Use Cases
Routed Optical Networking

Cisco Knowledge Network

Leigh Wade
David Nicholson
Rick Gomez

June 2023

What you will walk away today

- RON saves power **DCO** vs **Transponders**
- Use Cases: **DCI, Metro, SP Core, 5G**
- **Specialists** available to assist
- CKN Offers:
  - 400G **RON Assessment**
  - 400G **Bright ZR+** Friends & Family Promo

Presenting

Leigh Wade
Technical Solutions Architect
Global Specialists

David Nicholson
Tools Development
Global Specialists

Rick Gomez
400G Business Development
Global Specialists

Reach us at ask-specialist@cisco.com

Let’s set the stage… for RON

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Cisco Routed Optical Networking
named
Most Innovative Routing and Switching Solution

Data explosion

By 2025,

Consumption of Data will grow

50% per each year!

Creation of Data will grow

61% to 175 zettabytes!

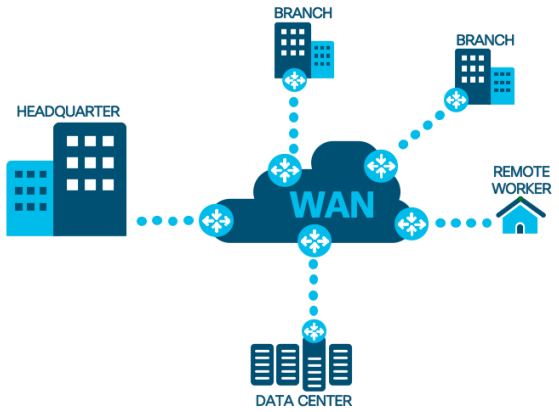
Over the last 2 years,

90% of the world's data was generated.

IDC

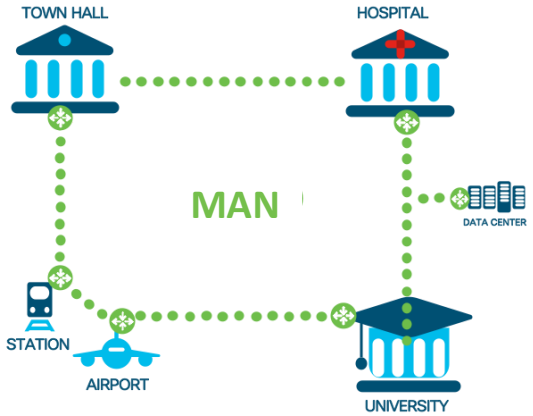
Opportunity: Double digit Growth

Solutions



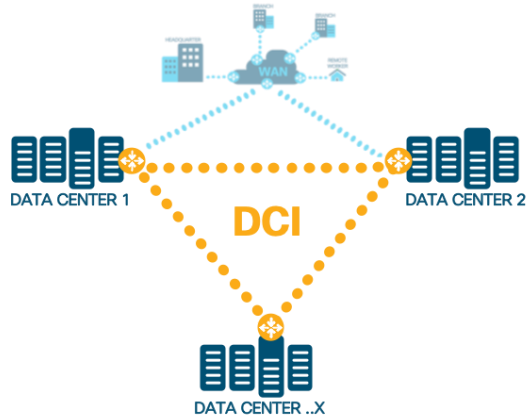
Wide Area Network

MPLS Network
Corporate WAN
SD WAN



Metropolitan Area Network

MAN
Campus network
Optical network



Data Center Interconnect

Data Center Optical Network
Peering

Verticals

Opportunity

Migration from 1 to 10 to 100 to 400G networks implementing Routing Over Optical

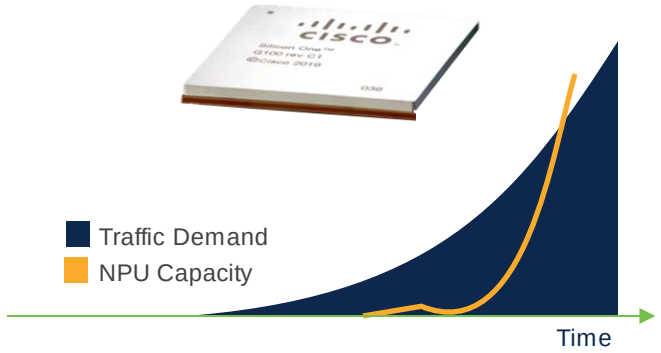
Migration from Traditional MPLS to Segment Routing MPLS

Migration from Optical Network to Routed Optical Network

Shifts in Economics and Technologies

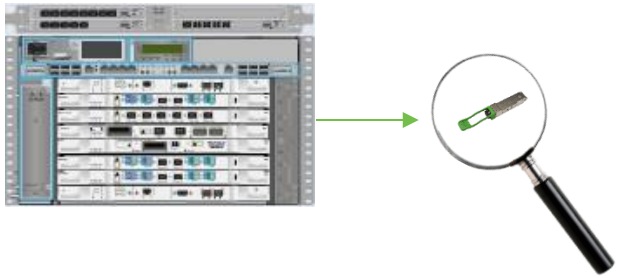
Optics and Routing

Routing Scale Evolution



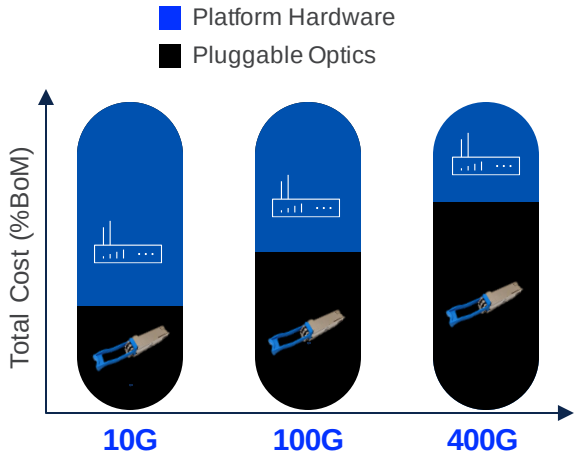
Router capacity outpaces projected traffic demand

Optical Systems Evolution



Chassis-based solutions replaced by pluggable optics for short- to medium-distance applications

Shift in Economics



Optics cost becomes greater part of the cost

Routed Optical Networking-Key Enablers

Putting it all together

Massively scalable silicon

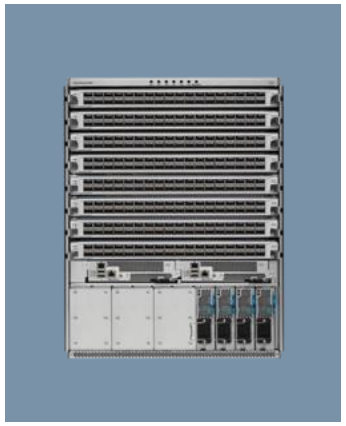
Shipped 100,000 400ZR/ZR+

Transponder → pluggable With ZR/ZR+ optics (Common Form Factor)

Manageability of IP+Optical: Industry standardization & interop

Open DWDM: Industry standardization & interop

- 45% TCO savings
- CAPEX: Higher wavelength utilization
- OPEX: Less power/space

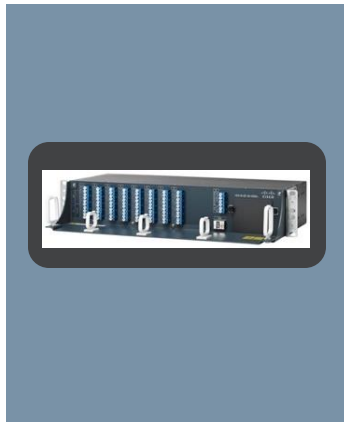


>250Tbps

+

400GE ZR/ZR+

+



Simple DWDM Line System

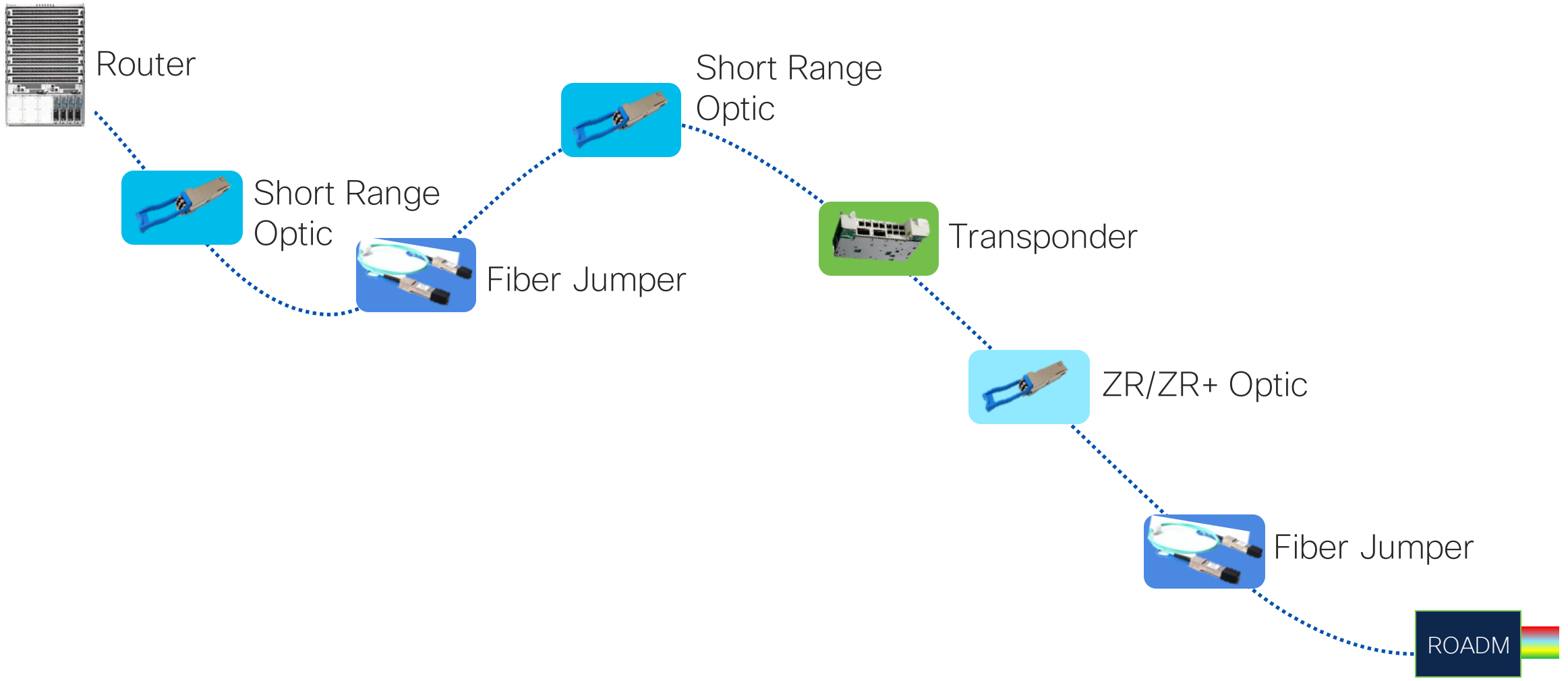
+

Modern Software & Control Plane

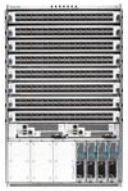
=

New Network Paradigm

Removing Complexity



Removing Complexity



Router

Short Range Optic

Fiber Jumper

Short Range Optic

Transponder

ZR/ZR+ Optic

Fiber Jumper

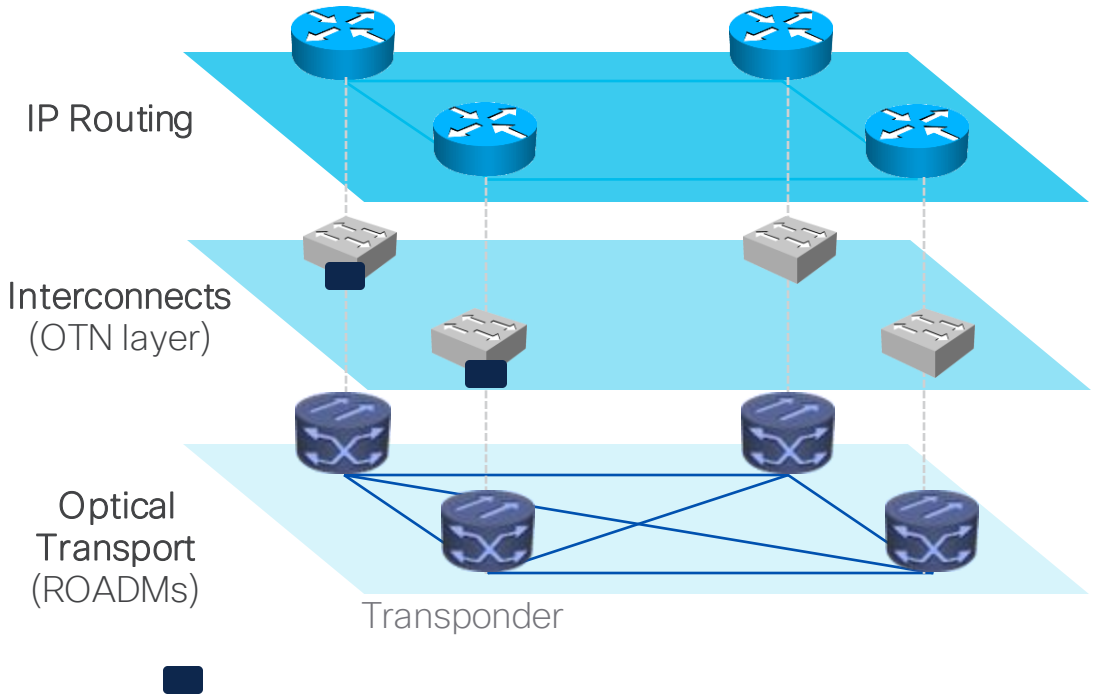
ROADM

Transponder (385 Watts)

ZR Optic (20 Watts)

Toward a Routed Optical Networking Future

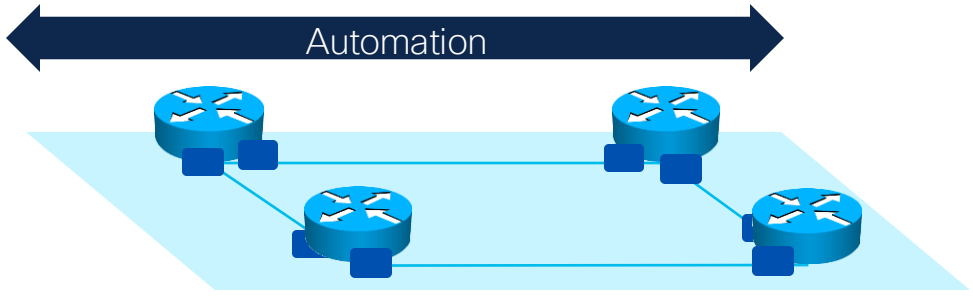
Traditional Layers in IP Transport Networks



Lower TCO with highest fiber utilization

Fewer platforms: easier to manage, more secure

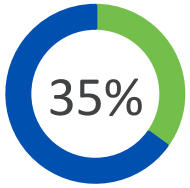
Converged IP Transport (Routing and Optical)



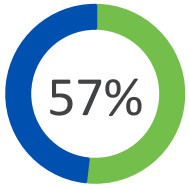
IP Routing + Interconnects + Optical (ROADMS)

Reducing space and power requirements

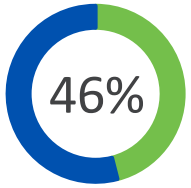
Intermediate success: alien wavelength support



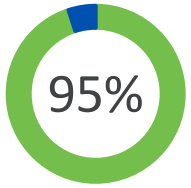
CapEx Savings*



OpEx Savings*



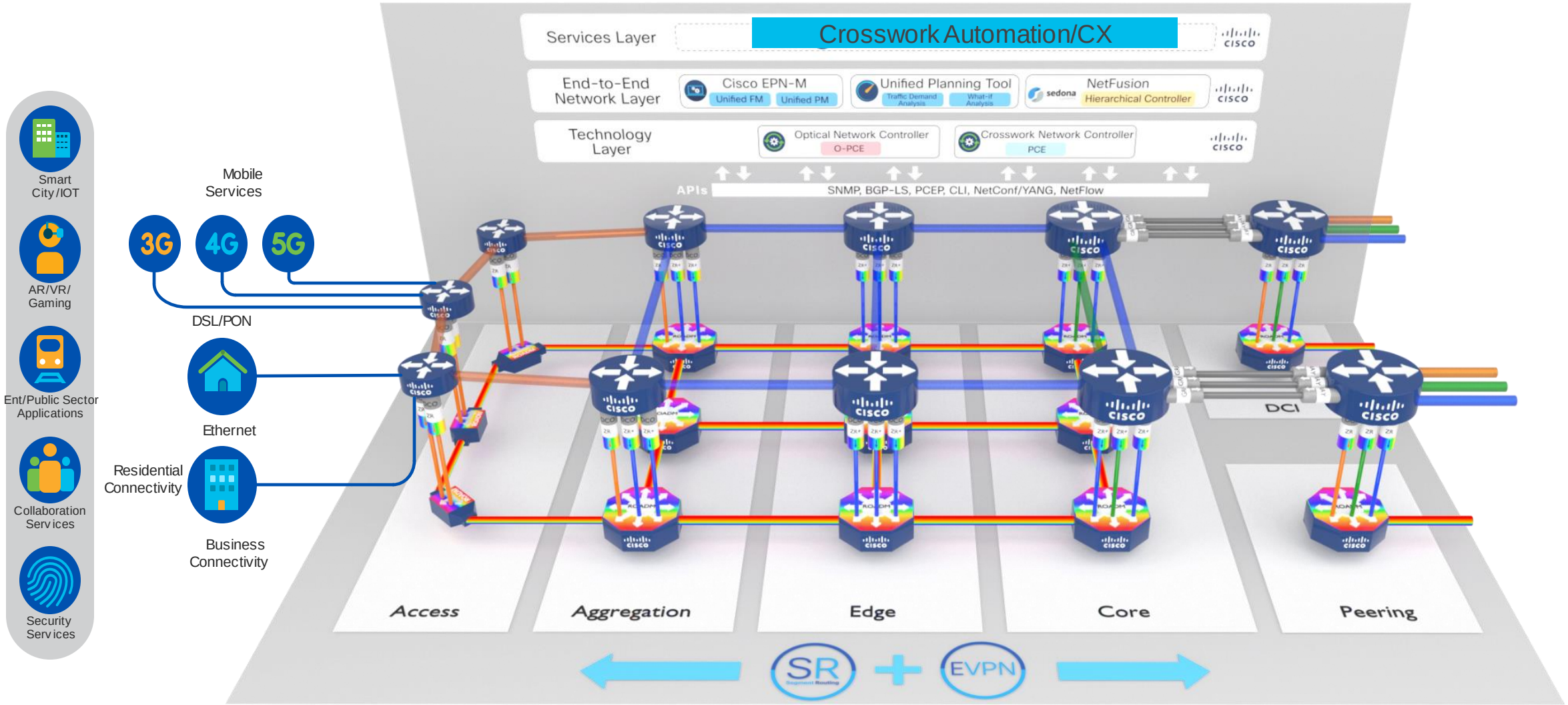
TCO Savings*



Power savings vs. transponders

Routed Optical Networking

End-to-end solution and applications



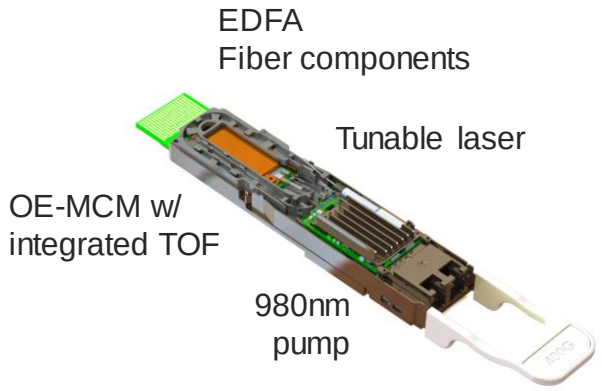
Broadest 400G MSA Pluggables Portfolio

- Leading 400G pluggable deployments (>**70%** share--**150k+ ports** shipped)
- Long history of coherent pluggable technology leadership
- Drove coherent standardization efforts

Bright 400G ZR+ QSFP-DD Module for ROADM Networks

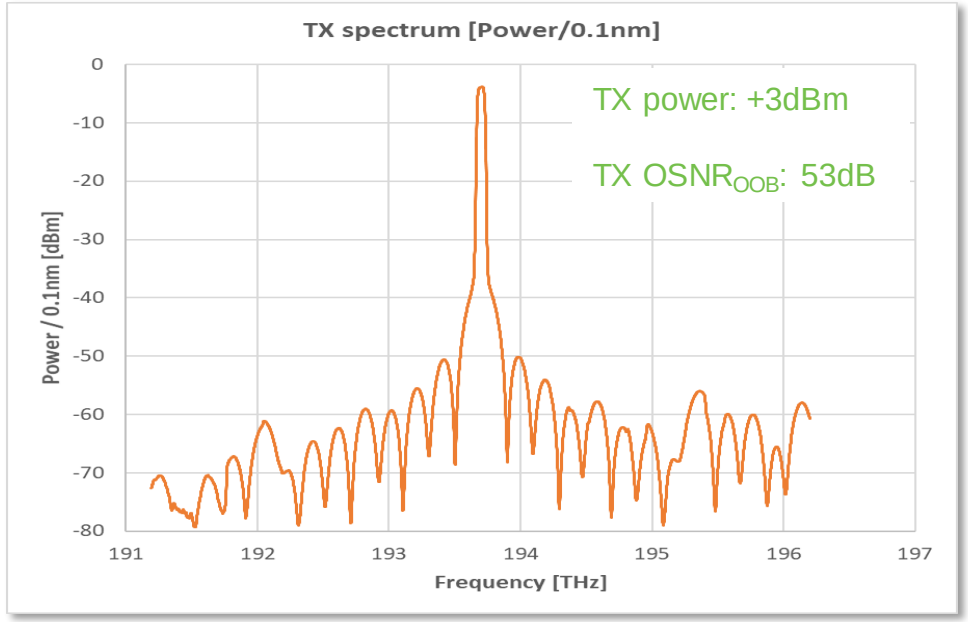
Applications:

- Seamless deployment in ROADM line systems (e.g., architectures w/ colorless multiplexing)
- Brownfield & Greenfield
- Transponder alternative



Key Features:

- 400G ZR+ QSFP-DD pluggable with up to +1dBm TX Power
  - Includes integrated TX EDFA
  - Includes new PIC with integrated TOF
  - High TX power in all operating modes
  - Enhances by about 12dB the un-amplified reach respect ZR+
  - Increased OSNR performances



Cisco 400G Router Portfolio

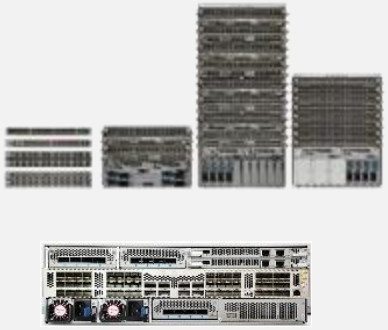
NCS 540

Shipping

N540-24Q8L2DD-SYS

NCS 5700

Shipping



Jericho 2

NC57-24DD
(24x400GE LC)

NC57-18DD-SE
(18x400GE LC)

NCS-57C3-MOD

NC57-MPA-2D4H

CISCO 8000

Shipping

Cisco Silicon One

8201
(24x 400GE + 12x 100GE)

8202
(12x 400GE + 60x 100GE)

36x 400GE LC

ASR 9000

Shipping

Cisco Light Speed Plus

A9K-20HG-FLEX-SE/TER
(5x 400GE + 15x 100G)

A9K-8HG-FLEX-SE/TR
(2x 400GE + 6x 100GE)

*Check compatibility tool for optics support

Cisco Nexus 400G Switch Portfolio

Nexus 3400-S

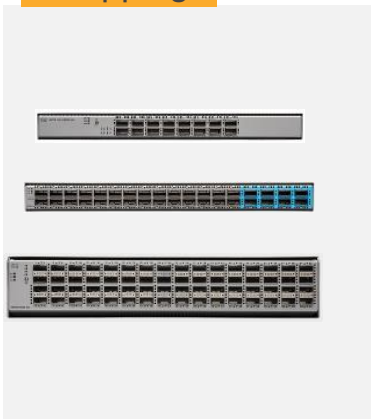
Shipping

Innovium Terralynx

1RU 32p 400G Switch
4RU 8-slot Switch

Nexus 9300 GX

Shipping



Cisco Cloud Scale GX

1RU 16p 400G Switch

1RU 28p 100G
+ 8p 400G Switch

Nexus 9500 GX

Shipping

Cisco Cloud Scale GX

16p 400G Line Card
8-slot GX 400G Fabric Module
4-slot GX 400G Fabric Module
(Compatible with EX/FX Line Cards & FM-E/FM-E2 Fabric Modules)

Nexus 9500 R Series

Shipping

Broadcom Jericho 2

24p 400G Line Card
8-slot R2 400G Fabric Module

Nexus 9000 GX2, GX3

Shipping

Broadcom Jericho 2

24p 400G Line Card
8-slot R2 400G Fabric Module

*Check TMGmatrix compatibility tool for optics support

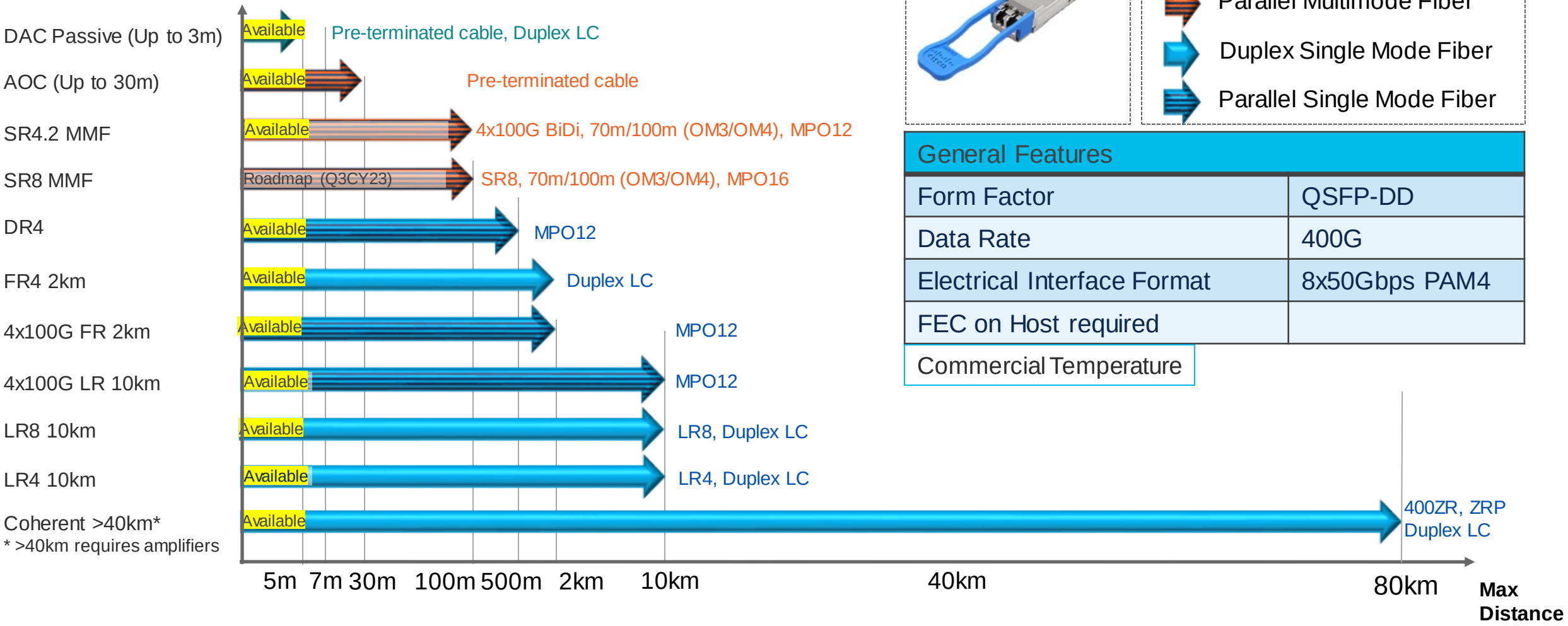
ACI – On Cisco Cloud Scale ASICs. NXOS – On Cisco Cloud Scale & Merchant ASICs.

400G Optics Transceivers Portfolio

Everything from Copper (Grey) to Digital Coherent

- Copper
- Parallel Multimode Fiber
- Duplex Single Mode Fiber
- Parallel Single Mode Fiber

General Features	
Form Factor	QSFP-DD
Data Rate	400G
Electrical Interface Format	8x50Gbps PAM4
FEC on Host required	
Commercial Temperature	



Use Cases Summary

Summary and Key Differences with Use Cases

Routed Optical Networking for Access and Aggregation

	Core	Aggregation	Access
Geography	Long Haul, Regional	Metro, Regional	Metro
Distance	100's to 1000's kms	10's kms	Few kms
Network Capacity	Tbps	Tbps	100's of Gbps
DWDM Topology	Mesh	Mesh, Rings	Rings
Logical Topology	Hop-by-hop (Recommended)	Hop-by-hop (Recommended)	Hop-by-hop, Dual homing
Fiber Capacity	Very high (64 @ 400Gbps)	Medium (32 @ 400Gbps)	Low (4/8 @ 400G/200G/100G)
ROADM Type	CDC-FS	CDC-FS	No ROADM or Fixed
DWDM Degrees	Medium (9)	High (20)	Low (typically 2)
Feasible DCO Speeds	< 400Gbps (average)	400Gbps	400Gbps
Extended Temp	Not required	Not required	Required for outdoor deployments
Max. depth	No constraints	No constraints	300mm typically
Class C Timing	Not required	Req. for 4G/5G	Req. for 4G/5G

Note: This table represents what we commonly see in networks. Not RON requirements.

Cisco NG Optical Networking Portfolio

Cisco Optical Network Controller
Cisco Optical Site Manager
Cisco Optical Network Planner

3rd party waves / Spectrum

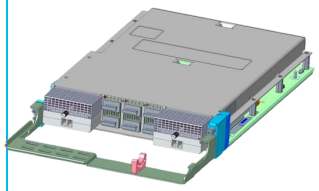
Coherent plugs

400G DCOs

1.2T C&L-Band

NCS 1014

Transponders/Xponders



2.4T C&L-Band

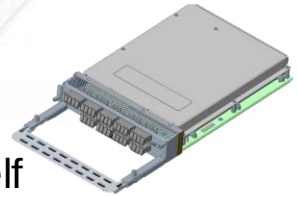
1.2T C&L-Band

CFP2/QDD 400G LCs

Compact Modular Shelf

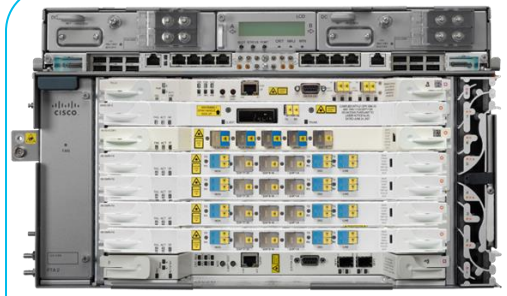
L0 and L1 cards

L0 cards



A/D, ROADM, AMP LCs

NCS 2000

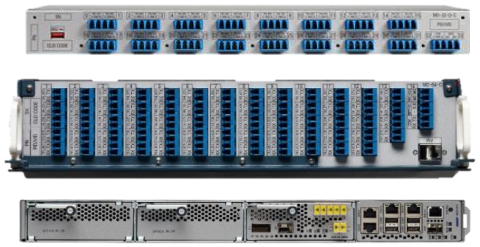


Metro, Regional, Long-Haul Line System

NCS 1010

C & L-Band Integrated Long-Haul Line System

NCS 1001



Metro DCI Line System

QSFP-DD OLS

Metro P2P Line System Pluggable

Use Cases
Data Center Interconnect (DCI) and Metro

DCI Solution Overview

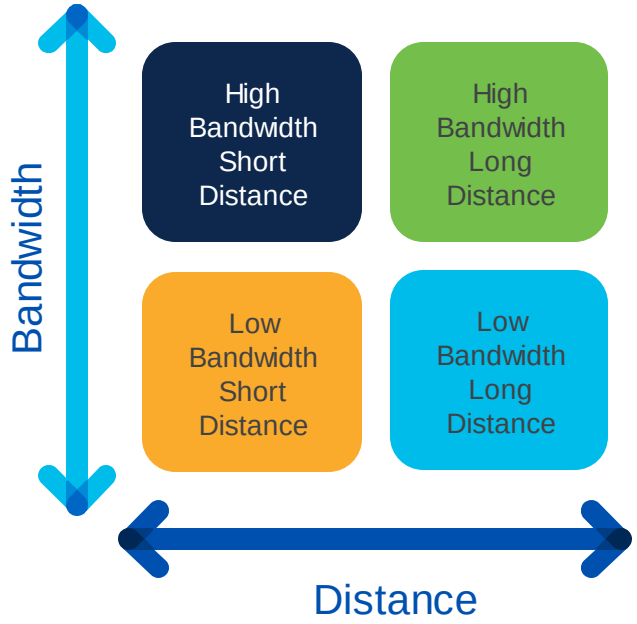
Business Value

- Cloud Optimized
- Traffic Growth
- Transport Costs

Solution

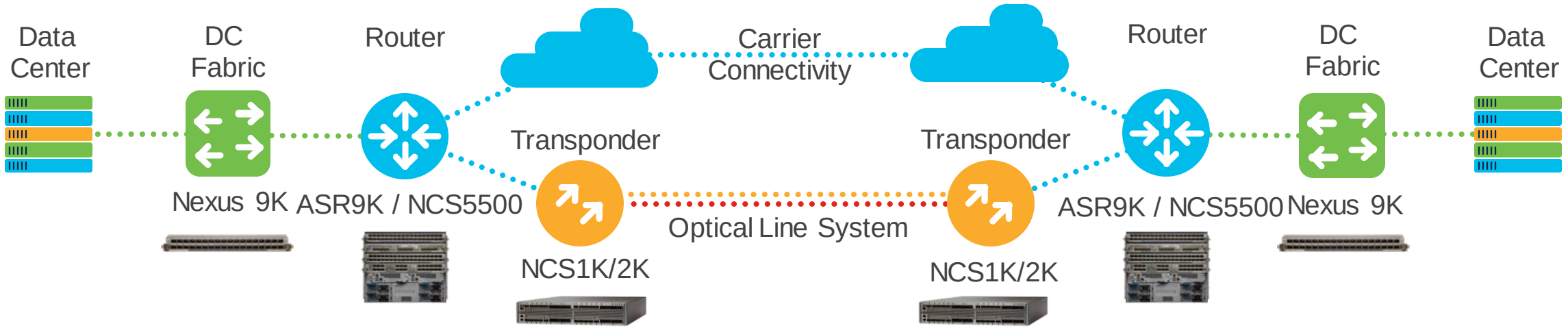
High bandwidth connectivity between data centers, colocation and cloud providers

Flexibility



Traditional DCI

Within the Data Center, DCI means DC Fabric overlays enabling inter-data center workload mobility. At the data center Edge, DCI means L2/L3 WAN Transport between data centers. Optical Transport DCI means to the L0/L1 optical connectivity between data centers over fiber. Cisco is the only company that offers a complete, end-to-end solution.



DC Fabric

- Inter-Data Center workload mobility
- ACI, EVPN, VXLAN, OTV
- Policy based SLAs for mobility and elasticity

WAN Transport

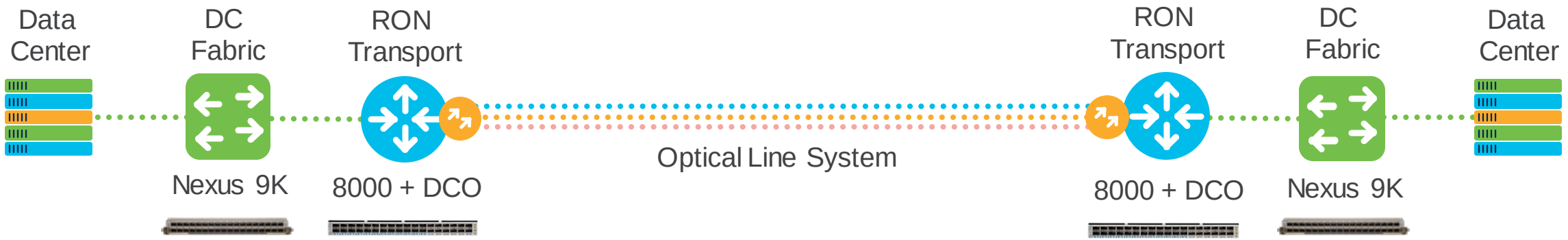
- Interconnect DCs and Peer with external networks
- MPLS, SR, L2/L3VPN, MACSec
- Transport level SLAs

Optical Transport

- Physical Transport
- Dark fiber or wavelength
- Path protection, encryption over long haul and metro routes

400G DCO Options for DCI and Metro Transport

Routed Optical Networking (RON) simplifies transport between data centers by removing the transponder layer. Combining the routing and transponder layer removes cost and complexity from the network, lowering TCO and simplifying operations. The consolidated transport network provides the ability to deliver L1 - L3 services.



DC Fabric

- Inter-Data Center workload mobility
- ACI, EVPN, VXLAN, OTV
- Policy based SLAs for mobility and elasticity

IP Services

- Interconnect DCs and Peer with external networks
- MPLS, SR, L2/L3VPN, MACSec
- Transport level SLAs

Optical Services

- OTN (Optical Transport Networking)
- L1 Encryption
- PLE (Private Line Emulation)

400G DCO Options for DCI and Metro Transport

ZR DCO Optic

Point to Point

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 30KM for unamplified P2P links" and "Up to 120KM for P2P amplified links

<30 km

ZR+ DCO Optic

Data Centric Networks

Data Centric
Web Scale, Data Center Interconnect, Non-SP/SP Router Interconnect

Cost Optimized
Essential power and features only to optimize for cost

Simple Features
Designed for open line systems that balance power levels and greenfield deployments

<40 km

Bright ZR+ DCO Optic

Long Haul & Brown Field

Transport Centric
Service Providers, Routed Optical Networking

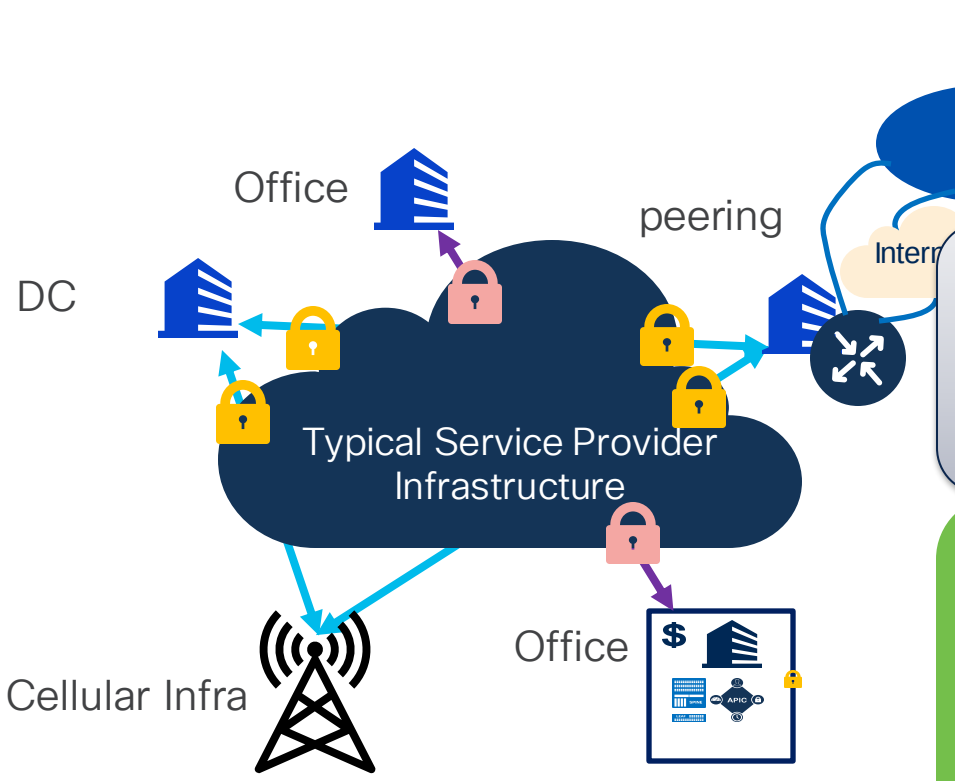
High TX Power
0dbm for difficult spans; interop with brownfield transponder & legacy line systems

Advanced Features
TOF, OTN and L1 Encryption features, Optical TAM, PLE

40 km+

Use Cases
Core/Regional Network

Use case: Service Provider

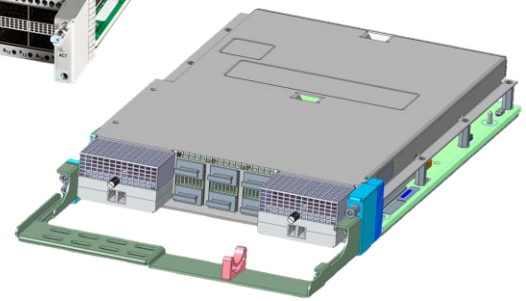


- Good Fiber availability.
- Vast customer base/ Coverage
- Bandwidth Hungry end customers
- Longhaul, Metro and Access coverage

L0 (Lambda level)

L1 (Muxp Level)

- Flex spectrum layer with optical protection and Restoration
- Multi Client protocol with 1G to 100G
- Timing requirement for 5G +
- C+L requirement



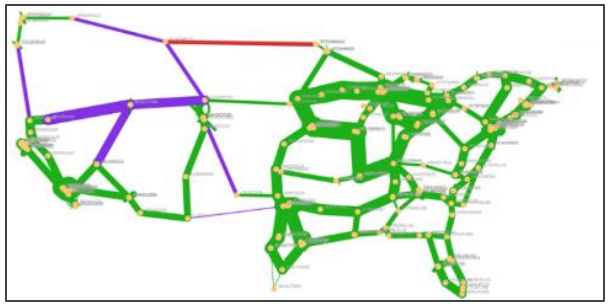
- Layer 0 with NCS 1010 C+L
- Layer 1 Solution with NCS 1004, NCS 1014
- Routed Optical networking for Router interconnects
- Hybrid RON and Layer 1 for TDM, FC, Ethernet applications

Opportunity for Network Grooming and optimization

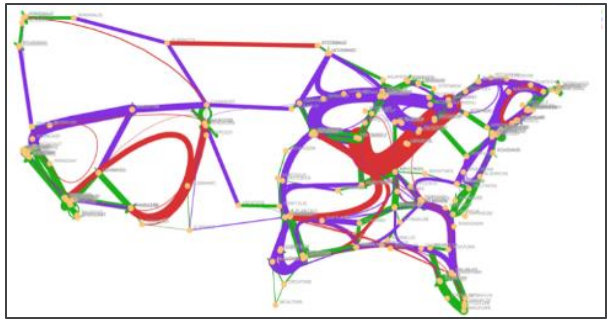
Alien wave to sweat assets

Nationwide Core Network

Routed Optical Network reduces cost of ownership and improves resiliency



Present mode of operation has capacity constraints

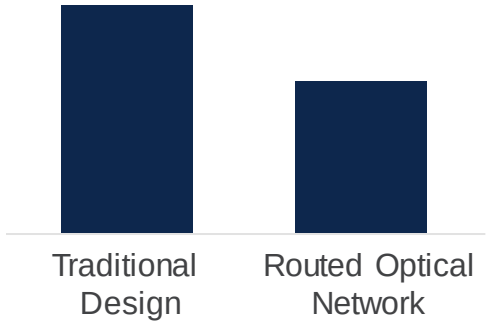


Routed Optical Network increases capacity

400G 200G 100G

Lower CapEx

Large core network comparison



The capital expense of a Routed Optical Network node can be 55% of the cost of today's networks

Lifecycle Savings

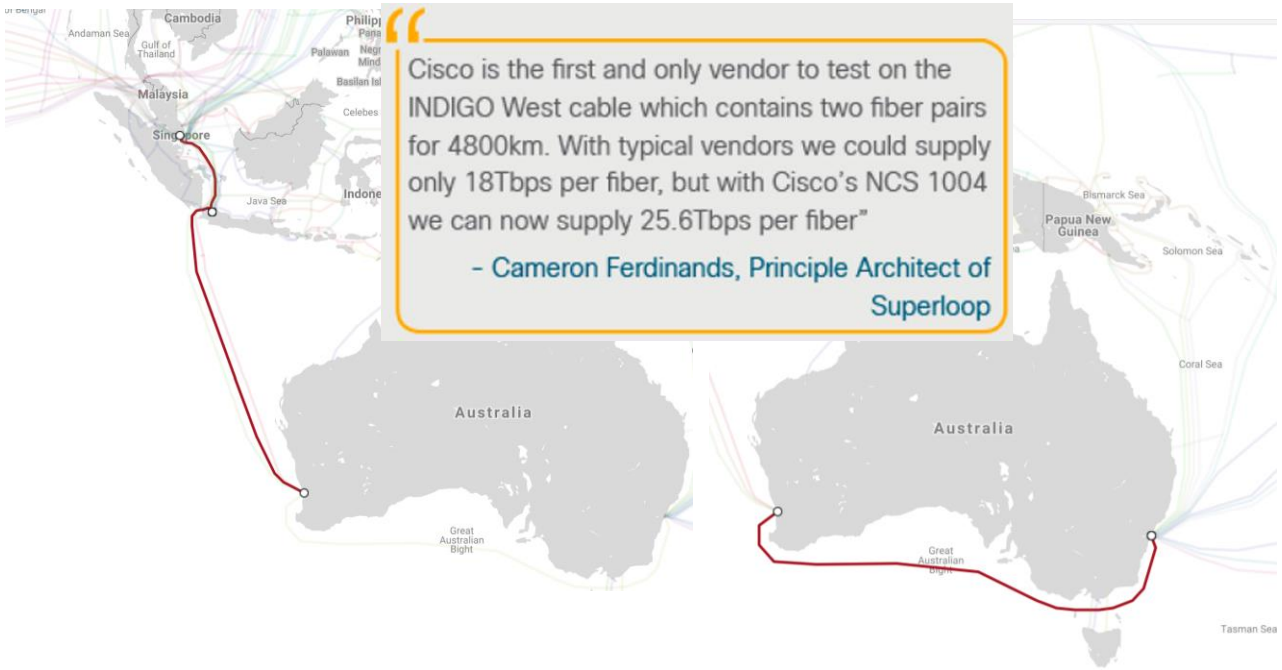
Today's typical node vs. a Routed Optical Network node:

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

Use Cases
Sub Sea

RON in Subsea

Indigo-West and Indico-Central



INDIGO-WEST
Singapore to Perth
4600km

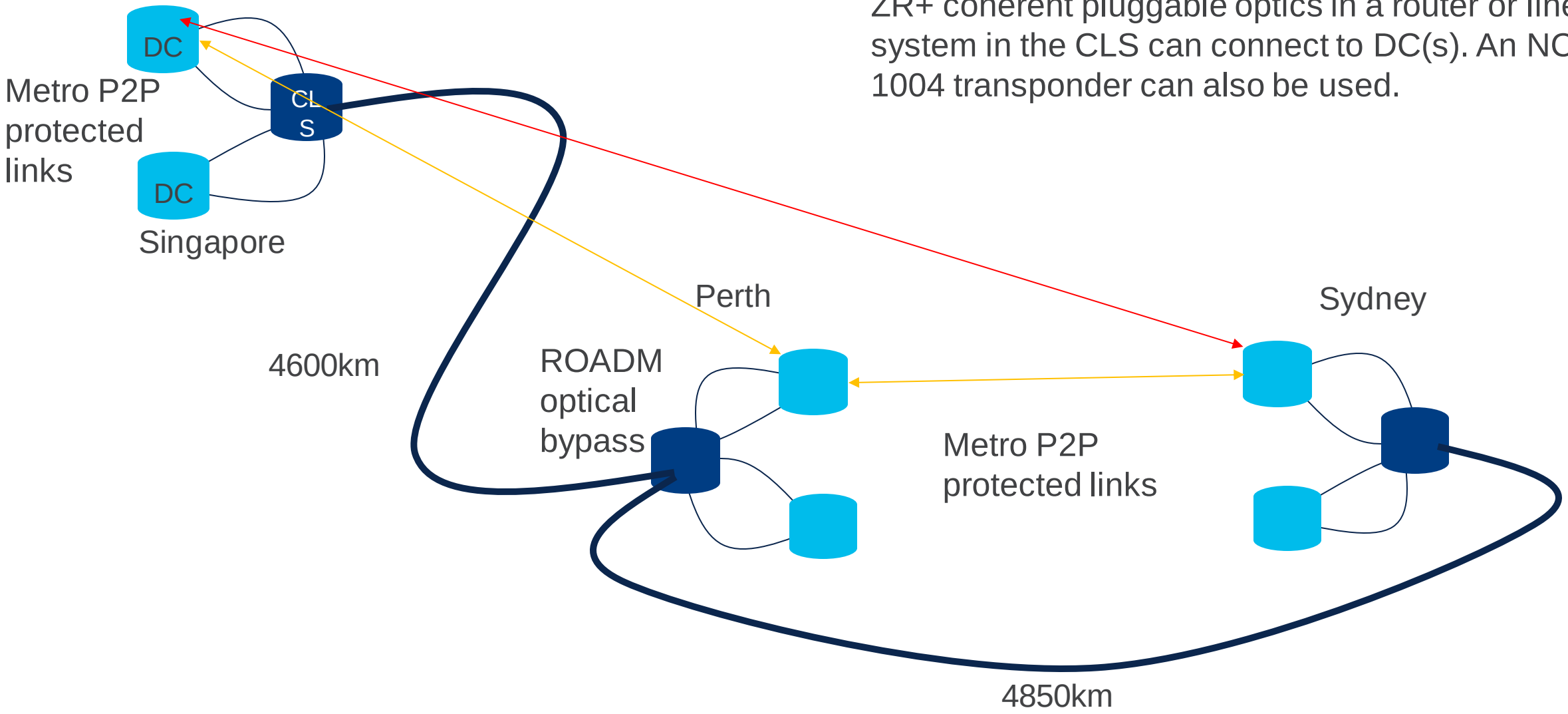
INDIGO-CENTRAL
Perth to Sydney
4850km

- NCS 1004 @ 400G over 4500km segments
- NCS 1004 @ 300G over 9400km Singapore to Sydney
- NCS 2000 line system connects into ASN Waveportal
- NCS 2000 for add-drop and channelized ASE
- Terrestrial back-haul to DCs.

https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=2008528

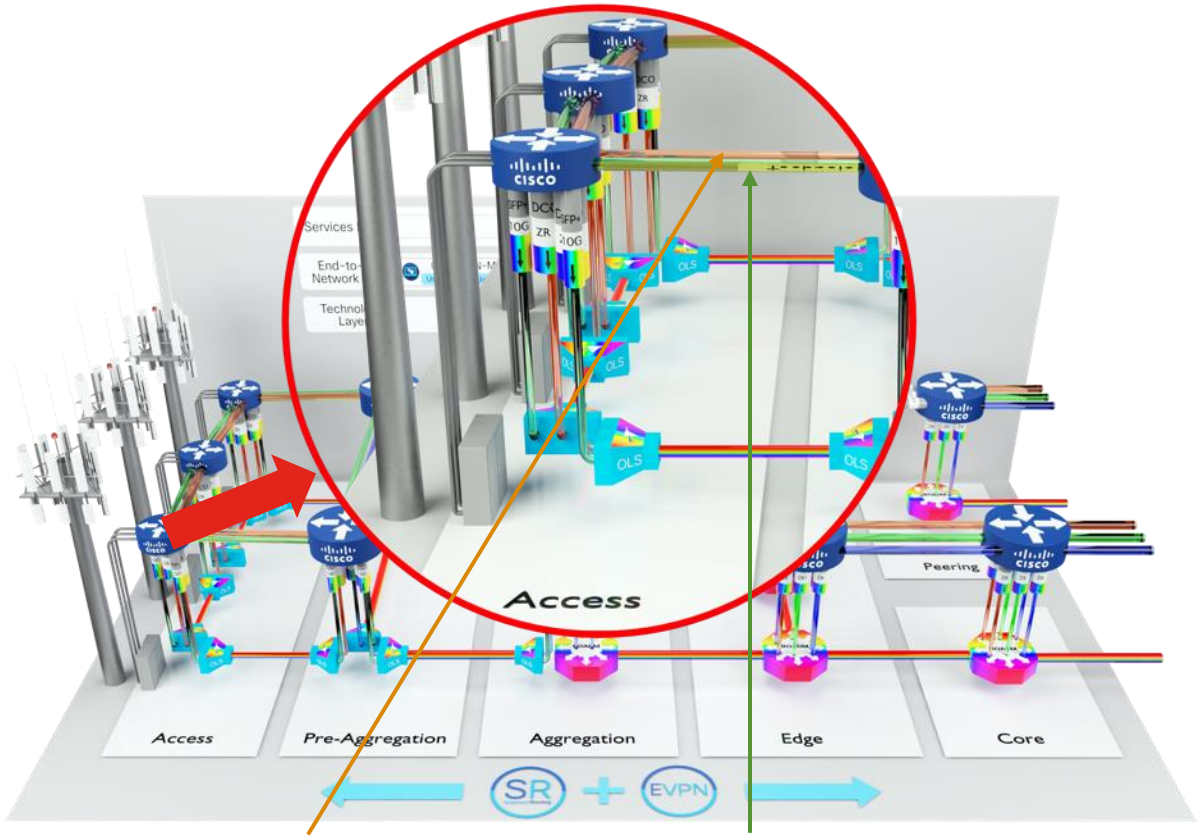
Subsea Use Case

ZR+ coherent pluggable optics in a router or line system in the CLS can connect to DC(s). An NCS 1004 transponder can also be used.



5G xHaul Use Case

Routed Optical Networking for Access and Aggregation



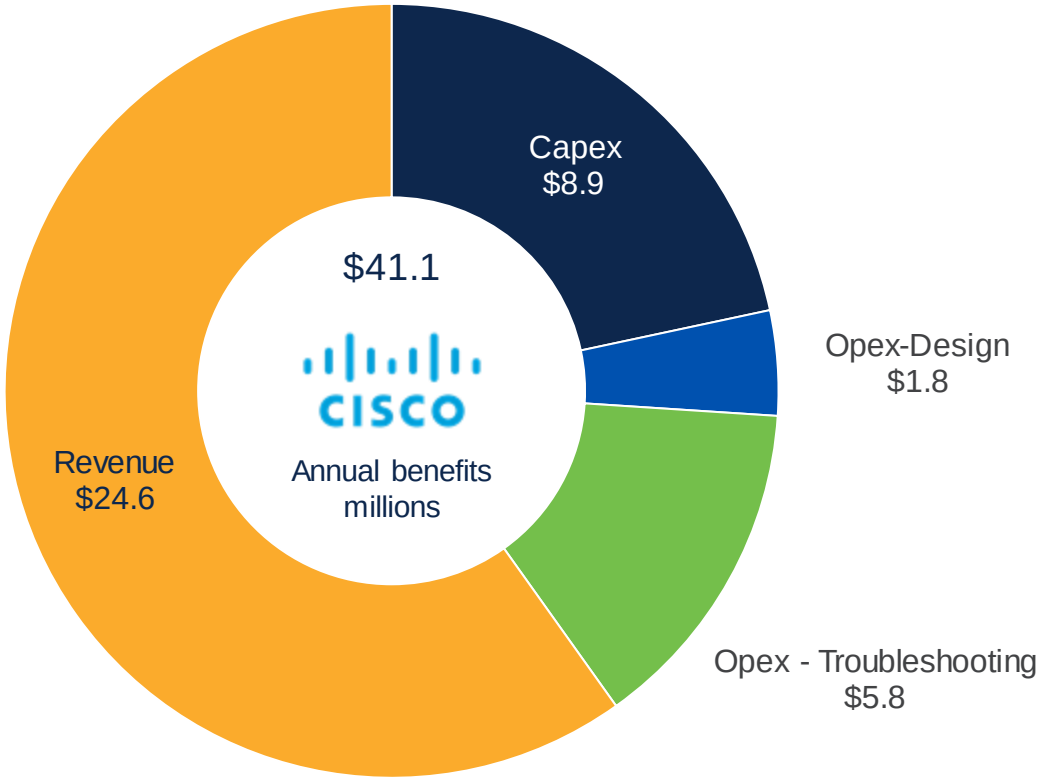
Orange Channel:
100G-400G
QSFP-DD DCO
Customer Traffic

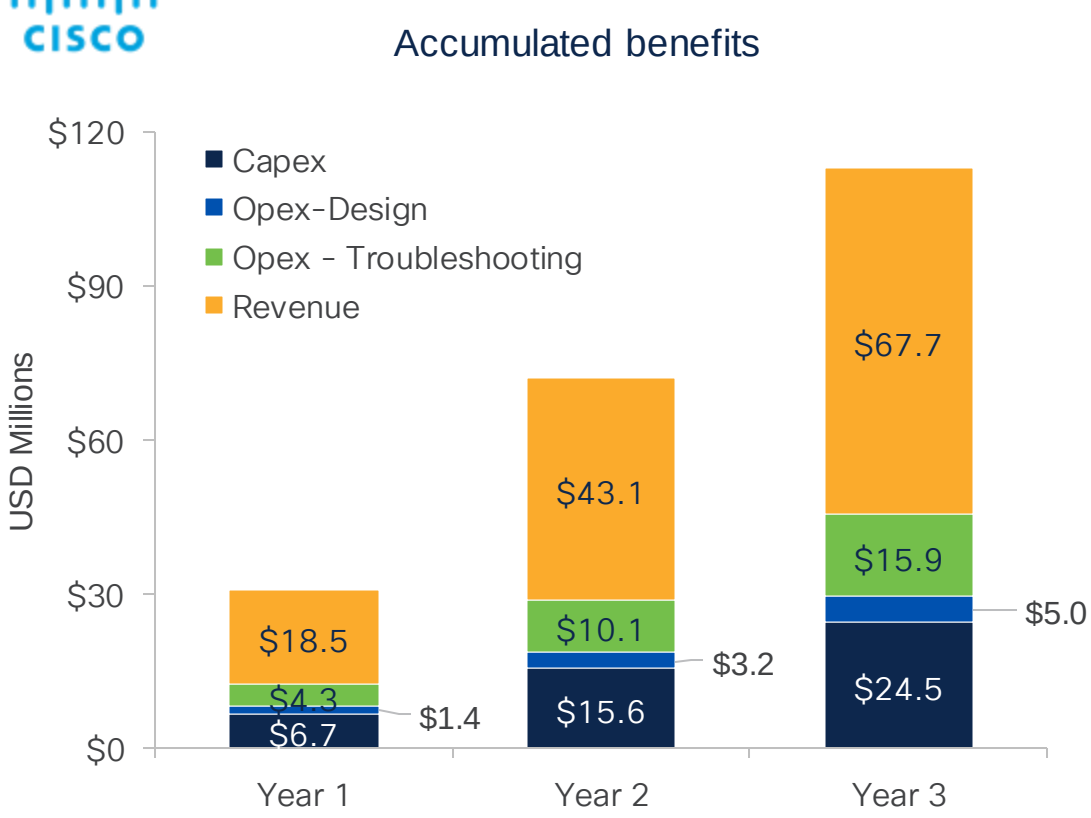
Green Channel:
10G
SFP+ Non-DCO
Timing, Management

- **Traffic Optimization with Segment Routing** with built-in sub-50ms protection
- **Incremental Revenue Services**
  - Security with Edge Protect
  - Physical Security
  - Video Surveillance
  - Residential & Business Services
- Class C Timing options
- **Network Slicing**
  - Segment Routing for soft (granular) slicing
  - Crosswork Network Controller for slice provisioning and management

Example Real-World Business Results

National operator with 17.5 million mobile subscribers, 900,000 fixed broadband subscribers, 4200 enterprise customers

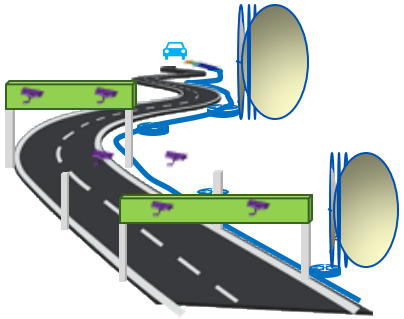




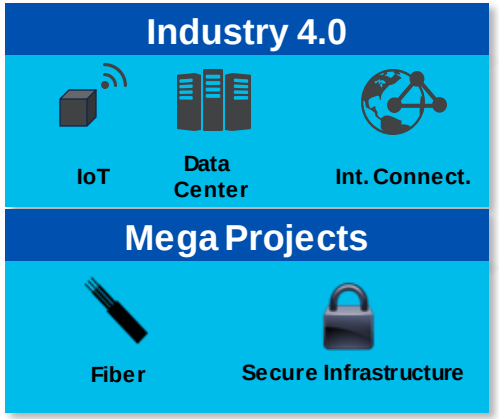
Source: Appledore Research report

Expand the Use Cases

Transportation

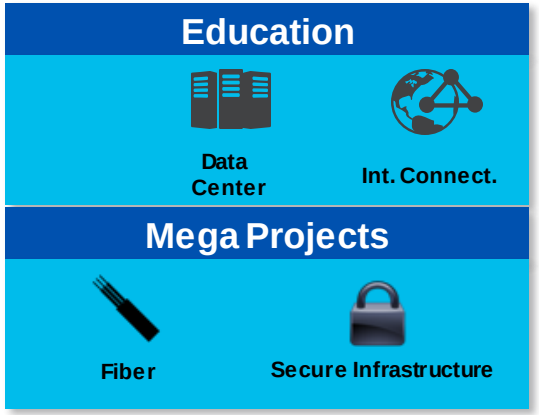


IP+Optical Network
Cisco E2E - 100G Ready
~200 nodes, 10G services

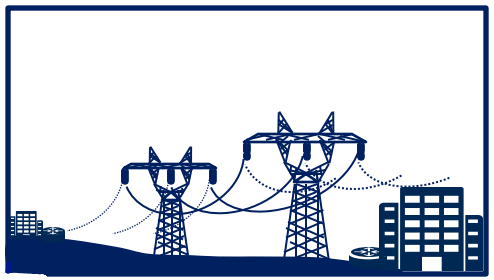


Education

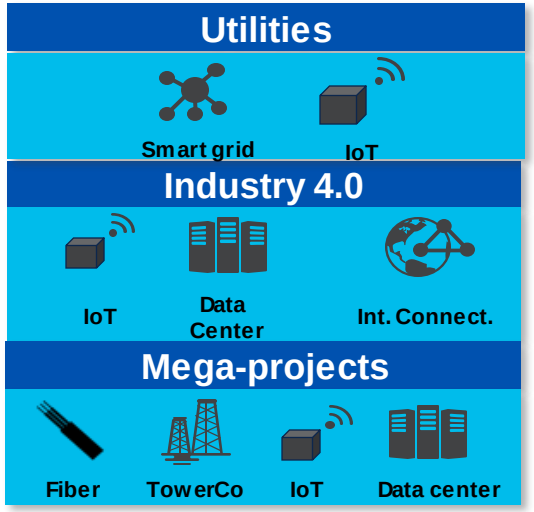
IP+Optical Network
Cisco E2E - 400G implemented
50 nodes, FlexGrid
RON Ready



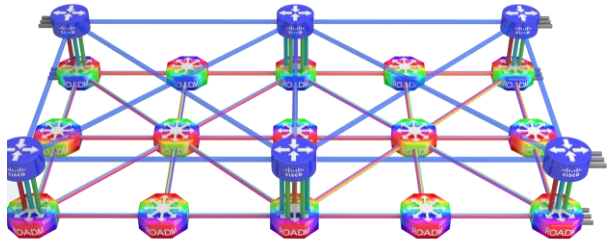
Utility



IP+Optical Network
Cisco E2E – 200G.
Deployment on going

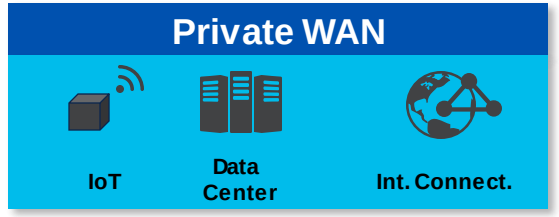


PS High Security



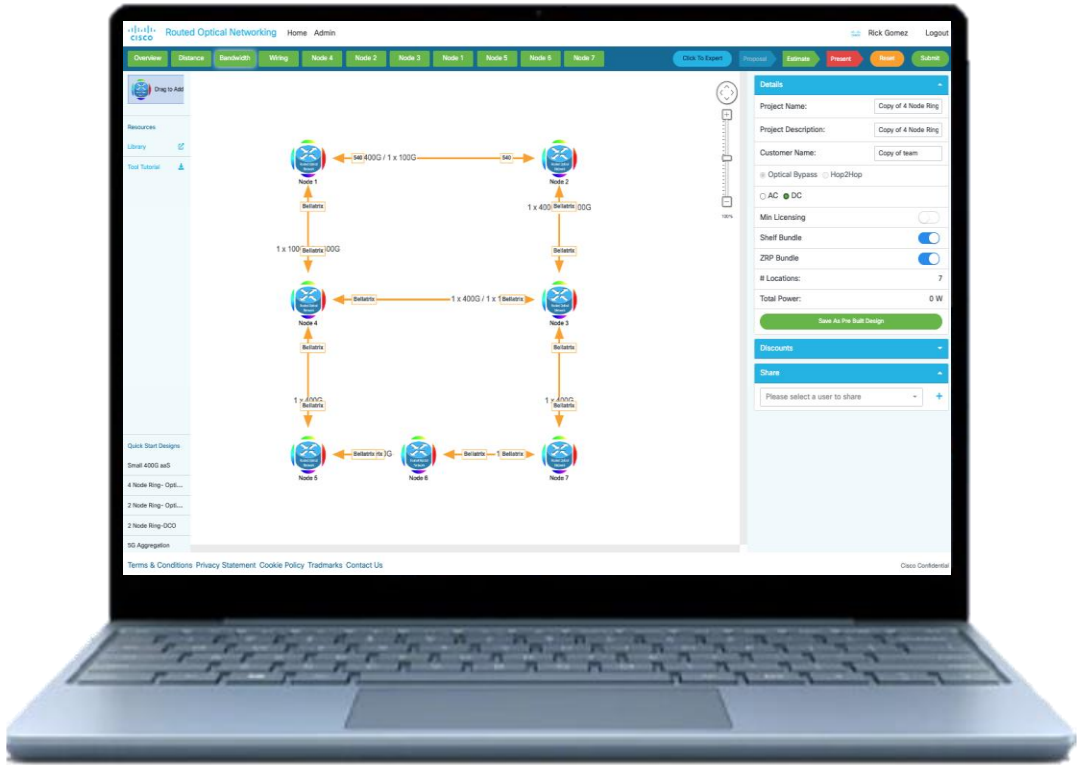
IP + Optical Network
Cisco E2E – 100G Ready

- 4500 km fibres
- 100 nodes
- 500 circuits



RON Tool demo

Routed Optical Networking Tool



- ✓ RON wizard Tool
- ✓ 60 minutes Whiteboard to 80% BOM
- ✓ Metro Networks (120km, no ILA)
  - Optical Bypass
  - Hop 2 Hop
- ✓ 8 nodes, 8 degrees/node
  - Bundles
  - FCM Licensing, RTU, Smartnet
  - Output: Excel, PPT
  - Contact ask-specialist@cisco.com

Question: What is your average # of nodes ? Ring or line topology

1. Identify Network Type: Optical Bypass vs Hop2Hop

ROADM Degrees

Colorless Add/Drop

MIG Router

Digital Coherent Optic – 400G

Optical Bypass uses ROADMS to allow for optical wavelength Pass-Thru capabilities.

It allows for dynamic colorless directional add/drop 6-48ch, optical channel spacing flexibility, and the ability to transport a mixture of wavelength types.

Optical Bypass Equipment:

- NCS2K Optical Transport System
- RON Licensed SMR20 ROADM, Add/Drop units
- Transponders NCS2K 400G-XP, NCS1K Bellatrix
- DCO: Cisco ZR+ Optics
- Routers

Hop2Hop is ROADM-less & Transponder-less OEO style architecture where Routers utilize DCO Optics, 64ch 75Ghz optical filters, amplifiers each Fiber Span.

This is a flat network architecture to simplify network deployment, operation and lower costs.

Hop2Hop Equipment:

- NCS1K AMP & Filter
- DCO: Cisco ZR+ Optics
- Routers

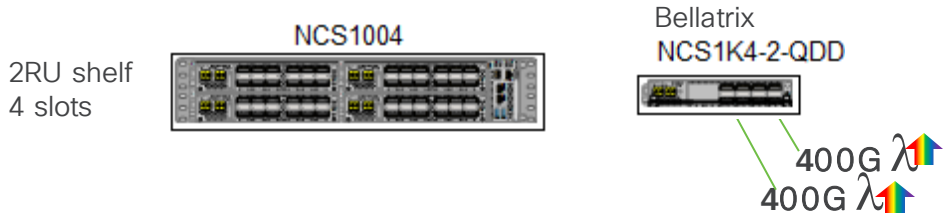
TIP: top sharepoint at: https://cisco.sharepoint.com/sites/optical-systems/SitePages/RON.aspx

2. Select Optical Transponders

400G TXP option

400G demands delivered by NCS1K: Bellatrix card

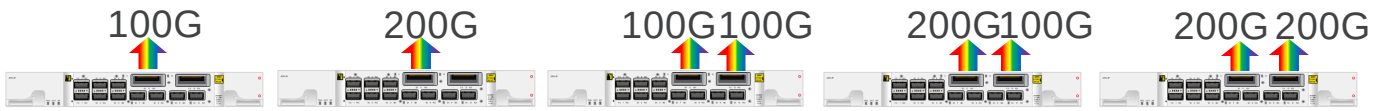
Bellatrix card: is capable of 2x 400G & is housed in a NCS1K



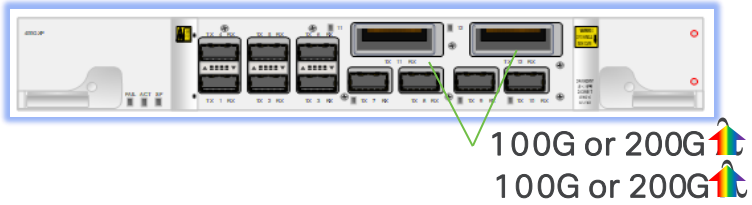
100G TXP/MXP option

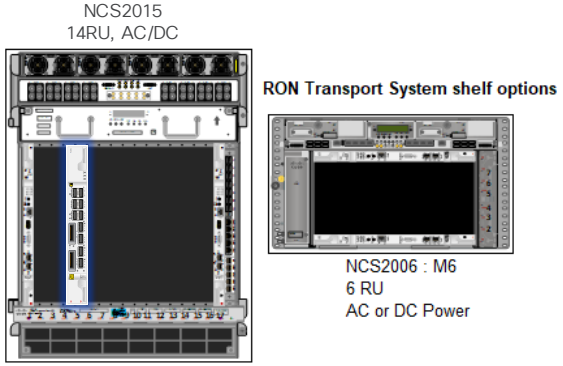
100G demands delivered by NCS2K: 400G-XP card

TXP BW	100G	200G	Split 200G	300G	400G
TRK Mode	1x 100G	1x 200G	2x 100G	1x 200G + 1x 100G	2x 200G
Modulation	QPSK	16QAM	QPSK	16QAM + QPSK	16QAM
Bundles 2023	NCS2K-400G-BUN2-SK	NCS2K-400G-BUN2-SK	NCS2K-400G-BUN2-SK	NCS2K-400G-BUN2-SK	NCS2K-400G-BUN2-SK
		E-NCS2K-100G-UPG2=	ONS-CFP2-BUN2-SK	E-NCS2K-100G-UPG2=	E-NCS2K-100G-UPG2=
				ONS-CFP2-BUN2-SK	ONS-CFP2-BUN2-SK
					E-NCS2K-100G-UPG2=



400G-XP card: is capable of 4x100G & is housed in a NCS2K





TIP: leverage NCS2K 400G transponder bundles

3. Select Routers

✓ includes
- ✓ FCM licensing
- ✓ Services

Fixed

8201-32FH

12.8Tb: 32x 400GE (16x ZR/ZRP)

8201

10.8Tb: 24x 400GE, 12x 100GE
12x 400G ZR/ZRP

NCS-57B1-6D24-SYS

4.8Tb: 6x 400GE, 24x 100GE
6x 400G ZR/ZRP

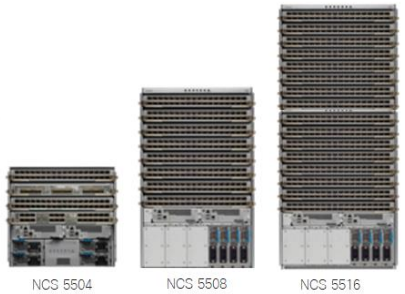
NCS-57C3-MOD-SYS

4Tb: 5x 400GE, 6x 200G, 8x 100GE
5x 400G ZR/ZRP, 3 MPA

N540-24Q8L2DD-

1Tb: 2x 400GE, 6x 200G, 8x 100GE
2x 400G ZR/ZRP, 3 MPA

Modular



NC-57-24DD
9.6Tb: 24x 400GE,
12x 400G ZR/ZRP

5504, 96 ports, 48 ZRP
5508: 192 ports, 96 ZRP
5516: 384 ports, 192 ZRP

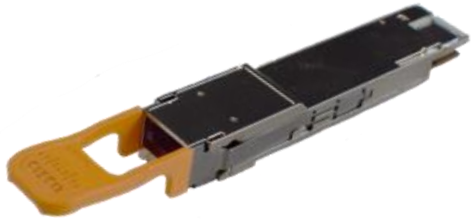
8800-LC-36FH
14.4Tb: 36x 400GE,
18x 400G ZR/ZRP

8808, 288 ports, 144 ZRP
8812: 432 ports, 216 ZRP
8818: 648 ports, 324 ZRP

TIP: Compare RON Bundles & no bundles when using 400G ZR optics bundles, the licensing makes a big difference.

4. Select Optics

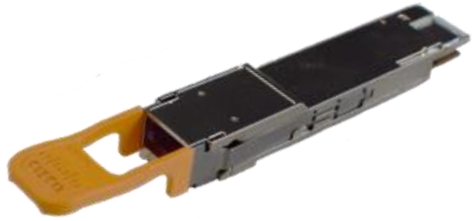
400G Digital Coherent Optics



QDD-400G-ZRP-S is optic replaces the Transponder

400G 1:1, =1
100G 4:1, =1/4

400G/100G Grey Optics



QDD-400G-**DR4** – 500m
QDD-400G-**FR4** – 2km
QDD-400G-**LR4** – 10km
QDD-4x100G-FR
QDD-4x100G-LR
QDD-400G-AOC

QSFP-100G-**DR** – 500m
QSFP-100G-**FR** – 2km
QSFP-100G-**LR** – 10km

TIP: Use ZR Friends & Family bundle for 15 ZR optics + the DCO RTUs! Big savings!

CKN Offer

Year End **400G Promotions**

- ✓ New Bright ZR optic
- ✓ Orderable

Friends & Family Bright ZR+ bundle

60x

15x

Contact your Cisco Partner, ask about

Order PID: **QDD400GZRH-15-BUN**

15x Bright ZR+, PID: DP04QSDD-HE0=

60x DCO-RTU

34% LIST Bundle savings

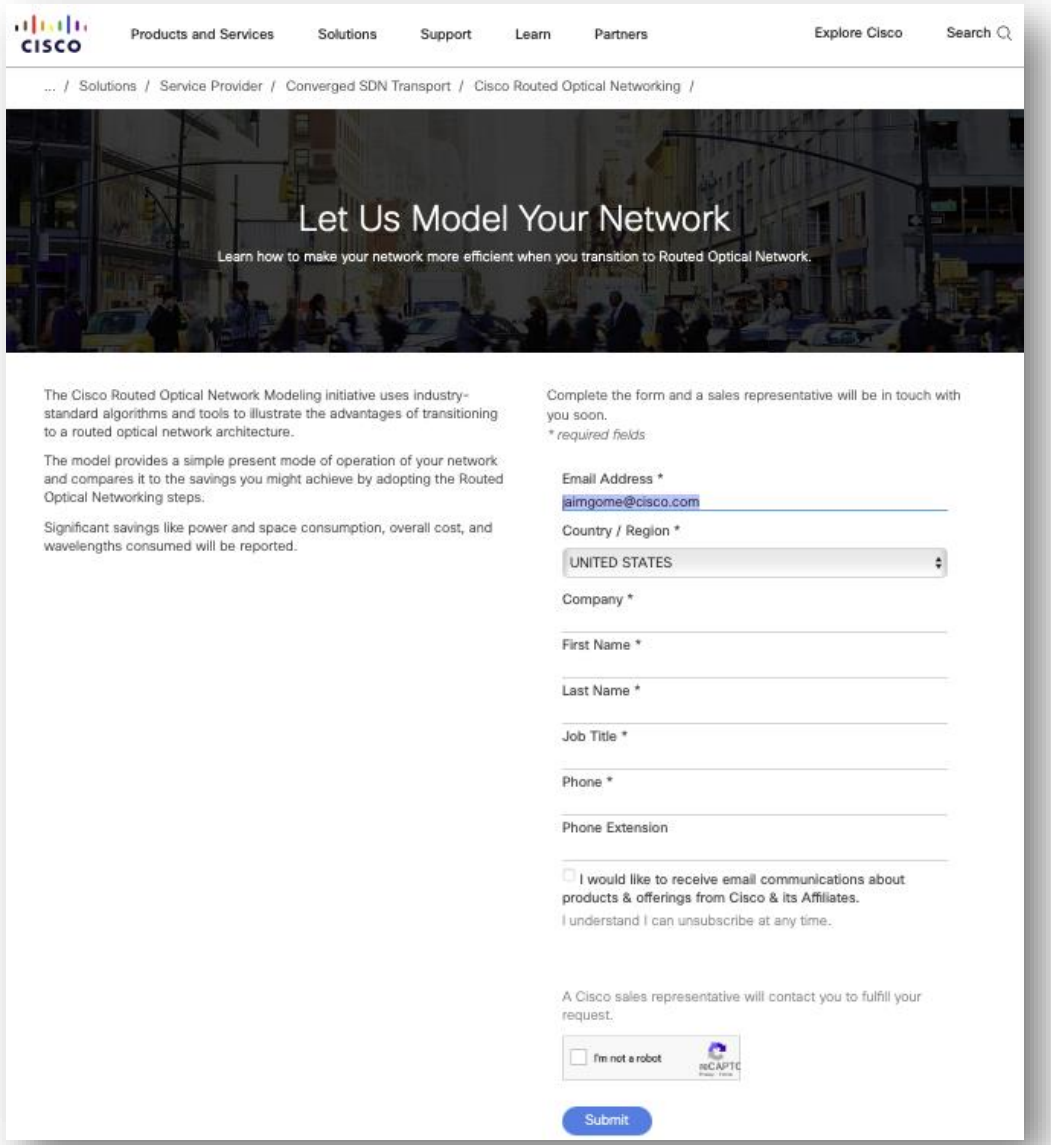
BONUS: DCO RTUs are included, BIG SAVINGS!

ASK: *Let us Model your Network*

- Cisco & Partner Experts available to Assist
- **Start: Virtual** Network review, Q&A Assessment, Recommendations
- **Medium: On-site** Optical, Routing, Optics discovery. Power & Space Recommendations
- **Advanced: Large** Network Review, Comprehensive report using UPT & On-site Partners

Significant savings like power and space consumption, overall cost, and wavelengths consumed will be reported. Transponder Harvesting recommendations

Fill out the form to sign up for a request.



Thank You!

Advantages

Fewer devices

Efficient network utilization

Traffic protection at single layer

Removes network complexity

Reduced TCO

CISCO

The bridge to possible

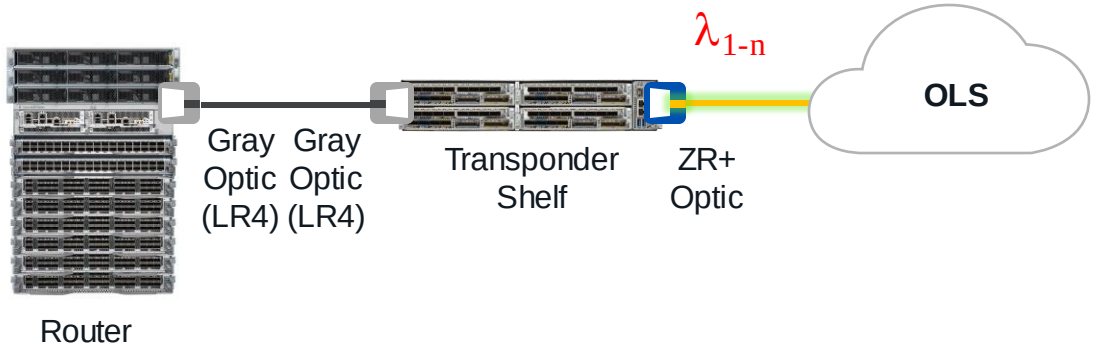
Cisco Routed Optical Networking

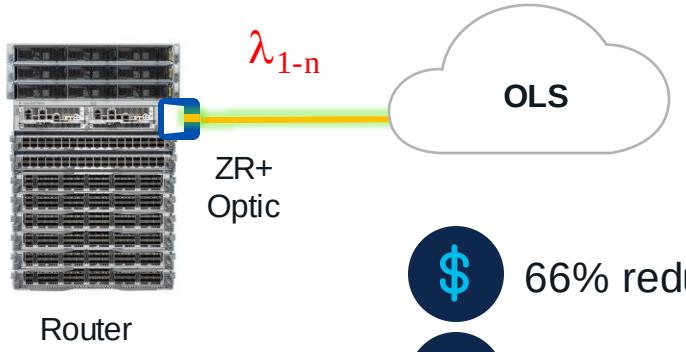
named

Most Innovative Routing and Switching Solution

Recent RFP Response - North American Provider

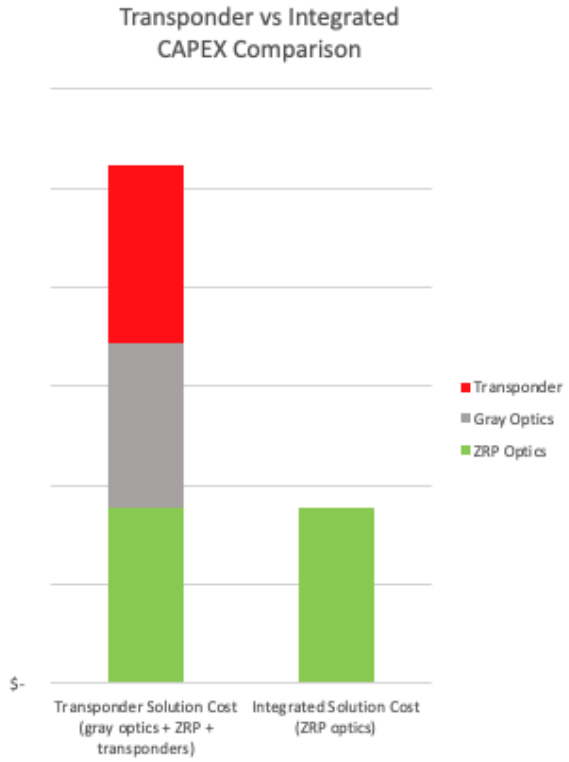
Transponder vs Pluggable 400G ZR+ Cost Comparisons



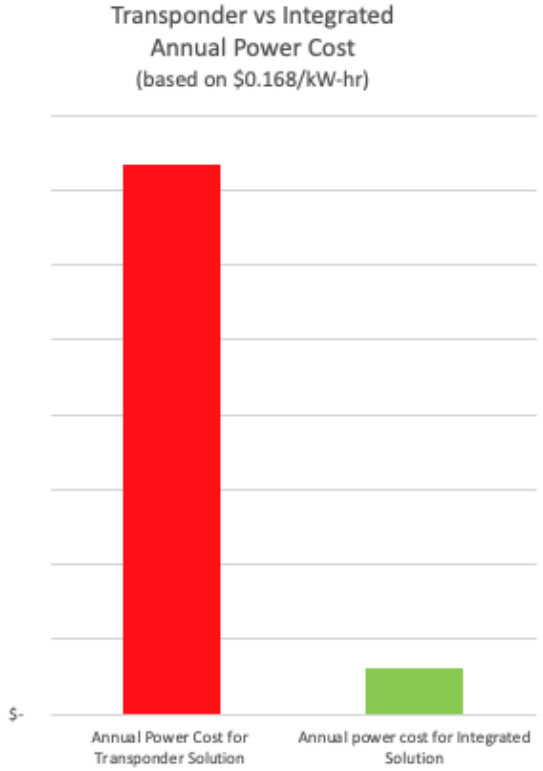


66% reduction in CAPEX

92% reduction on power



* Transponder costs based on Cisco RFP pricing



* Compares power consumption of pluggables & transponder (router power not included)