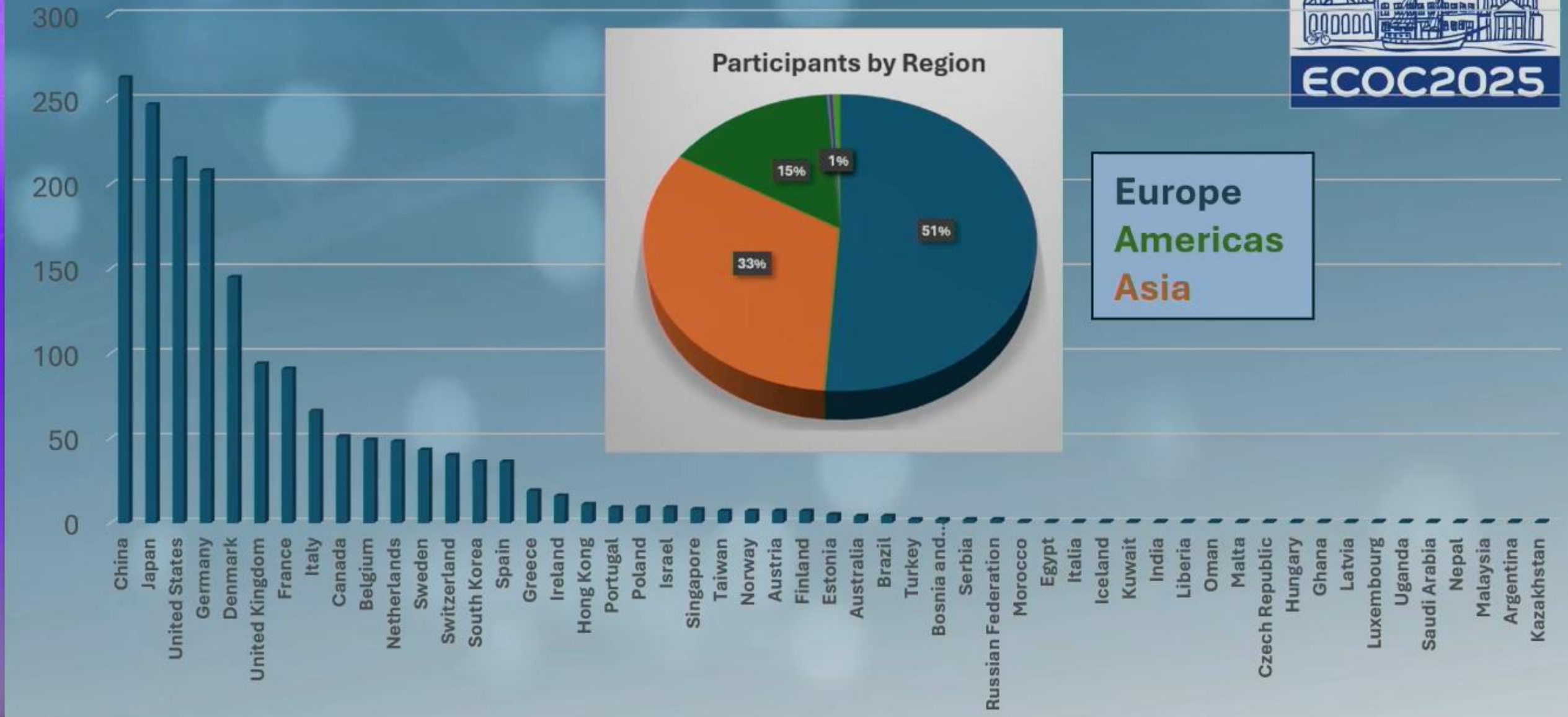
ECOC 2025
Copenhagen
https://ecoc2025.org/

Lunch Chat, October 07, 2025

Christoph Harder

Participants at ECOC 2025 per country



Europe
Americas
Asia

ECOC2025

962 submissions / 32 nations

Plenary talks

- Attosecond
- **Fibers**
- **Coherent**
- **Datacom**

- **https://ecoc2025.org/**

Next-generation optical fibre technology: expectations and applications

Kazuhide Nakajima

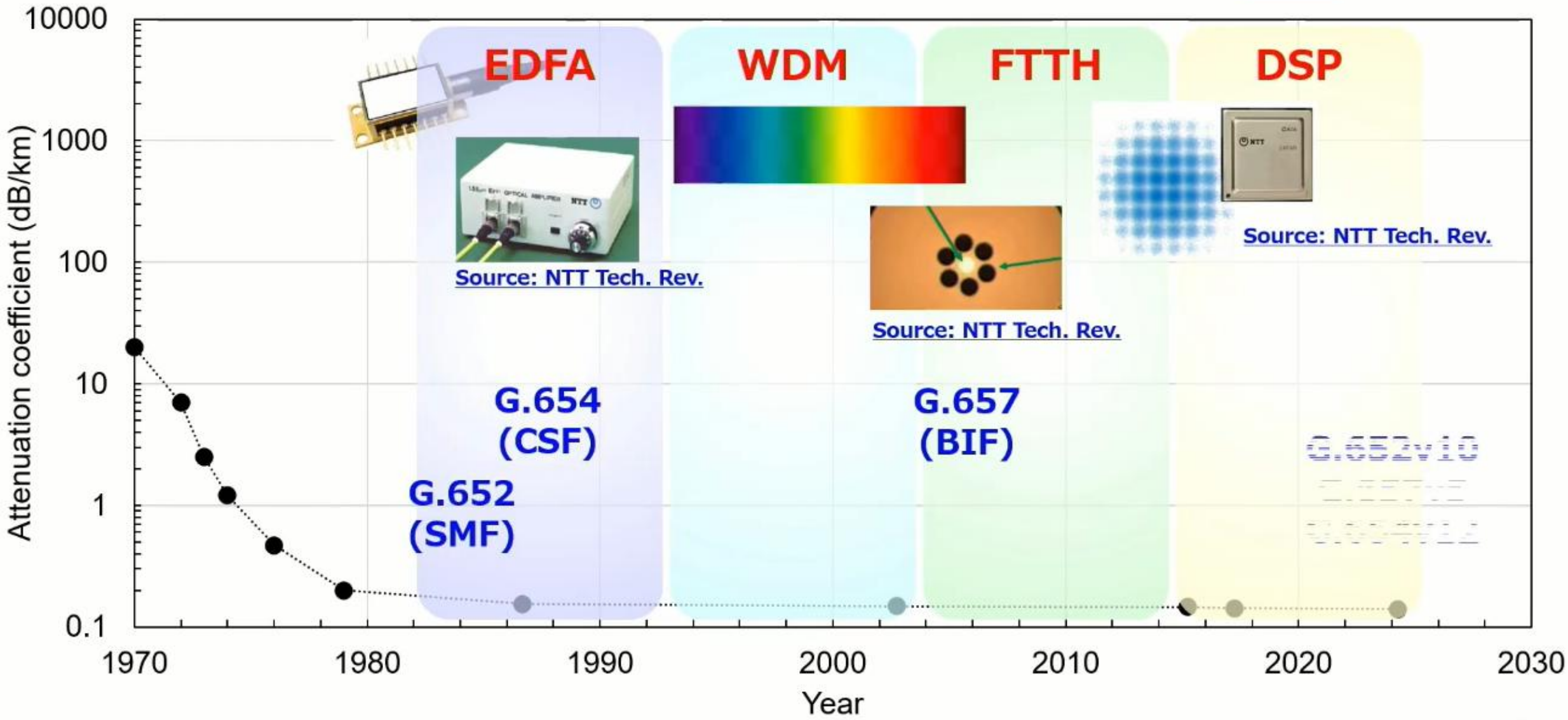
Access Network Service Systems Laboratories, NTT Inc.

29 September 2025

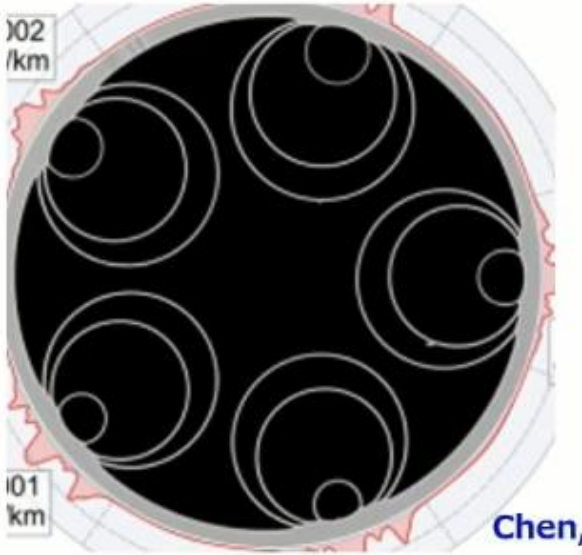
History of fiber

- **Charly Kao: Evangelist. Clean-up glass, then it will become transparent waveguide (SiO2)**
- **Corning: 1970 Mauer, Keck and Peter Schultz did it: (20dB/km)**
- **1310nm: Zero dispersion**
  - Open eye
- **1550: Low loss and … open eye**
  - Lowest loss
  - Dispersion -> dispersion shifted
- **And then**
  - EDFA (loss is no problem)
  - DWDM (dispersion is good.. Non-linearities) AND Electronics (dispersion compensation is no problem)
- **Future: ?**
  - Multicore fiber (vs thin fibers)
  - Hollow core fiber (costly -> short distances, high power)

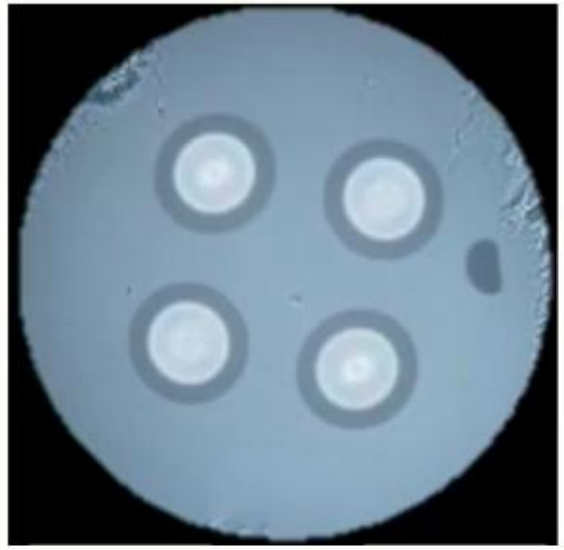
Recommendations G.65x



Hollow-core & Multi-core

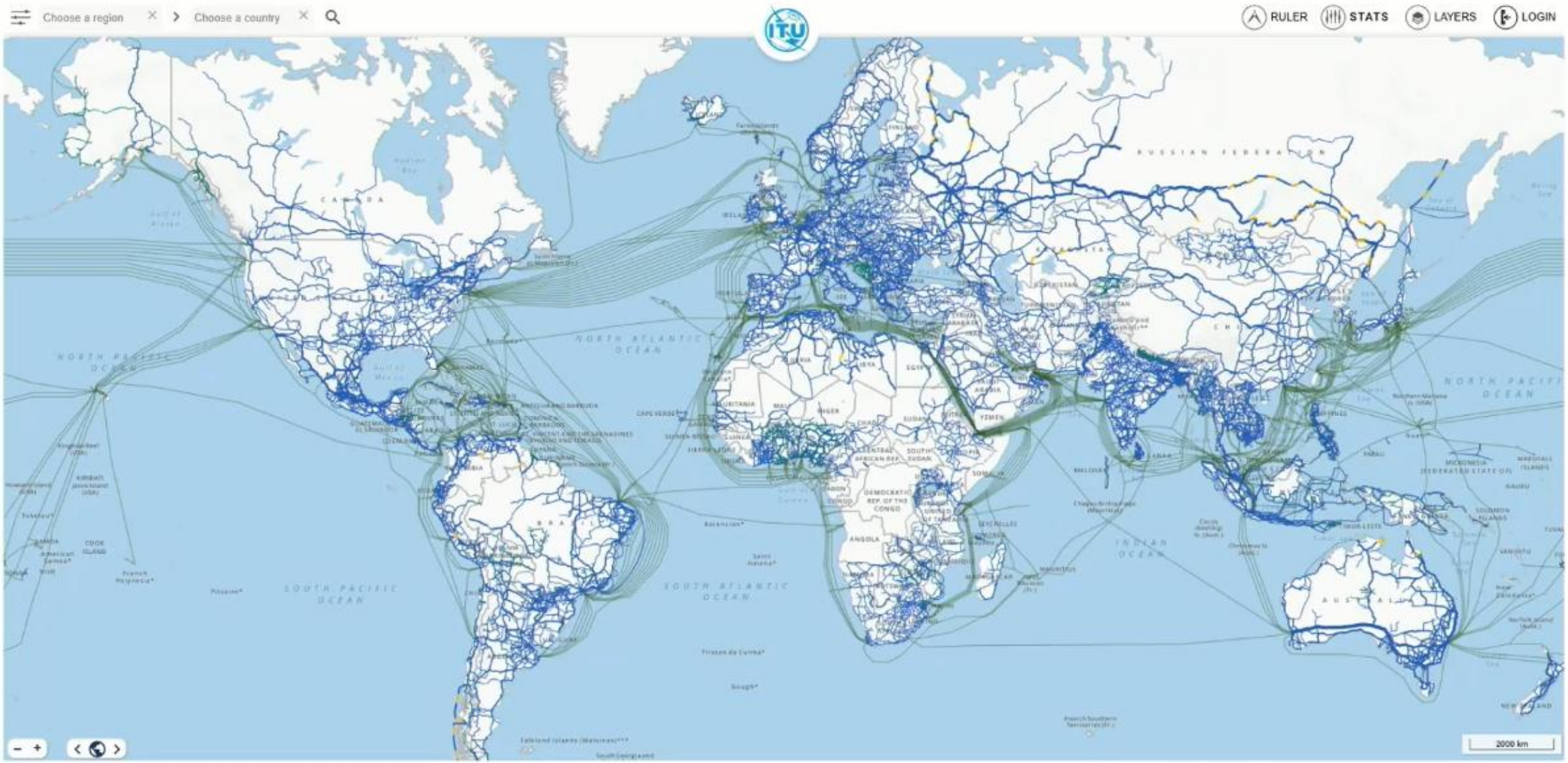


Chen, OFC, 2024



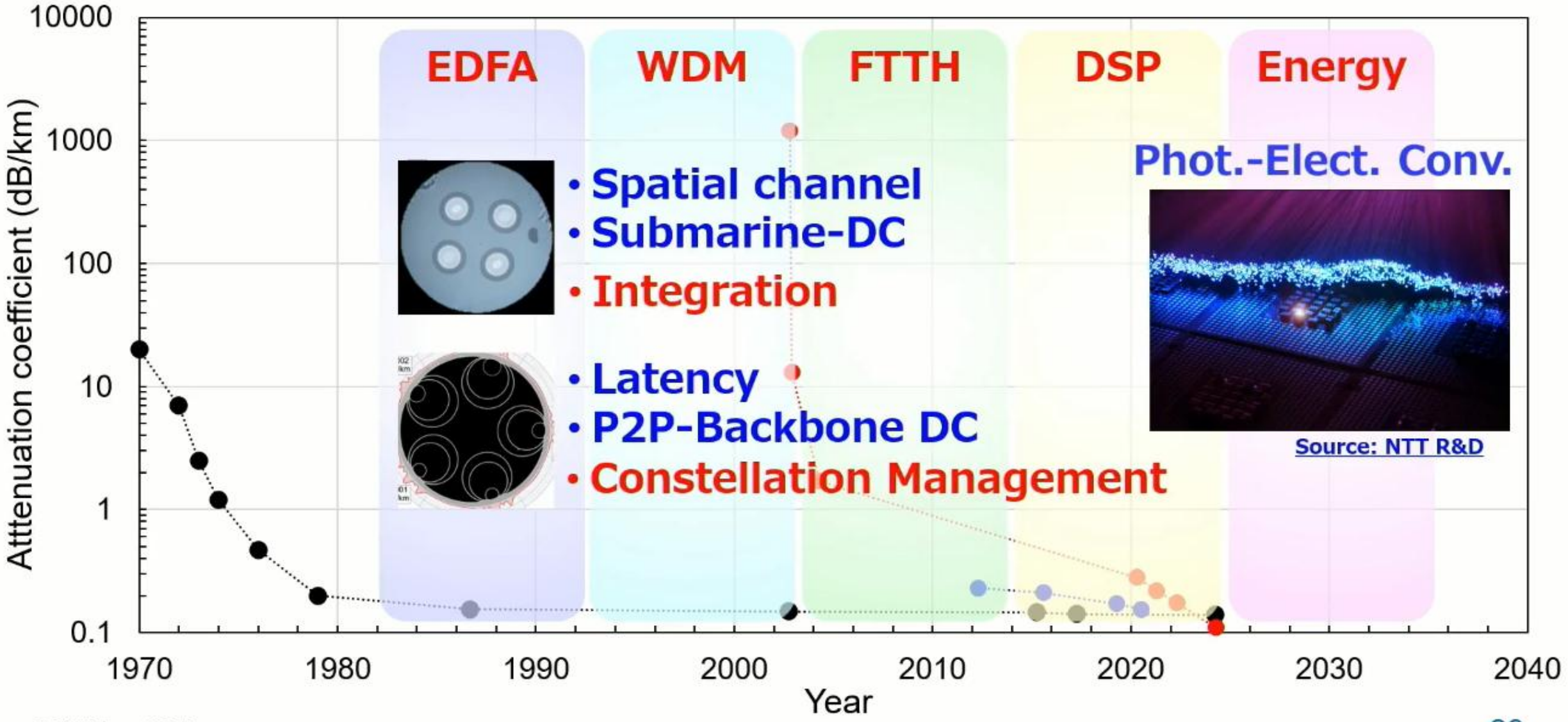
<0.10 dB/km	Attenuation	0.14-0.20 dB/km
>a few kW/core	Nonlinearity	< a few W/core
0.3 msec/100 km	Latency	0.5 msec/100 km

Can We Replace All?



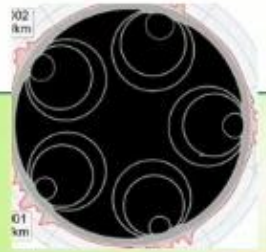
Source: ITU Connectivity Map

Summary



Roadmap and Objectives

ITU IEC



~20%

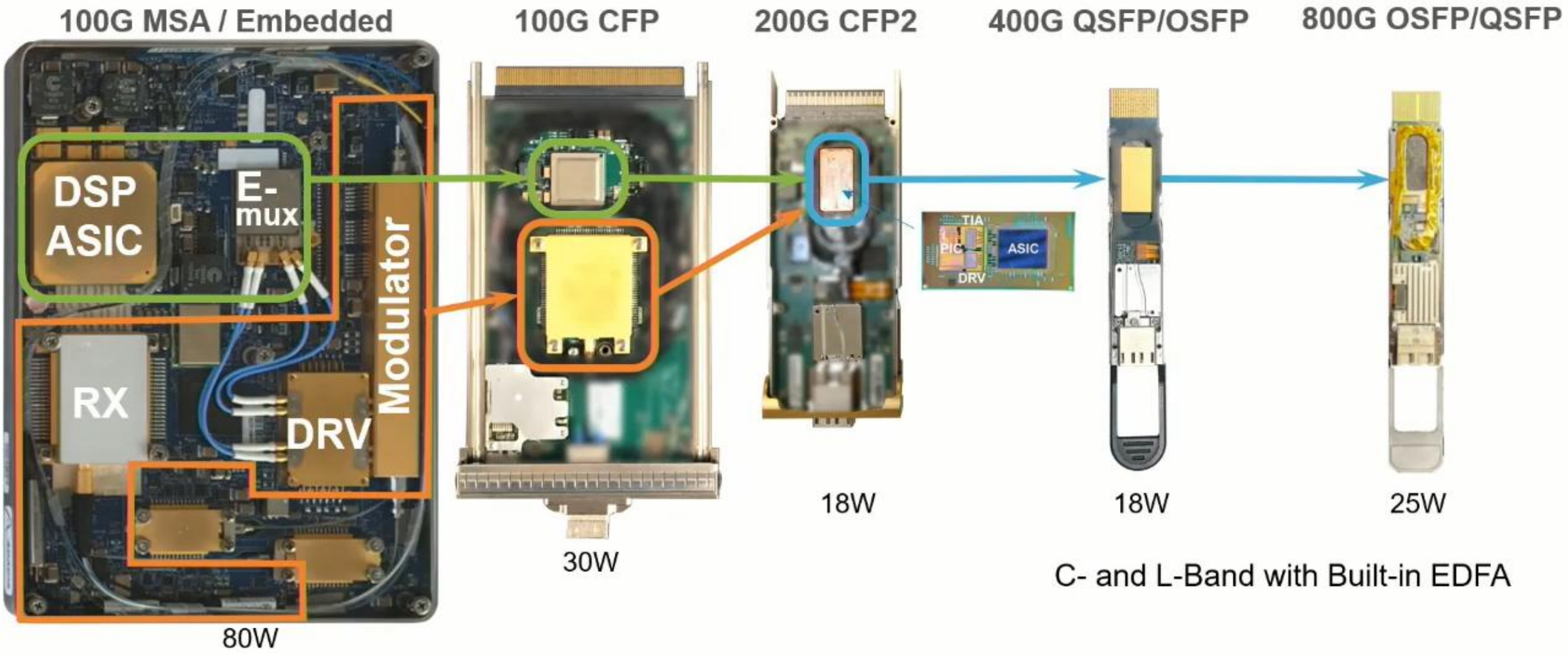
2025 2030 2035 2040

Coherent Optics: Powering the Next Decade of Optical Communications

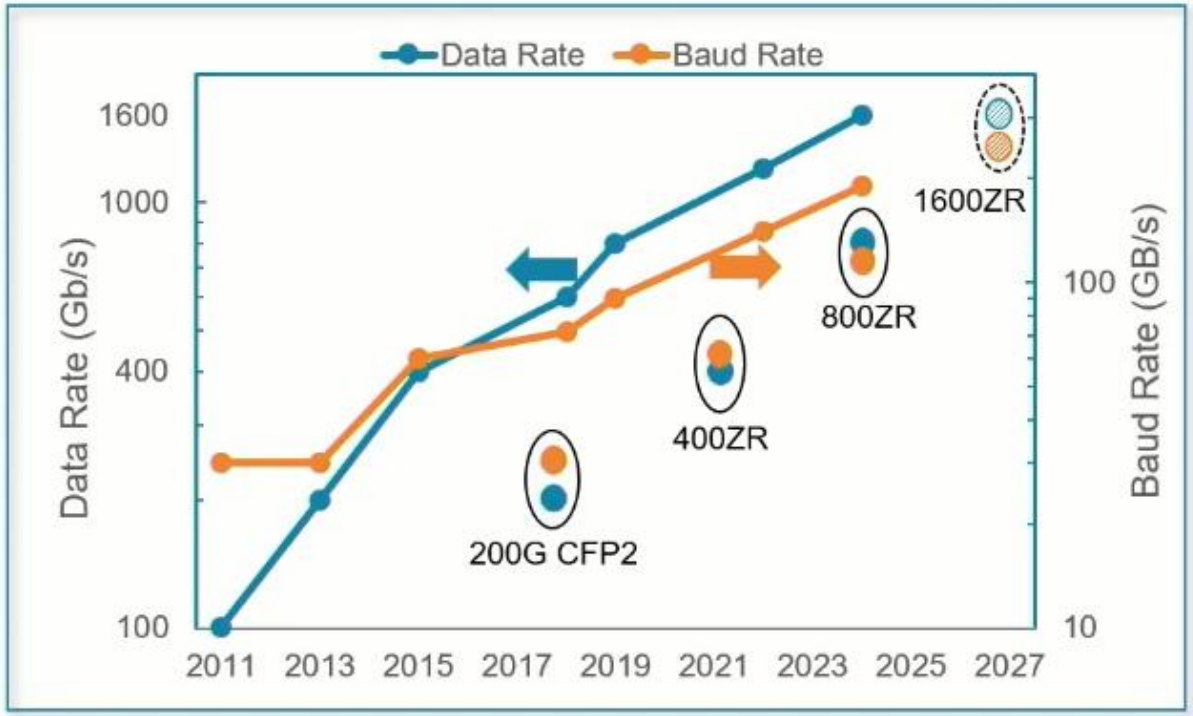
Benny Mikkelsen
SVP Cisco, GM Acacia

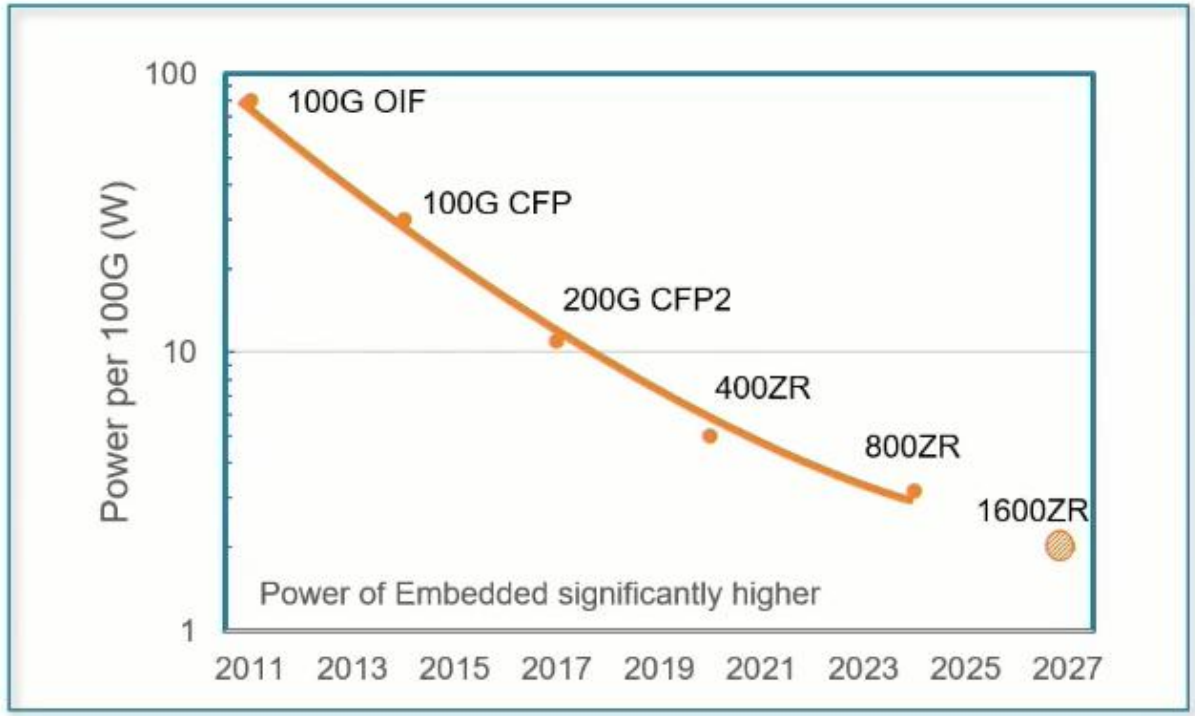
ECOC 2025 Sept 29, 2025

Evolution of Coherent Transceivers – from embedded to pluggables



Trends in Speed and Power Consumption

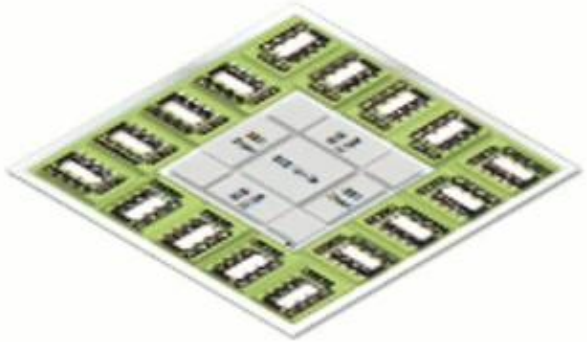




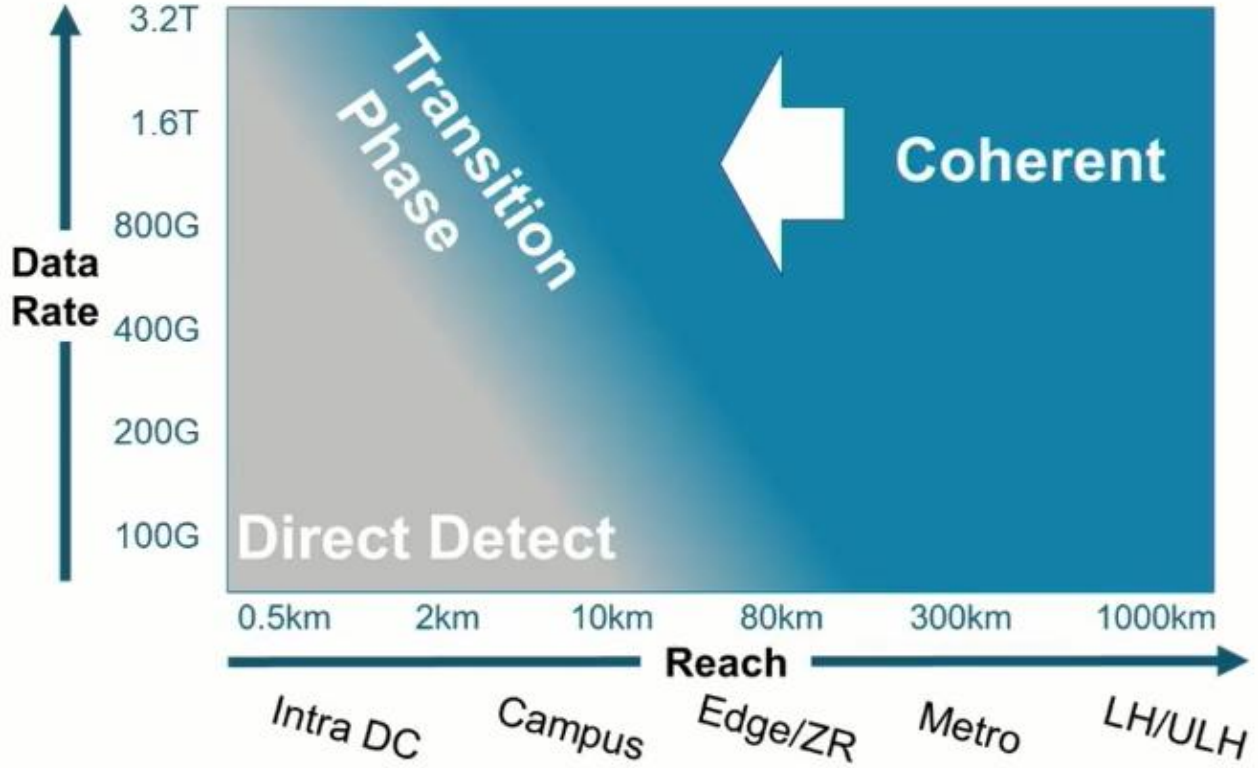
- Surpassed 1Tb/s per optical carrier in 2022 – Industry working on 1.6T with 240-260 Gbaud
- Getting more difficult to double speed / baud rate – likely to see optical multi-carrier implementations initially at 3.2T
- Higher baud rate provides lowest cost per bit
- Power consumption per 100G keeps decreasing – riding Moore's Law

Beyond Next Generation: Coherent moving into the Data Center

- Coherent eventually needed inside Data Centers as data rates keep increasing
- Overcoming the higher loss of Optical Circuit Switches
- Coherent might eventually be co-packaged with switches



Switch co-packaged with Coherent Optics



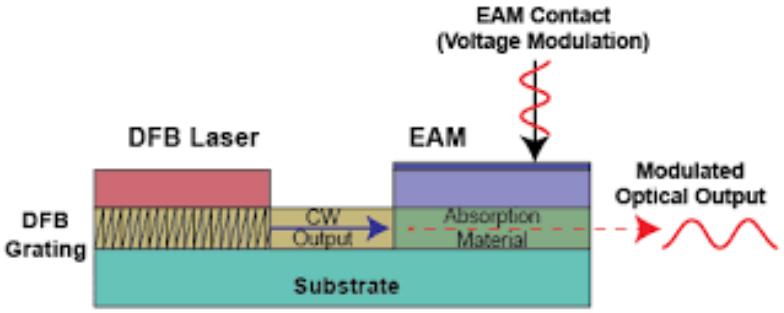
Datacom modulators

- **Direct modulation**
  - EML: Laser with built-in Electroabsorption modulator
  - VCSEL
- **Modulators based on phase shift**
  - MZM: Mach Zehnder modulators
  - MRM: Mircro Ring modulators
    - Phase shift
      - Si: pn junction
      - InP: pn junction
      - TFLN
      - Polymer
- **Configuration**
  - Pluggable
  - Near co-packaged, Linear….
  - Co-packaged

Modulators

Direct Modulation

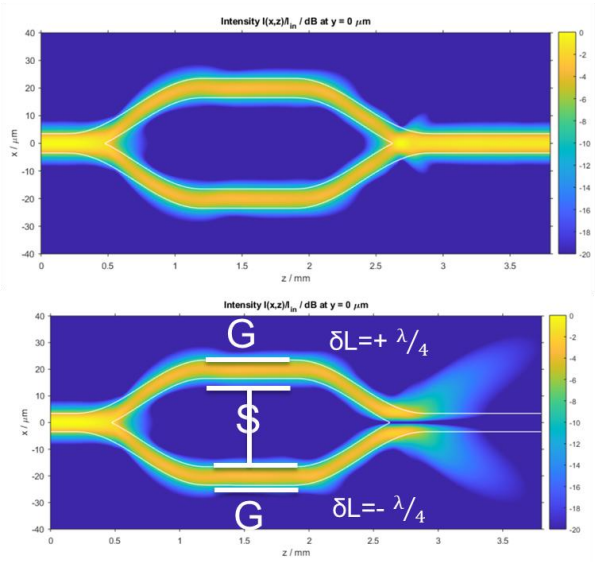
EAM



VCSEL

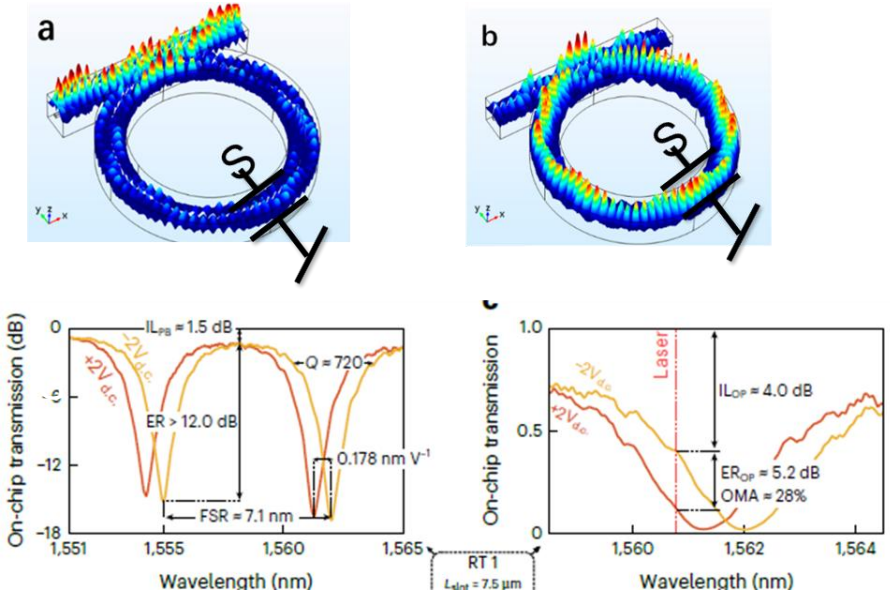
Mach Zehnder Device

MZM



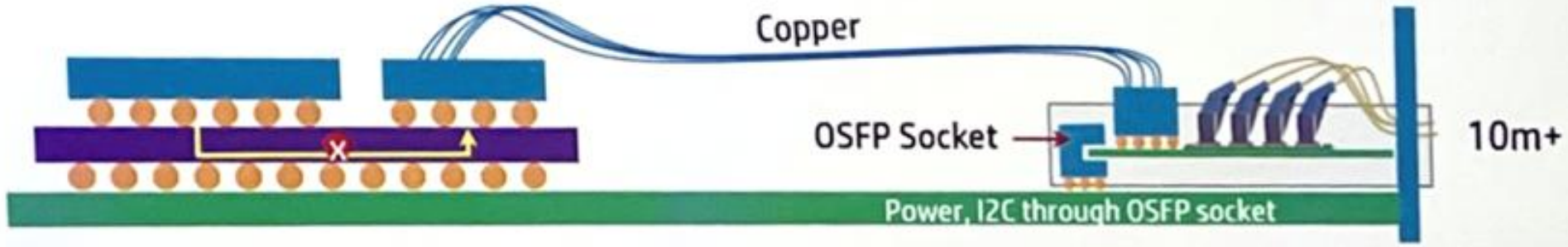
Micro Ring Modulator

MRM

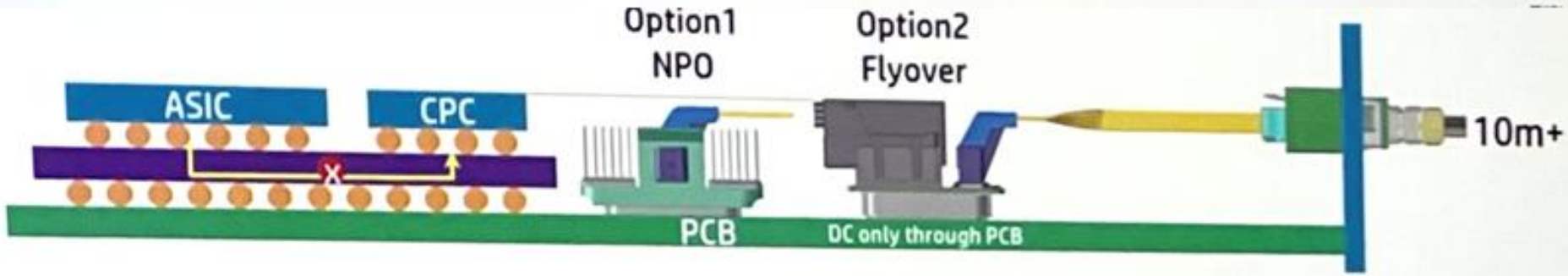


Serviceable from front panel

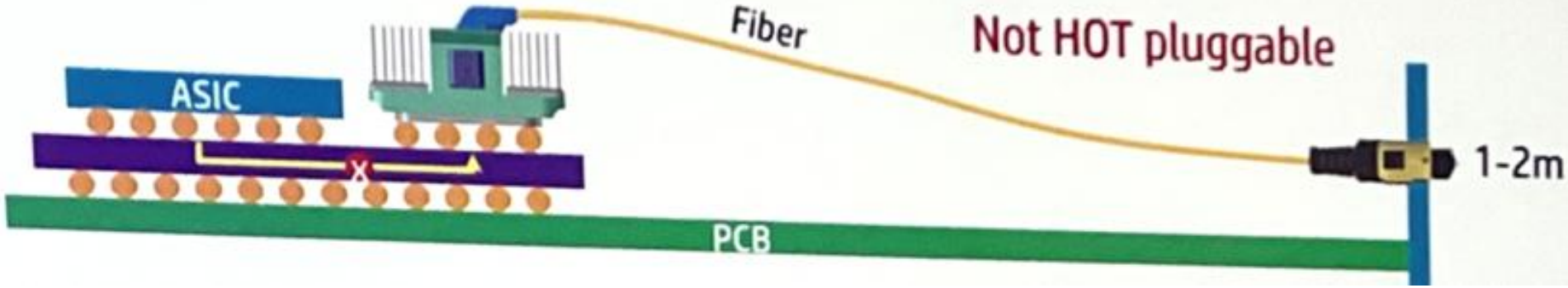
CPC to 32 lane **Pluggable***



Near-Packaged Optics, **NPO**



Co-Packaged Optics, **CPO**



MODULATOR TECHNOLOGIES FOR DATACOM IMDD TRANSCEIVERS

	100G/lane	200G/lane	400G/lane
Pluggable	InP EML, Si MZM, VCSEL	Si MZM, InP EML, VCSEL	Si MZM, InP EML [InP DFB-MZM, TFLN]
OBO/NPO/CPO (mod. driver)	Si MZM, Si MRM, VCSEL	Si MRM, Si MZM, VCSEL	Si MZM, Si MRM
CPO (Serdes 0.5-1V)	InP MZM on SiPh, InP EAM on SiPh, 3D TFLN on SiPh		

	Modulation efficiency	Size	Integration	Mitigation
InP MZM				Hybrid InP MZM with SiPh
InP EAM				Hybrid InP EAM with SiPh
Si MZM				
Si MRM				Improve modulation efficiency
TFLN MZM				Hybridization TFLN with SiPh

Coherent

Nividia

MZM: Mach-Zehnd
MRM: Microring Mo
EAM: Electro-Abso
EML: External Mod
VCSEL: Vertical Ca
Emitti
TFLN: Thin Film Lit

Poor

Toward direct drive by SERDES

Co-Packaged Optics In The Era Of AI

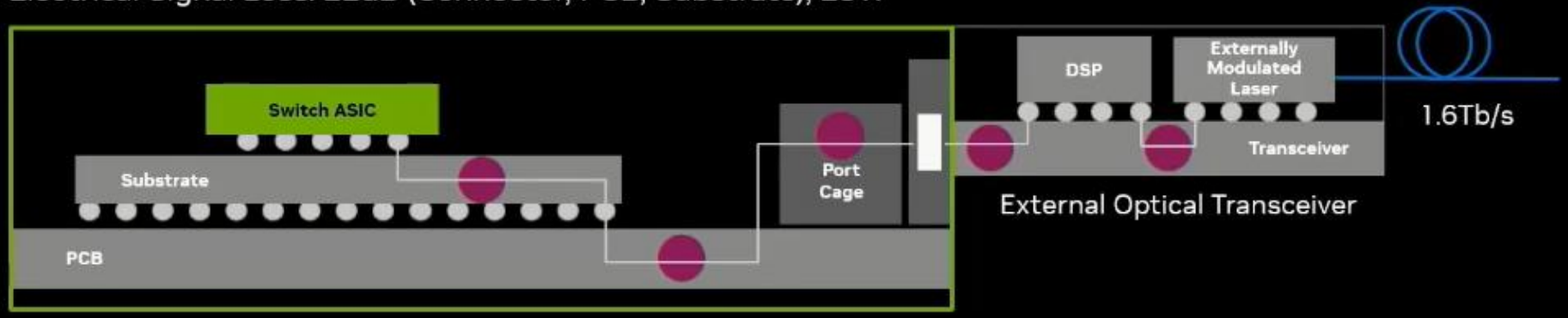
Edward Lee, Vice President, Mixed Signal Design

European Conference on Optical Communication 2025 Plenary

3.5X Power Saving, 10X Better Resiliency Spectrum-X Ethernet Photonics

Pluggable (25W)

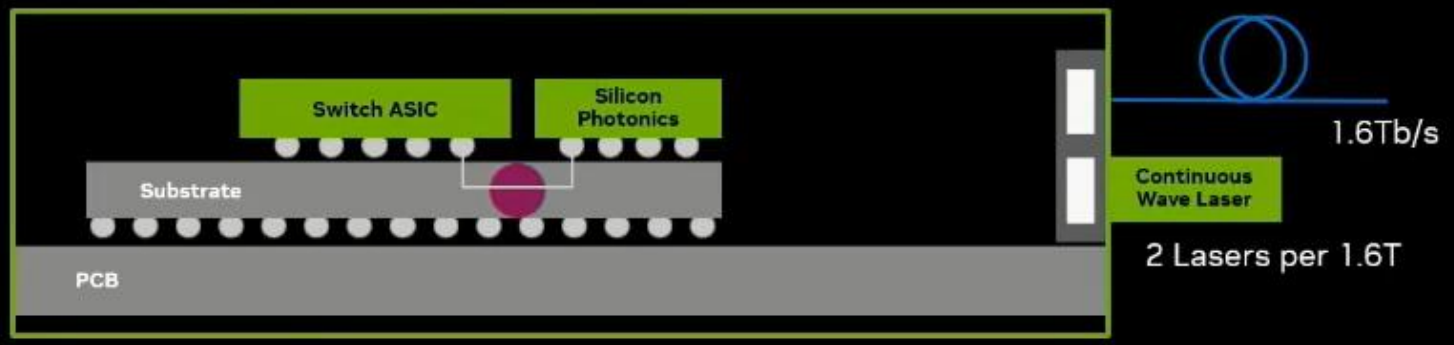
Electrical Signal Loss: 22dB (Connector, PCB, Substrate), 25W



Pluggable Switch

Co-packaged (7W)

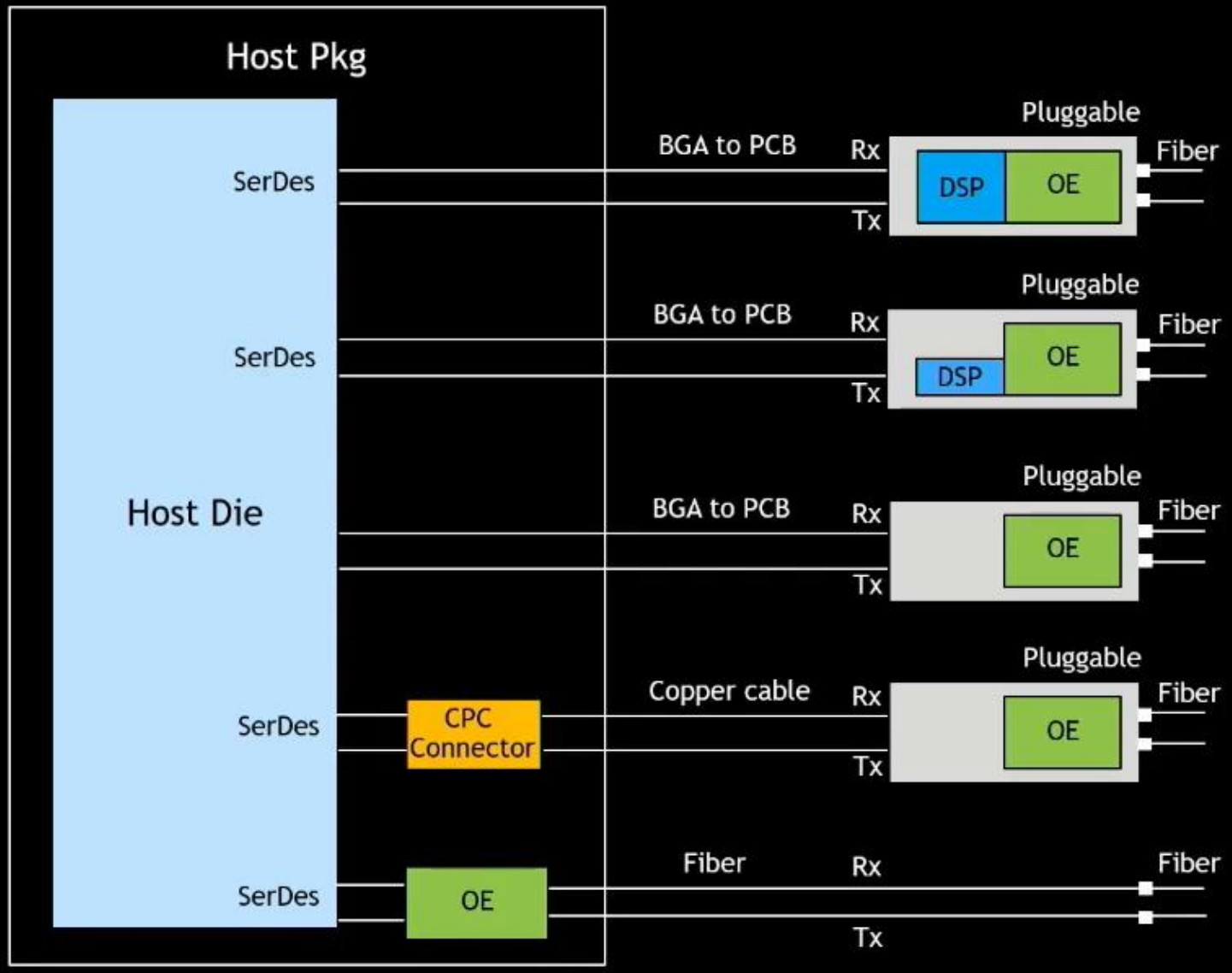
Co-packaged Optics: 4dB (Substrate), 7W



Spectrum-X Ethernet Photonics: Co-packaged Silicon Photonics

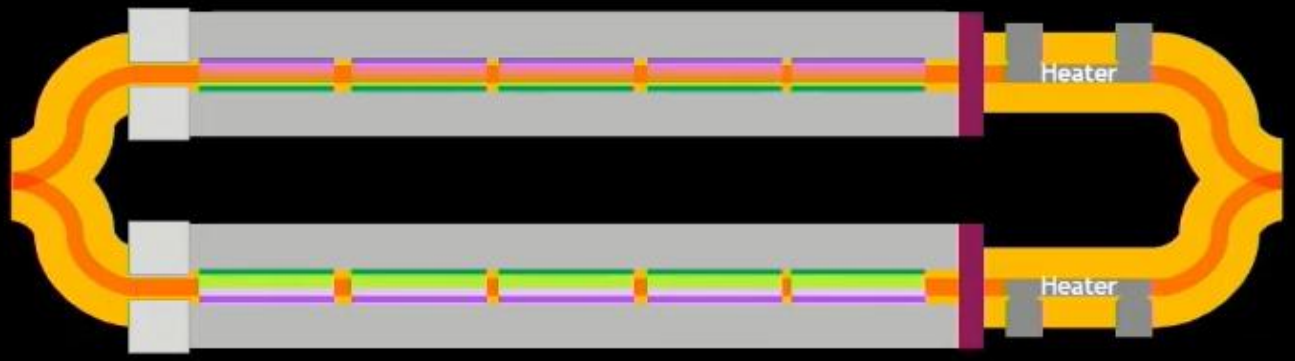
- Improved Signal Integrity
- Fewer points of failure
- Switch + Optics tested known good
- Low-touch installation and commissioning

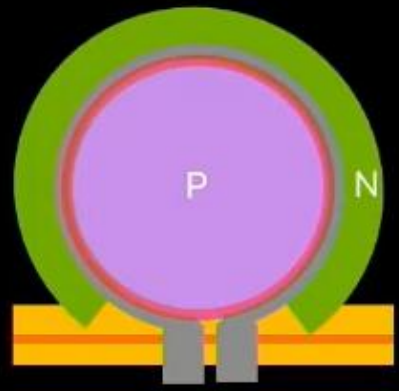
5 Versions of pluggable (power reduction)and one Co-packaed



	pJ/b	Power @1.6T
FRO (Full- Retimed Optics)	14	25W
TRO (Tx-Retimed Optics)	10	18W
LPO (Linear Pluggable Optics)	6.4	11W
LPO w/ CPC (Co-Packaged Copper)	6.4	11W
CPO (Co-Packaged Optics)	4	7W

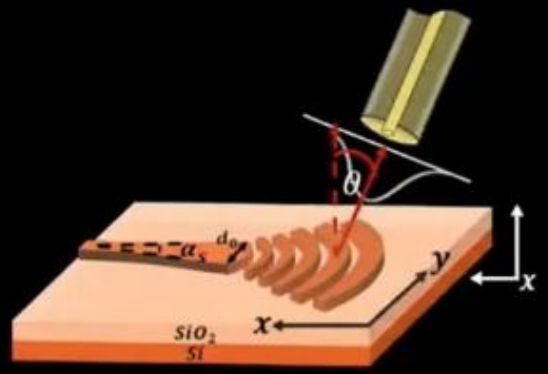
Si Modulator

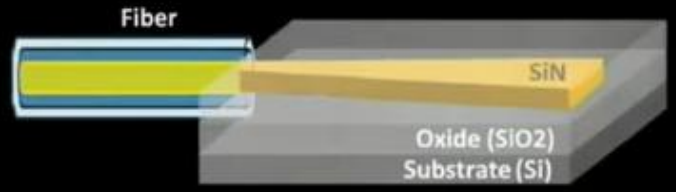




	TWMZM	MRM
Area	Large (millimeters)	Compact (microns)
Loss	4 ~ 7dB	4 ~ 6dB
Drive voltage	2 ~ 3.5Vpp	≤1.5Vpp
Modulation Bandwidth	< 50G	> 50G
Process sensitivity	Very little sensitivity	Q factor
Temperature sensitivity	Less	More

Optical Coupling



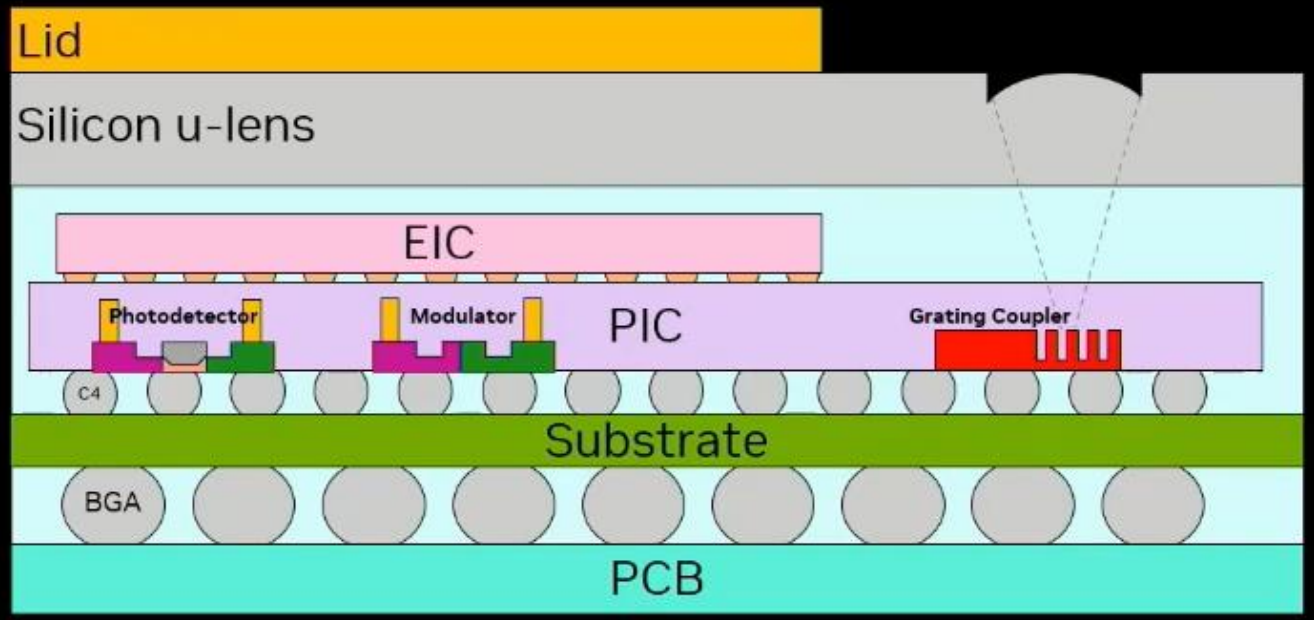


Frank Lee (2025). 3D Optical Interconnect Design *2025 Symposium on VLSI Technology and Circuit*

	Surface Coupling	Edge Coupling
Density	2D	1D
Footprint	50u x 50u	50u x 100s of um
Testing	Full link testing at wafer	Difficult at wafer level
Insertion loss with polarization handling	1.1x	1x
Process sensitivity	Under control	Challenging
Optical Bandwidth (1dB)	80nm	flat

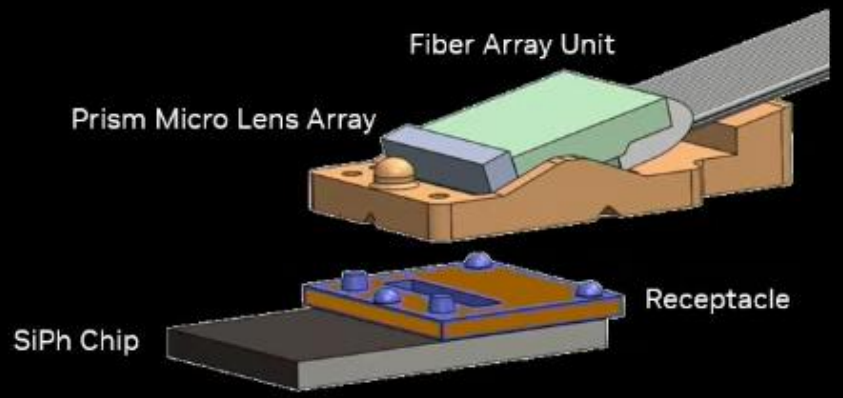
Photonics Engine

TSMC COUPE (Compact Universal Photonic Engine) Process

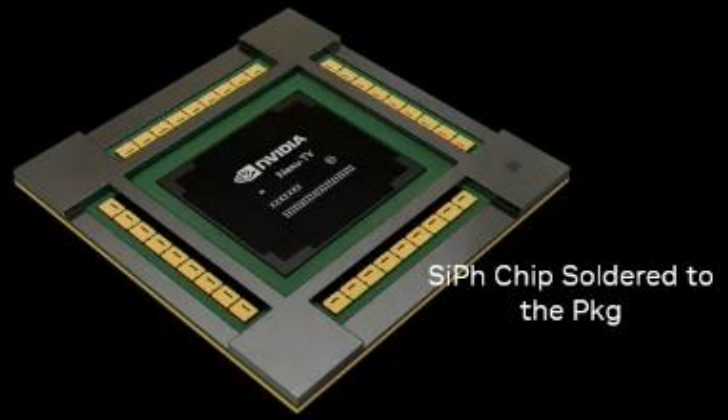


- EIC in TSMC FinFet logic process
- PIC in in SOI N65
- SoIC Bonding with dense RDL
- uLens design with Grating Couplers
- Integrated Metal Heaters
- Micro-Ring Modulators
- High-Speed Photo Detector

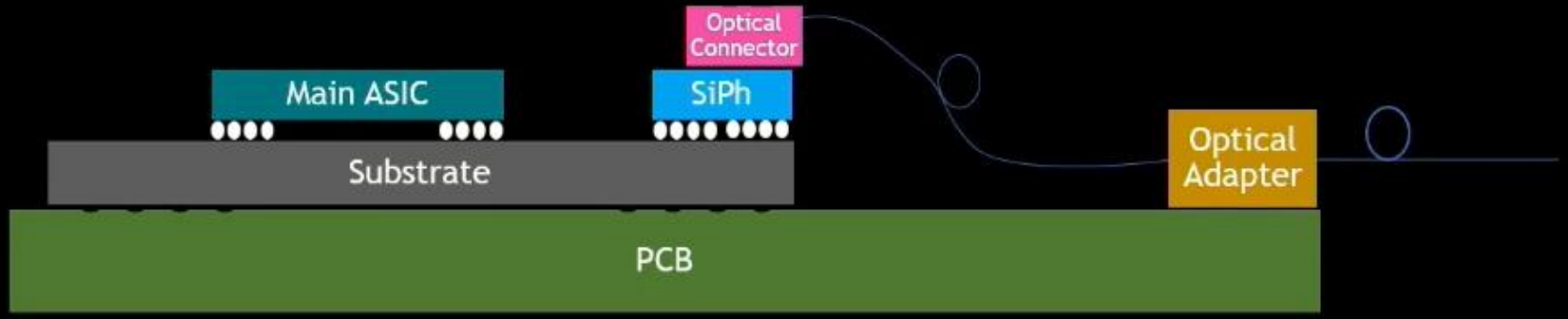
CPO Packaging



Detachable Connector



CPO Package (MCM)



Cross Section

High Power External Laser Source (ELS)

CW single-mode laser with high power, high efficiency and low noise

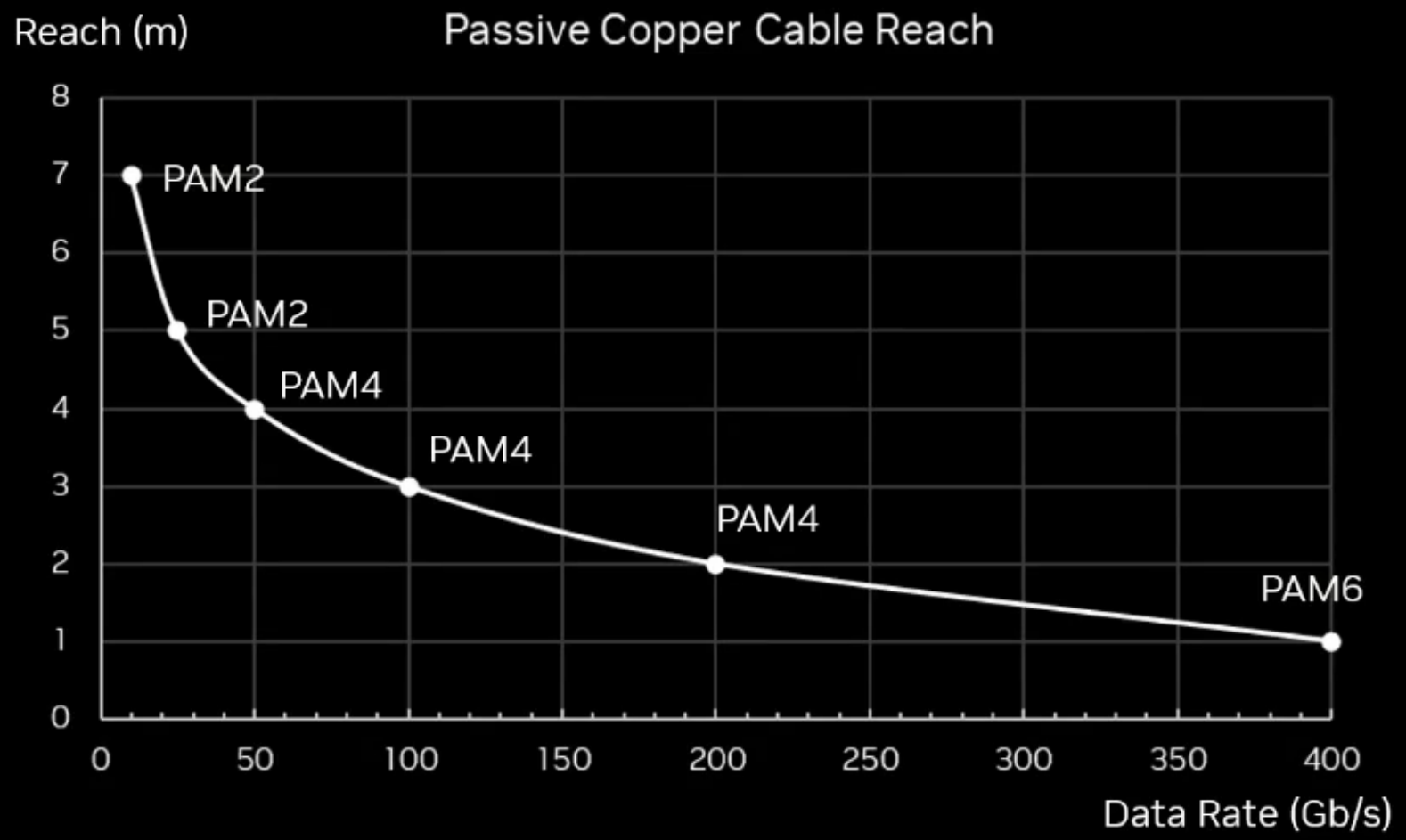
Main features:

- 1311nm
- High optical power of 200mW in fiber
- High efficiency > 20% E-O
- Low-noise (RIN and Linewidth)
- High yield and reliability

High optical power allows sharing lasers between multiple data lanes

- Reliability increase – reduce the number of lasers in a CPO system
- Packaging cost reduction – fewer PM fibers and fewer ELS modules
- CPO switch form-factor – smaller front-panel area occupied by ELS modules

Electrical Interconnect Scaling



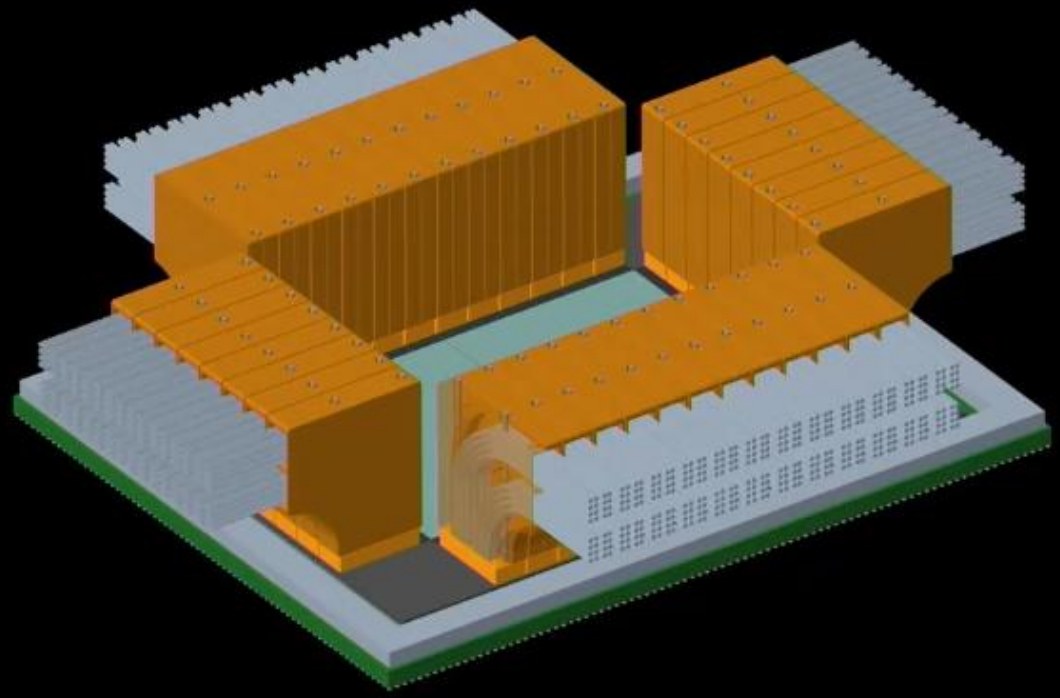
Solution and replacement must consider power, latency, cost

From narrow and fast to slow and wide VCSEL array

Bundles of Fibers Routed from Tx to Rx
- Moderate rate per fiber
- Most effective when combined with Optics On Interposer (OOI) due to lower-speed parallel data

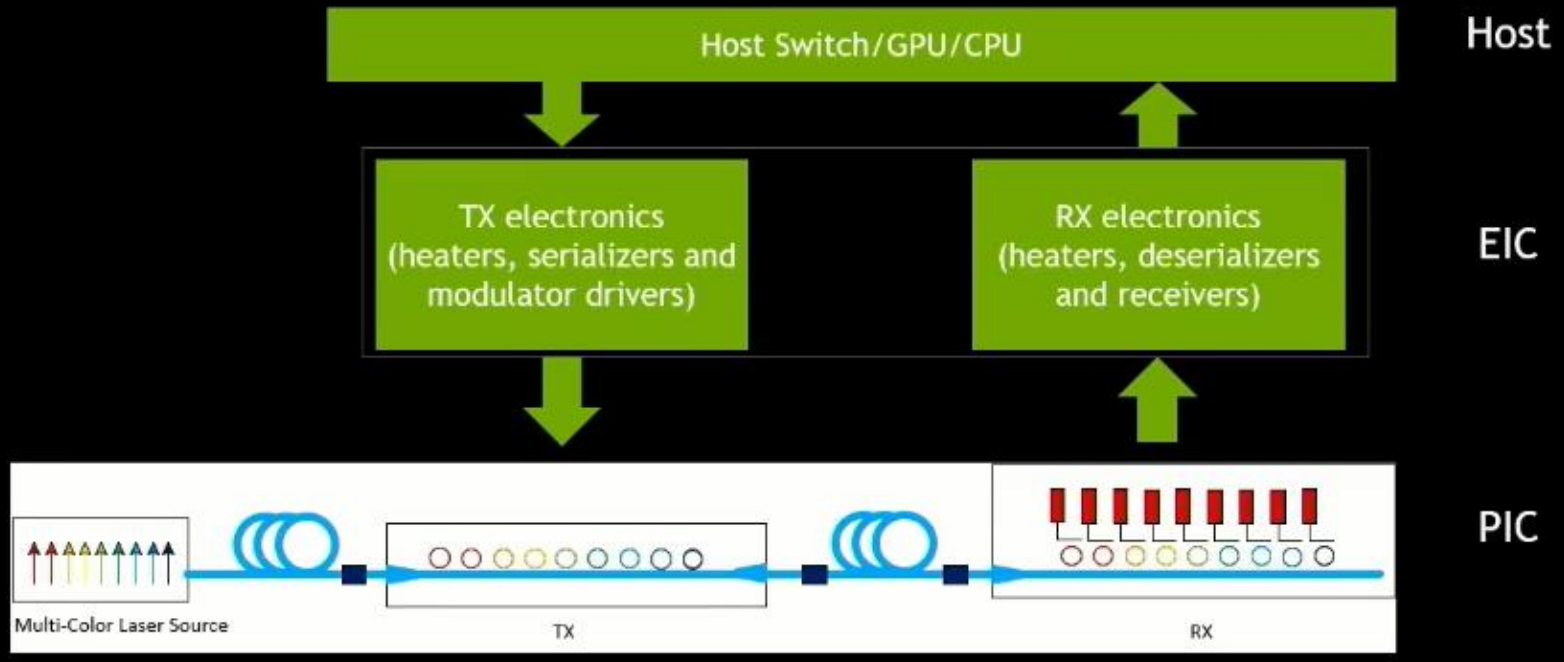
Pros +
- Potential for power and cost efficiency
- Simple communication channel

Cons -
- Transceiver heat must go down through the substrate
- Concerns on VCSEL reliability



VCSEL Reliability

From narrow and fast to slow and wide DWDM MRM



- Silicon Photonics with lowest possible pJ/bit (3.5-4 pJ/b including laser)
- 8-λ DWDM micro-ring resonators @ 50Gbps PAM2, 400G per fiber
- Most effective when combined with Optics On Interposer (OOI) due to parallel low-speed electrical interface
- Multiple scaling options via more λs, higher data rate per λ, higher PAM, polarization multiplexing