

CORNING

1 to 400G – Advanced Data Centre Technologies

Anthony Robinson RCDD CDCDP™ CNIDP®



Agenda

- Technology Roadmap
- Base 8 Advantages
- Base 8 Solution Advantages

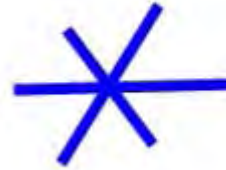
40G and beyond

Technology changes lead to parallel optics



3 Primary types of events that shape the future

Novelty



Discovery of new technology (Cloud)

Cycles



New DC Builds

Constants



Moore`s Law

Background

Increase in transmission speeds

Data



Processors

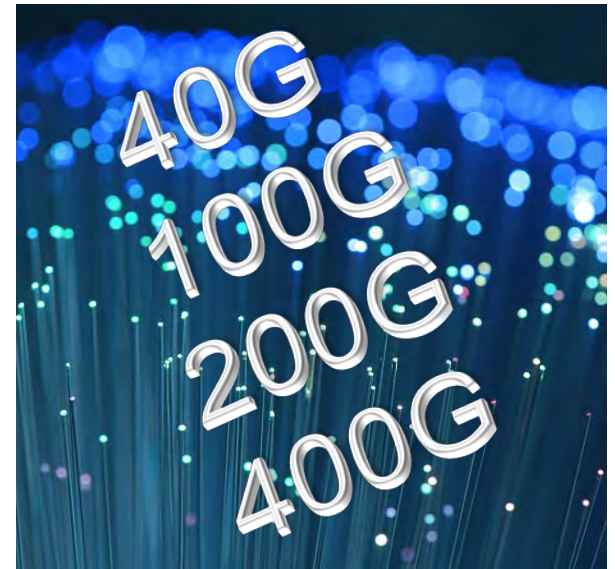
Server



Switch



Transmission
Speeds



New Product development – VOT

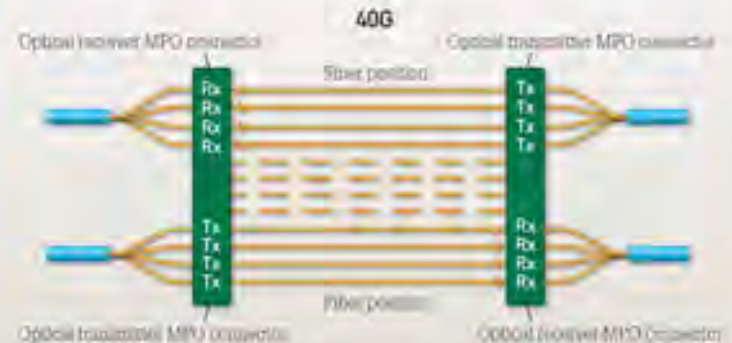


40G and beyond

Technology Defined: WDM and Parallel Transmission

Parallel Transmission

Parallel optic interfaces differ from traditional fiber optic communication in that data is simultaneously transmitted and received over multiple fibers.



Analogy: If people in cars are data packets, to increase throughput we add more lanes on the highway (people/car and speed stays the same)

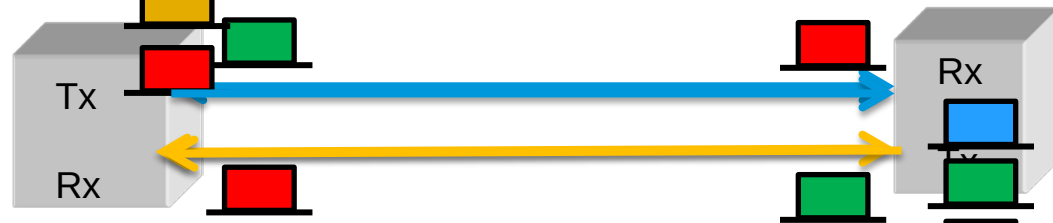
Transceiver Technologies

Serial vs. WDM vs. Parallel Transmission

Duplex
Serial uses
two fibres



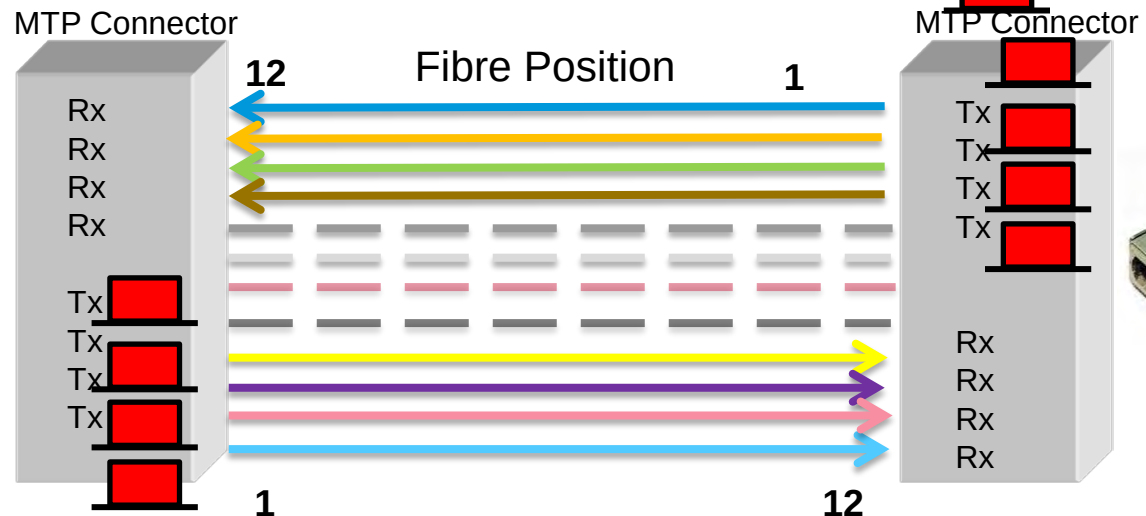
WDM
Wavelength
Division
Multiplexing



BiDi – 2λ
SWDM- 4λ

CWDM- 4λ

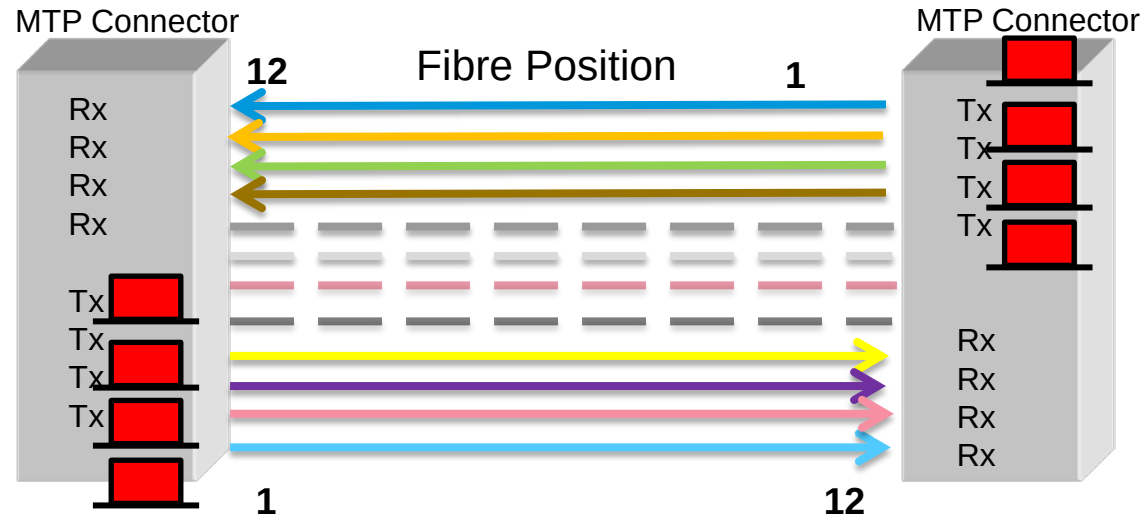
Parallel
uses 8
fibres



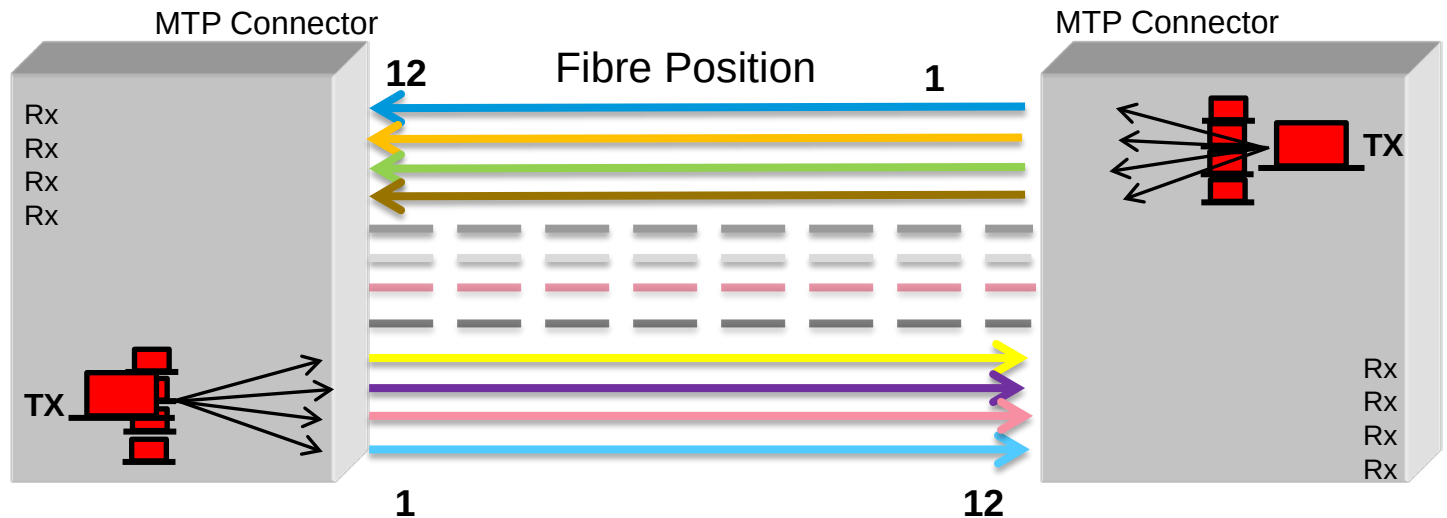
Transceiver Technologies

Parallel MM versus Parallel SM

Parallel Multimode (850nm)

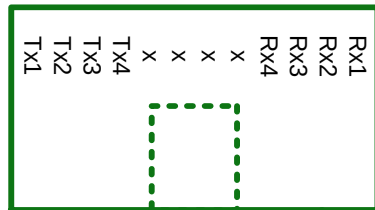


Parallel Singlemode (1310nm) (100-500m)



Transceiver Technologies

40G/100G-SR4 with MTP/MPO Connectors

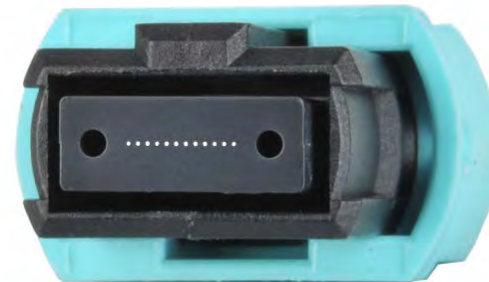


4 fibre
Transmit

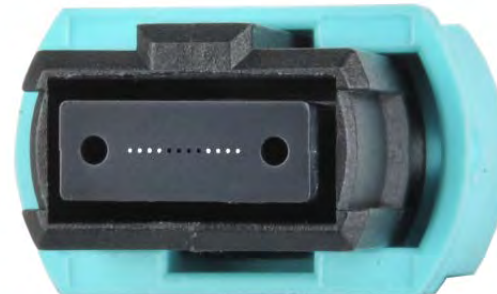
4 fibre
Receive

**4 x 10G
or
4 x 25G**

12 Fibre MTP Connector



8 Fibre MTP Connector



Transceiver Development

Technology and roadmaps

Ethernet Optical Transceiver Roadmap

Solution	Reach	40G
Duplex OM3/4	Short	BiDi WDM (UNIV)
Parallel OM3/4	Short and Mid	SR4/eSR4 4x10G
Duplex SM	long	LR4 (10km) LRL4 (2km)
Parallel SM	mid	PLR4

Transceiver Development

Technology and roadmaps

Ethernet Optical Transceiver Roadmap

Solution	Reach	40G	100G	400G
Duplex OM3/4	Short	BiDi WDM (UNIV)	BiDi WDM	??
Parallel OM3/4	Short and Mid	SR4/eSR4 4x10G	Gen2: SR4 4x25G	Gen3: SR4 4x100G

Technology Alignment

Ethernet

Speed	Lane Count
10 Gigabit	Duplex
25 Gigabit	Duplex
40 Gigabit	Parallel
50 Gigabit	Duplex
100 Gigabit	Parallel
100 Gigabit SR4	Parallel
200 Gigabit	Parallel
400 Gigabit	Parallel

FibreChannel

Speed	Lane Count
8GFC	Duplex
16GFC	Duplex
32GFC	Duplex
64GFC	Duplex/Parallel
128GFC	Parallel
256GFC	Parallel

***Parallel Transmission is in the Roadmaps of both Ethernet and FibreChannel.**

Base-8 Advantages

TCO

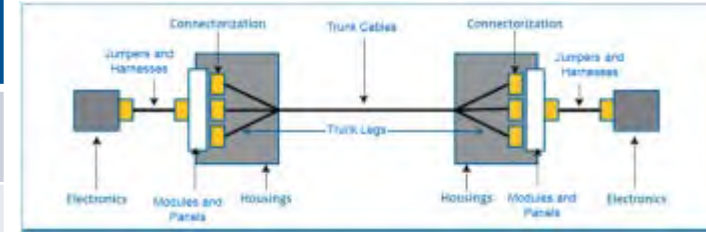
Port Breakout



Base8 Solutions

The cabling system is driven by the electronics

Ethernet	Fibres	Available	Base2	Base8	Base12	Base24
1-10G	2F	Yes	●	●	●	●
40G	8F	Yes	▲	●	▲	▲
	2F	Yes	●	●	●	●
100G	20F	Yes	▲	▲	▲	▲
	8F	Yes	▲	●	▲	▲
	2F	Yes (SMF)	●	●	●	●
400G	32F		▲	●	▲	▲
	16F		▲	●	▲	▲
	8F		▲	●	▲	▲
	2F		●	●	●	●



● = 100% Fibre Utilisation and good port mapping

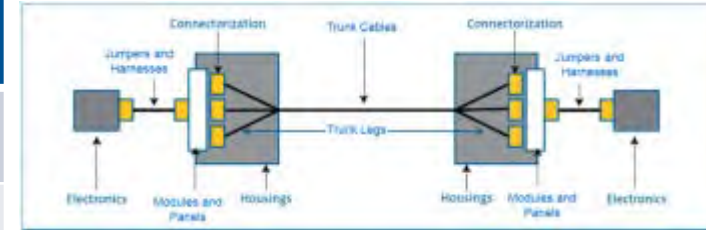
▲ = Not Ideal



Base8 Solutions

The cabling system is driven by the electronics

Ethernet	Fibres	Available	Base2	Base8	Base12	Base24
1-10G	2F	Yes	●	●	●	●
40G	8F	Yes	▲	●	▲	▲
	2F	Yes	●	●	●	●
100G	8F	2015	▲	●	▲	▲
	2F	Yes (SMF)	●	●	●	●
400G						
	8F		▲	●	▲	▲
	2F		●	●	●	●



● = 100% Fibre Utilisation and good port mapping

▲ = Not Ideal



Base8 Solutions

Comparison of Parallel vs. Duplex- Total Cost of Ownership

- Total Cost of Ownership includes Structured Cabling, Patching, and Optics
 - Cabling is a long term investment to support multiple generations of transceivers
- What would it cost over time to migrate a network from 40G to 100G?
 - Cost Model Scenario includes structured cabling, patch cables and optics in support of (72) optical links

Structured Cabling for Duplex Transceivers



OM4

Description	Part Number	Qty
144F Trunk	G7575E4QPNDU200F	1
Modules	ECM-UM12-05-93Q	24
Housing	EDGE-01U-SP	2
Jumpers	797902QD120003M	144

SM

Description	Part Number	Qty
144F Trunk	G9090E4GPNDUxxxF	1
Modules	ECM-UM12-04-89G	24
Housing	EDGE-01U-SP	2
Jumpers	787802GD120003M	144

Structured Cabling for Parallel Transceivers



OM4

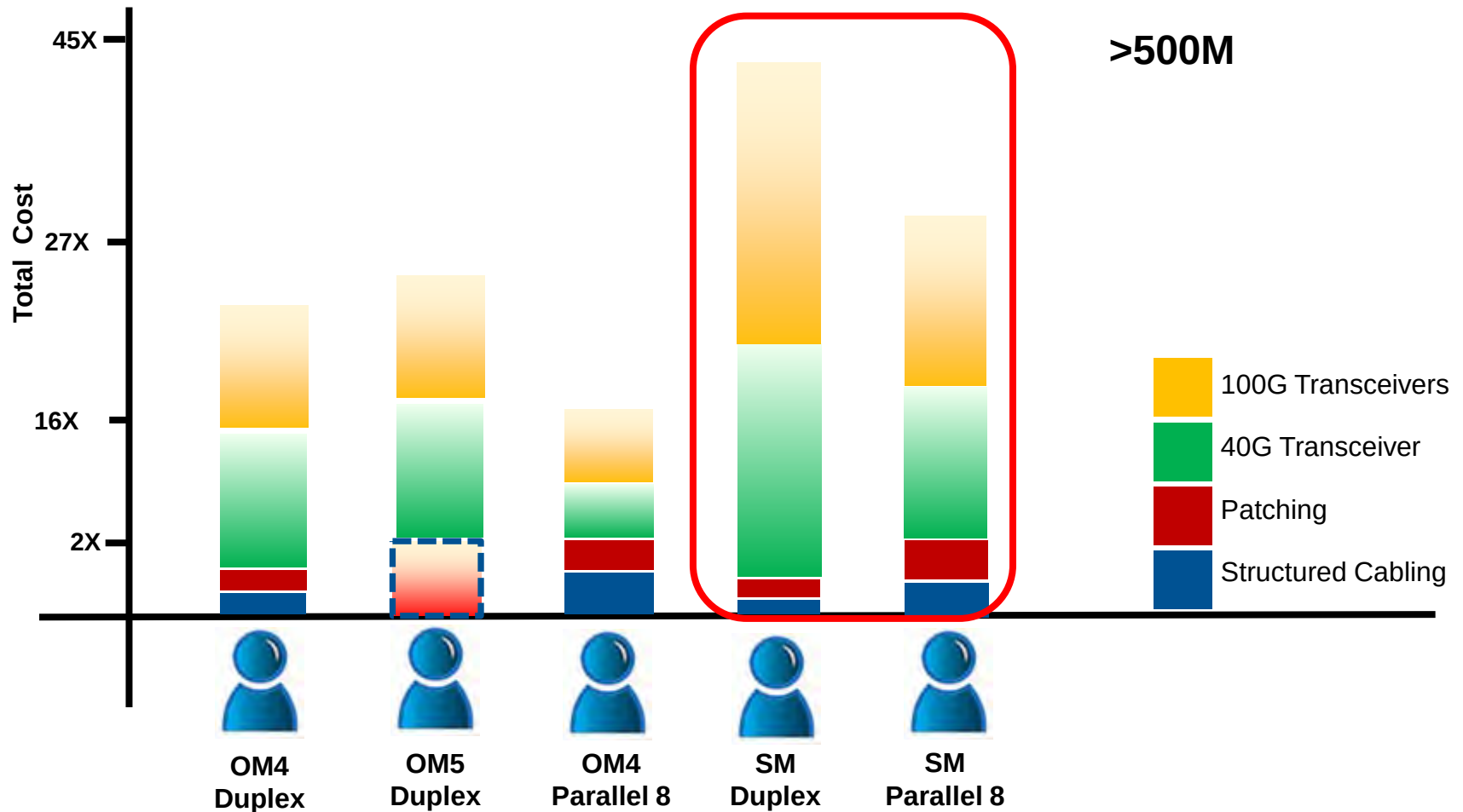
Description	Part Number	Qty
144F Trunk	GE5E5E4QPNDU200F	4
Panels	EDGE8-CP32-E3	36
Housing	EDGE8-01U-SP	4
Jumpers	JE6E608QE8-NB003M	144

SM

Description	Part Number	Qty
144F Trunk	GE7E7E4GPNDU200F	4
Panels	EDGE8-CP32-90	36
Housing	EDGE8-01U-SP	4
Jumpers	JE8E808GE8-NB003M	144

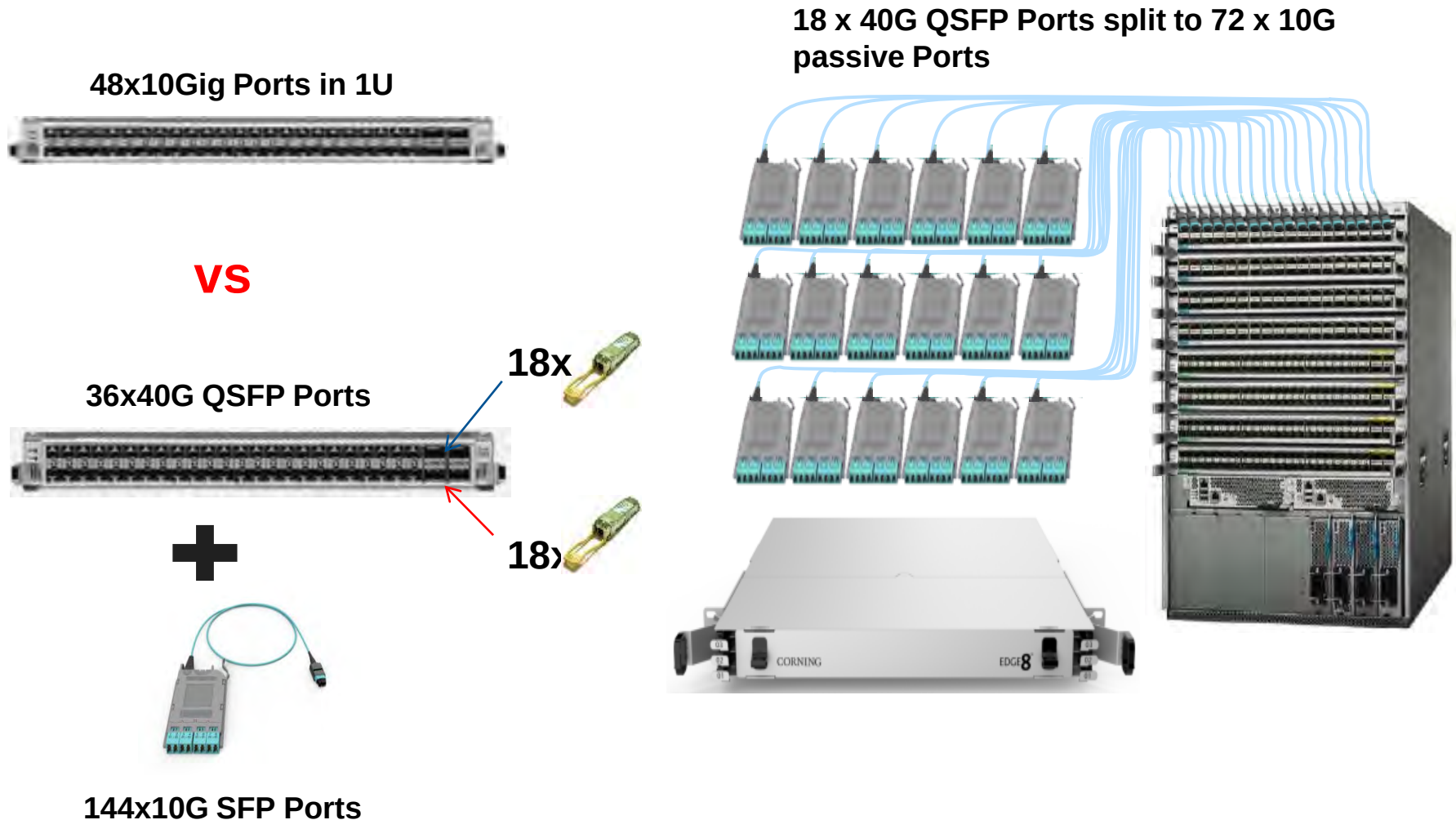
Total Cost of Ownership Model For Inter Switch Links

Comparison of Parallel vs. Duplex Connectivity – 60M Reach



Total Cost of Ownership Model for Middle of the Row

Using 48x10G Line Card vs. 36x40G Line Card

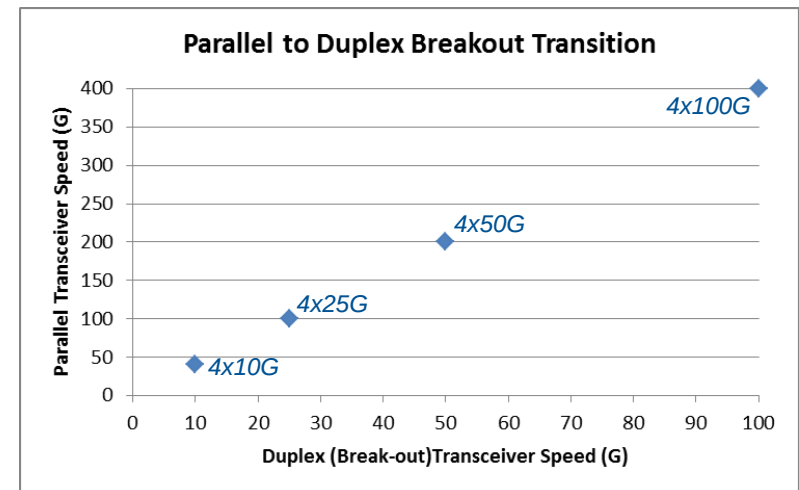


Parallel Optics Port Break-out Applications

Comparison of Parallel vs. Duplex

Product	Amount	Total Price
48 Port 10GbE (SFP+) Line card	1	45,000 €
10GBASE-SR SFP+ Transceiver, LC-Duplex, 300 m, LP per PCE. 900 €	48	43,200 €
Cost of 10G Ports (total with 48) = 88,200 € : 48		1837 € / Port

- Over half of 40GbE QSFP ports shipped are being used to break-out to 4x10G
- Why operate a 40GbE port in a “break-out” configuration?
 - **2-3x the 10G density per blade**
 - **50% less power per port**
 - **30% cost savings per port**
 - **Switch migration path (do not repurchase 40G optics or cards)**



40G to 4 X 10G Port Breakout

1152 x 10G Ports: 3 Switches each with 8 x 48 Ports 10G Line Cards

Switch 1 Switch 2 Switch 3
384 x 10G 384 x 10G 384 x 10G

= Total 1152 10G Ports



Energy consumption: 1152 W/s only Transceiver

+

Energy consumption of: 24 x 48 SFP+ Line cards

+

Energy consumption of: 3 Chassis + Accessory

1 Switch with 8 x 36 Ports 40G Line Cards



Line Card 1 36 x 40G de-aggregated to 144 x10G

Line Card 8 36 x 40G de-aggregated with 144 x10G

8x 144 = Total 1152 10G Ports

Energy consumption of: 432 W Transceiver + 8 Line cards + 1 Chassis

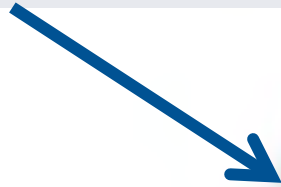
Base-8 Solution Advantages



Base-8 Solutions

Pinned Trunks

8 fibres per leg
-Exact match to SR4 transceivers (no wasted fibres)



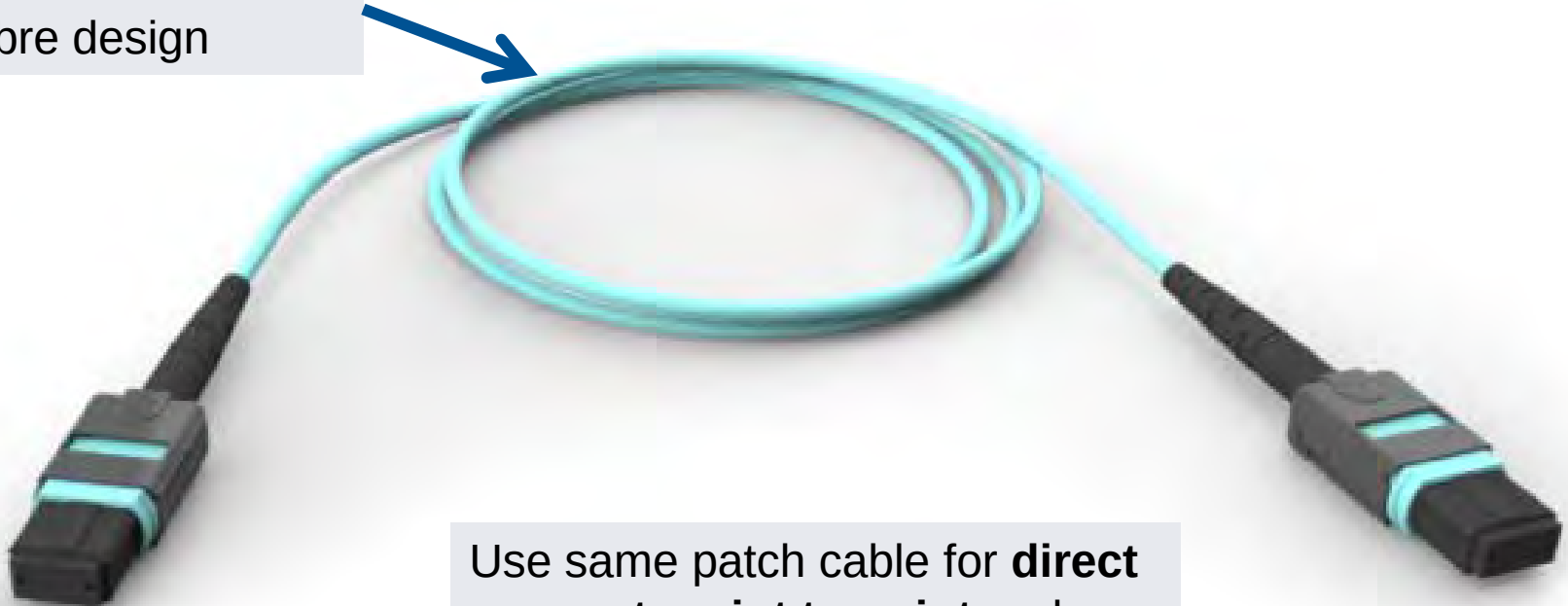
Pinned Trunks
-Allows usage of one type of MTP jumpers.



Base-8 Solutions

Non-pinned MTP Patch Cables

2.0mm diameter
8 fibre design

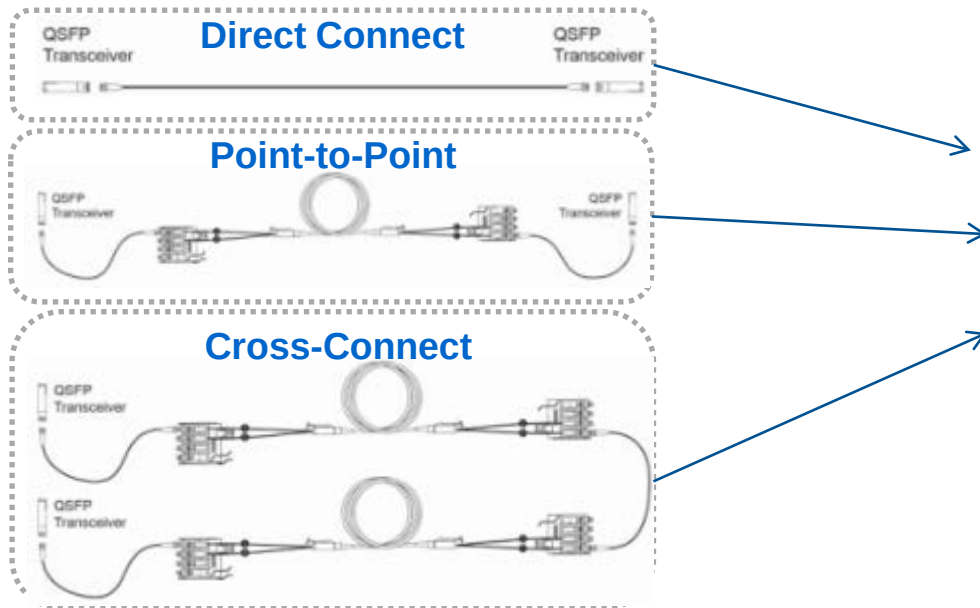


Use same patch cable for **direct connect**, **point to point** and **cross connect** patching

Non Pinned MTP
Connectors

Base-8 Solutions

What is the Non-Pinned Patch Cable Value Proposition ?



Base-12 (pinless trunks)

Pinless-Pinless

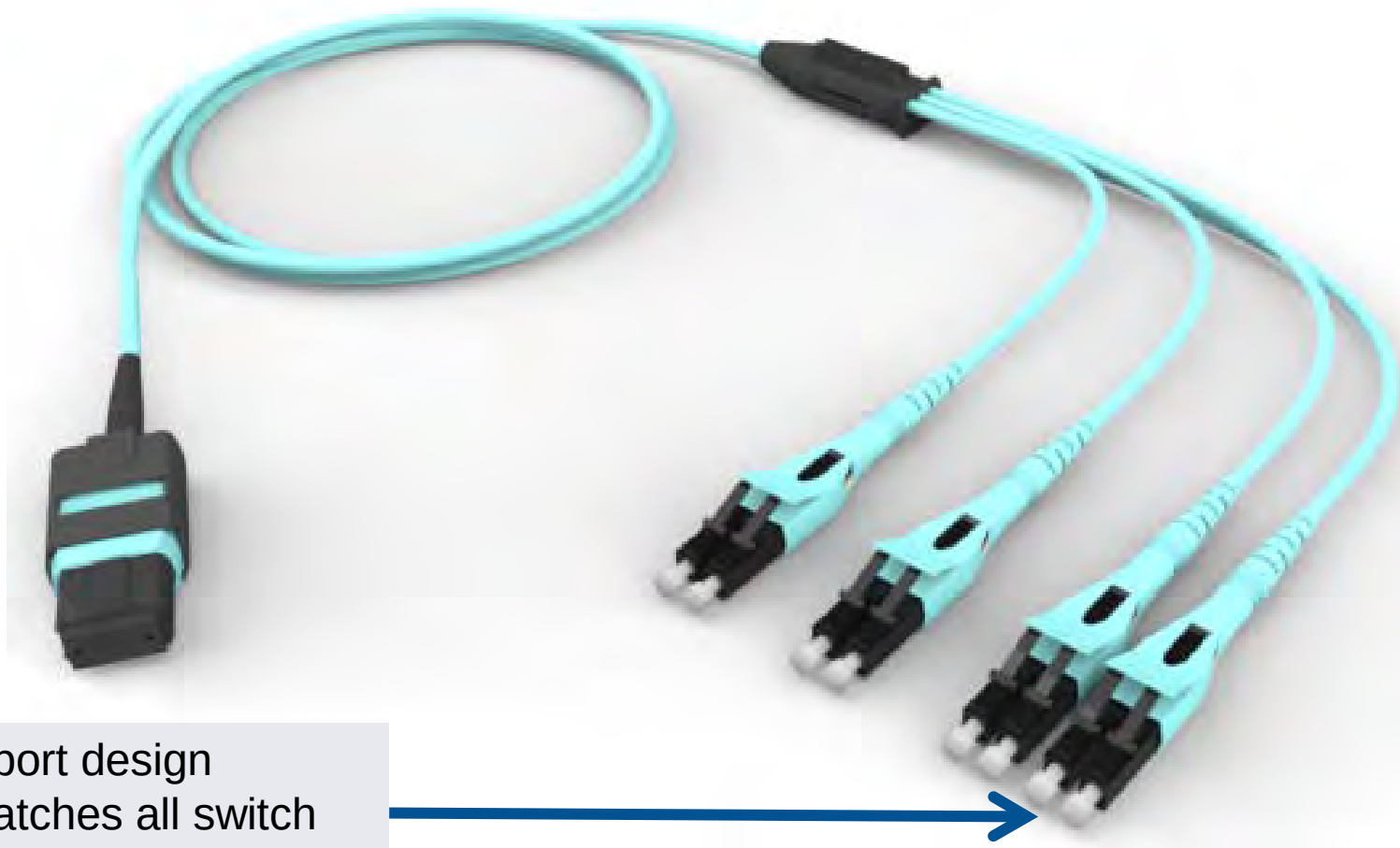
Pinned-Pinless

Pinned-Pinless
+
Pinned-Pinned

= 3 patch cable
configurations

Base-8 Solutions

QSFP to SFP+ Harness

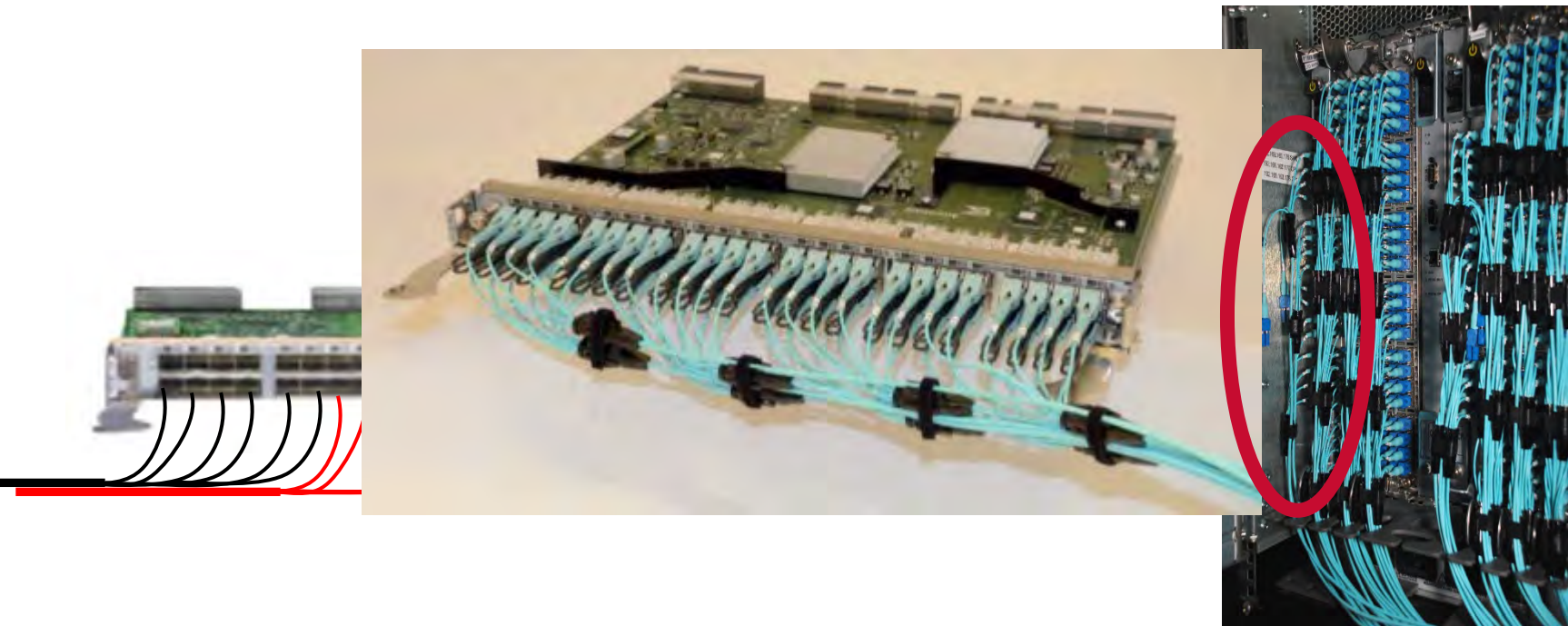


4 port design
matches all switch
blades

Base-8 Solutions

What is Base-8 Harness Value Proposition?

Area	Value	Comments
Port Mapping	Optimised Harness Mapping	Allows for 24, 32, 36, 48-port blades on large chassis switches to be cabled with 8f harnesses without having to deal with under utilised fibre/connectors.



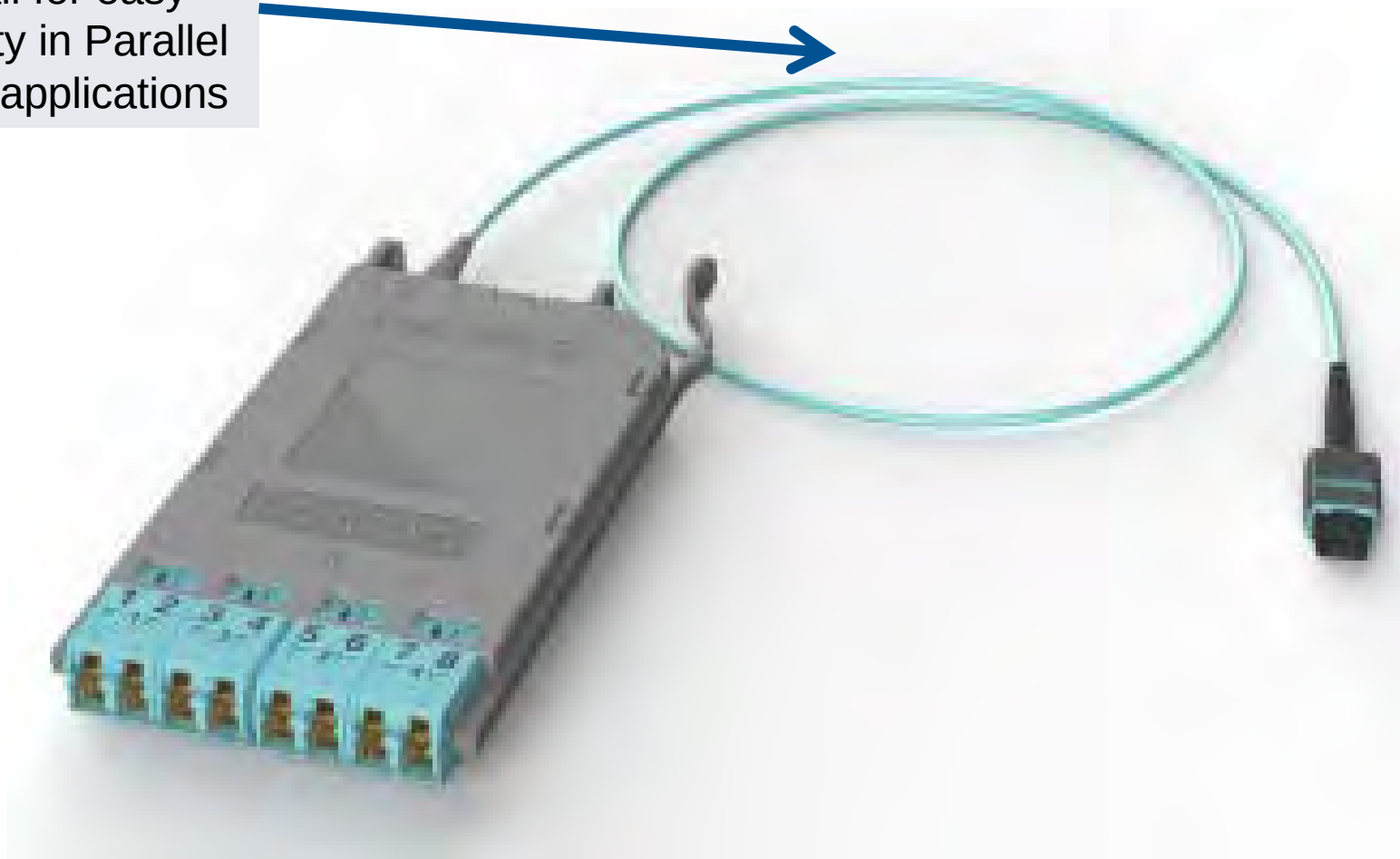
Note: Base-8 cabling eliminates the under utilised connectivity for all line card port counts.

***AE Note -157**

Base-8 Solutions

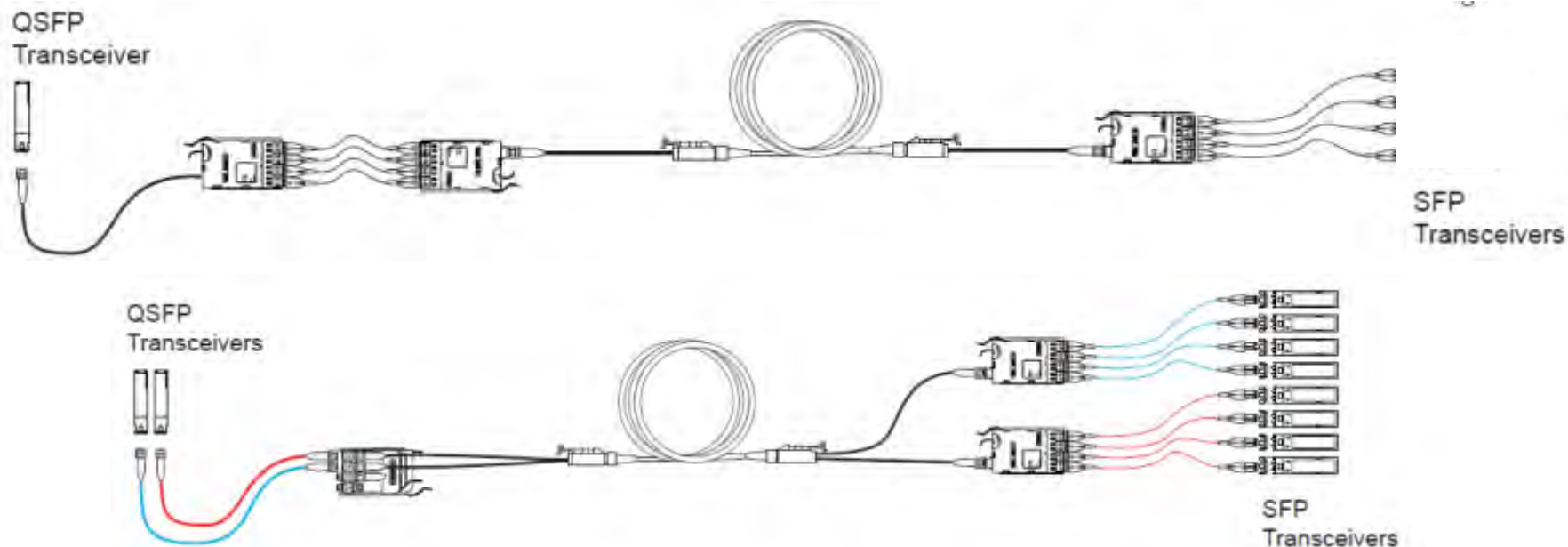
Port Breakout Modules

MTP Pigtail for easy connectivity in Parallel Break-out applications



What is Base-8 Port Breakout Module Value Proposition?

Area	Value	Comments
Port Mapping	Optimised Port Breakout	With 8f breakout modules all 4-channel parallel protocols (SR4, PSM4, etc) are now mapped cleanly to a single element.



Network Monitoring

- Is the use of a system that constantly monitors a network for slow or failing components and outside threads; and notifies in case of outages or other trouble
- What is monitoring looking for?
 - Security threats
 - Performance issues
 - Optimisation (I/O bottlenecks)
 - Troubleshooting

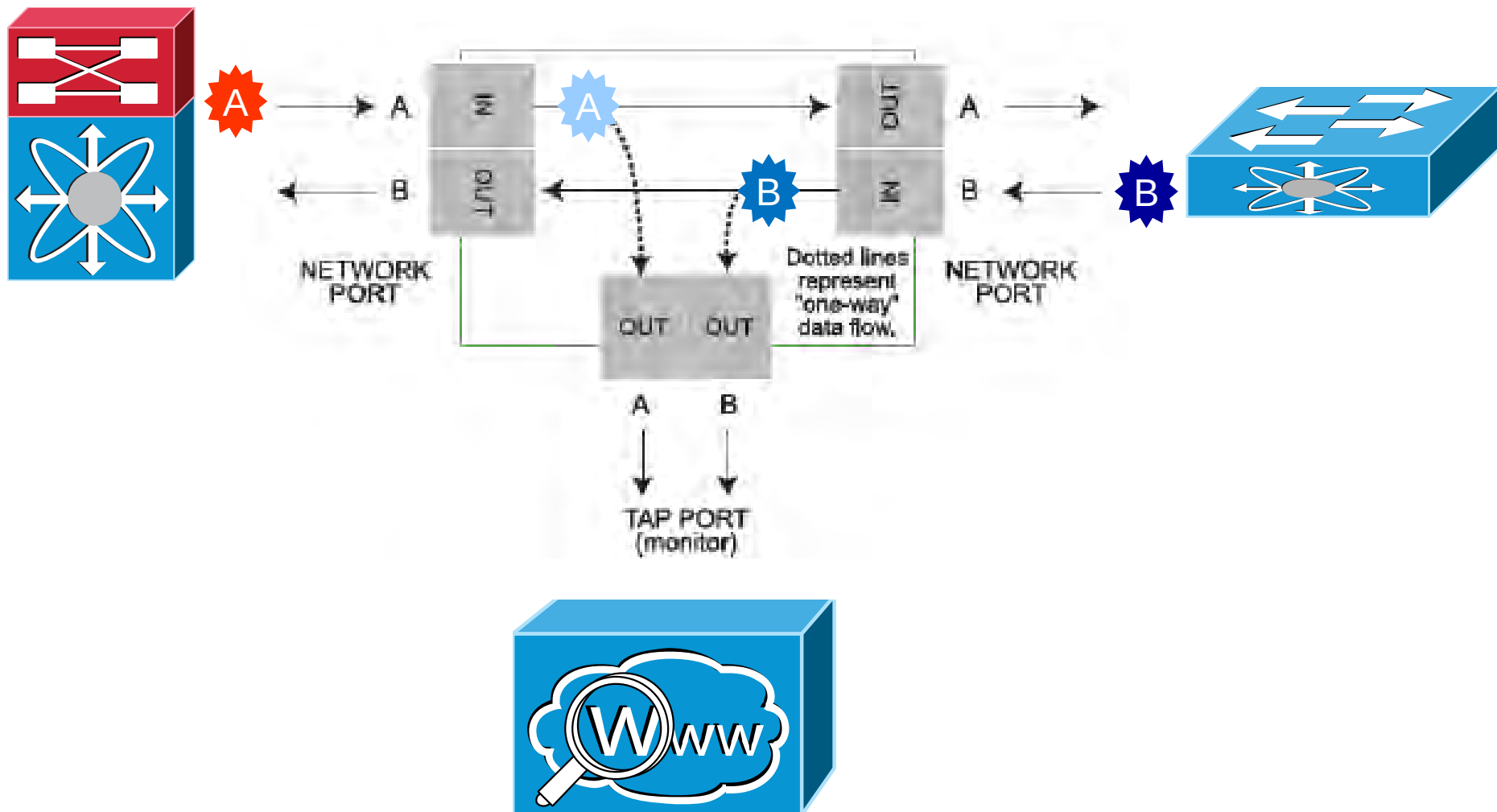


Tapping?

- Is a method to extract the network data so it can be analysed
- Network layer data must first be extracted in order to apply the analysis tools
 - SPAN ports (Switch Port for Analysis) (active)
 - Port TAP (Traffic Access Point) (passive for optical)



TAP (Traffic Access Point) Passive



Base8 Solutions

Base8 Tap Modules

Product Family	Description	Product
EDGE8™ Tap Modules	- LC-LC, MTP-LC, MTP-MTP, BiDi 50/50, 70/30, 80/20 & 90/10 Split Ratio options - Provides connectivity to Network Performance Monitoring equipment	



LC-LC 6f Tap Module
1 x 10G MM port
1 x 40G SM port



MTP-LC 8f Tap Module
4 x 10G MM ports
4 x 40G SM ports



MTP-MTP 8f Tap Module
1 x 40G Parallel MM port
4 x 10G MM
4 x 40G SM

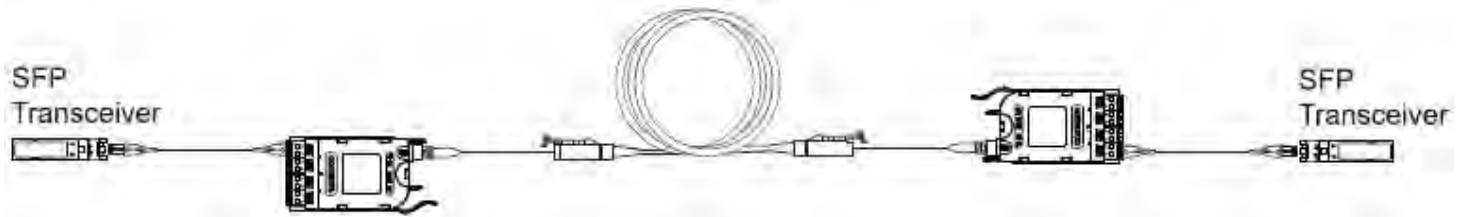


BiDi 8f Tap Module
1 x 40G port

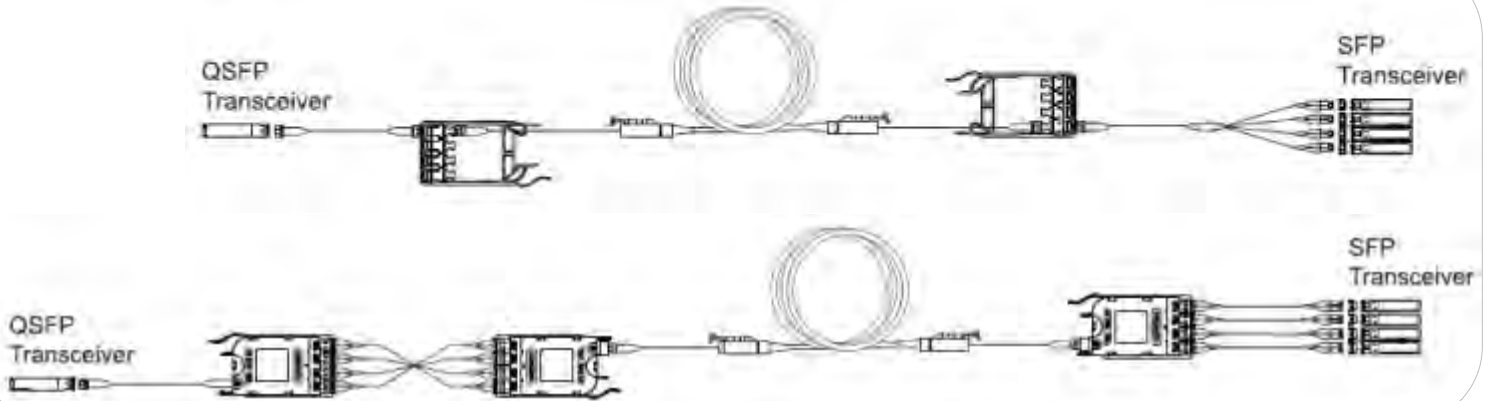
EDGE8 Solutions for Data Centres

Migration from 10G to 40G to 100G

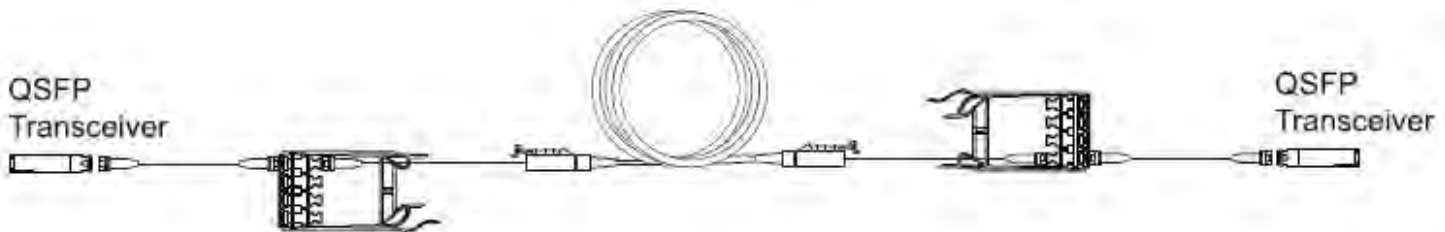
**10G
(Duplex)**



**40G-4x10G
100G-4x25G
(Parallel Breakout)**



**40/100G
(Parallel)**



100%
Fibre
Utilisation

0.5 dB
Channel
Loss

EDGE8™ Solutions

Outstanding value in all areas of structured cabling

	Benefit	Value
Link Cost Savings	15-25% Savings	100% fibre utilisation without the need for conversion modules, result in 30% less MTPs in the link
Reduced Link Attenuation	50% Reduction in Parallel Link	By eliminating the Conversion Modules, we cut the link attenuation in half resulting in longer SR4 link distances
	30% Reduction in Duplex Link	Standard MTP-LC EDGE8 module has a loss of 0.35dB as compared to 0.5dB for standard MTP-LC EDGE modules.
Migration	100% fibre utilisation	Allows 100% fibre utilisation for 4-channel (SR4, PSM4, etc) and 8-channel (SR8, LR8)
Patch Cable Complexity	67% Reduction in Inventory	Pinning the trunks allows for a single pinless patch cable deployment for all installations, reducing stocking and deployment complexity.
Port Mapping	Optimised Port Breakout	With 8f pigtailed modules all 4-channel parallel protocols (SR4, PSM4, etc) are now mapped cleanly to a single port
	Optimised Harness Mapping	Allows for 24, 32, 36, 48-port blades on large chassis switches to be cabled with 8f harnesses without having to deal with unutilised fibre/connectors.
Passive Optical Tapping	Performance Monitoring	Allows integration of network performance monitoring of SAN and LAN networks for greater system uptime and simplified trouble-shooting

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Back up Slides

OM5



Lumentum and Finisar Demonstrate 100G SWDM4 Optical Transceiver Interoperability at ECOC 2016

MILPITAS, CA and SUNNYVALE, CA -- (Marketwired) -- 09/19/16 -- Lumentum Holdings Inc. (Lumentum) and Finisar® (NASDAQ: FNSR) are showcasing the industry's first interoperability demonstration of 100G SWDM4 optical transceivers at the European Conference on Optical Communications ([ECOC](#)) in Dusseldorf, Germany, from September 19-21.

The demonstration is scheduled to take place on the exhibit floor of ECOC 2016 where a live data link will be set up to run between the Lumentum and Finisar booths. The two module manufacturers will be exchanging data generated by local sources through their respective SWDM4 optical transceivers. They will be linked via a traditional duplex MMF link thus demonstrating the transceivers' ability to communicate with each other. The QSFP28 modules will be plugged into test systems provided by Anritsu and Viavi.

Using shortwave wavelength division multiplexing (SWDM), a novel technology in short reach data communications, multiple data streams from lasers emitting different wavelengths in the 850nm band are optically multiplexed into a single fiber at the transmitter and de-multiplexed at the receiver into the original data streams. This provides a direct, low-cost solution for 100G data rate upgrades for data center customers who have an installed base of duplex multimode fiber (MMF) running at 10G today. Before SWDM, the standard upgrade path was to switch to multi-mode ribbon fiber and use 100G SR4 over four parallel data streams.

"SWDM is expected to play an important part in the migration from a 10G-centric data center to an architecture based on 40, 100, or 200G," said James Wynia, director of product management at Dell EMC Networking. "We are pleased to see multiple vendors embrace a common interface because of the security of supply it provides to end customers."

Lumentum and Finisar use a common set of transceiver optical specifications in order to provide interoperability of their respective transceivers. This benefits customers by presenting two well known optical module suppliers with this key technology for the most economical 100Gbps upgrade path.

"This demonstration marks an important step in the development of a low-cost 100G solution for a great many customers who have made the investment over the years in a duplex multimode fiber infrastructure for their data centers," said Kevin Redner, product line manager at Lumentum. "We know the technology existed to use SWDM for 100G short reach applications and today we're pleased to show that customers can move confidently forward knowing that they have multiple sources for this product."

"SWDM technology enables data center operators to extract ongoing value from their legacy duplex multimode fiber plant," added Tony Abdilla, senior product line manager at Finisar. "Duplex multimode fiber was widely deployed for 10G data transmission. With SWDM transceivers, the same fiber can be used to carry 100G data."

In 2015 the SWDM Alliance (www.swdm.org) was created with the express purpose of promoting this technology in response to a need in the industry. With SWDM4, an optical transceiver with a standard QSFP28/CAUI-4 electrical interface can be plugged into an Ethernet switch or NIC and drive 100Gbps over legacy duplex MMF.

Published & Expected Distance Capabilities (in metres)

	40G				100G			
	Std SR4	COC eSR4	COC BiDi	Finisar SWDM	Std SR4	COC eSR4	Prelim BiDi	Finisar SWDM
OM3								
OM4								
OM5								

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