



# PICs for data center interconnects

Photonics Days Berlin Brandenburg 2021

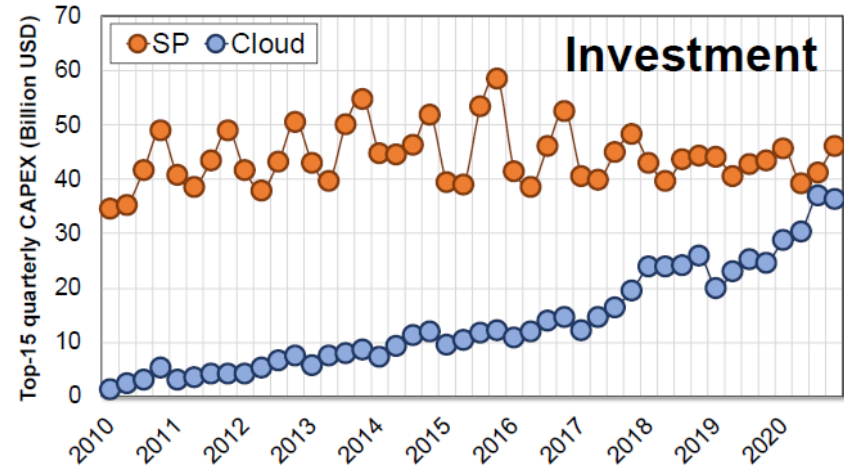
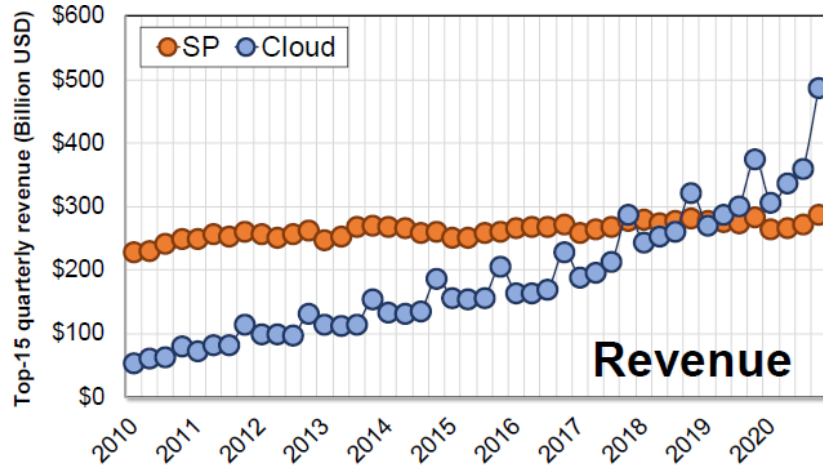
5.10.2021



# Data centers are good business!

## Top 15 hyperscalers vs. top 15 service providers

Industry has changed tremendously over the past years with the rise of hyperscalers.

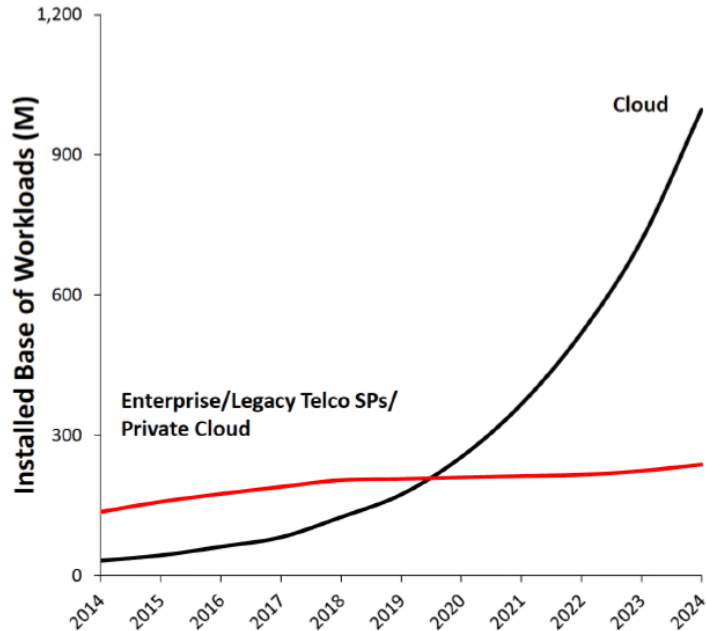


From: Lightcounting March 2021 Quarterly Market Update Report,  
Adapted: High-capacity data center interconnects, SC461, OFC 2021

DCI is a large and fast-growing market for system vendors

# Compute is ascending into the clouds

## On-site vs cloud servers



From: Alan Weckel , 650 Group Guest Speaker at OIF", OIF2020.295.00

- Exponential growth of compute resources going into cloud infrastructure
  - Cloud data centers provide scale advantages
  - Growth across all areas, especially in areas such as IoT and AI/ML
  - "Stagnant" quantity of servers deployed on premise by enterprises
- Distance between compute and end-user increases
  - More transport DC-to-user needed

More interfaces inside data centers and outside data centers needed.

# Microsoft's global data centers

Where are they and why?

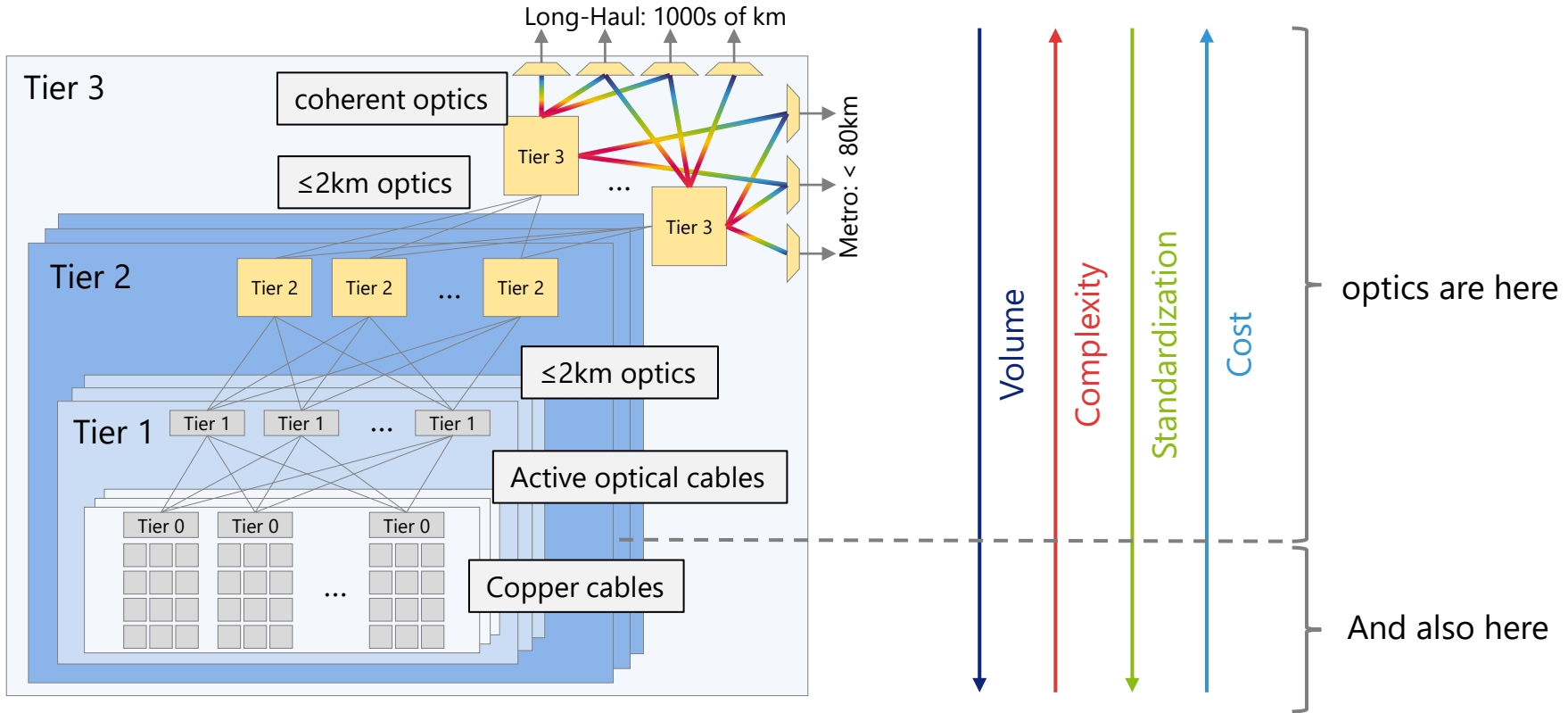


- Locations in almost every region of the world
- Even multiple locations in same region
  - Close to customers,
  - with familiar legislation,
  - developed infrastructure
  - and cheap energy and land

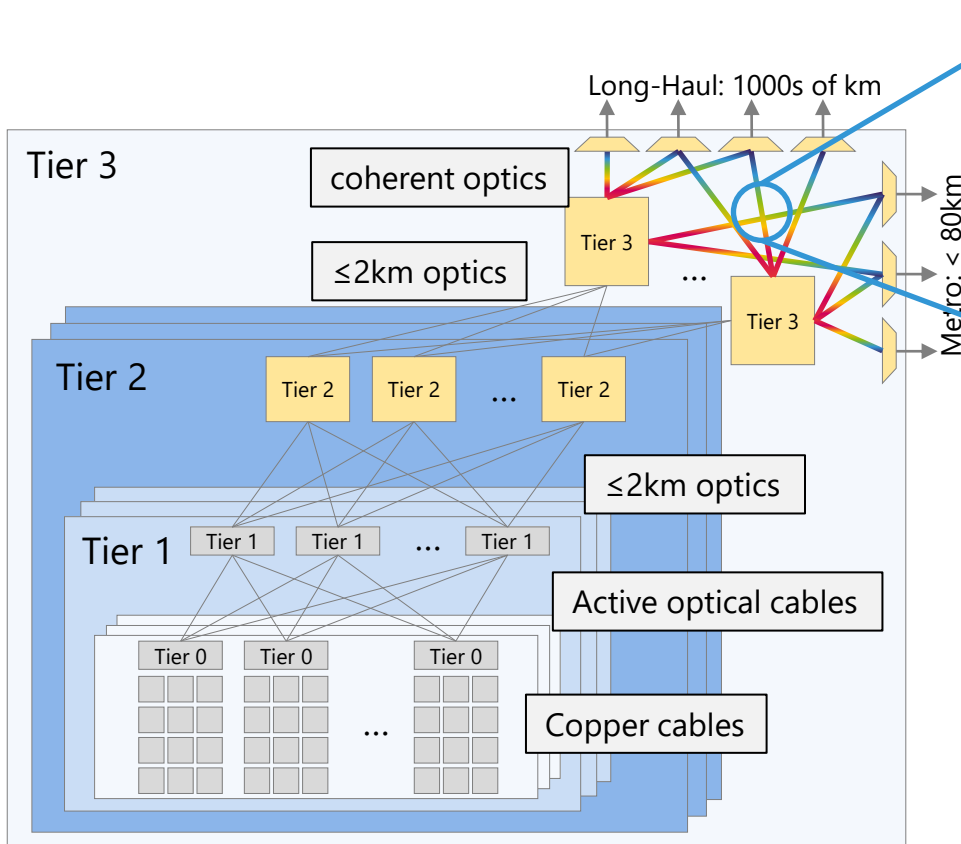
Close to customers and where OpEx is cheap

# Data center network architecture

## "Clos" network



# Inter-DCI optics

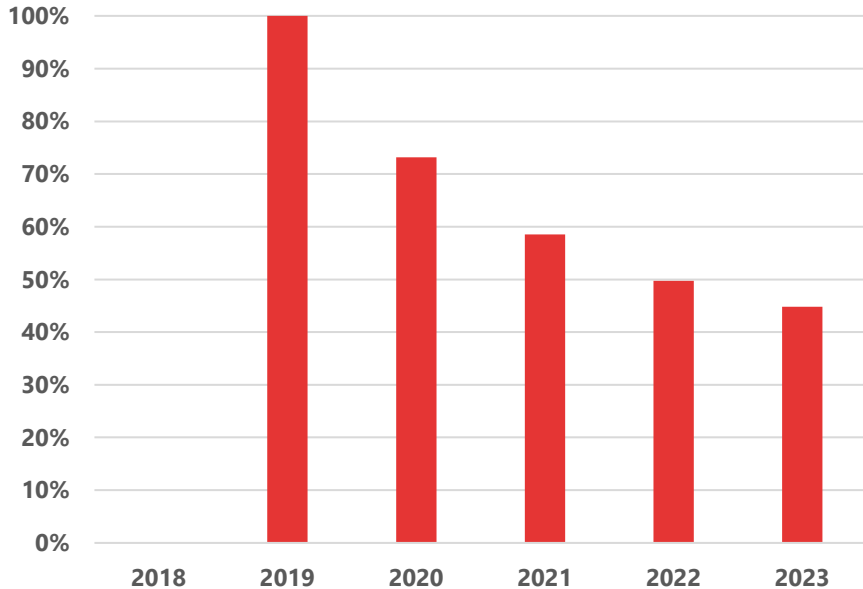


Inter-DCI	Intra-DCI
Up to 600 Gb/s	Up to 400 Gb/s
Single wavelength	Up to 8 wavelengths
Coherent transmission	Direct detection
Amplified links	Unamplified
C-band tunable	O-band (fixed WL)
> 40km	< 10km
Dispersion compensation	-
Up to 25.6 Tb/s systems	-

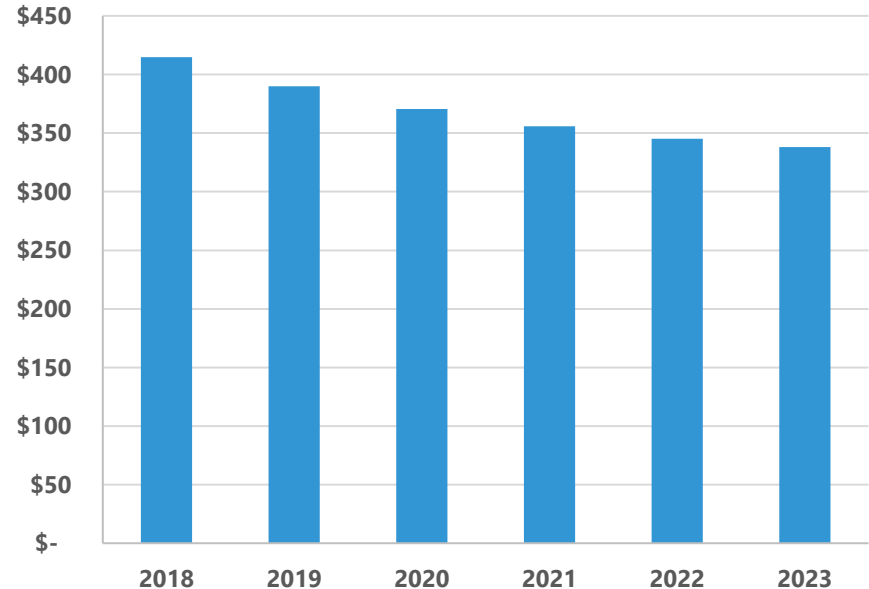
# Market expectations

Vs. reality

## 400G CFP2-DCO ASP



## ITLA ASP



50% reduction of cost every 5 years



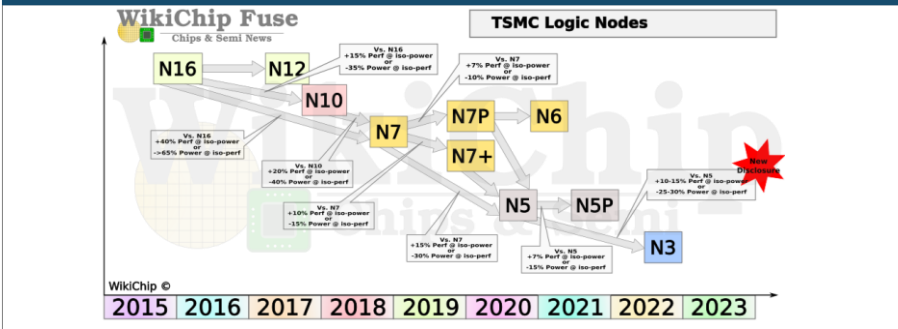
# Transceiver trends



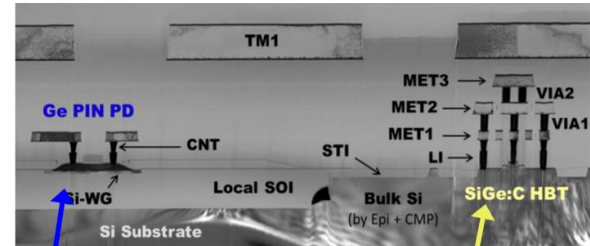
# Higher bandwidth density

## Faster modules

### DSP ASIC

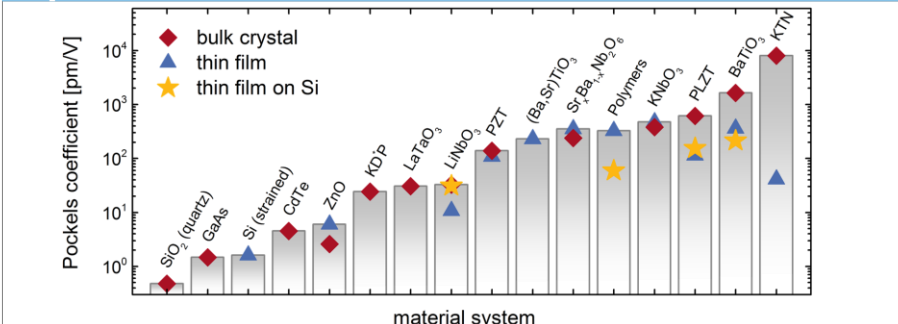


### RF electronics

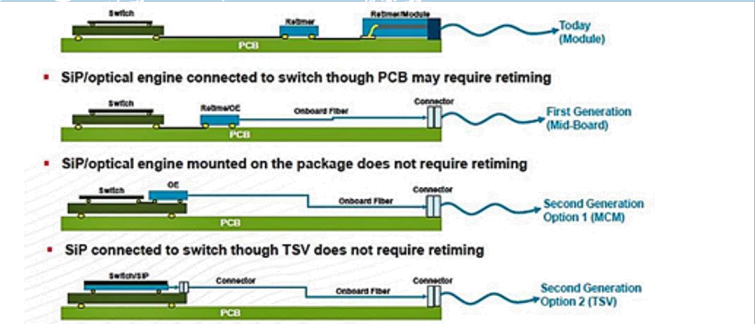


67 GHz Bandwidth Germanium Photo Diode      220 GHz  $f_T$  290 GHz  $f_{Max}$

### Optics



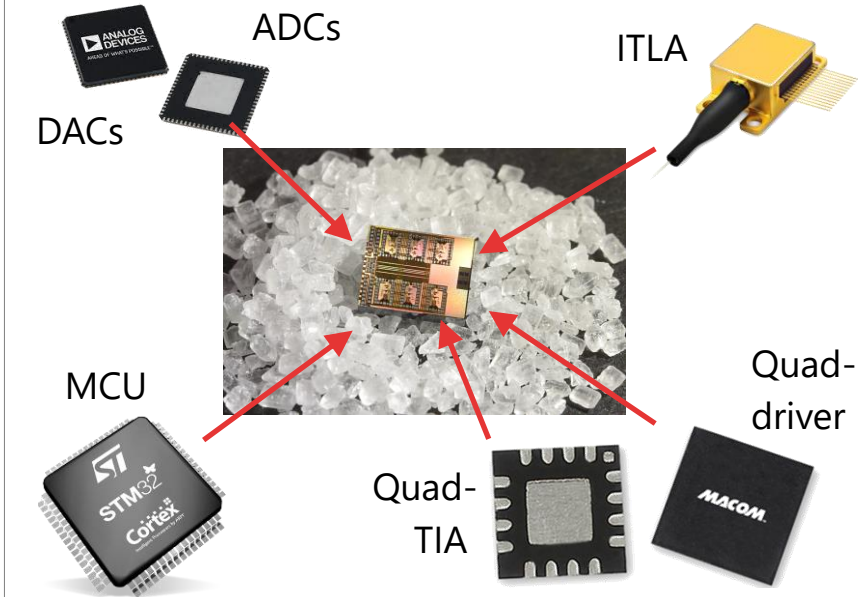
### Packaging



# Cost

~80% of cost is in packaging

## Higher level of integration

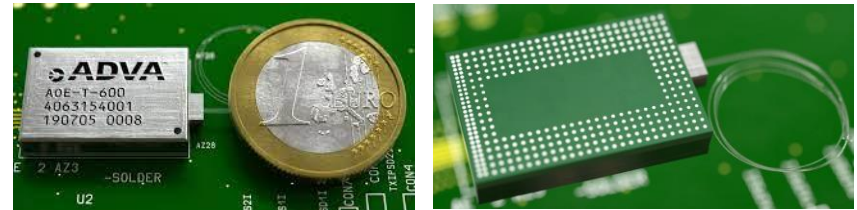


## Automation & standards

- Single automated optical alignment step



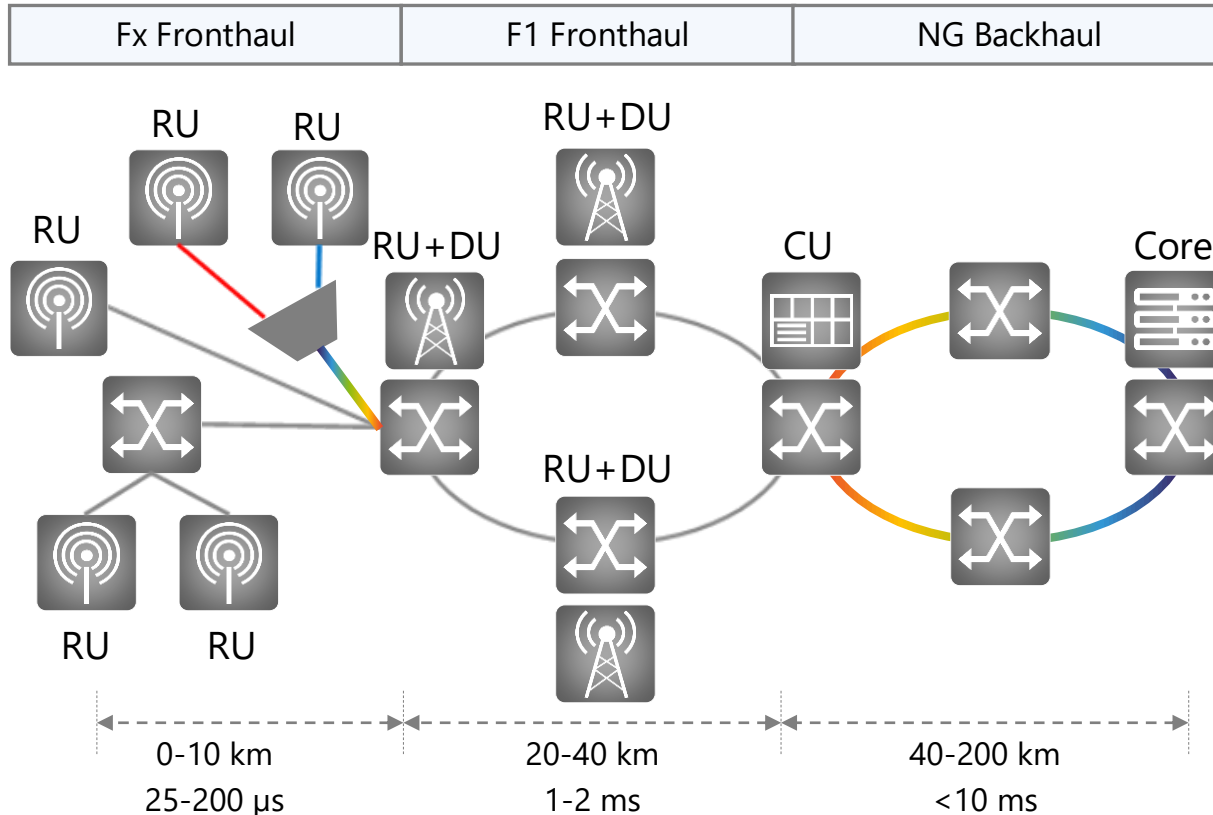
- Leverage electronic IC infrastructure (e.g. flip-chip assembly)



Integration, automation & volume

# New application - Short reach coherent

For 5G and intra-DCI



Direct detection	Coherent transmission
Low cost	Higher cost
Low footprint	Large footprint
<5W power consumption	~15W power consumption
QSFP formfactor	CFP2 formfactor
O-Band transmission	C-band transmission
No dispersion compensation	Dispersion compensation
Unamplified links	Amplified links
Single polarization	Dual-polarization
Poor scaling (PAM4 modulation)	Good scaling (QPSK to 64QAM)

# Summary



- Smaller, faster, denser optical modules required
- Coherent transmission gaining ground vs direct detection
- Simplified assembly process for PICs needed to reduce costs
- Evolution of PICs towards hybrid EPICs integrating various materials and functions

Exciting work ahead!



# Thank you

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