100G/ 400G Optics & 400G ZR Solution

Transceiver Quick Refresher

*Serializer Deserializer
**Physical Layer device
***Multi-Source Agreement

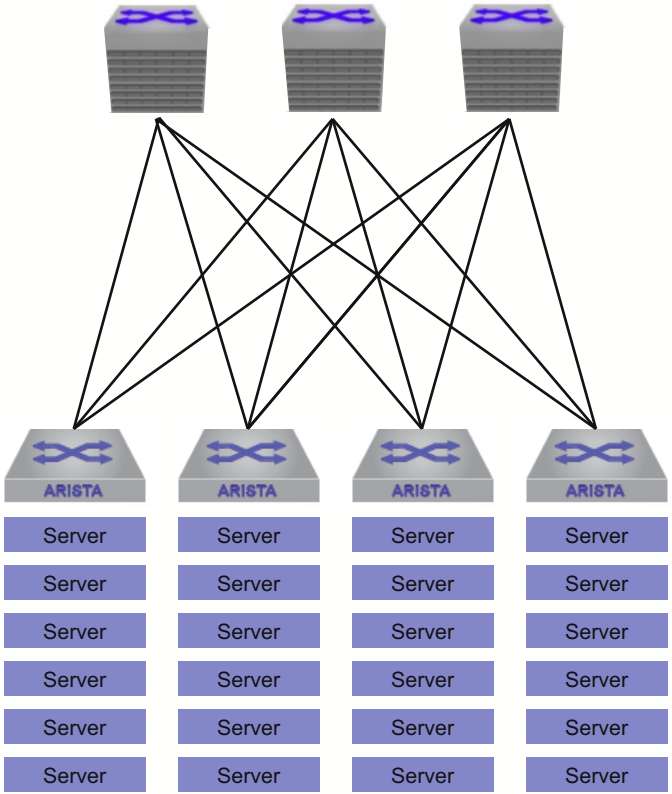
Host Side
(Electrical)

Line Side
(Optical or Electrical)

- Transceivers convert a host-side (internal) signal to the line-side (external) signal
- **Host-side** interfaces are known as **SerDes***
  - Defined by IEEE standards
  - Designed for short range high speed signalling (i.e. chip to chip)
  - Connect the PHY** to the transceiver.
  - PHY may be inside the switching silicon or an external component (e.g. Base-T PHY)
- **Line-side** interfaces may be electrical or optical
  - Defined by IEEE standards or by industry groups (e.g. 10G-LR)
- Transceiver format and electrical interface design
  - **Physical** form factor, electrical interface defined by MSA***

To interoperate with hosts and link partners, transceivers must meet many common standards

Comprehensive Range For Datacenter Connectivity



Long reach Optical Modules
For DCI and DWDM

10km – 100km+

Optical Modules
For TOR to leaf or leaf to spine

100m – 10km

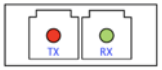
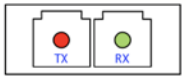
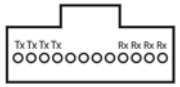
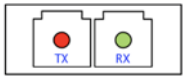
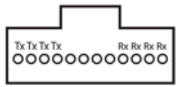
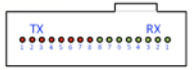
Active Optical Cables (AOCs)
For TOR to leaf

1m – 30m

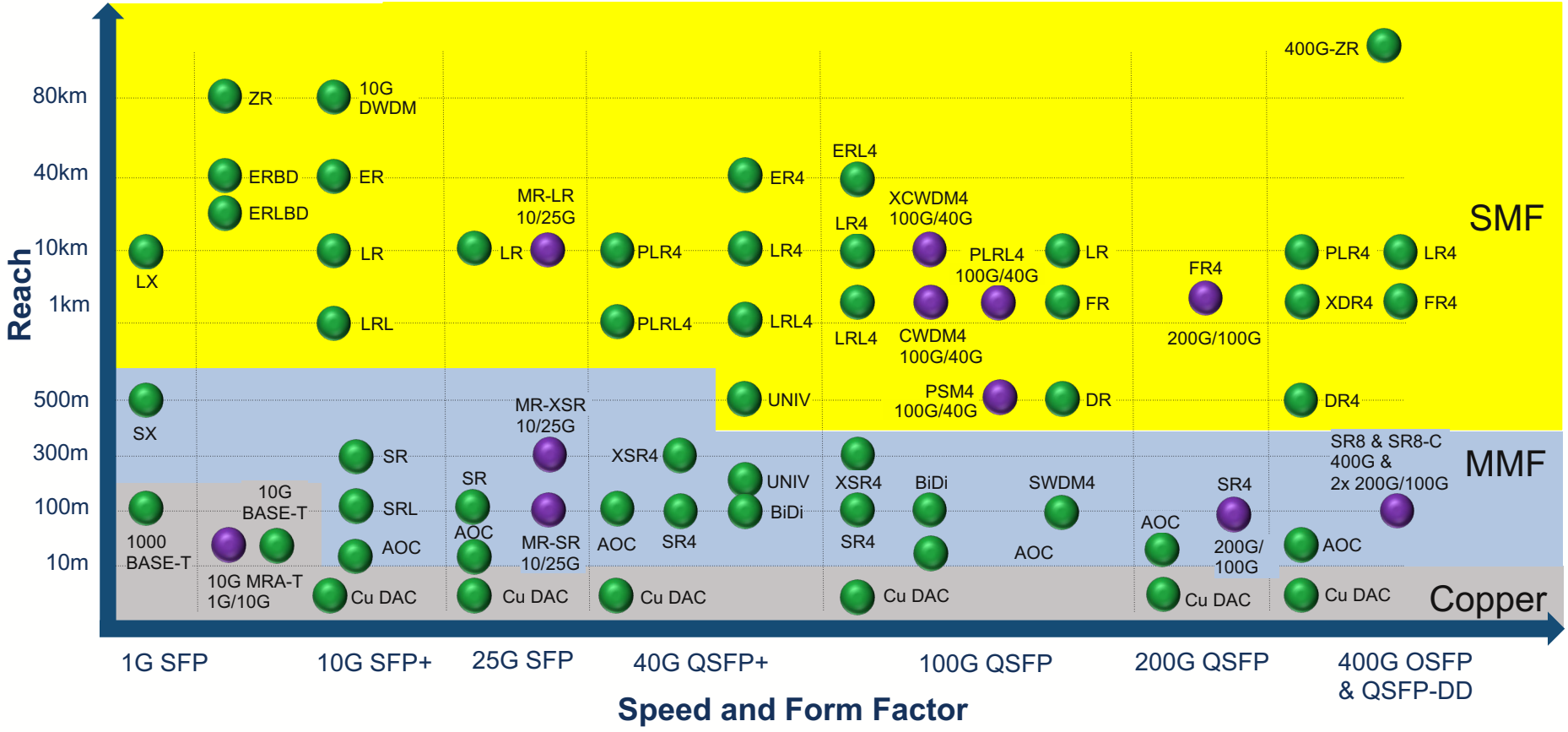
Direct Attach Cables (DACs)
for TOR to server

1m – 5m

Optical Transceiver Basics

Electrical interface	Form factor & data rate	Optical conn.	Fiber type	Wavelength	Max reach
1G & 10G	 **SFP**: 1G, 10G & 25G	Dual LC 	Duplex SMF	1310/1550nm	80km
			Duplex MMF	850nm	400m
4 x 10G (40G) or 4 x 25G (100G)	 **QSFP**: 40G & 100G	Dual LC 	Duplex SMF	4x ~1310/1550nm	40km
			Duplex MMF	4x or 2x ~850nm	40G: 150m, 100G: 100m
		MPO-12 	Parallel SMF	1310nm	40G: 10km, 100G: 500m
			Parallel MMF	850nm	40G: 400m, 100G: 300m
8 X 50G	 **OSFP**: 400G	Dual LC 	Duplex SMF	4x ~1310nm	2km, 10km
		MPO-12 	Parallel SMF	1310nm	2km
		MPO-16 	Parallel MMF	850nm	100m
8 X 50G	 **QSFP-DD**: 400G	Dual CS 	2 x Duplex SMF	4x ~1310nm	2km

Arista Optics & Cables: Broad Portfolio from 1G to 400G



ARISTA

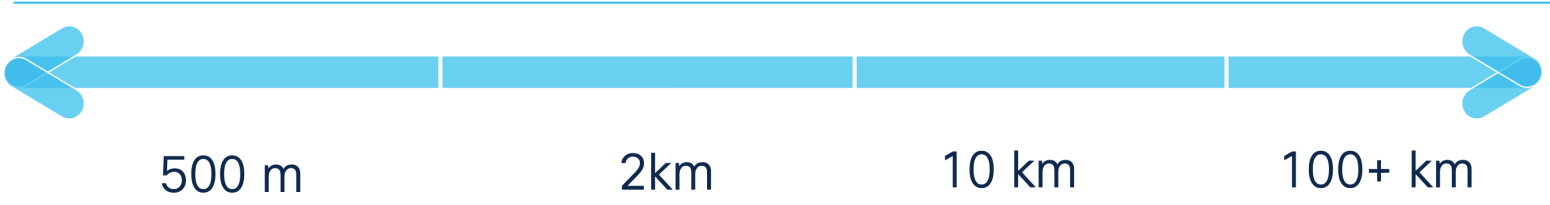
100G Optics

100G Optics: A Brief History

Why are there so many variants of 100G optics?

- First 4 channel 100G Optics for **duplex SMF**: 100G-LR4: 10km reach, but expensive
  - Many ISPs and Colos have standardized on 100G-LR4. Will stick around for a long time.
  - "100G-LRL4" or "100G-LR4-Lite": Same 'family' as 100G-LR4, 2km reach, somewhat lower cost
  - "100G-ERL4" or "Extended reach – Lite": 40km, Same 'family' as 100G-LR4, 40km reach with FEC
- Data centers wanted large volume, low cost 100G optics → 100G-CWDM4: 2km reach
  - Widely deployed within the data center.
  - "100G XCWDM4", extended reach CWDM4: 10km, interop with CWDM4, cheaper than LR4.
- The future is 100G-lambda optics: 100G-DR/FR/LR with 500m, 2km, 10km reach
  - Interop with 400G, lowest cost 100G SMF optics, but NOT interoperable with 100G-LR4/CWDM4
- **For duplex MMF**: 100G-SWDM4 and 100G-BIDI (SRBD)
  - Two "equivalent" options for duplex MMF, but **NOT** interoperable with each other
- For **breakouts** to 4x25G (with **parallel fiber**)
  - SMF: **100G-PSM4** (500m)
  - MMF: **100G-SR4** and **XSR4** (100m and 300m)

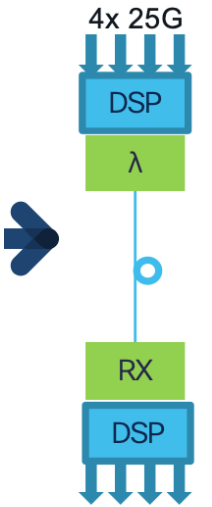
100G / 400G Photonics with distances



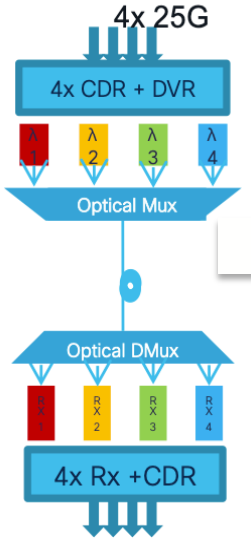
	500 m	2km	10 km	100+ km
100G Optics	100G-PSM4 100G-DR	100G-CWDM4 100G-FR1 4X100G-FR1	100G-LR4 4x100G-LR	100ZR4 100G CFP2 DCO
400G Optics	400G-DR4	400G-FR4	400G-LR4-10	400ZR 400ZR+

Optics in the Fabrics

Module 100G	Connector	Distance	SM/MM	Cost
SR4	MTP8/12	100m(OM4)	MM	*
CWDM4	LC	2km	SM	****
LR4	LC	10km	SM	******
DR	LC	500m (1) (Data Center Reach)	SM	**
FR	LC	2km (Fiber Reach)	SM	***
LR	LC	10km	SM	****



100GBASE-DR
100GBASE-FR
100GBASE-LR

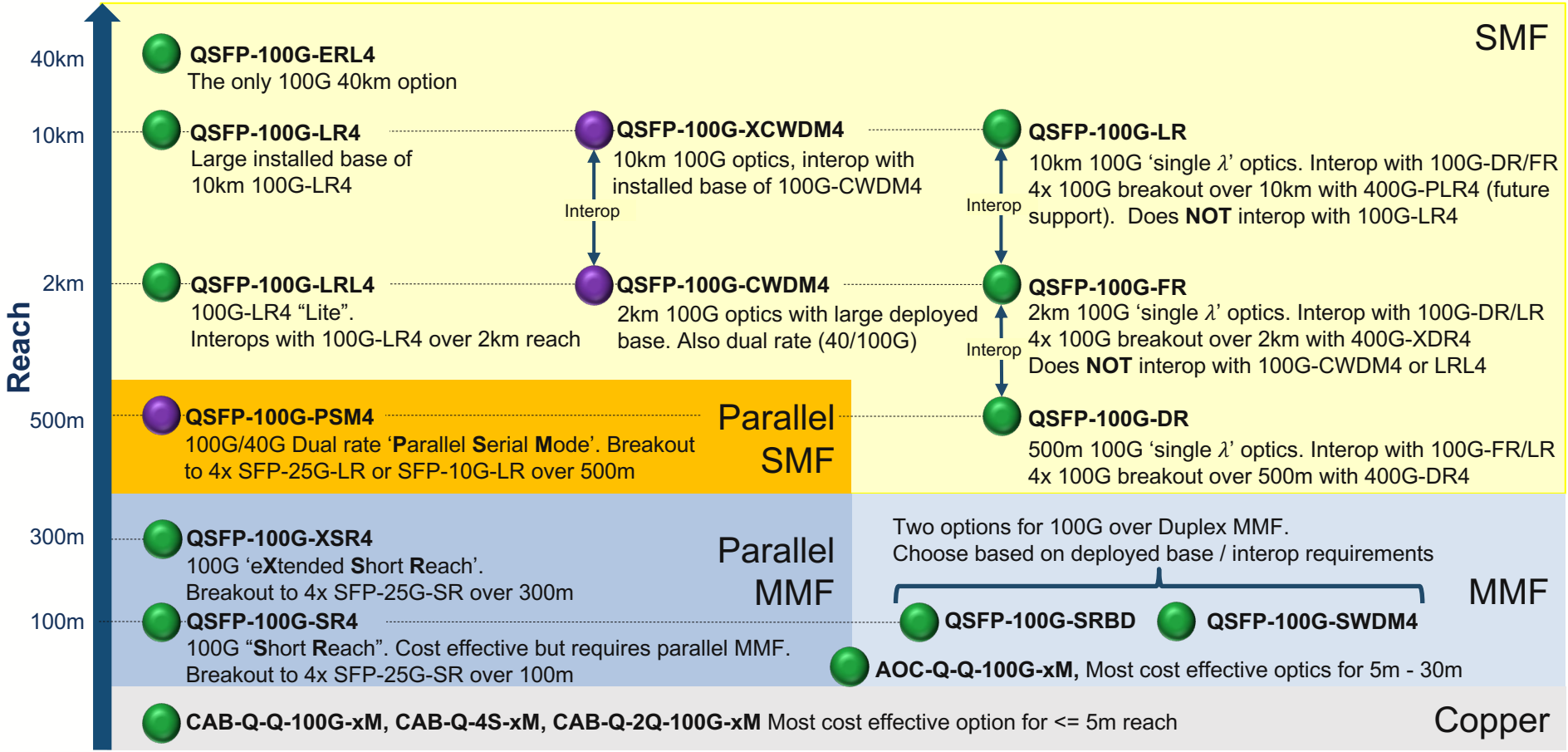


100G-CWDM4

(1): 500m is the maximum distance in some very high scale Data Center

ARISTA

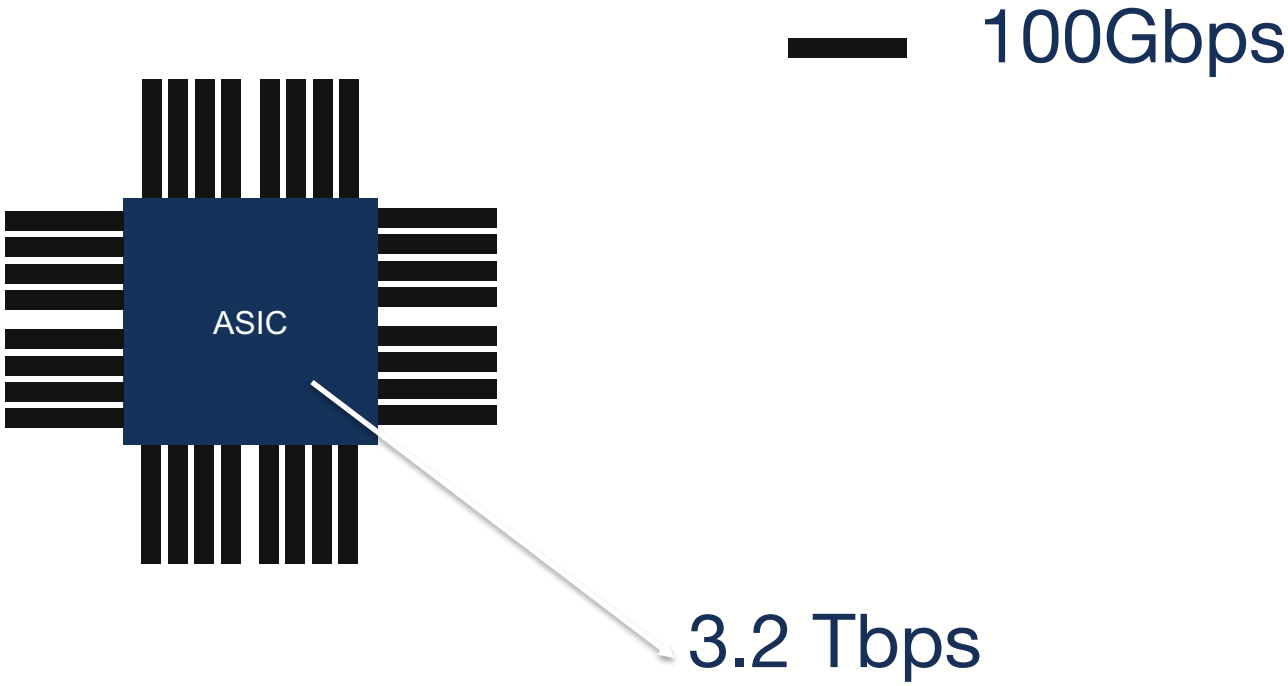
100G Optics Selection Guide



ARISTA

400G Optics

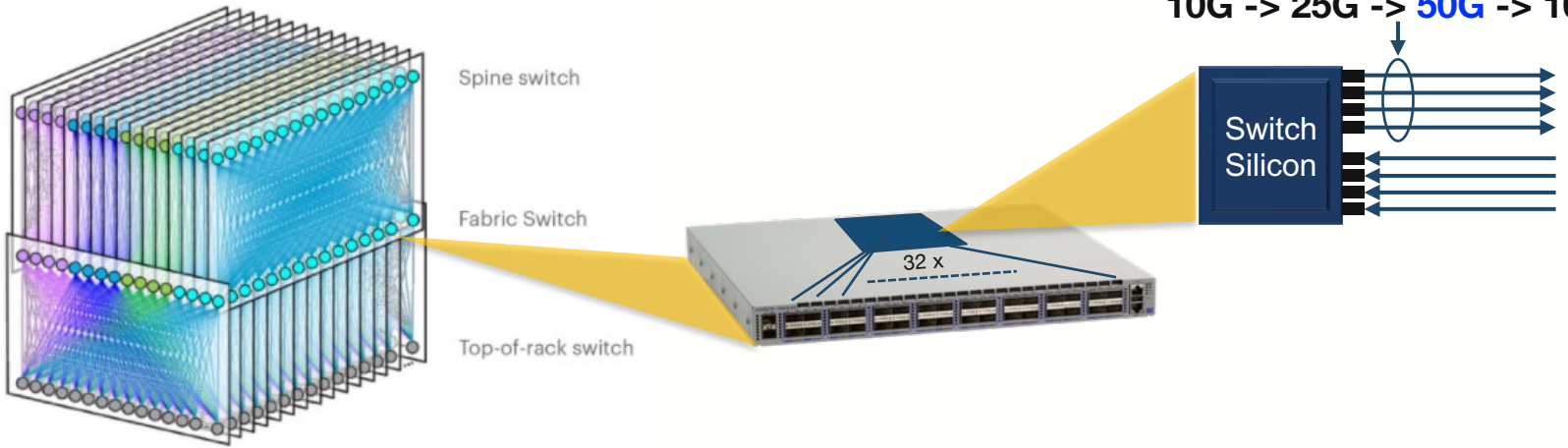
SER DER: Serializer - Deserializer



SERDES Speeds are Key to Scaling Datacenters

- Serdes (or **Ser**ializer-**Des**erializers) refer to the technology used for high-speed chip I/O
- Serdes speeds place a fundamental limit on datacenter bandwidth
- The easiest way to go faster is (for serdes speeds) to go Faster

Ethernet switch chip I/O **(or serdes) speeds**:
10G -> 25G -> 50G -> 100G



Facebook F16 data center network topology.
https://engineering.fb.com/data-center-engineering/f16-minipack/

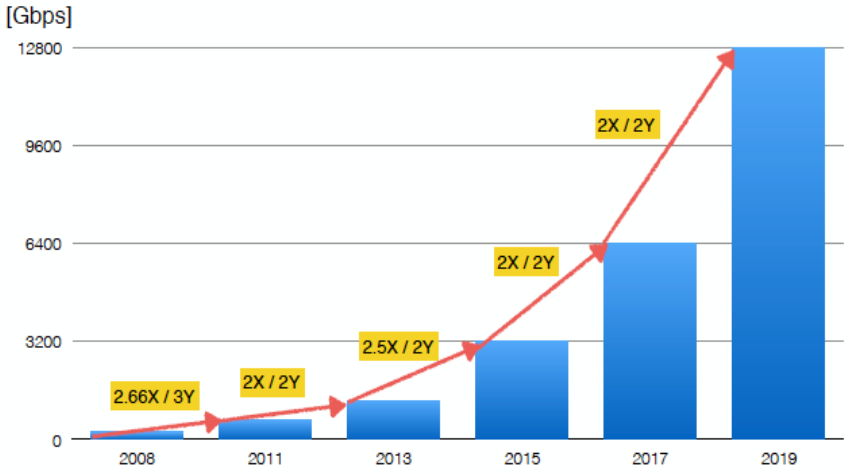
Single-chip Switch Bandwidth & Serdes Speeds

10G Serdes
- 2008: First 24 port 10G single chip
- 2011: First 64 port 10G single chip
- 2013: First 32-port 40G single chip

25G Serdes
- 2015: First 32-port 100G single chip
- 2017: First 64-port 100G single chip

50G Serdes
- 2019: First 32-port 400G single chip

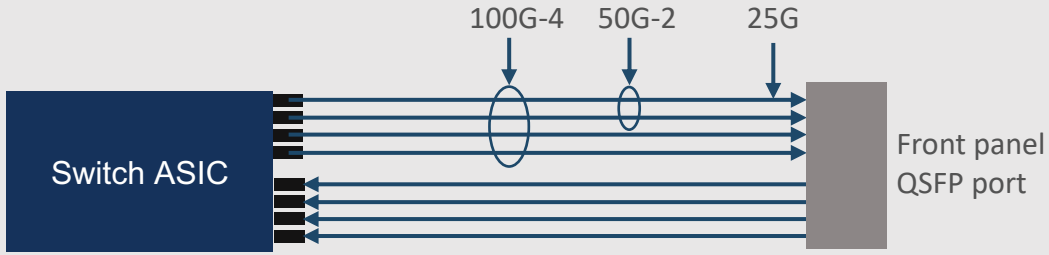
100G Serdes
- 2022: First 64-port 400G single chip
- 2023: First 32-port 800G single chip



Ethernet Speed (and Serdes) transitions have increased the throughput and cost-performance of datacenter networks

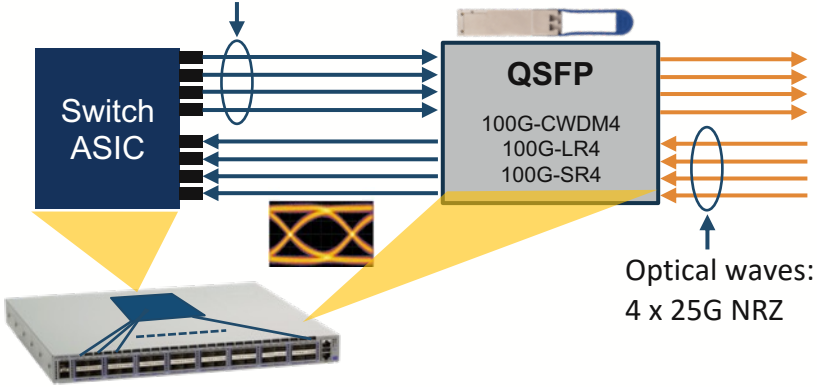
25G SerDes Switch

Switch I/O with 25G NRZ Serdes



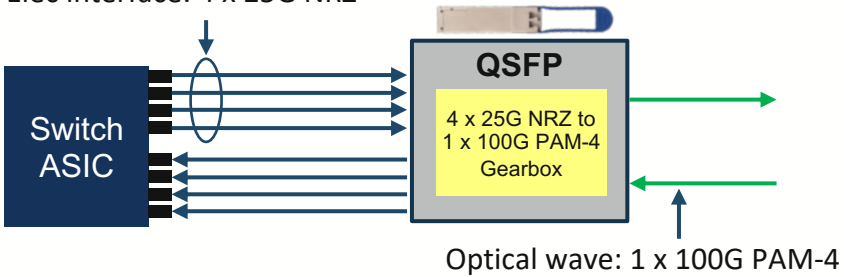
Legacy 100G Optics

Elec interface: 4 x 25G NRZ



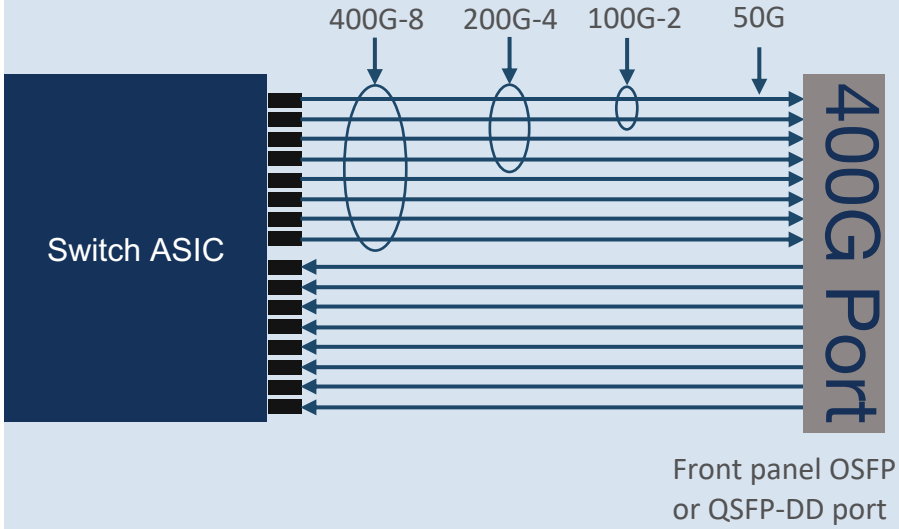
100G-DR (single lambda) Optics

Elec interface: 4 x 25G NRZ

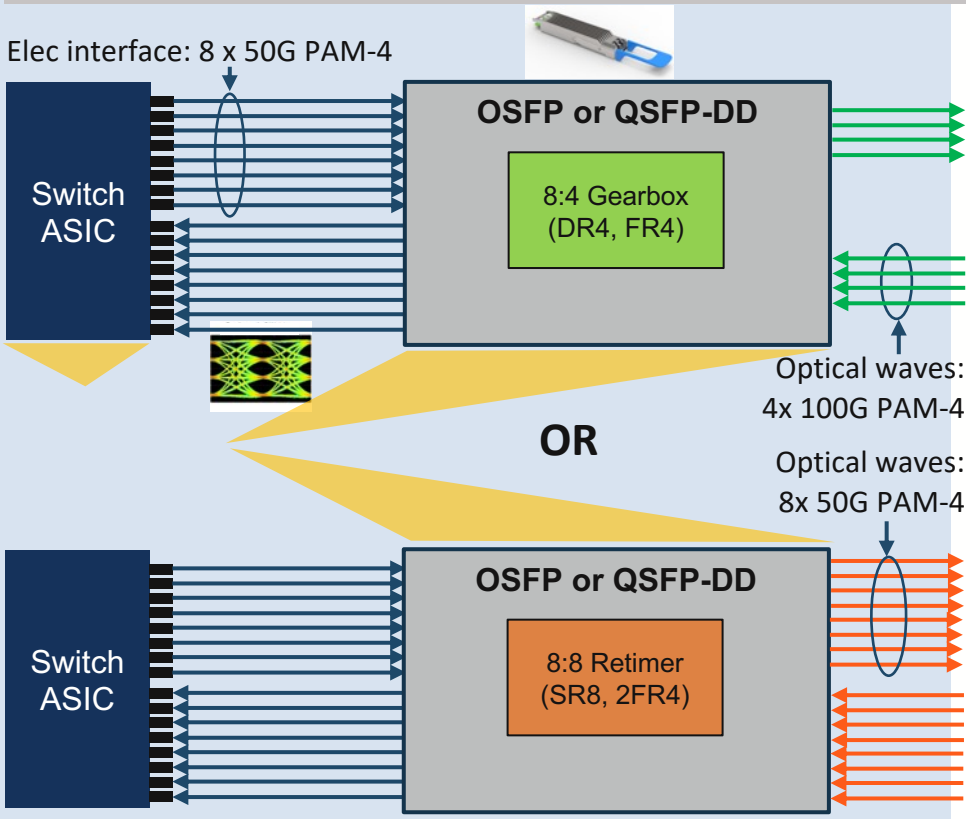


50G SerDes Switch

Switch I/O with 50G PAM-4 Serdes



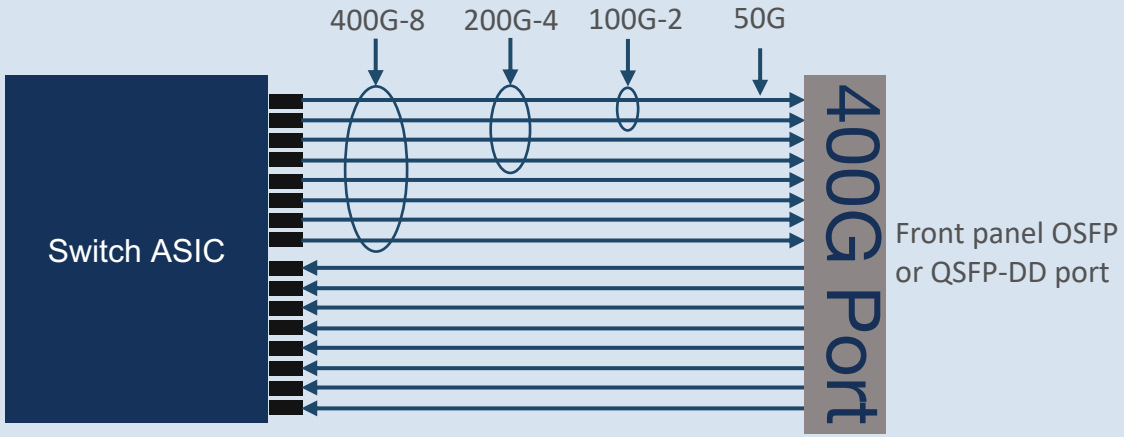
400G Optics - 2 architectures: 4x 100G-λ or 8x 50G-λ



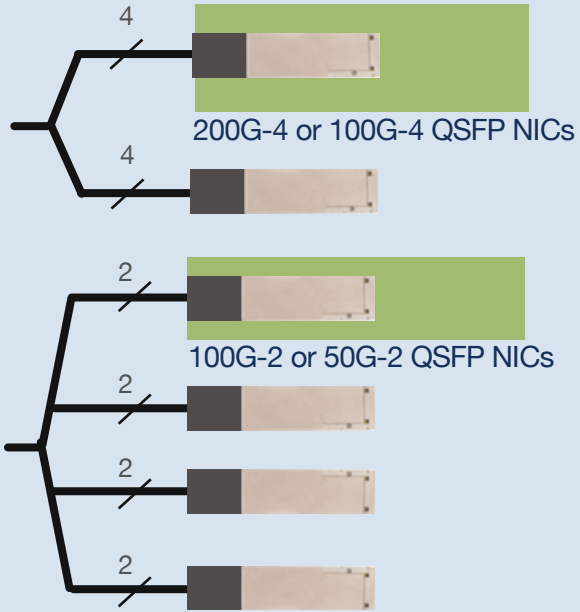
ARISTA

50G SerDes Switch

Switch I/O with 50G PAM-4 Serdes



OSFP/QDD → QSFP Breakout Options

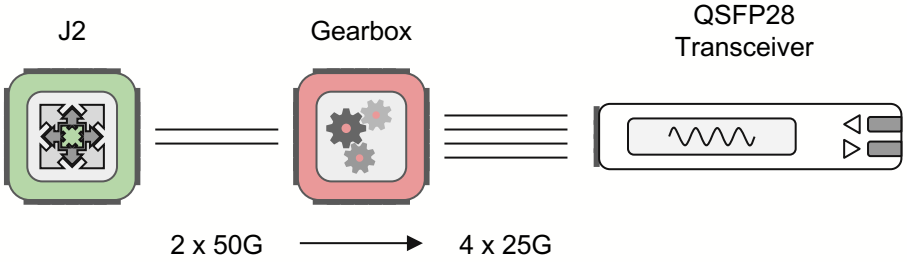


ARISTA

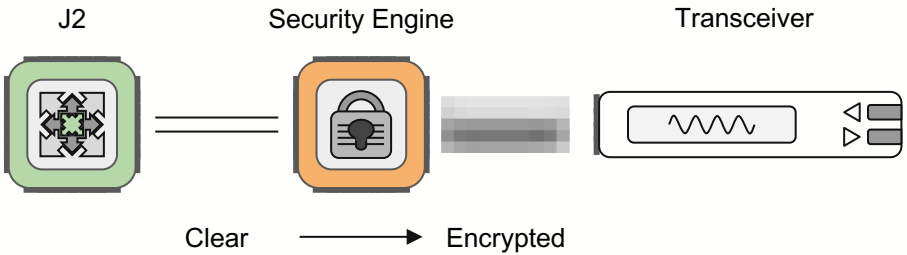
50G SerDes Switch / What is the Gearbox ?

Provides rate conversion and may add other features:

Rate Conversion:



Encryption:

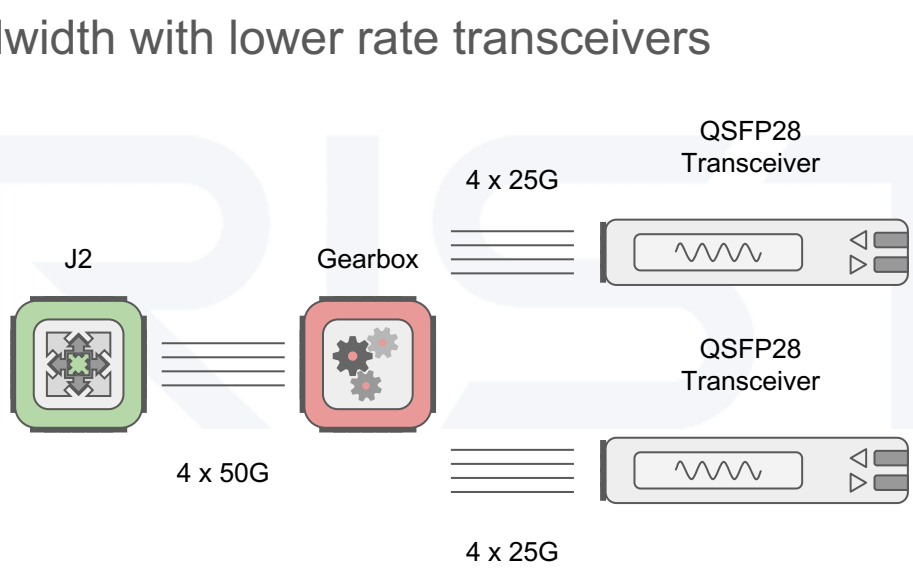


Gearbox converts 2 x 50G to 4 x 25G to support QSFP28

ARISTA

50G SerDes Switch / What is the Gearbox ?

Maximize chip bandwidth with lower rate transceivers

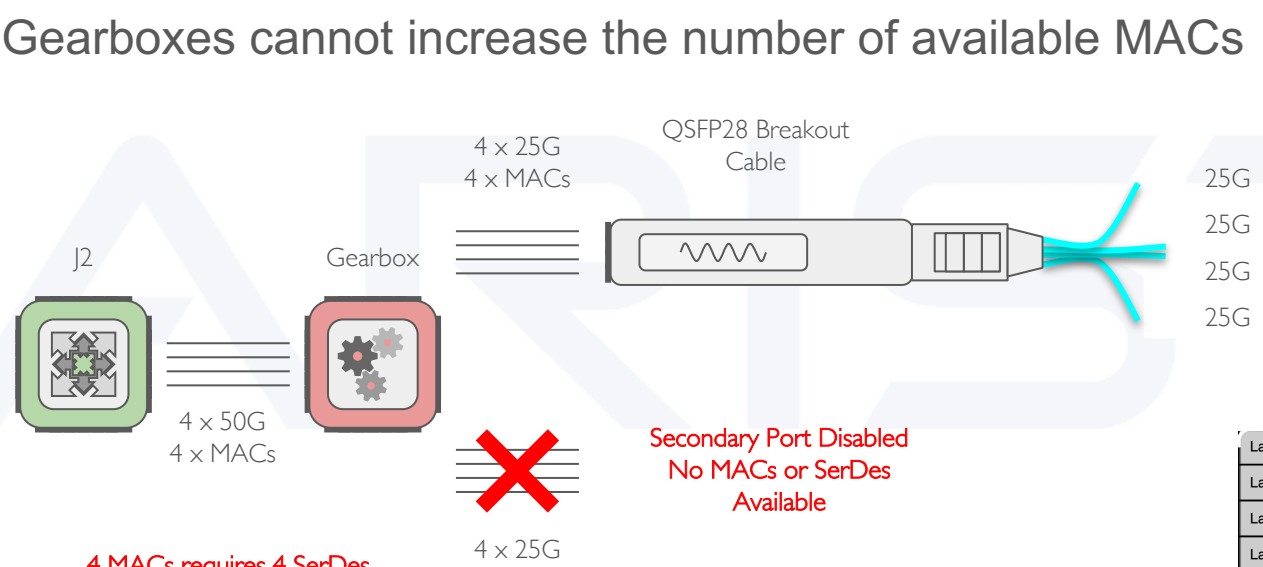


2 x 100G QSFP28 Ports are realised with 4 x 50G lanes and 2 MACs

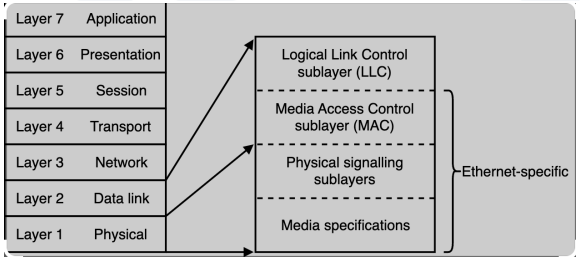
Gearbox allows a single J2 to support 48 x 100G interfaces - 100% utilization

50G SerDes Switch / What is the Gearbox ?

Gearboxes cannot increase the number of available MACs



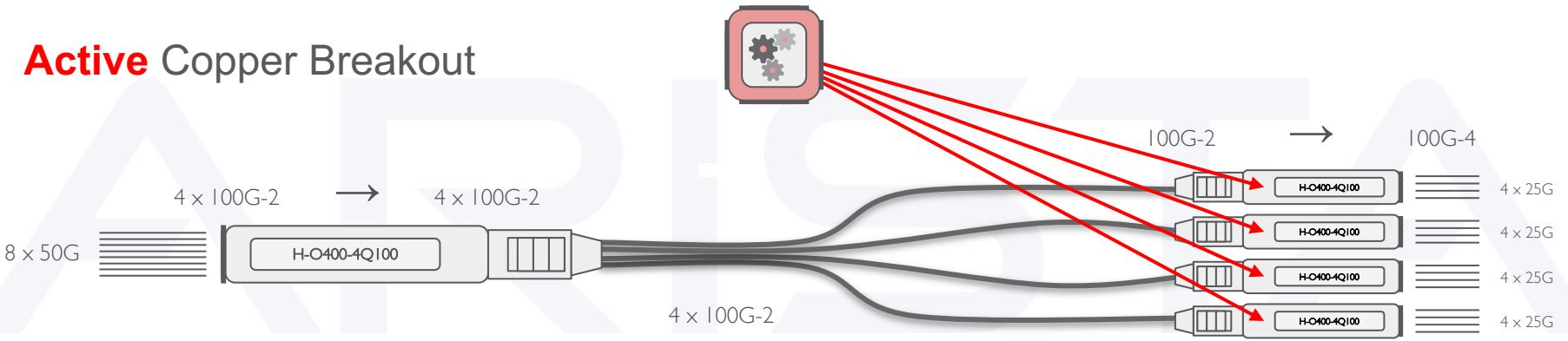
4 x 25G ports
Requires 4 MACs



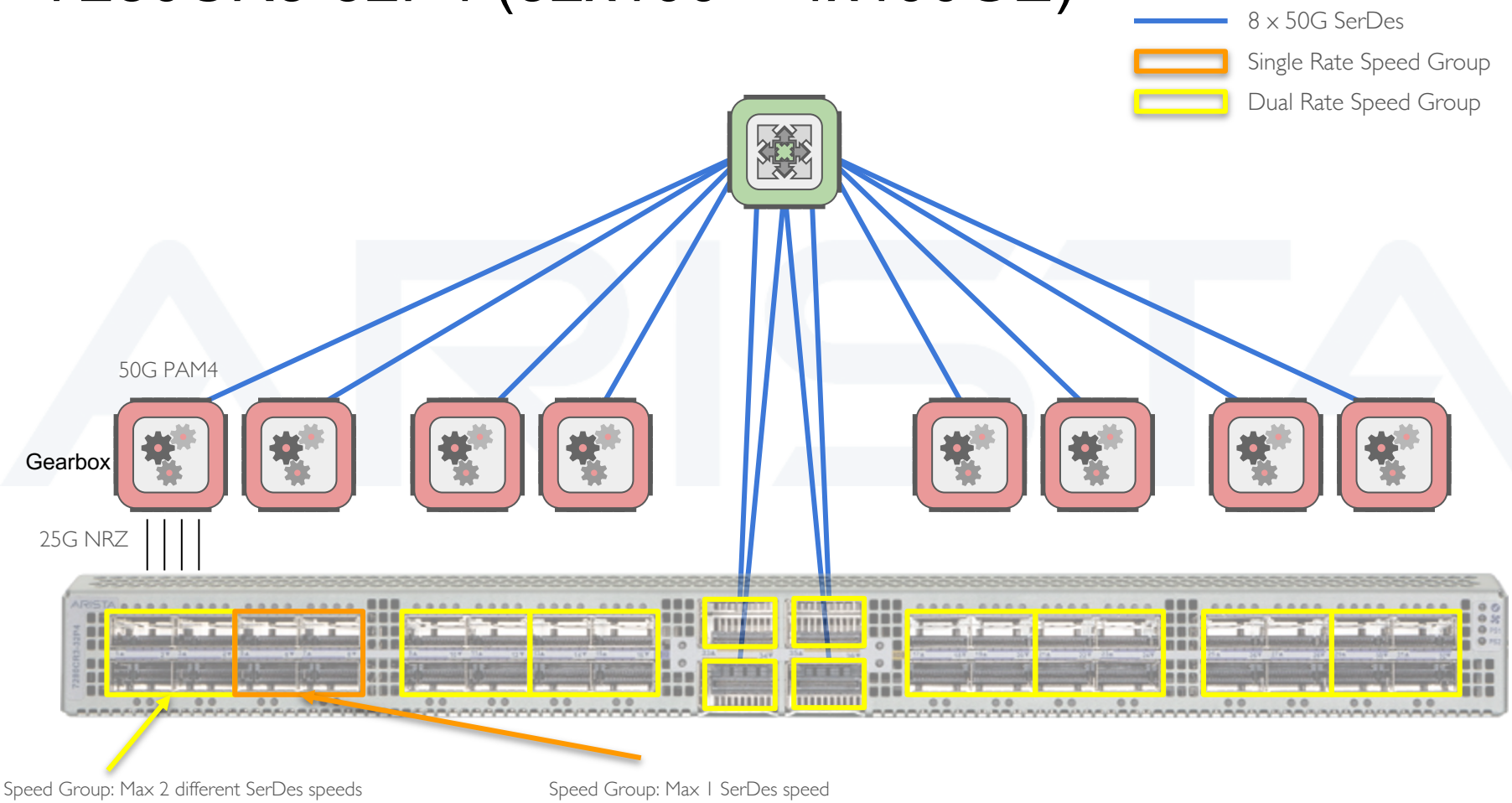
Gearbox is not a switch - does not overcome maximum interface limitations

Other Gearbox Examples

Active Copper Breakout

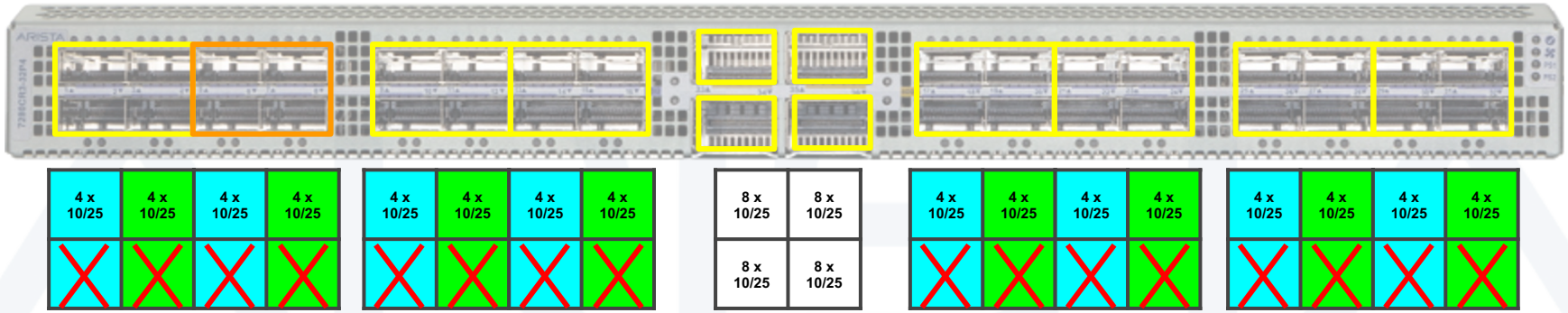


7280CR3-32P4 (32x100 + 4x400GE)



7280CR3-32P4 (32x100 + 4x400GE)

Maximum 96 Logical Ports, one logical port per SerDes/MAC:

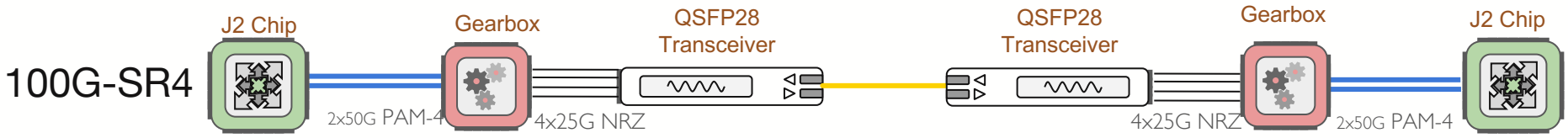


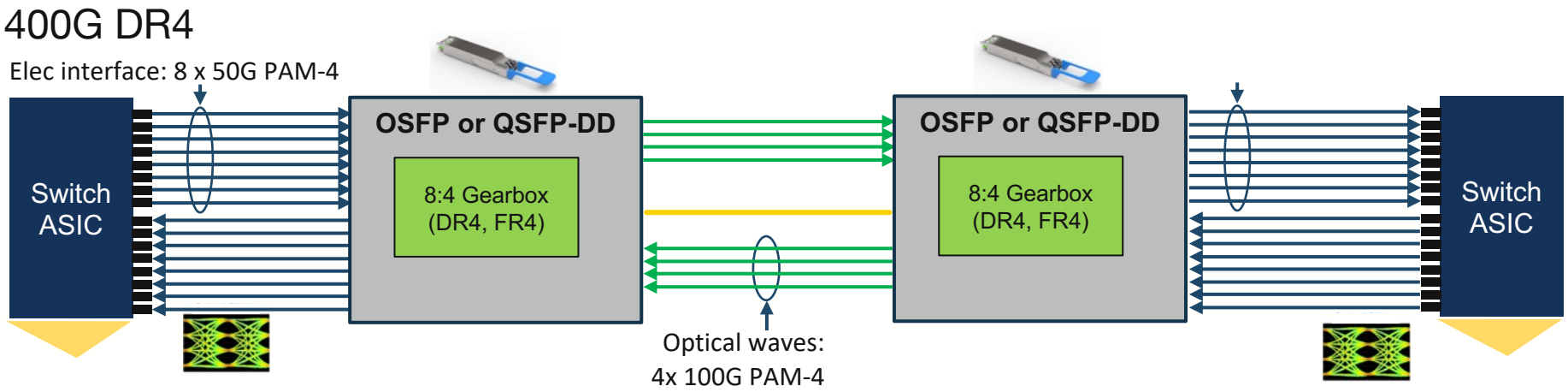
Limited support for 4x25G mode on 100G ports connected via a Gearbox

- The gearboxes convert 2 x 50G PAM4 into 4x25G NRZ meaning there are only 2 logical ports available. For a port to operate in 4x25G mode requires the adjacent port to be disabled.
- In 7280CR3-32P4, QSFP100 ports can be configured as 4x25G or 4x10G when the adjacent *QSFP100 port is disabled*

Model Comparison	7280CR3-32P4
Ports	32 x QSFP100, 4 x OSFP
Max 400G Ports [1]	4
Max 100G Ports [1]	48
Max 50G Ports [1]	96
Max 40G Ports [1]	36
Max 25/10G Ports [1]	96
Max Total Interfaces [2]	96

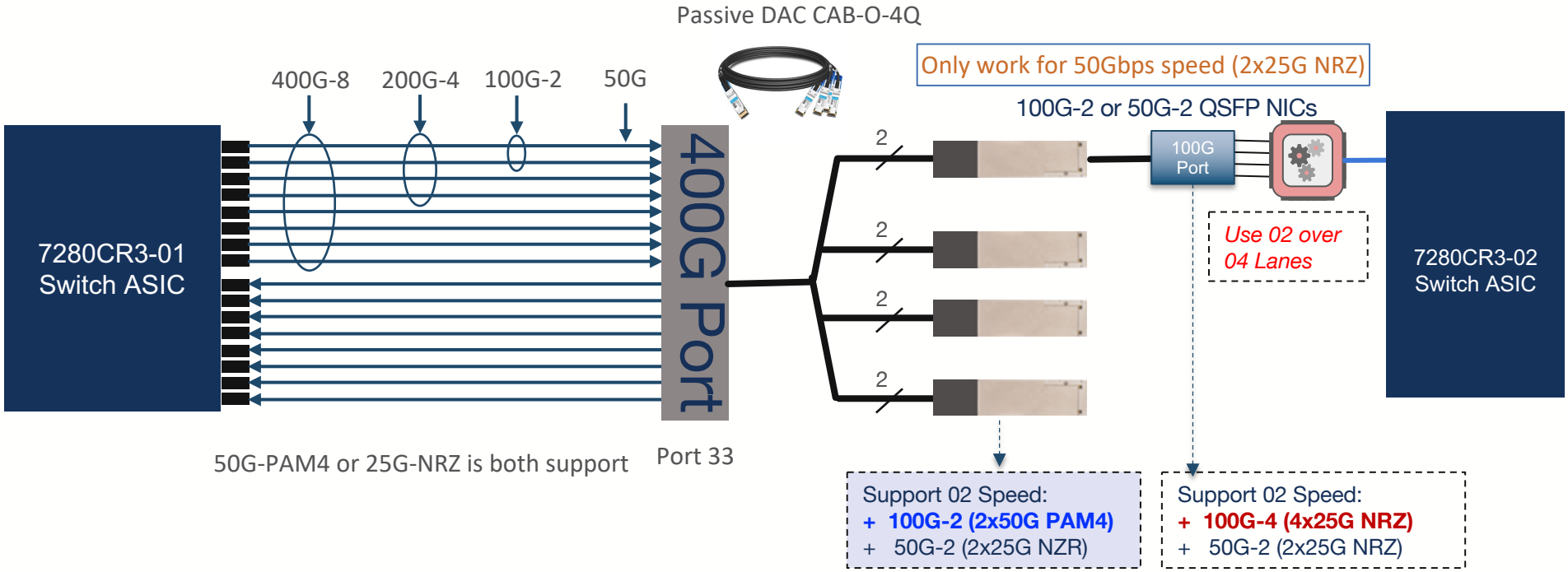
7280CR3 - Interconnect





ARISTA

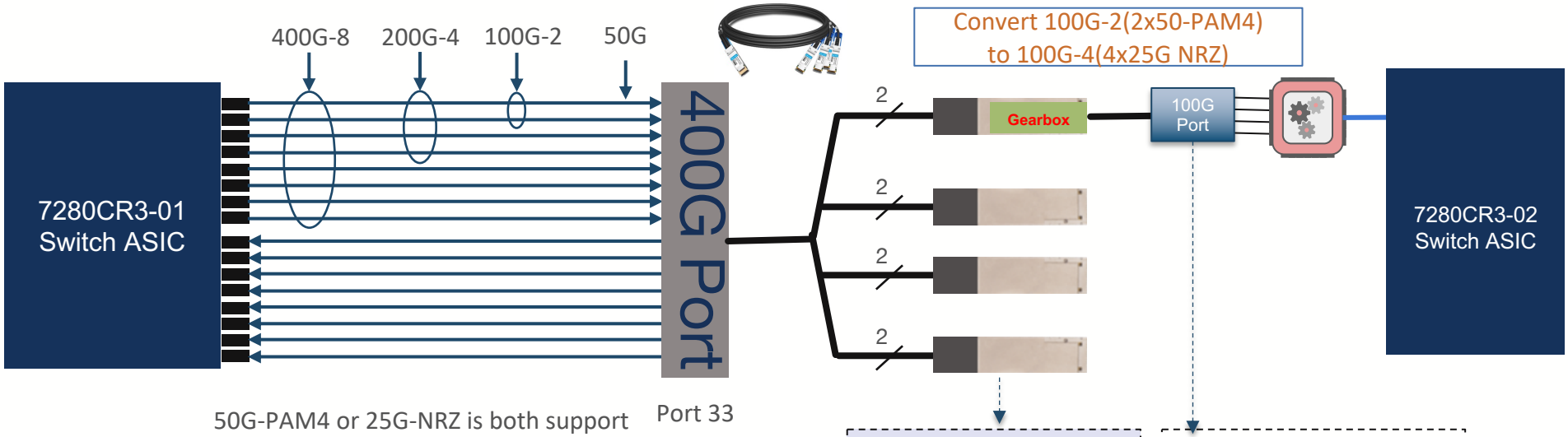
7280CR3 - Interconnect



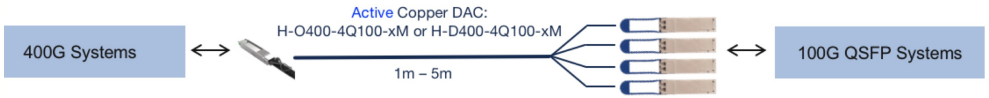
With 400G Breakout Passive DACs (CAB-O-4Q-400G-3M), when connect to 02 7280CR3, the speed 50Gbps (2x25G NRZ) is only support.

7280CR3 - Interconnect

ACTIVE DAC H-O400-4Q100

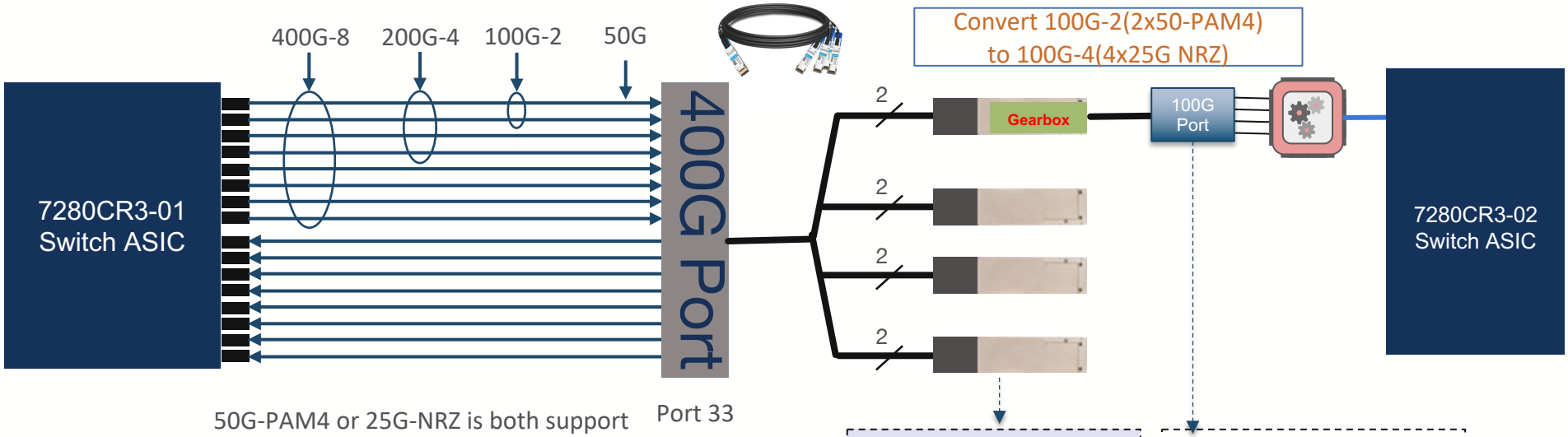


iv) **H-O400-4Q100-xM (or H-D400-4Q100) to 4x QSFP100 ports with Active Copper DACs, 1m – 5m.** Connect up to 4x 100G QSFP ports to a single 400G OSFP or QSFP-DD port. The QSFP end of the active breakout DAC includes a gearbox chip which converts 2x50G PAM-4 electrical signals into a 4x 25G NRZ interface, the modulation format used in legacy 100G QSFP ports.

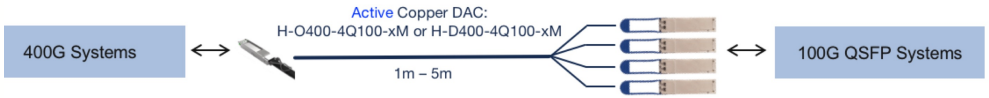


7280CR3 - Interconnect

ACTIVE DAC H-O400-4Q100

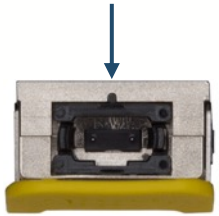


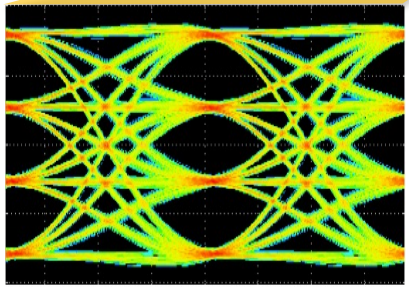
iv) **H-O400-4Q100-xM (or H-D400-4Q100) to 4x QSFP100 ports with Active Copper DACs, 1m – 5m.** Connect up to 4x 100G QSFP ports to a single 400G OSFP or QSFP-DD port. The QSFP end of the active breakout DAC includes a gearbox chip which converts 2x50G PAM-4 electrical signals into a 4x 25G NRZ interface, the modulation format used in legacy 100G QSFP ports.



400G Optical breakout to 4x 100G QSFPs

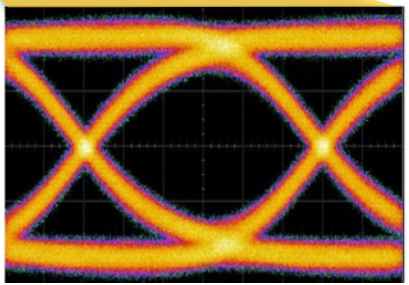
- 400G Parallel Serial Mode Optics, with MPO-12 optical connector
- Three reach options: DR4 (500m), XDR4 (2km), PLR4 (10km)





100G PAM-4

- 100G “single lambda” QSFP
- Three reach options: DR (500m), FR (2km), LR(10km)



4 x 25G NRZ

ARISTA

400G to 4x 100G QSFP Optical Breakouts: Reaches

Arista 100G Single λ QSFP SKU	Reach	Optical Standard	Arista 400G SKU for 400G → 4x 100G breakout	Availability
QSFP-100G-DR	500M	100G-DR	OSFP-400G-DR4 and QDD-400G-DR4	Released
QSFP-100G-FR	2km	100G-FR	OSFP-400G-XDR4 and QDD-400G-XDR4	Released
QSFP-100G-LR	10km	100G-LR	OSFP-400G-PLR4 and QDD-400G-PLR4	Released

400G Form Factors: OSFP & QSFP-DD

400G Form Factors

1G, 10G, 25G

SFP, SFP+, SFP28

40G, 100G

QSFP+, QSFP28

400G

OSFP

QSFP-DD

Arista fully supports both OSFP and QSFP-DD for 400G

7060PX4
32 x 400G OSFP Ports

7060DX4
32 x 400G QSFP-DD Ports

7368-4P
4 x 400G OSFP Ports

7368-4D
4 x 400G QSFP-DD Ports

Open Choice of 400G Pluggable Form Factors

Arista fully supports both OSFP and QSFP-DD

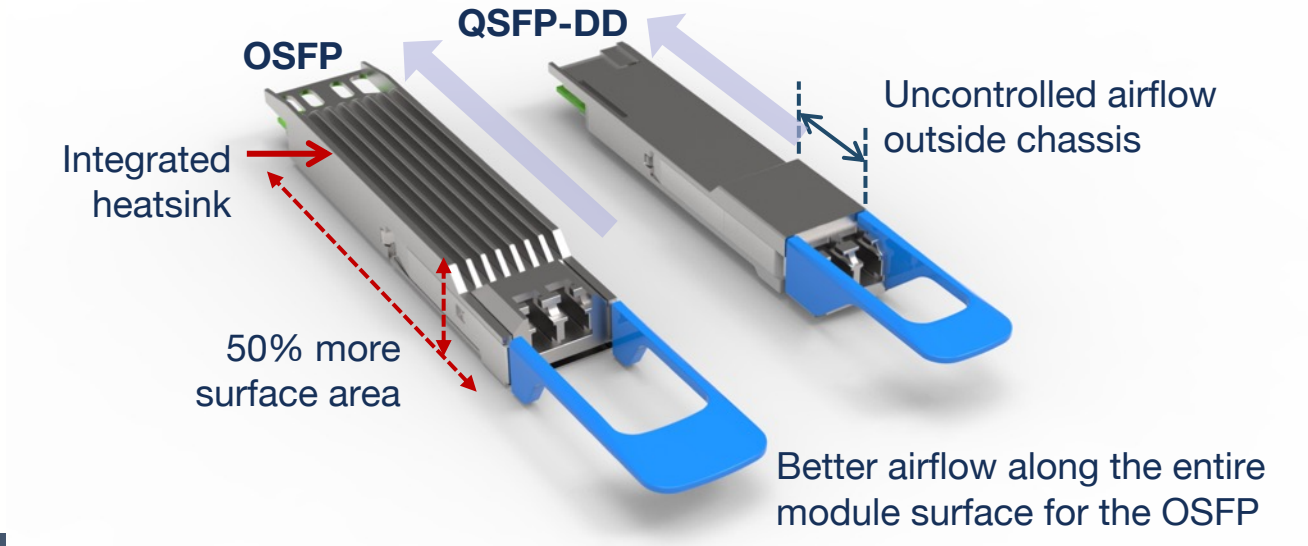
	OSFP	QSFP-DD
		
36 ports per 1RU	Yes	Yes
24W Thermal Capacity for 400G-ZR+ & 800 G	Yes	TBD
Forward compatible with 800G systems	Yes	TBD
Backwards compatible with QSFPs	Yes, with adapter	Yes
Max Copper DAC length	3m	2.5m

OSFP to QSFP Adapter (100G)

Why Does the OSFP Have Better Thermal Performance?

1. Integrated heatsink directly attached to temp sensitive components
2. ~50% Greater surface area and volume
3. Better airflow across entire surface of the module

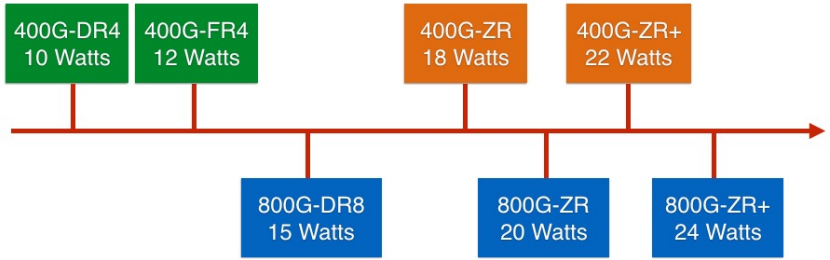
→ OSFPs operate ~10 to 15C cooler than QSFP-DDs for equivalent platforms



Why is Thermal Performance Important for Optics?

At 15W / Module → ~500W of power JUST for optics!

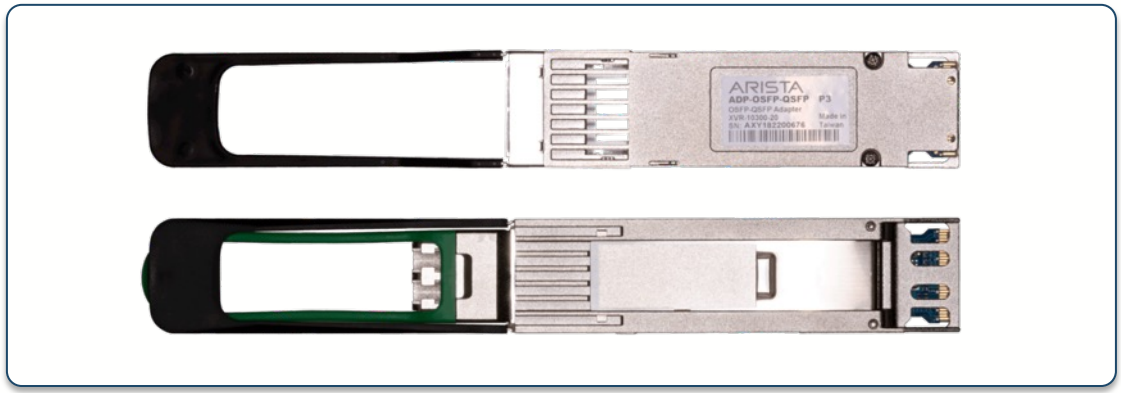
- Lower operating temperatures → **dramatic increase in optics reliability**
  - 10C temp increases optics failure rate by ~2x
- Easier to cool → Lowers system fan speeds → **10% - 25% less system power**
- Support wide range of optics, including **400G-ZR / ZR+**



OSFP to 100G QSFP Passive Adapter

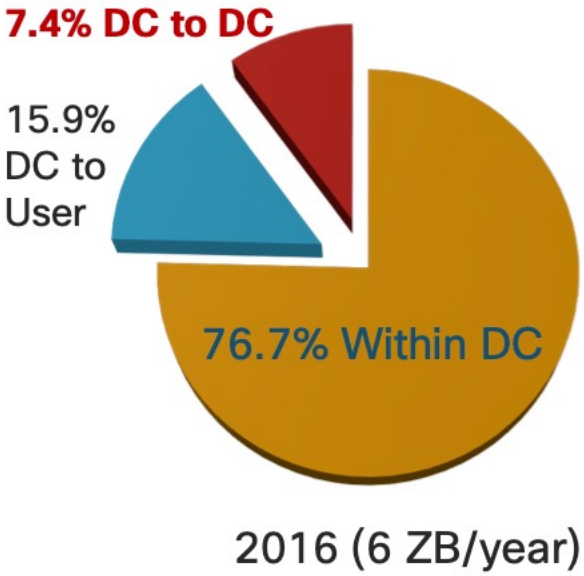
Category	SKU	Description
100G Adapter	ADPT-O-Q-100G	OSFP to QSFP100 Adapter

- Support for full range of existing 100G Optics
- Reuse existing optics in new 400G systems
- Future proof migration with **no compromise on 400G**

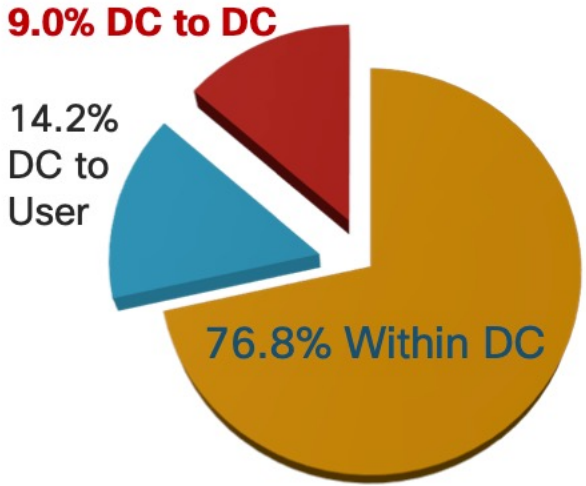


Arista 400G ZR DCI Solutions

Data Center (DC) Traffic Growth ..



2016 (6 ZB/year)



2021 (19.5 ZB/year)

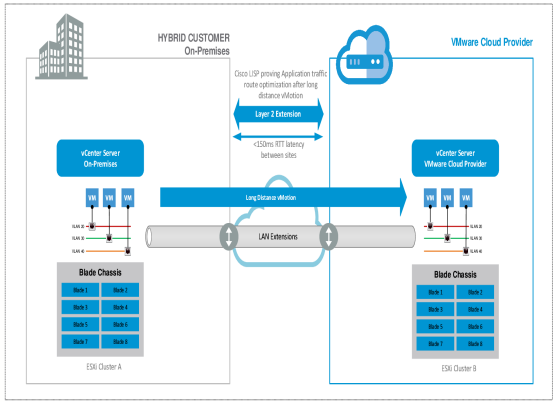
Source: Cisco Global Cloud Index

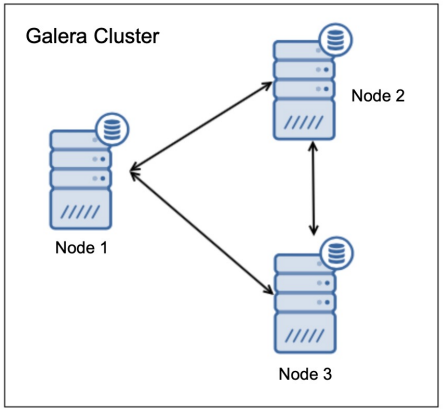
Drivers for DataCenter Interconnect (DCI)

Workload mobility between DCs for better resources utlization

Layer 2 Connectivity for Cluster Applications (Cluster Nodes located in different DCs)

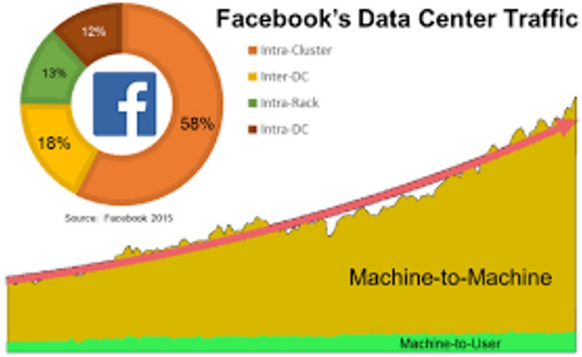
Backup and Disaster Recovery between DCs in different geo locations

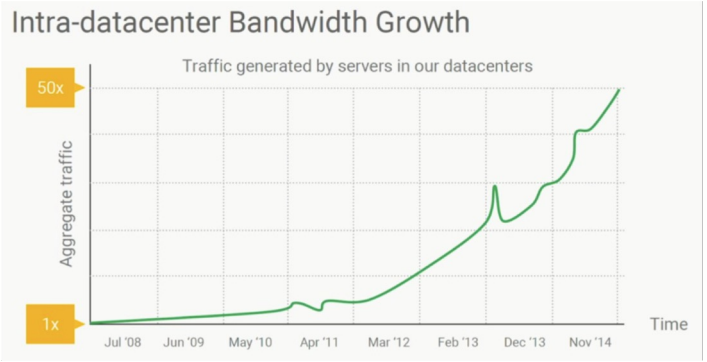




Drivers for 400G in the Data Center

1. **Bandwidth demand** of hyperscale cloud networks





Source: Urs Hoelzle, Google, OFC 2017

1. **Lowest cost / bit**

   A customer perspective:

   "It is all about cost, in particular, $ per Gbps, there is no other religion"

2. **Lowest power / bit**

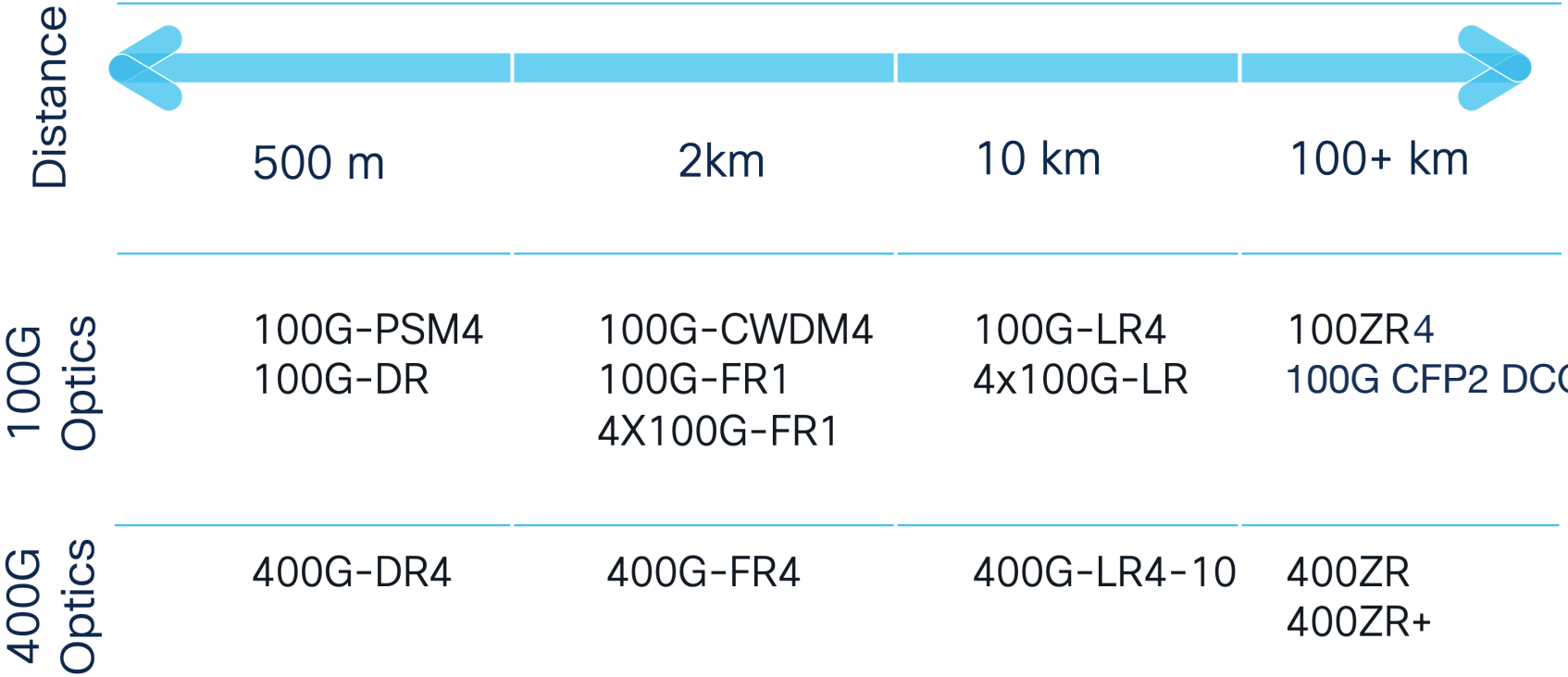
DCI by technologies

Layer 3 DCI:
- Layer 3 Routing between DCs
- Overlay over L3 Networks: IP-VPNv4 / L3 EVPN (MPLS/VxLAN)

Layer 2 DCI:
- Pure Layer 2 transport: VLAN/Trunking (802.1q) + MC-LAG/VPC
- Overlay over L3 Networks: L2EVPN / VPLS / VPWS

Layer 1 DCI:
- Dark Fiber with 100G ZR4 / 400G ZR
- WDM (Wavelength Division Multiplexing)

100G / 400G Photonics with distances

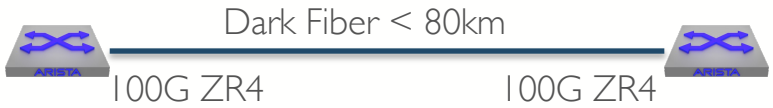


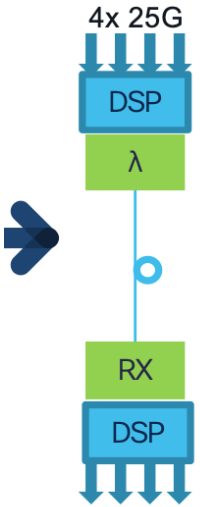
Option 1: 100G DCI with 100G ZR4

- Uses 4 wavelenghts for receive and transmit: 1295.56 ; 1300.05 ; 1304.58 and 1309.14nm
- Up to 80km with LC Connector
- Support on some Arista Platforms :

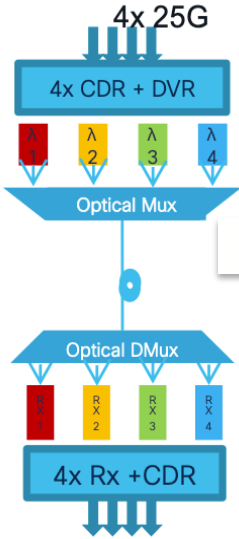
Table 5.1: Platform Support for QSFP-100G-ZR4 Transceiver Modules

Platform Family	Platform SKU	Supported Ports & Comments
7020R	7020SR-32C2	Both 100G QSFP ports, front to rear (-F) airflow only
7280R3	7280CR3(M)(K)-32D4(S) and 7280CR3(M)(K)-32P4(S)	Ports 15 - 18, front to rear (-F) airflow only at a max ambient temperature of 35C
	7280SR3(K)-48YC8	All 8 100G QSFP ports, front to rear (-F) airflow only at a max ambient temperature of 35C
	7280CR3-36S	All 100G QSFP ports, front to rear (-F) airflow only
7500R3	7500R3-36CQ	All 100G QSFP ports when using R3 Fabric cards





100GBASE-DR
100GBASE-FR
100GBASE-LR

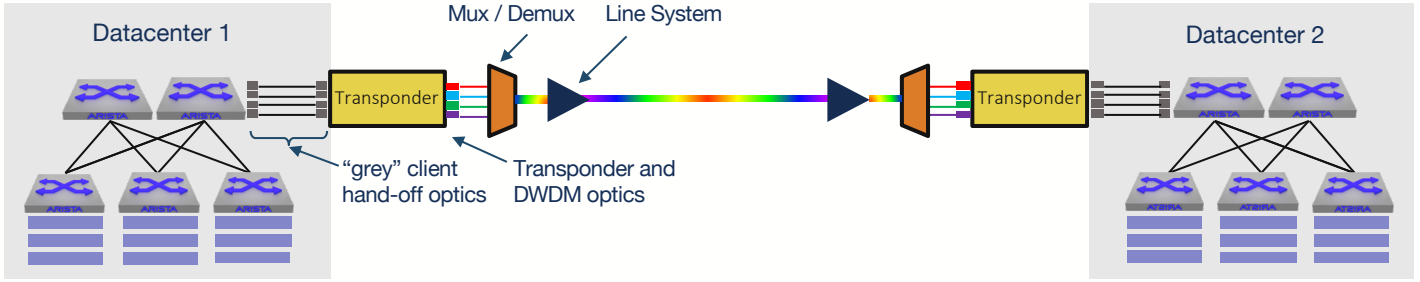


100G-CWDM4
100G ZR4

ARISTA

Option 2: Arista 400G DCI Overview

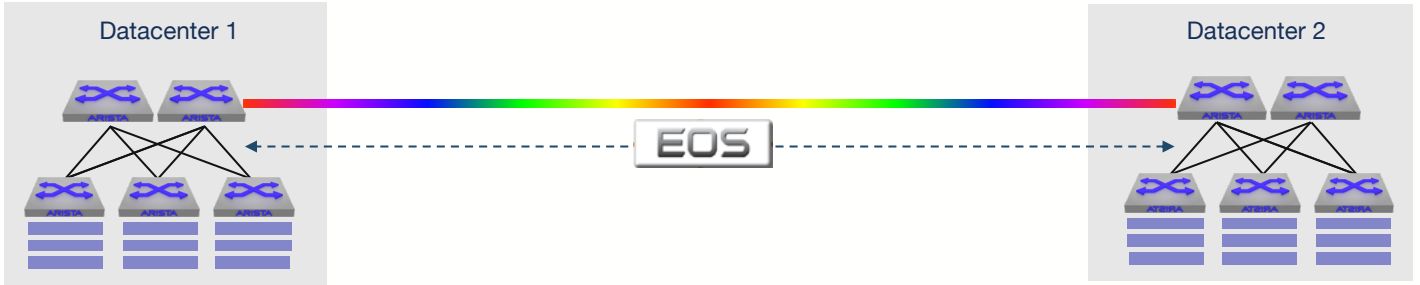
Before



Collapse DWDM systems into the switch:

1. Eliminate transponders with **400G-ZR** DWDM Optical Modules
2. Eliminate external line-systems with the **OSFP-Line System** (OSFP-LS) Module
3. Eliminate external mux with a colorless fiber Mux / Demux

After

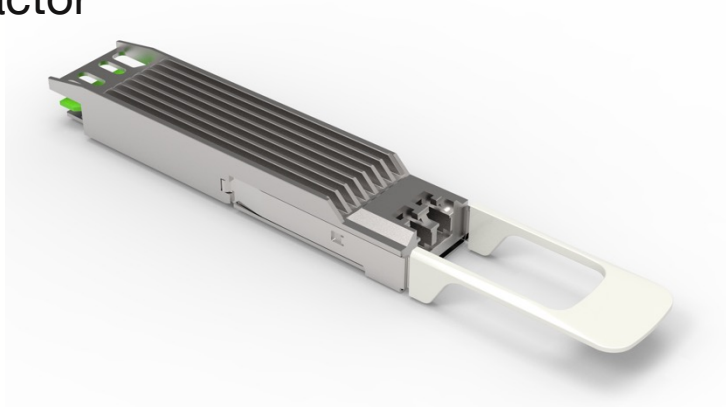


Simplify DCI by integrating DWDM into the switch

ARISTA

(1) Replace DWDM Transponders with 400G-ZR Modules

- 400G DWDM Optical Module in a client form factor
- Plugs into a ‘regular’ Arista OSFP port
  - DWDM optics with **no loss of port density**
- Tunable over the full C-band
  - 400G per wave (coherent DP-16QAM modulation)
- Open – standardized by the OIF
  - Interoperable and multi-vendor
- Most cost effective DCI optics
  - Replace expensive and proprietary DWDM transponders
  - A revolution for DCI
- Requires optical amplifiers (i.e. a line-system) for DCI reach of 40 – 120km

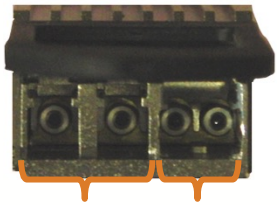


(2) Replace External Line Systems with OSFP-LS Module

- 400G-ZR modules require optical amplification to close 40km – 120km
  - Traditionally provided by external line systems
- The OSFP-LS is a fully autonomous optical line system in an OSFP package
  - Plugs into any Arista OSFP port
  - Provides amplification to extend the 400G-ZR reach to 120km
  - Auto configures gain for any link length from 1km – 120km, no user configuration required
  - Plug and play simplicity

OSFP-LS

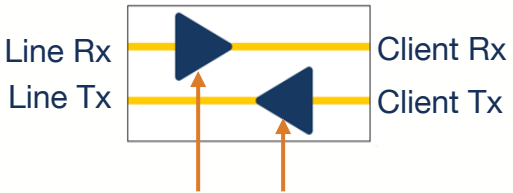
OSFP-LS, front view



Line (120km DCI)
LC connector

Client (to/from 400G-ZR)
CS connector

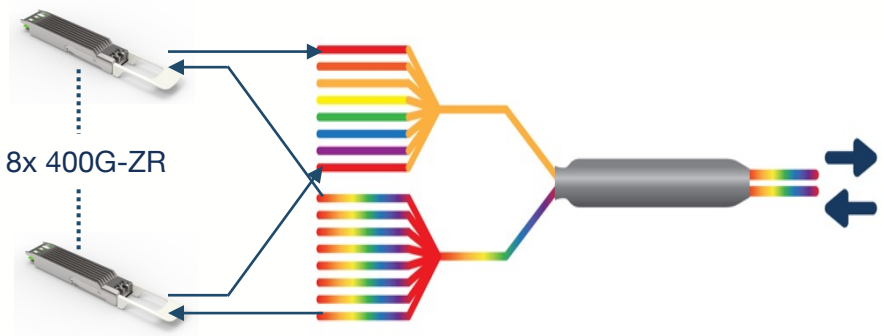
OSFP-LS, schematic



Erbium Doped Fiber Amplifiers
(EDFAs)

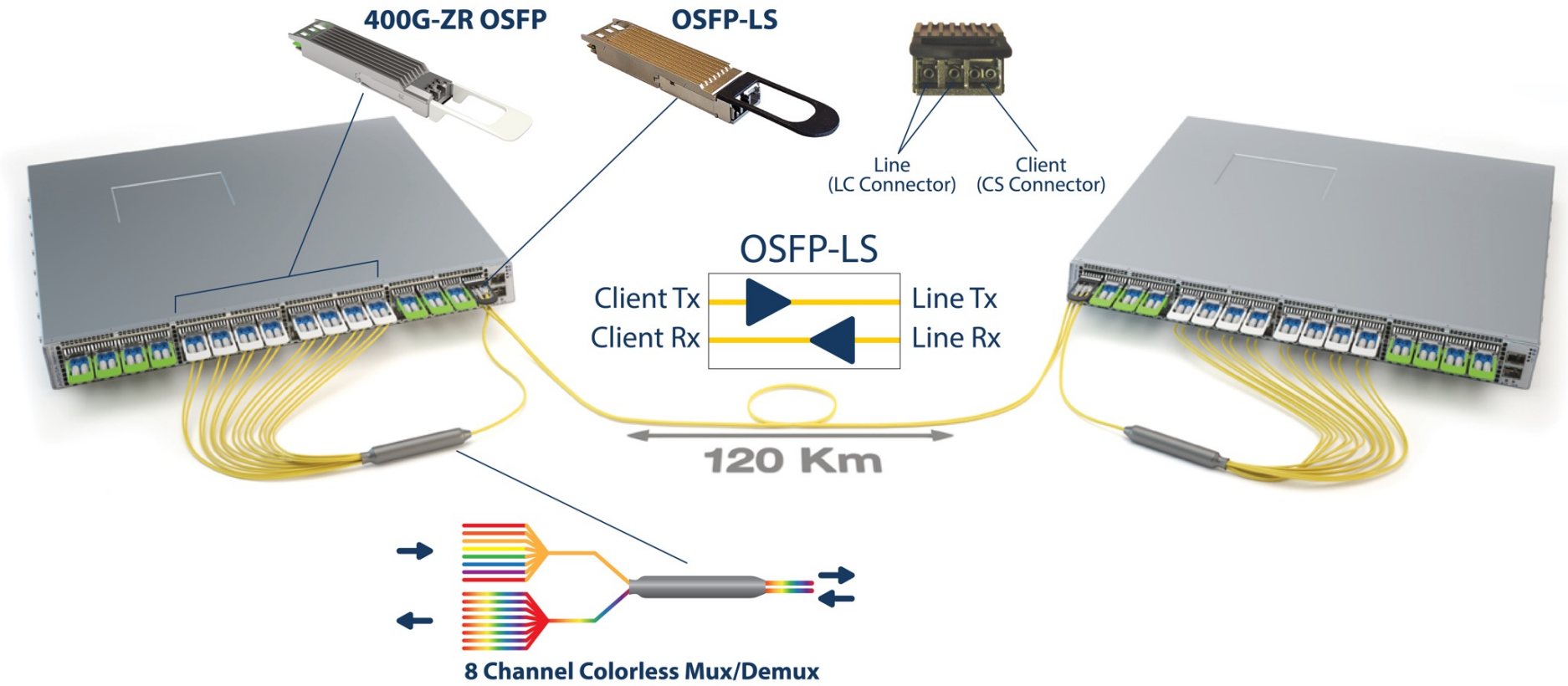
(3) Replace External Mux with Colorless Fiber Mux

- Multiplex up to 8x 400G-ZR modules using the Fiber-based Mux / Demux
- Enables up to 3.2T of DCI bandwidth over a single fiber pair

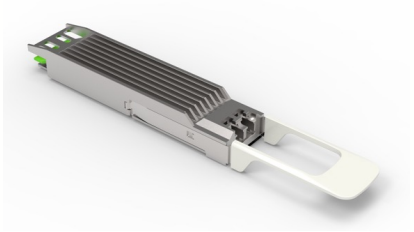


- The Fiber Mux / Demux is **colorless,** which **Simplifies deployment:** Don't have to match a specific port to a specific lambda
- Connect any port of the fiber mux to a 400G-ZR module, and set the wavelength channel through EOS
- The coherent receiver of the 400G-ZR will lock onto the wavelength channel selected
- **True plug and play operation**

Data Center Interconnect - Simplified



Arista's 400G DCI Solution: Simple, Open, Cost Effective



400G-ZR Transceiver

Line System

Colorless Fiber Mux

- 3.2T of DCI Bandwidth over a reach of 120km
  - Using no external transponders or line-systems
- As simple as connecting two switches together – true plug and play
- EOS Software from end-to-end, across the entire network
  - Consistent visibility
  - Consistent management and control
  - Consistent operational models

Platform Support for Arista Branded 400ZR Modules

Jericho2

Tomahawk3

Platform Family	Form Factor	SKU	Supported Ports & Comments
7800R3	OSFP	7800R3-36P-LC	Top row (Ports 1, 3, 5, ..., 35)
	QSFP-DD	7800R3(K)-36D(M)-LC	All 36 ports
7500R3	OSFP	7500R3-24P-LC	All 24 ports, 35C max temp
	QSFP-DD	7500R3-24D-LC	Not supported due to thermal limits
7280R3	OSFP	7280PR3-24	Top row (Ports 1, 3, 5 ..., 23). Requires bottom row (ports 2, 4, 6, ..., 24) modules with <= 12W power
	QSFP-DD	7280DR3-24	
7280R3	OSFP	7280R3(M)(K)-32P4(S)	All 4x 400G ports, front to back (-F) airflow only
	QSFP-DD	7280R3(M)(K)-32D4(S)	
7280R3	QSFP-DD	7280CR3-36S 7280CR3K-36S	2x 400G ports, 35C max temp
7060X4	OSFP	7060PX4-32	Top row (Ports 1, 3, 5, ..., 31), 35C max temp
	QSFP-DD	7060DX4-32	
7368	OSFP	7368-4P	All 4x 400G ports, front to back (-F) airflow only
	QSFP-DD	7368-4D	

Support only guaranteed for Arista branded 400ZR modules

Benefits of Layer 400G DCI

(1) High Capcity (up to 3.2Tbps per dark fiber)

(2) Longer reach (120km)

(3) Low Latency (up to 1.5us with using 7368x4)

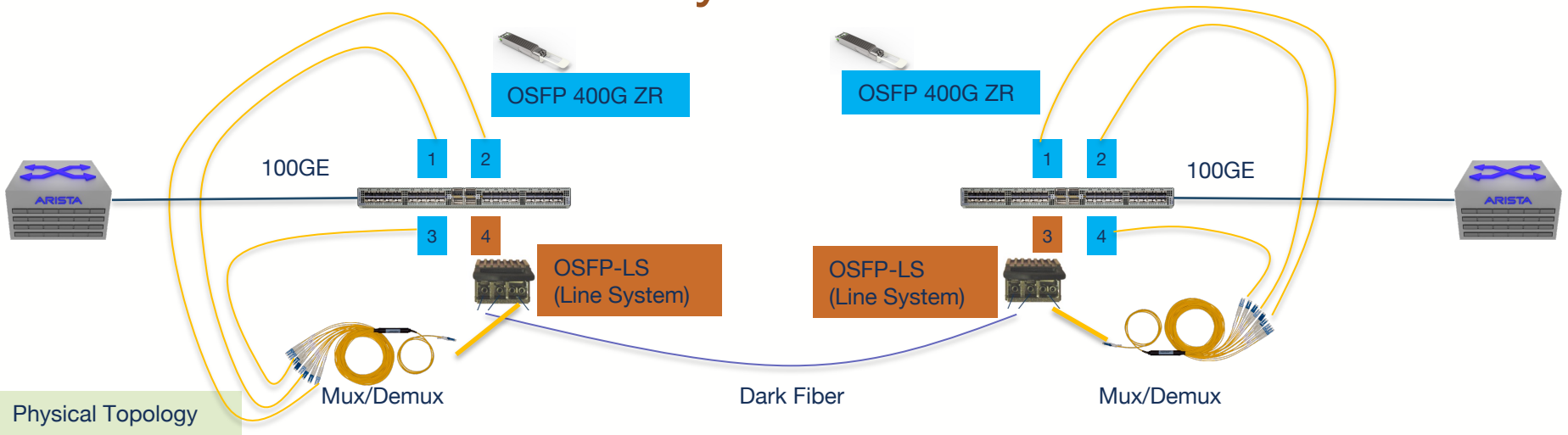
(4) Protocol Independent

(5) Simplicity

(6) Security

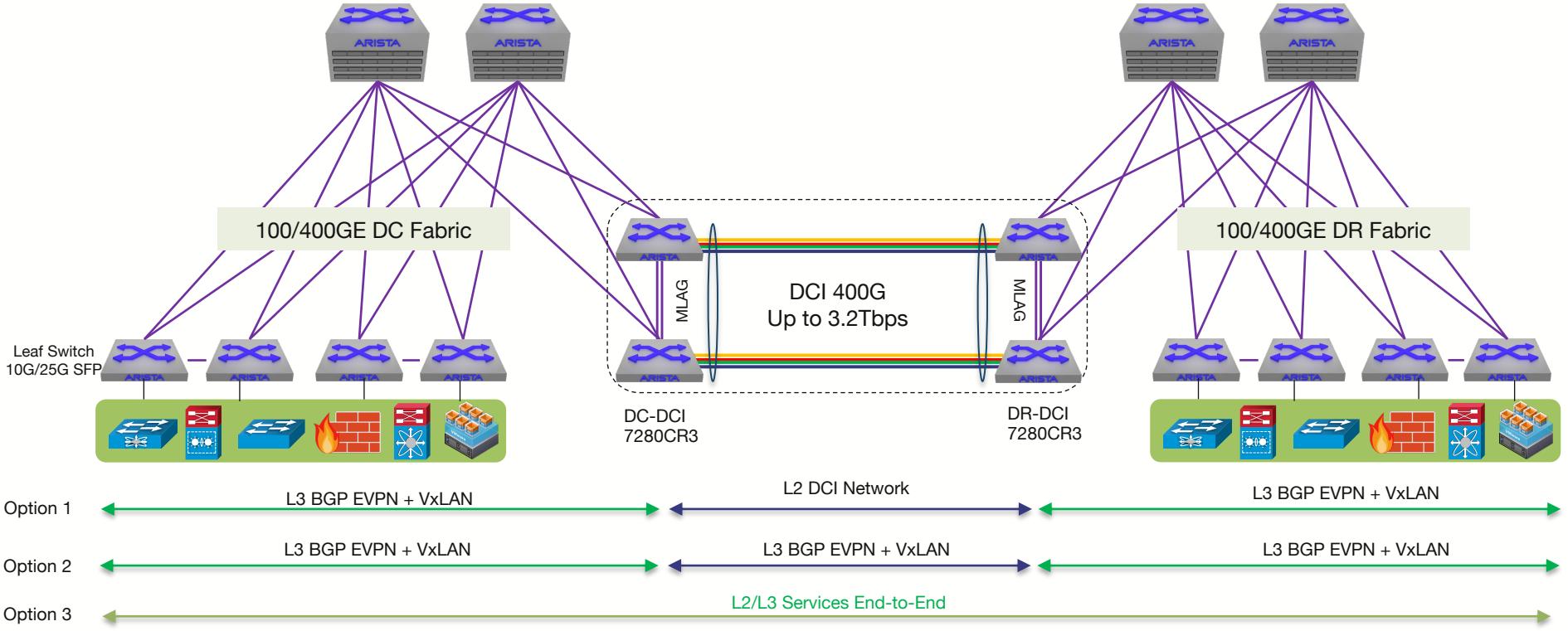
Up to 3.2Tbps
with 120km distance

02 Site DCI Connectivity



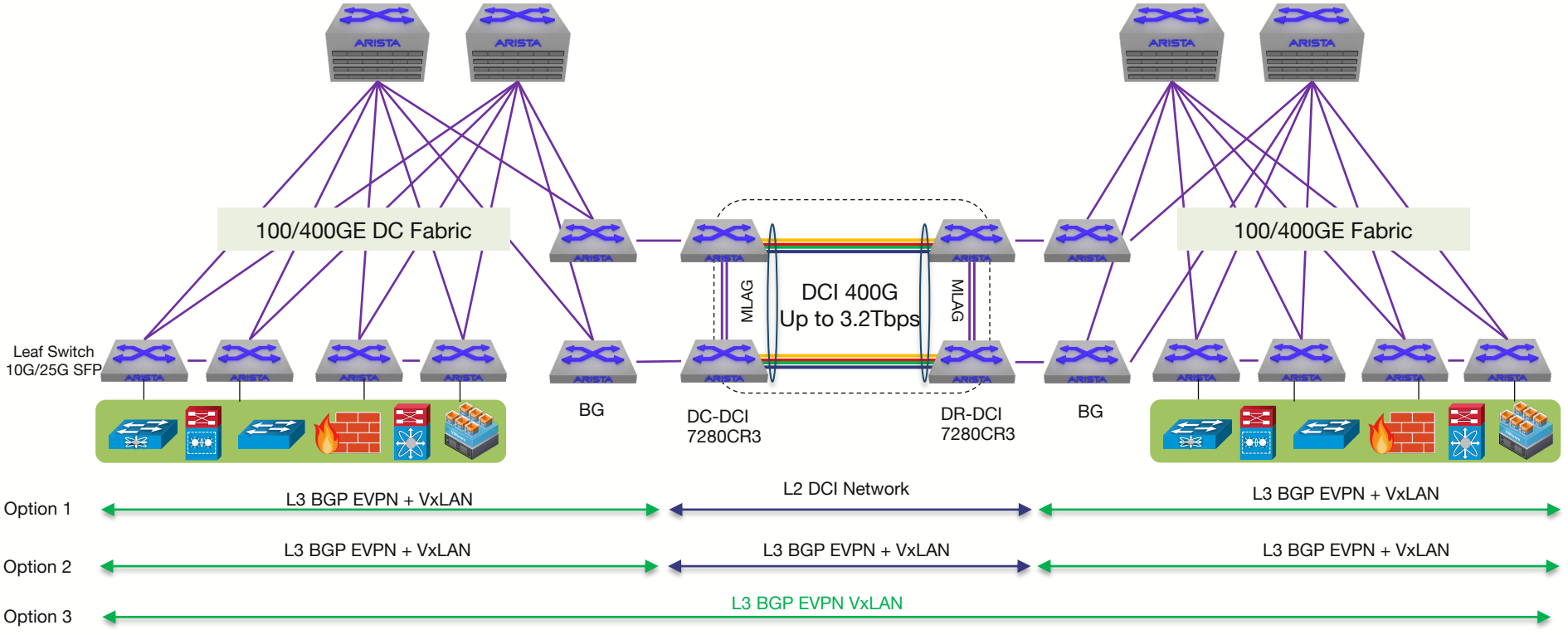
02 Site DCI Connectivity

Integrated BG & DCI

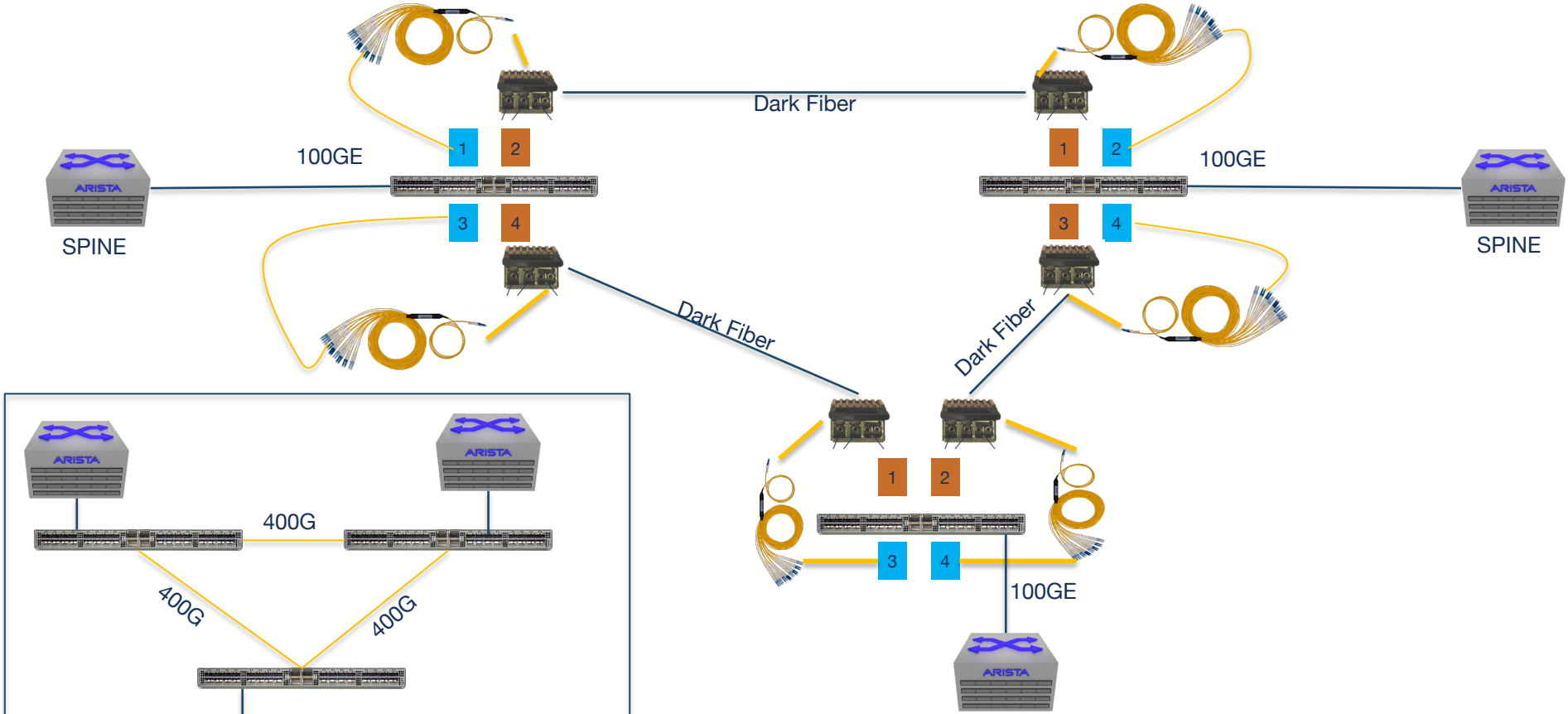


02 Site DCI Connectivity

De-couple BG & DCI

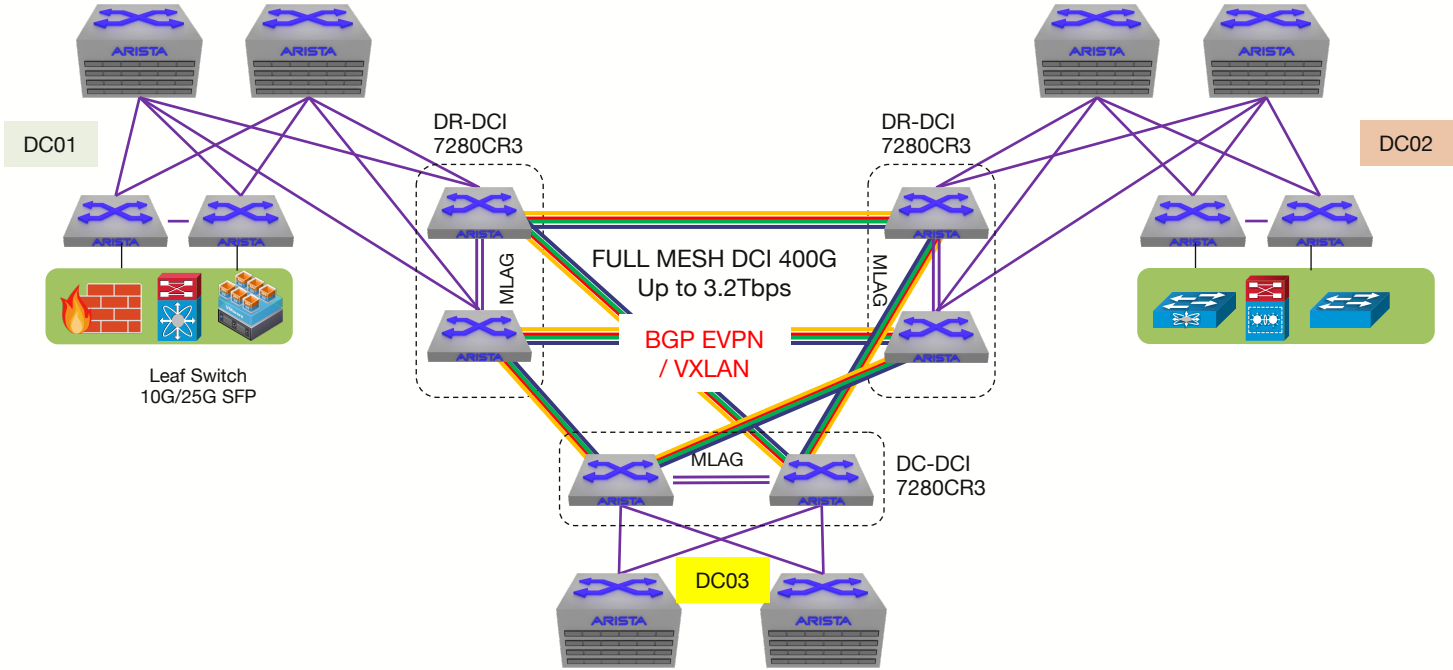


03 Site DCI Connectivity



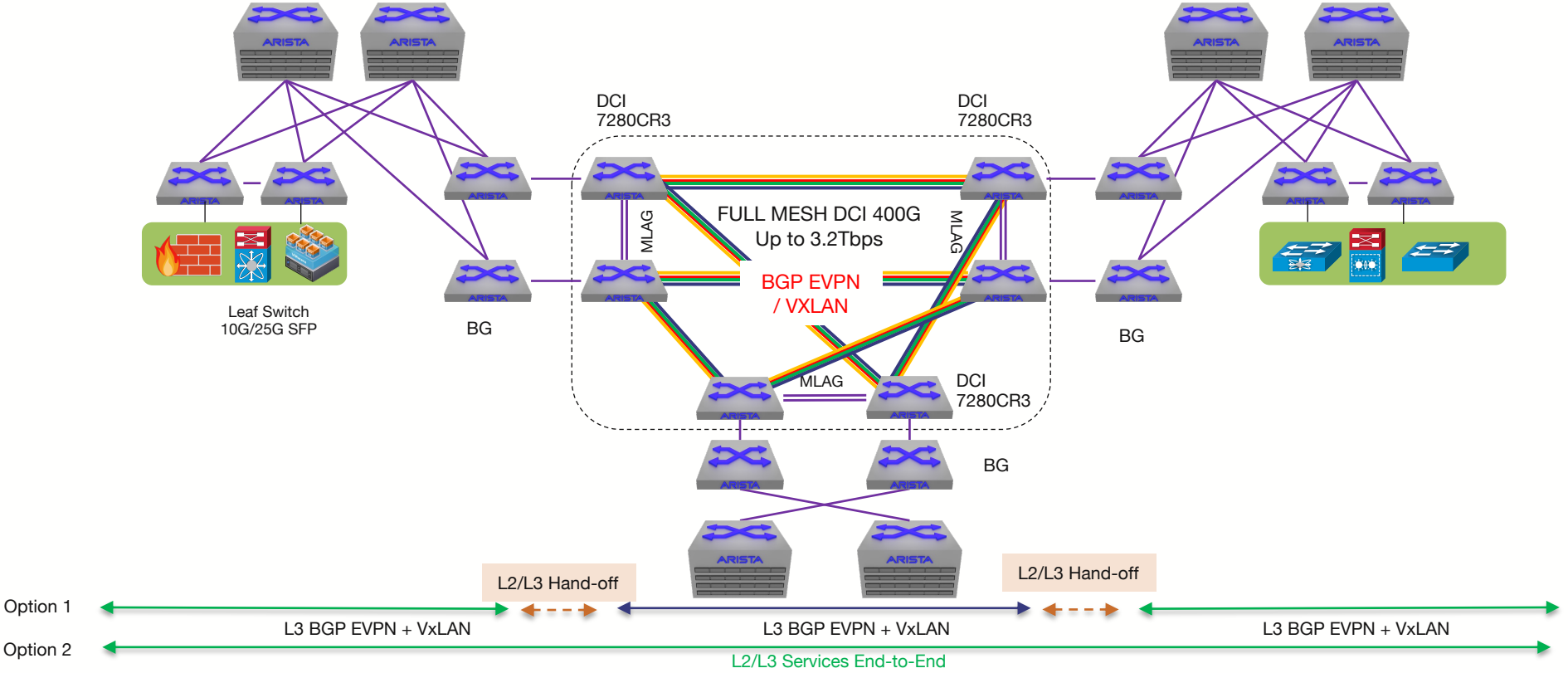
03 Site DCI Connectivity

Integrated BG & DCI



03 Site DCI Connectivity

De-couple BG & DCI



7280CR3 and 7280CR3K Series – 1RU – Fixed Systems

High Capacity Compact Deep Buffer System with 32 x 100G / 4 x 400G

- Consistent with 7500R3 and 7280R3
- Flexible 10G/25G/100G and 100G/400G
- Future Proof: 100G and 400G
- Enabler for Next Gen Leaf and Spine designs
- Power Efficient under 12W per 100Gbps
- Wire speed L2 & L3 with Advanced Routing
- Flexible Forwarding Profiles for DC and Routing

- Ultra deep buffer – 8GB
- Full Internet Scale – 1.3M Routes
- Large Scale (2.5M) Routes
- Under 4usec latency
- Front to rear and rear to front airflow
- Choice of AC or DC

32x QSFP 100G and 4 x OSFP 400G

Product	Interfaces	RU	Forwarding Rate	Throughput	10G	25G	40G	50G	100G	400G
7280CR3-32P4 7280CR3K-32P4	32 QSFP100 4 OSFP	1	2Bpps	4.8Tbps	96	96	36	96	48	4

Arista 7280CR3-32P4 and 7280CR3K-32P4 Architecture

High Performance

- 32 wire speed 100G and 4 400G ports
- Non-blocking 4.8 Tbps and 2Bpps
- FlexRoute™ - 1.3 / 2.5 Million+ IPv4 & IPv6 Routes

R-Series Architecture

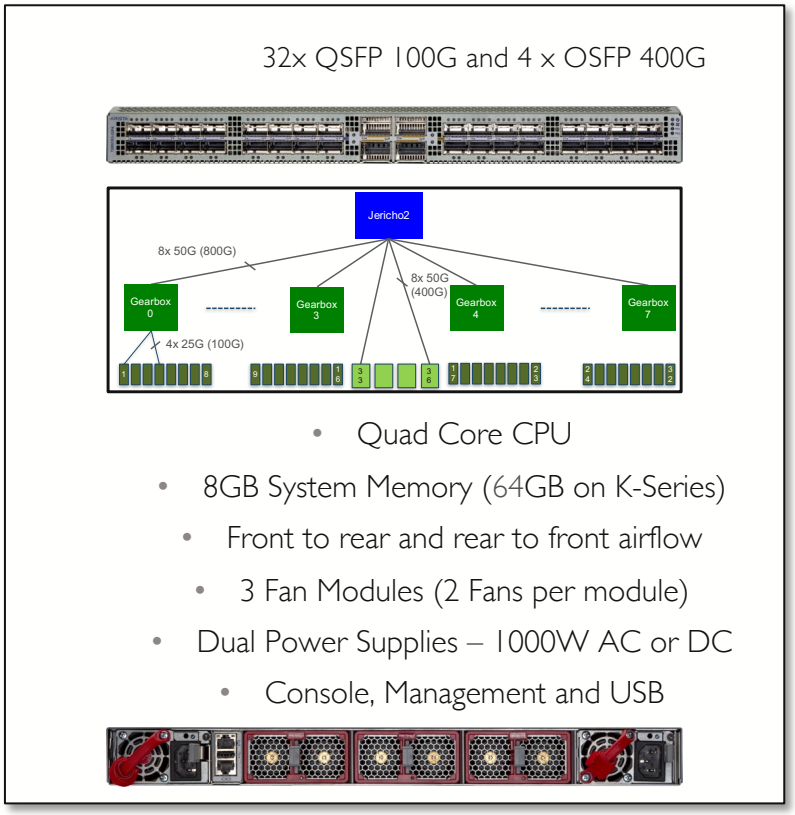
- VOQ architecture for lossless forwarding
- 8GB Deep packet buffers
- EOS for convergence and scale

Advanced Features

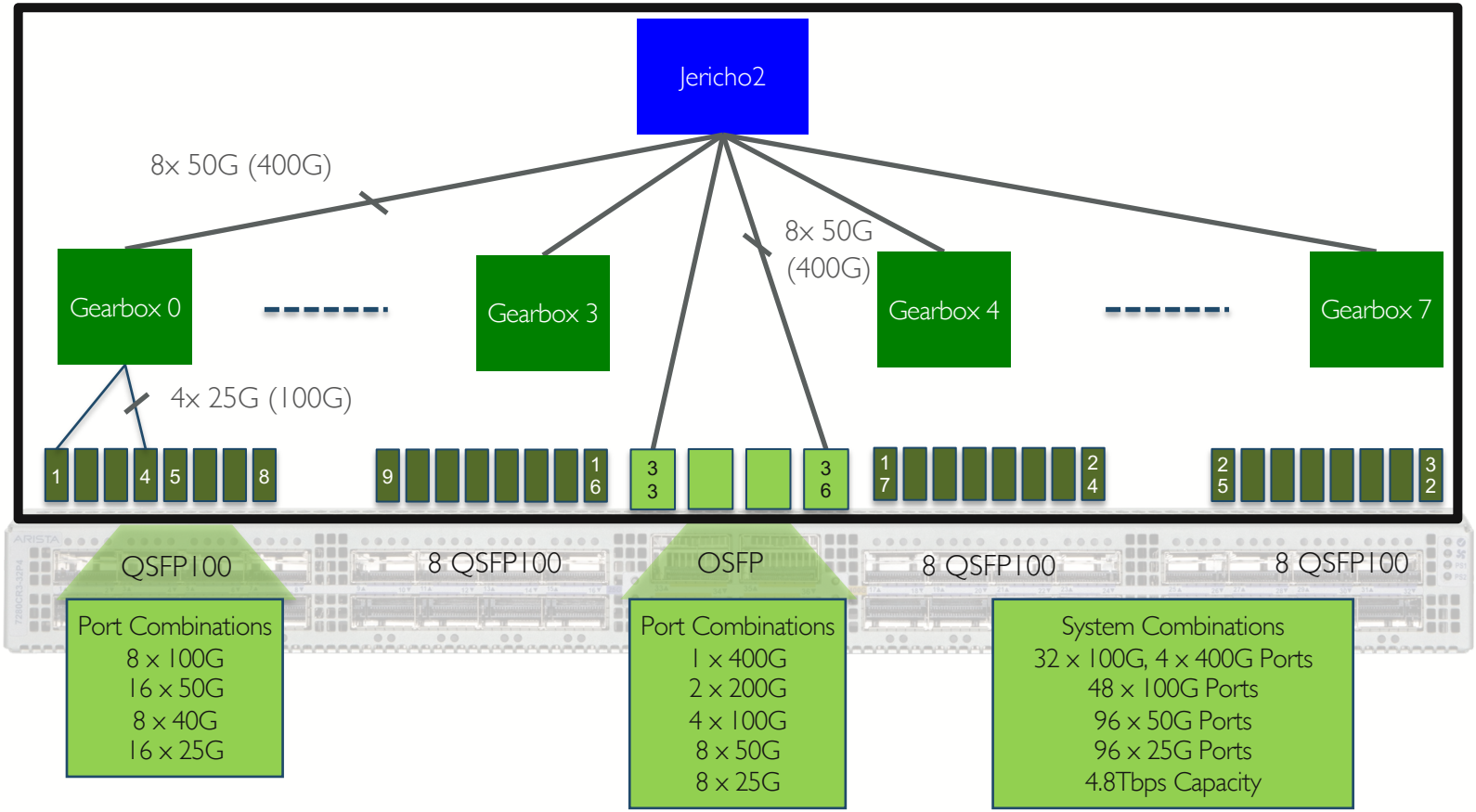
- VXLAN Routing, Advanced Load Balancing
- Algorithmic ACLs and Accelerated sFlow
- EVPN, MPLS, Segment Routing

Cloud and Carrier Grade Networking

- Dense 100G for SP, Cloud, Internet Routing, HPC & CDN
- Less than 12W per 100G port



7280CR3-32P4 & 7280CR3K-32P4: 32 x 100G, 4 x 400G



ARISTA

Arista 7368X4 Series 100G/400G

100/400G High Performance Semi-Fixed System

- High Performance 100G/400G system with hyperscale features
  - High Performance with 12.8Tbps and 8Bpps
  - Latency - 700ns port to port with cut-through mode
  - Shared 64MB Smart-buffer and monitoring with LANZ
- Datacenter Optimized
  - Datacenter Spine and next gen Leaf
  - Under 17W per 400G port typical to lower TCO
  - Increased routing scale and robustness
  - Elephant Flow Detector to automatically manage large flows
- Hyperscale Cloud Networks Scalability
  - OSPF, BGP, Multicast & MLAG - 400K routes, 128-way ECMP
  - Dynamic Load Balancing & Dynamic Group Multipath
  - Optimized hashing and ALPM for large scale IPv4 and IPv6

128 Ports 100G – 12.8Tbps

32 Ports 400G – 12.8Tbps

Tomahawk3

Consistent certification, knowledge, sparing, and architecture

Hyper-scale Cloud - Cost and Power Efficient Bandwidth

- Demand for more bandwidth in the cloud
  - High Network Radix Modular System
  - High performance 12.8Tbps switch
- 4U System Optimized for cloud networks
  - Modular Design and Architecture
  - Choice of port module configurations
  - Pay as you grow and expand
  - System upgradeable to next generation
  - Choice of airflow directions with 128 x 100G
- Improve power efficiency per bandwidth

7368X Series

128 x 100G Ports
64 x 200G Ports
32 x 400G Ports

Released and shipping in volume with 100G and 400G

Open 400G-ZR+

- Arista has demonstrated OSFP technology operating at >25W.
- Bigger power envelope to drive optics further.
- Potentially beyond 1000Km.
  - Likely to be 300 --> 400 km with SMF-28
- Inter-capital connectivity becomes a viable use case.
- Can provide coverage for all of Europe, most of the US.
- Presents further significant cost savings in optical equipment and integration for Service Providers.

OpenZR+

OIF 400ZR
Edge DCI

Client: *400GE* → Line: *400ZR*

Simplified functionality
Edge optimized FEC (C-FEC)

OpenROADM
SP Metro, Regional, LH

Client: *100G, 200G, 300G, 400G Ethernet, OTN, FlexO* → Line: *100G, 200G, 300G, 400G OpenROADM*

Flexible Client Mapping +
High Performance FEC (oFEC)

Combination of two standardization efforts that enables high performance pluggable modules that provide multi-vendor interoperability.

OpenZR+
Edge DCI and Regional

Client: *100GE, 200GE, 400GE* → Line: *100G, 200G, 300G, 400G*

Simplified functionality +
High performance FEC (oFEC)

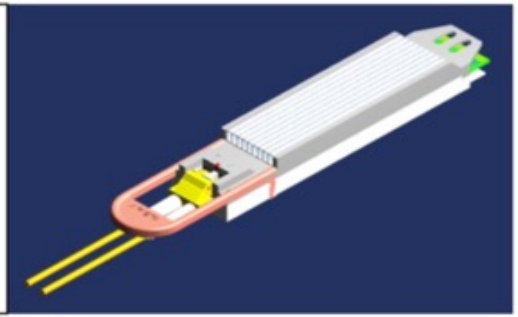
400G-ZR+: Up to 1000km Reach

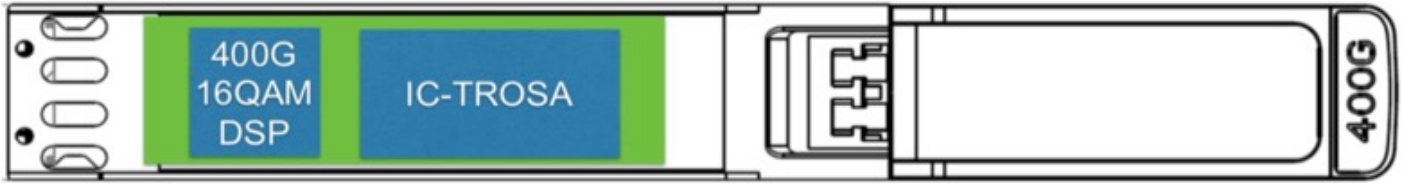
400G-16QAM DSP + Coherent Laser

Up to 52 Terabits per dark Fiber (C+L Band)

400G-ZR: Up to 100 km Reach, 15W power

400G-ZR+: Up to 1000 km Reach, 20W power

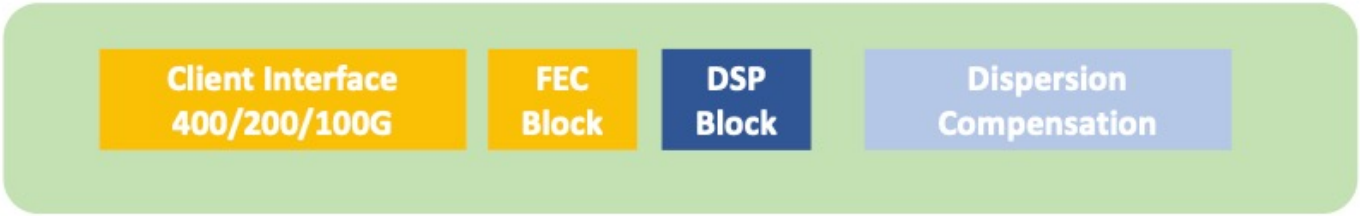




Metro and Long Reach Coherent at same port density as Datacenter Optics

20

Inside the 400G-ZR/ZR+ DSP Chip



400G-ZR Standard supports 100km Reach

400G-ZR+ with enhanced FEC increases reach up to 1000km

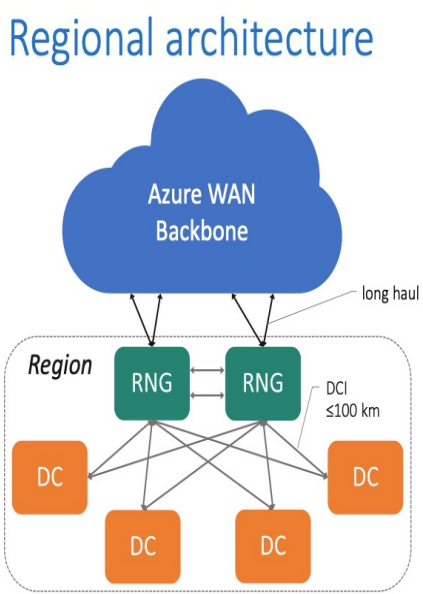
Performance approaching high-end / high power DSPs

Same DSP supports 200G-8QAM and 100G-QPSK

Coherent 400G Comparison

Parameter	400ZR	OpenZR+	Multi-Haul DCO
Multivendor Interop	Yes	Yes	No – Proprietary
Primary Application	Pt – Pt, single-span	Pt – Pt or Multi-span ROADM w/ amplified add/drop	Multi-span ROADM OTN switch
Optical Reach	< 120 Km	~ 400 Km (400G)	500 - >2,000 Km (400G – 100G)
Line Capacity	400G	100G – 400G	100G – 400G
Modulation	16QAM	QPSK, 8QAM, 16QAM	QPSK, 8QAM, 16QAM
Baud Rate	~ 60 Gbaud	30 Gbaud (100G) 60 Gbaud (200 – 400G)	28 – 64 Gbaud
Tx Launch Power	-10 dBm	-10 dBm	+0 dBm
Client Interface	100GE, 400GE	100GE, 400GE	100GE/ OTU4, 400GE
Power	15 – 20W	18 – 20W	20 – 26W
Typical module options	QSFP-DD, OSFP, CFP2-DCO	QSFP-DD, OSFP, CFP2-DCO	CFP2-DCO

Uses Case for 400G ZR / ZR+

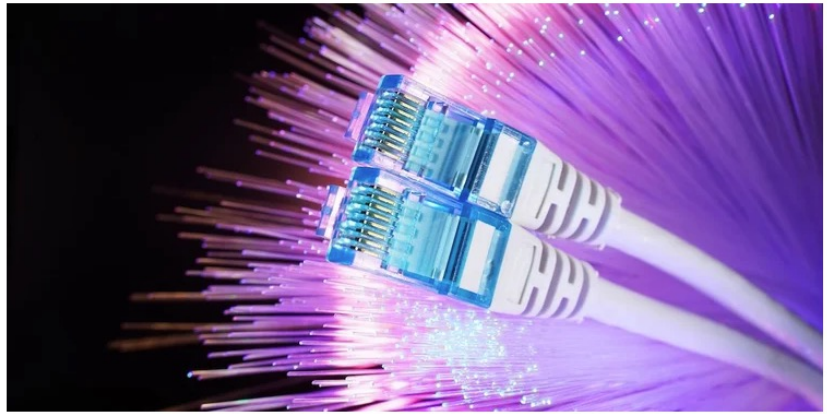


- distributed data center model
- massively parallel and highly resilient
- latency SLAs constrain maximum fiber distances
- need focused, cloud-friendly solutions for these application spaces

Arista, Microsoft Validate 400G ZR Optical Pluggables

Tobias Mann | Editor
February 17, 2021 10:20 PM

Share this article:



Arista today said it successfully tested the interoperability of its routers with 400G ZR optical pluggables

ARISTA

Uses Case for 400G ZR / ZR+

400G-ZR+ Covers all of Europe with 400G-DWDM

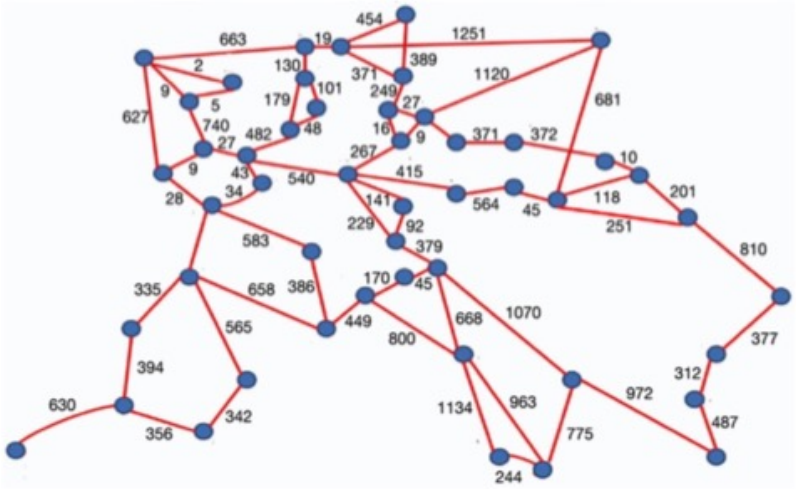


Image Credit: Mattia Cantono, Roberto Gaudino, Vittorio Curri, Stephan Pachnicke, "Potentialities and Criticalities of Flexible-Rate Transponders in DWDM Networks: A Statistical Approach," J. Opt. Commun. Netw. **8**, A76-A85 (2016);

ARISTA

Uses Case for 400G ZR / ZR+

400G-ZR+ Covers Most of USA with 400G DWDM

Internet-2 100G Research Network (May 2017)

ARISTA

ARISTA