

# Optical Networks toward 2030 Webinar #1

---

**Moderators: David Hillerkuss and Xiang Liu**  
April 24, 2024, 9:00-10:00am EST

# About ON2030

New bi-monthly webinar series,  
"Optical Networks toward 2030 (ON2030)"

The webinar strives to provide an overview of the most important topics in our industry

Key experts explore next generation technologies, including critical aspects such as

- energy efficiency,
- reliability,
- sustainability,
- efficient ecosystem scaling,
- and future-proof solutions.

Update on key advances in international optical network standards (ITU-T, IEEE, OIF and BBF etc.)

Join this series to stay up to date with latest developments and highlights

See the website for regular updates and future instances:

[https://www.optica.org/membership/member\\_programs/optical\\_networks\\_toward\\_2030/](https://www.optica.org/membership/member_programs/optical_networks_toward_2030/)

# Agenda

## Optical Industry Highlights

- David Hillerkuss – Infinera
- Xiang Liu – Huawei

## High-Speed Inter-Data-Center Optics, (400G/800G/1.6T ZR/ZR+)

- Paul Doolan – Infinera
- Ian Betty – Ciena
- Tom Williams – Cisco
- Jeff Rahn – Meta
- Q&A / Panel Discussion

**OPTICA** **WEBINAR #1** **N2030**

## High-speed inter-data-center optics (400G/800G/1.6T ZR/ZR+)

**DATE: 24 April, 2024** **TIME: 09:00 - 10:00 AM EST**

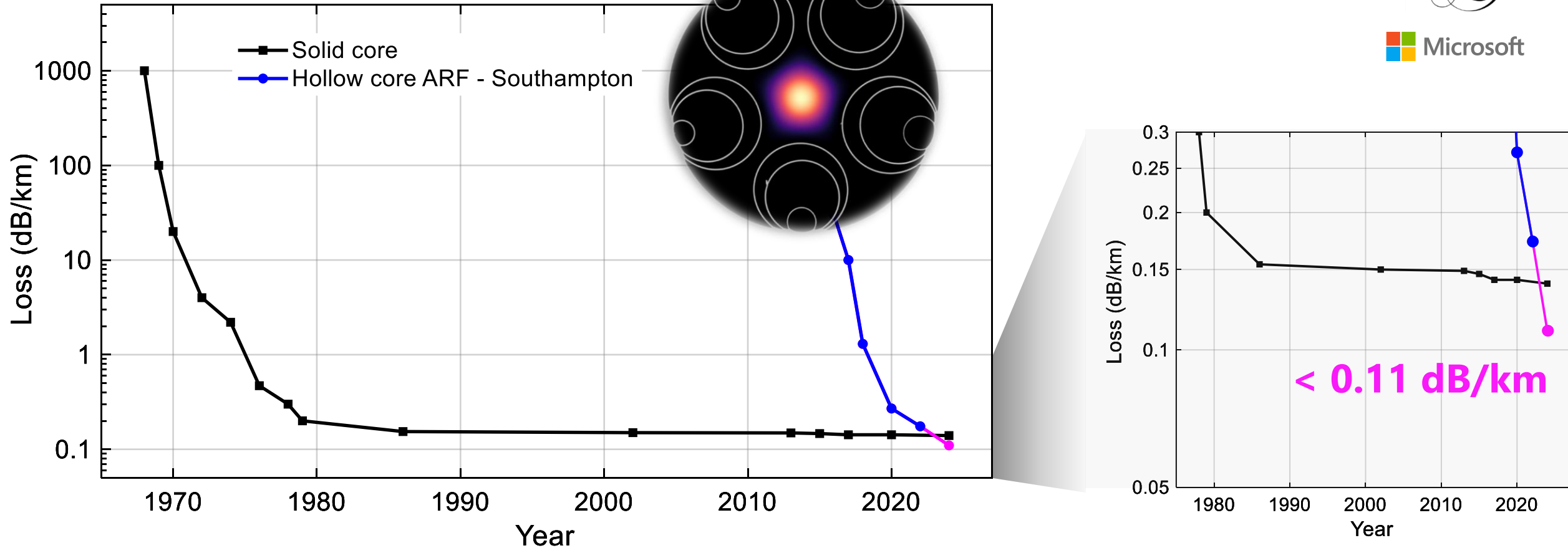
**Jeff Rahn** Meta  
**Ian Betty** Ciena  
**Tom Williams** Cisco  
**Paul Doolan** Infinera

Moderators: David Hillerkuss (Chair of the Photonics and Opto-Electronics Division on the Optica Board of Meetings) and Xiang Liu (Fellow of OSA and IEEE)

# Highlights in our Industry

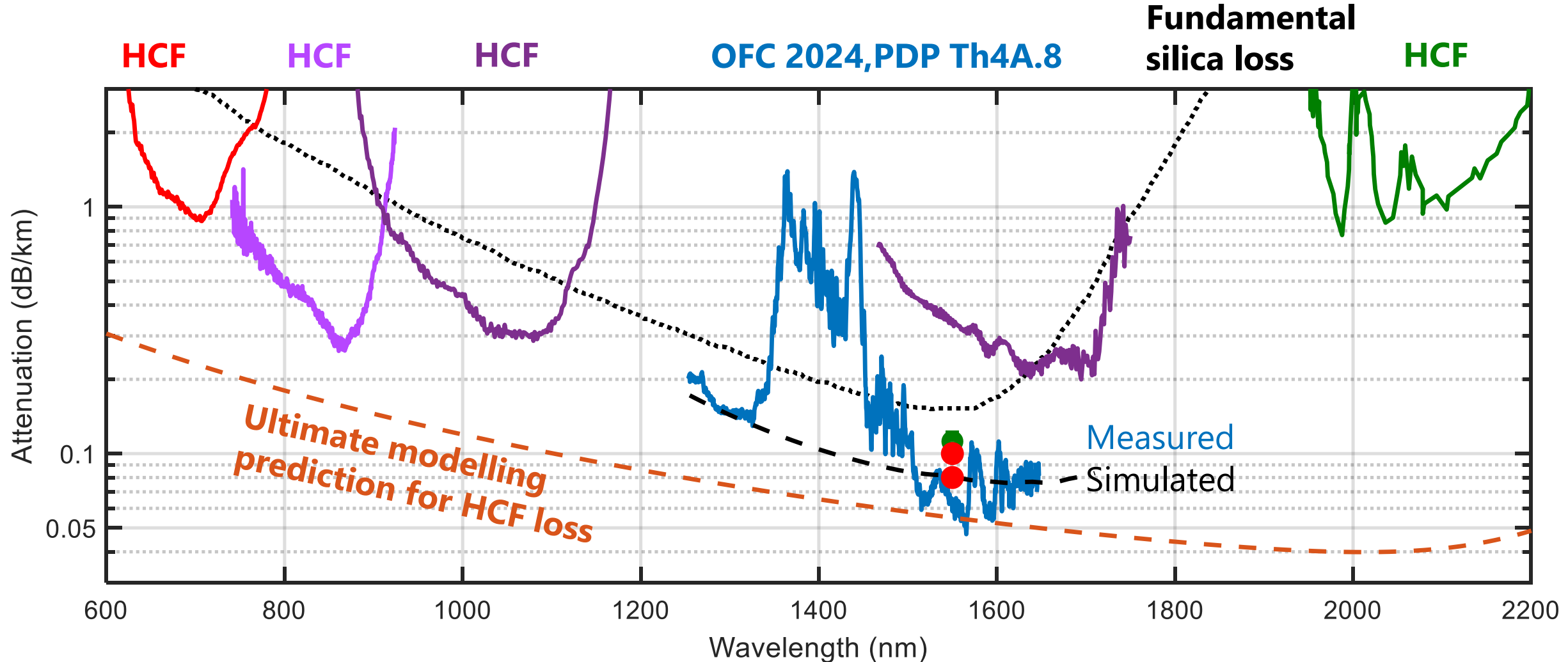
1. Hollow Core Fibers with a record low loss of 0.11 dB/km (OFC2024 PDP)
2. AI for optics, optics for AI, and optics+AI
3. CPO, LPO, and half-LPO for energy-efficient connections
4. 400Gb/s pluggable transceivers enabling the AI wave in intra-data-center connections
5. 1.6Tb/s ZR/ZR+ standardization started in OIF for inter-data-center connections
6. High symbol rate long-haul coherent transmission for 1.6Tb/s and beyond
7. P2MP any-rate (XR) optics being deployed for metro aggregation networks
8. The debate between IM/DD and coherent extended to next-generation PON beyond 50Gb/s
9. Distributed fiber sensing transitioning from research to standardization (OFC2024 workshop organized by ETSI ISG-F5G)
10. ITU-T SG15 envisioning the evolution of optical transport networks to support IMT2030 (OFC2024 workshop organized by ITU-T)

# On the verge of a new fibre optics revolution?



At the recent OFC, a way to achieve lower propagation loss than fundamentally achievable with silica-core telecoms fibres was demonstrated **using a HOLLOW CORE fibre**

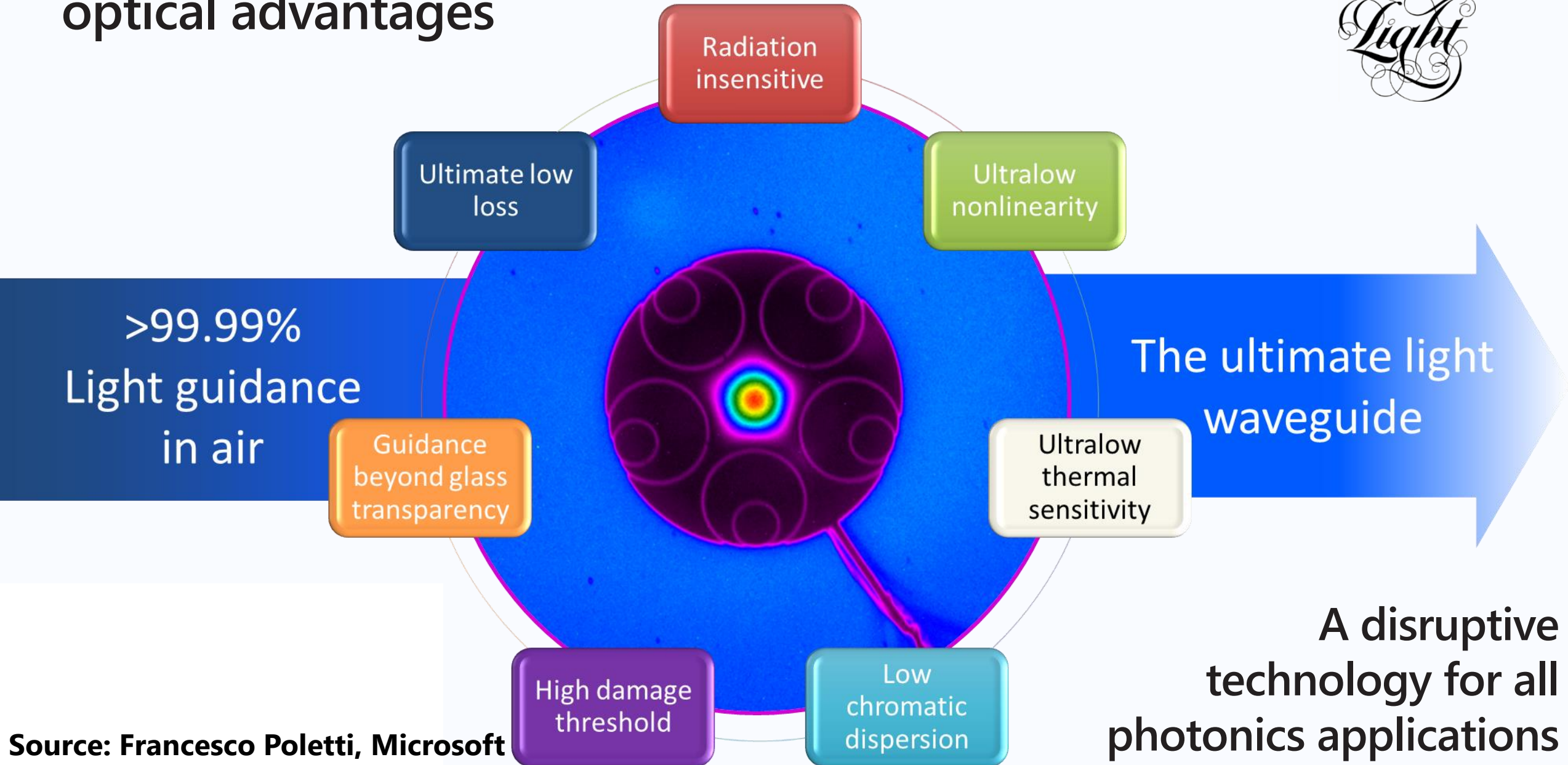
# HCFs: ultralow attenuation... anywhere



Potential to **open new communication windows** away from telecoms C-band, where technology convergence can allow cost reduction and system performance improvements

**Source: Francesco Poletti OFC 2024, PDP Th4A.8**

# HCFs: additional appealing properties and optical advantages





# Developing Implementation Agreements

---

Paul Doolan

04/24/2024





# Disclaimer

- Not speaking for OIF
- Not speaking for Infinera
- Can't talk about WIP

# Public record

**Fremont, Calif.—September 8, 2023** – [OIF](#) concluded its hybrid Q3 Technical and MA&E Committees Meeting, August 8-10 in Vancouver, BC, Canada, with the launch of four groundbreaking new projects.

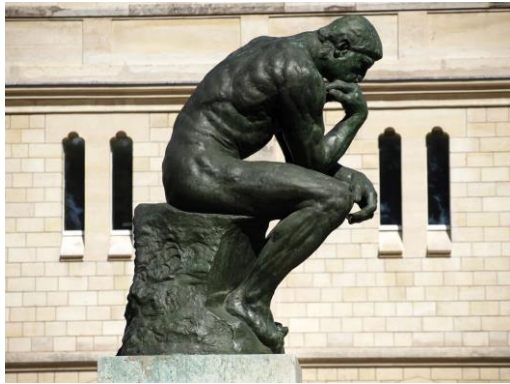
## **1600ZR Project**

The 1600ZR project will define a power optimized solution for a multi-vendor interoperable 1600 Gbps coherent optical interface, with a focus on Data Center Interconnect (DCI) scenarios. This Implementation Agreement (IA) will create a comprehensive electrical/protocol/optical framework that facilitates realization into pluggable modules. It will also establish a reference point for additional applications that contribute to the growth of the coherent ecosystem.

.....

This project further validates that OIF is the platform for next-generation coherent line interface discussions and to facilitate the development of innovative applications and architectural solutions. We encourage network operators to actively participate in these efforts to help shape the specifications to best meet their needs.”

# Getting to an IA



↑  
Q3/2023

# Some data points

400G - 324

[('FEC', 44), ('CLIENT', 0), ('MODULATION', 1), ('MAPPING', 4), ('LINE', 4), ('FRAME', 6)]

800G - 123

[('FEC', 8), ('MODULATION', 0), ('CLIENT', 6), ('MAPPING', 3), ('LINE', 4), ('FRAME', 2)]

1600G - 47 ☺

IA	Start	Published	Quarters
400G ZR	Q4 2016	Q1 2020	13
800G ZR	Q3 2020	TBD	15
1600G ZR	Q4 2023	TBD	2.5

Key sections of 400G ZR *digital spec*

8. Host to ZR data path

9. Adaptation

10. FEC

11. Symbol mapping

12. DSP framing

# Final thoughts

- Editors work for the group
  - Under direction of chair
  - Create drafts based on proposals (accepted contributions)
- Converging on big ticket items requires specific proposals
  - Architecture, digital spec, optics
- I'm optimistic my workload is going to increase soon





# Coherent Optics Unleashed

## ON2030 Webinar #1

### High-speed inter-data-center optics (400G/800G/1.6T ZR/ZR+)

Ian Betty

Senior Director– WaveLogic Technologies

April 24<sup>th</sup> 2024

# OIF Scope is Expanding



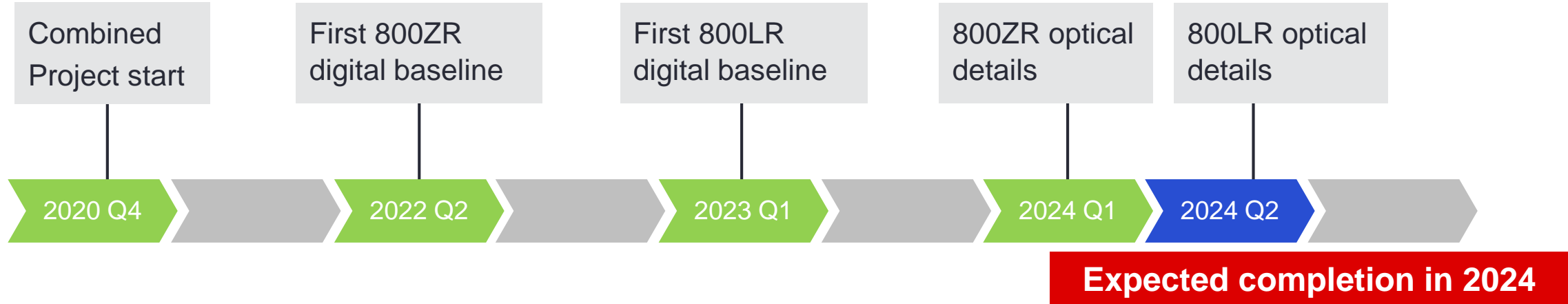
OIF is expanding its scope

Defining coherent interfaces for “LR” 10km – Data center campus, service provider edge

Defining coherent interfaces for “ZR+” 1000km – Metro/Long-haul point-to-point Ethernet

OIF complementing other forums

# 800ZR and 800LR Update



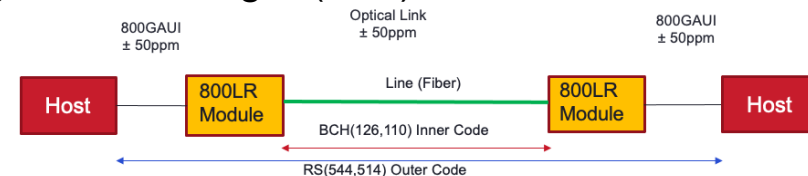
## 800ZR covers more than DCI use case

- Client muxing (100GE-800GE support)
- High performance soft-decision OFEC (2% CBER)
- Various optical power ranges (including -2dBm)
- DWDM
- 800ZR similar to OpenZR+/OpenROADM 400G



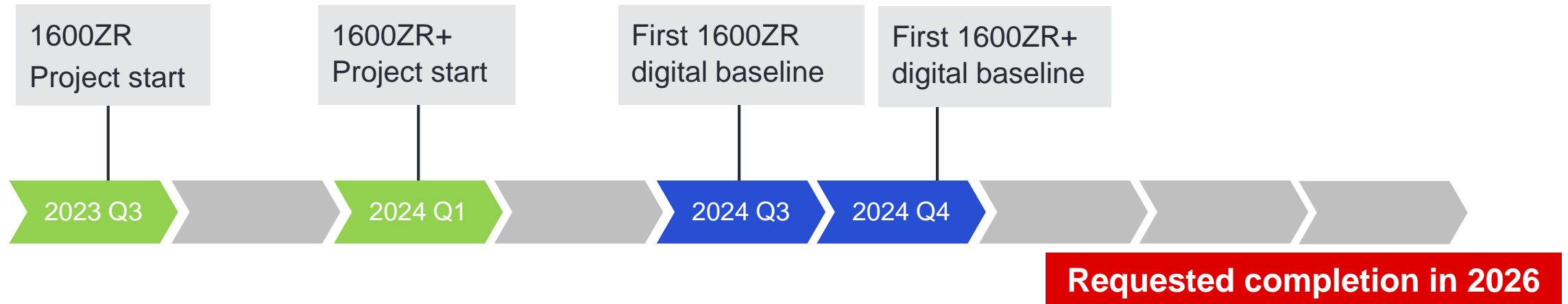
## 800LR is fit-for-purpose technology

- Low power/latency concatenated FEC (1.1% CBER)
- Synchronous clients
- O-band and C-band applications
- Higher loss budget (8dB)





# 1600ZR and 1600ZR+ Update



## 1600ZR DCI application

Single amplified span  
Single laser for FITS considerations  
300GHz spacing, C-Band.  
Equivalent 400ZR link budgets (<120km)  
• Proposing modem RSNR target = ~18.5dB  
Enable 400ZR backwards compatible implementations

## 1600ZR+ metro/long-haul application

Multiple amplified span  
300GHz spacing, C and L Band.  
Equivalent 800G ZR+ link budgets (<1000km)  
• Proposing modem RSNR target = ~13.7dB  
Enable 800G ZR+ backwards compatible implementations

# 1600ZR and 1600ZR+ Exploration

## 1600ZR Project Start:

Create IA to define 1.6Tbps coherent line interfaces. Single-lambda, single carrier, and 16QAM modulation is preferred for power consumption, FIT rate and interoperability considerations.

### Modulation tradeoffs

- **1600ZR** 16QAM CFEC results in ~238Gbaud
- PCS-64QAM can reduce baud 236GBd → 200GBd
- **1600ZR+** PCS-16QAM + OFEC results in ~262Gbaud
- PCS-64QAM can reduce baud 262GBd → 245GBd

### Tradeoffs of FEC complexity vs aggregate baud vs power

- ~15% OH with CBER at 2% (e.g. OFEC) – 800ZR
- ~15% OH with CBER at 1.2% (e.g. CFEC) – 400ZR
- ~20% OH with CBER at 1.1% (e.g. KP4+BCH2) – 800LR

### FDM considerations and Interop benefits

- Clock recovery penalty
- Implementation penalty
- Lower CD compensation power

Discussion on technology options and tradeoffs to meet application requirements underway

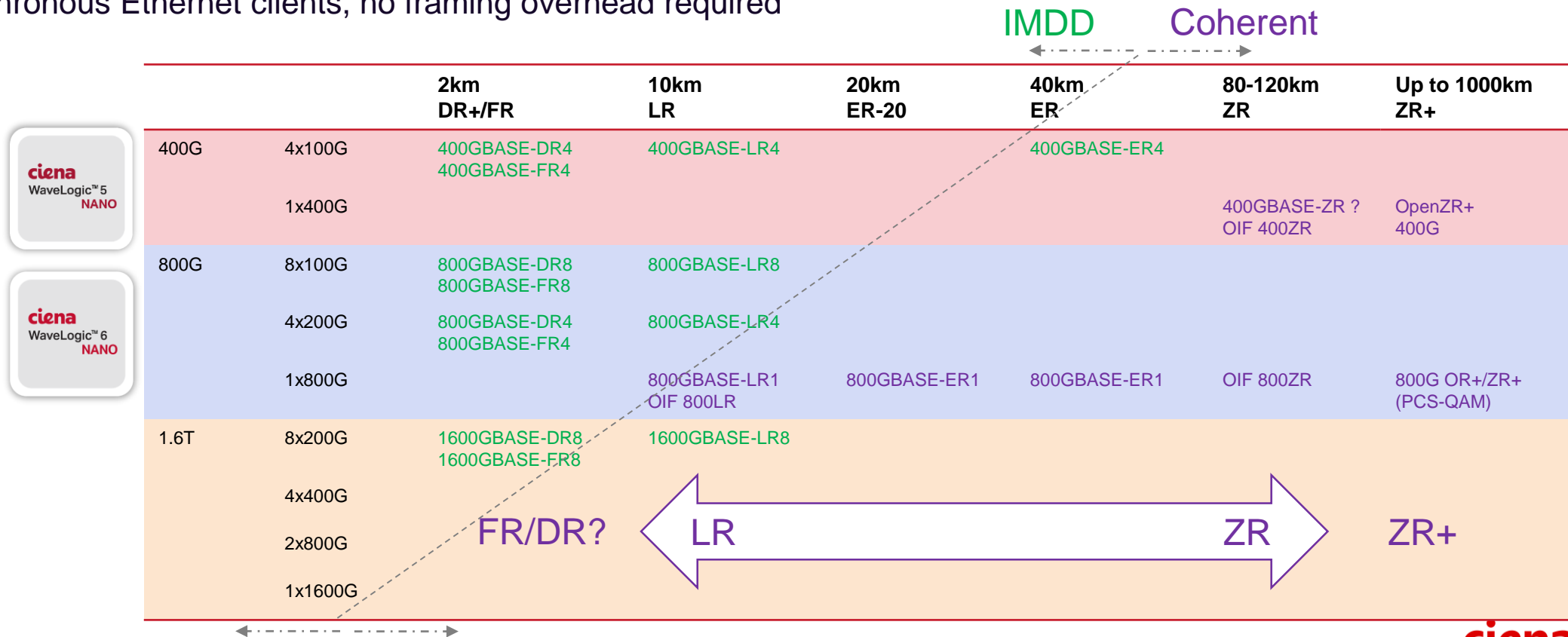
# Coherent Ethernet from LR to ZR

The industry should consider different technology bundling options

- ZR and ZR+ with ZR+ being incremental power and performance
- LR and ZR covering all applications in between including ER and ER-20

LR has the right required OSNR for ZR applications

- LR and ZR are deployed as pluggable modules in routers
- Synchronous Ethernet clients, no framing overhead required



# Take Aways

- OIF is a leading-edge forum for interoperable coherent interfaces and is expanding its scope
- 800G is in final stages of definition
- 1.6T is starting
- OIF is exploring landscape of 1.6T technical solutions

**ciena**<sup>®</sup>

# Thank You

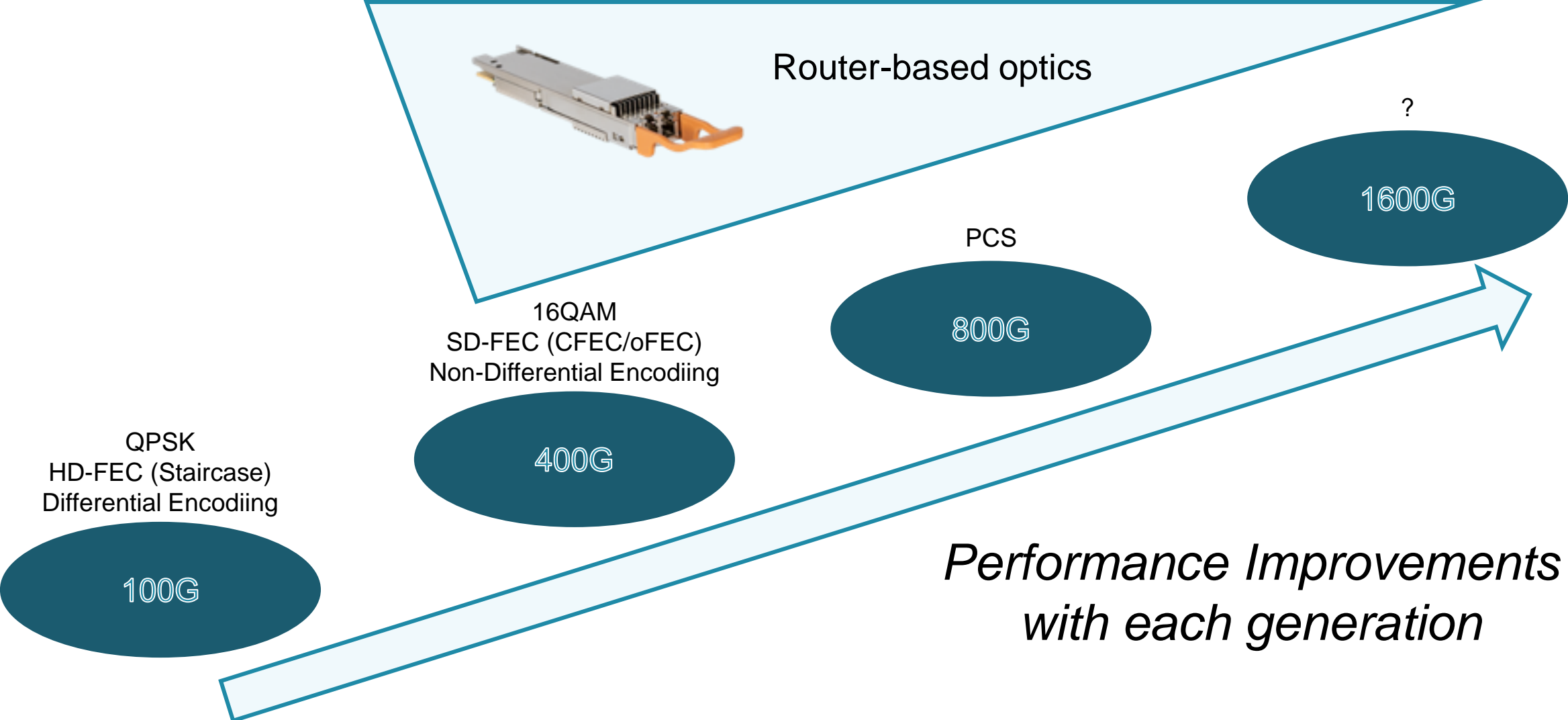
[ibetty@ciena.com](mailto:ibetty@ciena.com)



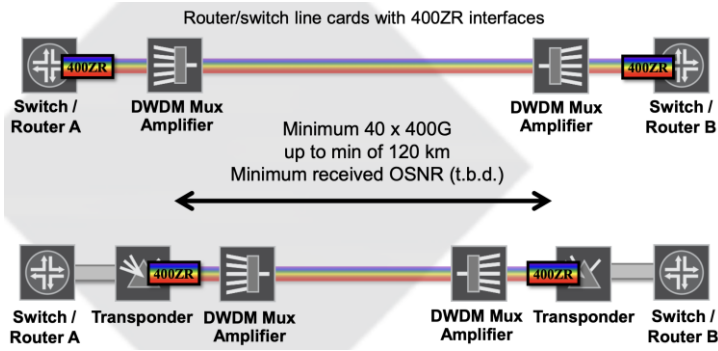
# Evolution and Next Steps in Interoperable Coherent Interfaces

Tom Williams

# Evolution of Coherent Interop Standards



# Interoperable 400 Pluggables – A Success Story

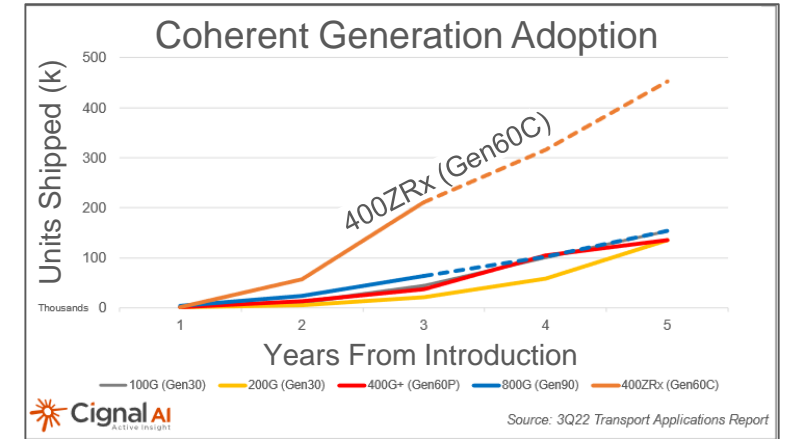


Open ROADM

+

OpenZR+  
MULTI-SOURCE AGREEMENT

=



- Early 400ZR project start
- Broad industry support
- Clearly defined objectives

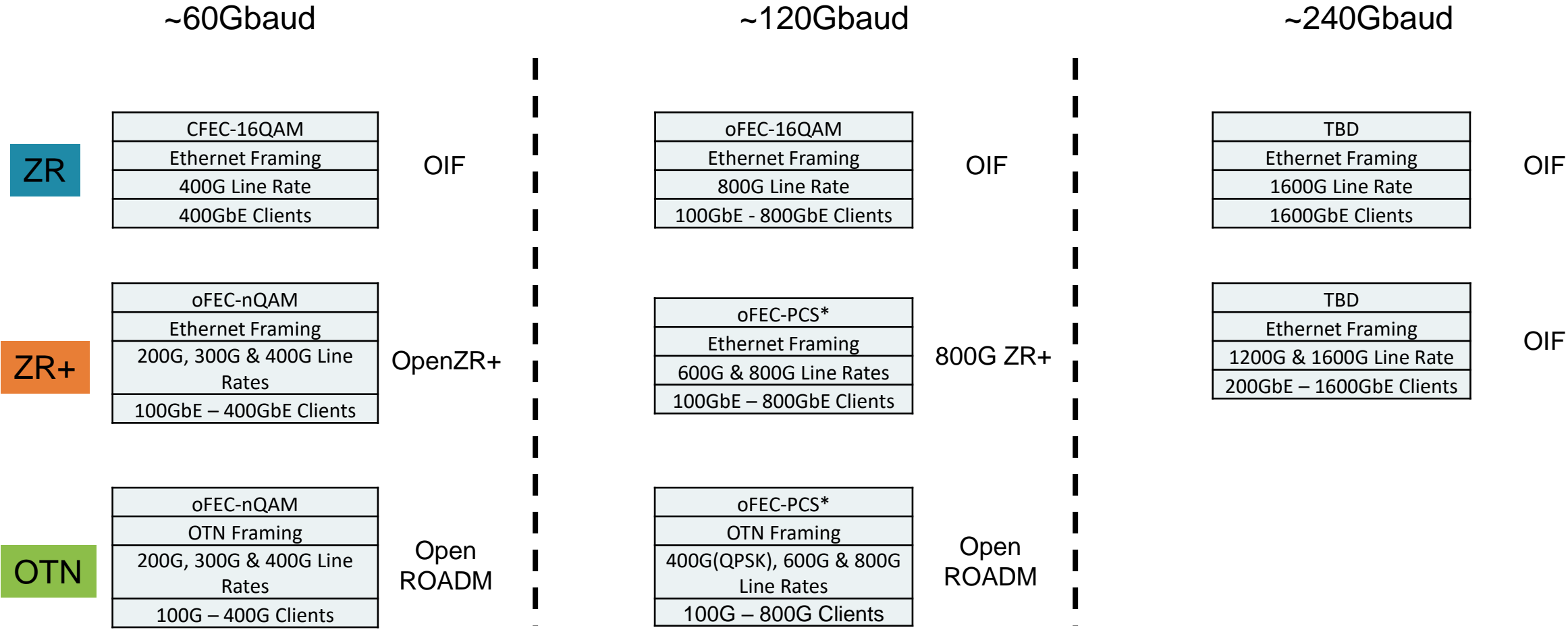
- Higher performance
- Additional use cases
- Expand addressable market

- Fastest ramping coherent technology
- Increased adoption of standardized interfaces

***400ZR triggered a fundamental change in the coherent transport market....and it's not going back***



# Interoperable Coherent Interfaces Summary



\*Open ROADM has published interop PCS protocol for OTN and Ethernet framing

# 1600G Standardization at OIF

- 1600ZR

- Project start in Q3 2023
- Key Requirements
  - 24dB span without optical protection switch
  - 20dB with optical protection switch
  - No mid-span amplification in either case
  - Define max power consumption per module
- 224G PAM4 host signaling

- 1600ZR+

- Project start in Q1 2024
- Key Requirements
  - 1-2dB improved ROSNR compared to ZR enabling 1,000km reaches with RAMAN
  - Support for 1200G mode
  - Align key building blocks with 1600ZR where possible
- 224G PAM4 host signaling

***OIF defining both 1600ZR and 1600ZR+ enabling broad industry alignment***



Connecting at the speed of light



# Applications for power efficient optics in Meta backbone network

ON2030 Webinar #1

High-speed inter-data-center optics (400G/800G/1.6T ZR/ZR+)

April 24, 2024

**Jeff Rahn**

Optical Engineer, Backbone & Edge Networks



# Agenda

- Meta Global Network
- Power and Performance Considerations
- Application to Meta's Network





*Give people the power to build community  
and bring the world closer together*

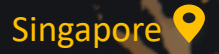


More than 3.98 Billion people using the  
Meta family of apps each month

# Meta Data Centers

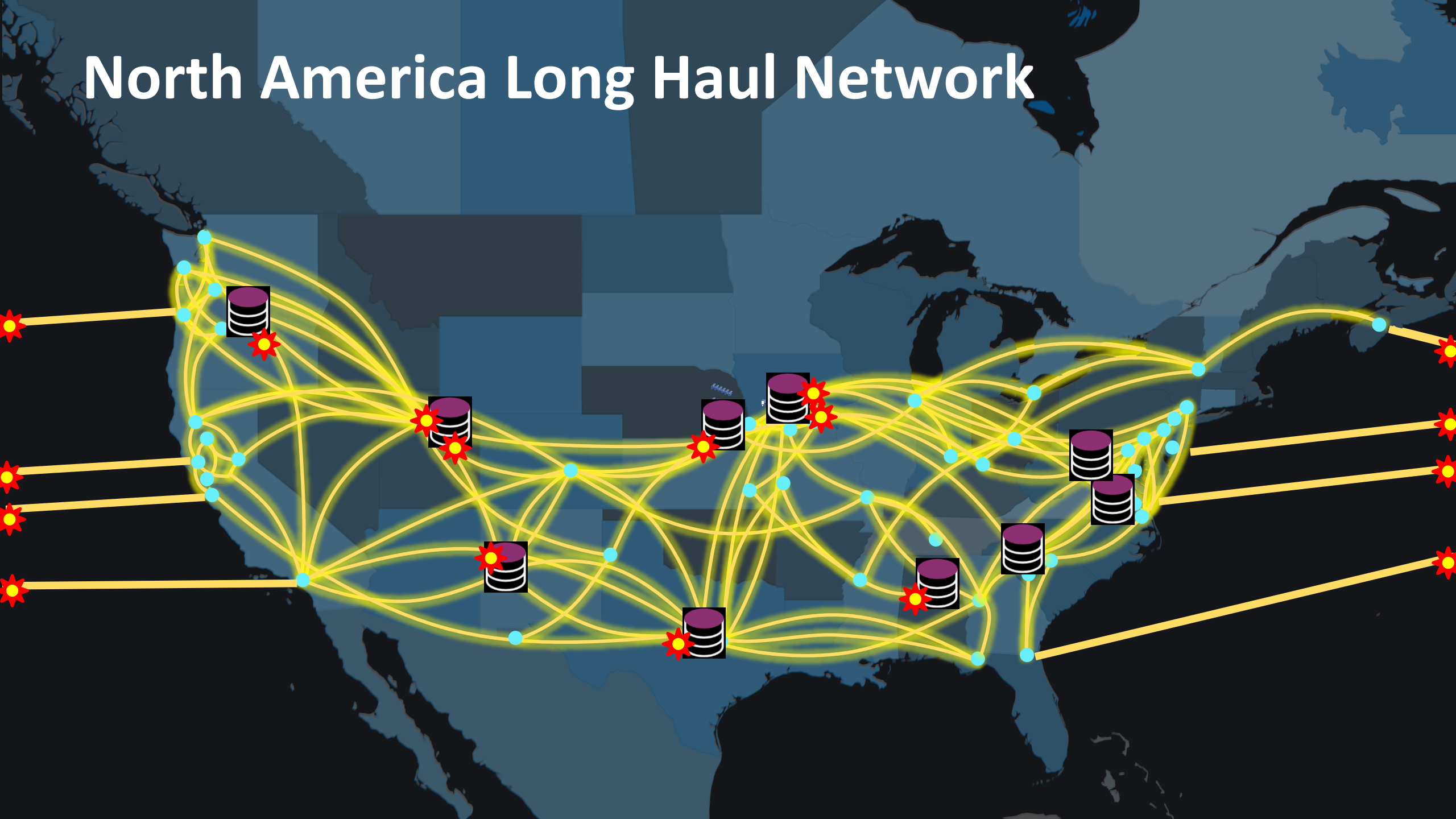


-  New construction
-  Serving traffic

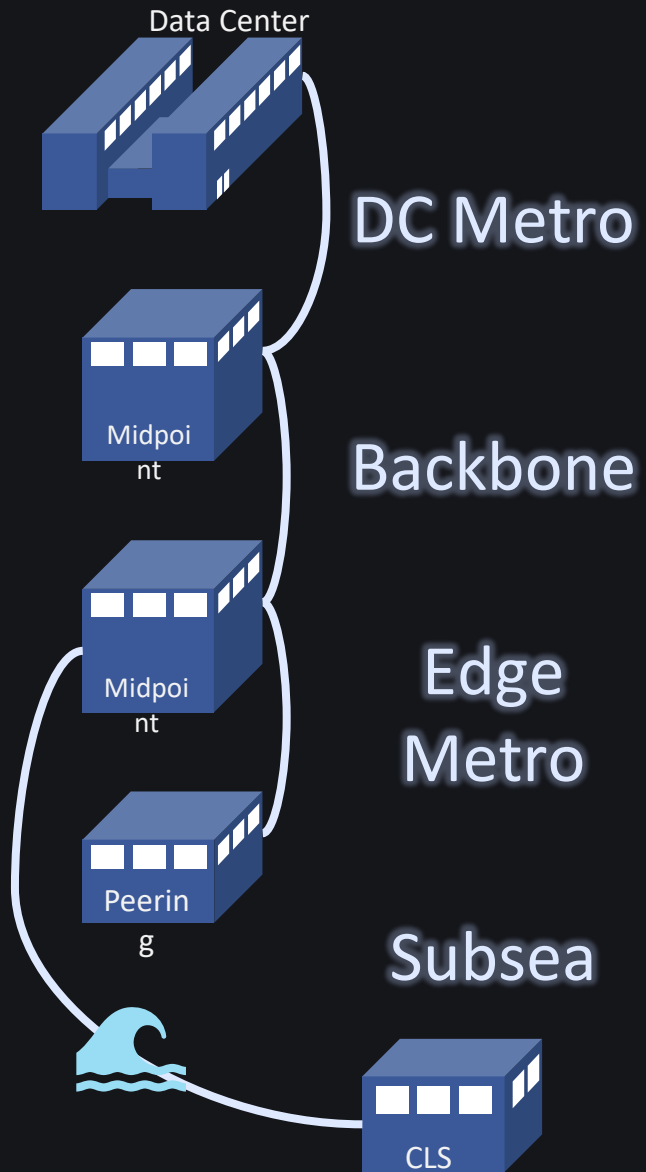




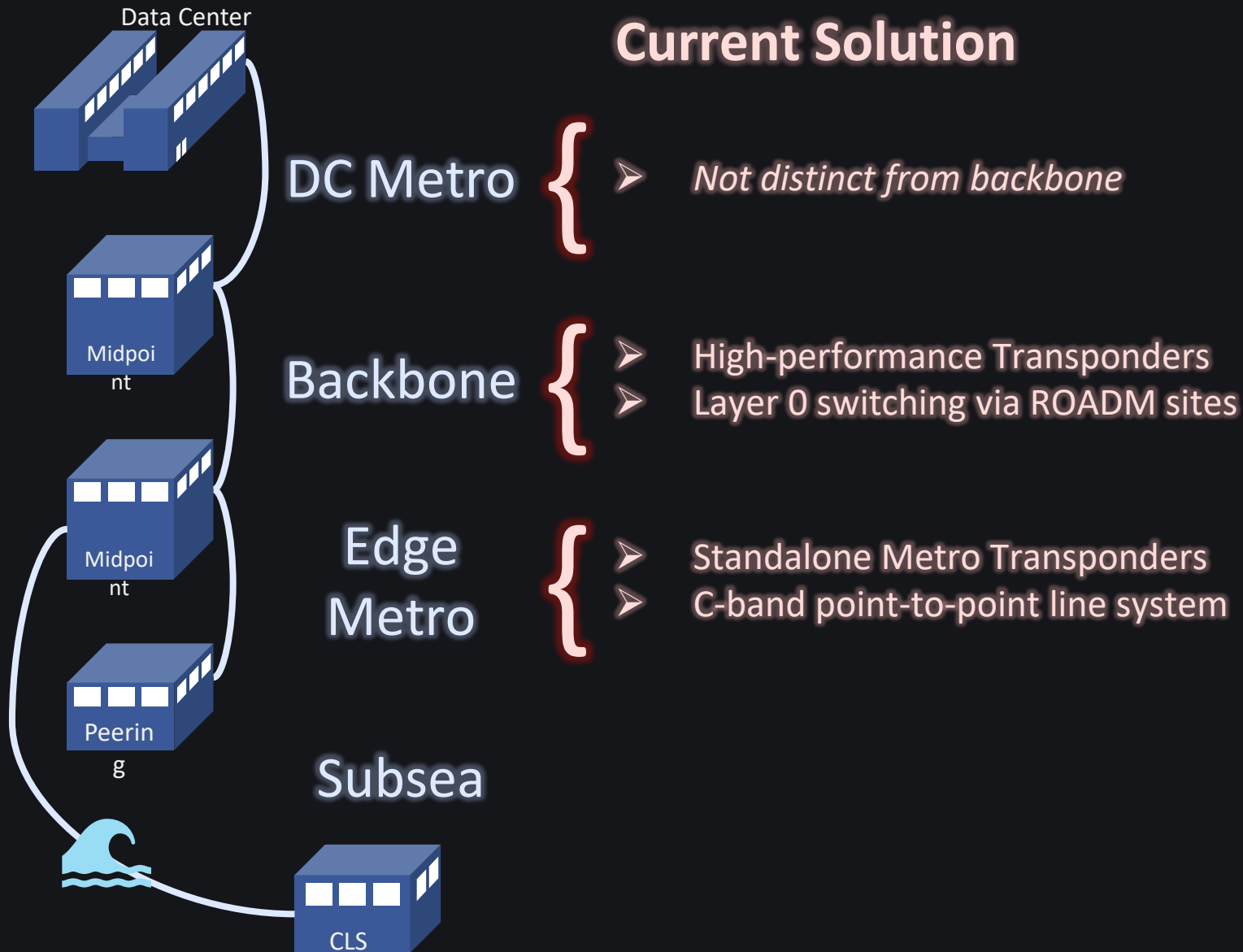
# North America Long Haul Network



# IP Connectivity



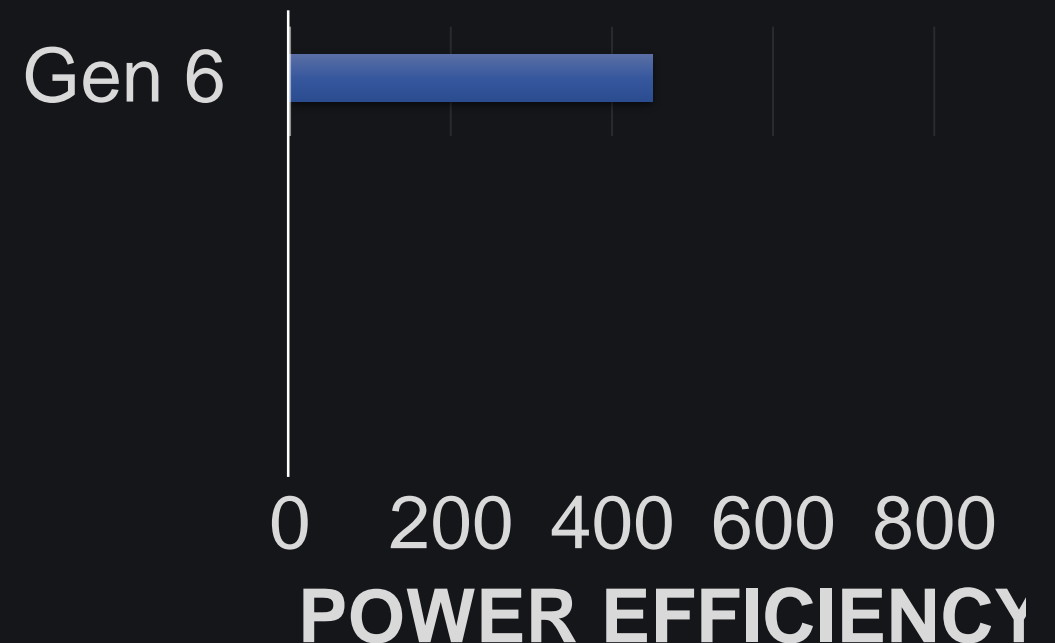
# Optical Solutions Enabling IP Connectivity



# IP + Optical Power Efficiency

- Power efficiency
  - L3 switch
  - Transponder
  - Line system w/ILAs
- Power efficiency worse with L3 regen
  - Optimum uses long paths
  - Wavelength switching
- ZR+ gives better power efficiency
  - Despite lower spectral efficiency
- ZR+ enables efficient L3 regen
  - Shorter, high-capacity links
  - Frequent IP grooming
  - Wavelength switching replaced with direct fiber routing

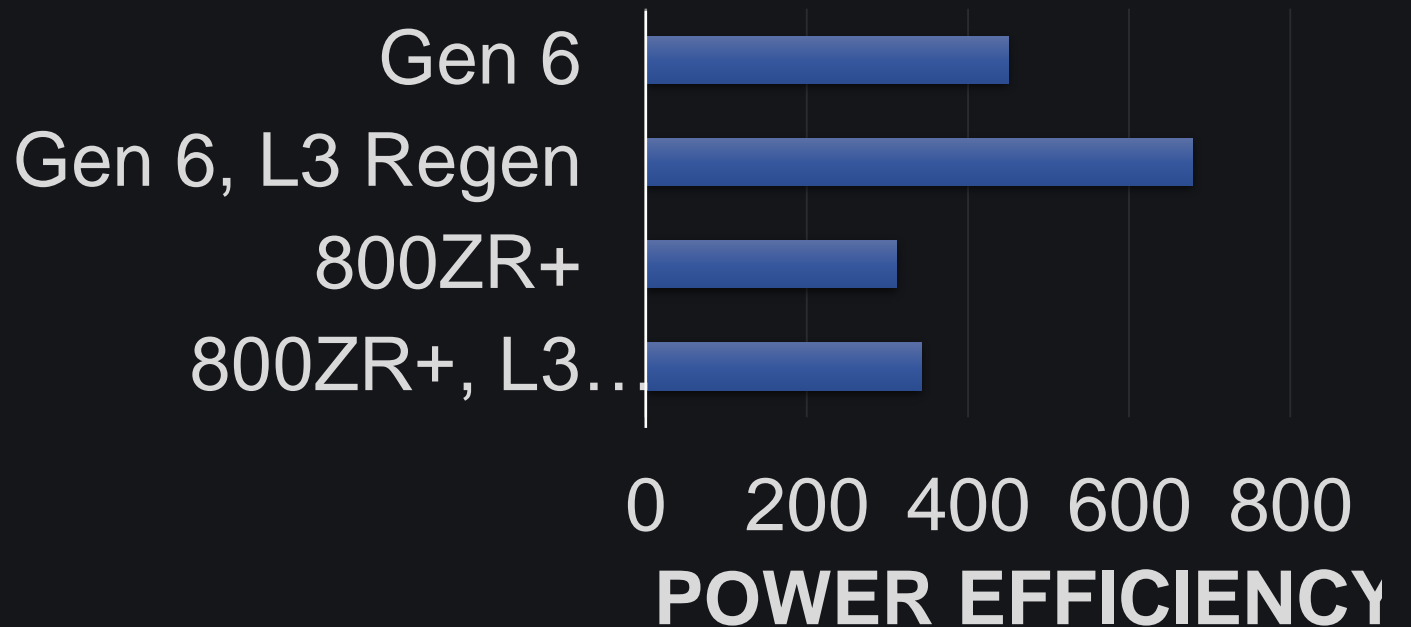
## Power Efficiency for 1200 km link



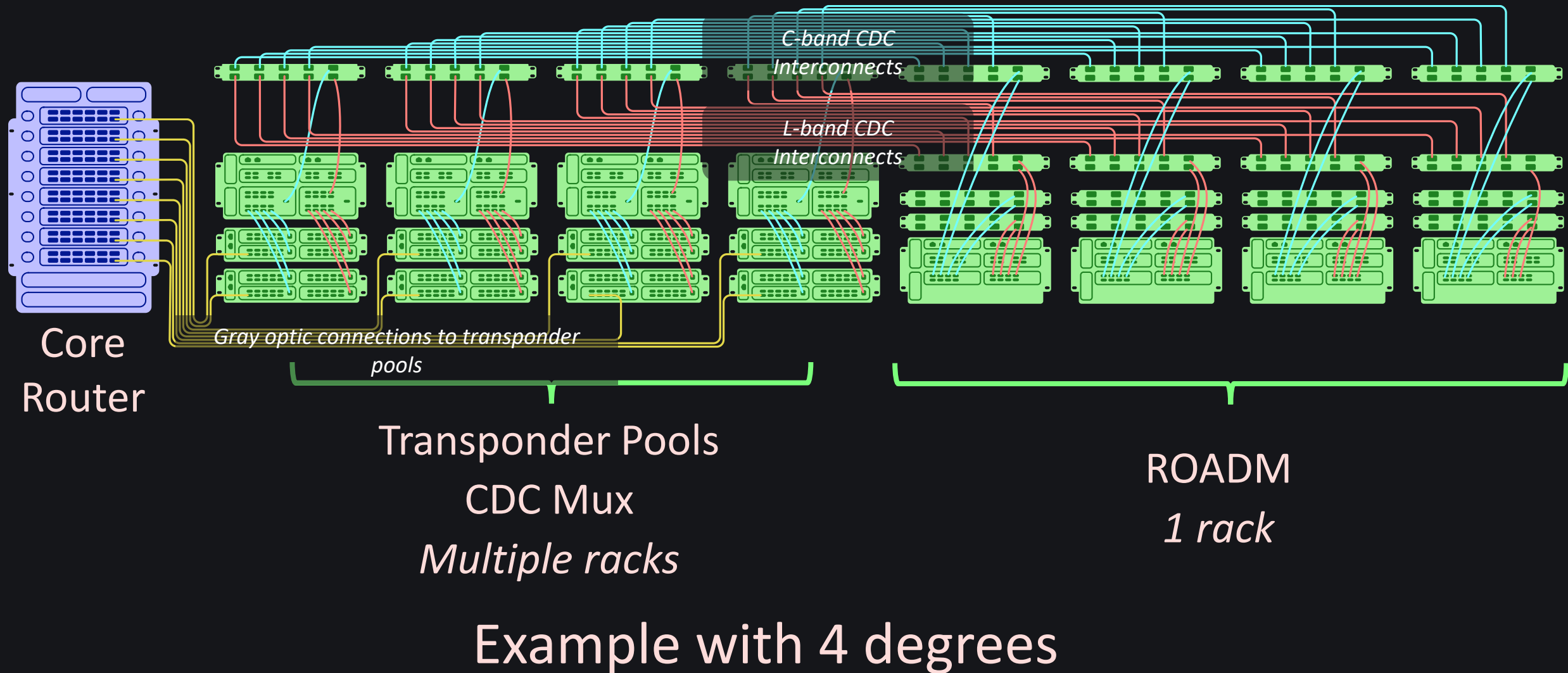
# IP + Optical Power Efficiency

- Power efficiency
  - L3 switch
  - Transponder
  - Line system w/ILAs
- Power efficiency worse with L3 regen
  - Optimum uses long paths
  - Wavelength switching
- ZR+ gives better power efficiency
  - Despite lower spectral efficiency
- ZR+ enables efficient L3 regen
  - Shorter, high-capacity links
  - Frequent IP grooming
  - Wavelength switching replaced with direct fiber routing

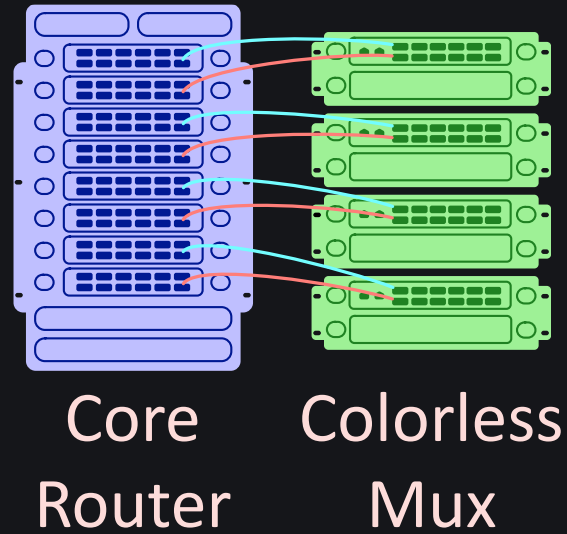
## Power Efficiency for 1200 km link



# CDC node supporting Optical Express

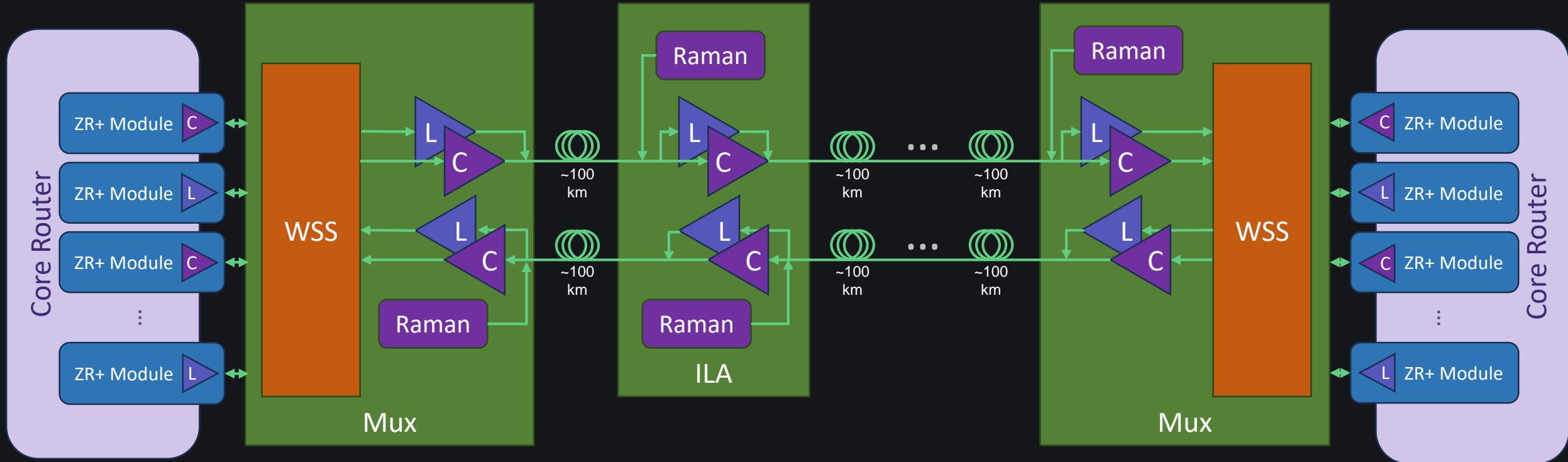


# Node Simplification with ZR and P2P



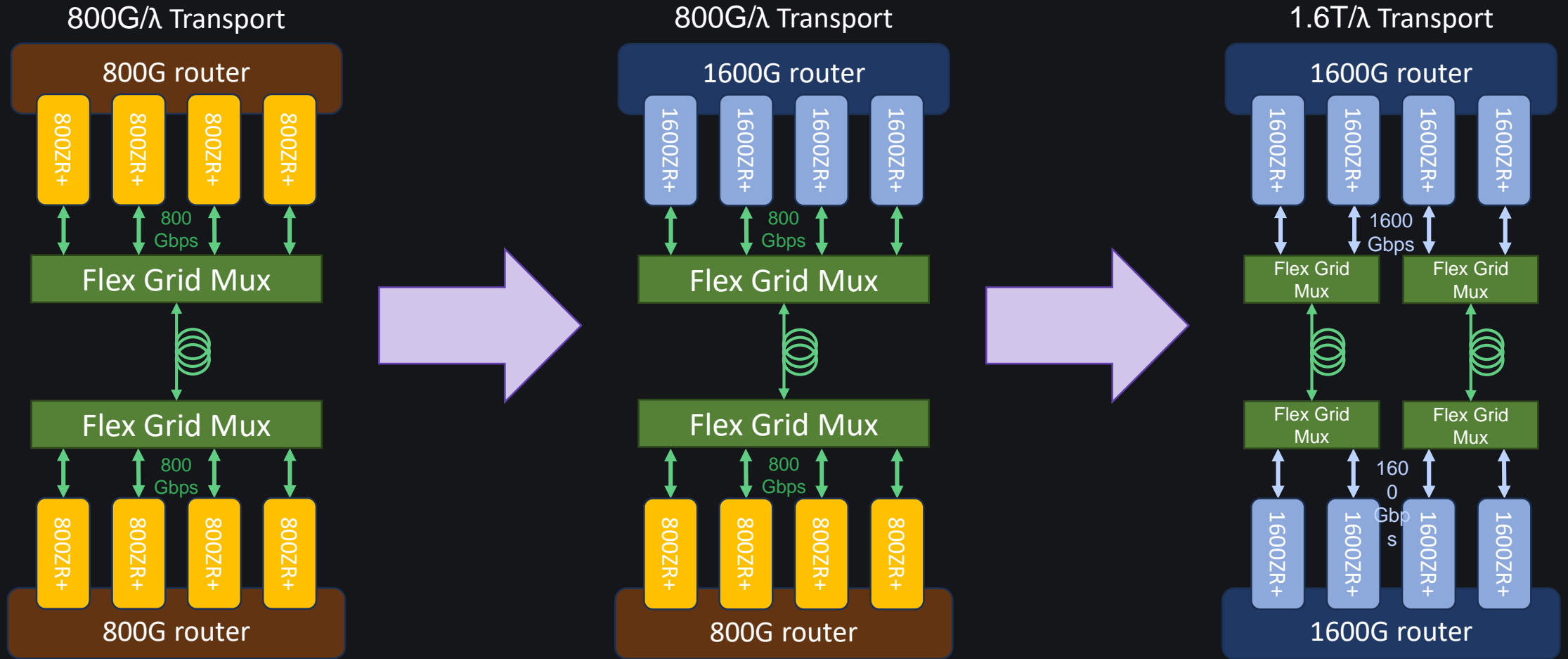
Example with 4 degrees

# Meta Point-to-Point Optimized Line System



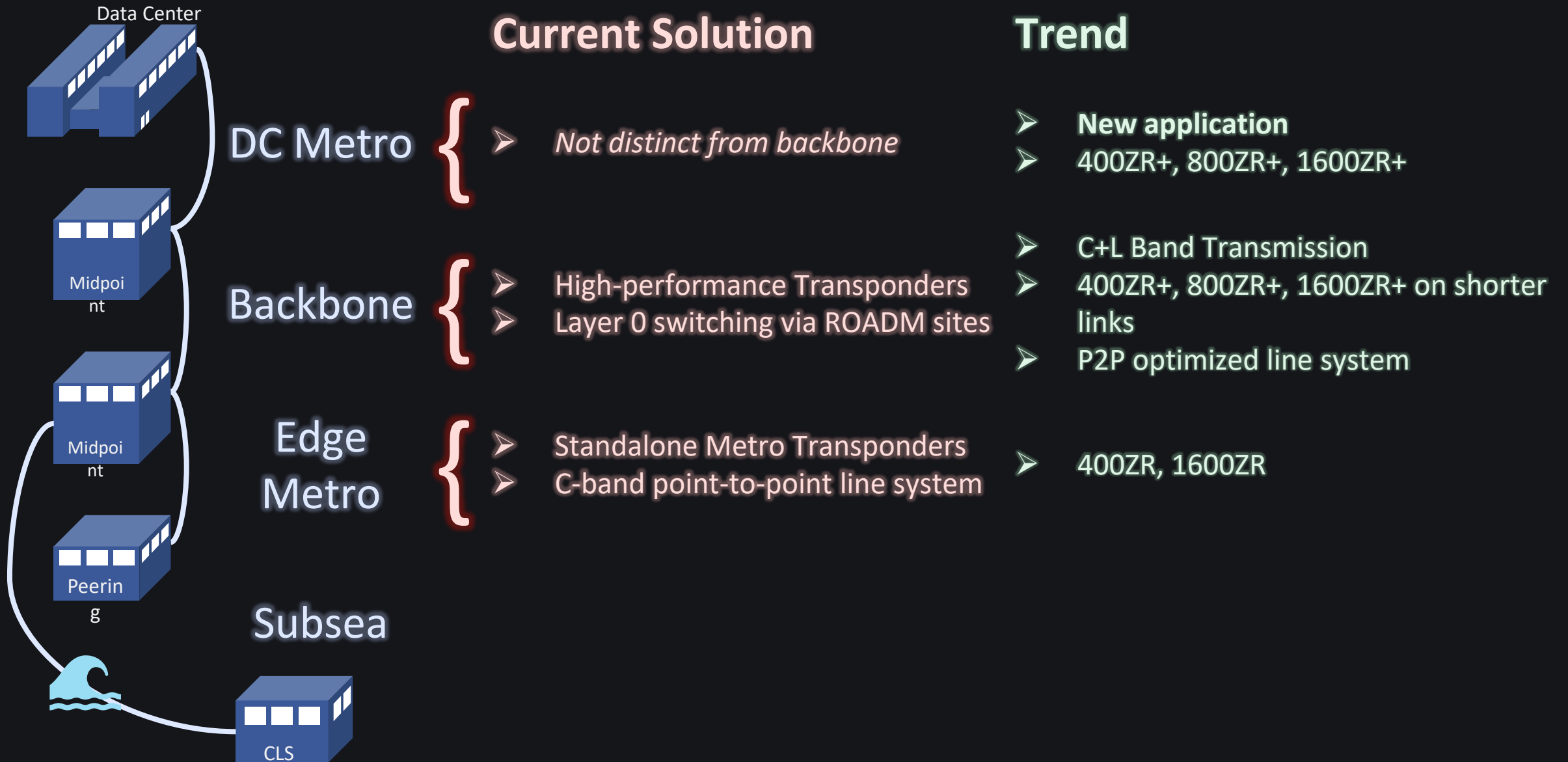


# Upgrade Process and Flexibility Required

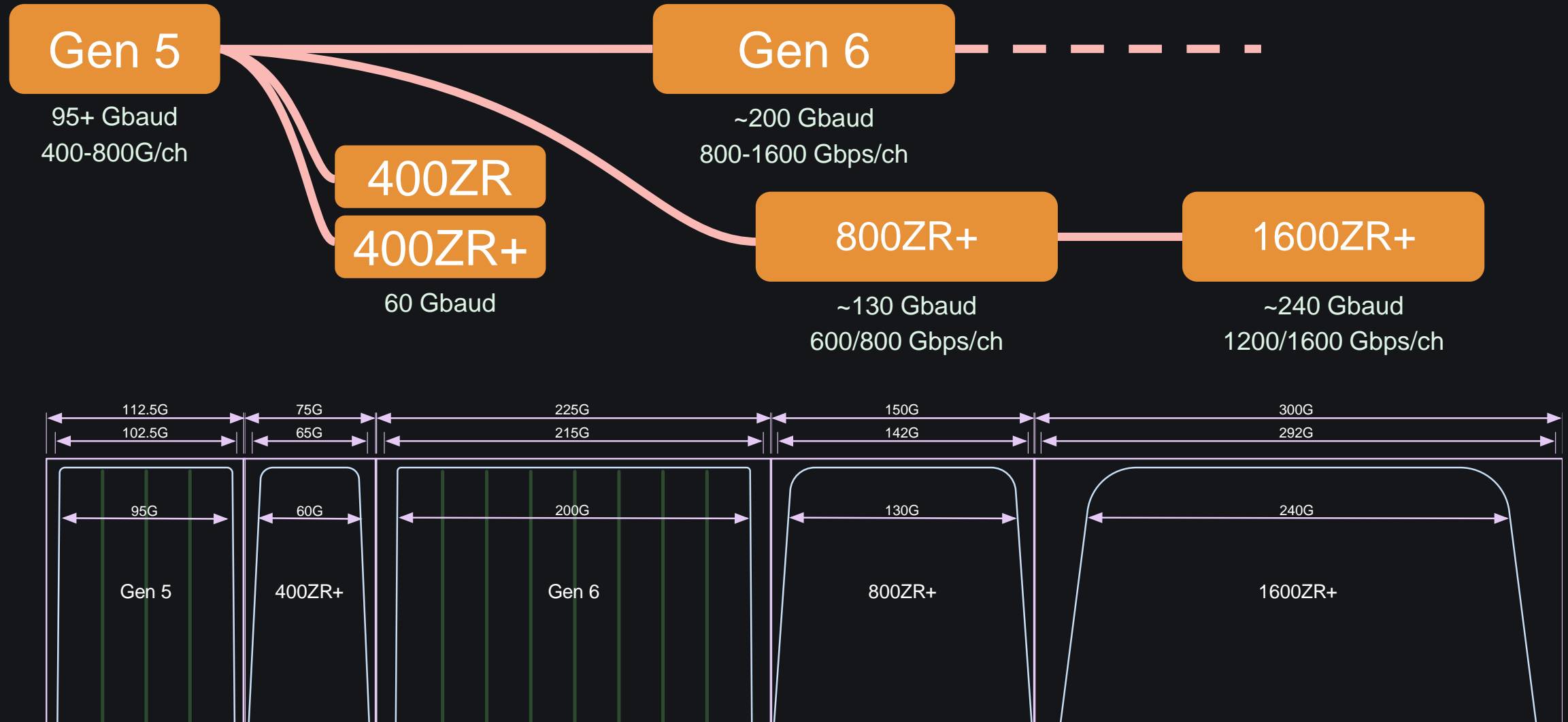


Optical interface backward compatibility needed to modes deployed in volume in existing network

# Optical Solutions Enabling IP Connectivity



# Generations of High-Performance Transponders



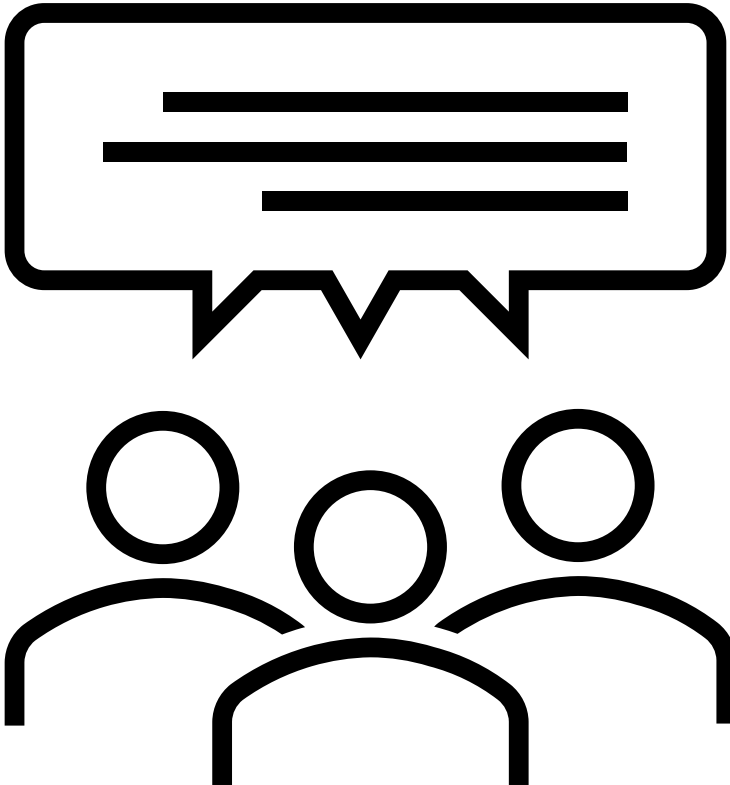
# Summary: Enabling Network at Scale

- ZR optics are significantly more power efficient
- ... this enables new network architectures
  - Shorter reach optimized
  - Point-to-point line system with simplified mux
- Standardized optical modes critical for IP/Optical integration
  - Industry Ecosystem
  - Interop for operational efficiency
  - Network upgrades

The logo consists of a blue infinity symbol (∞) on the left, followed by the word "Meta" in a white, sans-serif font on the right.

Meta

# Panel Discussion



**Thank you**