

Advancements and Applications of Coherent Pluggable Technology in High Bandwidth Transport Networks

CISCO Live !

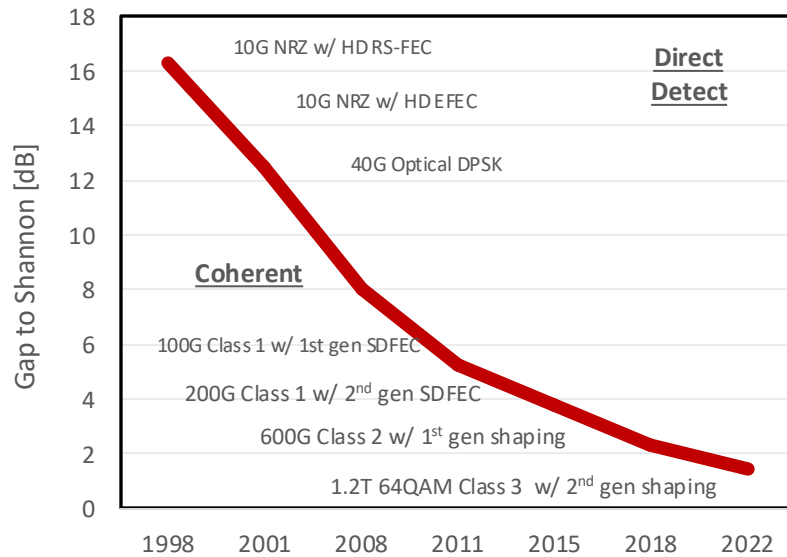
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Agenda

- 01 Technology & Market trends
- 02 Cisco Innovations & Product Portfolio
- 03 Benefits of Coherent Plugs
- 04 Product Offerings
- 05 Customer Use Cases & Applications

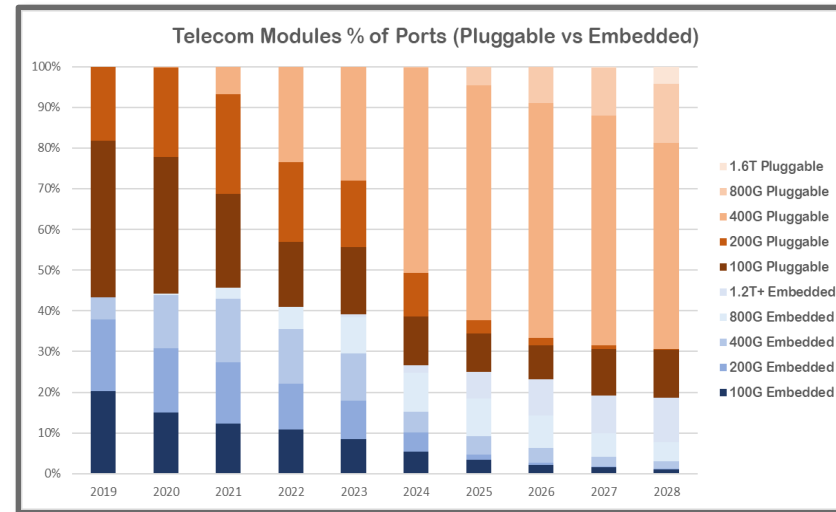
Technology Trends

Trends in Optical Networking



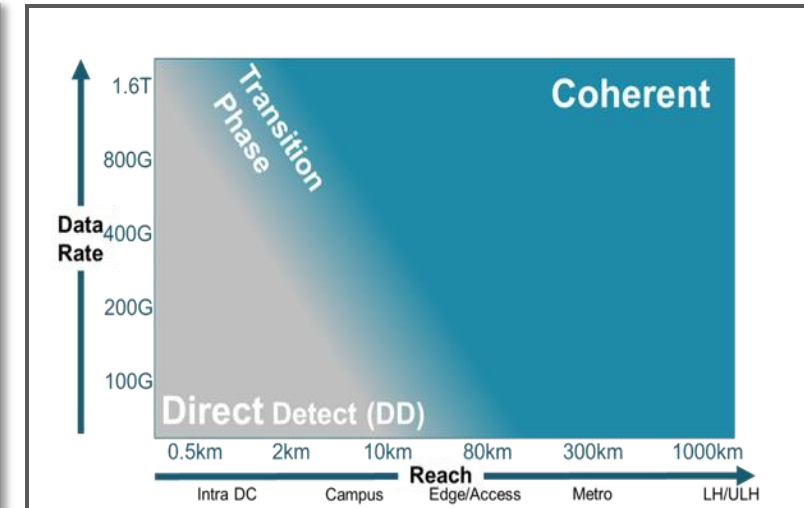
Approaching Shannon Limit

- Incremental improvements in spectral efficiency
- Ongoing investment driven by cost, power, footprint reduction



Shifting trend towards coherent pluggables*

- 400ZRx: fastest coherent product ramp ever
- Gaining share in DCI/Metro



Coherent moving to shorter reach applications

- Higher volume
- Interoperable
- Pluggable

High-volume standardized applications will drive next-generation industry investment

Open Networks

OPEN LINE SYSTEMS

Any vendor-coherent transponder or spectrum connects into line system



ALL Cisco line systems are OPEN

OPEN COHERENT INTERFACES

Interoperable standards-based coherent DWDM interfaces supported in MSA standard form factor



Cisco committed to driving OPEN standards

OPEN MANAGEMENT

Vendor-neutral device management; multi-layer, multi-domain, multi-vendor management

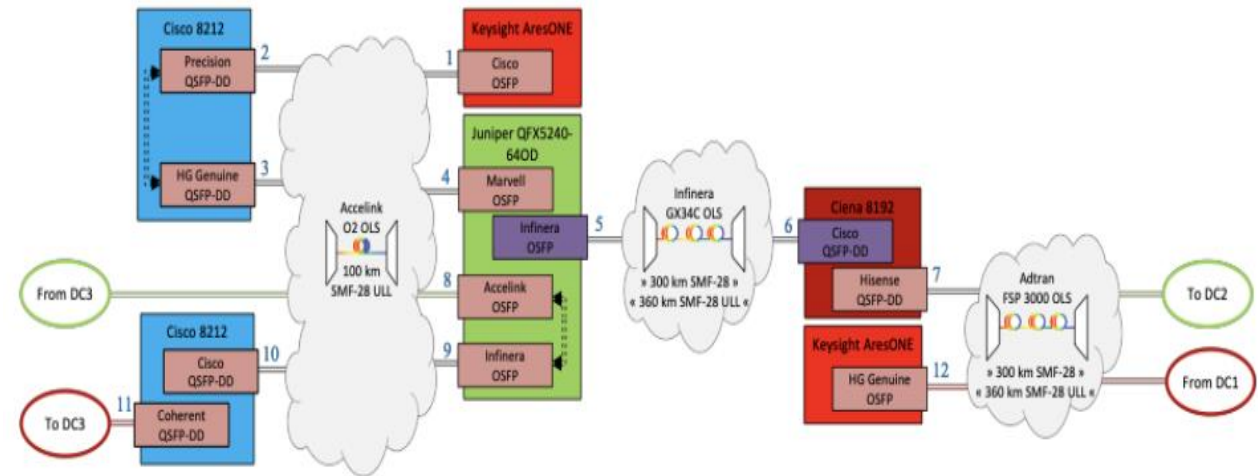


Cisco participates in key forums and developing MGMT support

Standardization and Multi-Vendor Interoperability Ecosystem

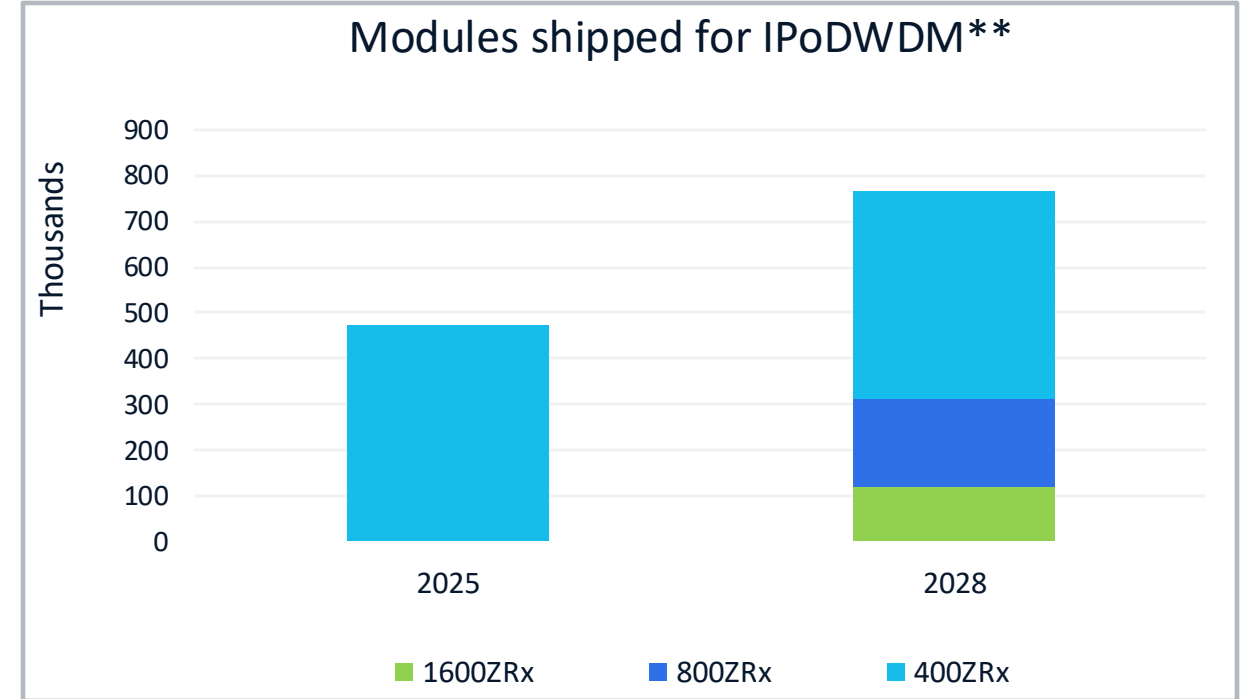
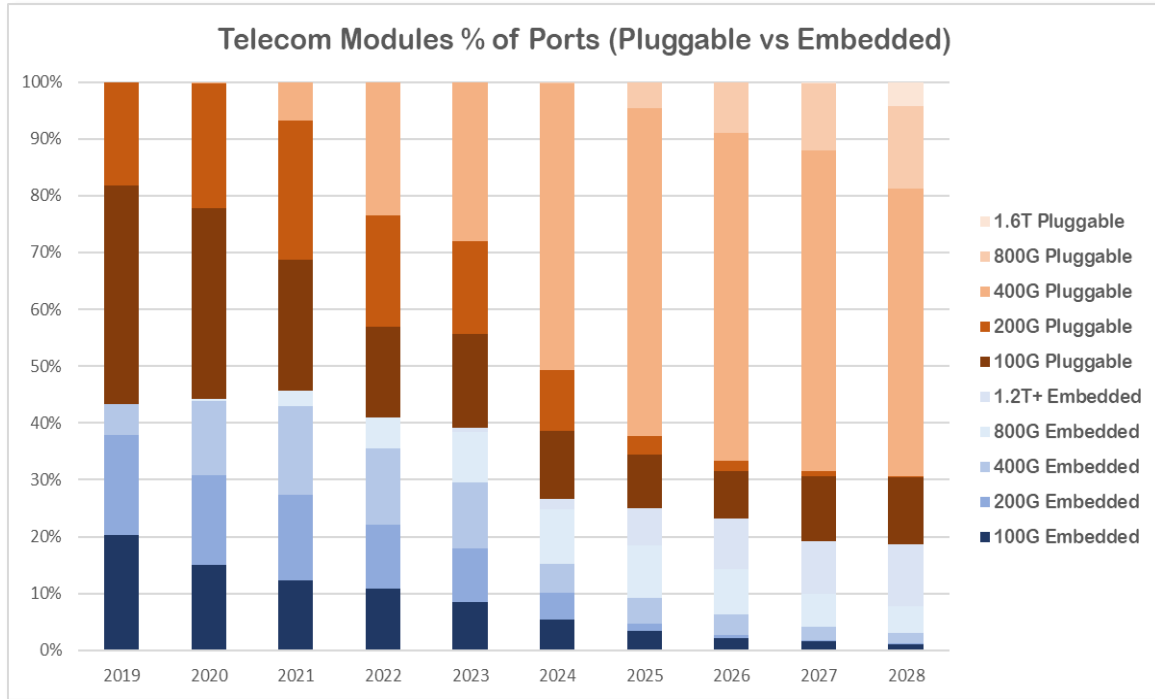
- Industry efforts to drive rapid multivendor time-to-market and economies of scale
- Cisco drove multiple industry standardization
 - Co-authored OIF 400ZR project start; editor
 - Actively drove 800ZR and 800G ZR+
 - Co-authored OIF 1600ZR project start
 - OpenZR+ MSA founding member & Co-Chair
- Contributed oFEC to support higher performance coherent interfaces

OFC 2025 800G Multi-Vendor Interop Demo



Market Trends

Big Opportunity and rise of “Coherent Pluggables”



Today >70% of the coherent ports are pluggable coherent optics*

Cisco/Acacia is pioneer and market leader for coherent pluggables

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

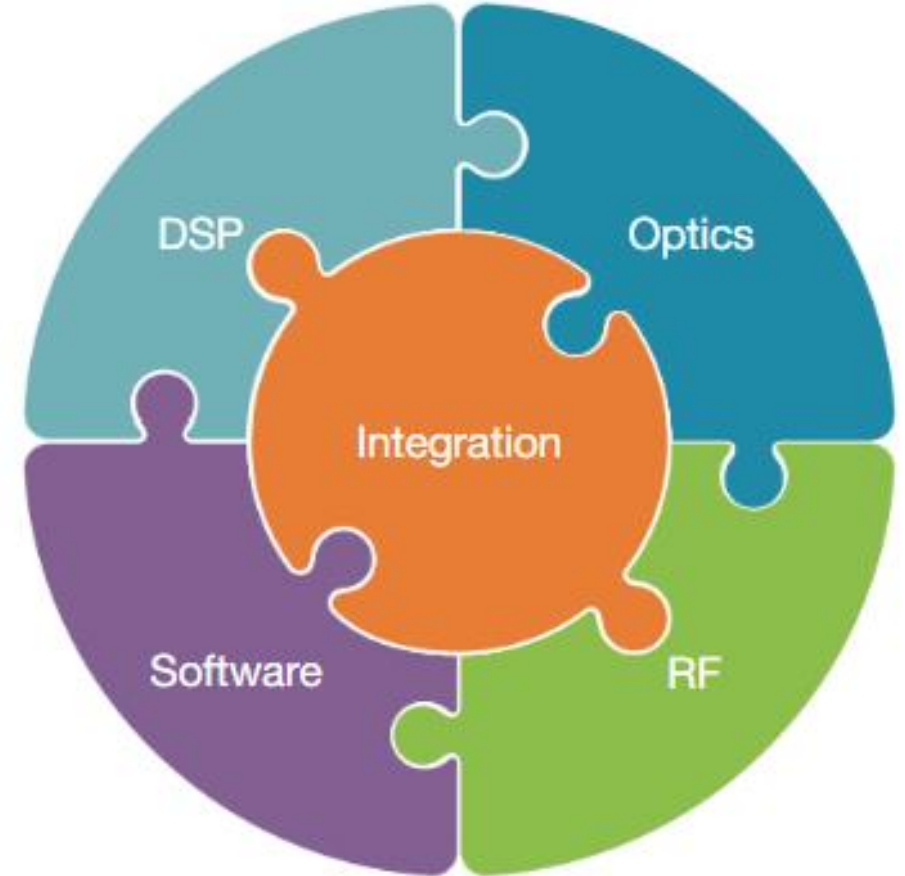
Cisco/Acacia Innovations

Acacia Coherent Technology Innovation



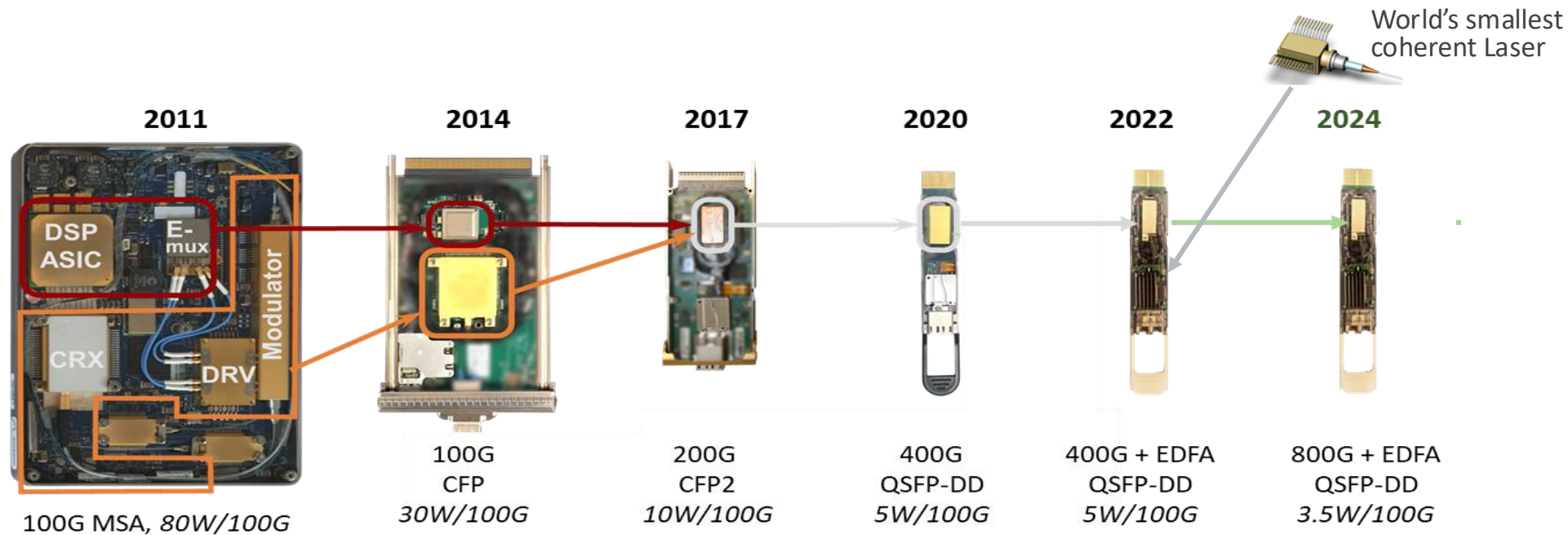
Acacia is part of Cisco

- Leader in Coherent Optical Technology
 - >25% coherent port market share worldwide
- Diverse markets served
 - DCI, Metro, Long-Haul, LEO, Submarine, Access, Campus
- 100% Vertically Integrated
 - In-house key components: DSP/ASIC, Optics, RF
 - Advance 3D packaging



¹Signal AI as of 2Q24

Vertical Integration is Key to Lowest Cost and Best Performance



In-House:	DSP	+ SiPh Optics	+ OE-MCM	+ ASIC	+ Laser	100% Vertical
QAM:	QPSK	QPSK	16QAM	16QAM	PCS	
CMOS:	40nm	28nm	16nm	7nm	4/3nm	
Optics:	Discrete, InP, LiNbO3	SiPh	SiPh	SiPh	SiPh	

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

Cisco Coherent Optics Value Proposition

Pioneer in Coherent Pluggables

- 4th generation DSP for MSA coherent pluggables
- Market leader in 400G pluggable ports

Industry leading performance

- Low power consumption
- Designed for C/CD/CDC ROADM architectures

Best in class Quality

- Very high MTBF
- 100M+ service hours without failure for Bright ZR+

100% Vertically Integrated

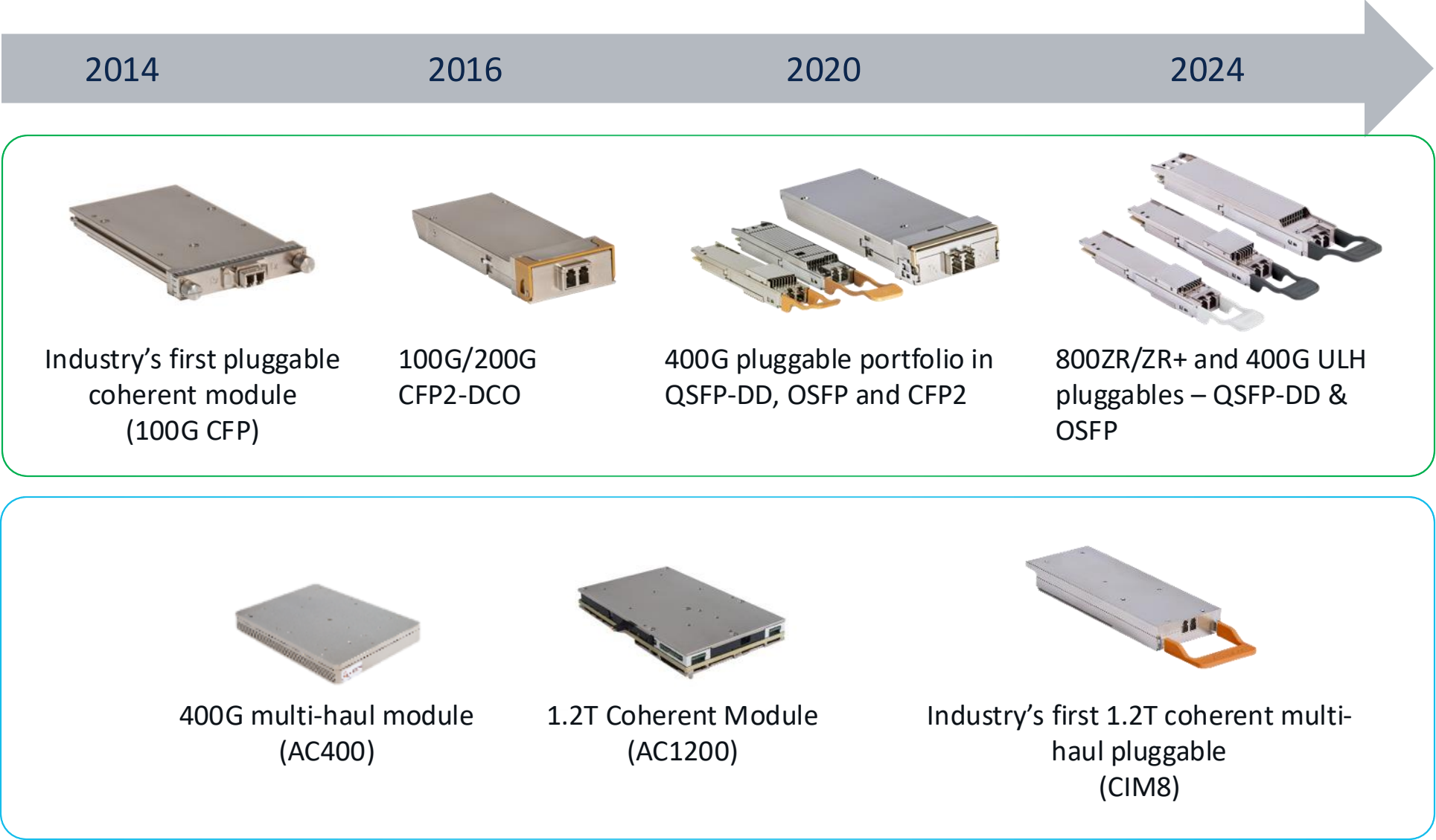
- In-house DSP, PIC, Laser, RF components

Scalable and Reliable Global Supply Chain

- Fabless manufacturing
- Scalable module build/test capacity to meet demand

Product Offerings

Approaches of Coherent Implementation

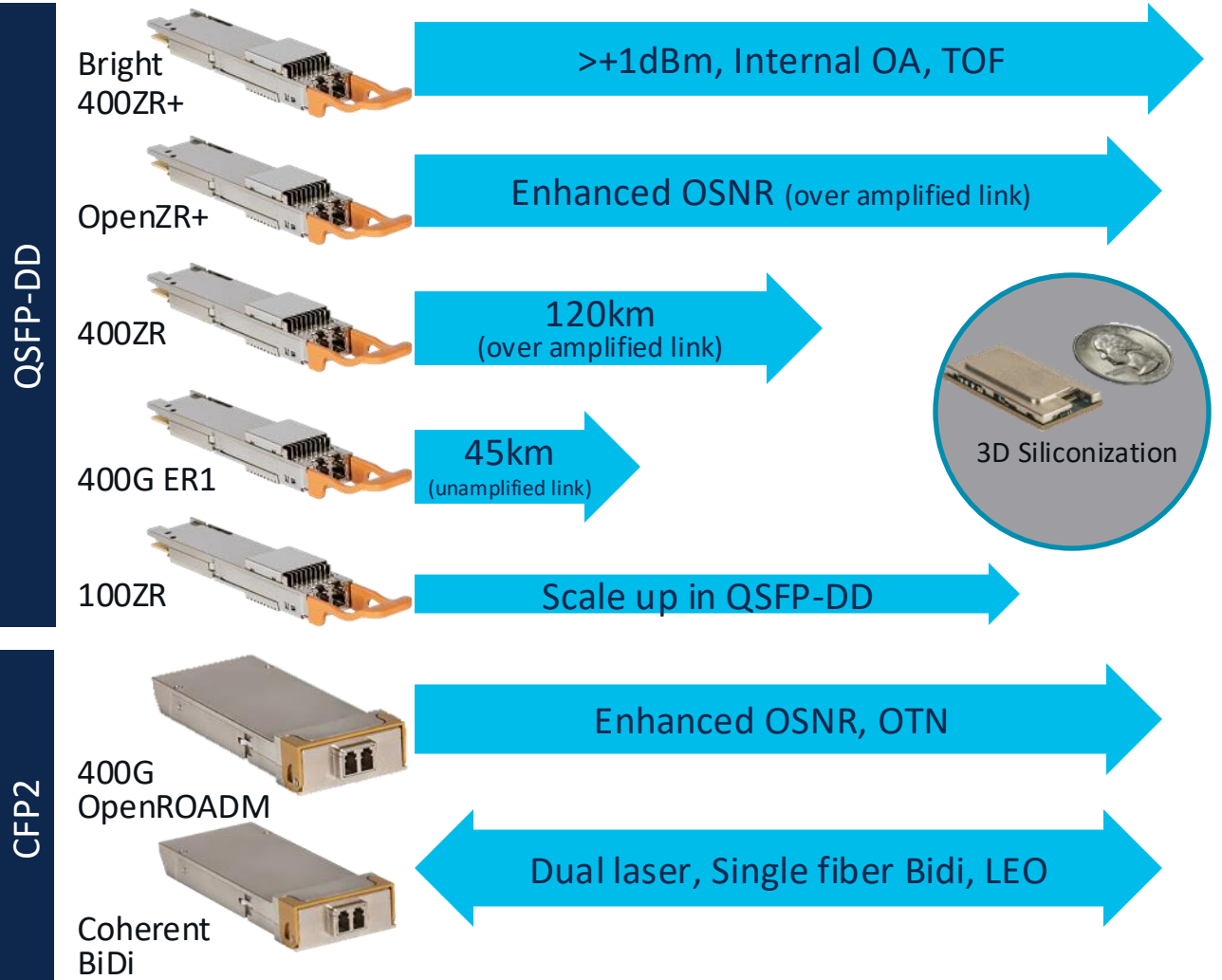


Comprehensive 400G MSA Pluggables Portfolio

Industry leading 400G
pluggable deployments - 500K+*

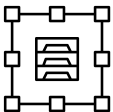
Best in class quality

Standards compliant



400G QSFP-DD Digital Coherent Optics Portfolio

ER1



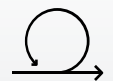
Point to Point

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



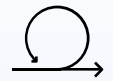
Point to Point

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



Low Cost

Lowest cost 400G DCO option for very simple designs



Short Reach

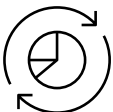
Up to 120KM for P2P amplified links

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

Next-Generation Coherent MSA Pluggables

Powered by Delphi DSP



Welcome to the Next-Gen Coherent Pluggables!

- Latest 4nm CMOS process
- Up to 131 Gbaud Optics
- 1st to support interop PCS 800G ZR+ (OpenROADM) and OIF 800ZR modes
- Supports CMIS 5.3
- C & L Band

800ZR

800G ZR+ (Interop PCS, +1dBm)

400G Ultra Long Haul

Delphi
DSP
800G

3D
Siliconization

Silicon Based

OIF

OpenZR+
MULTI-SOURCE AGREEMENT

OpenROADM

400G ULH QSFP-DD Field Trials

Enables Ultra Long-Haul Routes

Arelion: 2,253km Link

- Denver-Chicago, w/ margin
- 112.5 gigahertz spectrum
- 400G ULH pluggables
- Cisco 8000 series routers

*Arelion



Reduces
Costs

35%
CAPEX

84%
OPEX

Internet2: 3,000km Link

- Albany-Indianapolis
- 400G ULH pluggables
- Cisco 8000 series routers
- Third-party OLS



Reduces
Power

68%*

* Enabled by optical and routing advancements

800G ZR+ Successful Service Provider 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



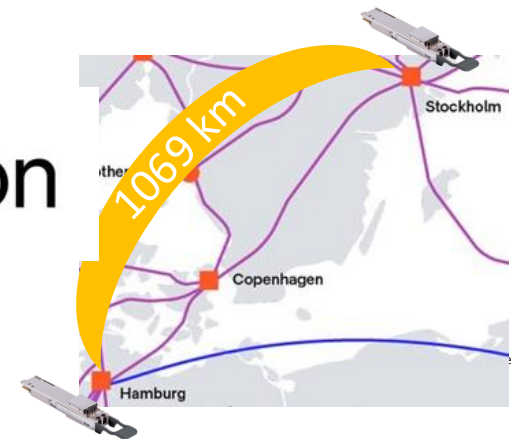
Reduces
Power

33%
compared to 400ZR+

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

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

*Arelion



Reduces
Costs

66%
CAPEX

95%
OPEX

400G Pluggables Specs Comparison: Today & Future

		400ULH	Bright ZR+
Data rate	Baudrate/Format	Modes	Modes
400G	PCS Modes	✓	
	66Gbd – 118Gbd	✓	
	60Gbd 16QAM	✓	✓
200G	60Gbd QPSK	✓	✓
100G	30Gbd QPSK	✓	✓

→ 400G ULH with PCS provide multiple line side modes for different reach/capacity requirements

400G ULH provides 1.5x performance wrt Bright ZR+ in same channel plan (76 GHz)

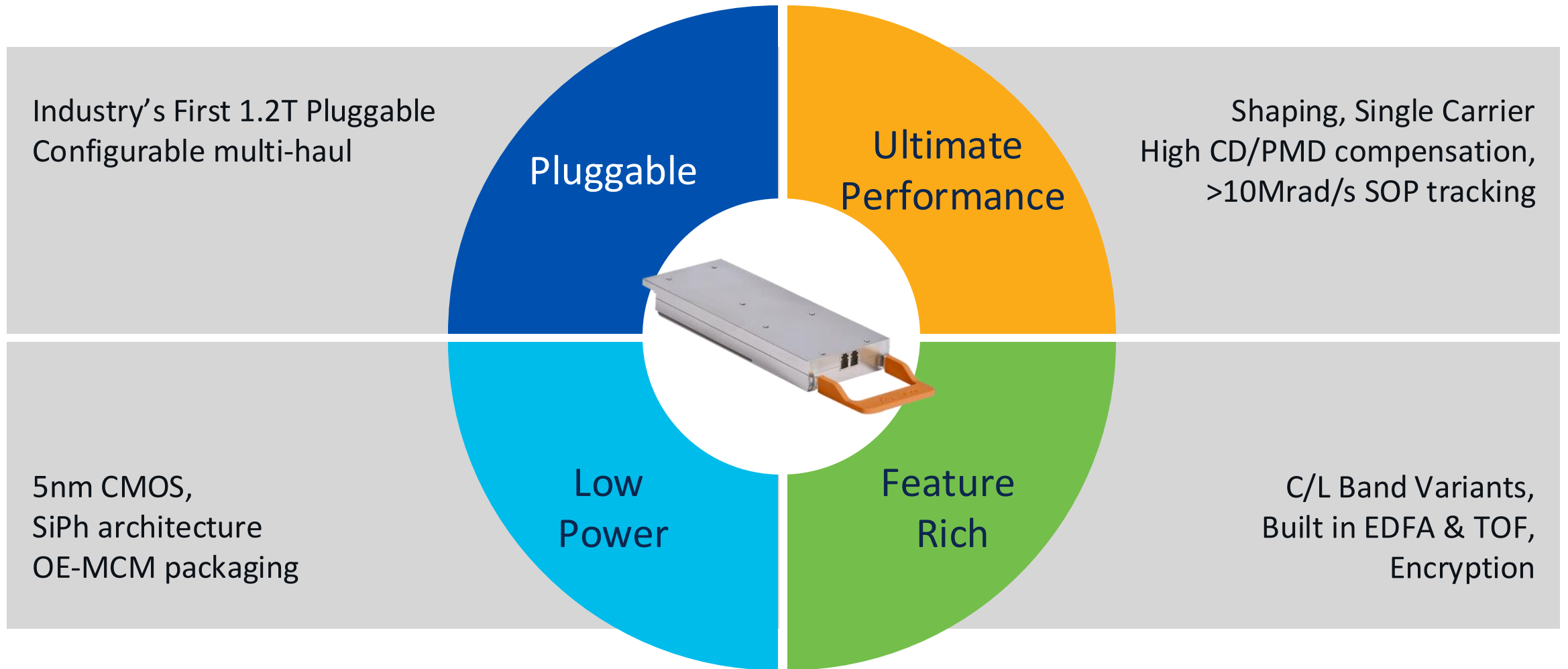
→ Backward compatible with Bright ZR+ in OpenZR+ 2.0 modes

400G ULH modes with Delphi

OpenZR+ 2.0 MSA modes

Performance Optimized Coherent: CIM 8

Coherent Interconnect Module 8 (CIM 8)



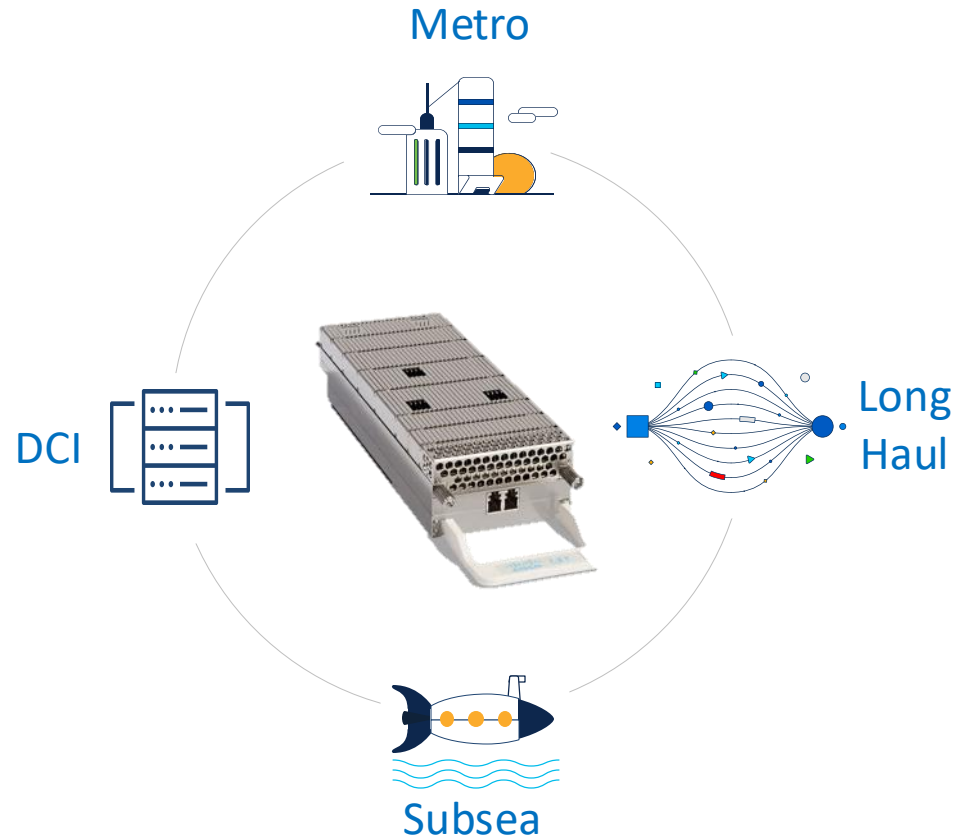
First Pluggable to Break into the Terabit Era

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



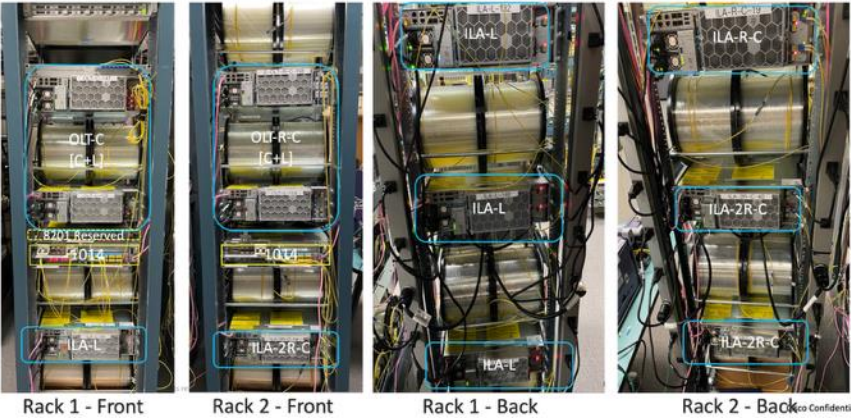
Longest distance 400 Gbps transmission trial on the Indigo subsea cable system; 18,400 km from Sydney to Singapore

NCS 1014 CIM8 Delivers 64T for C+L Long Haul

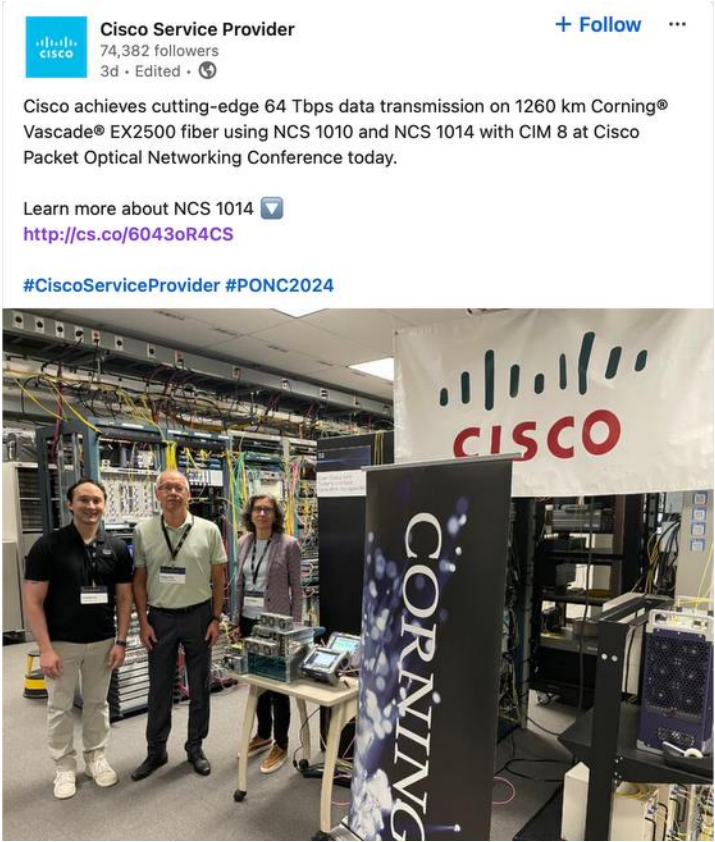
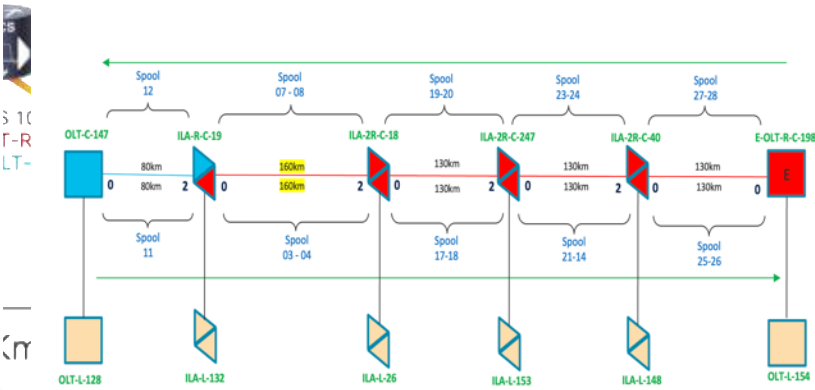


64T (32T in C-Band and 32T in L-Band) with NCS 1014 and CIM8 over NCS 1010 C+L Open Line Systems and *Corning Vascade EX2500* fiber

Demo 3: NCS 1010 LH



Demo 3: Fiber Spool per Span + Direction



Applications and Customer Use Cases

Routed Optical Networking Deployments

350+

Customers
Engaged

300+

Customer deployments

4x

Growth in
deployments

Majority of the RON deployments are over 3rd party line system (Ciena, Nokia, Infinera etc.)

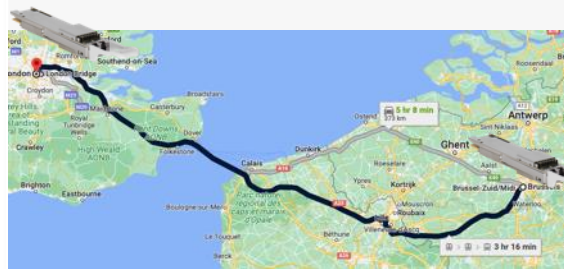
40G DCO Can Go the Distance

SP in EMEA



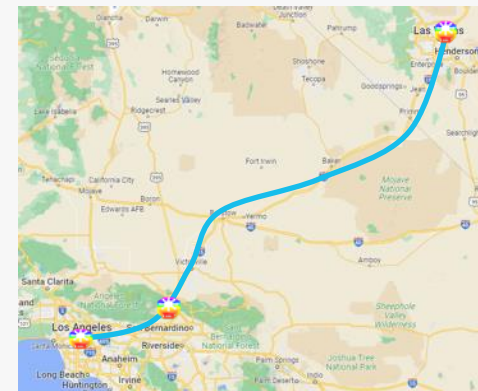
- Bright 400ZR+ QSFP-DD
- Alien λ over 3rd party line system
 - CDC ROADM, EDFA only
- Good deployable margin
- Plug and play!

colt



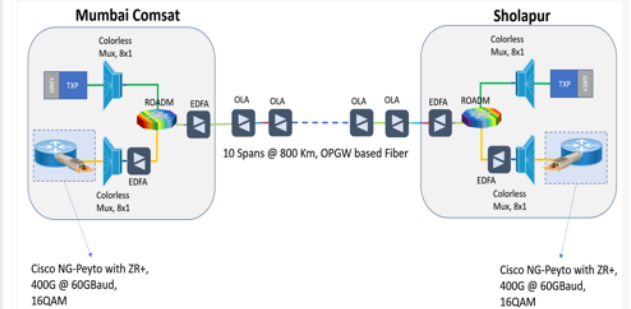
- Bright 400ZR+
- Across the English Channel with challenging high loss span
- Trial 1 at 430km; Trial 2 at 640km
- **Good deployable margin**

MSO in NA



- Bright 400ZR+ with 8201
- 520km high loss E-LEAF fiber, span > 26.5dB
- Two different OLS vendors
- Error free with margin

Tier 1 SP in India



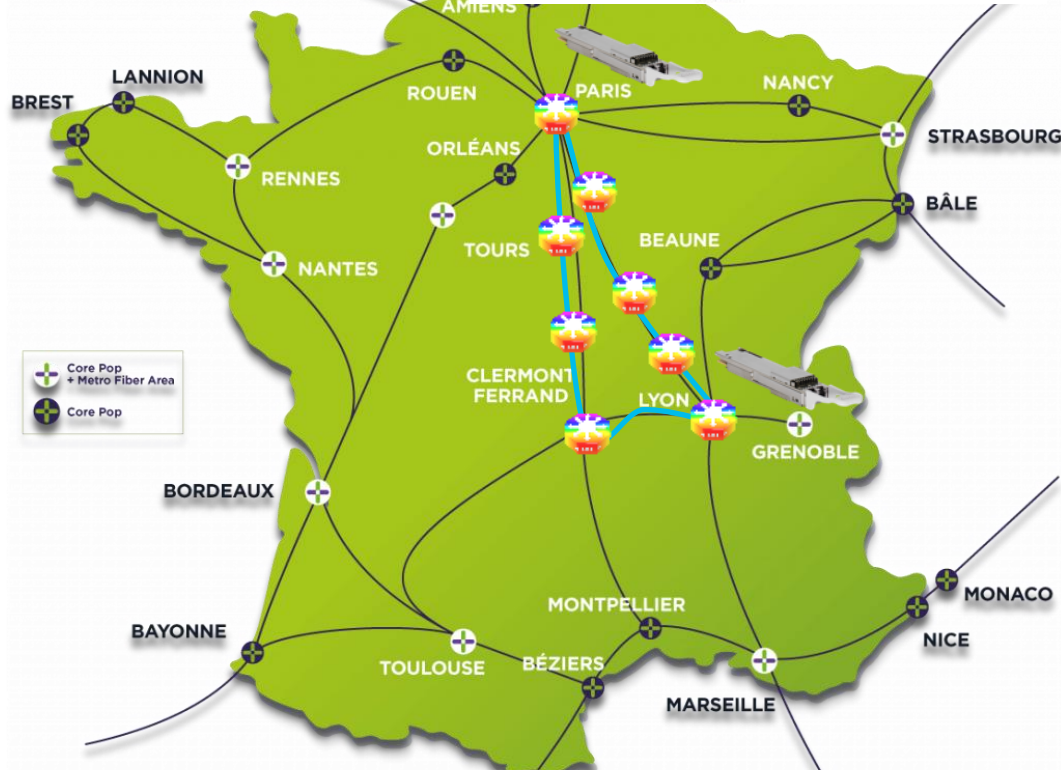
- 400ZR+ with Cisco routers
- >800km longest route
- Core network over 3rd party ROADM OLS

Bright ZR+ has reach 600-800KM with good deployable margin over ROADM based OLS

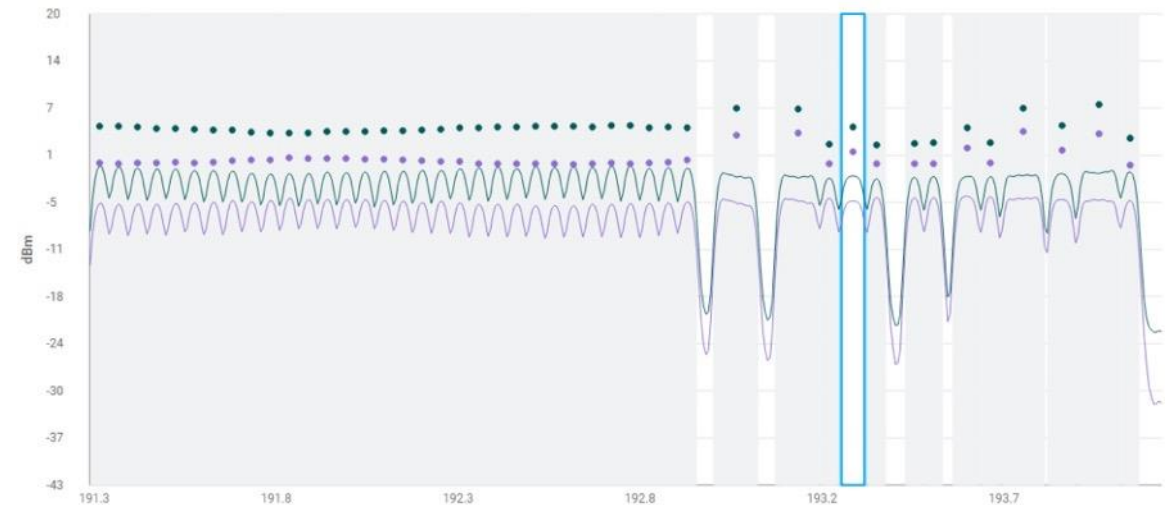
Sipartech – 400GbE over 1337km with Bright ZR+



SP360: Service Provider
Cisco at OFC 2023: Announcing Successful
Test with Sipartech to Deliver 400G Over
1,337 km
Bill Gartner



- Mixed SMF28 and E-LEAF fiber with 8 ROADM sites
- Alien λ over 3rd party CDC ROADM line system, plug and play!



“With the interoperability of Cisco’s equipment, we can deploy our next generation 400G+ services with speed, simplicity, and flexibility to meet our customers’ needs, while optimizing energy expenditure and our carbon footprint as part of our global strategy.” - Julien Santina, Sipartech CEO

Reshaping network architecture for AI connectivity

Challenge

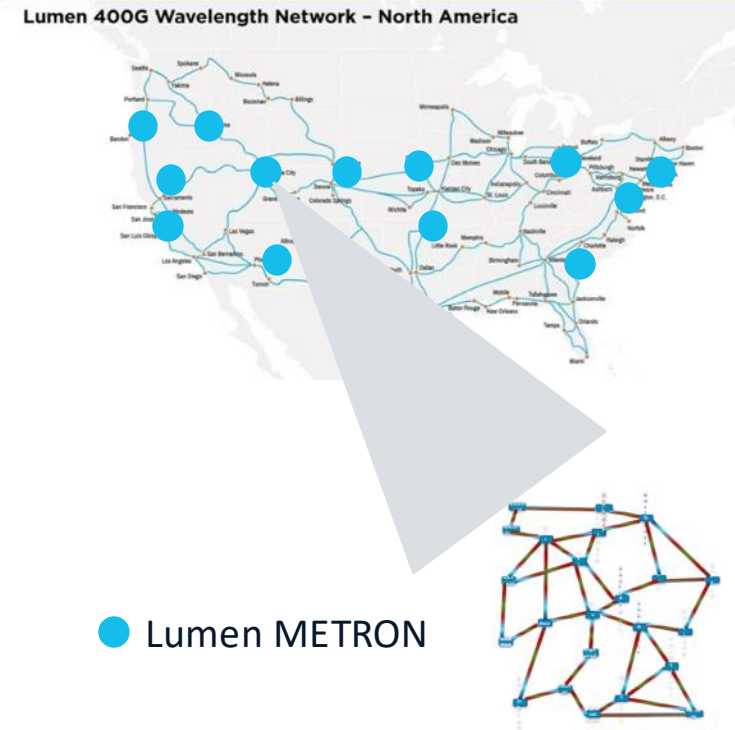
- Deliver bandwidth demands
- Support customers' AI-driven initiatives
- Reduce latency and costs to drive business

Outcomes

- Satisfies demanding bandwidth, latency, and resilient transport for AI workloads.
- API-driven control and automation of its network to include wavelengths, Ethernet, and IP
- Reduces costs and increases fiber network capacity with direct paths to data centers and clouds

Routed Optical Networking

- Cisco 400G ZR/ZR+ coherent optics
- Cisco 8200 Series
- Cisco NCS 5700 Series
- Cisco NCS1001 efficiency



Scaling network to 400G



Customer Goals

- Modernize network for efficiency
- Agility to grow business through differentiated services

Business Results

- Savings up to 125 million Canadian dollars over next ten years, with ~27% reduction in CapEx.
- CapEx savings will more than double when deployed directly over dark fibers
- Strengthen financial health and generate more value for shareholders
- Deliver new fixed and wireless services more cost-effectively and speed time to market
- Provide visibility to troubleshoot in an instant

Solution

- Replace transponders with Bright plugs
- Cisco 8K routers
- Alien line system

“It will enable us to reduce the space and power consumption of our network by a staggering 76%.”

- Marc-André Gilbert,
Senior Manager of Transport Planning at Bell Canada

Arelion and Cisco: Building the Blueprint for AI-Driven Connectivity

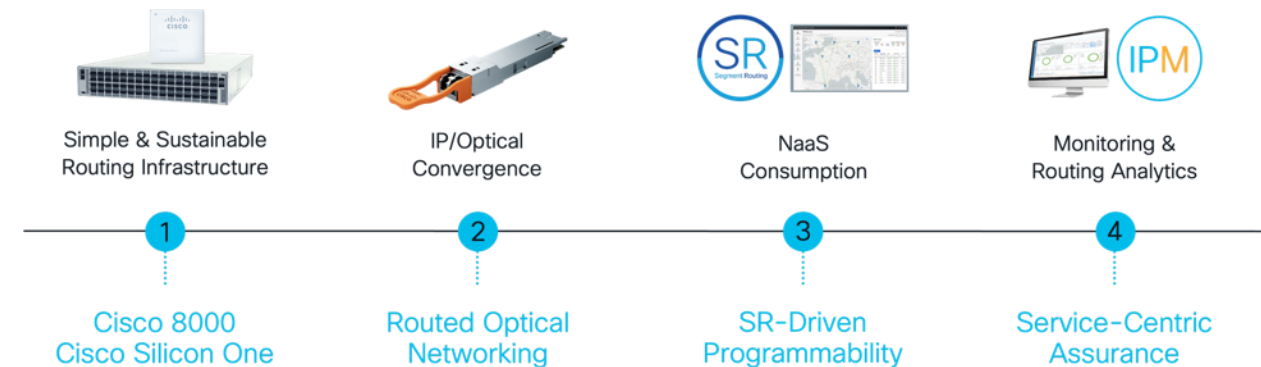


Solution

- IP and optical convergence leveraging Cisco Bright coherent pluggables
- Sustainable routing infrastructure: Cisco Silicon One-based 8000 Series Routers provide a unified architecture for operations and automation
- Programmability and NaaS: Segment routing with SRv6 in IOS XR enables consistent and flexible routing, tailored to SLA requirements.
- Monitoring and analytics: Enhanced IP Measurement with Cisco Silicon One and visibility from Cisco Provider Connectivity Assurance

Outcomes

- Routed Optical Networking enabling savings up to 66% CapEx and 95% OpEx compared to legacy, discrete solutions



Energy Utility - RON Win

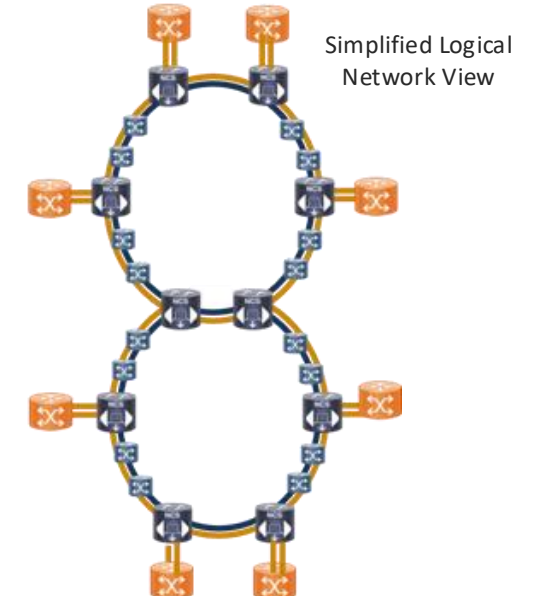


- SNAM – Italian Energy Infrastructure Company
- High-Capacity RON with more than 100 sites
- Brownfield with exiting Cisco DWDM nodes (NCS-2K)
- Networks consolidated to **NCS 57xx and ASR9K** routers with 100/200G/300G/400G uplinks
- Transponder/Muxponder functions moved to IP network with coherent pluggable transceivers **400G QSFP-DD High-Power (Bright)**



IP Layer
200G/400G
NCS 57C3

Transport Network
NCS 2000 ROADM
200G/400G λ



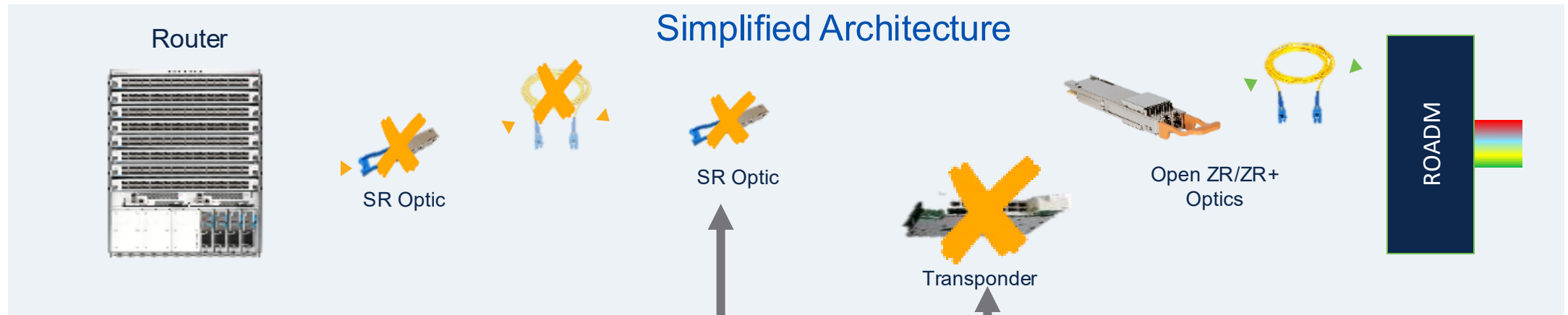
Pluggables expanding in Subsea Market

400G ULH trial on Indigo Central

- Field trial of 400G ULH on Indigo Central in collaboration with AARNET
- More than 92,000 ps/nm of dispersion, >4600KM with terrestrial extension
- 400G ULH designed for existing 400G QSDD slots
- Used in NCS1014 3.2T transponder



Summary – Coherent Optics enables IP-Optical Convergence



- Eliminate transponder and associated shelf/chassis
- Eliminate client optics

“Simplicity is the ultimate sophistication” – Leonardo da Vinci

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Earn 100 points per survey completed and compete on the Cisco Live Challenge leaderboard.



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education with DevNet,
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in Labs



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