CONNECTING AT THE SPEED OF LIGHT

Coherent Optical Solutions for Data Center Interconnections

OPTINET 2019

JUNE 13, 2019

The World Has Moved to the Cloud

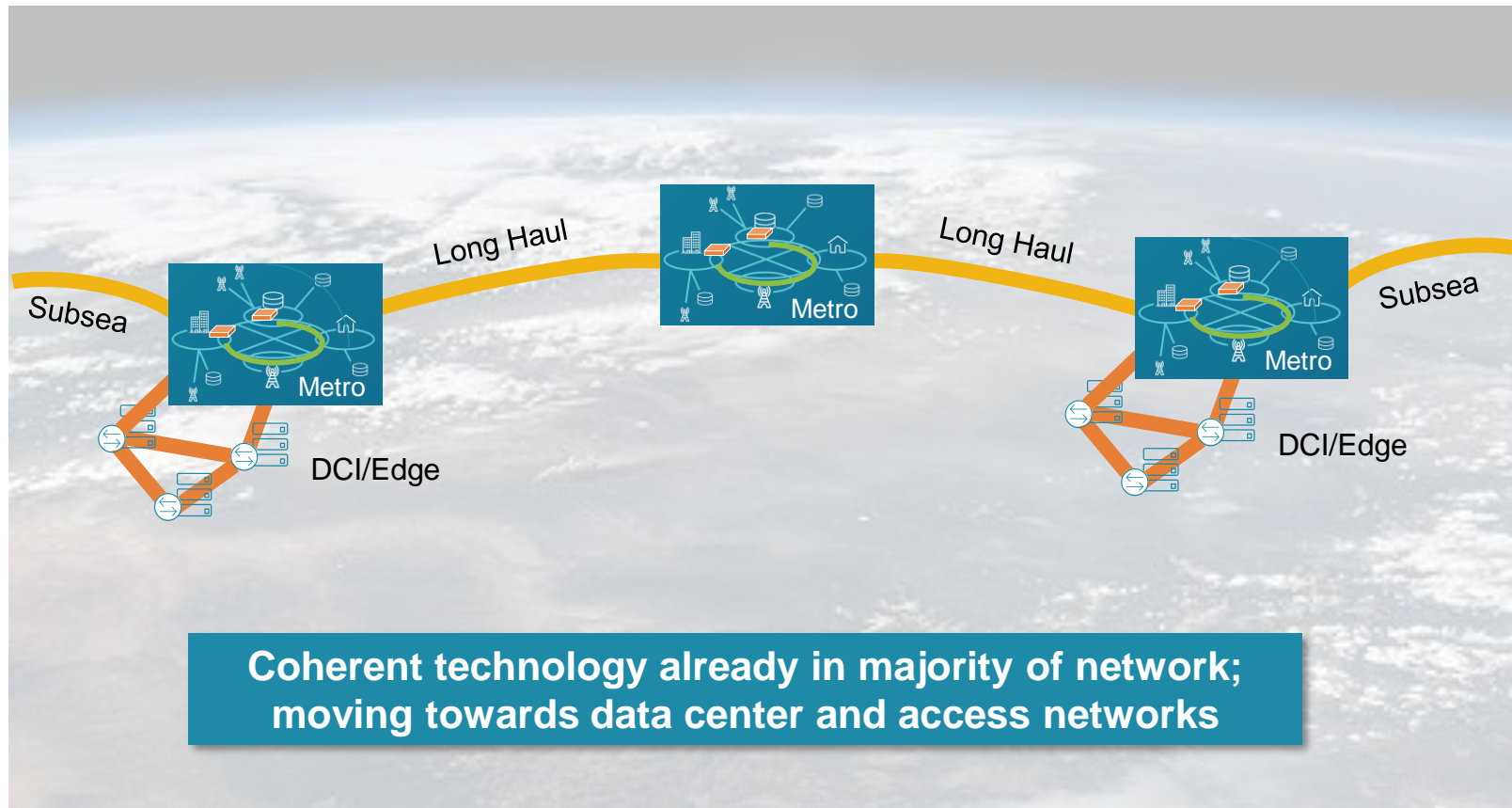Millions of Servers in the Cloud

Billions of Smart Phones

- From RagingWire

Hyper-scale Datacenter Era

Network Coherent Requirements are Expanding

Subsea

Long Haul

Long Haul

Subsea

Metro

Metro

Metro

DCI/Edge

DCI/Edge

Coherent technology already in majority of network; moving towards data center and access networks
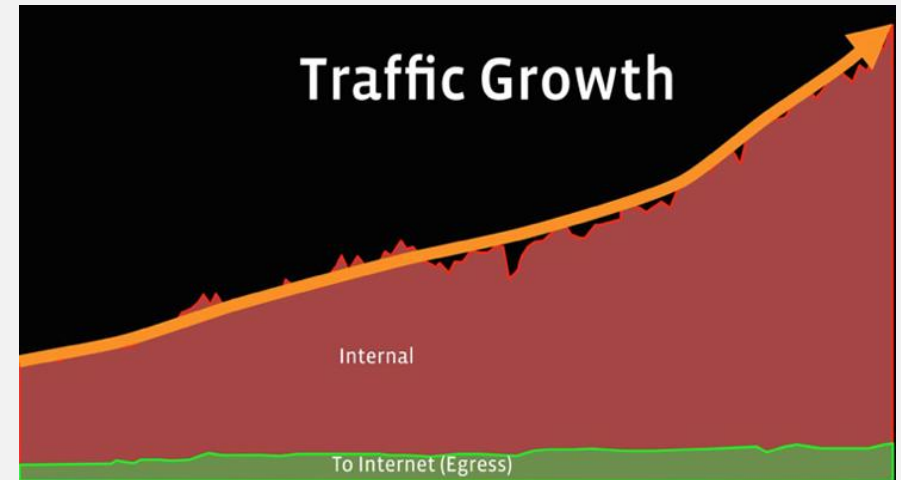
ACACIA
COMMUNICATIONS, INC.

Data Center Traffic Patterns and Trends

Intra-datacenter Bandwidth Growth

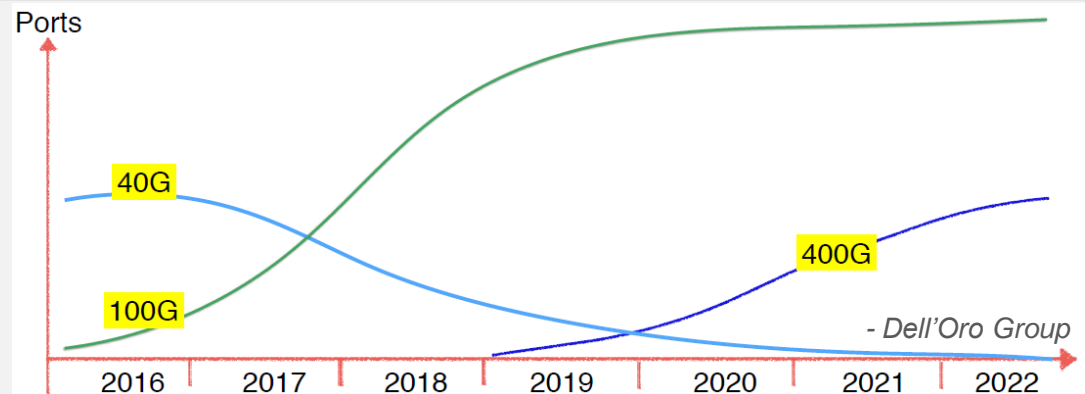Traffic generated by servers in our datacenters
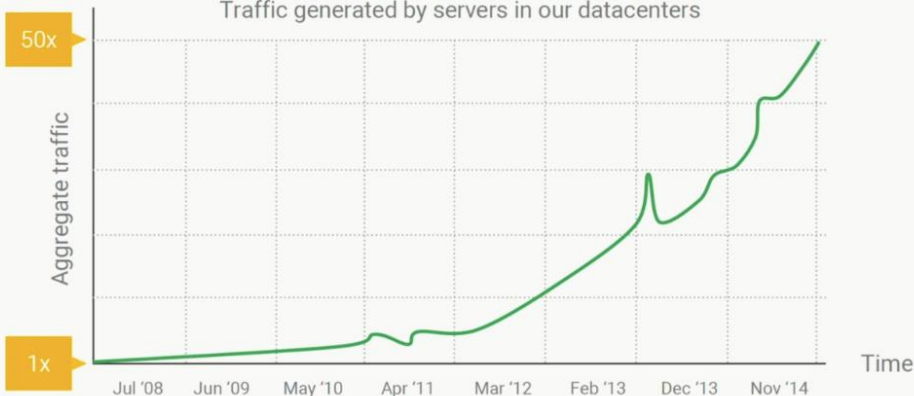
- *Google*

- *Facebook*

- Bandwidth doubling/year
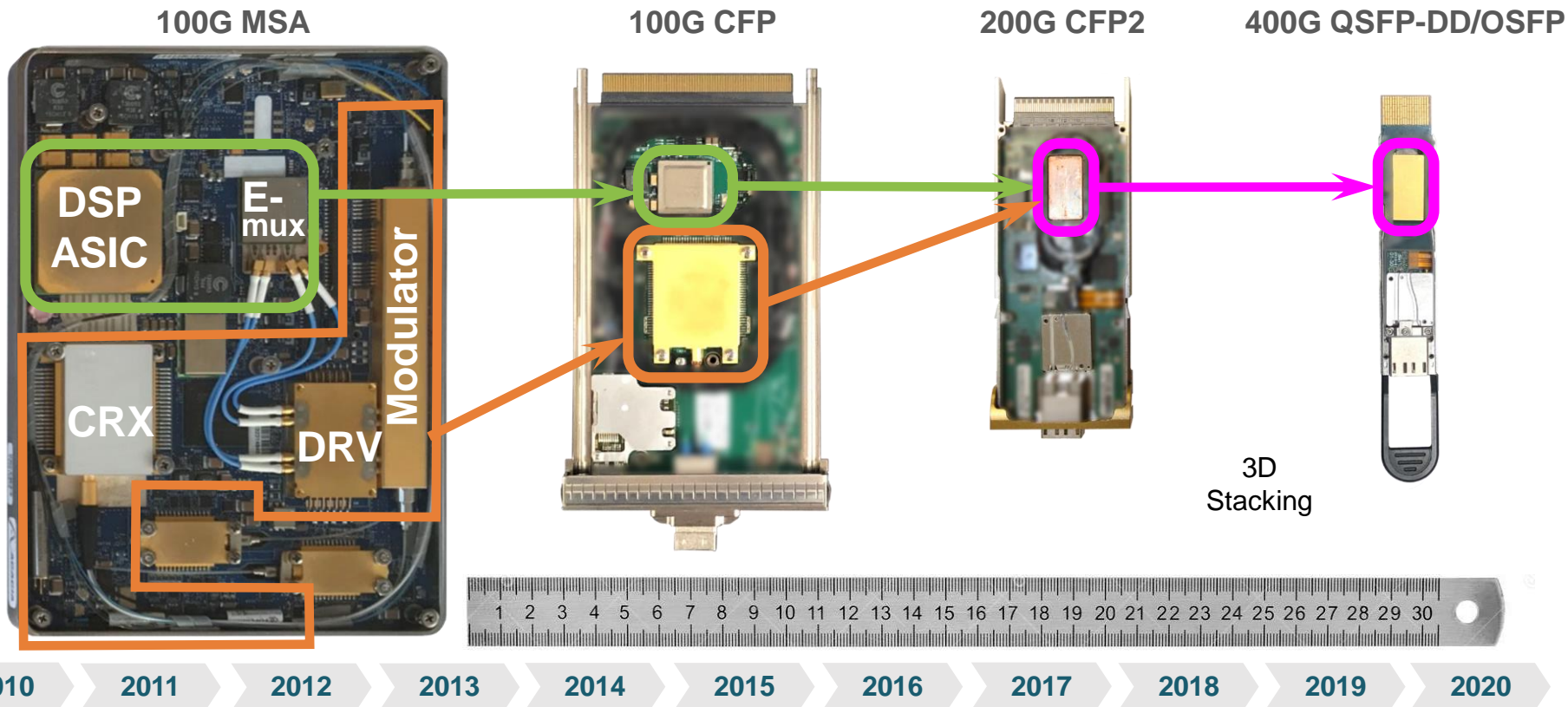- Driven by video, artificial intelligence, and machine learning

Switch Port Transition
400G passes 100G bandwidth in 2022

- *Dell'Oro Group*
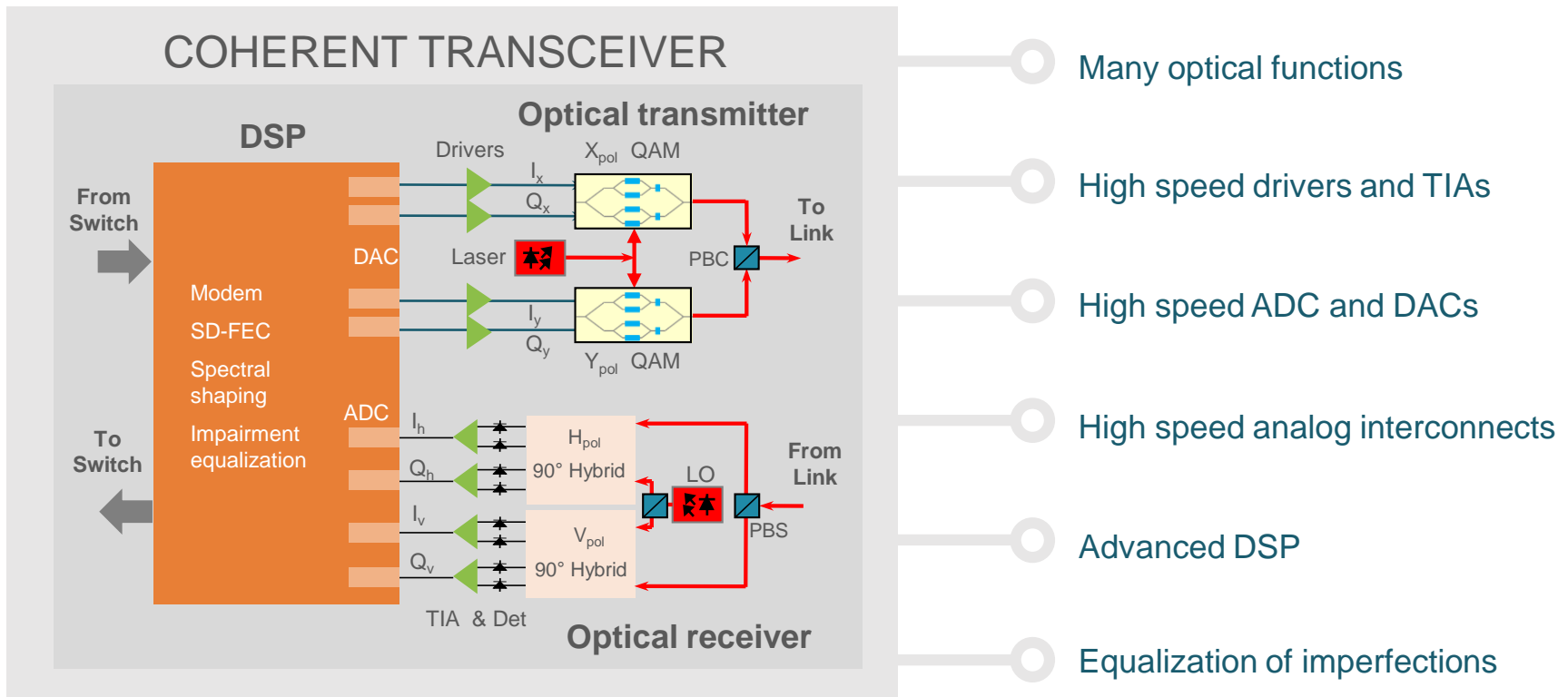
Coherent Gets Smaller and Smaller

100G MSA   **100G CFP**   **200G CFP2**   **400G QSFP-DD/OSFP**

DSP ASIC — E-mux — Modulator — CRX — DRV

3D Stacking

2010   2011   2012   2013   2014   2015   2016   2017   2018   2019   2020

Coherent: Ideal for Electro-Photonic Integration

COHERENT TRANSCEIVER

- Many optical functions
- High speed drivers and TIAs
- High speed ADC and DACs
- High speed analog interconnects
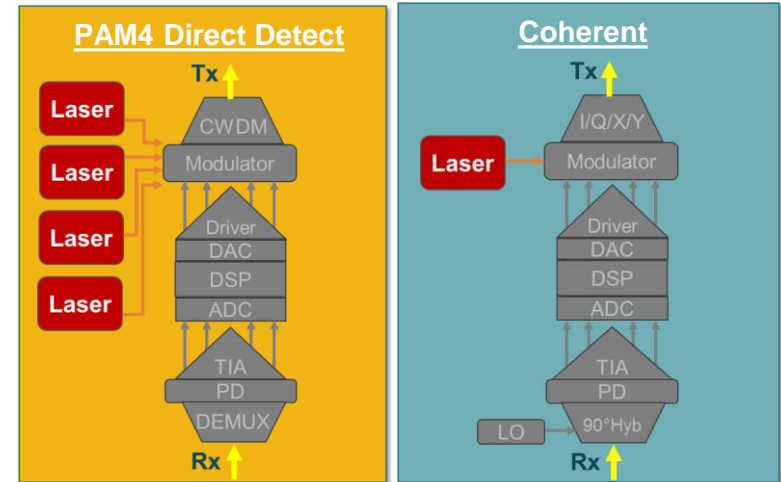- Advanced DSP
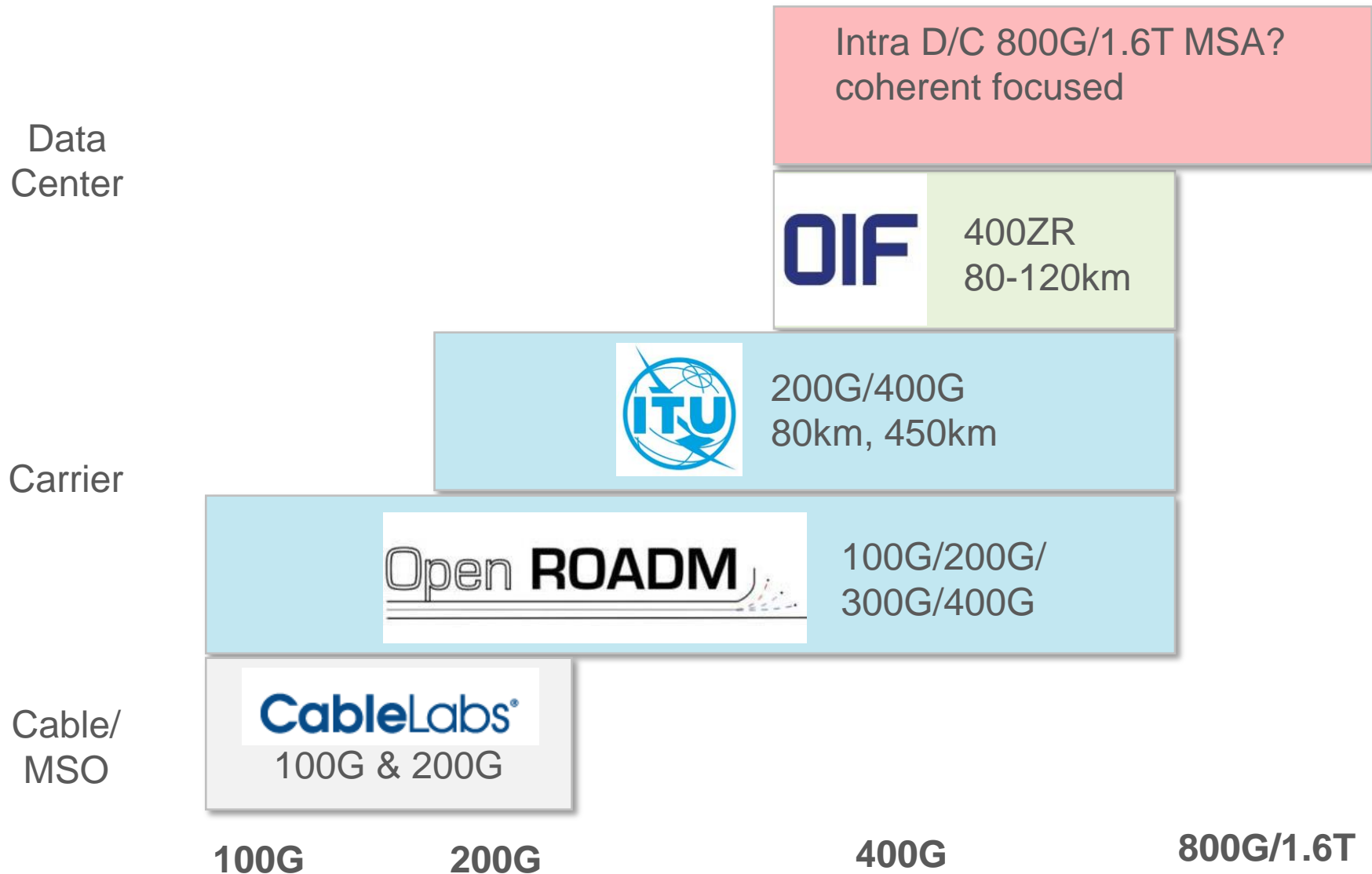- Equalization of imperfections

Optical Interconnect Trends
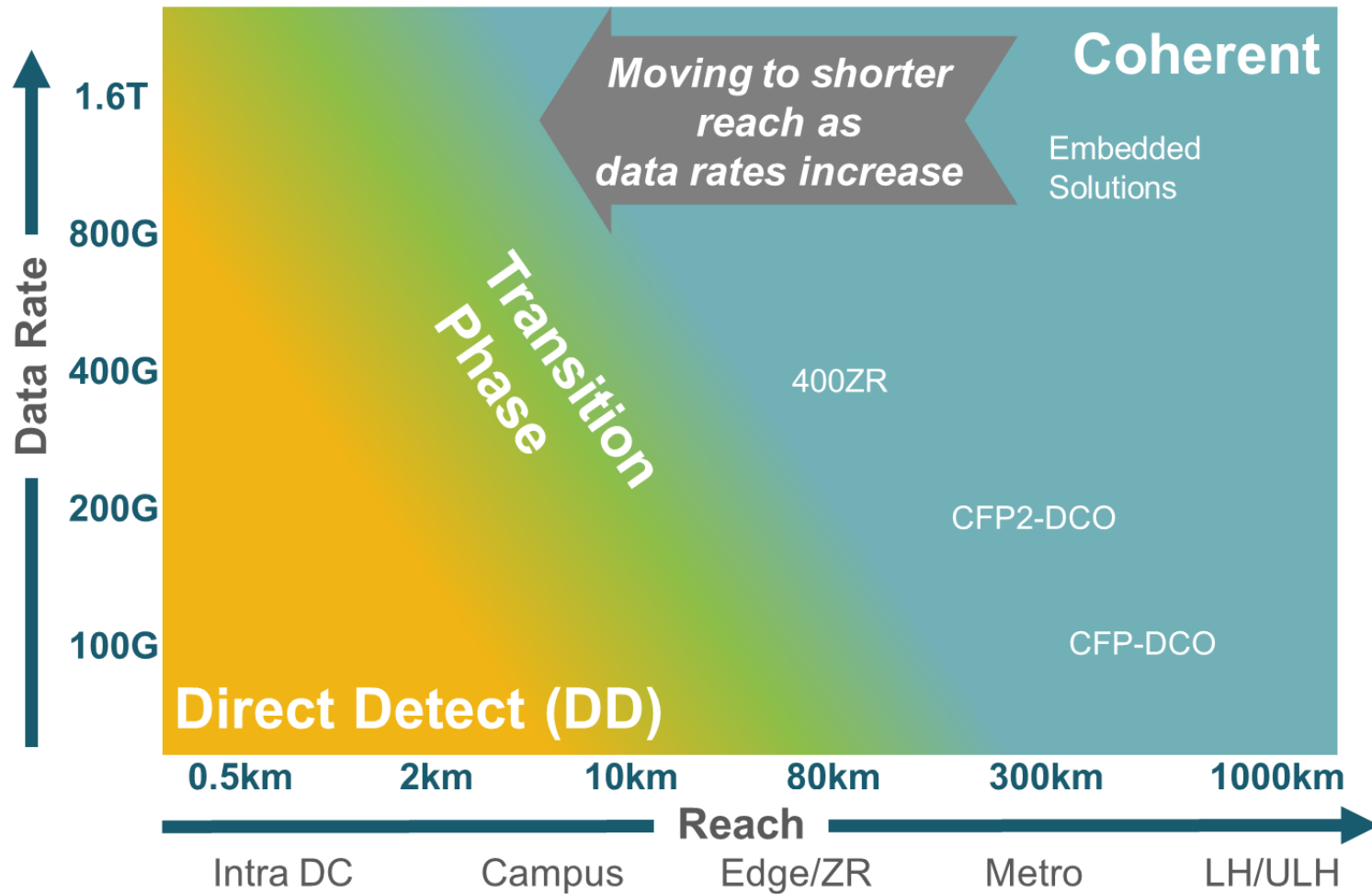
Moving into the Data Center: Coherent Advances

- ≥400G Sweet Spot for Coherent

  - Similar complexity as PAM4

  - Move complexity to Electronic domain

  - Add Pol and Phase for 4x capacity

  - Efficient EQ for non-perfect optics

  - Power of 800G <18W

- Enabling Technology Advances

  - Silicon Photonics

  - Multilevel with DSP being introduced at 400G

  - Advanced miniaturization/integration (co-packaging)

  - 2.5D and 3D stacking

Very similar building blocks
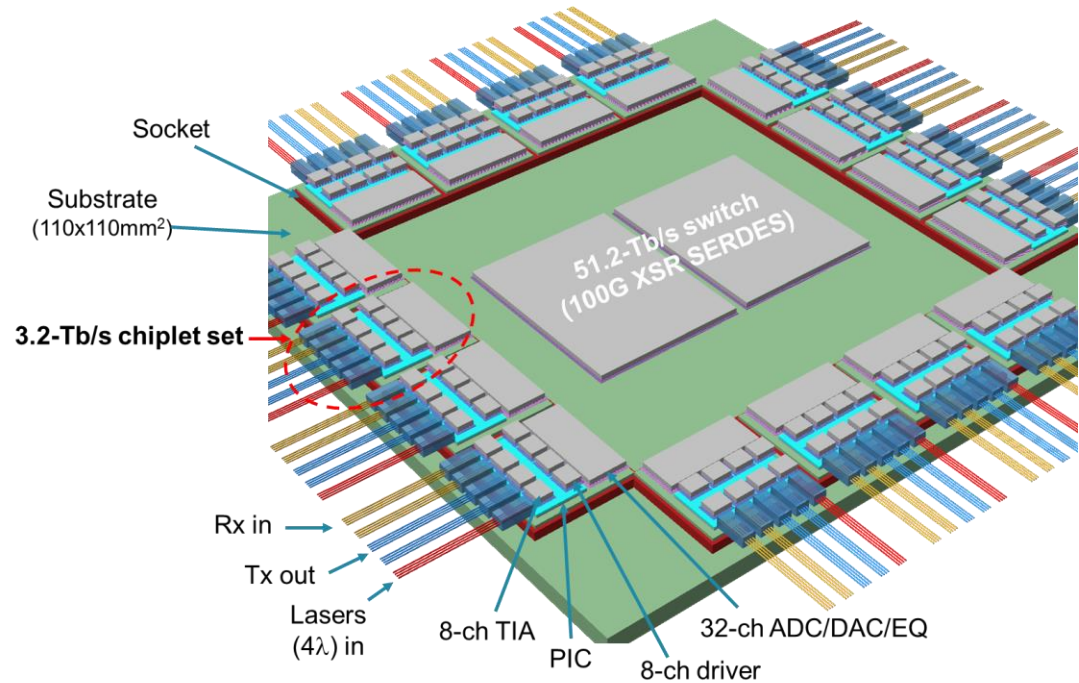

PAM4 Direct Detect — Tx — Laser, Laser, Laser, Laser, CWDM, Modulator, Driver, DAC, DSP, ADC, TIA, PD, DEMUX — Rx

Coherent — Tx — Laser, I/Q/X/Y, Modulator, Driver, DAC, DSP, ADC, TIA, PD, LO, 90°Hyb — Rx

ACACIA
COMMUNICATIONS, INC.

Standardization Momentum on Coherent

Intra D/C 800G/1.6T MSA?
coherent focused

Data Center

OIF — 400ZR 80-120km

Carrier

ITU — 200G/400G 80km, 450km

Open **ROADM** — 100G/200G/300G/400G

Cable/ MSO

CableLabs® — 100G & 200G

100G   **200G**   **400G**   **800G/1.6T**

ACACIA COMMUNICATIONS, INC.

50Tbps Switch with Co-packaged Optics

Switch-to-Optics Options

Pluggable Optics

On-board Optics

Co-packaged Optics

Socket

Substrate
(110x110mm²)

3.2-Tb/s chiplet set

51.2-Tb/s switch
(100G XSR SERDES)

Rx in

Tx out

Lasers
(4λ) in

8-ch TIA
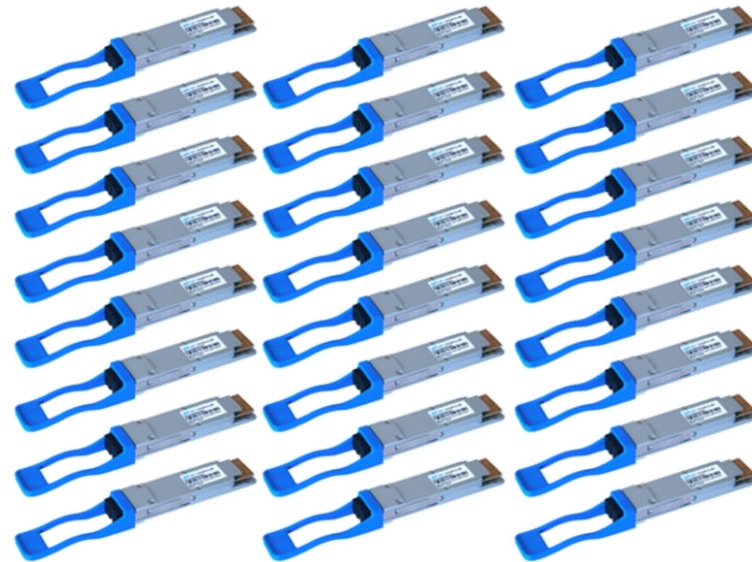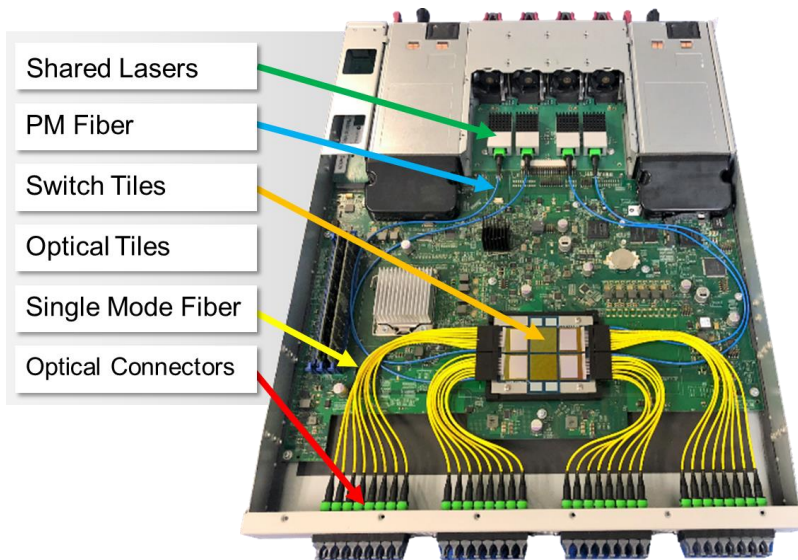
PIC

32-ch ADC/DAC/EQ

8-ch driver
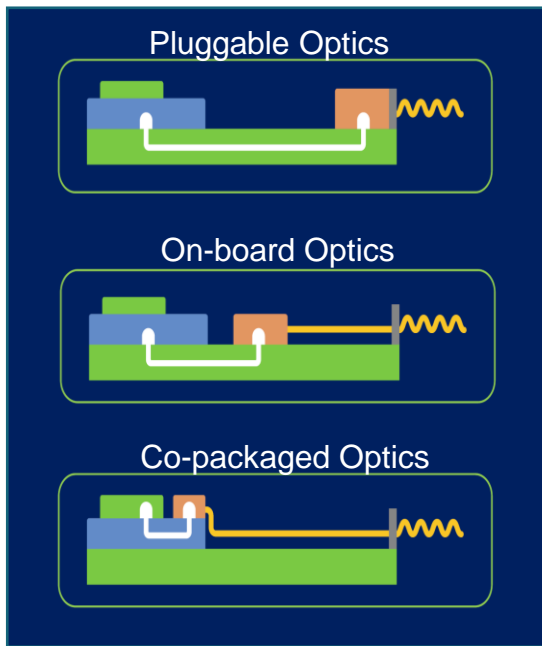
50Tbps Switch with Co-packaged Optics Saves Power and Space

Switch IO Bandwidth	Lane Speed	Type of Pluggables	Number of Ports	Line-card Height	ASIC Core Power	SERDES and Retimer Power	Optics PMD Power	Total Power
25.6Tb/s	100Gb/s	400G DR4/FR4	64	2RU	400W*	340W*	500W	1240W
51.2Tb/s	100Gb/s	400G DR4/FR4	128	2+RU	560W*	480W*	860W	1900W

100%
Reduction

15-20%
Reduction

Shared Lasers

PM Fiber

Switch Tiles

Optical Tiles

Single Mode Fiber

Optical Connectors

Courtesy of Luxtera

ACACIA
COMMUNICATIONS, INC.

Conclusion

- Coherent optical technology moving toward shorter reaches

- Standardization momentum towards coherent, especially ≥ 400G

- Miniaturization of optics/electronics required for 400ZR as well as intra-data center links

Thank You