Skylane optics
IT INFRA presentation

NEW LIGHT MODULATION TECHNOLOGIES FOR DATA CENTER INTERCONNECT

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November 16th 2023

Overige slides

Tustin & Minneapolis / **USA**

- Sales office
- Production centre
- Customer service
- Technical support
- Sourcing

Ciudad de Mexico / **Mexico**

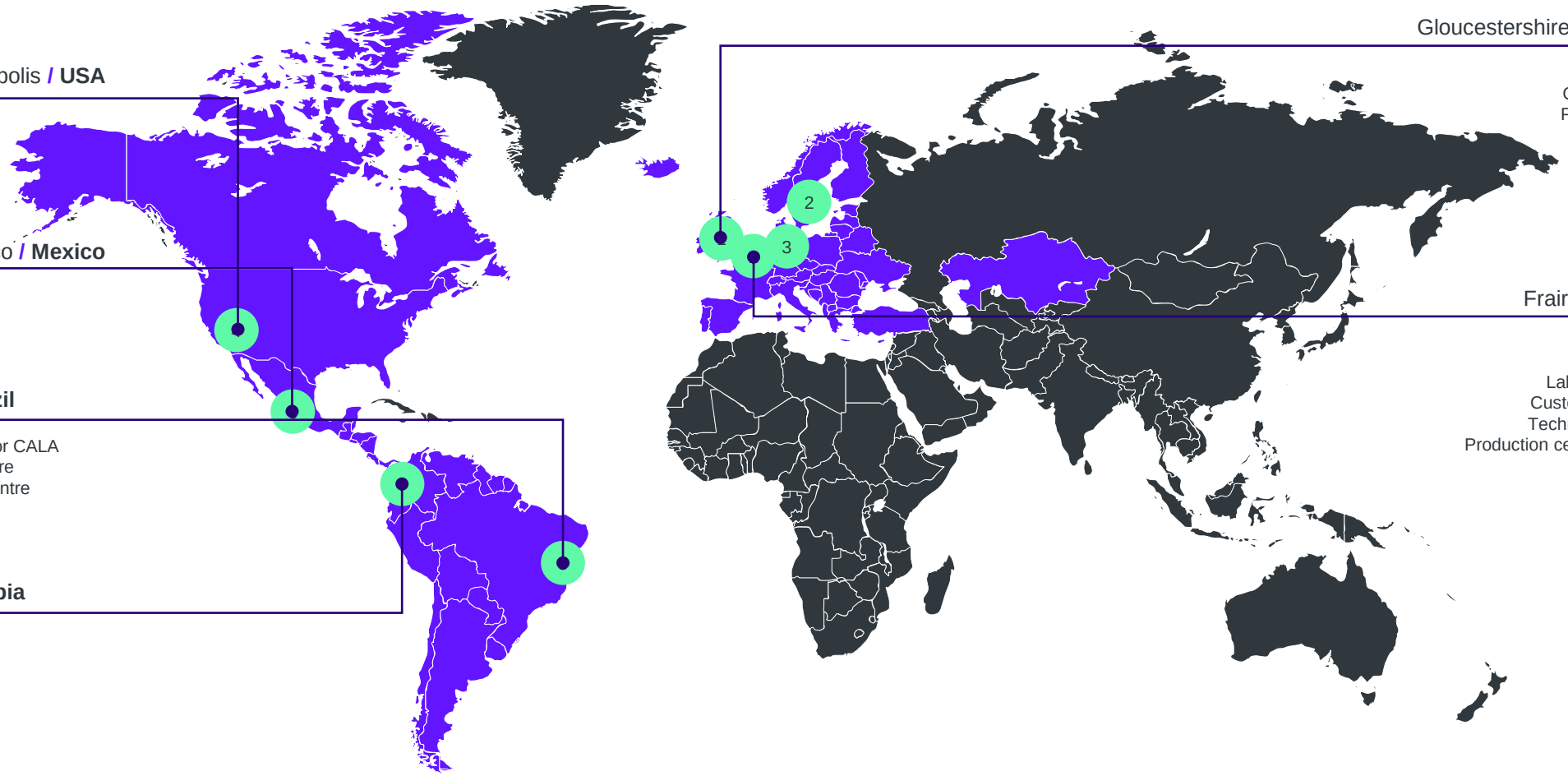
- Sales office

Campinas / **Brazil**

- Sales office for CALA
- Logistics centre
- Production centre

Bogota / **Colombia**

- Sales office



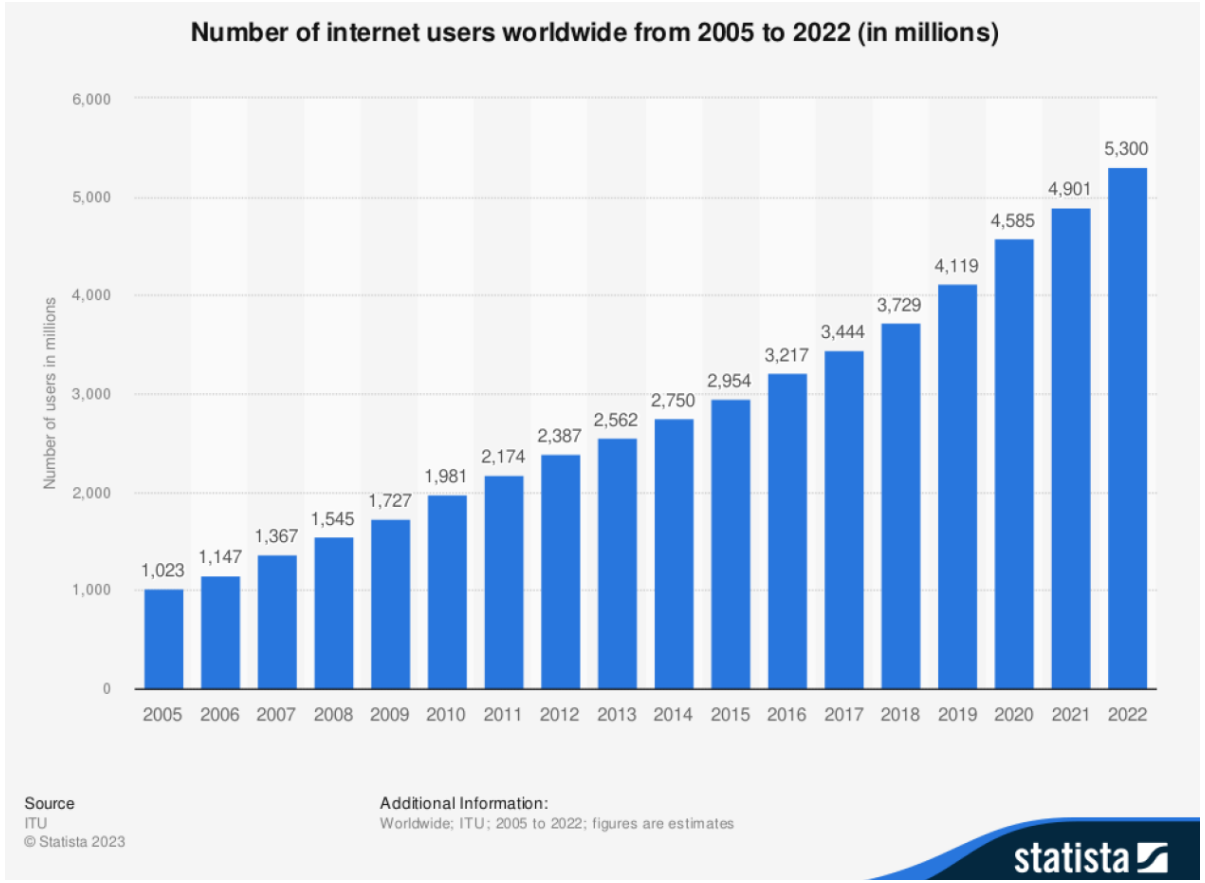
Gloucestershire / **United Kingdom**

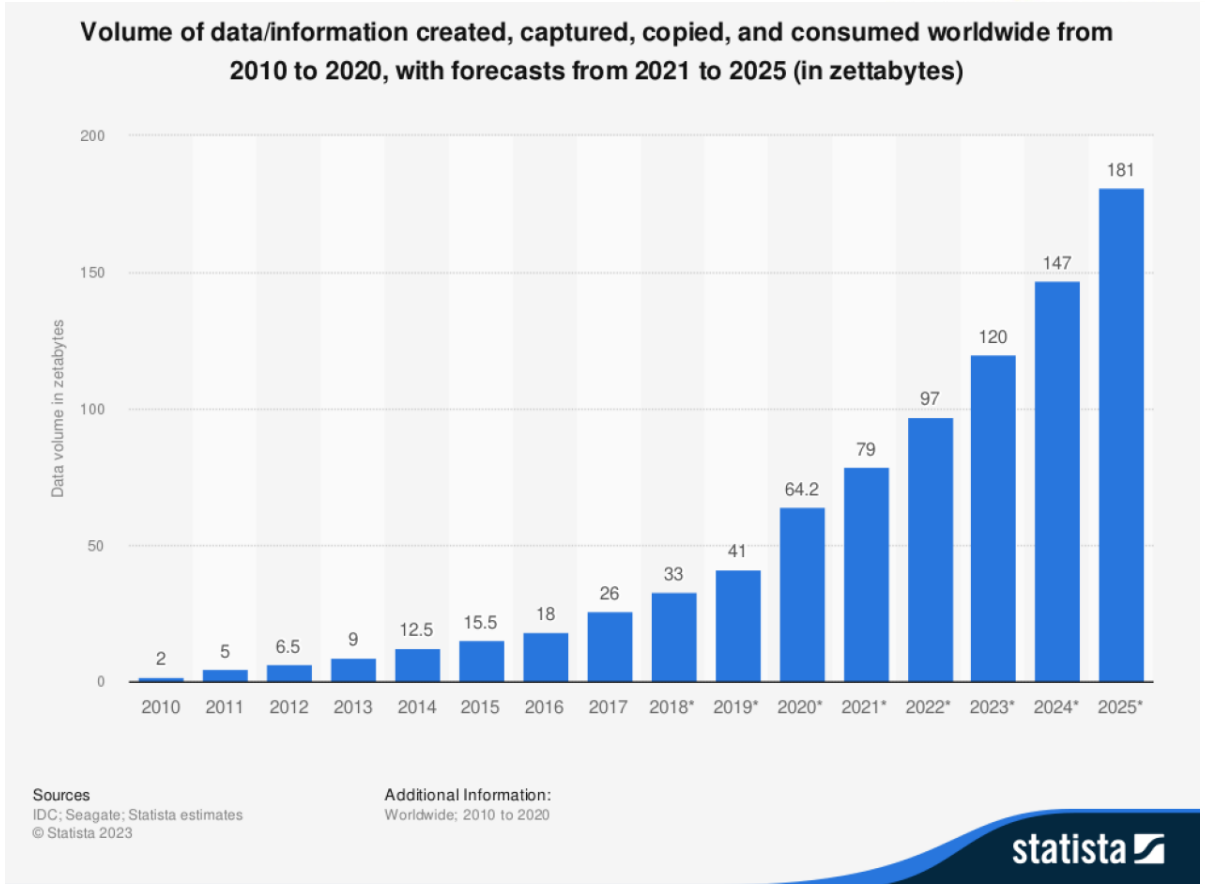
Sales office for UK
Customer service for UK
Production centre for UK

Fraire / **Belgium / (HQ)**

Sourcing
Sales office for Europe
Laboratory for qualification
Customer service for Europe
Technical support for Europe
Production centre for Europe and US

INTRODUCTION



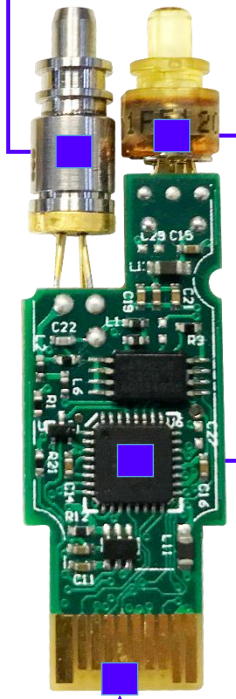


- 5.18 Billion internet users
- 100 Billion web pages
- 100 Million websites

Average **+28% yearly** consumption rate over the last **10years**

WHAT IS AN OPTICAL TRANSCEIVER

Building blocks



ROSA
Receiver **O**ptical **S**ub- **A**ssembly
Part of the transceiver that receives light beams.

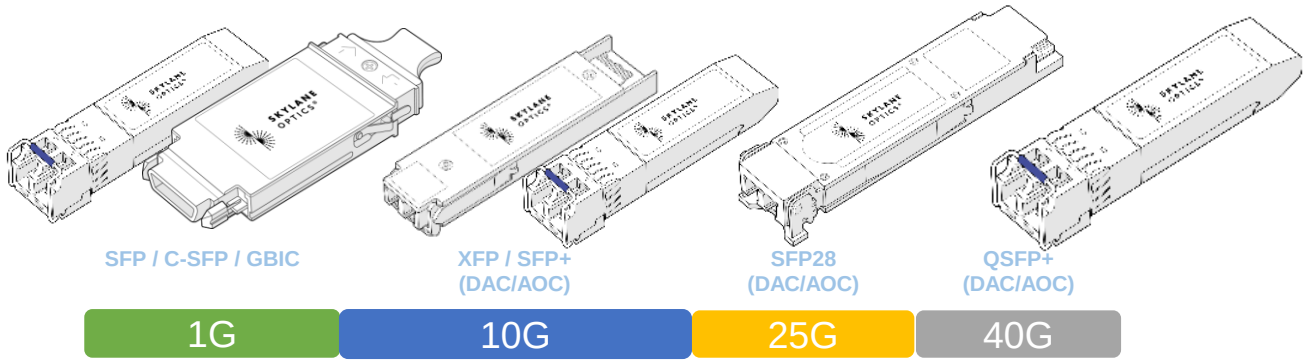
MCU
Micro **C**ontrol **U**nit
The chip that storing compatibility code and helping the function of sending and receiving data.

TOSA
Transmit **O**ptical **S**ub- **A**ssembly
Part of the transceiver that emits light beams.

Electrical host interface

WHAT IS AN OPTICAL TRANSCEIVER

Shape and form factors



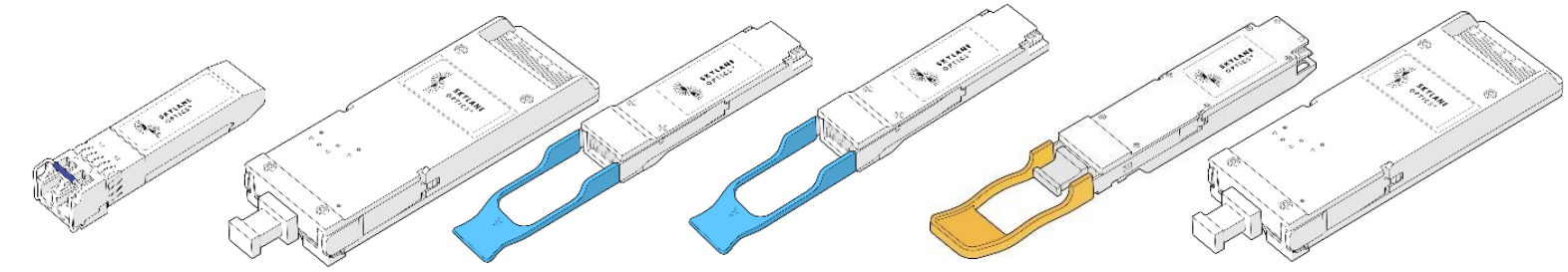
SFP / C-SFP / GBIC

XFP / SFP+ (DAC/AOC)

SFP28 (DAC/AOC)

QSFP+ (DAC/AOC)

1G | 10G | 25G | 40G



SFP56 / SFP-DD

CFP / CFP2 / CFP4 / QSFP28 (DAC/AOC)

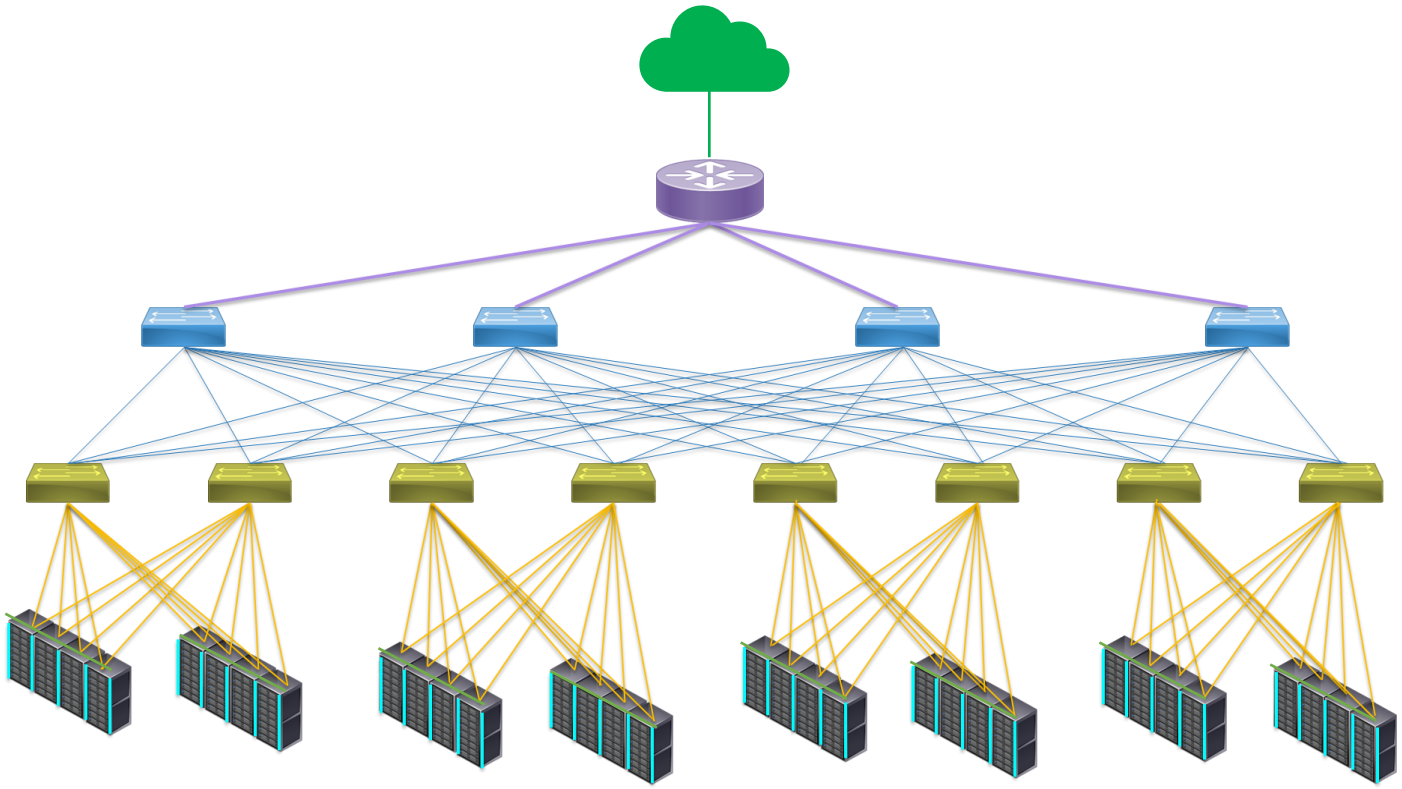
QSFP56 / QSFP28-DD (DAC/AOC)

CFP8 / OSFP / QSFP56-DD

50G | 100G | 200G | 400G

KEY CHALLENGES

DC network architecture – focus on data transmission



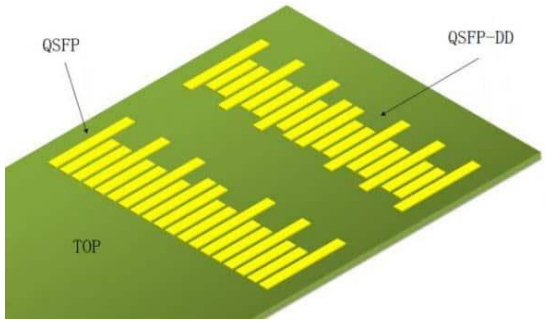
	100G	200G	400G
DCI	• 100G ZR4 • 100G ER4/L • 100G LR4 • 100G DWDM PAM4 • EDFAMUX	• 400G Open ZR+ • 2x100G LR4	• 400G ZR • 400G LR4 • 400G LR8 • 400G ER8
Core	• 100G CWDM4 • 100G CLR4 • 4WDM • 100G LR4	• 200G FR4 • 2x100G CWDM4	• 400G FR4 • 400G DR4+
Spine	• 100G PSM4 • 100G CWDM4	• 200G FR4 • 2x100G CWDM4	• 400G DR4 • 400G FR4 • 100G FR1
Leaf	• 100G SR4 • 100G AOC	• 200G SR4 • 200G AOC	• 400G SR8 • 400G SR4.2 • 400G AOC • 100G DR1
TOR	• 25G AOC • 25G DAC • 25G SR • 100G DAC	• 200G DAC • 200G AOC • 25G SR • 50G SR	• 400G DAC • 200G SR4 • 100G SR1.2 • 100G DAC • 50G SR

KEY CHALLENGES

What are the constrains and optical solutions offered

- **SPEED** - Increasing bandwidth requirement push the transmission speed boundaries
- **CONSUMPTION** - First Generation 400G Transceivers are power hungry ~ 14W
- **LATENCY** - New Digital Signal Processing for higher bandwidth and retiming require power and add latency

8 Lane Transceivers Reduce Latency

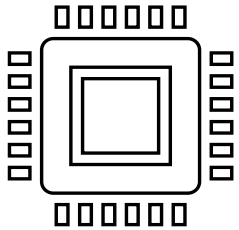


- Multiplying lanes instead of increasing data rate in order to reduce latency
- The DSP used in QSFP-DD SR8, LR8, & ER8 transceivers does not retime, offering **better performance in latency sensitive** environments.

Passive DAC Cables Sip Power ~ <1W!

- Passive DAC cables are ideal for very short in-rack and in-cabinet interconnects. Direct Connect and 4x100G and 8x50G options are available.
- Without the burden of optoelectronic components, passive DACs not only reduce **power consumption**, but also **latency**.

Component Roadmap Offers Improvements

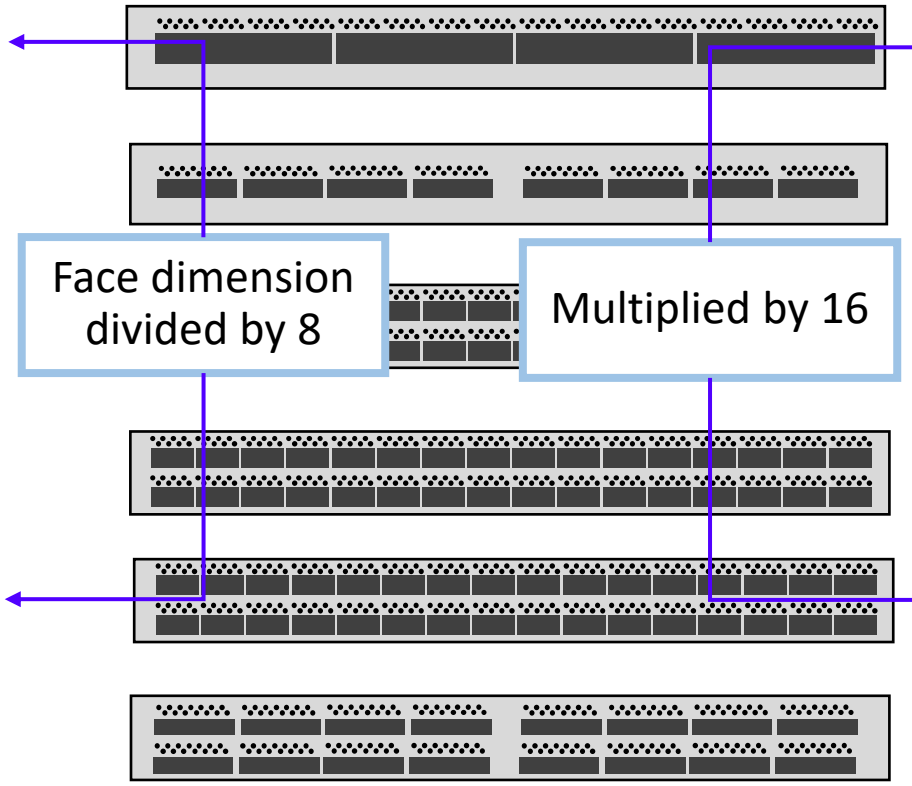


- 2nd generation digital signal processing (DSP) are driving power consumption below 10W for 400G
- Silicon photonics are being introduced in DR4 and FR4, offering **reduced power consumption**.

KEY CHALLENGES

Energy consumption

Form Factor	Modules per 1RU	Total Capacity	Module Power	Watt/Gig
CFP	4	400G	8-32W	0,32W/Gig
CFP2	8	800G	< 12W	0,12W/Gig
CFP4	32	3.2T	< 6	W/Gig
QSFP28/56	32	3.2T/6.4T	< 3.5W	0,035W/Gig
OSFP QSFP-DD	**32**	12.8T	~ 10W	0,025W/Gig
CFP8	16	6.4T	< 12W	0,03W/Gig



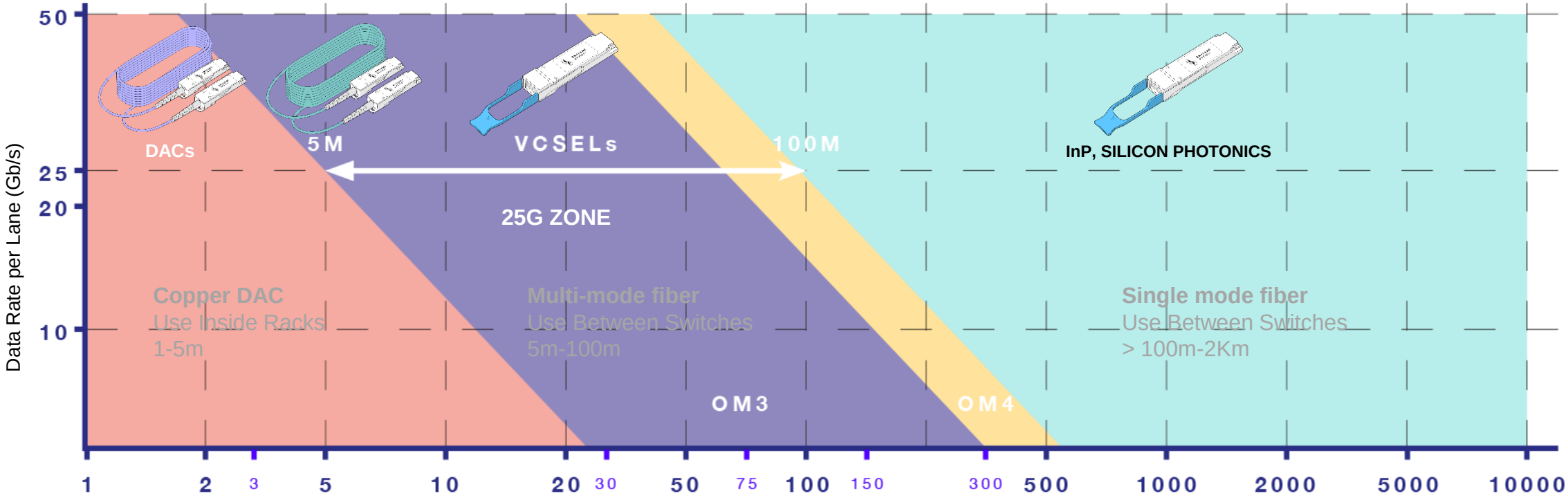
Face dimension divided by 8

Multiplied by 16

Divided by 10 per Gig

KEY CHALLENGES

Optics and Laser technologies



Direct Attach Copper
- Based on twinax
- Distance: 3m

Active Optical Cables
- VCSEL 100m
- Distance: 3-20m

SR4 VCSEL Transceivers
- Up to 100m
- MultiMode Fiber
- Structured cabling

Silicon Photonics Transceivers
- Up to 2Km
- SingleMode Fiber
- PSM4 or WDM4 in parallel

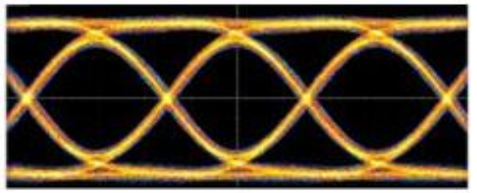
KEY CHALLENGES

Signal modulation

SIGNALING METHODS

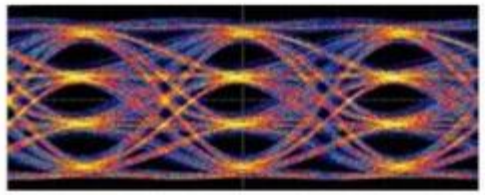
Most high speed Ethernet signaling has been Non Return to Zero (NRZ), but Pulse Amplitude Modulation 4 Level (PAM-4) signaling delivers twice as many bits per sample.

NRZ
Non-Return to Zero

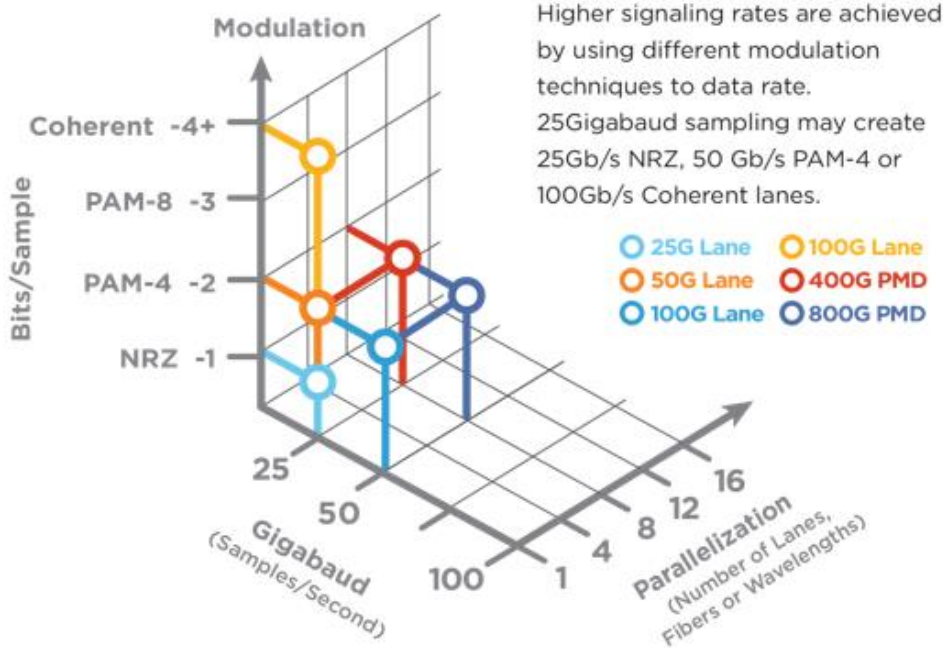


1 bit per clock cycle

PAM-4
Pulse Amplitude Modulation —4 Levels



2 bit per clock cycle



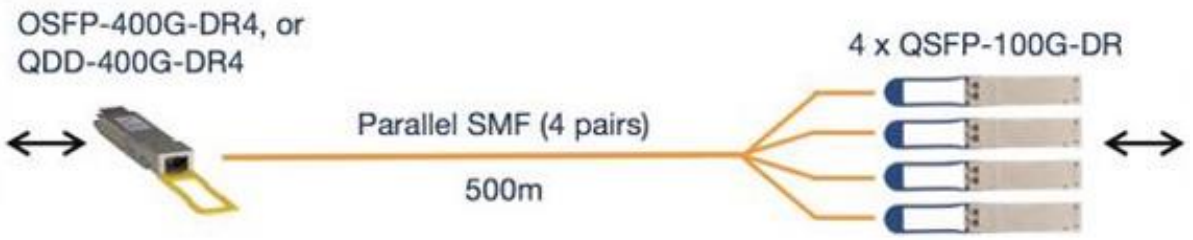
Higher signaling rates are achieved by using different modulation techniques to data rate. 25Gigabaud sampling may create 25Gb/s NRZ, 50 Gb/s PAM-4 or 100Gb/s Coherent lanes.

- 25G Lane
- 50G Lane
- 100G Lane
- 100G Lane
- 400G PMD
- 800G PMD

USE CASE EXAMPLE

100M | 500M | 2KM | 10KM | 100KM

400G QSFP-DD or OSFP System

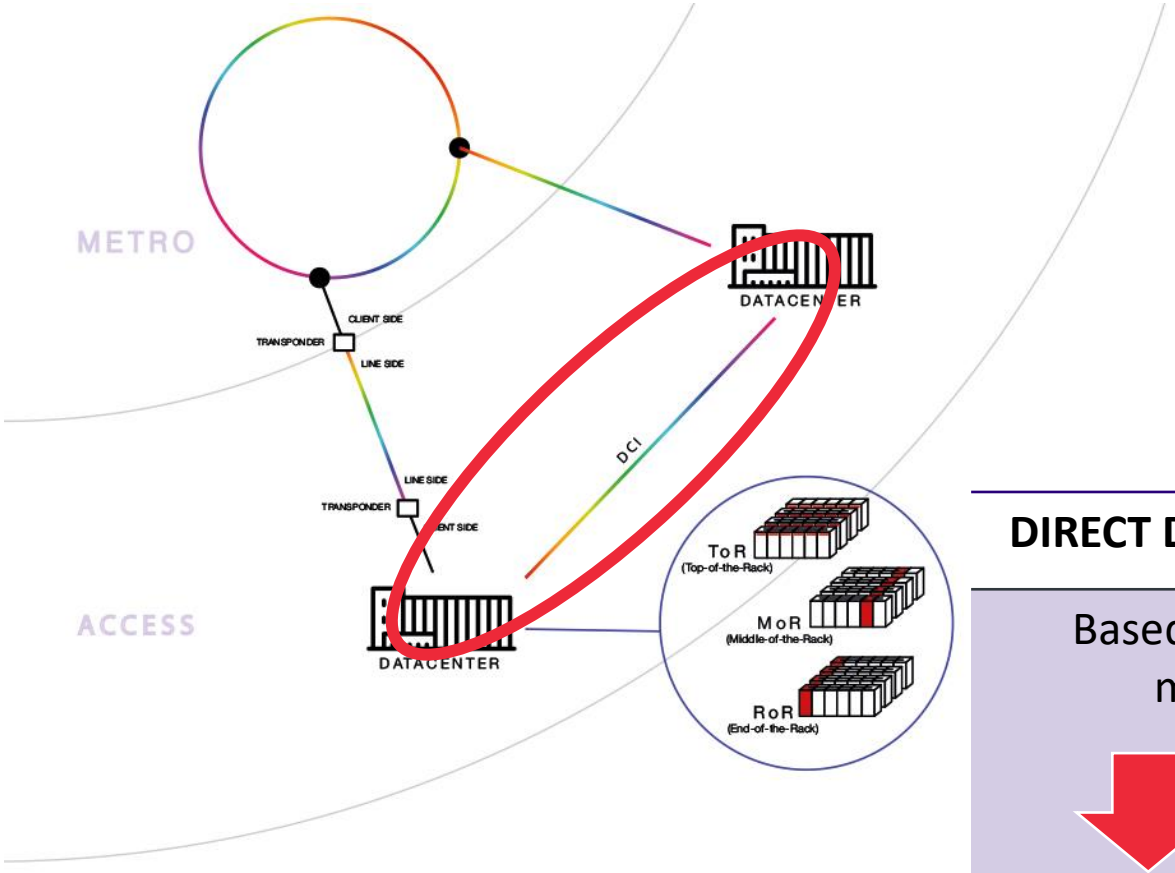


100G QSFP Systems

Standard	Data Rate	Media	Connector	Electrical Signaling	Optical Signaling	Optical Type	Part Number
DR4	400G	SMF	MPO-12	8x50G PAM4	4x100G PAM4	Parallel Series	QBP13P50E0PF
DR1	100G	SMF	LC	4x25G NRZ	1x100G PAM4	Parallel Series	Q2C31P50C00F

USE CASE EXAMPLE

100M | 500M | 2KM | 10KM | 100KM



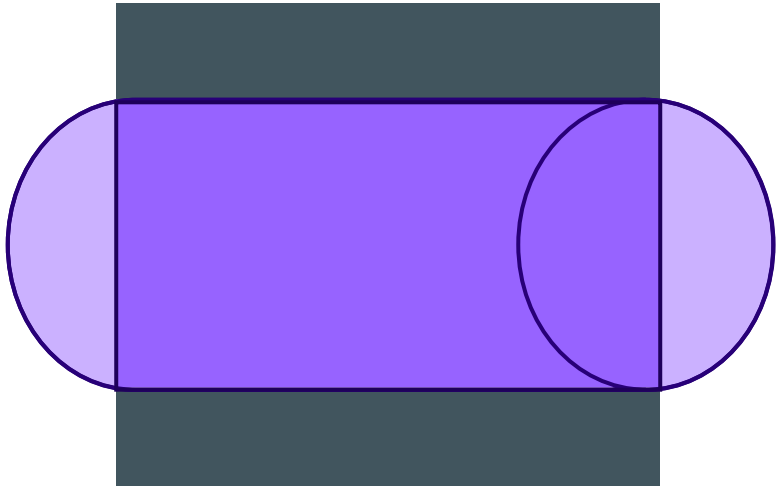
DATA CENTER INTERCONNECT USE CASE

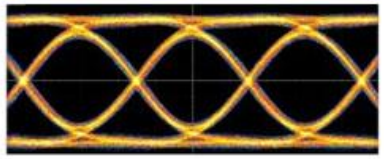
- Large quantity of data
- Long distances up to 100km or beyond
- Limited fiber infrastructure

DIRECT DETECT MODULES	COHERENT
Based on amplitude modulation	Encoding using phase and polarization
Decrease in reach Increase of data rate	Data rate Transmission distance

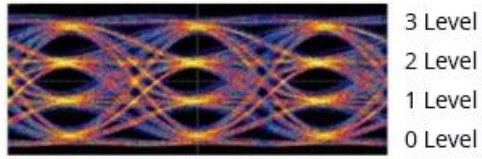
COHERENT TECHNOLOGY

Changing the perspective



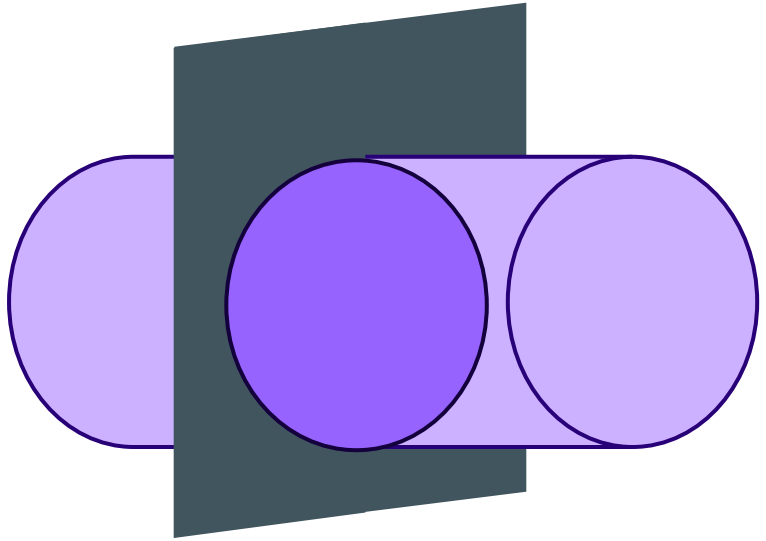


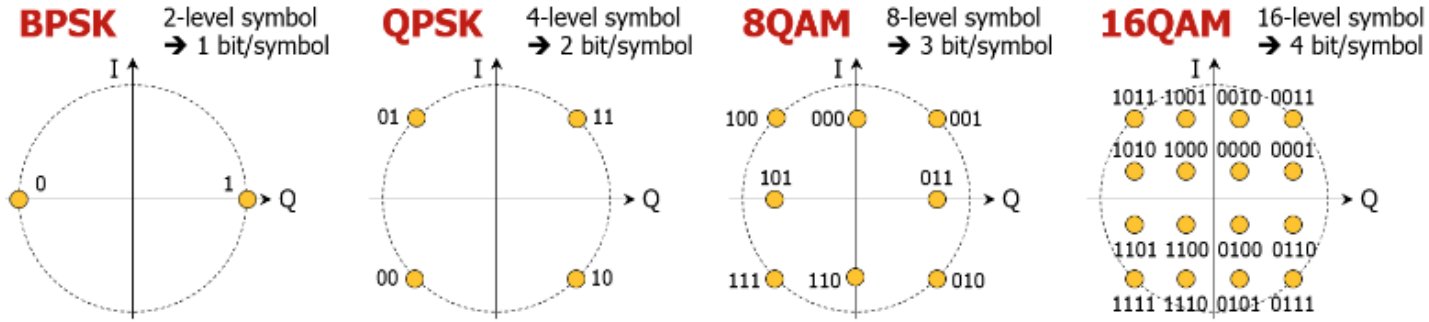
1 bit per clock cycle



2 bit per clock cycle

Amplitude modulation





Adding polarization

Adding phase management

COHERENT TECHNOLOGY

What this allows

FROM A TRANSCEIVER PERSPECTIVE

- Forward Error Correction performed on module (CFEC or OFEC)
- Dispersion compensation performed by module

IN APPLICATION CASES

- Simplified upgrade path without changing the existing fiber infrastructure
- Tune the laser to allow different data rates with the same module
- High data rate transmission **over 120km point to point**

Coherent modulation offers a great opportunity to overcome today's challenges and support continuous data rate increases

Downside remains the cost/gig as these are complex modules embedding lots of technology

QUESTIONS & ANSWERS

SKYLANE OPTICS®
AN AMPHENOL COMPANY

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intronics **Come visit us at booth 23**

Transceiver related topic this afternoon with CN Rood presentation