

# Unlocking Hyperscale Connectivity: The Rise of Managed Optical Fiber Networks (MOFN)

**CISCO** Live !

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# Cisco Webex App

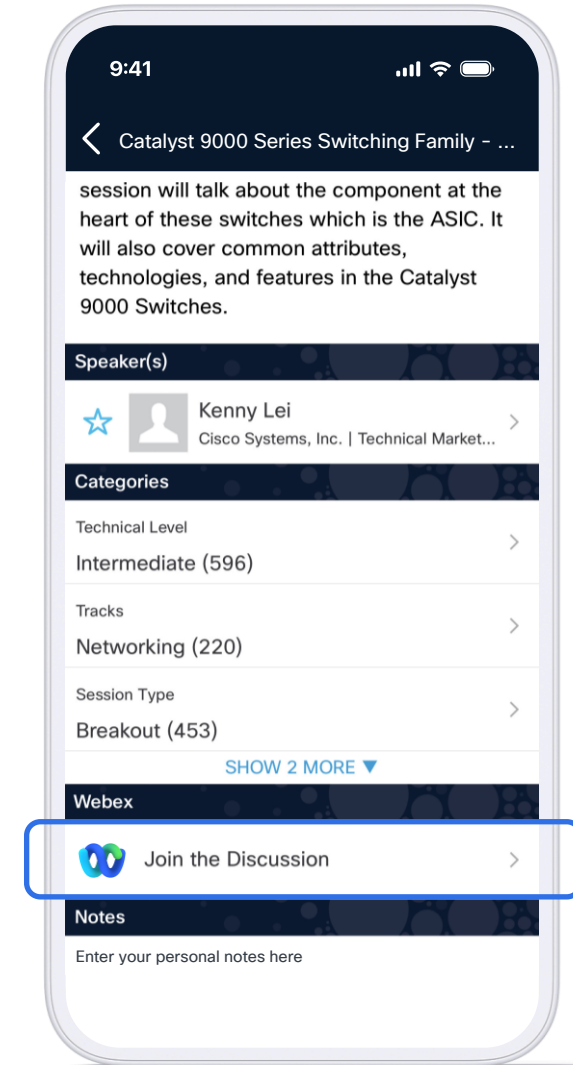
## Questions?

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# Agenda

- 01 What is MOFN ?
- 02 Key Drivers for MOFN
- 03 Types of MOFN
- 04 Cisco MOFN Solutions
- 05 Cisco Coherent Optics
- 06 Cisco Optical Transport

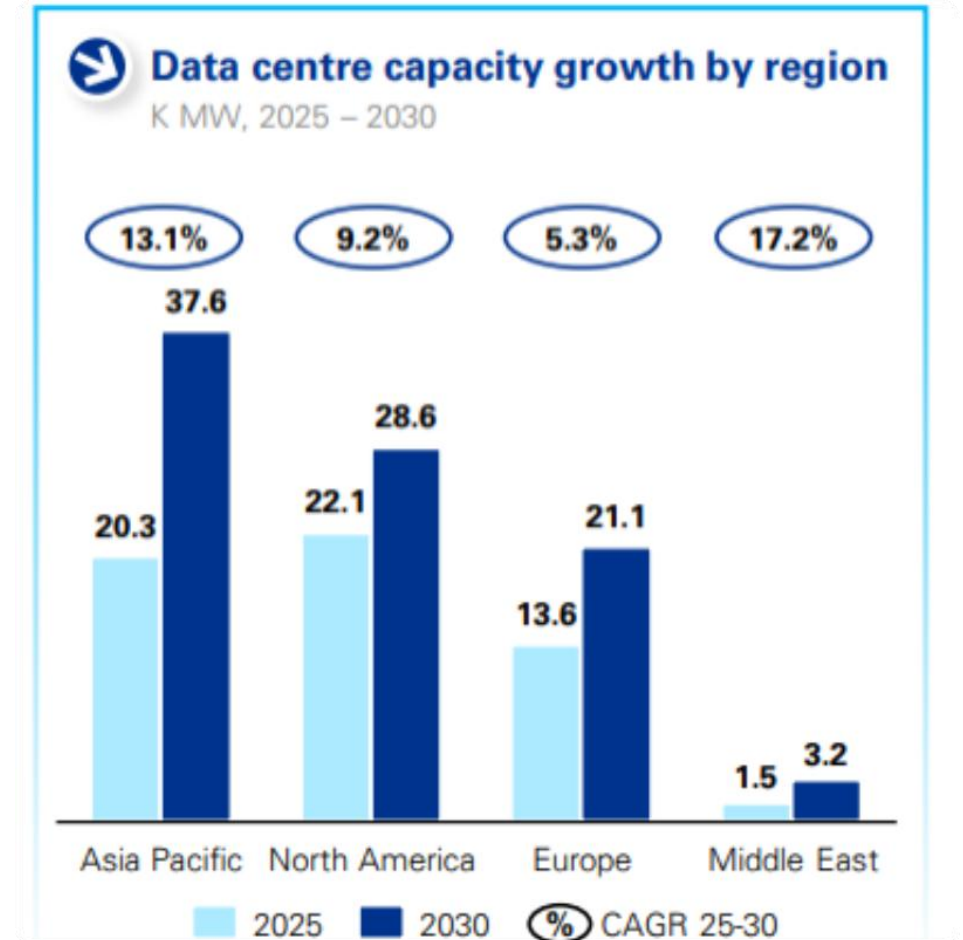
# Demystifying MOFN

# MOFN – What ChatGPT says?

A **Managed Optical Fiber Network (MOFN)** is a fiber-based connectivity service where the network provider delivers **high-capacity optical links** and **actively manages** the performance, configuration, and maintenance of the network for customers such as hyperscalers, enterprises, and carriers.

# The need for connectivity ..

- AI training and inference workloads are driving increases in global data center capacity
  - \$5.2T in data center CapEx expected through 2030<sup>1</sup>
  - 3.5x increase in data center capacity demand through 2030<sup>1</sup>
- Content and cloud providers now account for more than 70% of international bandwidth, driving the need to connect to data centers at major regional hubs/landing stations<sup>2</sup>
- Regional data center capacity growth is exploding
  - By 2030, Asia Pacific will have the highest data center capacity and growth: 13.1% increase in capacity to 37.6 gW<sup>3</sup>
- Critical need for data center interconnects which can be a few kilometers to thousands of kilometers apart.
  - From landing stations to inland data centers
  - Between regional training data centers and enterprise data sources



KPMG The Asia Data Centre Landscape:  
<https://assets.kpmg.com/content/dam/kpmg/cn/pdf/en/2025/03/the-asia-data-centre-landscape.pdf>

# Capacity Service Options by Service Providers

## Dark Fiber

- Fiber lease or IRU
- Fiber Route Diversity
- Colocation and/or Hut facilities
- End customer has full control to engineer network
- OTDR monitoring



COLO/ILA-huts

External Fiber Plant

## Wavelengths

- 1G/10G/100G/400G/800G
- Protected, unprotected
- Latency SLAs
- Proactive monitoring and repair



CPE



Central Office



External Fiber Plant

## Managed Spectrum

- N x 12.5GHz
- Faster turn-up, lower cost and opex compared to dark fiber
- Guard Band applied to protect other services
- Spectrum Power Monitoring



COLO/POP



External Fiber Plant

## MOFN

- Managed Network including Fiber at SLA specified
- Product/Architecture can be specified by end customer
- Proactive monitoring and repair



COLO/DC

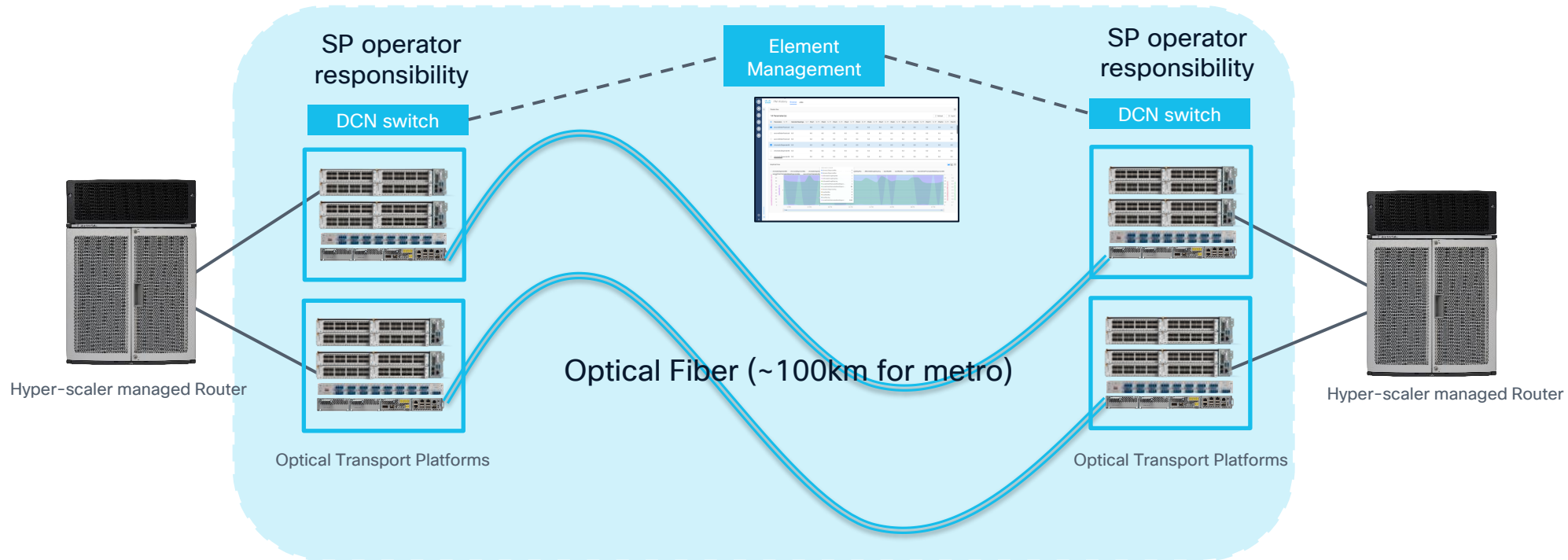


External Fiber Plant

# Managed Optical Fiber Networks (MOFNs)

- Key Drivers:
  - Web/Hyperscale operators cannot own/lease dark fiber without a telecom license in certain geographies
  - Faster TTM vs procuring fiber and managing network directly
- Local carriers to build and manage optical transport networks for end customer using technologies/products they prefer.

## Managed Optical Fiber Network (SP responsibility)



# Why MOFNs are Win-Win for Hyperscalers & Service Providers ?

Hyperscalers

Faster time to market

Scale

Customization



Service Providers

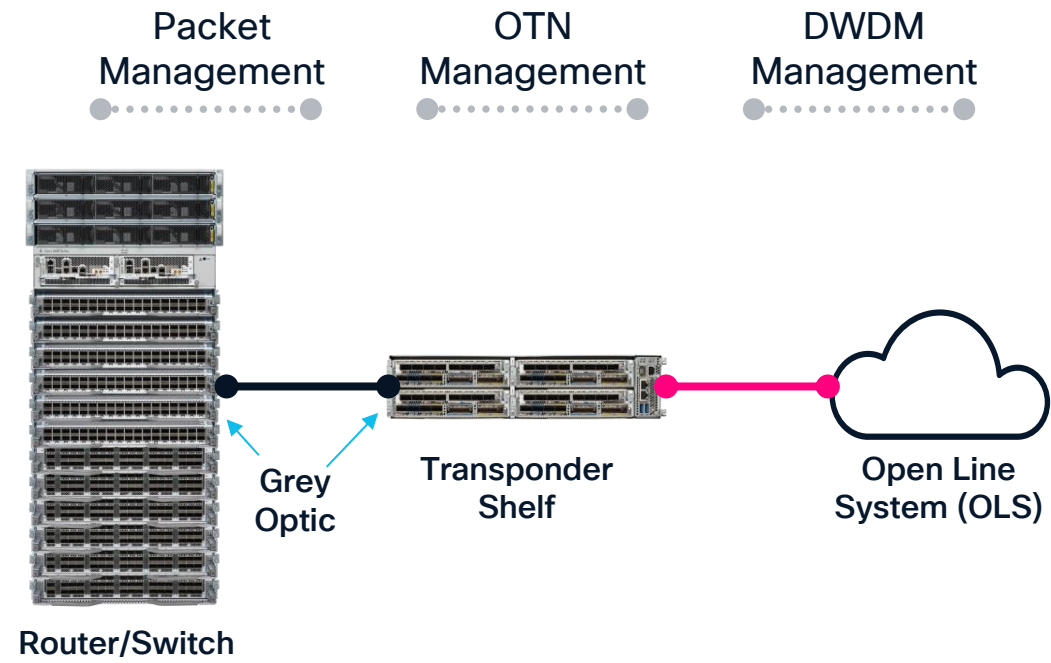
Incremental Revenue

Partnership

# MOFN Solutions

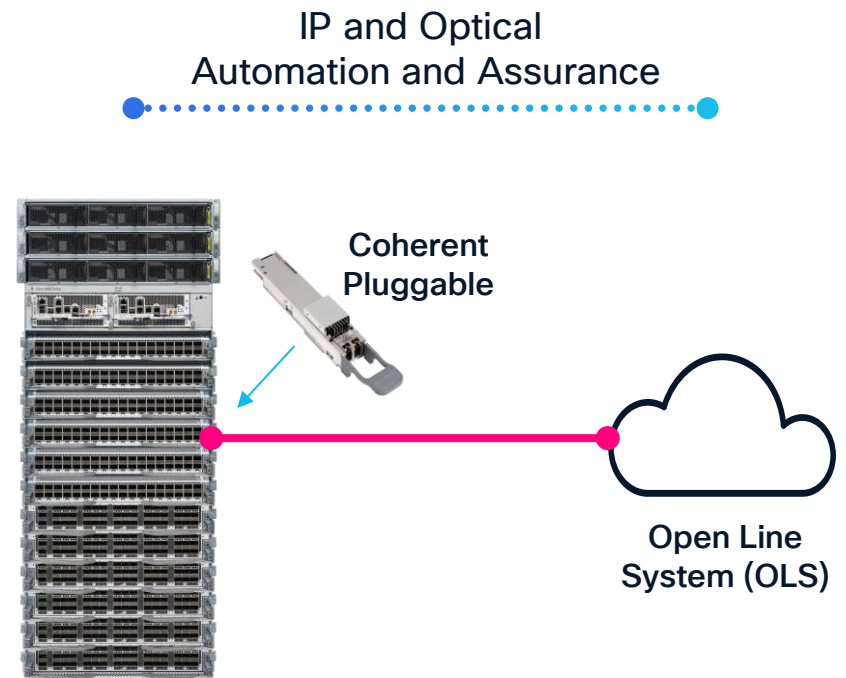
# Architectures choices for MOFN

## Traditional Architecture



Demarcation between IP and Optical

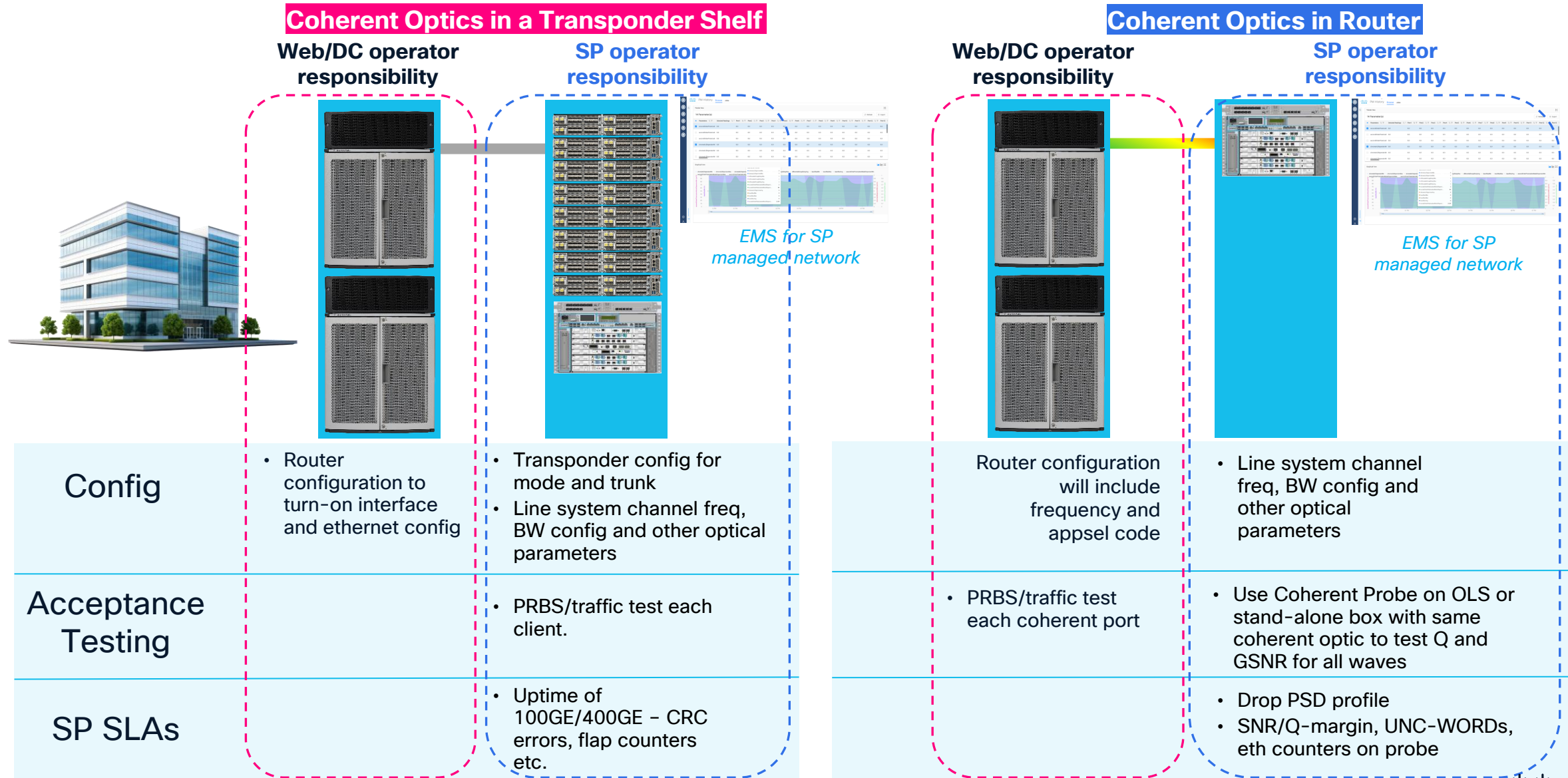
## RON Architecture



Much Lower Total Cost of Ownership (TCO)

Significantly reduce capital and operating expenses  
by 50% or more

# How to operate a MOFN network ?



# Cisco MOFN Solution Building blocks...

## Cisco Routing Platforms: 8000, NCS, and ASR

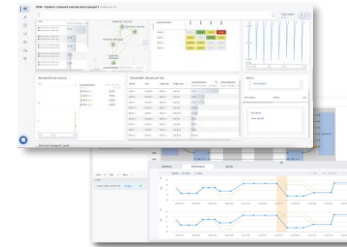
Unparalleled performance, TCO, and operational simplicity



## IP & Optical Automation & Assurance

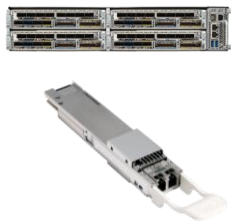
Vendor Agnostic Hierarchical Control

Visualization, Assurance and Provisioning of both IP and Optical domains



## Cisco Coherent Pluggables & Optical Transport

Comprehensive lineup of coherent optics and optical transport platforms



## Cisco or 3<sup>rd</sup> Party Open Line Systems (OLS)

Full featured OLS with mesh ROADMs and in-line amplification



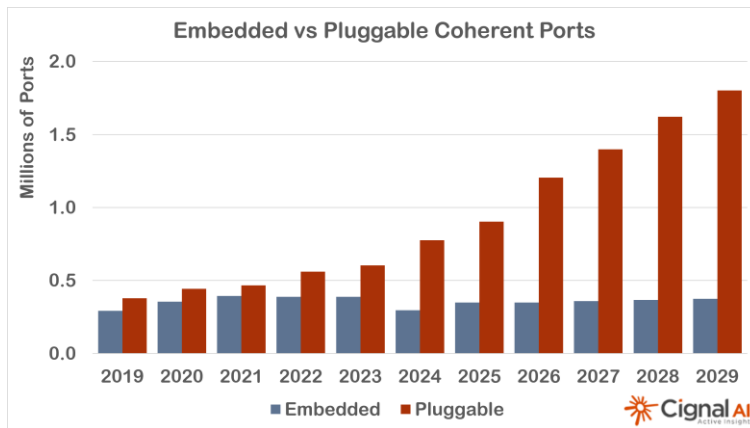
**MOFN  
Solution**

# Cisco Optical Innovations & Coherent Pluggables

# Market/Technology Trends – Coherent Pluggables

## Coherent Pluggables % Continue Increasing

- Today coherent ports are dominated by pluggables
- IP-over-DWDM gaining widespread adoption



## Coherent Pluggables Expanding Applications

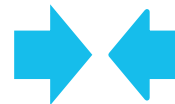
Farther: 400G ULH



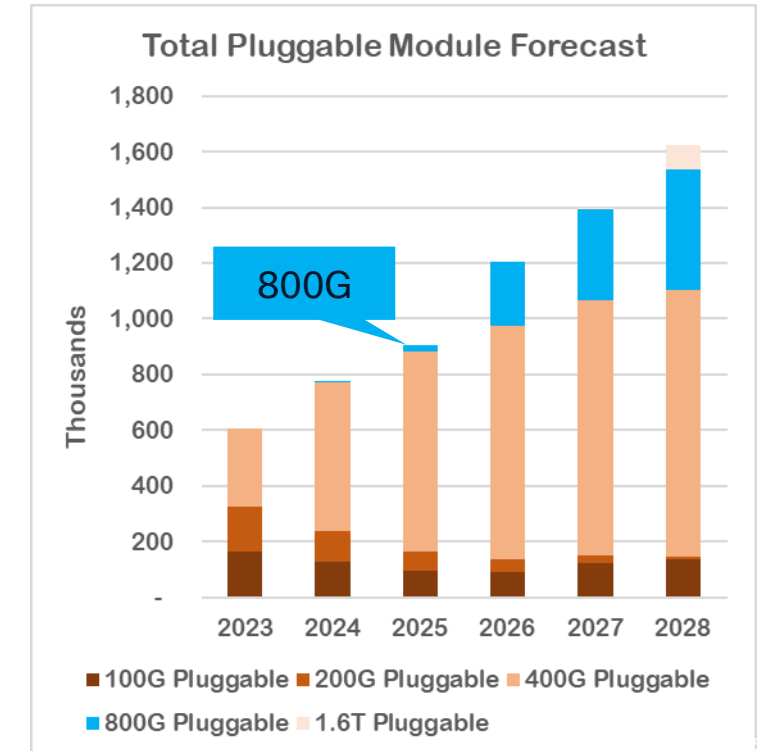
Wider: L-Band



Shorter: Coherent Lite



## 800G Coherent Market Takes Shape



Acacia/Cisco continues to be the pioneer in coherent pluggables: 800G ZR+ (interop PCS), 400G ULH

# Coherent Pluggable Brings Some Important Levers



01

## Network costs and efficiencies

CapEx cost breakdown, \$/100G, PAYG models, etc.

02

## Power, thermal, and space

Compact devices, Watt/100G, DC power and rack space optimization

03

## Network architectures

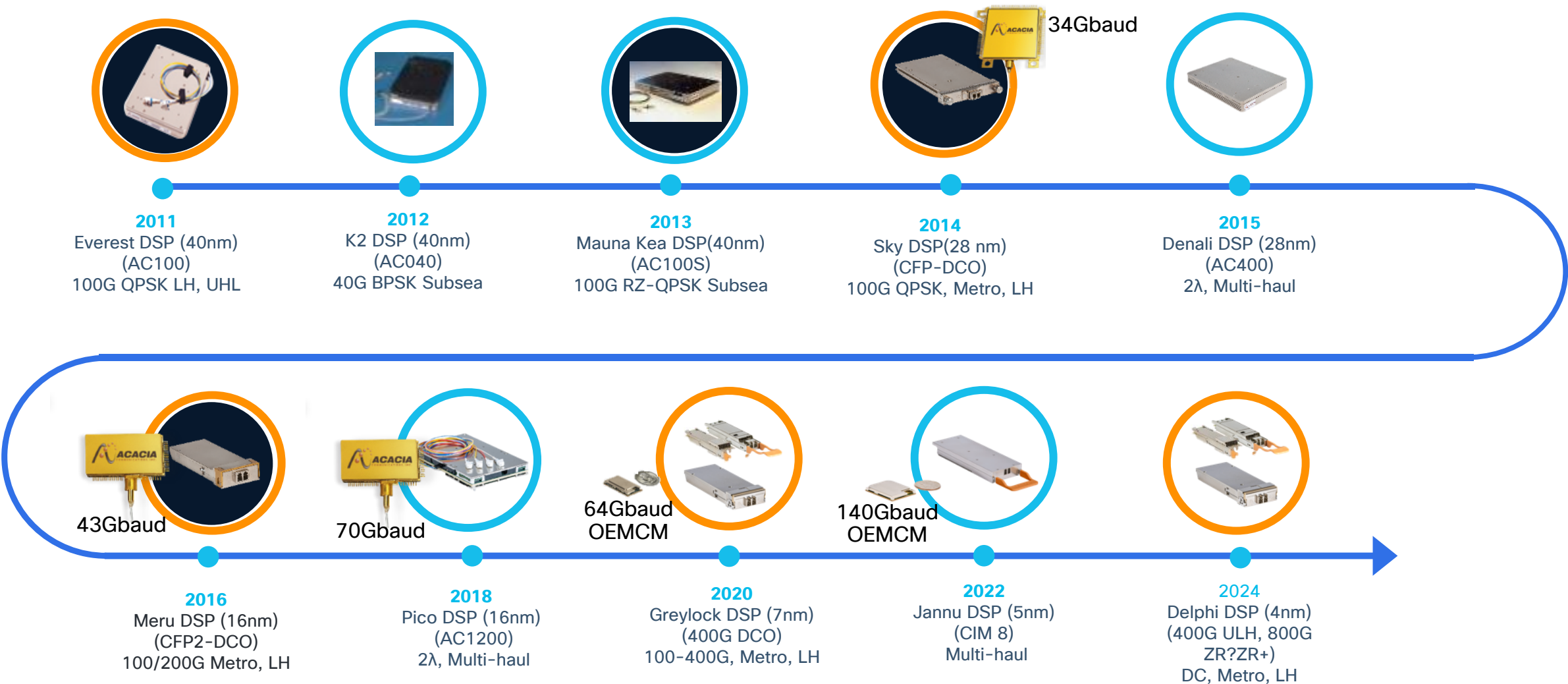
Disaggregation, optimize topologies, spectrum efficiency

04

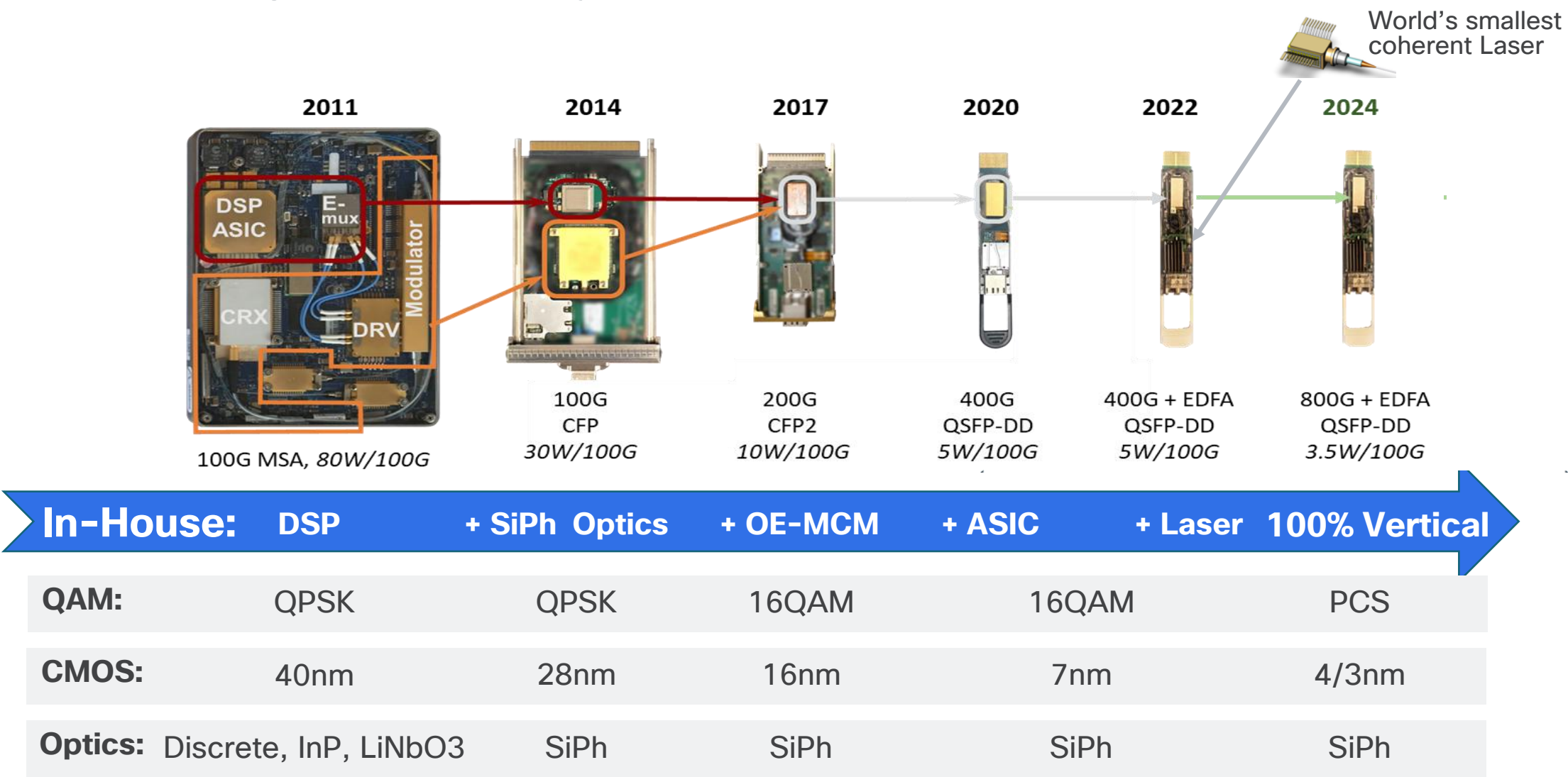
## Drives interoperability

MSAs/standards, best in breed adoption

# Acacia Coherent Technology Innovation



# Vertical Integration is Key to Lowest Cost and Best Performance



Cisco is the only company that is 100% Vertically Integrated today

# Approaches of Coherent Implementation



MSA  
Pluggable  
(aka DCO)



Industry's first pluggable coherent module (100G CFP)



100G/200G CFP2-DCO



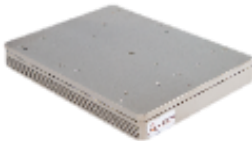
400G pluggable portfolio in QSFP-DD, OSFP and CFP2



800ZR/ZR+ and 400G ULH pluggables - QSFP-DD & OSFP

Deployed in router/switches and transport platforms (e.g., 8K, ASR9K, NCS, Nexus 9K etc.)

Performance  
Optimized



400G multi-haul module (AC400)



1.2T Coherent Module (AC1200)

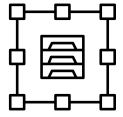


Industry's first 1.2T coherent multi-haul pluggable (CIM8)

Deployed in transport platforms (e.g., NCS 1004, 1014 etc.)

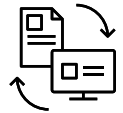
# 400G QSFP-DD Digital Coherent Optics Portfolio

## ER1



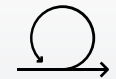
### Point to Point

Intra-data center, campus interconnect, core-to-edge router



### Lowest Cost

Based on fixed laser with simple point-to-point connectivity



### Short Reach

Up to 45KM for unamplified at 13dB

Use Case %



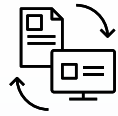
Network Coverage

## ZR



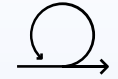
### Point to Point

Web, Data Center Interconnect, Non-SP/SP router interconnect



### Low Cost

Lowest cost 400G DCO option for very simple designs



### Short Reach

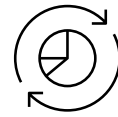
Up to 120KM for P2P amplified links

Use Case %



Network Coverage

## Bright ZR+



### Transport Centric

WebService Providers, Routed Optical Networking



### High TX Power

+1dbm for difficult spans; interop with brownfield transponder & legacy line systems



### Advanced Features

TOF, OTN and L1 Encryption features; integrated optical amplifier

Use Case %



Network Coverage

## 400G ULH



### Transport Centric

Service Providers, Routed Optical Networking



### Long Haul Optimized

400G with **RON Anywhere** up to 3000km, high Tx power



### Power Optimized

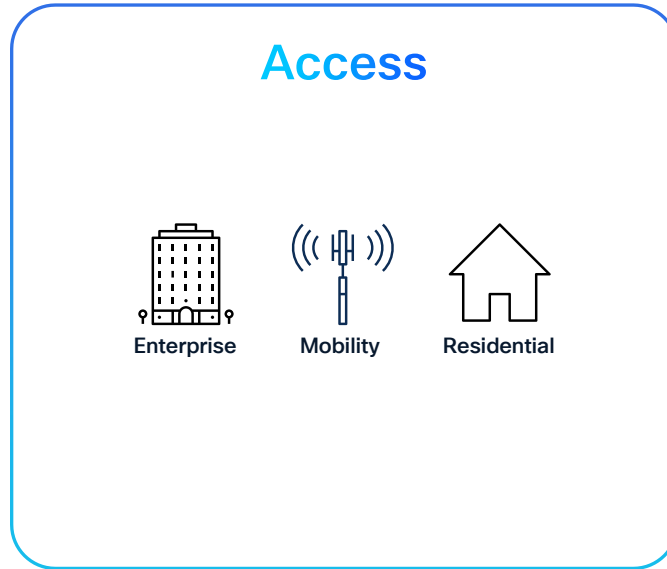
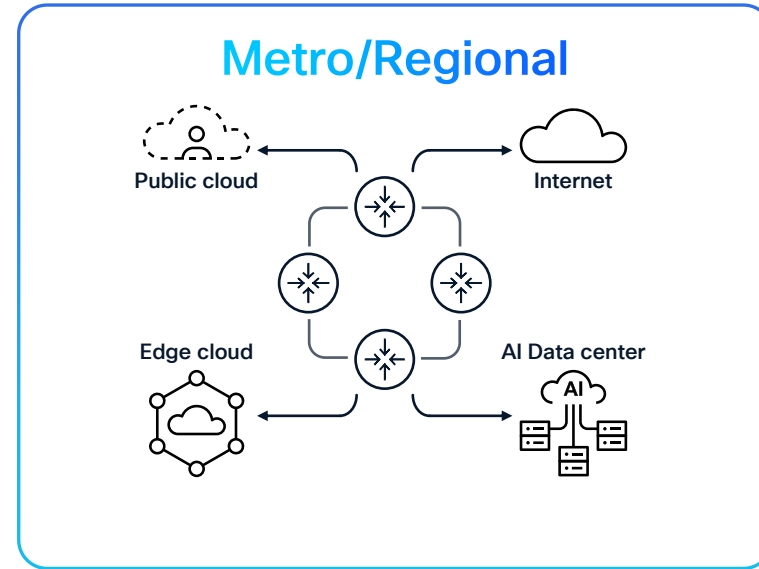
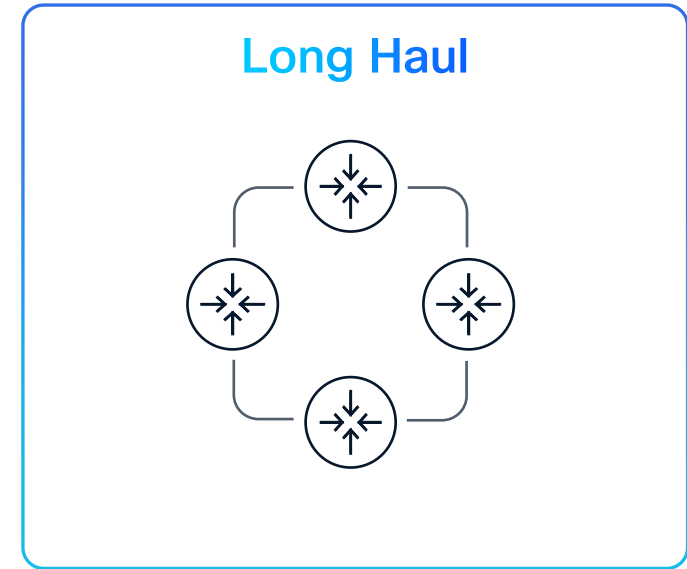
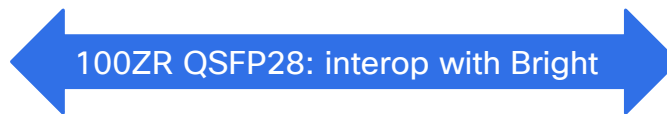
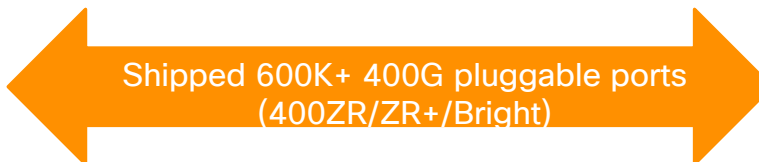
Designed to fit in all routers support 400G Bright ZR+ today

Use Case %



Network Coverage

# Expanding Pluggables to Access & Long-Haul networks ..



# Cisco 400G Ultra Long-Haul (ULH) Module

GA

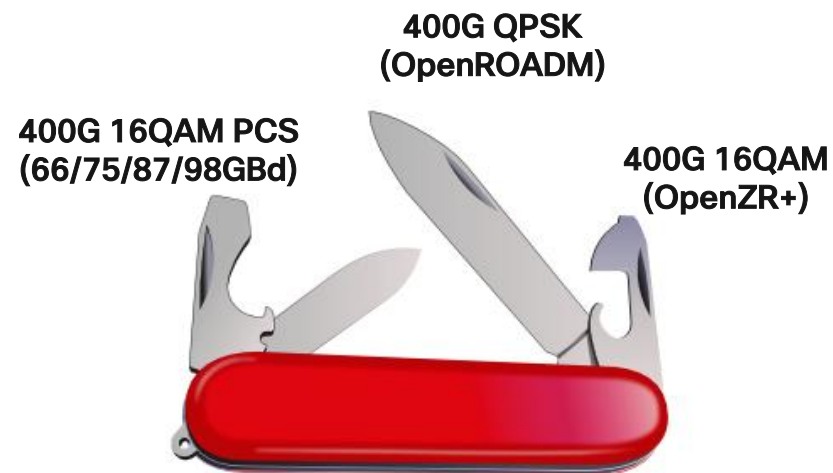
400G High Performance module suitable for regional, long haul and subsea use cases

Designed for existing host platforms with same electrical interface (8x56G SerDes) and power <24W

Feature rich – integrated amplifier & TOF (Tx power +1dBm), C & L band variants, CMIS 5.3 compliant



Cisco 400G QSFP-DD ULH  
(DP04QSDD-ULH-A1)



# 400ULH: Successful Field Trials\*

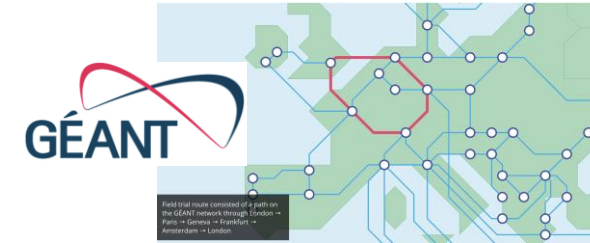
## AARNet: 4,600km Link

- Sydney-Perth Indigo Central subsea cable
- 75Gbaud transmission



## GÉANT: 3403km Link

- London → Paris → Geneva → Frankfurt → Amsterdam → London
- Multiple spans, 7 ROADMs, 42 amplifier sites, 3<sup>rd</sup> party OLS
- 118GBaud, 150GHz spacing



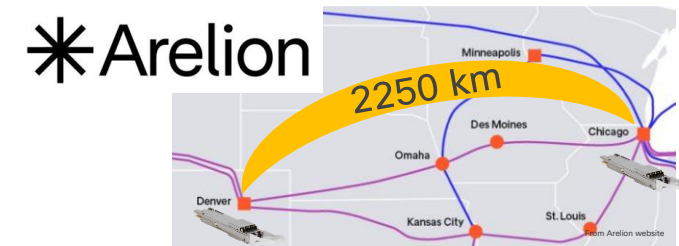
## Internet2: 3000km Link

- Albany-Indianapolis
- Multiple spans, multiple ROADMs, 3<sup>rd</sup> party OLS
- 118GBaud, 137.5GHz spacing



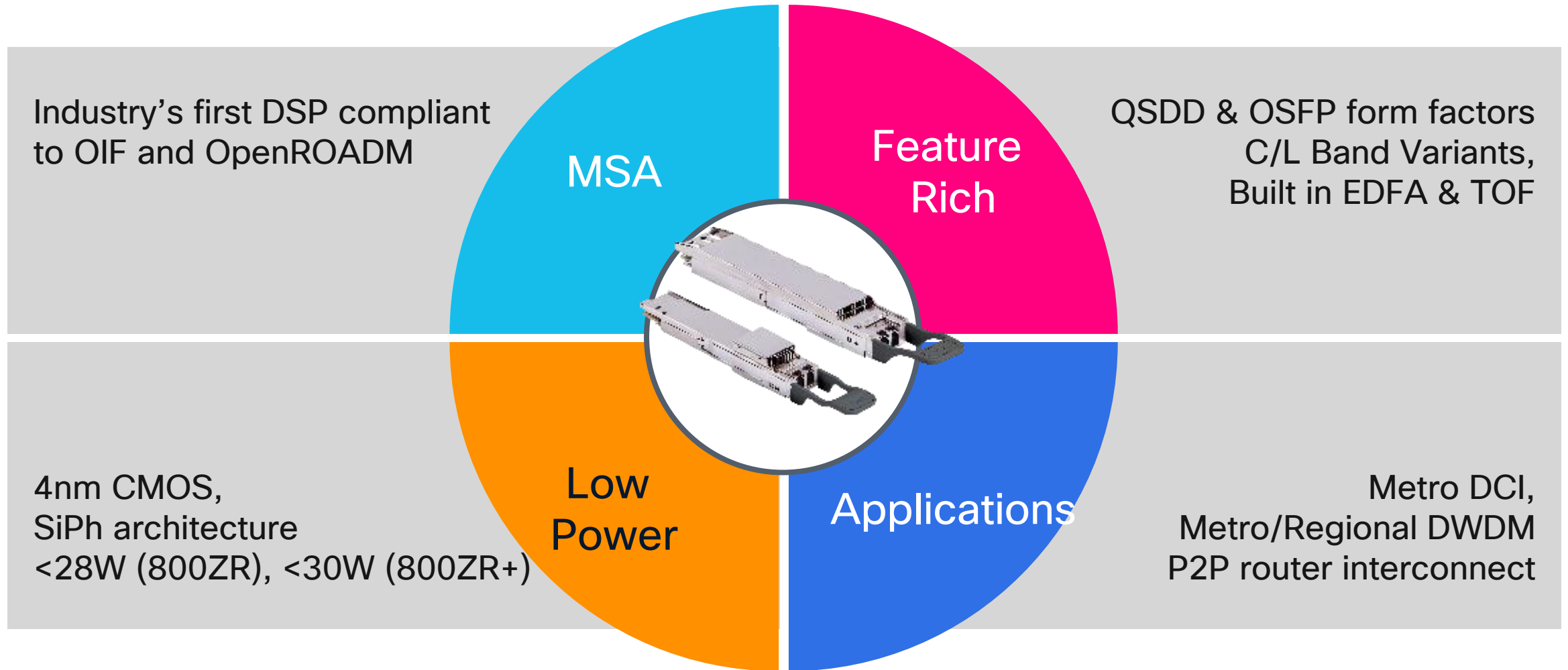
## Arelion: 2250km Link

- Denver-Chicago
- Mix of G.652 and G.655, multiple ROADMs, 3<sup>rd</sup> party OLS
- 98Gbaud, 112.5GHz spacing



# 800G Coherent Pluggables

GA



# 800G ZR+ Successful Field Trials

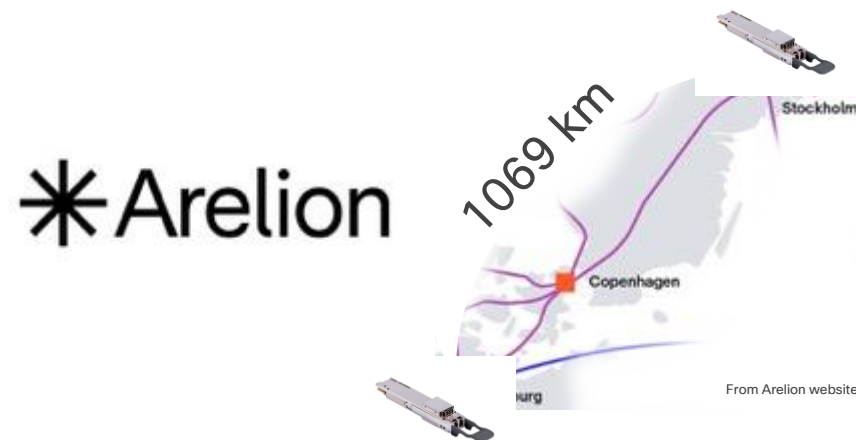
## Colt: First Ever 800G ZR+ Field Trial

- Frankfurt-Munich, 634km w/ margin
- Mix of G.652 and G.655 w/ multiple >100km spans, multiple ROADMs



## Arelion: First >1000km 800G ZR+ Field Trial

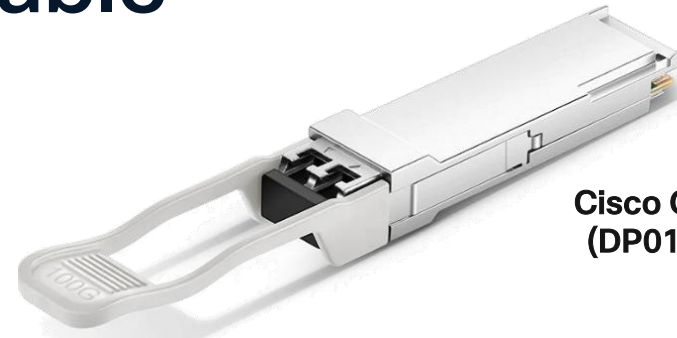
- Stockholm-Hamburg, 1069km w/ margin
- Multiple >100km spans, multiple ROADMs



- Trials used Acacia/Cisco 800G ZR+ QSFP-DD coherent pluggable modules (DCOs)
- Leverages industry standard enhanced performance OpenROADM interoperable PCS mode

# 100ZR QSFP28 Coherent Pluggable

Designed for Access, Aggregation,  
Metro, X-haul, and Campus  
Interconnect



Cisco QSFP28 100G ZR  
(DP01QS28-E20/E25)

## Gen 1

- P2P unamplified reach: 80KM
- Amplified reach: 300KM
- Tx power: -8dBm
- Max power <5.5W

## Gen 2

- P2P unamplified reach: 140KM
- Amplified reach: 500KM
- Tx power: 0dBm
- Max power <6W

GA

iTemp variant available for deployment in outdoor plants and environment

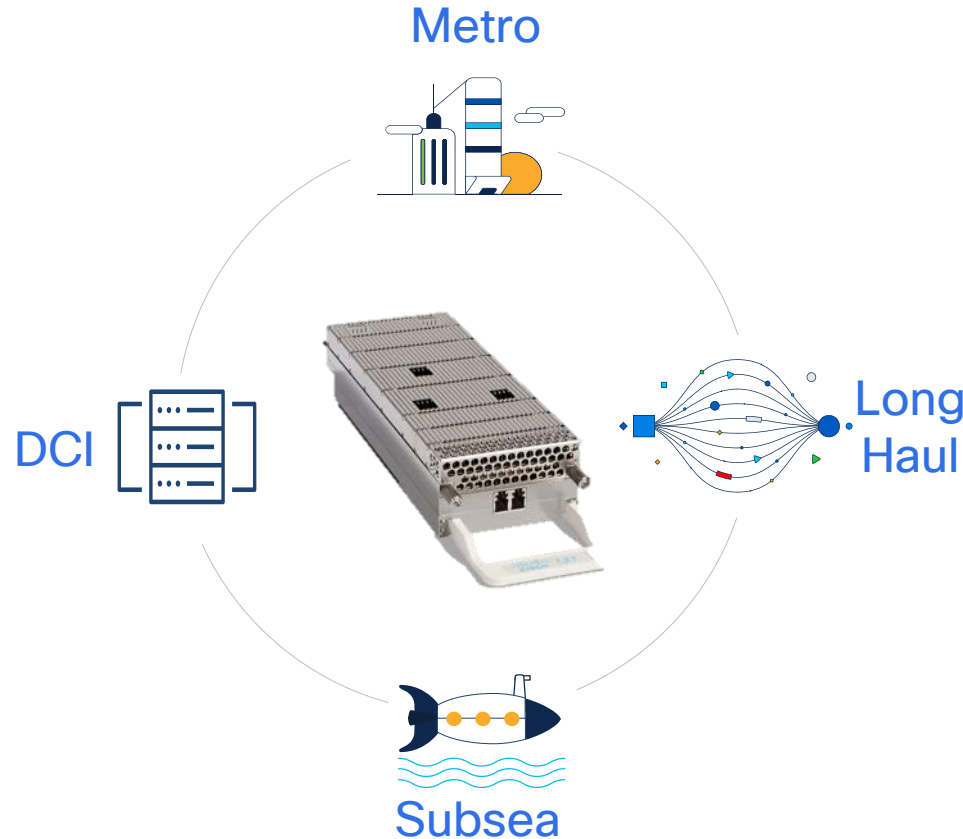
# First Pluggable to Break into the Terabit Era

Coherent Interconnect Module 8 (CIM 8) powered by Jannu DSP

20%+ performance with 3D shaping – 800G covers 90% of network

65% lower power than competition

3D Siliconization packaging



**2.4Tbps Transponder**



**NCS 1014 Next-Gen compact modular shelf**



Single carrier 140Gbd 1.2T faceplate pluggable

# Top Networks Are Adopting Our Technology

NCS 1014 Industry Leading Performance

**verizon**✓



Commercial fiber network with 1Tbps across 14x spans



windstream wholesale



1 Tbps wavelength over a 1,100 km link across Windstream's Intelligent Converged Optical Network



800Gbps on the Amitié transatlantic communications cable



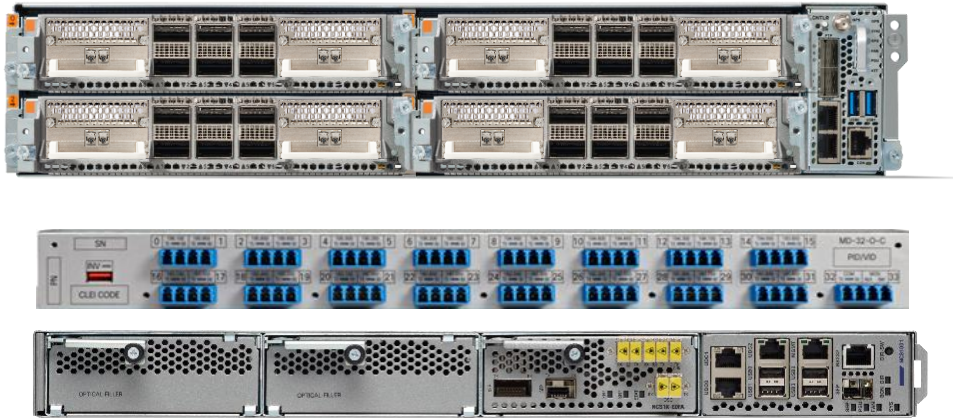
Longest distance 400 Gbps transmission trial on the Indigo subsea cable system; 18,400 km from Sydney to Singapore

# Cisco Optical Transport

# MOFN Optical Transport Solution Offerings

## Solution #1: 1.2T CIM8 Module

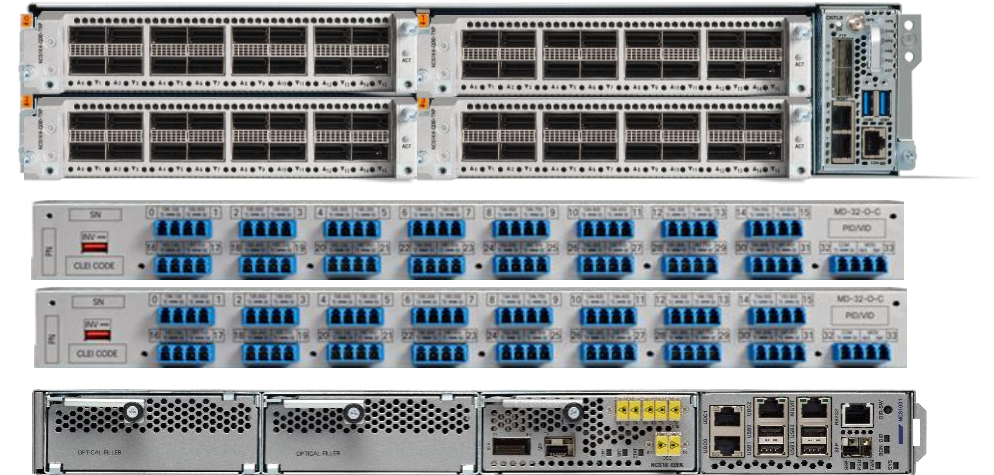
NCS 1014 2.4T Transponders with NCS 1001 Line Systems  
Managed by Cisco Optical Network Controller



- 9.6T in 2RU
- 32x1.2T, 38.4T/fiber pair best capacity (C band)
- 4 x NCS1014 per fiber pair

## Solution #2: 400ZR/ZR+ Coherent Pluggables

NCS 1014 3.2T Transponders with 400ZR optics and Cisco or 3<sup>rd</sup> party OLS  
Managed by Cisco Optical Network Controller



- 12.8T in 2RU
- 64x400G, 25.6T/FP (C band), 2 x NCS1014 per FP
- Highest density
- Low power consumption

# NCS 1014 Optical Transport Solution

## 3.2T QXP with 400G Coherent

## 2.4T TXP with CIM8



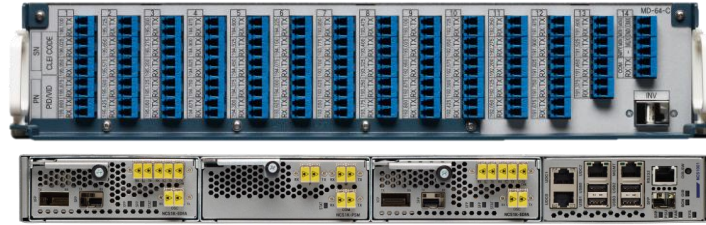
- 400ZR, 400ZRP, 400G-ULH\*
- 100GE, 400GE
- Wire-speed Line Encryption\*
- C-Band, L-Band support\*
- 8x TXP/MXP/Regen\* per card – 32x per shelf
- In-built PRBS testing
- QDD-OLS, QDD-OTDR\*, QDD-PSM\* plugs supported

- 140GBd 1.2T
- 100GE, 400GE, 800GE
- Wire-speed Line Encryption
- C & L-Band support
- Subsea extended CD support, NLEQ support
- Fast SOP tracking for aerial fibers
- In-built client and trunk PRBS testing

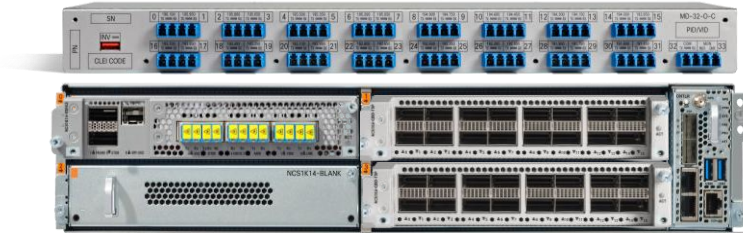
# Metro-DCI Line Systems



QDD-OLS



NCS 1001 with MD64



NCS 1014 DCI-OLS with MD32

- Compact
- Built-in OTDR, OCM (NCS 1001, 1014)
- Built-in Coherent Probe and equalization (NCS 1014)
- Different fixed add-drop option – MD32, MD64
- PSM protection (NCS 1001, NCS 1014\*)
- QDD-OLS for low-capacity use cases
- NCS 1014 allows TXPs and OLS to be combined in one shelf

# Cisco NCS 1010 C+L Line System

## Enhanced Visibility and control

- Equalization Everywhere
- Optical Channel Monitoring (OCM) everywhere
- OTDR everywhere
- ASE loading

## Automation First

- ZTP for device turn-up
- Automated E2E link turn-up
- Streaming telemetry

## Multi-purpose

- Open Line System
- Spectrum Service Ready
- Terrestrial & SLTE
- HCF ready

## Simple & Integrated design

- One degree / ILA per shelf
- Better MTBF
- Easier to deploy

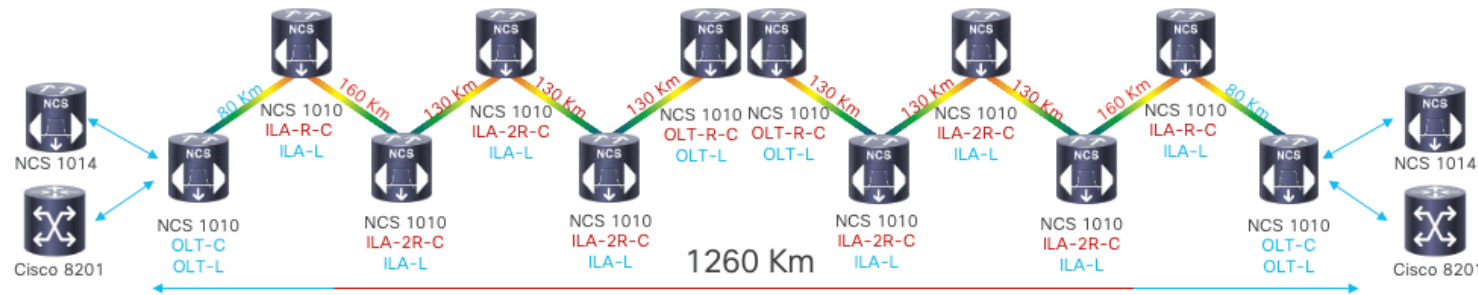


NCS 1010

C+L Long Haul Open Line System

# NCS 1014 CIM 8 Delivers 64T for C+L Long Haul

64T (32T in C-Band and 32T in L-Band) with NCS 1014 and Coherent Interconnect Module 8 over NCS 1010 C+L Open Line Systems and *Corning Vascade EX2500* fiber

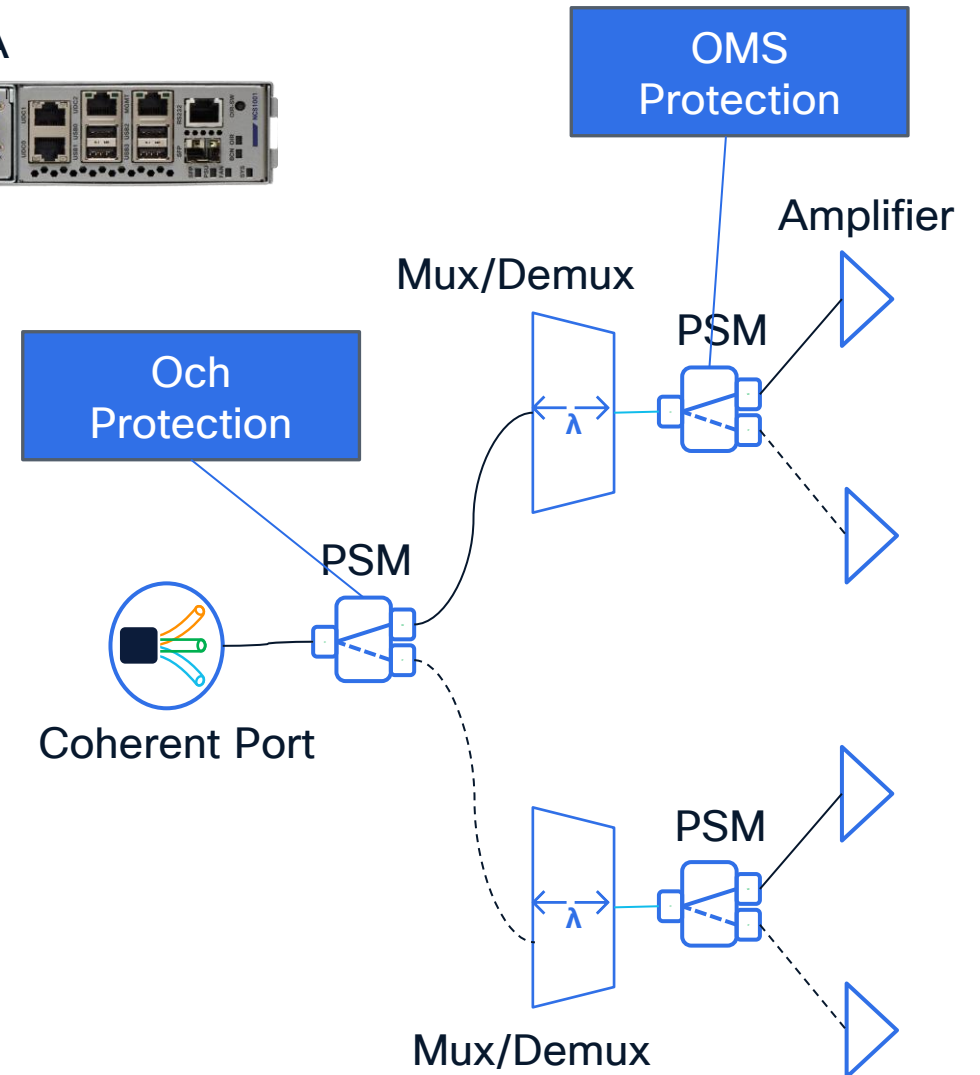


# MOFN Optical Transport Protection Options



## Optical Protection Options for different customer use cases

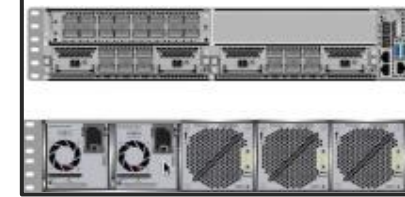
- **Optical Channel Protection (with or without restoration)** – mainly used in Long Haul
- **Optical Multiplex Section Protection** – 2-way, 3-way, 4-way – used in metro
- **Optical Transport Section Protection** – 2-way for span protection in Long Haul
- **Client Protection** – E2E protection required by some enterprise customers.



# Cisco Optical Site Manager (COSM)

- COSM is a Web UI for NCS1K/2K
  - Run in NCS1K RCP embedded SW (XR) or
  - Run in NCS2K SVO-LC (up to 15 COSM per SVO Controller)
- Rack/Chassis/Module mechanical View
- Visualize Alarms (on chassis/card/port)
- Alarms & events table – Current & History
- Visualize physical and logical Inventory
- Card Mode Configuration wizard (steppers)
- PM Live & Last 32 bins
- PRBS, Loopbacks
- TCA & Alarm profile settings
- SW Database , Upgrade Backup & Restore
- Netconf/YANG NBI

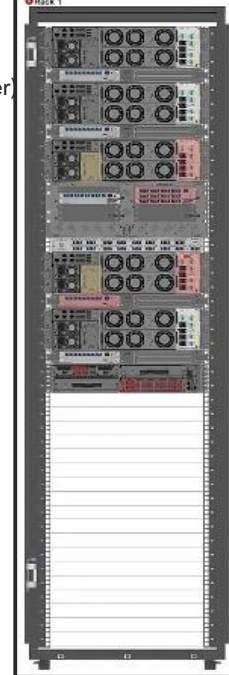
Chassis front/back View



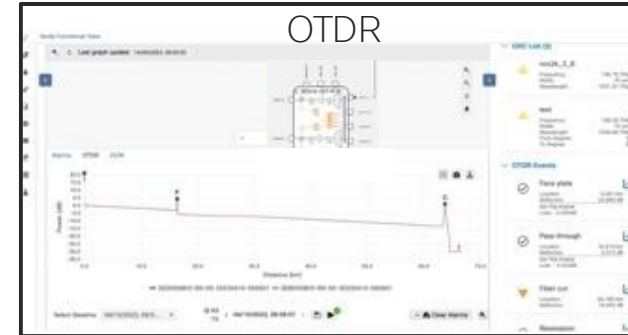
Card View



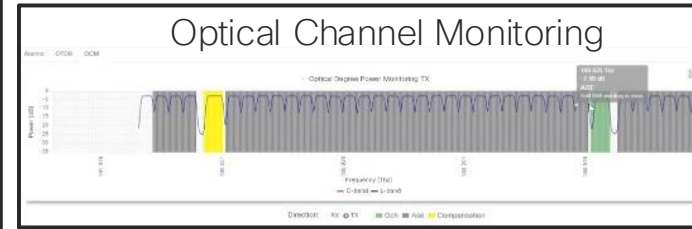
Rack View



OTDR

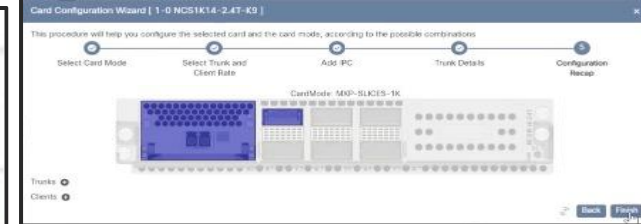


Optical Channel Monitoring



Card – alarms, events

Card Mode Configuration

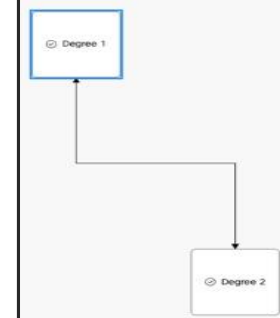


PM – last 32 intervals

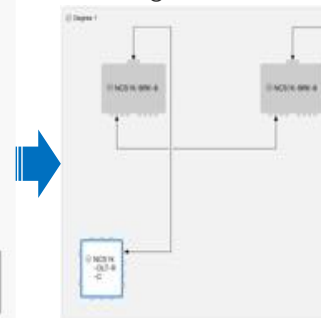
Live PM | PRBS | Loopbacks



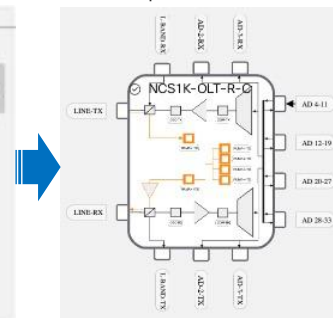
Node View



Degree View



Component View



# Cisco Optical Network Controller (CONC)

CONC is web-UI, Microservices K8s software  
NCS 1000 and NCS 2000 – available on 25.x

## Telemetry & KPI

**OUTCOME:** Reduce time to identify anomalies, time to act

## Configuration/Provisioning

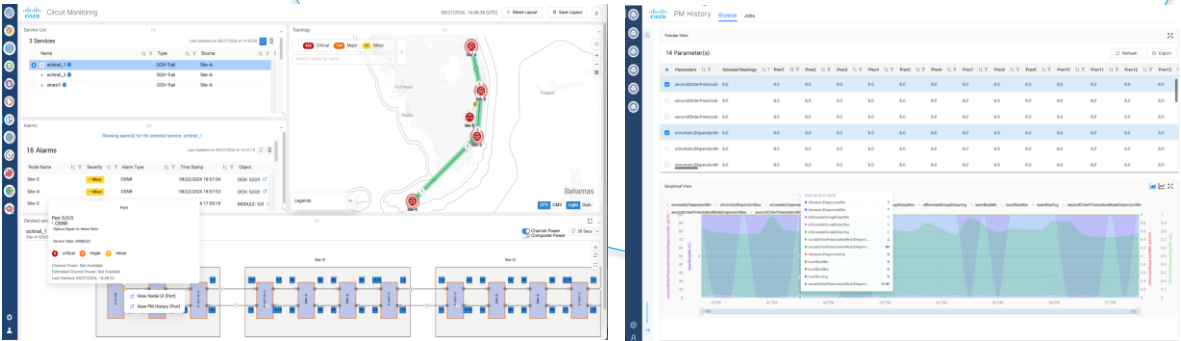
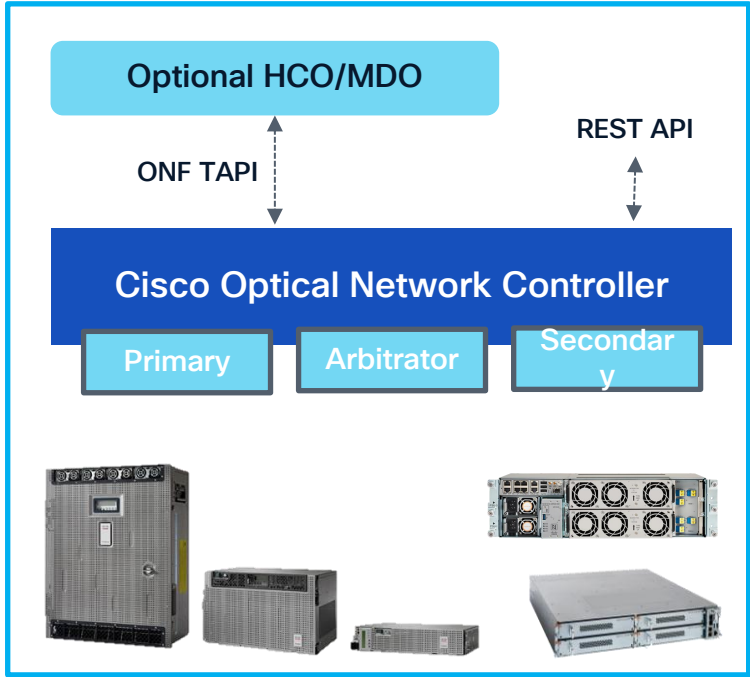
**OUTCOME:** Reduce time to monetize, Eliminate errors in provisioning, TAPI or REST NBIs for multi-later orchestration

## Fault Management

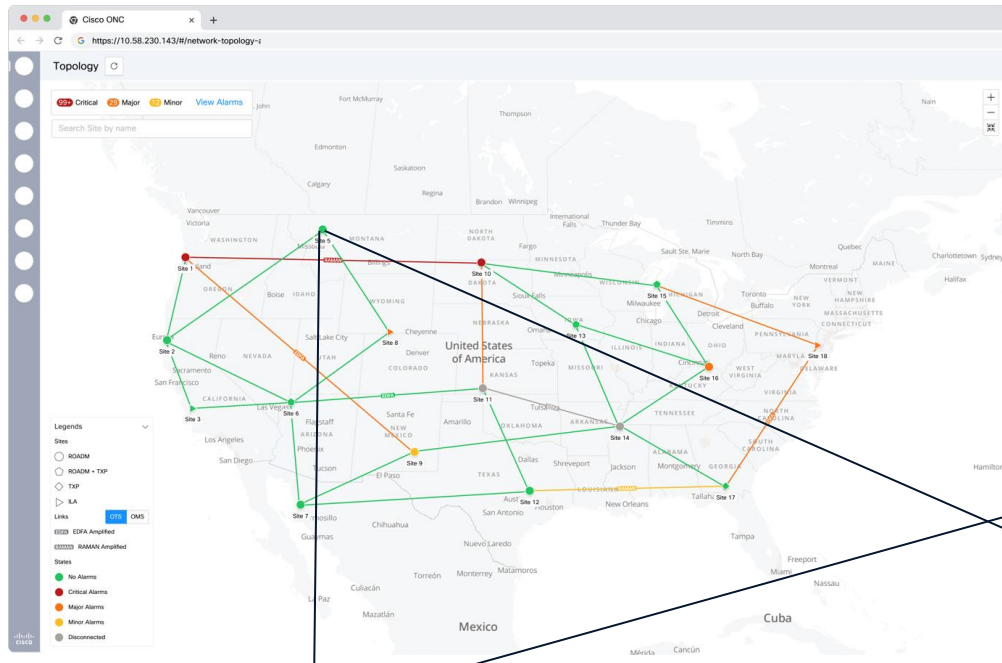
**OUTCOME** Reduce time to identify anomaly, time to restore services, time to plan maintenance/growth

## Inventory and Topology Management

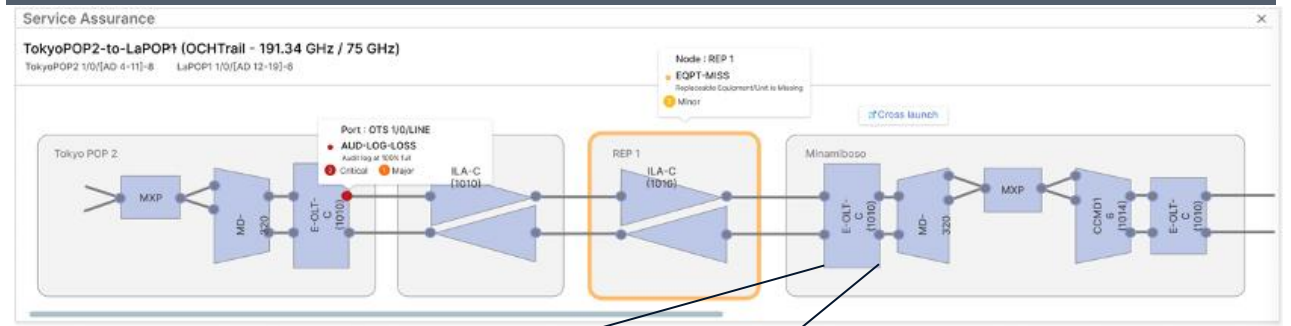
**OUTCOME** Know your network, simplify operations



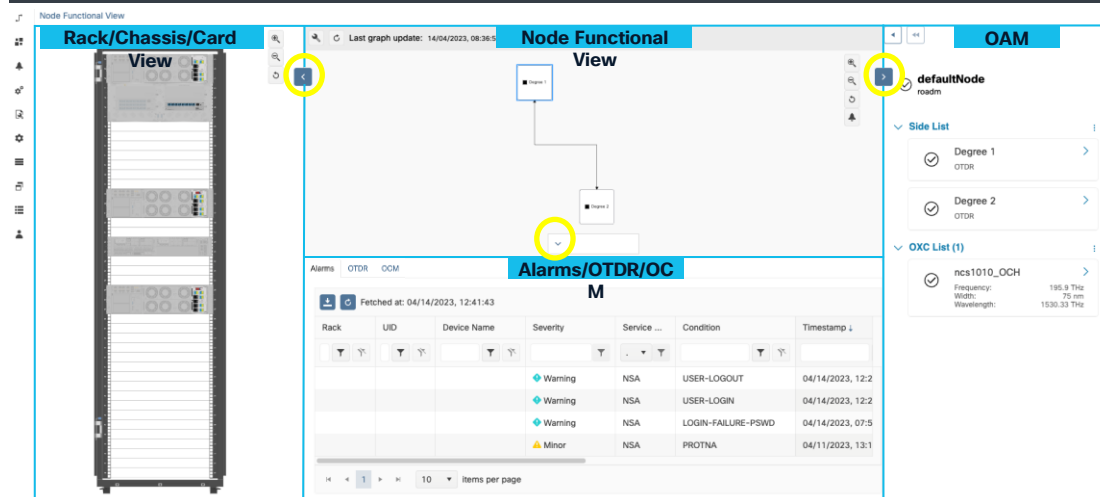
## Network: Topology view



## Network: Circuit view

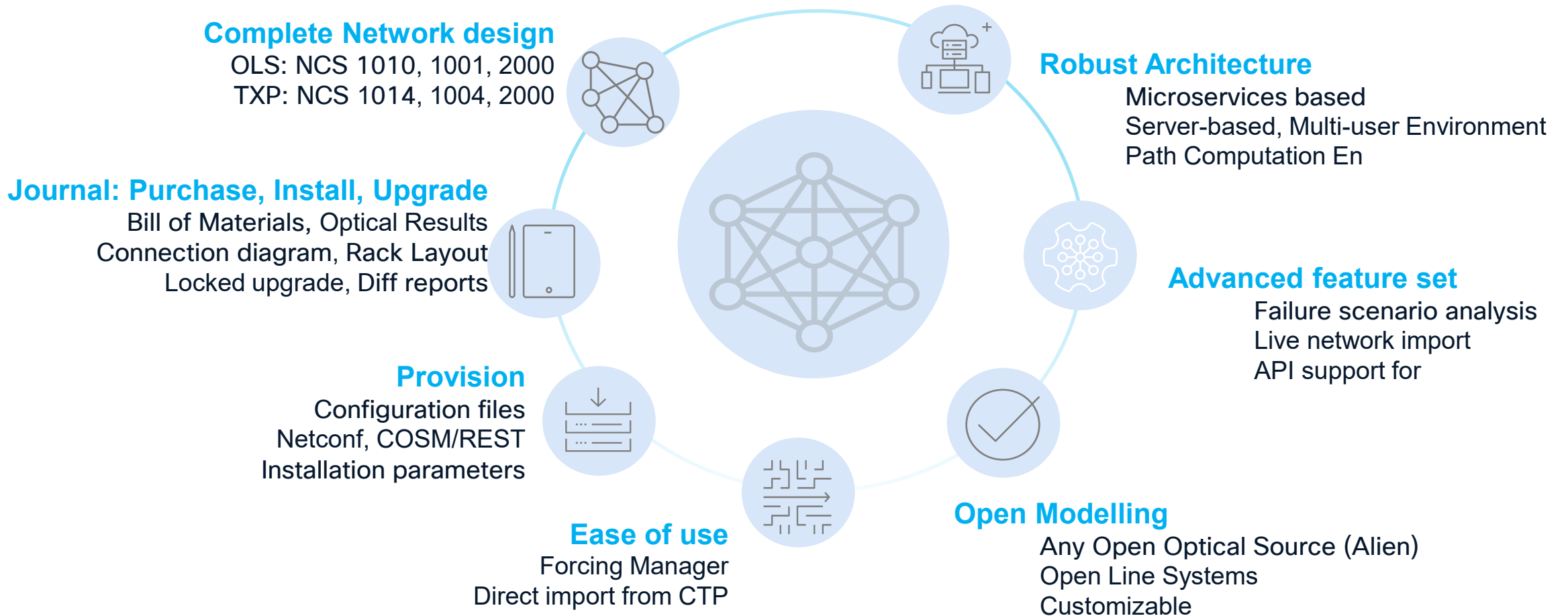


## Site view



# MOFN Optical Transport Network Planning & Design

## Cisco Optical Network Planner: The Next generation Multi-layer Design and Planning tool from Cisco



# Summary

## Market Momentum

Explosive growth in AI, DCI traffic; hyperscalers are turning to managed models for scalability and speed of deployment.

## MOFN is Win-Win

MOFN delivers scalable, and reliable optical transport to hyperscalers while offloading operational complexities.

## Cisco Advantage

End-to-end solution: optics, automation, management, and support with 100% vertical integration

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