



CORNING

The Road to 800G

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Market Development, Data Center

September, 2021



Technology Update

SFP+ Dominated 10G in the Data Center

Electrical

1 Tx/Rx lane at 10G



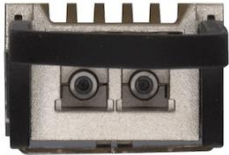
SFP+ = 10G
1x 10G

Optical

	SFP+ = 10G 1x 10G	
	MM	SM
	1λ @ 10G 2 F, LC	1λ @ 10G 2 F, LC
	10G-SR	10G-LR

400m

10km



IEEE Published Standard
IEEE Pending Standard
MSA/Eng Specification

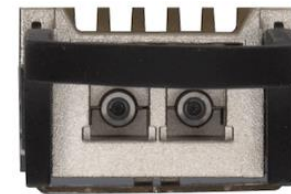
LC Connectivity

LC Duplex



The common duplex interface in the Data Center

- LC connectivity is the leading duplex form factor for 10G through 800G
- Low Loss of 0.10 dB per mated pair MM, 0.25dB per mated pair SM
- Round 2.0 mm cable with no preferential bend
- Enhanced bend performance enabled by ClearCurve® fiber
- Uniboot design eliminates connector rotation in duplex clip designs and allow polarity changes on-site

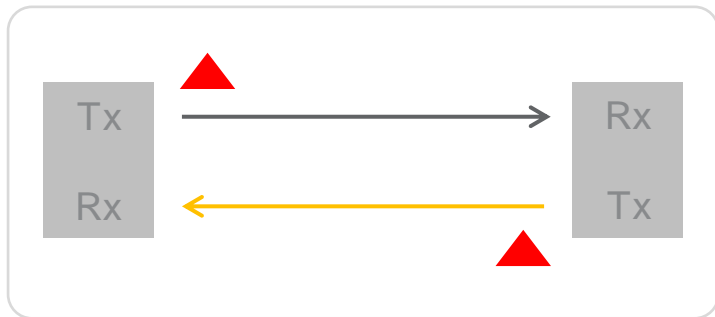


The optical road to higher data rates has a divergent path



1GbE, 10GbE, 25GbE

Single channel, serial transmission



Traditionally we've been able to increase the Bitrate within a single channel (turn the light off and on more quickly).



40GbE, 100GbE, 200GbE,
400GbE, 800GbE

Parallel



WDM



40G QSFP+ is mature

Electrical

4 Tx/Rx lanes each at 10G



QSFP+ = 40G
4x 10G

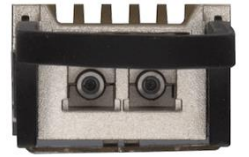
Optical

		WDM		Parallel		
		MM	SM	MM	SM	
		2λ @ 20G 2 F, LC	4λ @ 10G 2 F, LC	4λ @ 10G 2 F, LC	1λ @ 10G 8 F, MTP	1λ @ 10G 8 F, MTP
		40G-BiDi	40G-SWDM4	40G-LR4 40G-LR4L	40G-SR4 40G-eSR4	40G-PLR4 40G-PLRL4
		150m	350m	10km 2km	150m 400m	500m 1km

IEEE Published Standard

IEEE Pending Standard

MSA/Eng Specification



100G QSFP28 is mature

Electrical

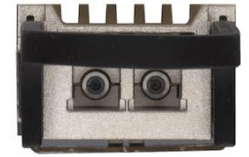
4 TX/RX lanes each at 25G



QSFP28 = 100G
4x 25G

Optical

		WDM		Parallel		
		MM	SM	MM	SM	
		2λ @ 50G 2 F, LC	4λ @ 25G 2 F, LC	4λ @ 25G 2 F, LC	1λ @ 25G 8 F, MTP	1λ @ 25G 8 F, MTP
		100G-BiDi	100G-SWDM4	100G-LR4 100G-FR4 100G-CWDM4	100G-SR4 100G-eSR4	100G-PSM4
		100m	100m	10km 2km 2km	100m 300m	500m

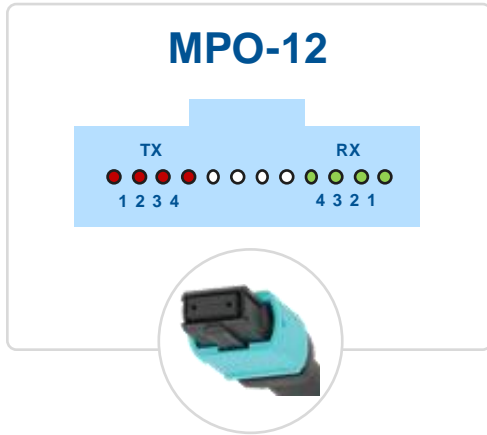


IEEE Published Standard

IEEE Pending Standard

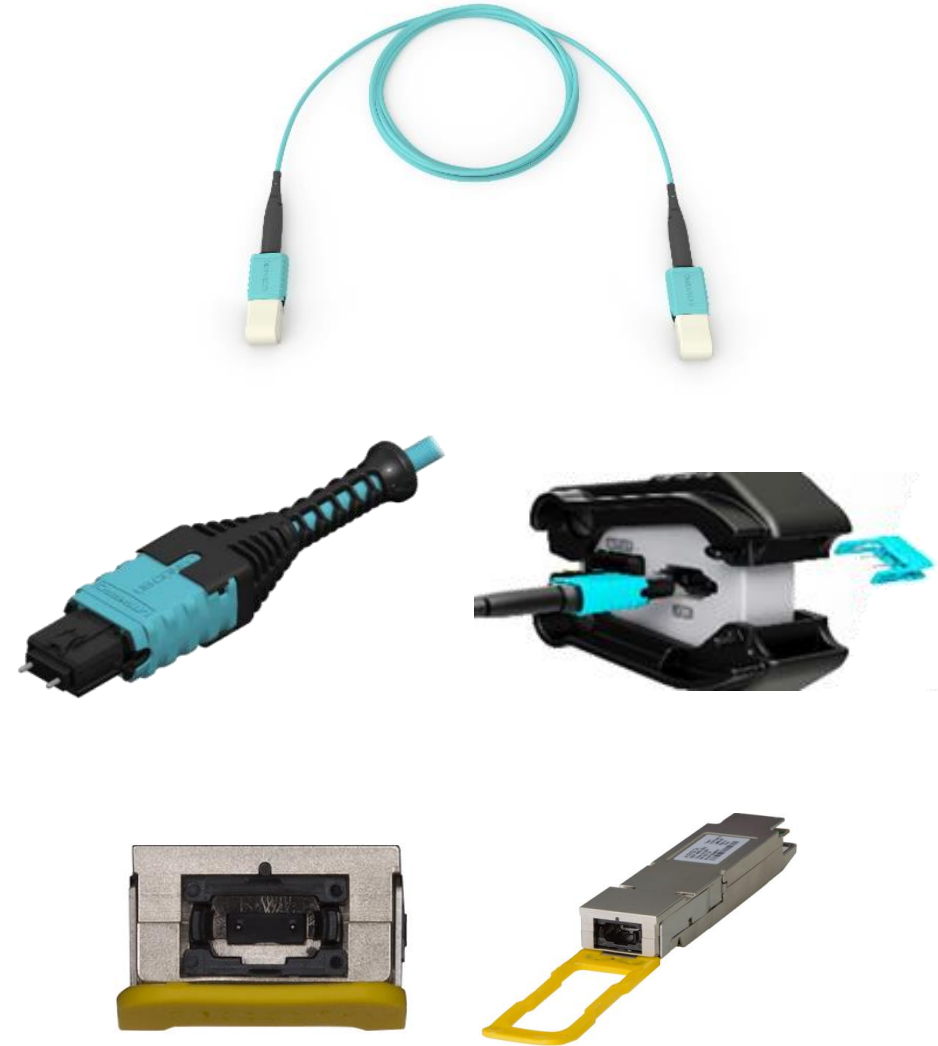
MSA/Eng Specification

8F MTP Connectivity



The most common interface for Parallel Optics in DC

- Same form factor as 12F MTP, but only uses 8 of 12 fiber positions
- Low Loss of 0.25 dB per mated pair MM, 0.35 dB per mated pair SM
- MTP Pro allows for pinning and polarity changes in the field
- Round 2.0 mm cable with no preferential bend
- Enhanced bend performance enabled by ClearCurve® fiber



400G PMDs Being Introduced in the Market

DRAFT

Electrical

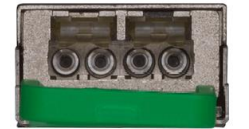
8 TX/RX lanes each at 50G



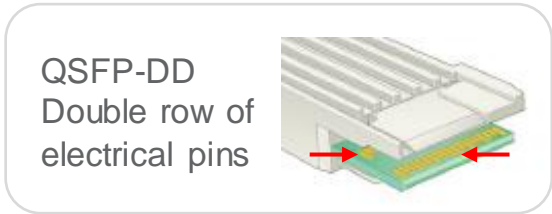
QSFP-DD or OSFP= 400G
8x50G

Optical

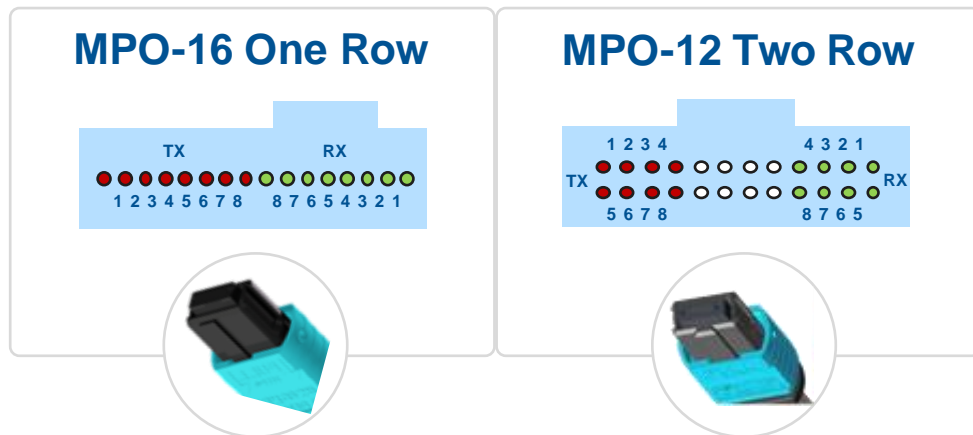
		WDM		Parallel		
		SM		MM		SM
	MM					
No solution identified	8λ @ 50G 2 F, LC	4λ @ 50G 2x 2 F, VSFFC	Parallel + WDM 2λ @ 50G 8 F, MTP	1λ @ 50G 16 F, MTP	1λ @ 100G 8 F, MTP	
	400G-LR8 400G-FR8	400G-2FR4	400G-SR4.2	400G-SR8	400G-DR4	
	10km 2km	2km	100m	100m	500m	



IEEE Published Standard
IEEE Pending Standard
MSA/Eng Specification



400G MM introduces new 16F MTP Interface



16F MTP Interfaces

- Two form factors exist on the market:
 - Single row of 16F
 - Two rows of 8F, utilizing the 24F MTP Footprint
- 8F MM solutions expected to be used for structured cabling
- 16F MM solution used to breakout 400G transceivers to 50G devices



800G is bringing changes to the roadmap

Electrical

8 TX/RX lanes each at 100G



DRAFT

QSFP-DD or OSFP= 800G
8x100G

Optical

		WDM		Parallel	
		SM		MM	SM
	MM	SM		MM	SM
No solution identified	8λ @ 100G 2 F, LC	4λ @ 100G 2x 2 F, VSFCC		1λ @ 100G 16 F, MTP	1λ @ 100G 16 F, MTP
	800G-LR8 800G-FR8	800G-2LR4 800G-2FR4		800G-SR8 800G-VR8	800G-DR8 800G-DR8+
	10km 2km	10km 2km		100m 50m	500m 2km

QSFP-DD800

800G Pluggable
ANALYTICAL INSTRUMENTS
MULTI-SOURCE AGREEMENT



IEEE Published Standard
IEEE Pending Standard
MSA/Eng Specification

Current work on development of 100G Lambda could bring changes in 100G and 400G transceivers

Future development of a 200G Lambda could lead to implement SMF WDM 800G-LR4, 800G-FR4 and Parallel 800G-DR4 versions

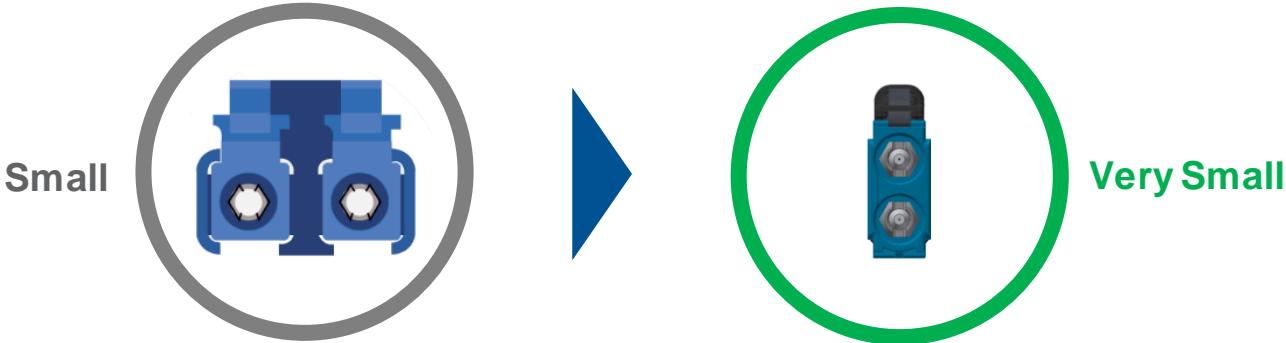
Definitions



What is a Small Form Factor Connector?

Google Search I'm Feeling Lucky

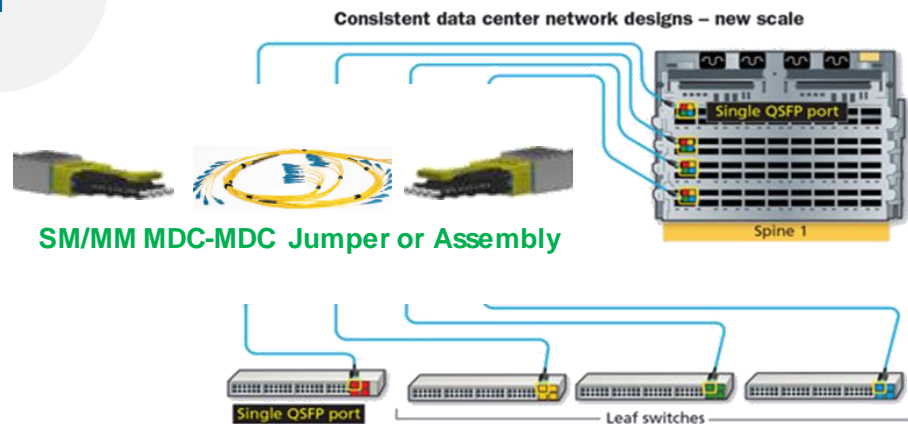
Small Form Factor (SFF) connectors are **compact** fiber optic **connectors** that are designed for **small** spaces. These types of **small** components are always beneficial in fiber network applications where space is a **factor**.



What is driving to have VSFF Connectors?

1

Breakout applications at the optics



- A smaller duplex connector can be used to **plug** the breakout fibers **directly** into a new multi-channel Tx/Rx device
- **Who drives it?**
 - Hyperscales / Carriers
- **What does it require?**
 - VSFFC transceivers, VSFFC jumpers or VSFFC trunks/assemblies

2

Higher density fiber management



- Smaller form factor connectors would increase density by **2 to 3 times (up to 432F)**
- **Who drives it?**
 - Enterprise DC / Carriers
- **What does it require?**
 - VSFFC jumpers, VSFFC modules, Housing to handle density

VSFFC Summary Table



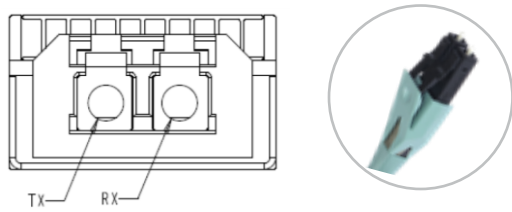
Transceiver breakout applications	QSFP-DD 2:1 (2X200G)	QSFP-DD 4:1 (4X100G) SFP-DD 2:1 (2X50G)	QSFP-DD 4:1 (4X100G) SFP-DD 2:1 (2X50G)
Are there transceivers available in the market today ?	Cisco / Arista	2021 / 2022	2021 / 2022
Connector manufacturers offering components to create a new solution	Connectors Adaptors ⁽¹⁾	Connectors Adaptors ⁽¹⁾	Connectors Adaptors ⁽¹⁾
Who has requested these connectivity?	Carrier Customer ⁽²⁾	Hyperscale Customer ⁽²⁾	Enterprise Customer Carrier Customer ⁽²⁾

1) *The variety of adaptors from the manufacturers will suit only specific applications and compatibility with existing hardware, meaning none of the VSFFC can provide the same Breakout application nor Density increase.*

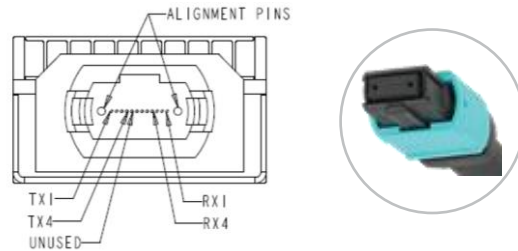
2) *Niche application and design based on customer specification.*

800G OSFP Optical Interfaces – Published on Aug 2nd, 2021

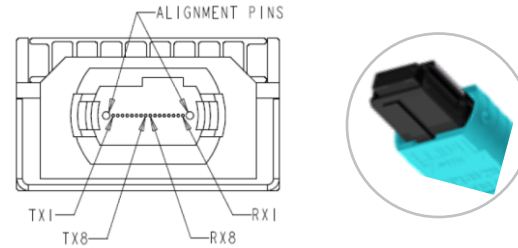
Duplex LC Optical Interface



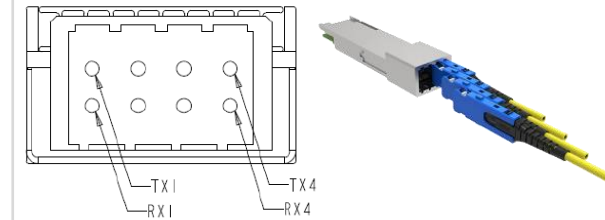
MPO-12 Optical Interface



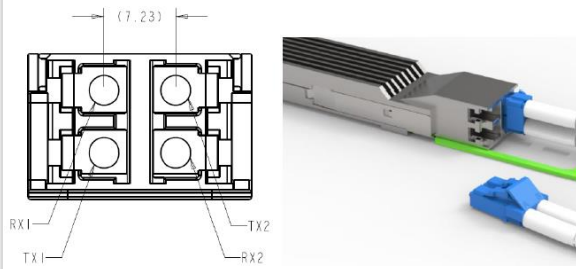
MPO-16 Optical Interface



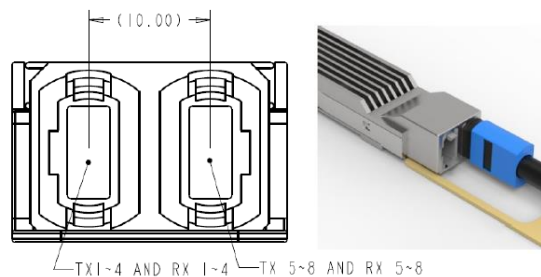
Quad SN Optical Interface



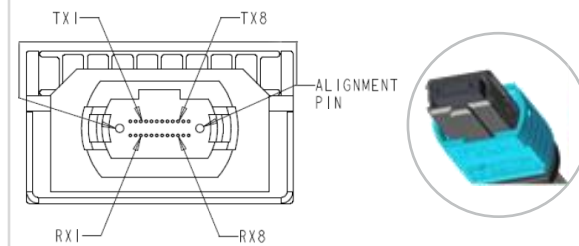
Dual Duplex LC Optical Interface



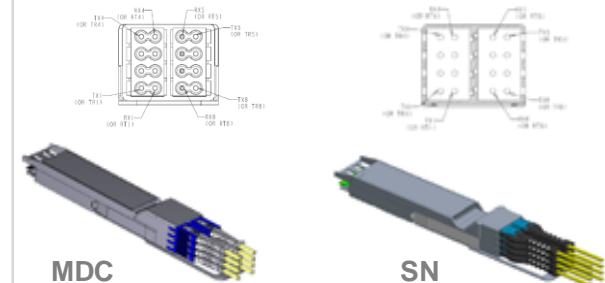
Dual MPO-12 Optical Interface



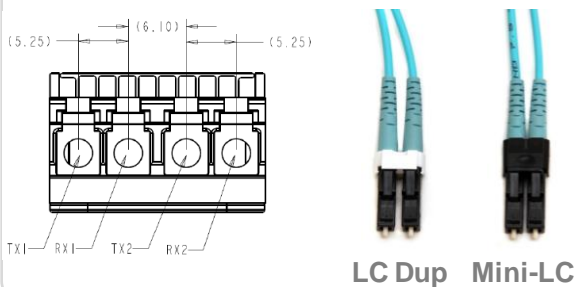
MPO-12 Two Row Optical Interface



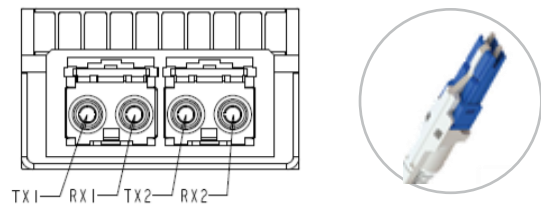
8x MDC and SN Optical Interface



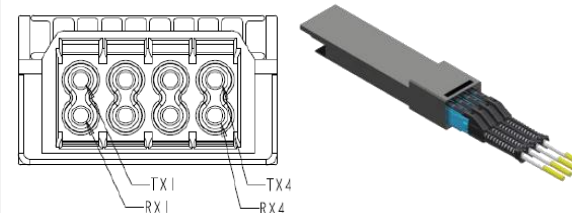
Dual Mini-LC Optical Interface



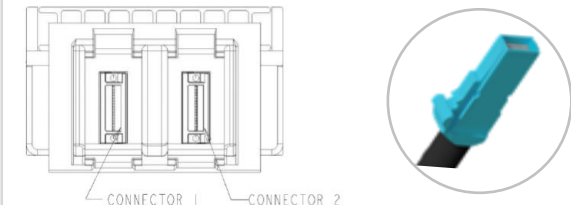
Dual CS Optical Interface



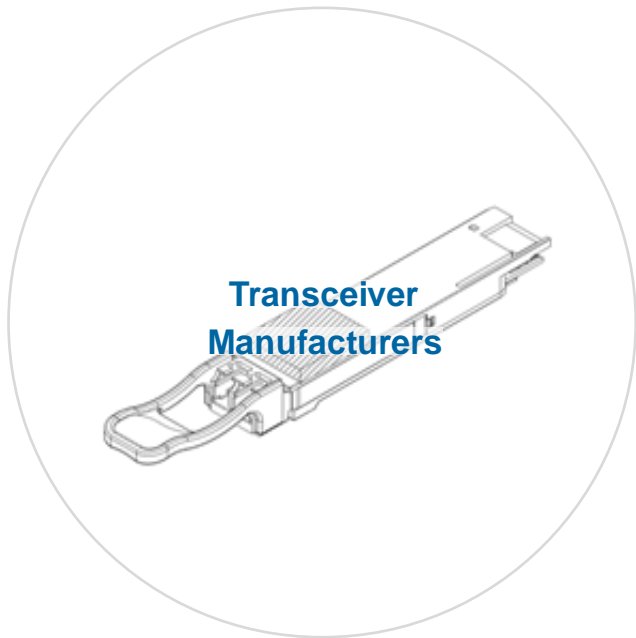
Quad MDC Optical Interface



Dual MXC Optical Interface



Technology Roadmap



Voice of Technology



● 10G

● 40G

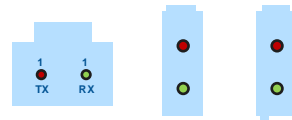
● 100G

● 200G

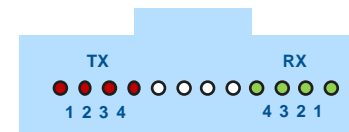
● 400G

● 800G

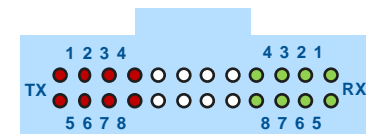
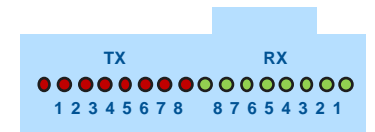
2 Fiber Connectivity



8 Fiber Connectivity

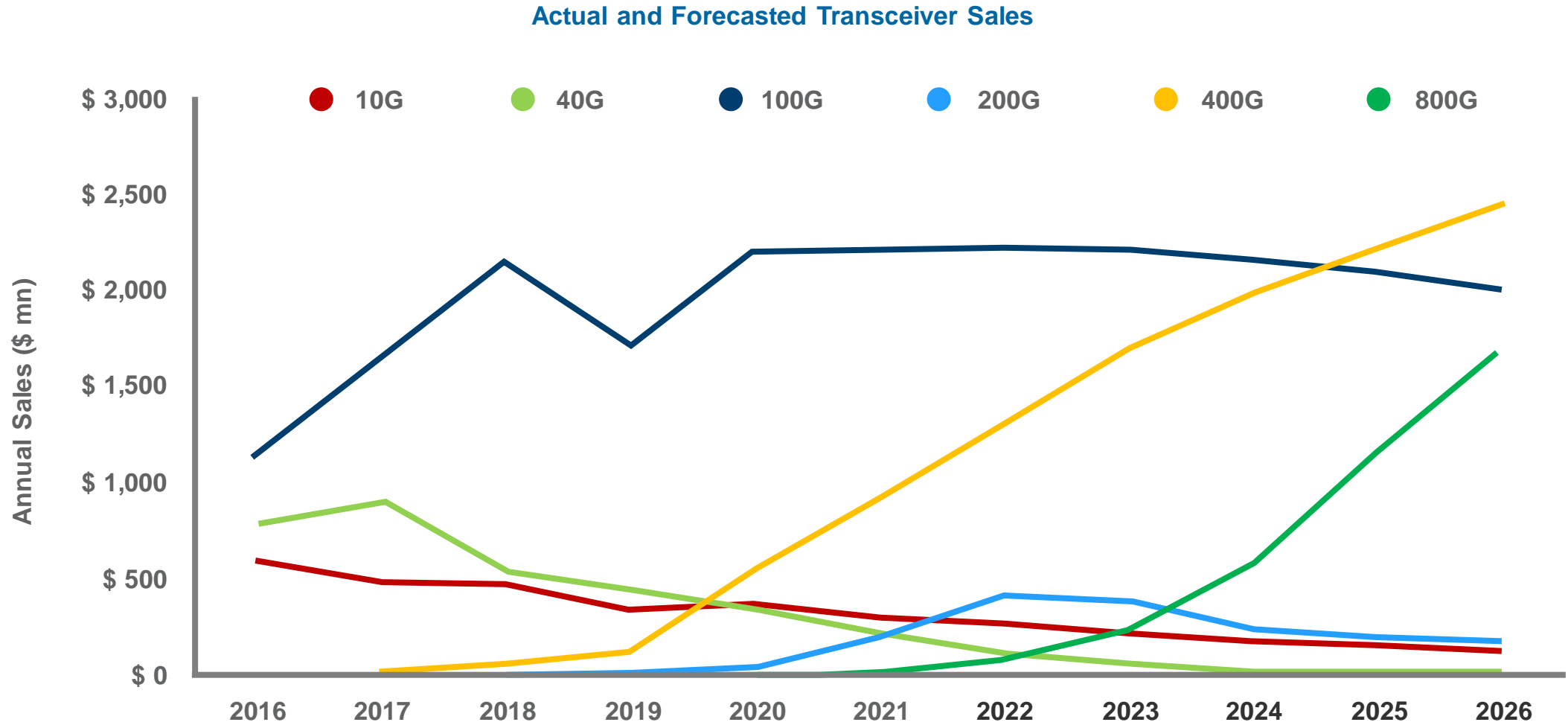


16 Fiber Connectivity



Deployment can be supported with Base-8

Technology Roadmap



Source: Lightcounting (April 2021)

EDGE8 Solutions

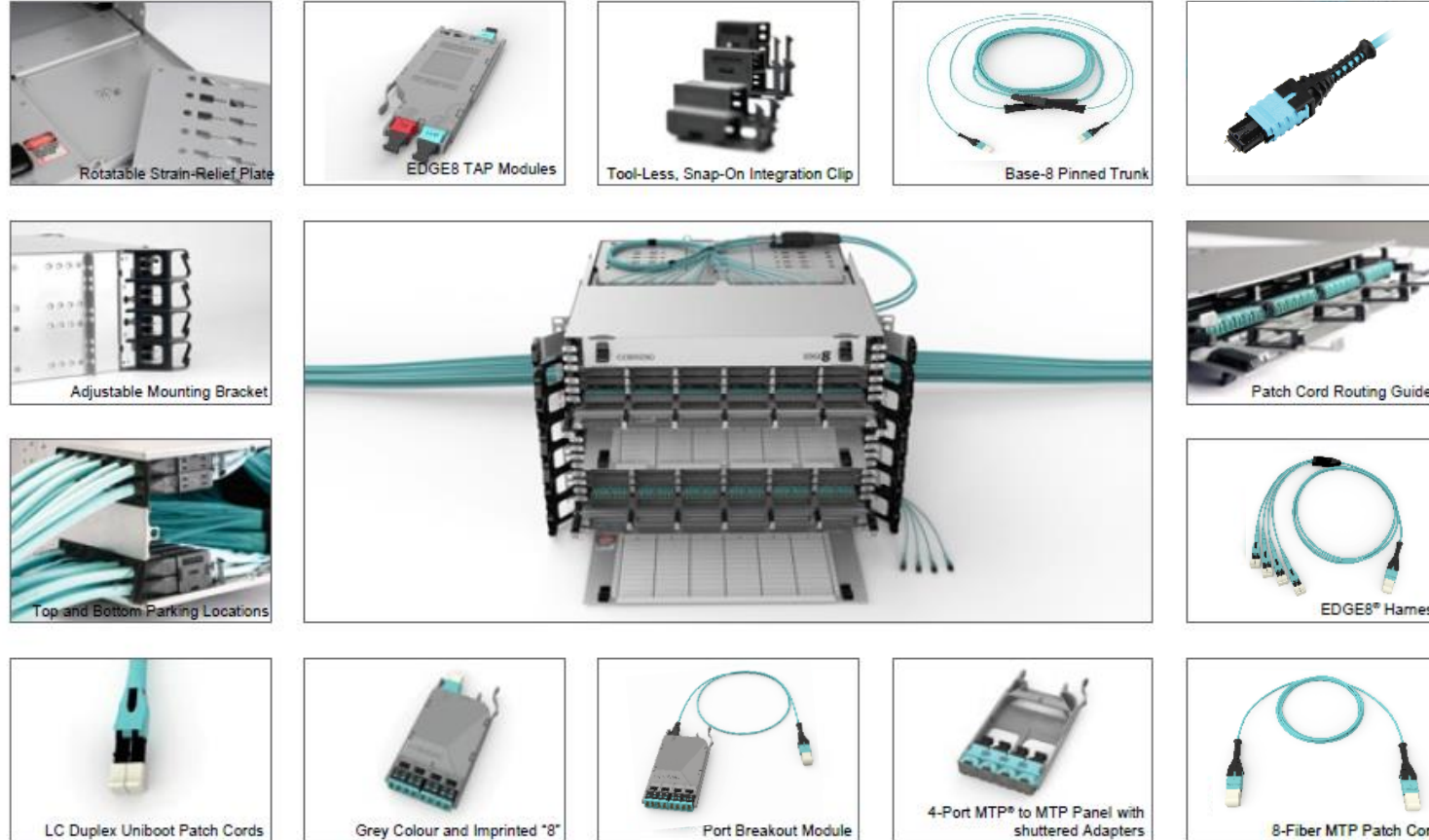
Preterm Cables

Input (Back) 

Best in class

- The EDGE/EDGE8 Platform is the world's **most versatile Switch-to-Switch data center solution**.
- B2ca a1 s1 d1 trunks** rated under CPR requirements
- MTP-Pro** connectors with **Push-Pull-Boot** allowing superior finger access and polarity changes in the field
- Utilizes Corning fiber providing **enhanced bend performance**
- LC Uniboot and MTP **Low Loss connectors** available for MMF and SMF connections
- Match the transceiver technology connectivity** with 100% fiber utilization

Components



Cable Assemblies

 Output (Front)


Value-Prop

- The best option supporting **migration** from 10G to 800G
- Supports Base-2, Base-8 and Base-16 connectivity with **duplex and parallel architecture**
- Supports port **breakout solutions** to save space, power and cooling
- Supports **network monitoring** without adding separate space consuming hardware
- Supports keyed connectivity for **Secure Solutions**

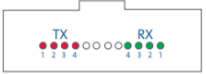


Interconnecting MDA to EDA with EDGE8

Example: MPO-12 to LC Duplex Across the Data Center With Trunk





MPO-12



➔

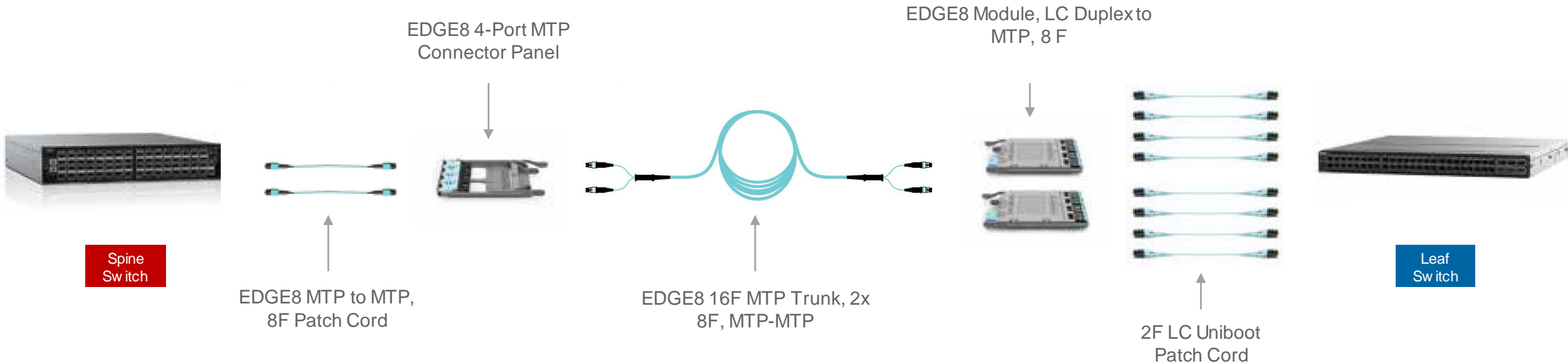
LC Duplex






Near End Optic (Left)		Far End Optic (Right)		Reach
OSFP-400G-DR4	single-mode	4x QSFP-100G-DR	single-mode	500 m
OSFP-400G-XDR4	single-mode	4x QSFP-100G-FR	single-mode	2 km
QDD-400G-DR4	single-mode	4x QSFP-100G-DR	single-mode	500 m
QDD-400G-XDR4	single-mode	4x QSFP-100G-FR	single-mode	2 km
QSFP-100G-PSM4	single-mode	4x SFP-25G-LR	single-mode	500 m
QSFP-40G-PLRL4	single-mode	4x SFP-10G-LRL	single-mode	1 km
QSFP-40G-PLR4	single-mode	4x SFP-10G-LR	single-mode	10 km

Near End Optic (Left)		Far End Optic (Right)		Reach
QSFP-100G-SR4	multimode	4x SFP-25G-SR	multimode	100 m
QSFP-100G-XSR4	multimode	4x SFP-25G-SR	multimode	100 m
QSFP-40G-SR4	multimode	4x SFP-10G-SR	multimode	150m
QSFP-40G-XSR4	multimode	4x SFP-10G-SR	multimode	150m

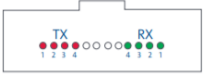


Interconnecting MDA to EDA with EDGE8

Example: MPO-12 to LC Duplex Across the Data Center With Trunk





MPO-12



➔

LC Duplex

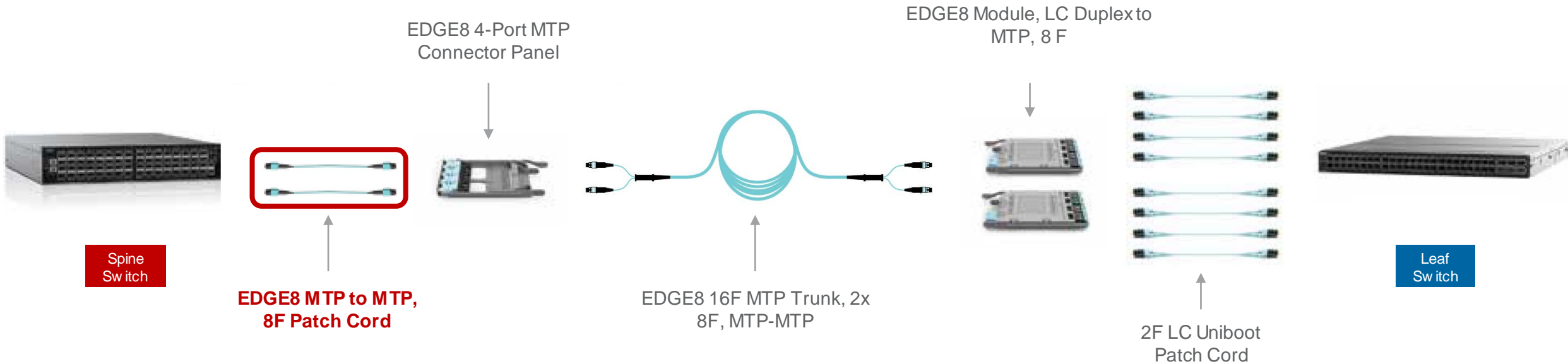




Near End Optic (Left)		Far End Optic (Right)		Reach
OSFP-400G-DR4	single-mode	4x QSFP-100G-DR	single-mode	500 m
OSFP-400G-XDR4	single-mode	4x QSFP-100G-FR	single-mode	2 km
QDD-400G-DR4	single-mode	4x QSFP-100G-DR	single-mode	500 m
QDD-400G-XDR4	single-mode	4x QSFP-100G-FR	single-mode	2 km
QSFP-100G-PSM4	single-mode	4x SFP-25G-LR	single-mode	10 km
QSFP-40G-PLRL4	single-mode	4x SFP-10G-LR	single-mode	10 km
QSFP-40G-PLR4	single-mode	4x SFP-10G-LR	single-mode	10 km


Near End Optic (Left)		Far End Optic (Right)		Reach
QSFP-100G-SR4	multimode	4x SFP-25G-SR	multimode	100 m
QSFP-100G-XSR4	multimode	4x SFP-25G-SR	multimode	100 m
QSFP-40G-SR4	multimode	4x SFP-10G-SR	multimode	300m

Near End Optic (Left)		Far End Optic (Right)		Reach
OSFP-400G-SR8*	multimode	8x SFP-50G-SR	multimode	100 m
OSFP-400G-SR8*	multimode	8x SFP-25G-SR	multimode	100 m
QDD-400G-SR8*	multimode	8x SFP-50G-SR	multimode	100 m
QDD-400G-SR8*	multimode	8x SFP-25G-SR	multimode	100 m

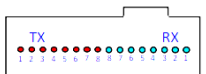



Interconnecting MDA to EDA with EDGE8

Example: MPO-16 APC One-Row to LC Duplex Across the Data Center With Trunk




MPO-16 One-Row



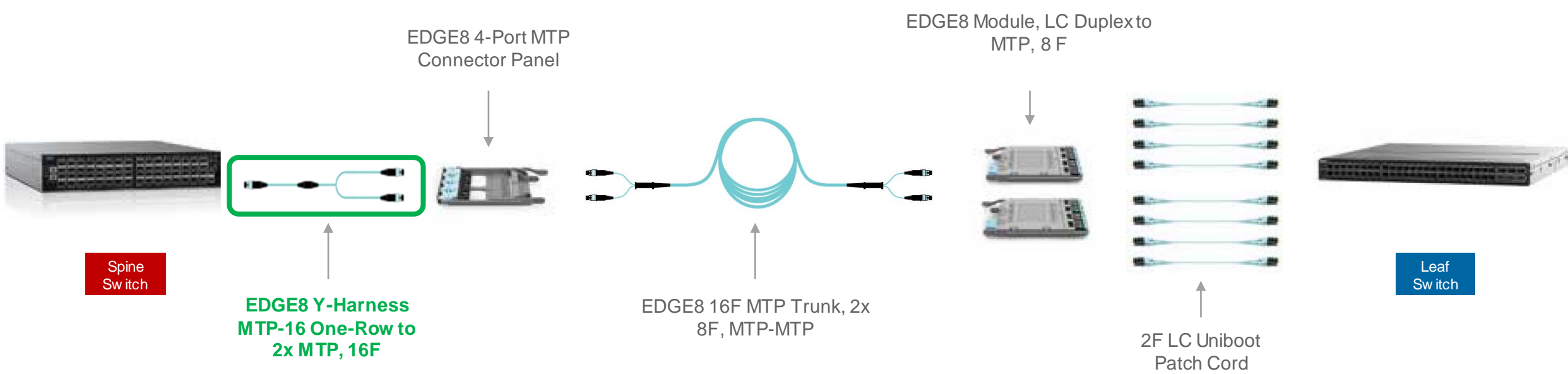


LC Duplex

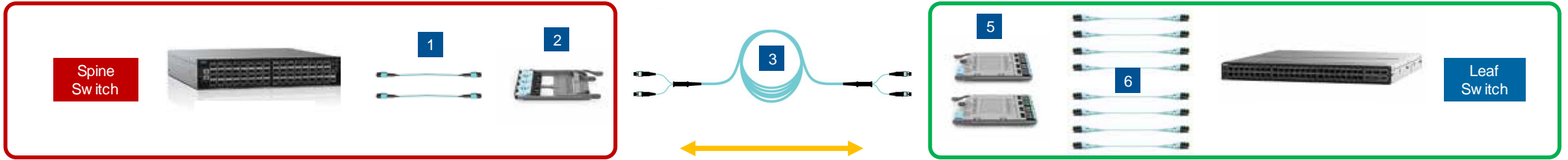


Near End Optic (Left)		Far End Optic (Right)		Reach
OSFP-400G-SR8*	multimode	8x SFP-50G-SR	multimode	100 m
OSFP-400G-SR8†	multimode	8x SFP-25G-SR	multimode	100 m
QDD-400G-SR8*	multimode	8x SFP-50G-SR	multimode	100 m
QDD-400G-SR8†	multimode	8x SFP-25G-SR	multimode	100 m

*Refer to Arista 400G FAQ for supported breakout modes.
†Configured to work as 2x 100G. Refer to Arista 400G FAQ for supported breakout modes.



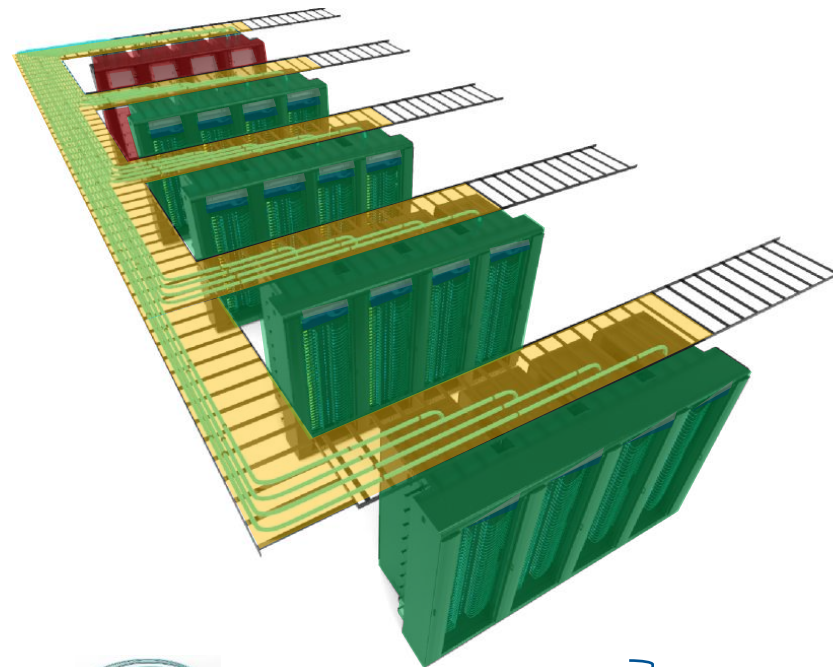
Interconnecting MDA to EDA with EDGE8



1 **MTP Patch Cords**
MTP patch cords with MTP PRO to allow field management of pinning and polarity. MTP patch cords support parallel optics like QSFP, QSFP-DD and OSFP

2 **MTP Adapter Panel**
Reverse polarity adapter for field polarity management

■ MDA ■ Switch ■ EDA ■ Horizontal Cabling ■ Housing



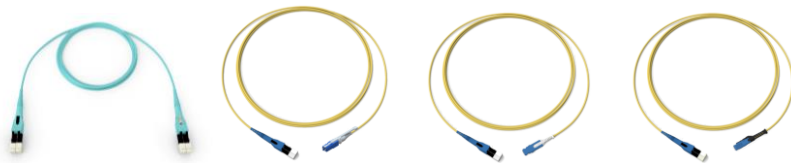
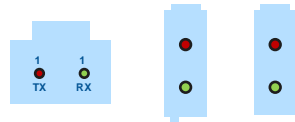
3 **Trunk**
MTP trunk with 100 lb pulling grip to simplify installation

5 **Module**
MTP-LC cassette to support port breakout functionality

6 **LC Uniboot Patch Cords**
Reverse polarity uniboot patch cords minimize patch cord density and optimize routing

Technology Roadmap

WDM 2 Fiber Connectivity



LC-Duplex

Lucent



CS

Corning-Senko



SN

Senko Nano



MDC

US Conec Mini-Duplex

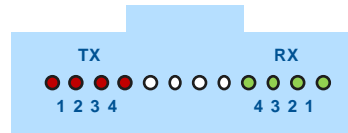
LCD-LCD

CS-CS
CS-LCD

SN-SN
SN-LCD

MDC-MDC
MDC-LCD

Parallel 8 Fiber Connectivity

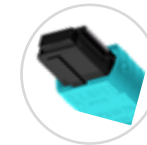
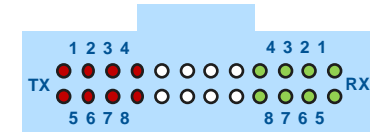
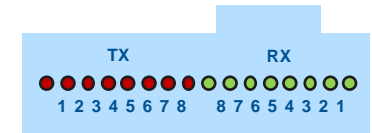


MPO-12 (8 Fibers)

Multi-fiber Push-on

MTP-8 – MTP-8

Parallel 16 Fiber Connectivity



MPO-16 APC One Row

Multi-fiber Push-on

MPO-12 Two-Rows

Multi-fiber Push-on

MTP-16 – MTP-16
MTP-16 – 2x MTP-8

MTP-24 – MTP-24
MTP-24 – 2x MTP-8

Deployment can be supported with Base-8



Budget & Cost



Space & Density



Deployment



Migration



New Tech



MACs

ISO / IEC 11801
EN 50173-1

Standards

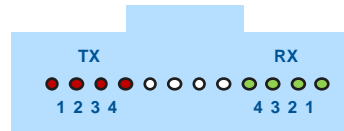
LC Duplex



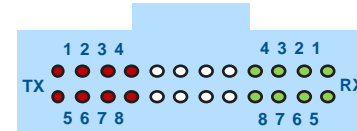
CS Duplex



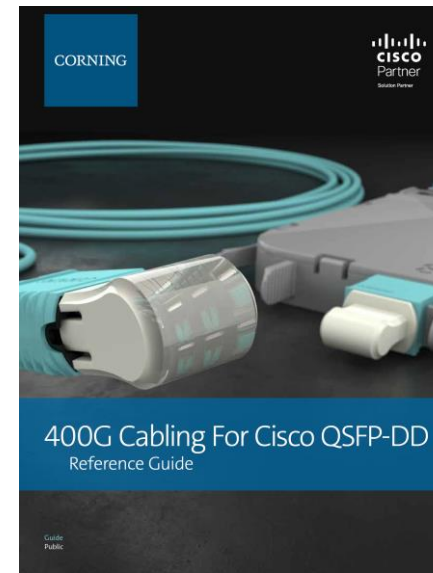
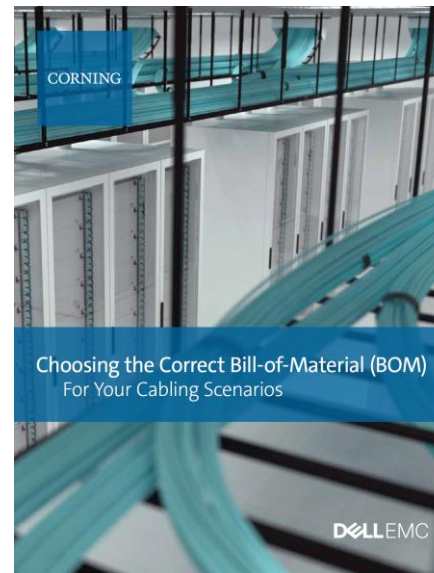
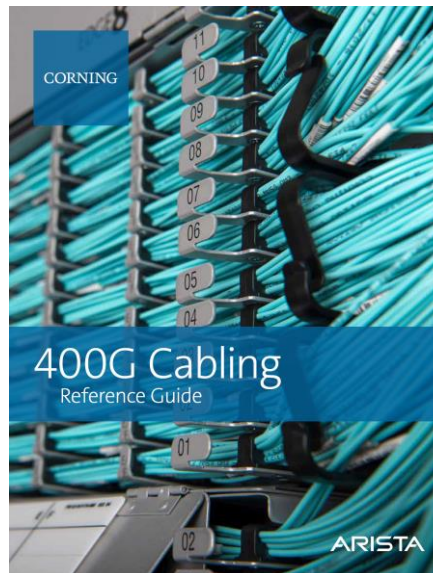
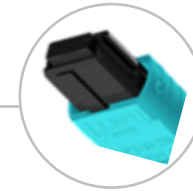
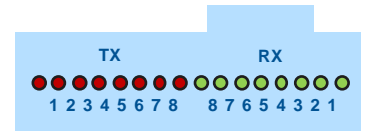
MPO-12



MPO-12 Two Row



MPO-16 One Row



CORNING



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Quiz time!

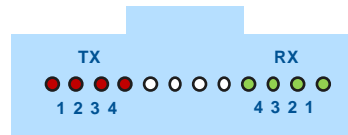
What is the most common connector type used in WDM?

A)



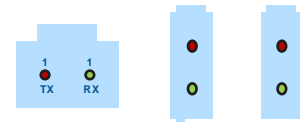
LC-Duplex

B)



MPO-12

C)



CS



SN



MDC

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