

CONNECTING AT THE SPEED OF LIGHT

Next Generation Coherent Beyond Transport Networks

Market Focus

ECOC 2019



Coherent Requirements in the Network are Expanding



More
Users



More
Devices

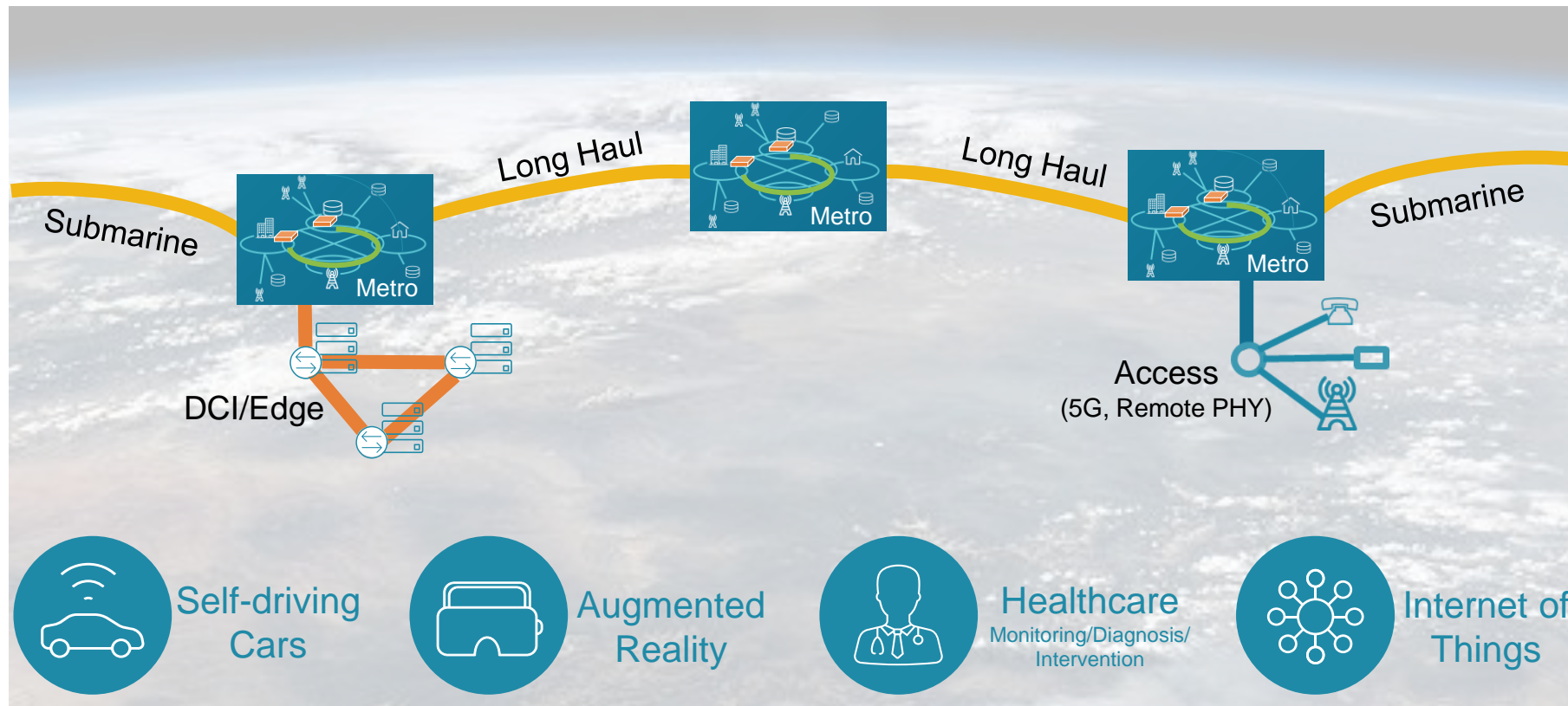


Faster
Speeds



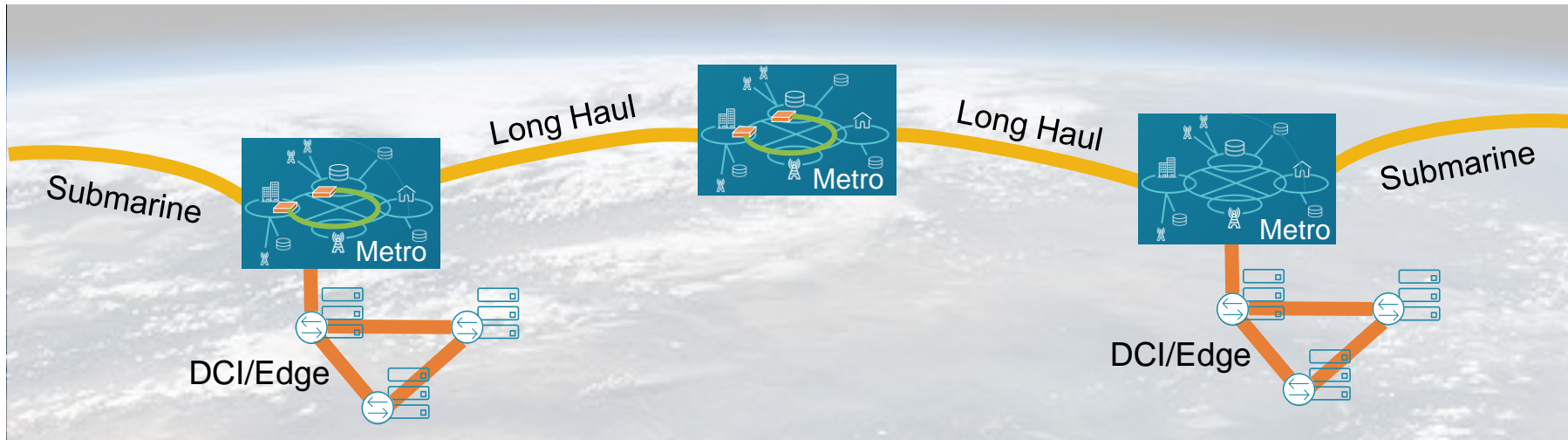
More
Video

Source: Cisco



Embedded Multi-haul

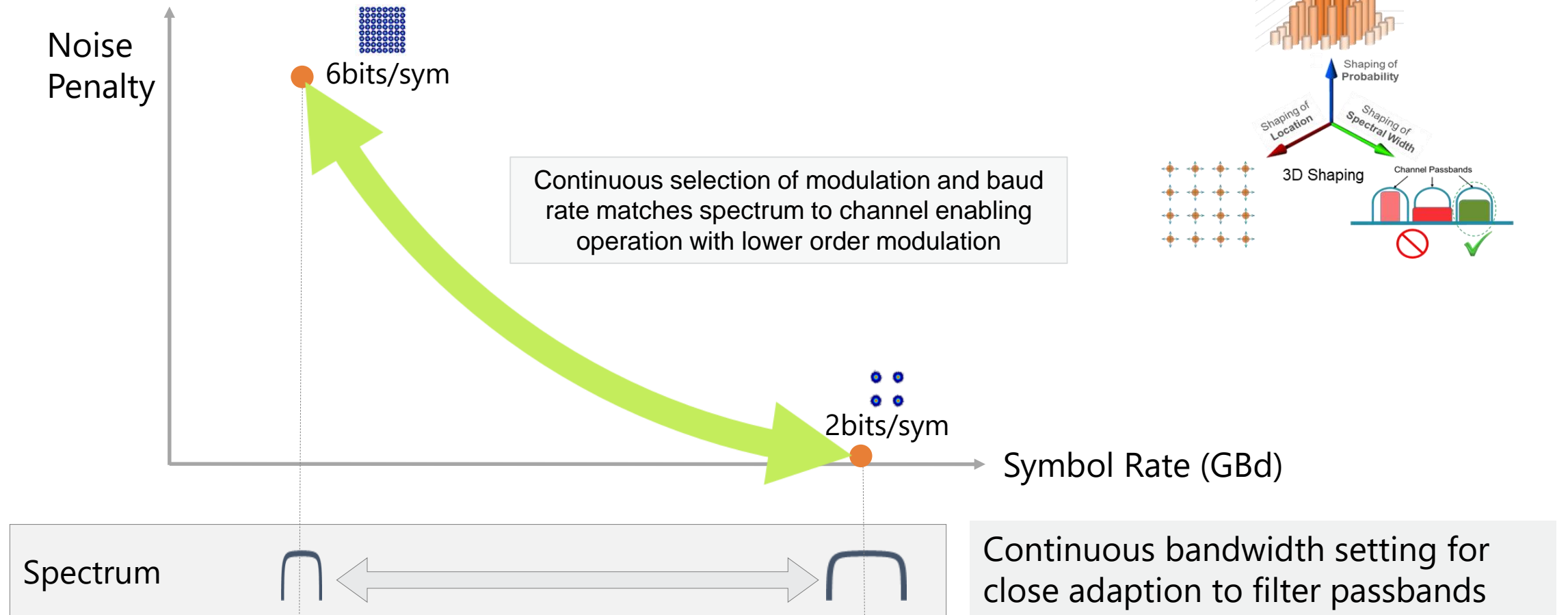
Coherent Enables a Wide-Reaching Transport Solution



Network Application	Key Characteristics	<u>Multi-haul</u> Coherent Solution	
Long Haul/ Submarine	High spectral efficiency at long distances	Common hardware with software configurable modulation	Transmission shaping & advanced FEC to optimize spectral efficiency/reach
Metro/ Regional	Channel narrowing from cascaded ROADMs		Adaptive baud rate to spectrally match aggregate passband--avoid wasted BW
DCI/Edge	High capacity transmission to reduce cost/bit, pt-pt		High modulation order

Continuously flexible modulation

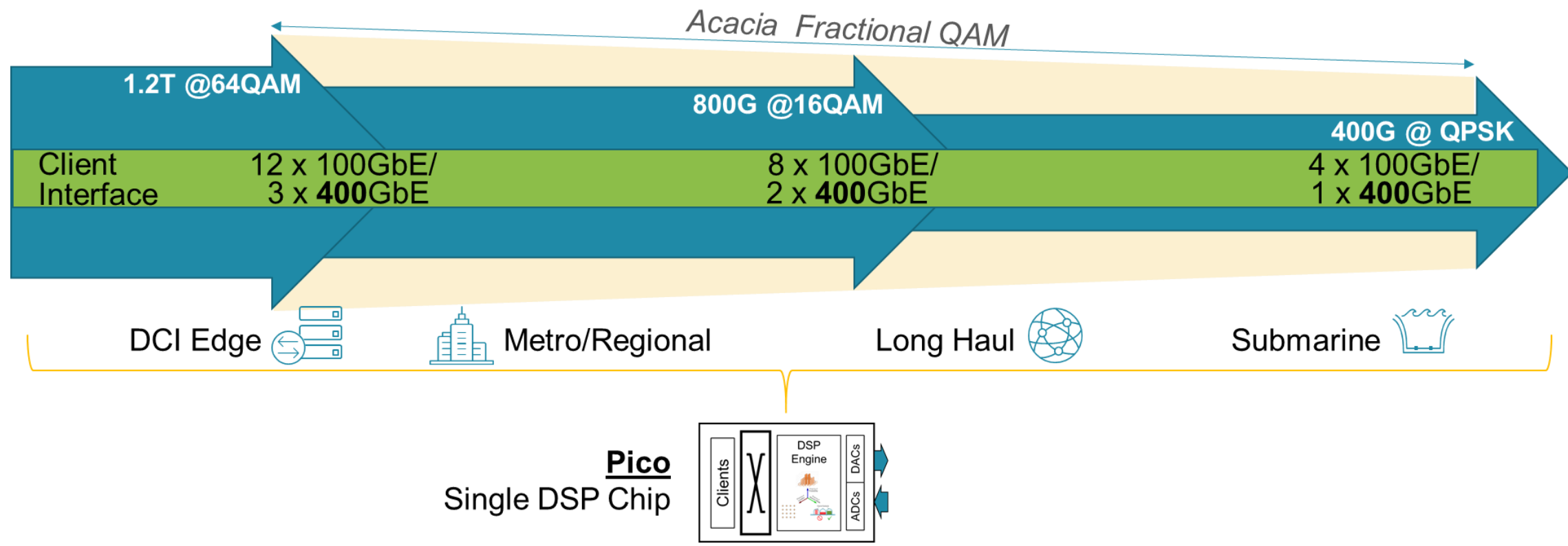
- Fractional QAM and adaptive baud rate



Improve capacity and performance by removing steps in optimization

Flexible Architecture for Transporting 100/400GbE

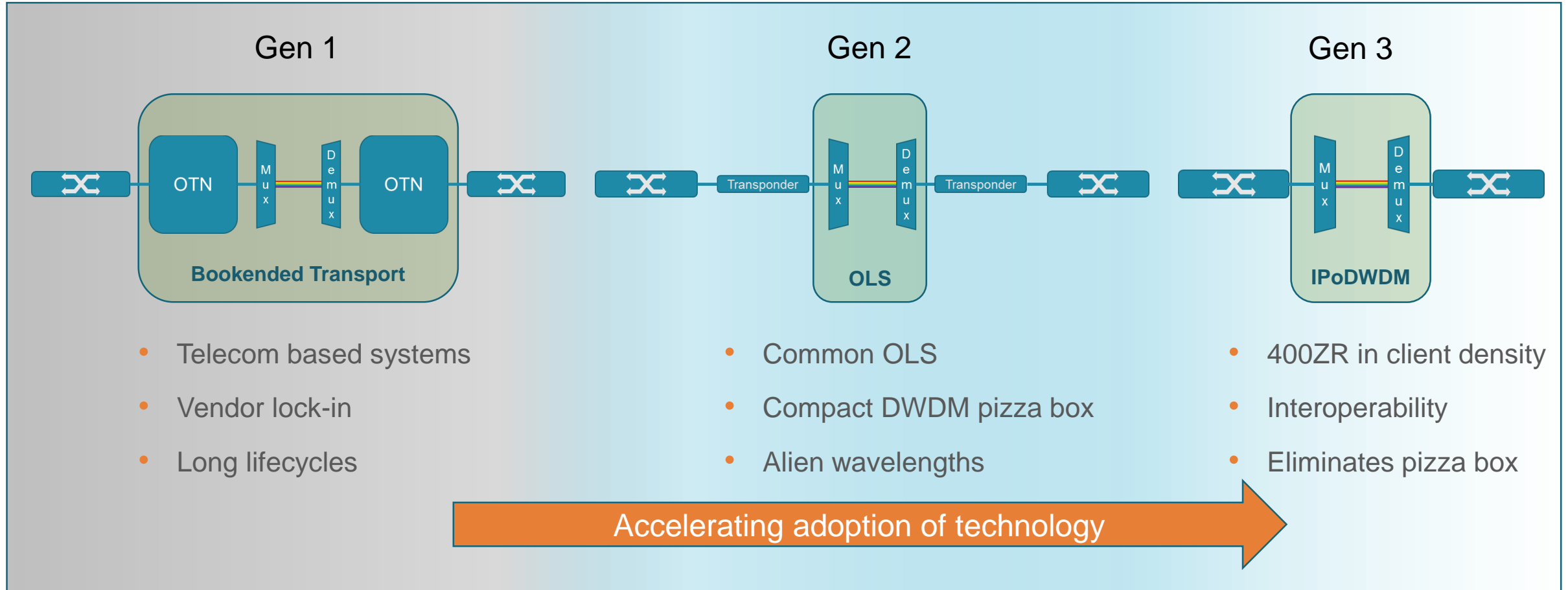
Multi-haul solution addressing network operator requirements from edge to submarine



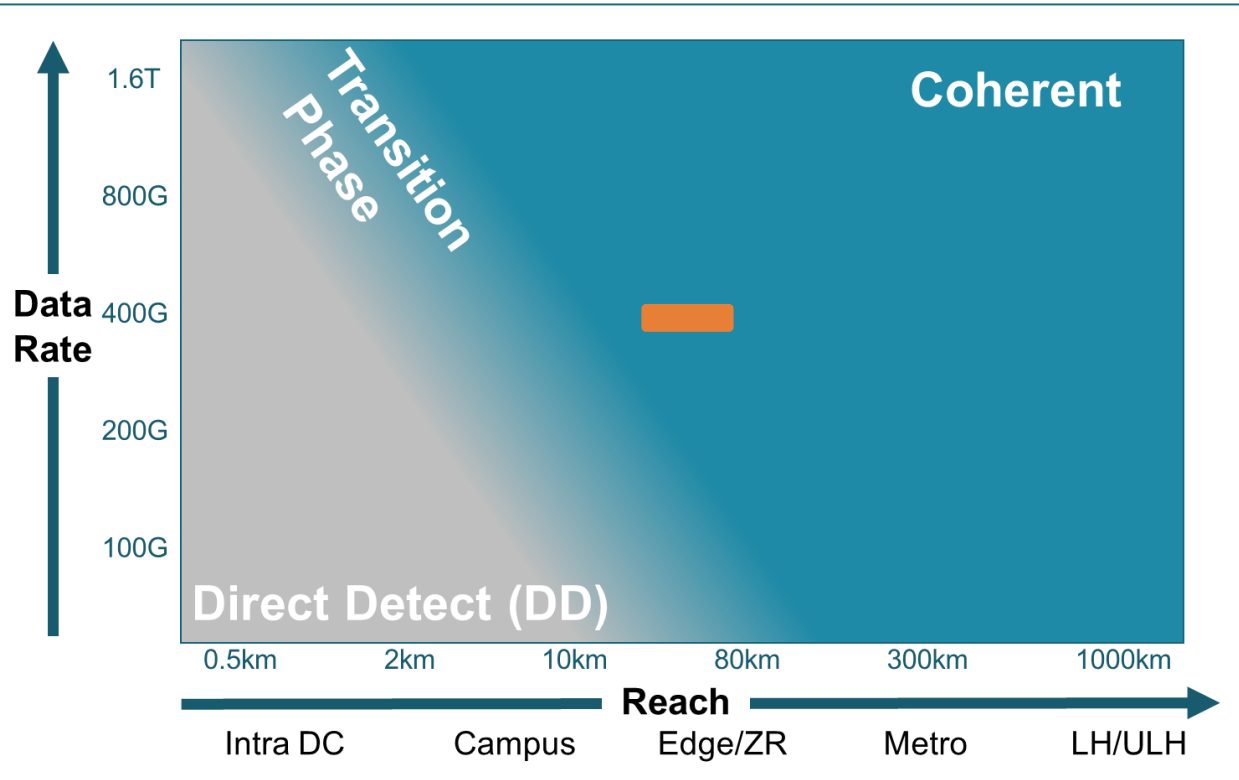
Flexible client interfaces, adaptive baud-rate and modulation ranging from QPSK to 64QAM

400G Pluggable

Evolving Architectures



400ZR

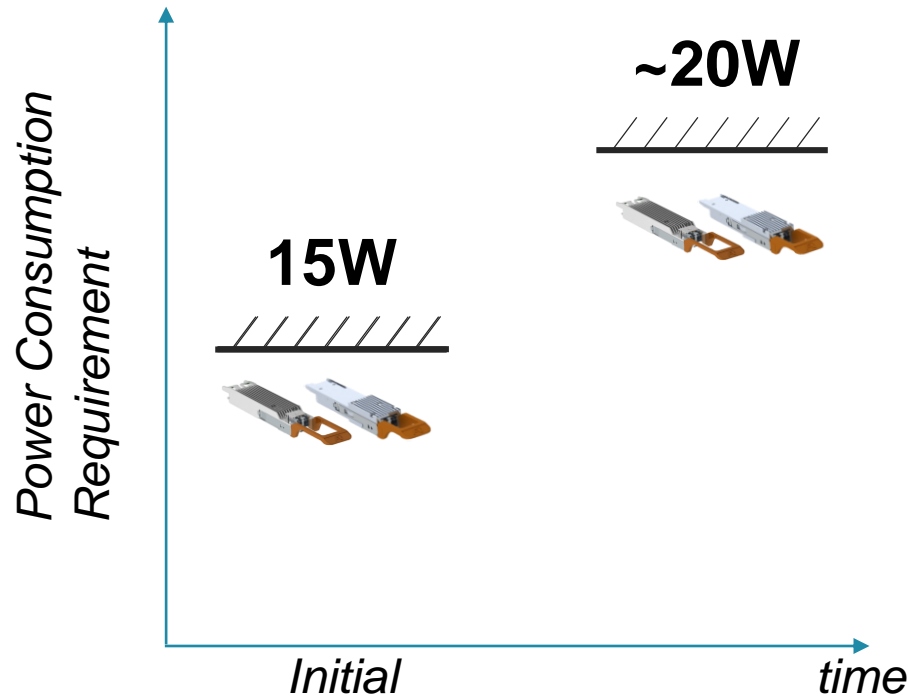


● 400ZR

- OIF project start in Q4 2016
- Scope
 - 400GbE host interface
 - Target 400G client module form factors
 - Sub-15W power dissipation
 - Metro DCI reaches
 - Sub 120km amplified DWDM
 - Power limited unamplified



Higher Performance 400G Pluggable



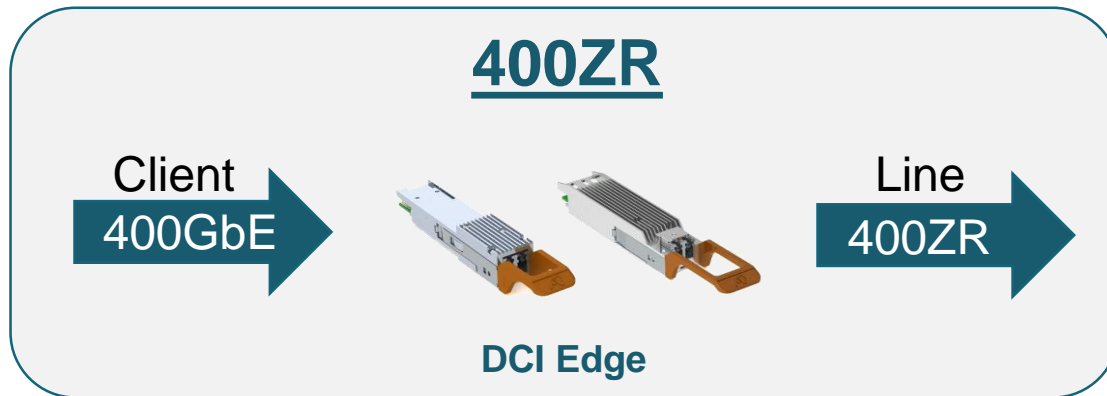
Switch vendors believe they can support 20W or more in a QSFP-DD or OSFP



Open ROADM

Carrier transport targets higher performance CFP2-DCO

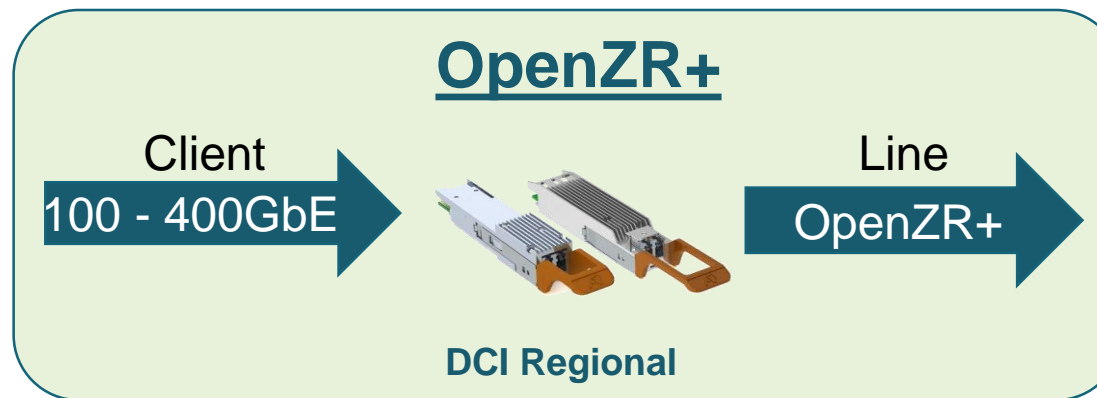
High performance + Multi-vendor interop



Simplified functionality, power optimized FEC



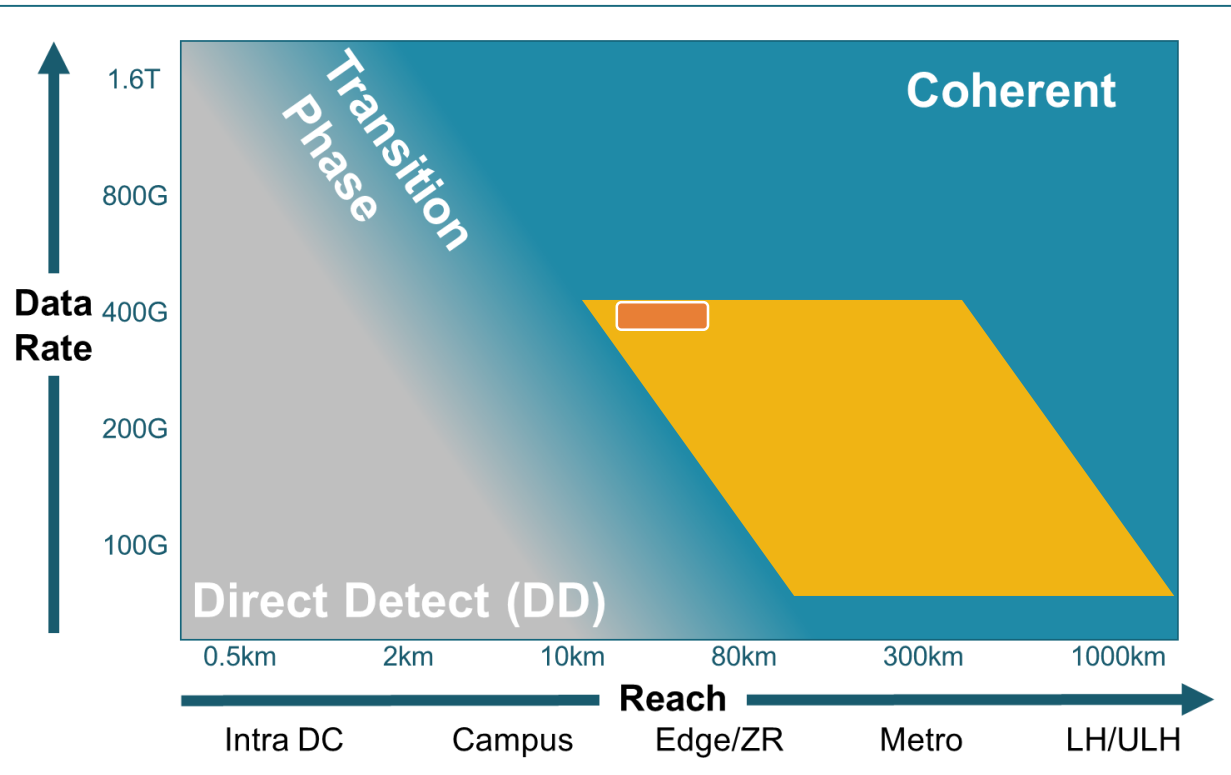
Full featured client mapping and **high-performance oFEC**



Simplified functionality w/ high-performance oFEC

**OpenZR+: The logical combination of two industry standardization efforts
Enables high performance DCI pluggable modules supporting multi-vendor interoperability**

400G Pluggable

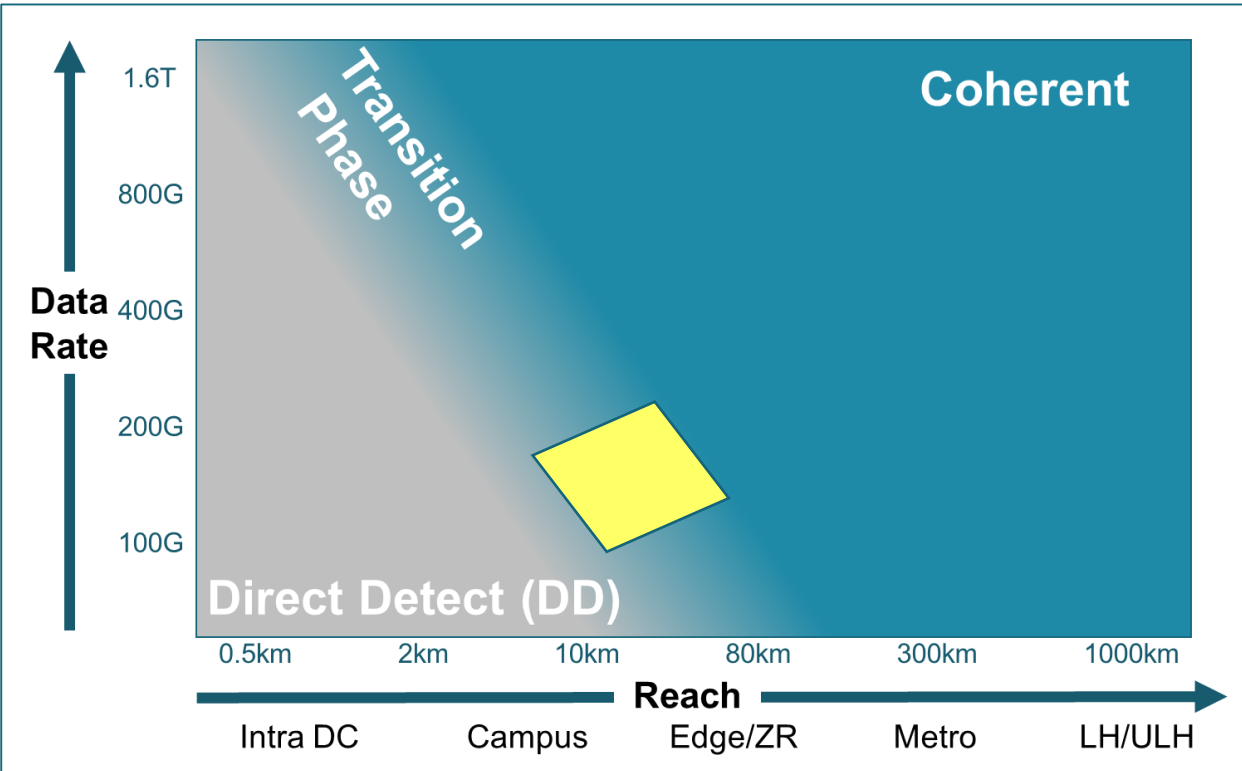


- 400ZR
- 400G Pluggable

- Expanded addressable market
 - Multiple form factors
 - Longer reaches
 - DCI and carriers
- Three module classes
 - 400ZR
 - 400GbE in QSFP-DD/OSFP
 - OpenZR+
 - 100GbE to 400GbE in QSFP-DD/OSFP
 - Open ROADM
 - 100G to 400G, Ethernet or FlexO in CFP2-DCO

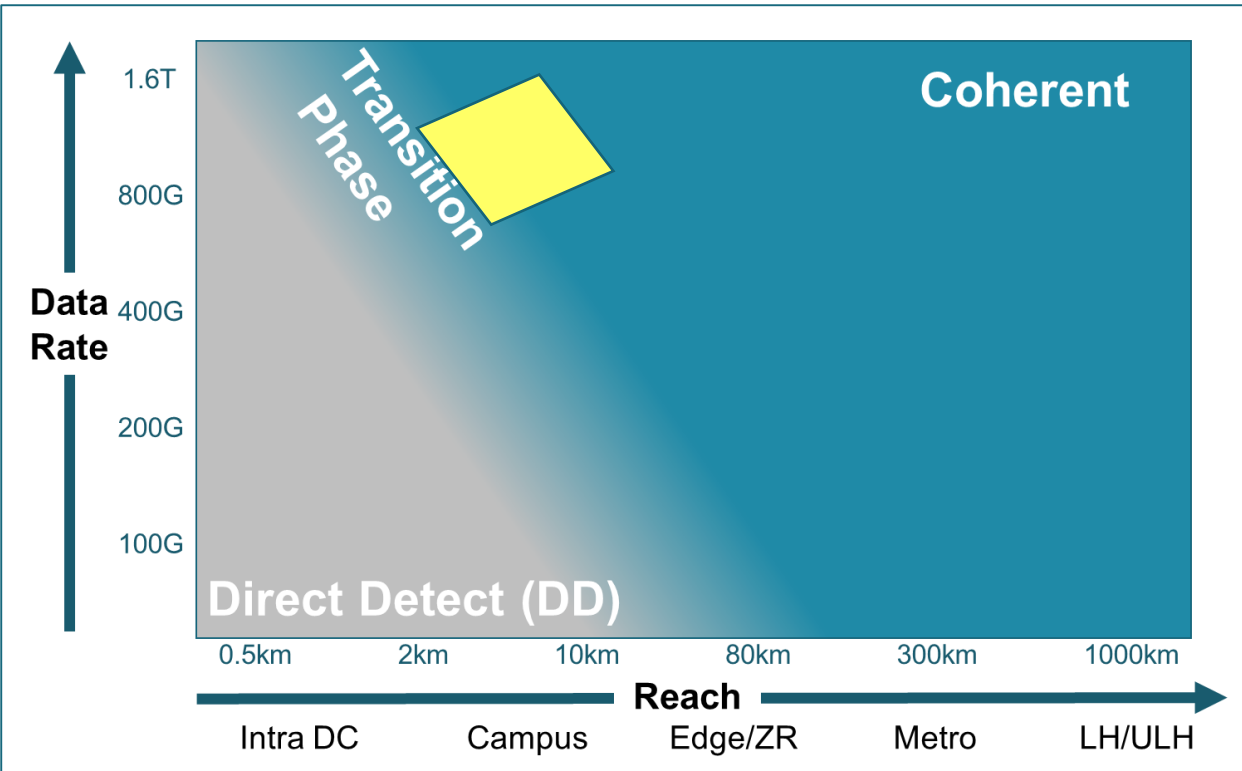
Coherent Beyond Transport Networks

Coherent In Access Network



- Fiber closer to the customer premise
 - Fiber Deep
- Common 10GbE aggregation points
- Reaches typically 10's of km
 - Dispersion penalty for direct detect is prohibitive >25Gbaud
- Coherent requirements
 - Low cost 100G/200G
 - Extended temperature operation
- CableLabs driving standardization efforts for cable access networks

Coherent Inside the Data Center



- Coherent more attractive inside data centers >400G
 - Fewer lasers
 - Electronic dispersion compensation
 - Lower loss at 1550nm
- Why stop at 800G, let's go to 1.6T
- Leverage advances in packaging and integration to drive scale

Barriers to Coherent Adoption



Form
Factor



Power



Standards



Price

Next Generation Coherent – Beyond Transport Networks

- Keys to broader coherent adoption
 - Packaging and Integration
 - Non-hermetic
 - Fewer assembly steps
 - High volume CMOS processes
 - Simpler Specifications
 - Fixed wavelength
 - Power-limited applications eliminate costly OSNR testing
 - Increased margin to reduce test requirements
 - Volume, volume, volume
 - Higher volume applications drive greater automation
 - Better amortization of development cost

Thank You