McDATA® | Mobilizing the World's Data™

How to Make Multimode 100 GigE Succeed

By Scott Kipp

Overview

- Review of 10 Gig and other Gigabit/sec technologies
- Review of fiber optic cabling technologies
- Review of transceiver technologies
- One more way forward on 100 Gig
  - 12 channels at 8.5 Gbits/sec is optimal

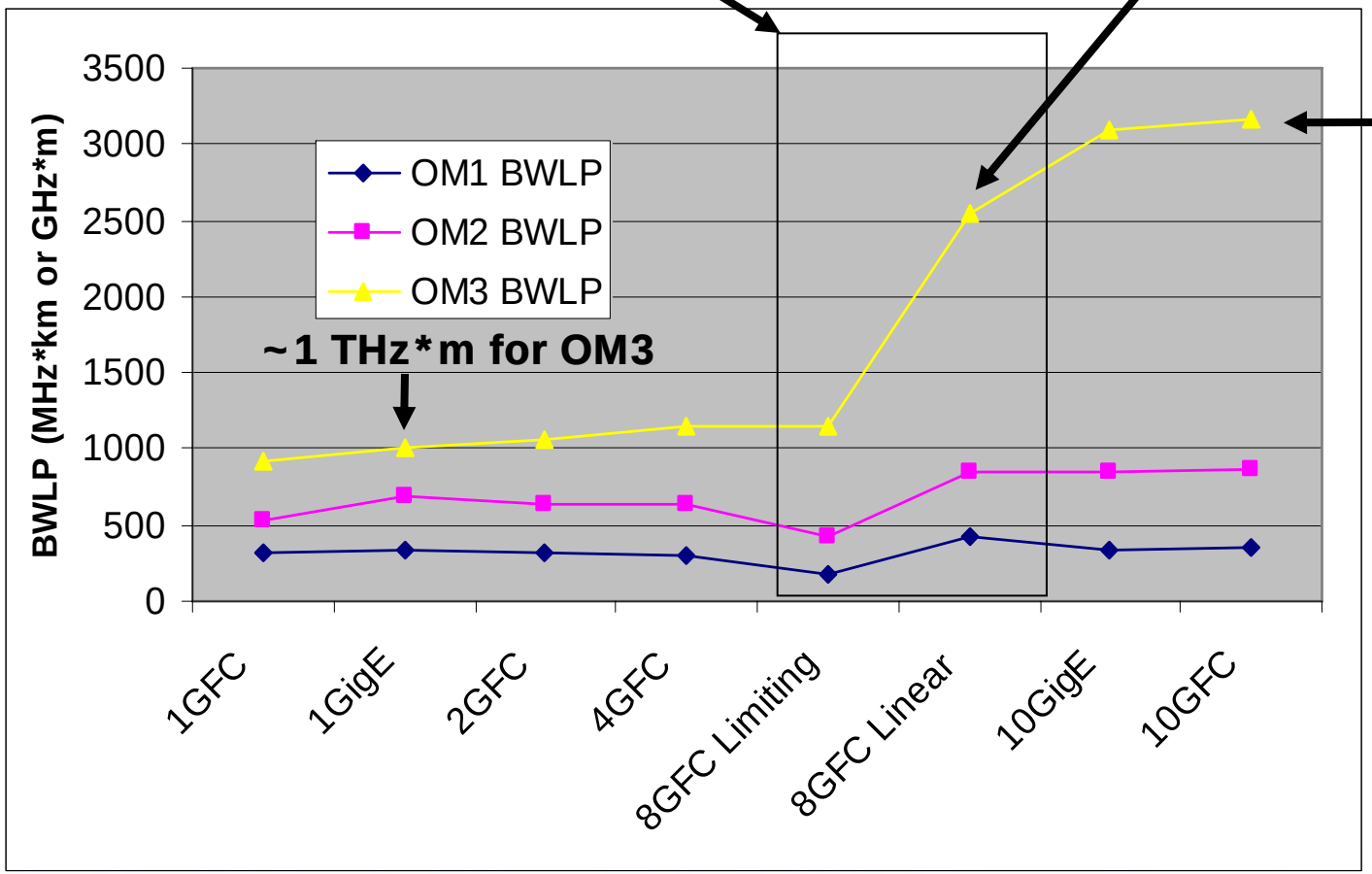
10 Gig to 300 meters

- 10 Gigabit Ethernet required a 300 meter distance on OM3 fiber that increased the bandwidth-length product (BWLP) of the link/transceiver combination
  - This increased the requirements on the transceiver
- To meet this distance, a high optical power was required while the spectral width of the laser was decreased. This lead to the transmitter optical sub-assembly (TOSA) being the highest cost component in 10 Gig modules
  - This was well documented by Finisar in 06-036v0 at www.t11.org
- High cost has lead to low adoption of 10GbE and 10GFC
  - Fibre Channel has tried to avoid the cost problem in 8GFC

Bandwidth Length Products of Multimode Fibers

8 Gigabit Fibre Channel (8GFC) under development at www.t11.org in FC-PI-4

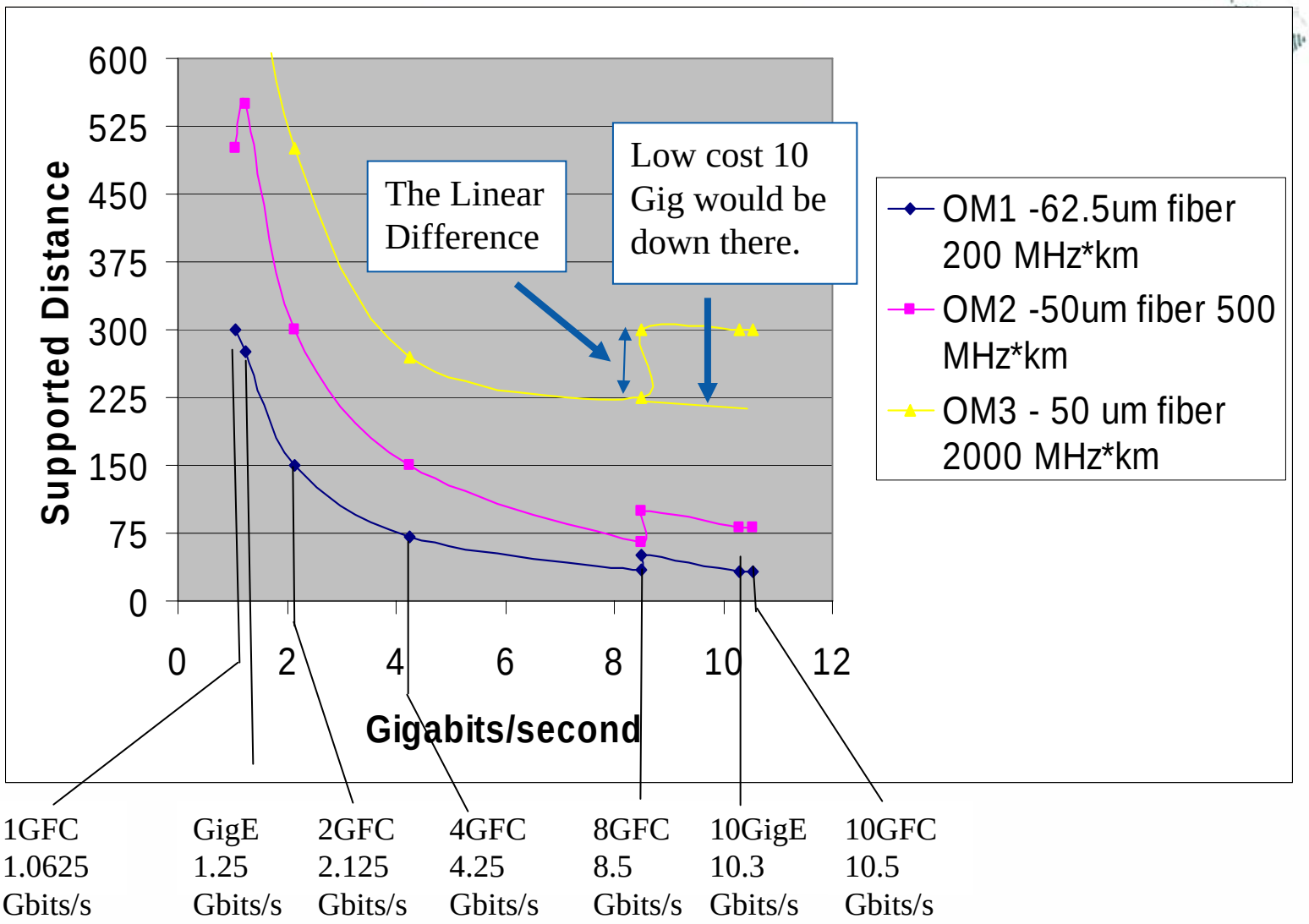
SFP+ Linear Specification under development in SFF Committee at ftp://ftp.seagate.com/sff/SFF-8431.PDF



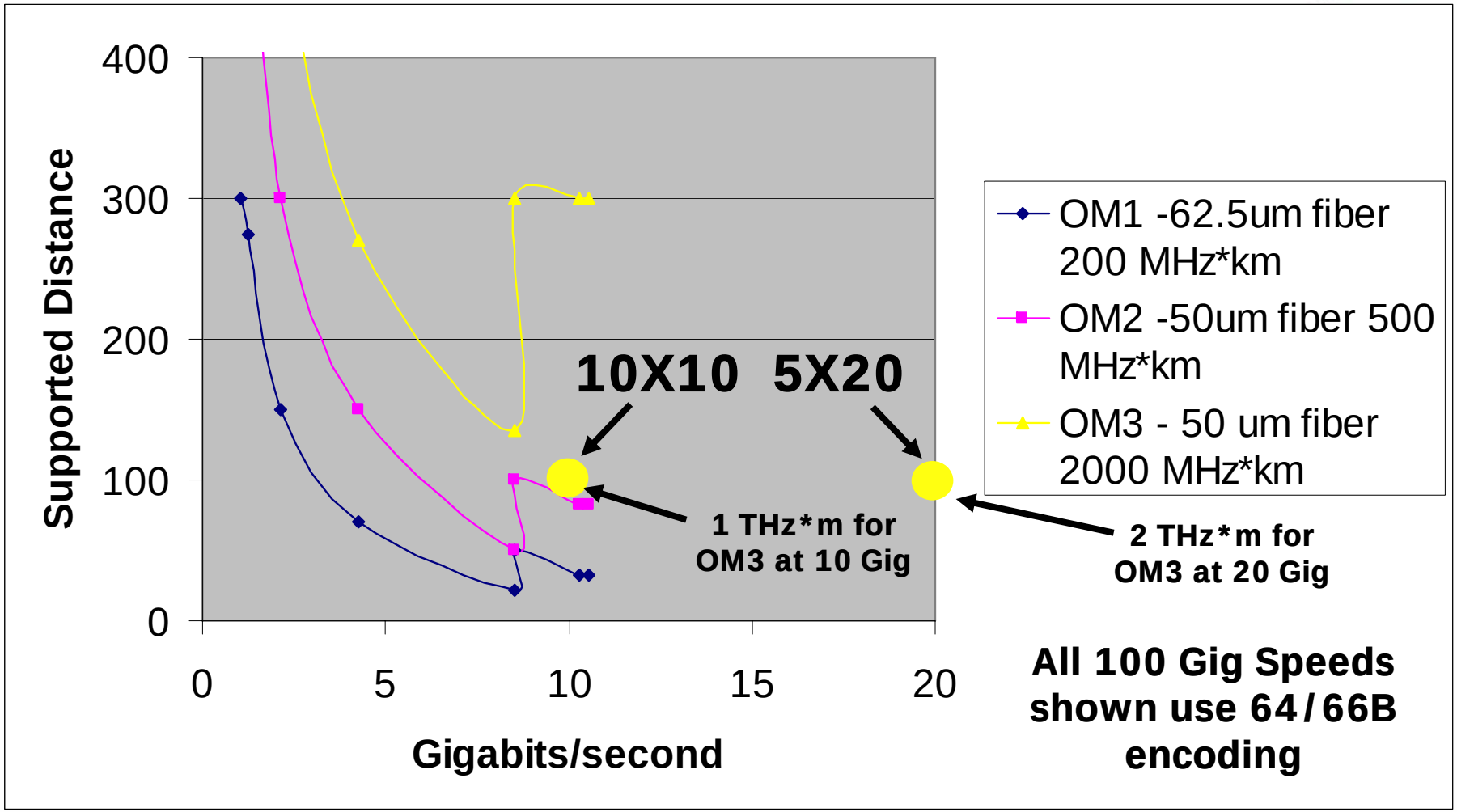
Over 3 THz*m for OM3 at 10 Gig

McDATA

Higher Speed Usually Leads to Shorter Distances



Add 100 Gig Ethernet to table



Standards for the Data Center

- TIA-942, Telecommunication Infrastructure Standard for Data Centers, defines recommended topologies for the data center considering WAN, MAN, LAN and SAN
- TIA-942 recommends structured cabling solutions that use distribution (patch) panels and trunk cables with many 12-fiber ribbon cables with MPO connectors
- Optimizing the use of fibers in the data center should be a priority for 100 Gigabit Ethernet

Cable Management Problems

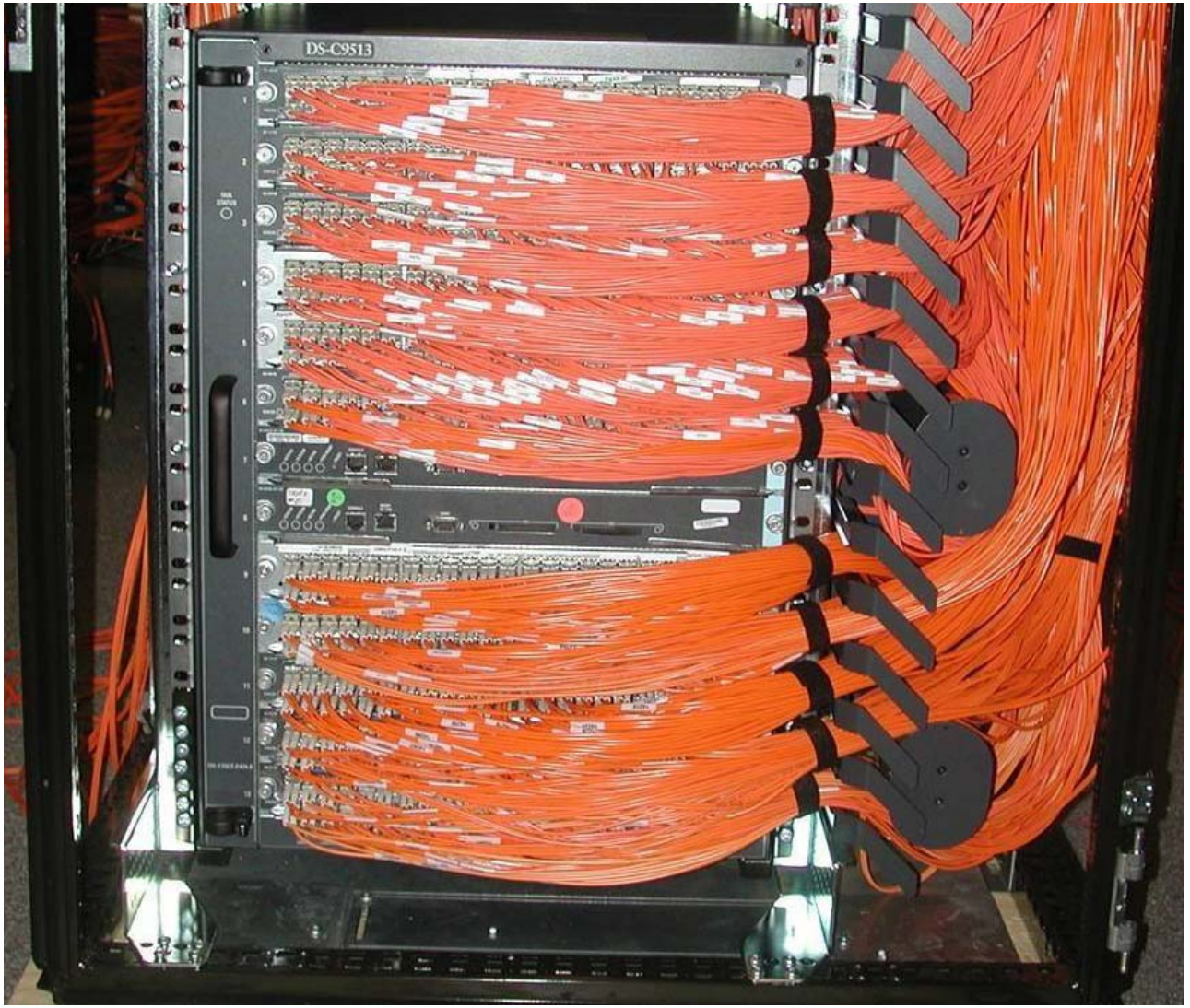
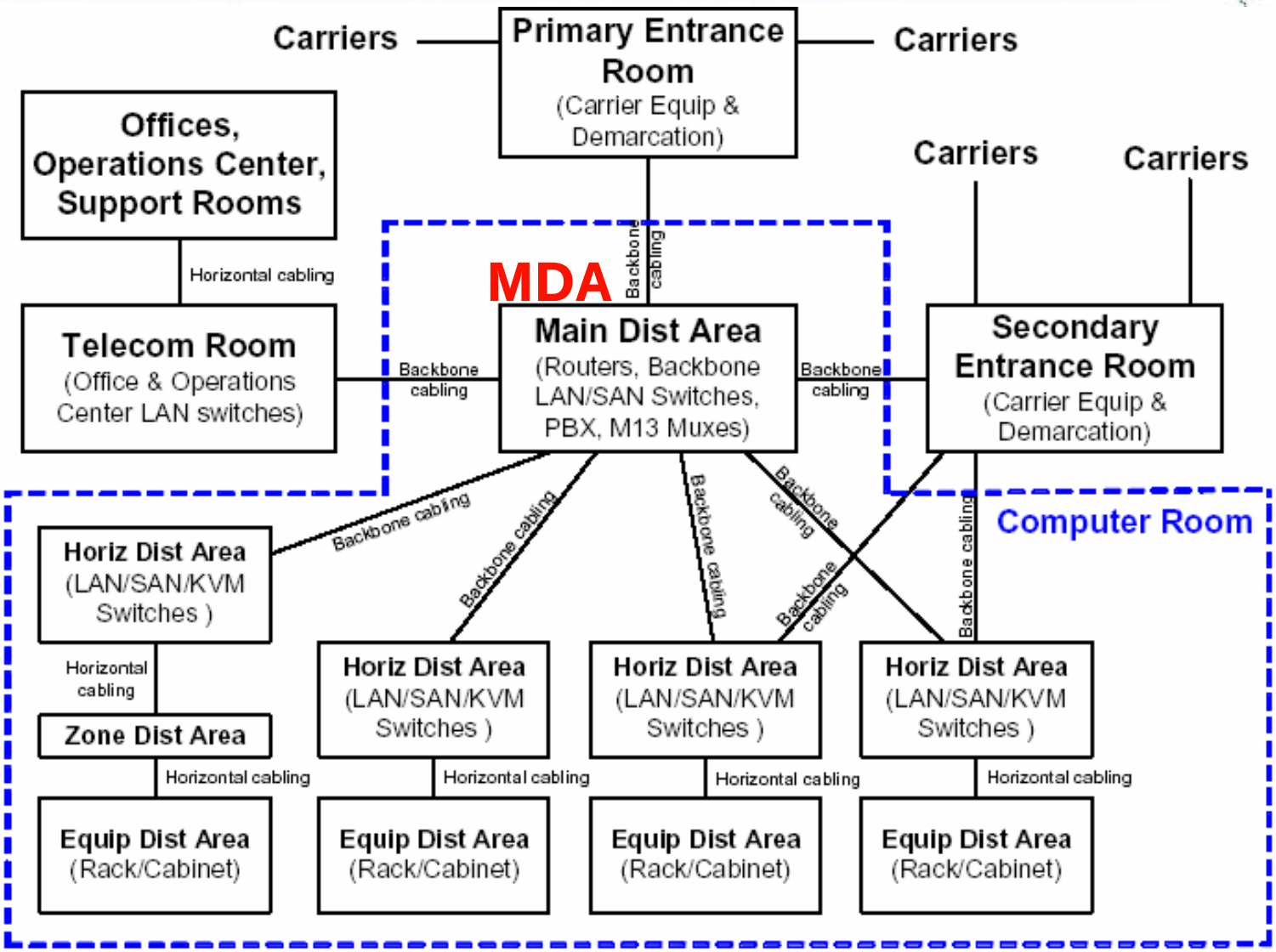
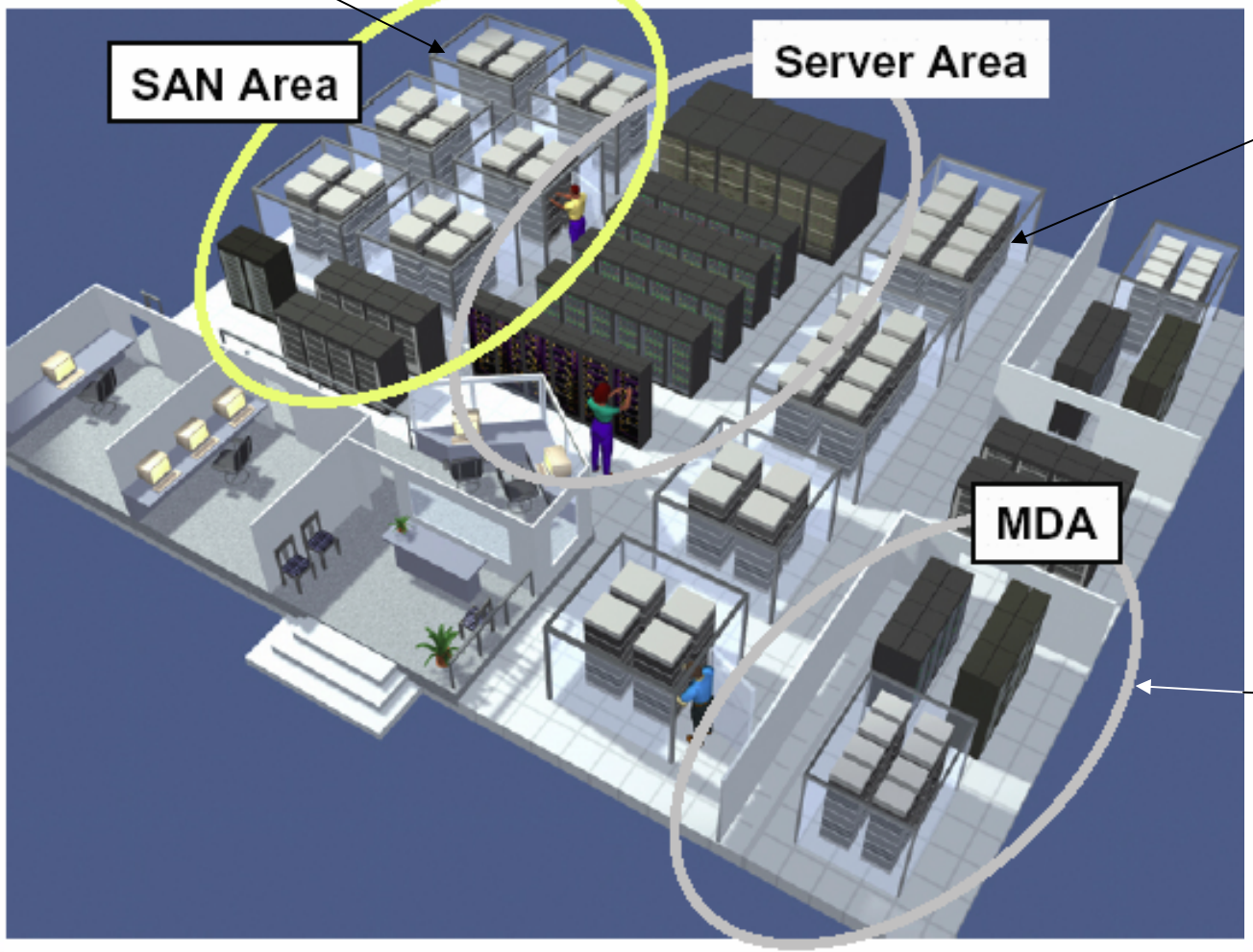


Figure 5 of TIA-942



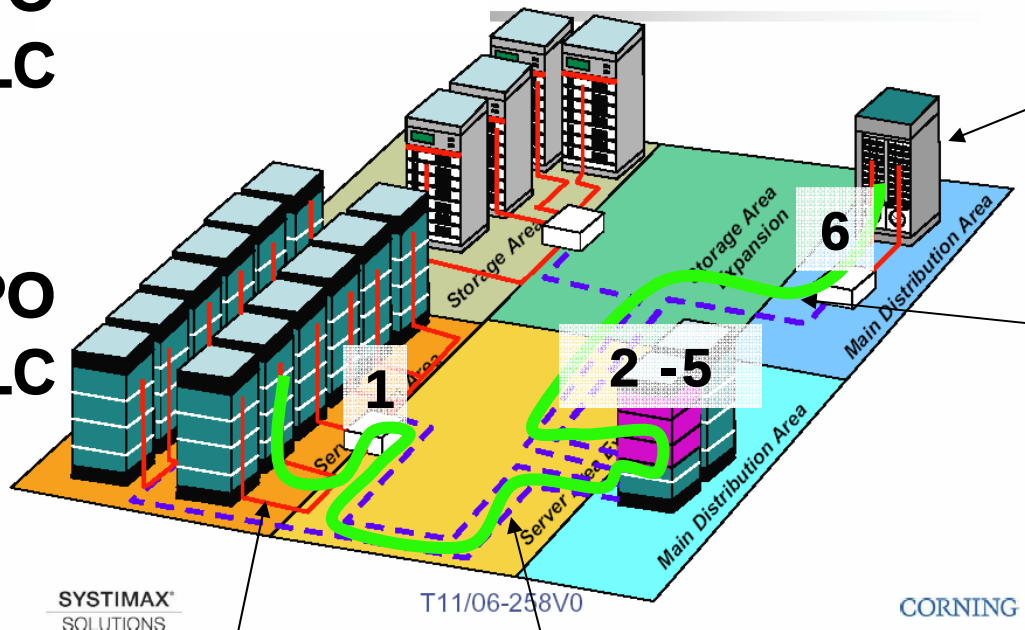
Sample Data Center



Longer Links and More Connections

4 Connections between Server or Storage and Switch:

1: LC to MPO
2: MPO to LC
3: LC to LC
4: LC to LC
5: LC to MPO
6: MPO to LC



Fibre Channel Switches

Longer Paths

LC-LC Patchcord

MPO-MPO Patchcord

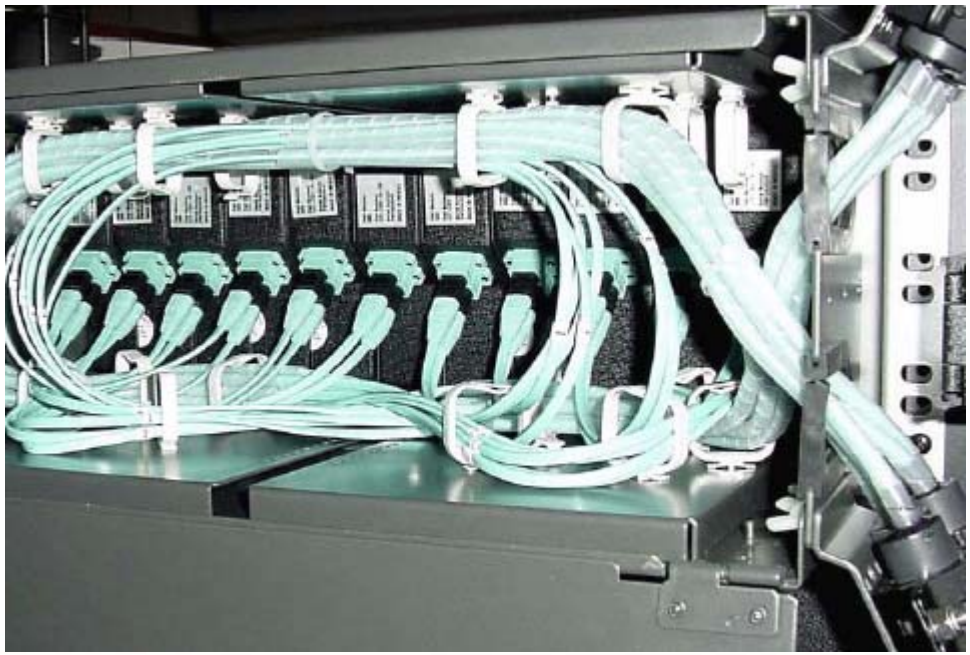
Copper will not scale well for these applications

MPO Yields Dense Patch Panel

144 Ports take up 4U of rack space

Front View
Dense LC Connectors to SFPs

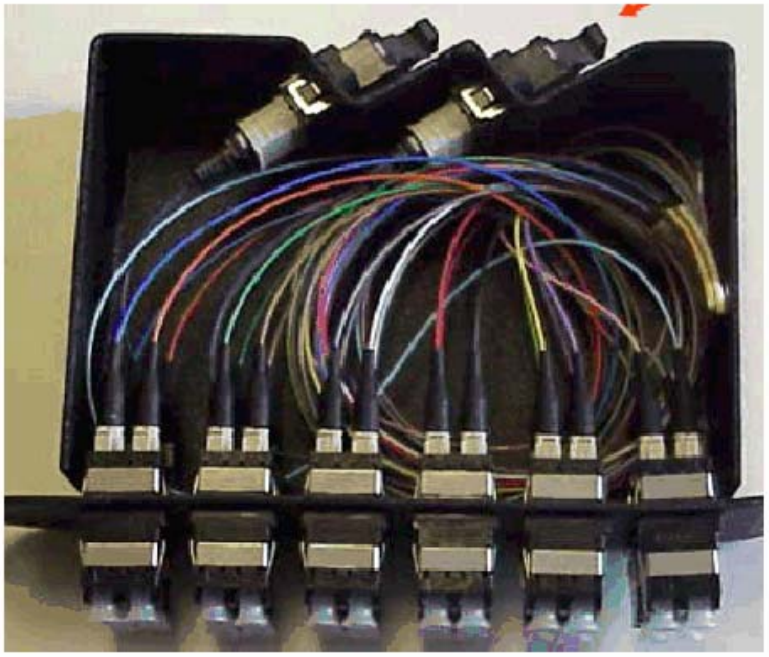
Rear View
MPO Connectors from Trunk Cables



Fiber Shufflers

- Key building block is MPO to LC fiber shufflers
- Rarely splice fiber in the data center now

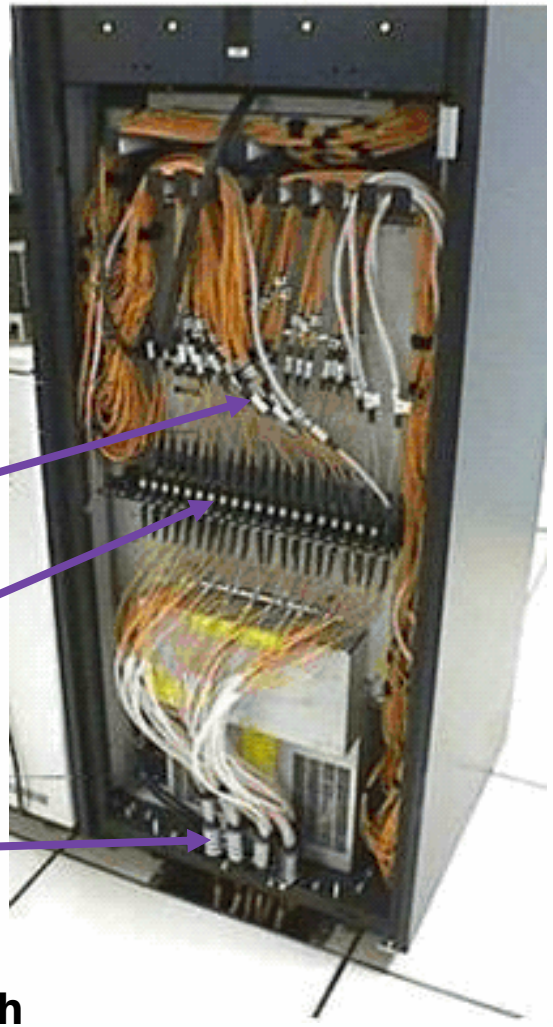
2 MPO In



12 LC Out

Fiber to the Rack

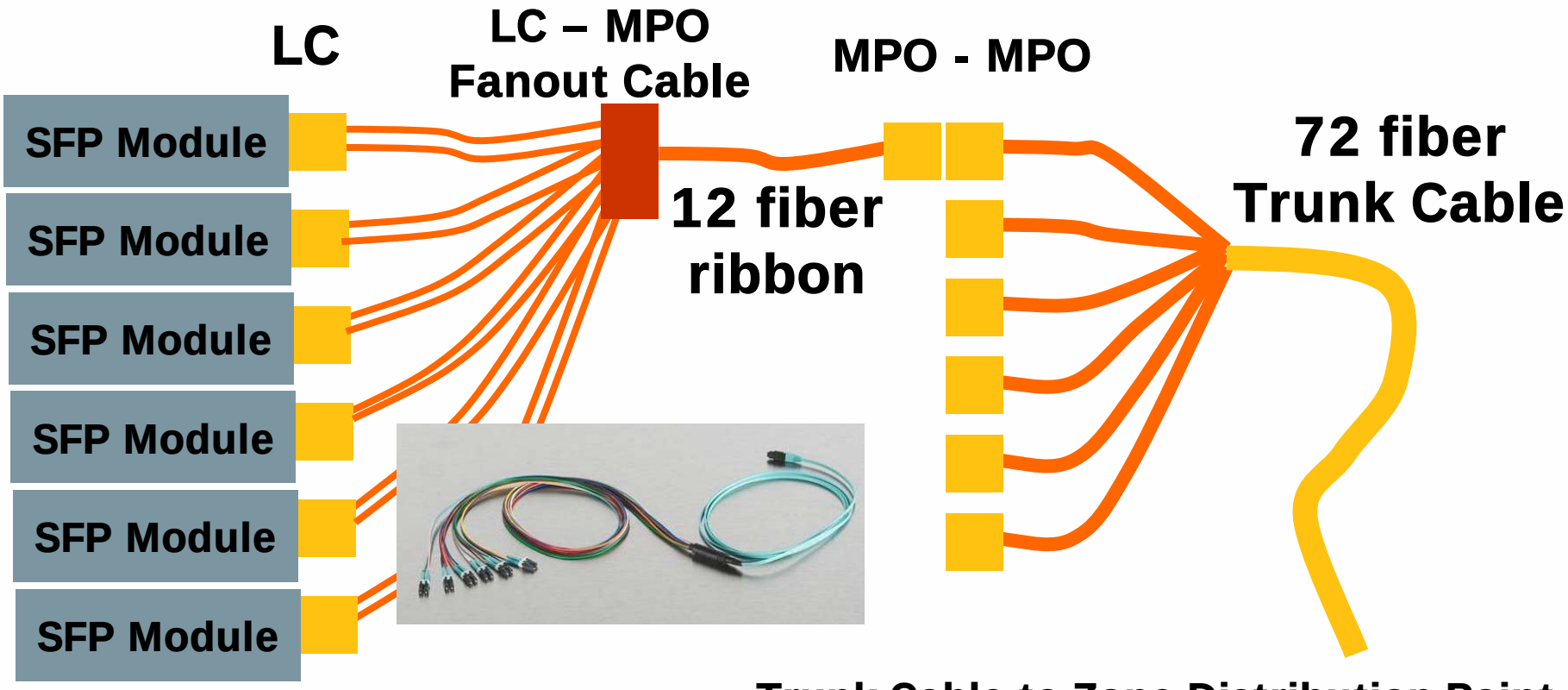
- Trunk Cables are routed directly to the rack
- 144 ports = 24 MPO ribbon cables *12fibers/cable = 288 fibers
  - **512 Port Directors will have over 1000 fibers in a rack**



Picture provided by Corning of McDATA's ESCON Switch

Distribution Points

- How the cable plant is connected - sometimes



10 Gig Transceiver Evolution

- The evolution of 10 gig transceivers has been a costly progression and transceiver companies have lost considerable money on the development of transceivers that were rarely used
  - Manufacturers are rallying around the SFP+
- If one form factor was commonly used, economy of scales could be seen
- The standardization of 100 Gig transceivers has not begun and should be considered to optimize the adoption of 100 Gig

10 Gig has followed a long path

- 10 Gig converging on SFP+

300pin
76 mm L x 56 mm W x 14mm H

XENPAK
121 mm L x 36 mm W x 11.98mm H

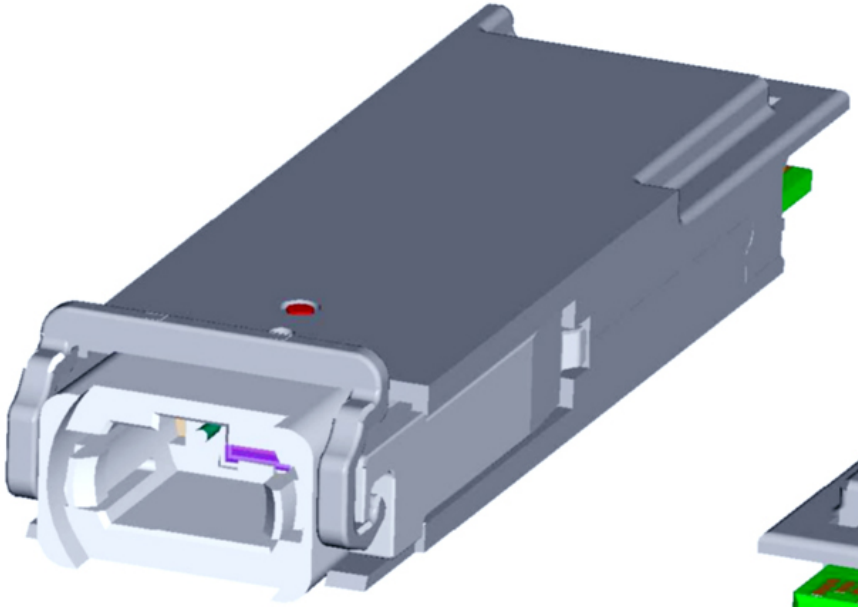
X2/XPAK
~76mm L x 36 mm W x 12/11mmH

XFP / QSFP
75mm L x 18 mm W x 9mm H

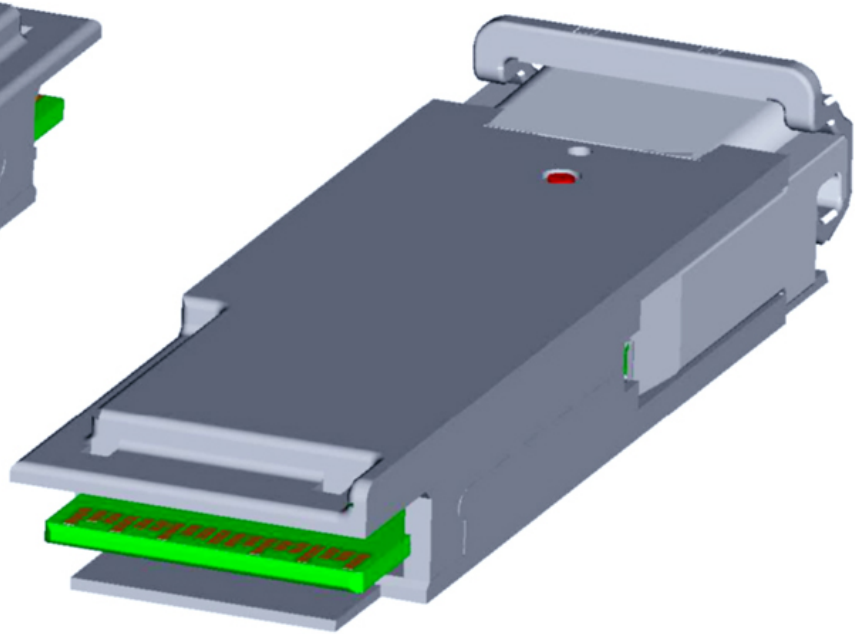
SFP+ / IPF
57mm L x 14 mm W x 9mm H

QSFP Designed for 40 Gig

- The Quad SFP Form Factor (QSFP) uses 4 channels at up to 10 gig/channel with one MPO cable to connect



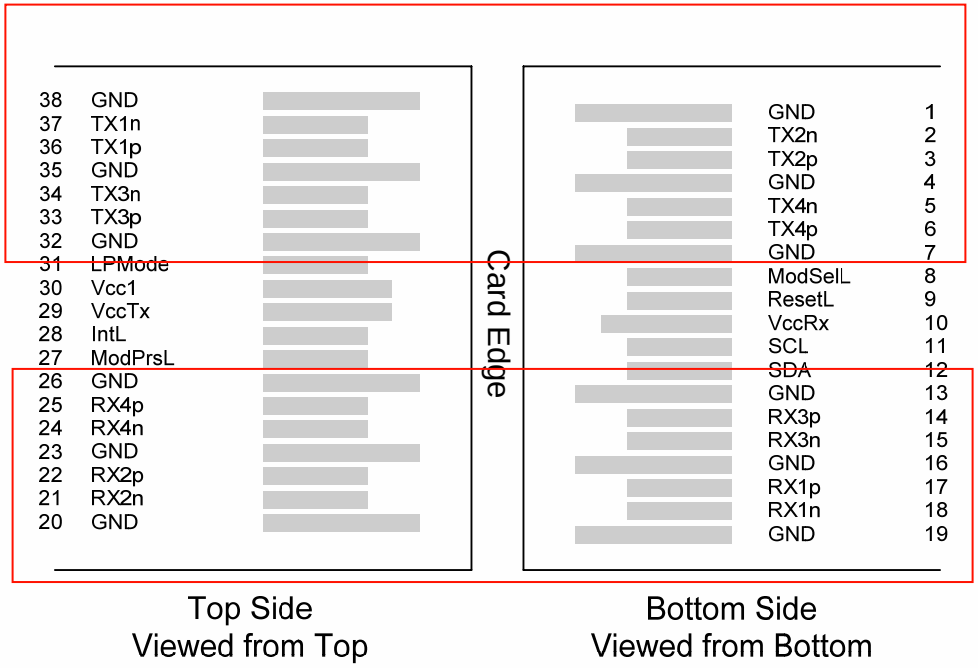
12 Optical Fibers in MPO but only 8 are used



38 electrical connections rated to 10 Gbits/sec

Electrically Limited

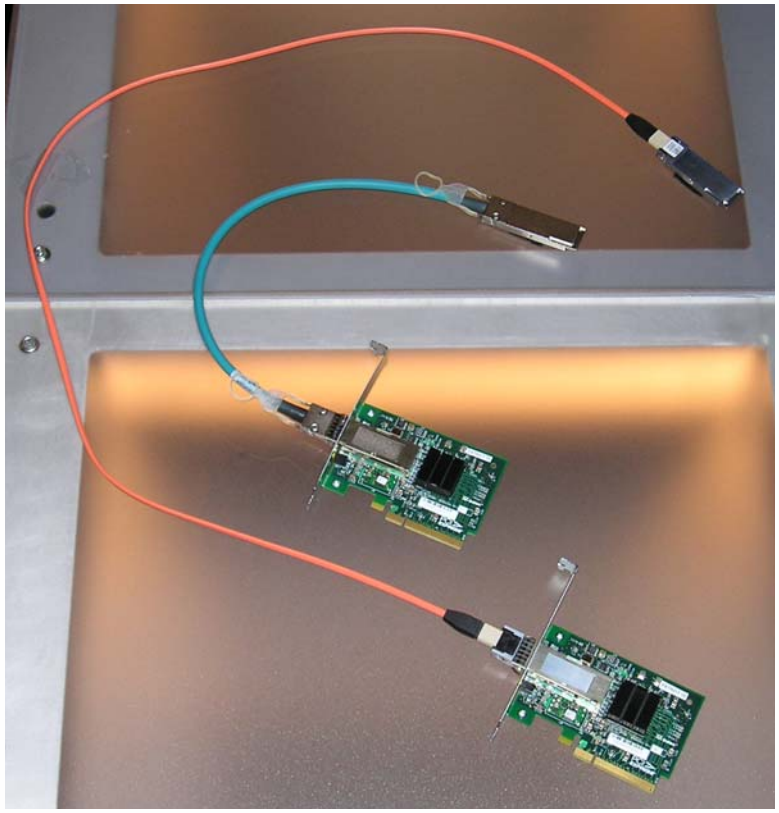
- The pluggable QSFP was limited to 38 pins in a small form factor
- 30 pins used for signaling
  - 4 transmit and 4 receive channels with differential signals meant 16 pins and 12 grounds for isolation
- A pluggable 100 Gig transceiver will be difficult to make with over 4 channels

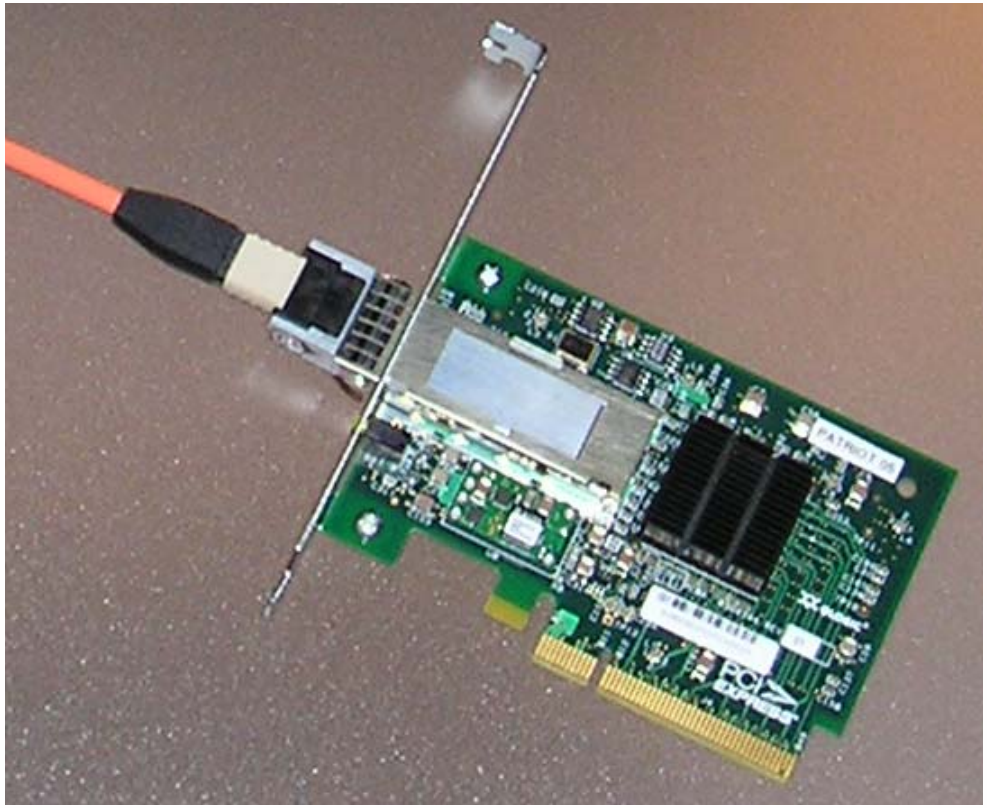


Tx_LOS, Tx_Disable, RX_LOS, RSO and RS1 implemented in software

QSFP Running at 20 Gig

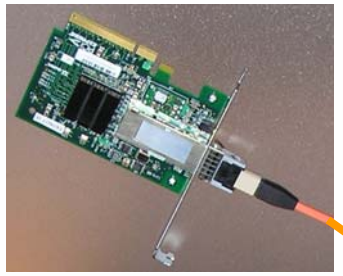
- These are photos of a 5 Gig/channel QSFP shown at the Super Computing Conference in Orlando in November

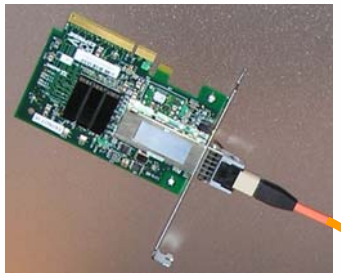


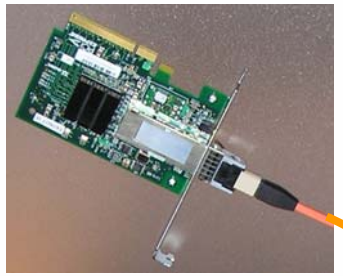


Only 8 Fibers Used in QSFP

- Using only 8 fibers require optimal cabling solutions

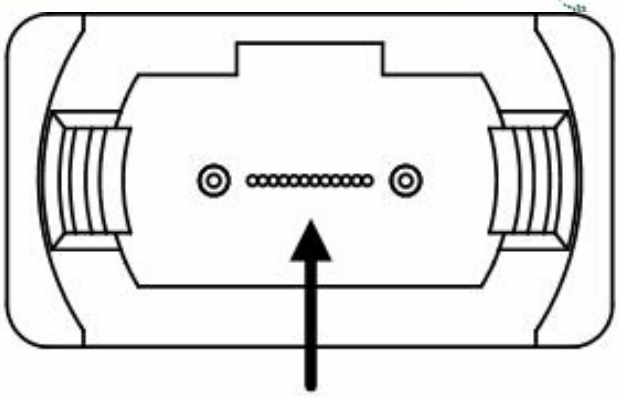


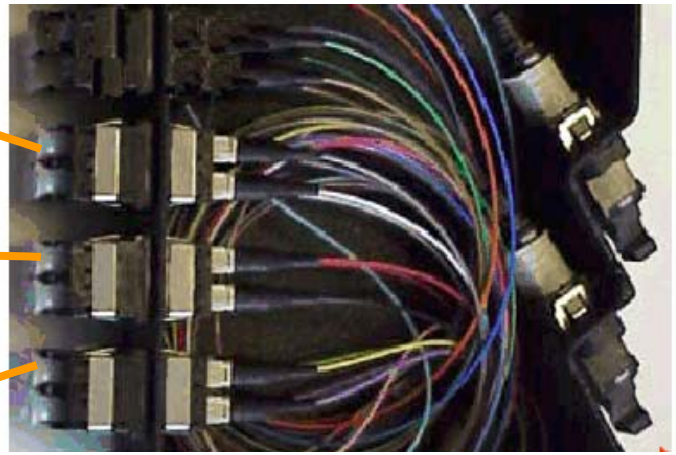




8 Fibers / MPO *3 QSFP = 24 Fibers

3 MPOs In

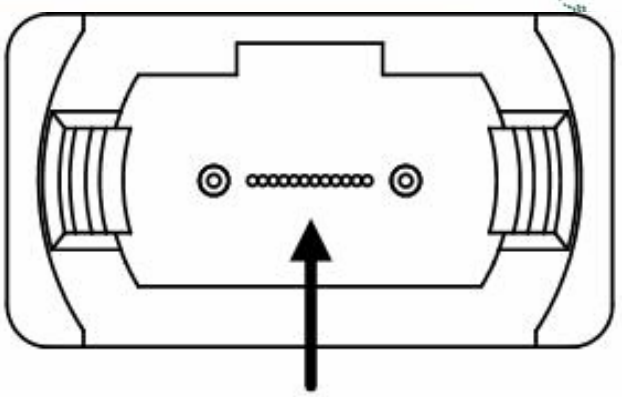




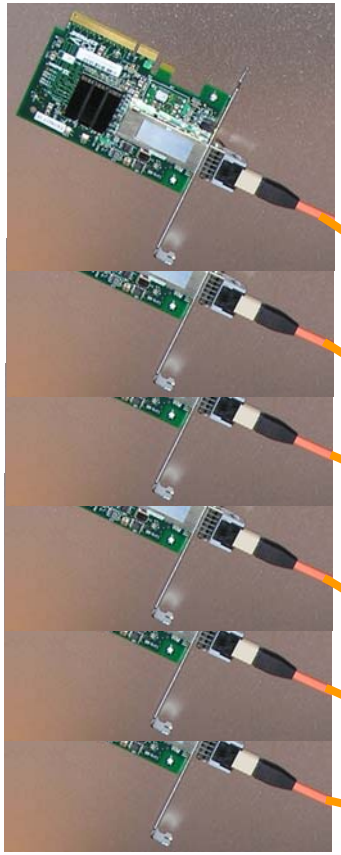
2 MPOs Out = 24 Optical Fibers in

10 Fibers / MPO Difficult to Cable

- Using only 10 fibers require non-optimal cabling solutions

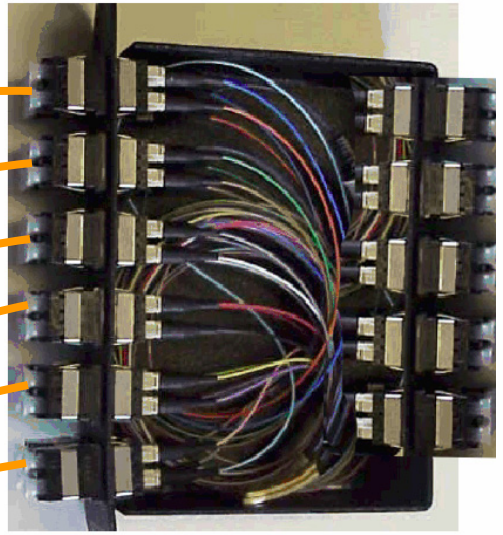


Fibre number	1 2 3 4 … 9 10 11 12	
Transmit channel	1 2 3 4 **5**	**5** 4 3 2 1 Receive Channel



6 Ribbons =10 Fibers / MPO *6 MPO = 60 Fibers

6 MPOs In



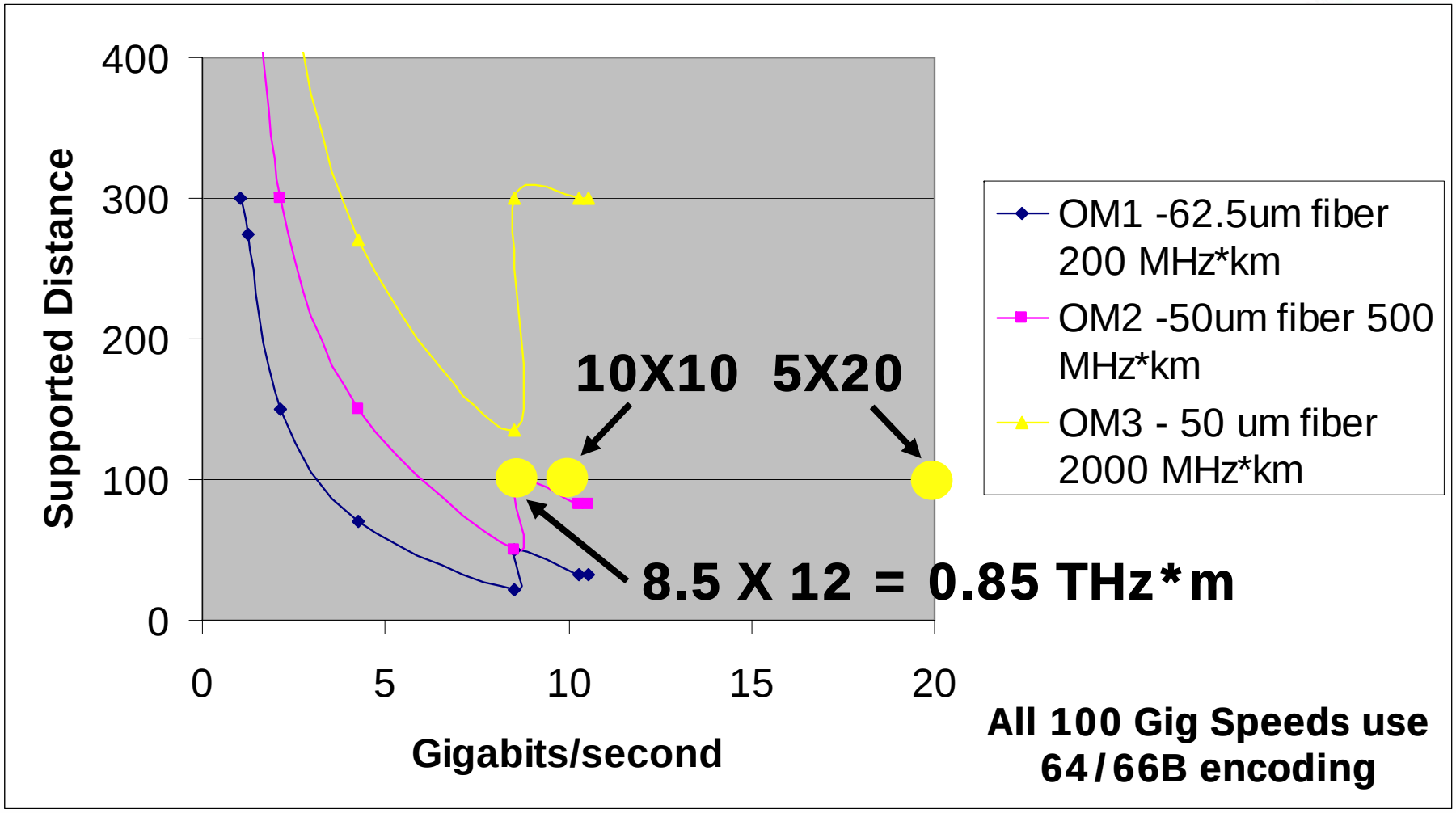
5 MPOs Out = 60 Fibers

This product is not available and would be difficult to route 60 fibers in the standard size

12 Channels / MPO is Optimal

- If all 12 fibers of the MPO were used, there would be no need for the fiber shuffler and a straight MPO-MPO connector could be used.
- With 12 fibers, the speed of each channel could be reduced to 8.5 Gbits/sec
  - The 8GFC standard running at 8.5 GFC could be used like Gigabit Ethernet did with 1GFC
- An 8X12 100 Gig solution would optimize the use of fiber optics and decrease the bandwidth-length product of each channel

Add 100 Gig Ethernet to table



Conclusion

- 12 fiber ribbons with MPO ribbons are used extensively in data centers, so 12 channels/transceiver should be used to reduce the need for optical shufflers
  - The cost of the optical shuffler is passed on to the end user adding to the total cost to the solution
  - Having 10 or 12 channels will cause the electrical connector of the transceiver to be considerably more complex
- By using all 12 fibers, the speed of each channel could be reduced to 8.5 Gbps
  - This could lead to a lower cost solution and the use of the 8GFC standard