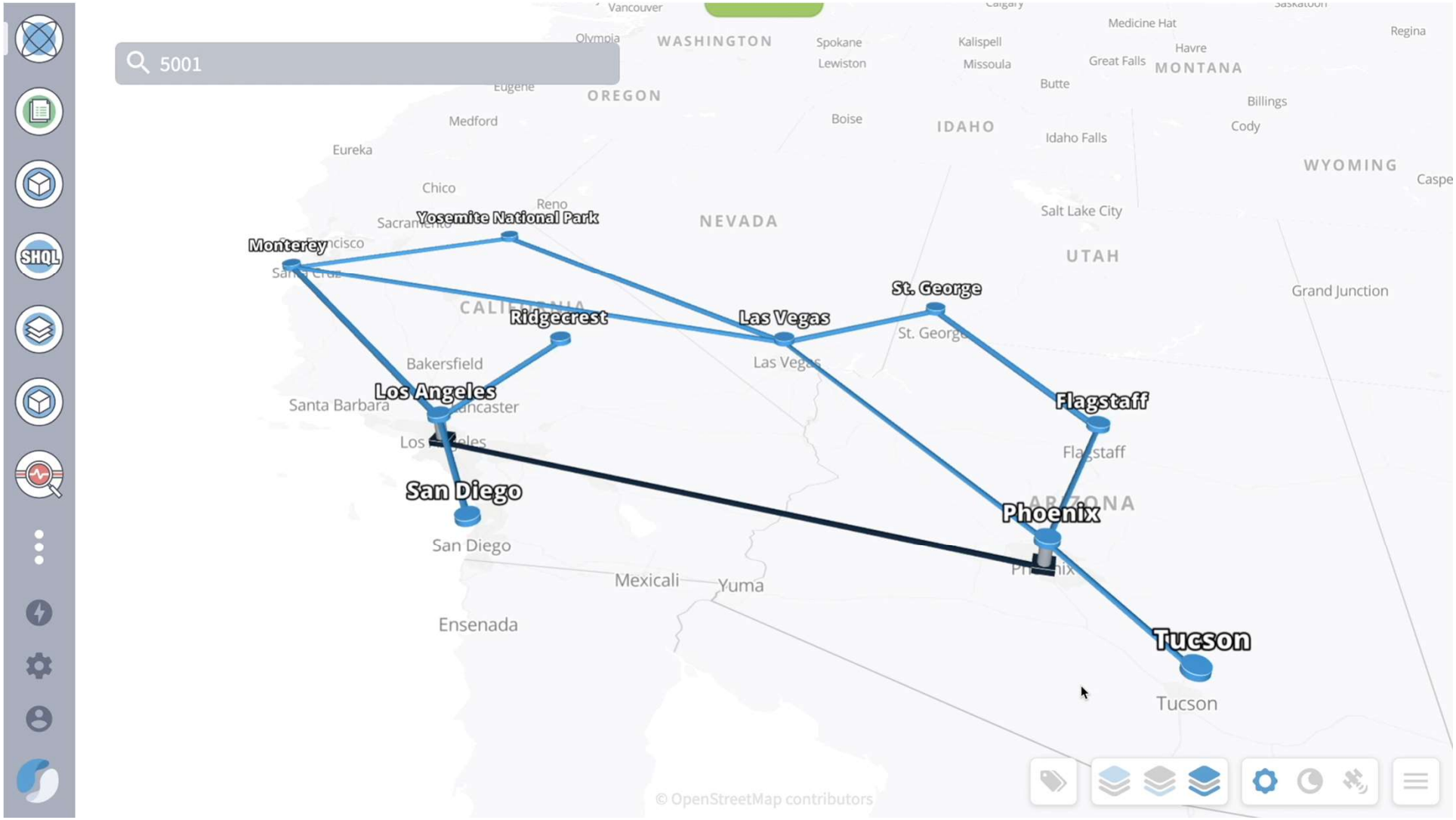


Demo
Optical Details



Routed Optical Network Open Automation

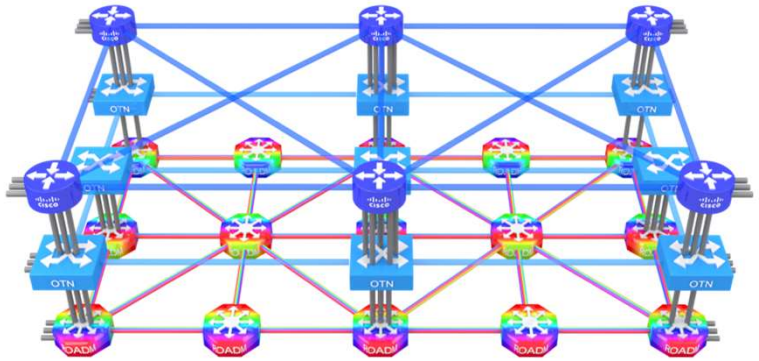



5001
Monterey
Yosemite National Park
Ridgecrest
Las Vegas
St. George
Flagstaff
Los Angeles
San Diego
Phoenix
Tucson
Vancouver
WASHINGTON
Olympia
Spokane
Lewiston
Kalispell
Missoula
Medicine Hat
Great Falls
Havre
MONTANA
Regina
Butte
Billings
Cody
OREGON
Eugene
Medford
Boise
IDAHO
Idaho Falls
Eureka
WYOMING
Chico
Reno
Sacramento
NEVADA
Salt Lake City
UTAH
Grand Junction
Bakersfield
Santa Barbara
Mexicali
Yuma
Ensenada
© OpenStreetMap contributors

Summary

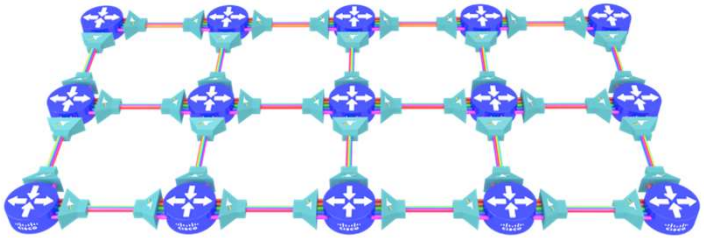
Rethinking the Way We Build Networks

Today



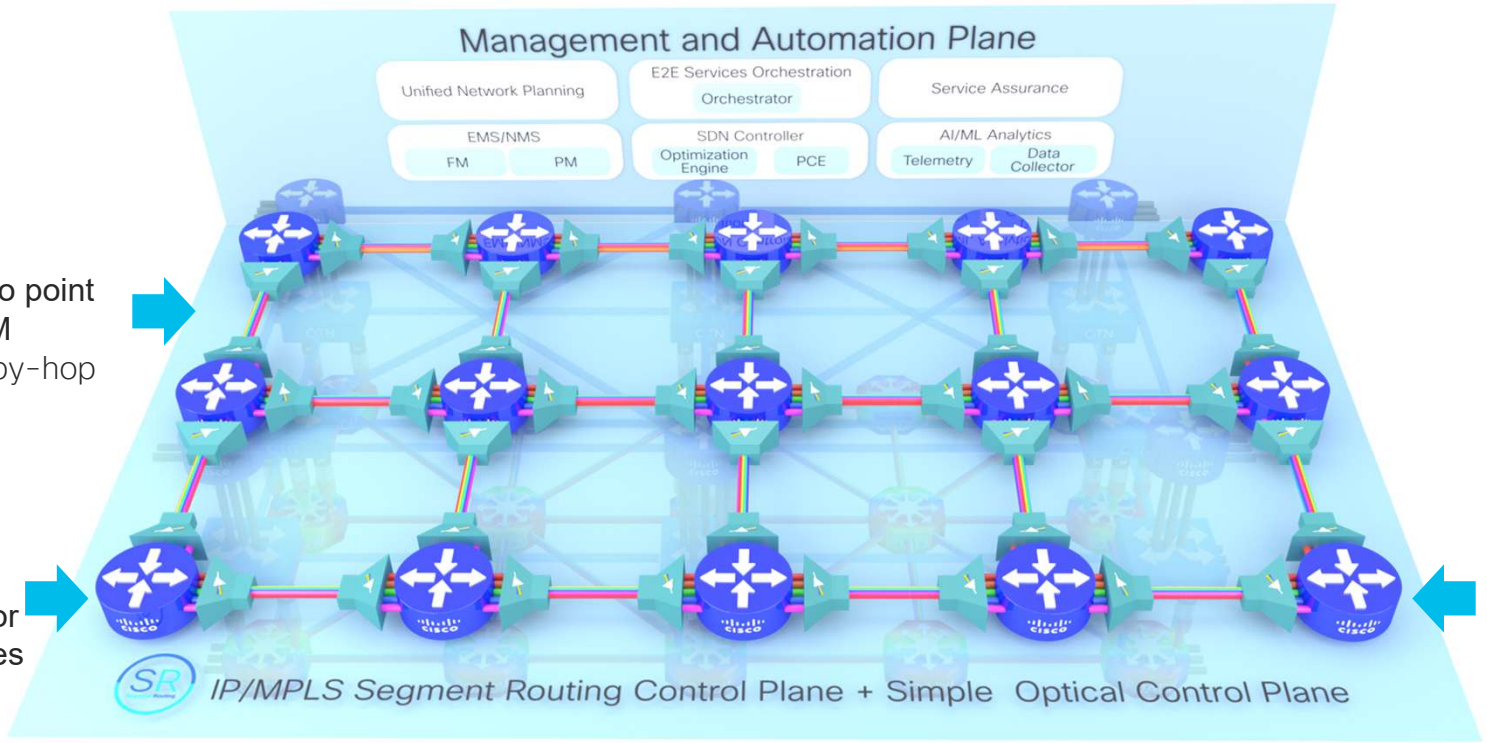
Traditional IP+Optical

Future



Routed Optical Networking

A Simpler Network Topology & Software Stack



Point to point DWDM (hop-by-hop IP)

Private Line Emulation for OTN services (PLE)

+Routers with 400G ZR+ (DCO)

Much simpler, lower TCO, fully integrated - All services over IP/MPLS

The bridge to possible