

400GE at the Cost of 4 x 100GE

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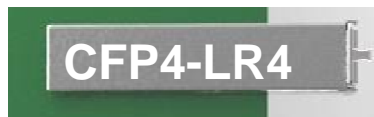
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400GE over SMF by using the 100GBASE-LR4 PMD

100G Ethernet up to 10 km

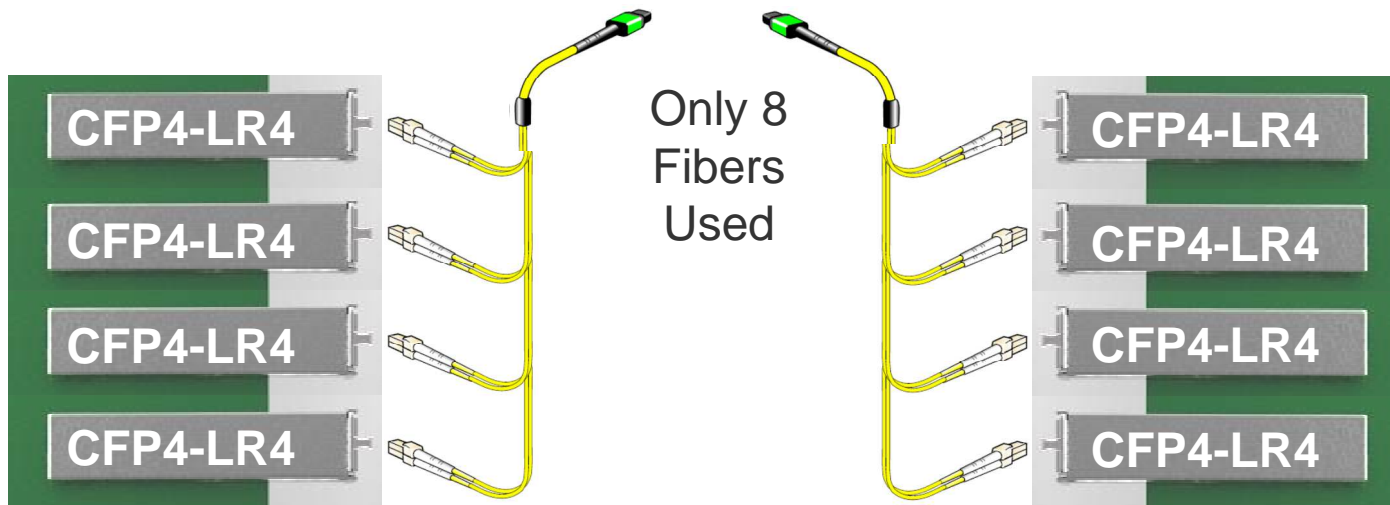


Duplex Single-Mode
Fiber Infrastructure



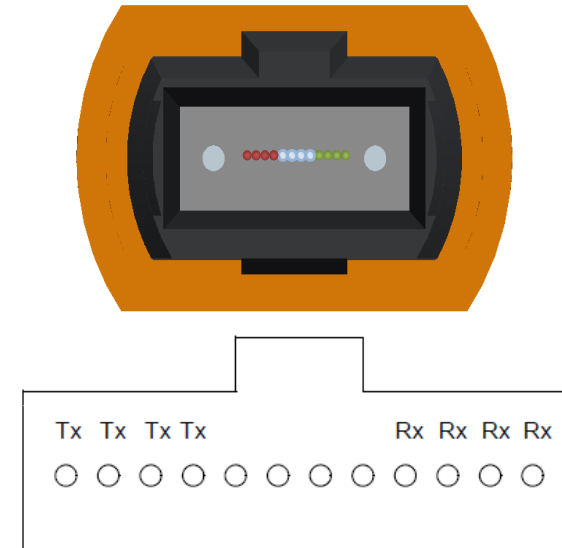
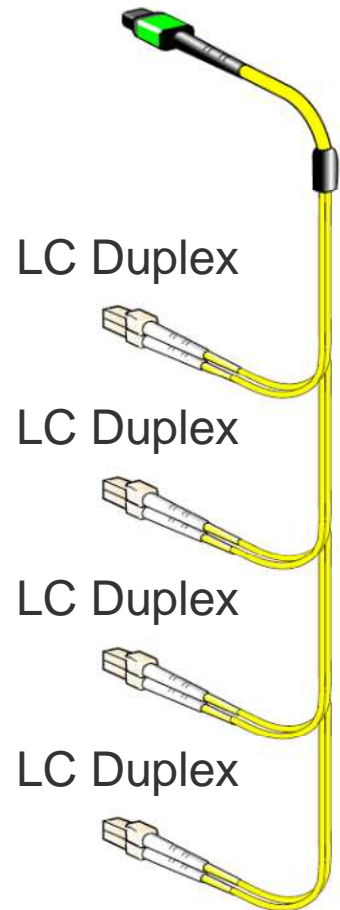
400G Ethernet up to 10 km

Parallel Single-Mode Fiber Infrastructure
(Actual distance limited by market adoption)



SMF Breakout Cables—Enabling 400G Adoption

1 x 12 (8 Used) MPO



Parallel Single Mode, 4 Lanes (PSM4)
4 x 100GBASE-LR4
4, Tx Fibers and 4, Rx Fibers
1x12 MPO Connector

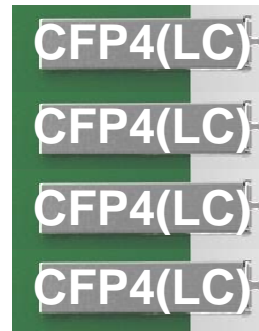
MSA Activity

CFP MSA

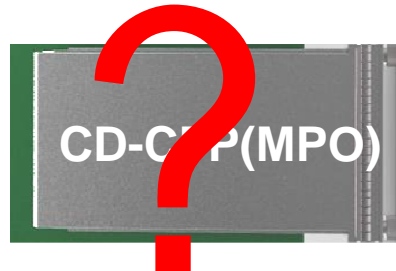
- CD-CFP: Current CFP would need a new connector supporting 16 x 25G
- CD-CFP2: Current CFP2 is ready for 8 x 50G
- CD-CFP4: CFP4 will be ready for 4 x 100G (at a maximum of 50GBaud)

High Density 100GE or Early Adopter 400GE Common Module on SMF

4 x CAUI-4
(16 x 25G NRZ)



CDAUI-16
(16 x 25G NRZ)



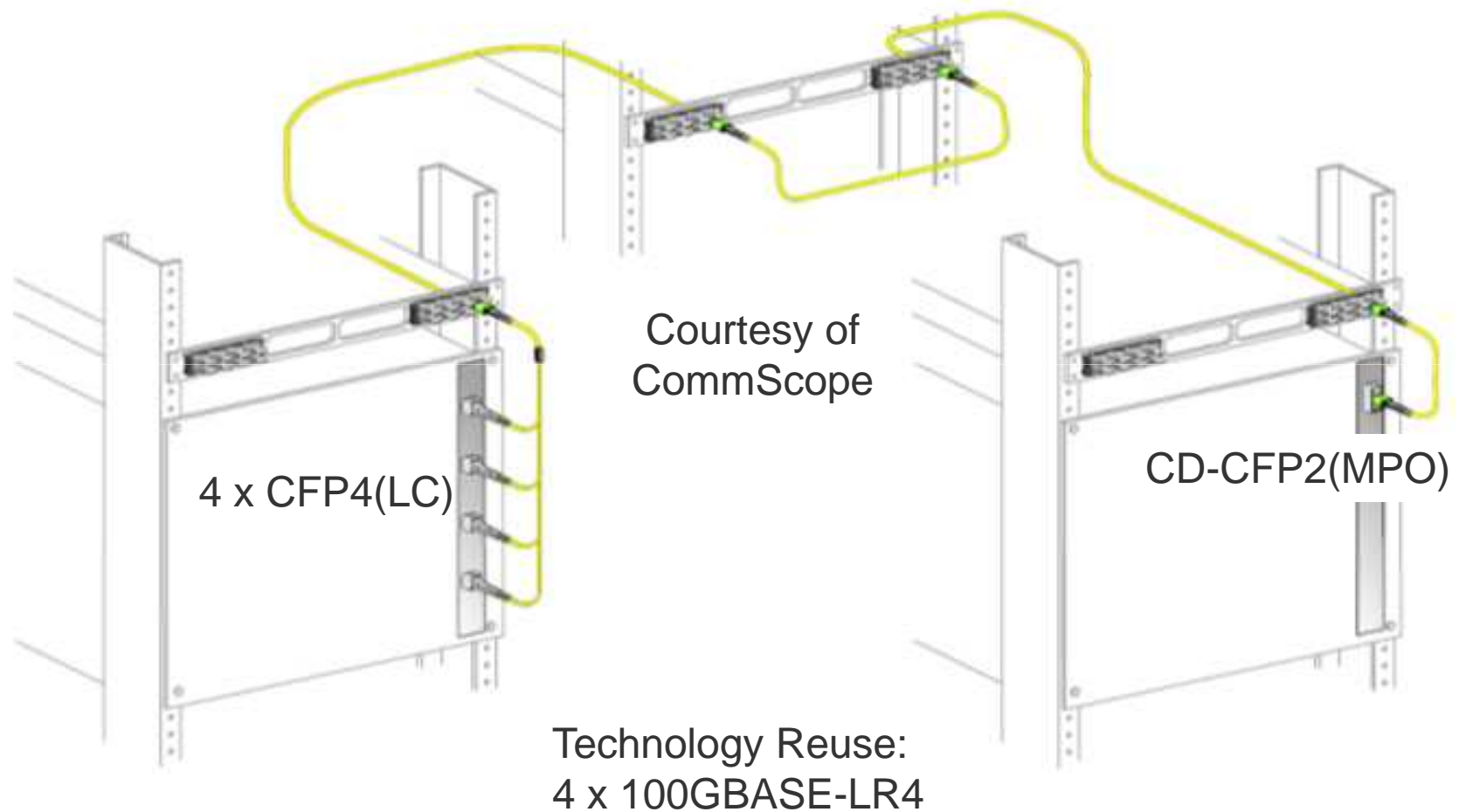
No density increase over the
use of four CFP4 modules.

OIF CEI-56G-VSR
(8 x 50G NRZ)



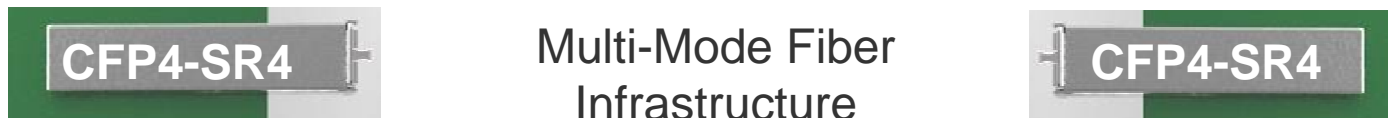
High-density 100GE or
400GE common module.

Early Adopter 400GE using SMF Structured Cabling



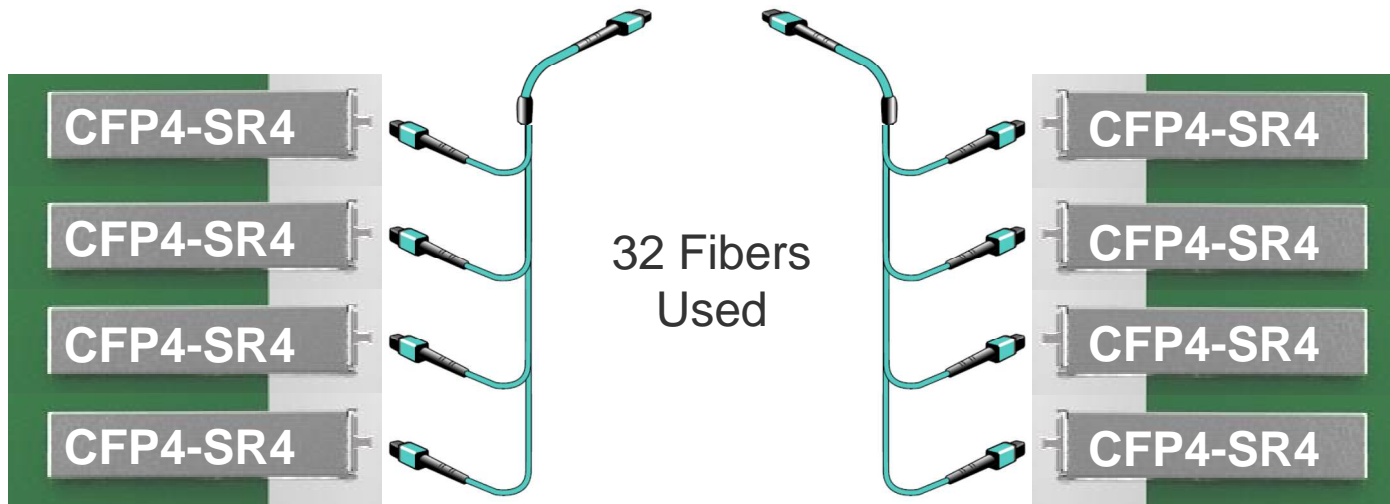
400GE over MMF by using the 100GBASE-SR4 PMD

100G Ethernet up to 100 m on OM4

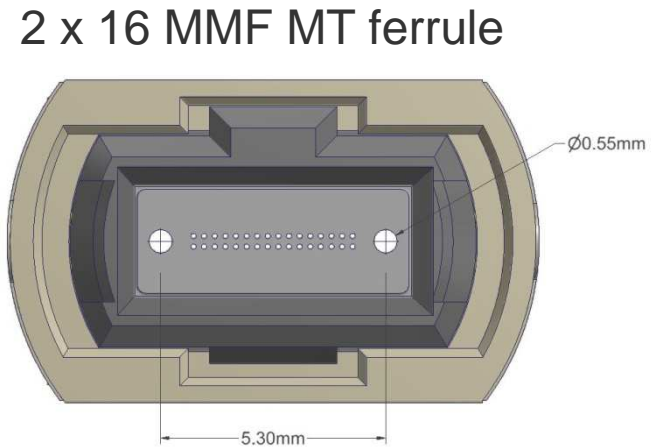
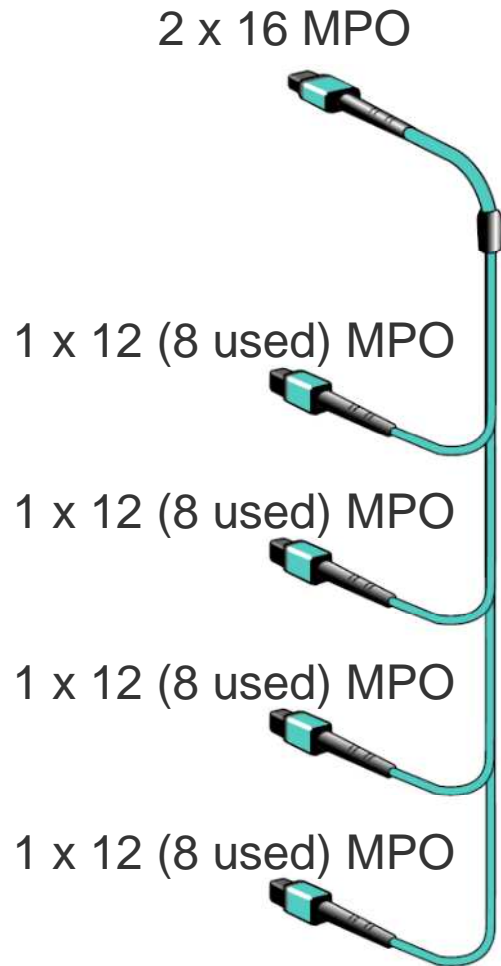


400G Ethernet up to 100 m on OM4

Parallel Multi-Mode Fiber Infrastructure



MMF Breakout Cables—Enabling 400G Adoption



Courtesy of
USConec

Parallel Multi-Mode
4 x 100GBASE-SR4
16, TX Fibers and 16, Rx Fibers
2x16 MPO

MSA Activity

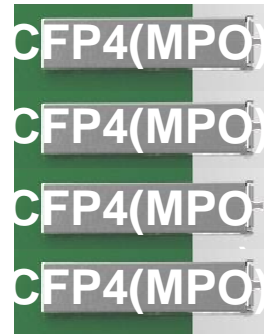
New CDFP MSA

- High-density form factor supporting 16 x 25G
- Likely supporting only copper cabling, AOC, and VCSEL optics
- From slide 26 of http://www.ieee802.org/3/cfi/0313_1/CFI_01_0313.pdf

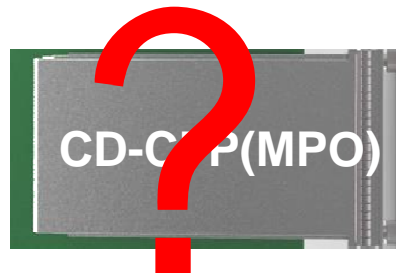


High Density 100GE or Early Adopter 400GE Common Module on MMF

4 x CAUI-4
(16 x 25G NRZ)



CDAUI-16
(16 x 25G NRZ)



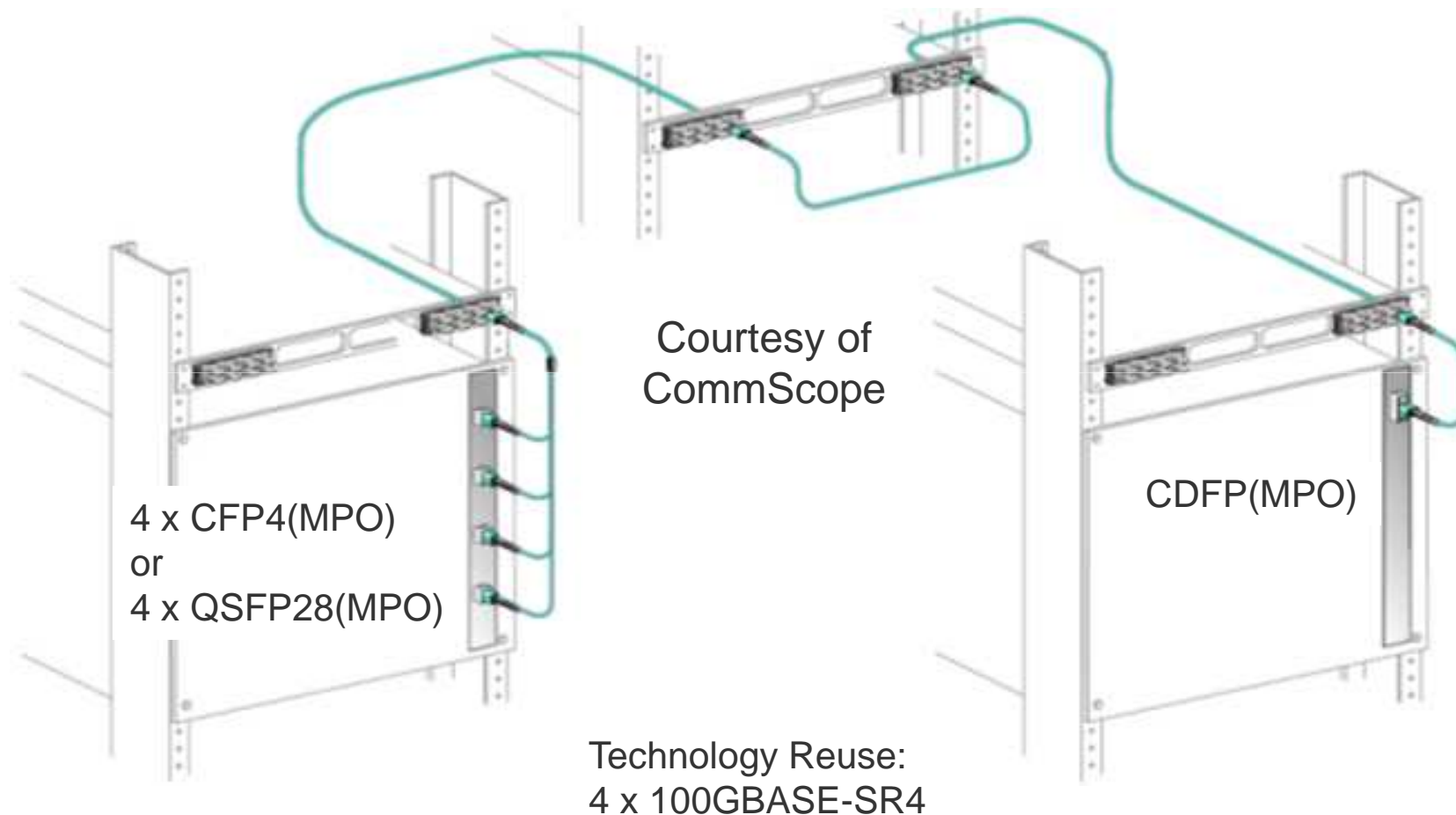
No density increase over the
use of four CFP4 modules.

CDAUI-16
(16 x 25G NRZ)



High-density 100GE or
400GE common module.

Early Adopter 400G using MMF Structured Cabling



Devise New PMDs based on Existing PMDs

400GE over SMF

- Reference Clause 88 of IEEE Std 802.3™-2012 for optical specifications of 100GBASE-LR4

400GE over MMF

- Reference Clause written in 802.3bm for optical specifications of 100GBASE-SR4

No New Electrical Interface Specifications to Devise

400GE over SMF

- Industry adoption of 8 lanes of OIF CEI-56G-VSR for use with CD-CFP2 form factor or similar

400GE over MMF

- Define CDAUI-16 as 4 x CAUI-4 for use with CDFP form factor or similar
- Reference Clause written for chip-to-module CAUI-4 in 802.3bm

Requirements for 400GE PCS

Support reuse of 100GBASE-R PMDs

Need option to use 802.3bj KR4 FEC or better

- No FEC used with 100GBASE-LR4 PMD
- FEC used with 100GBASE-SR4 PMD

Support 16-lane, 8-lane, and 4-lane interfaces

100GE Can Build 400GE at the Cost of 4 x 100GE

Technology Reuse:
4 x 100GBASE-LR4

Courtesy of
CommScope

Technology Reuse:
4 x 100GBASE-SR4

Potential Objectives for 400 Gb/s Ethernet Task Force

Define 400 Gb/s PHY for operation up to at least 500-meters of SMF

Define 400 Gb/s PHY for operation up to at least 100-meters of MMF

Summary on 400GE

Leverage of mature PMD from previous Ethernet rate

Early adopter 400GE by reusing 100G module and parallel cabling, SMF or MMF

Possible common module for 400GE and high-density (4-port) 100GE

- Implementation persists as high-density support of previous speed of Ethernet (e.g., 4 x 100GE) for industry investment protection

Establishes that initial adoption of 400GE can be at the cost of 4 x 100GE

- Market volume driven by the combination of 400GE and 100GE applications