Channel Cost Analysis
Duplex vs. Parallel Optics

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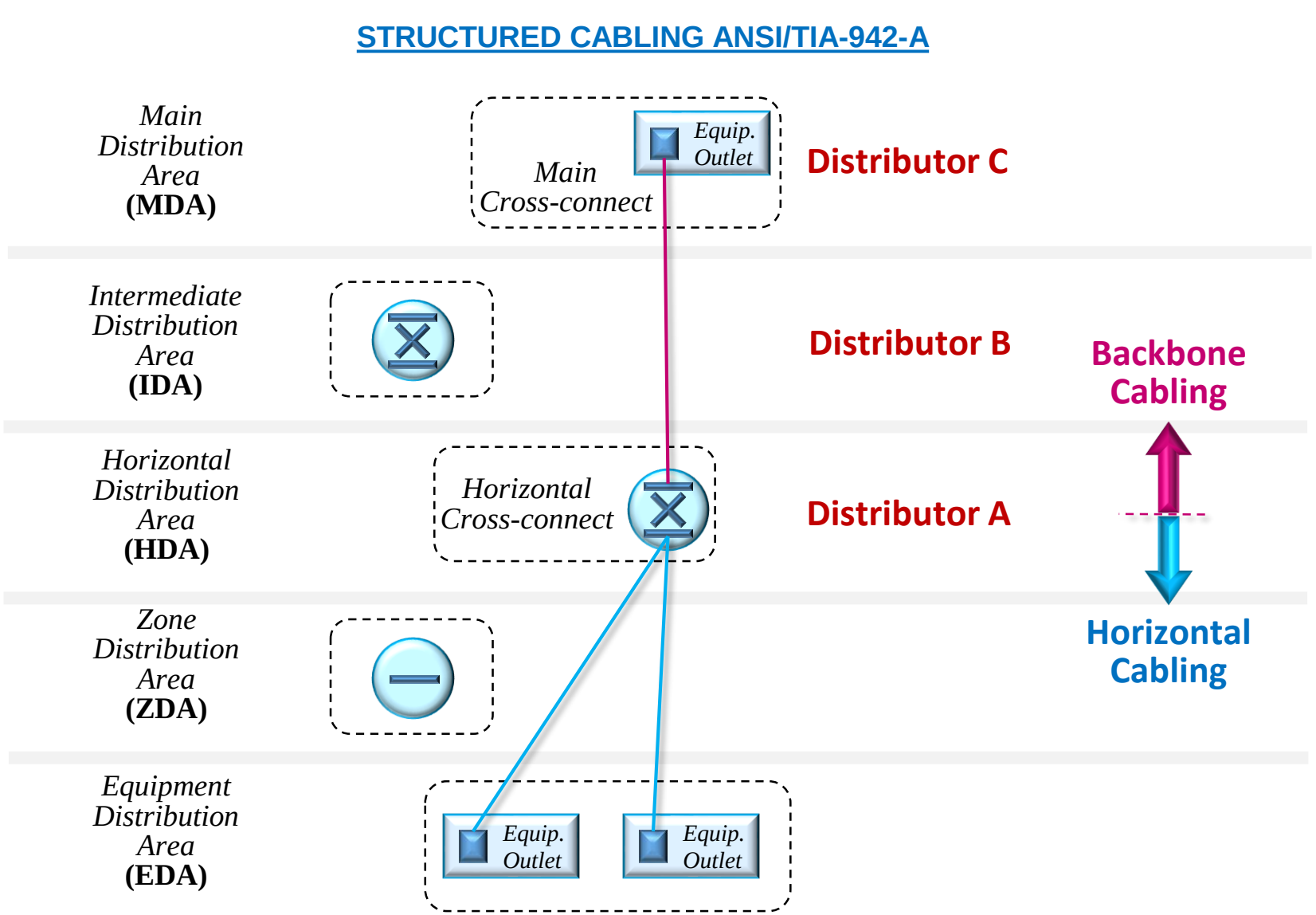
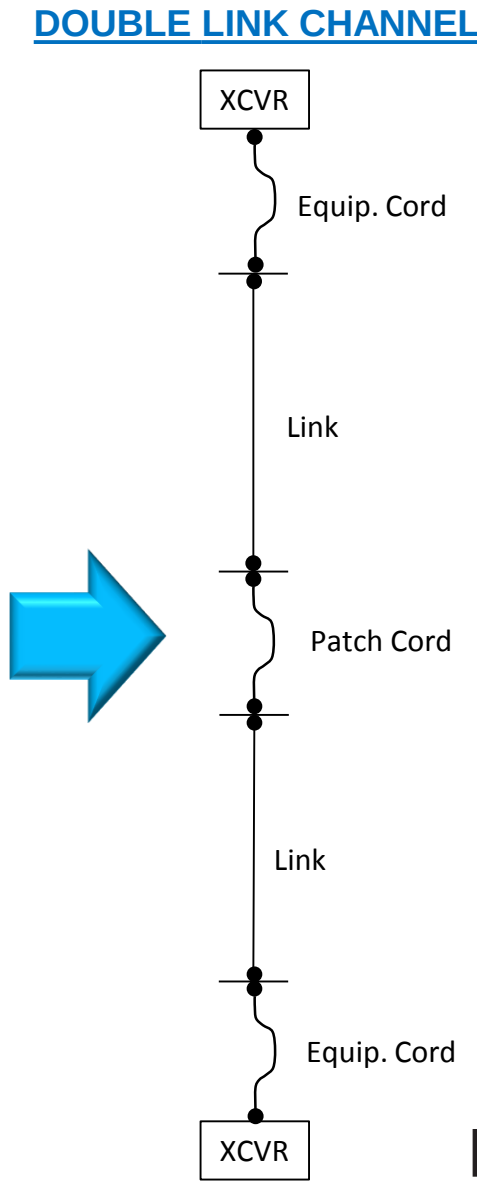
Next-gen 200 & 400 Gb/s PHYs over Fewer MMF Pairs
Geneva, January 2018

Double Link Channels





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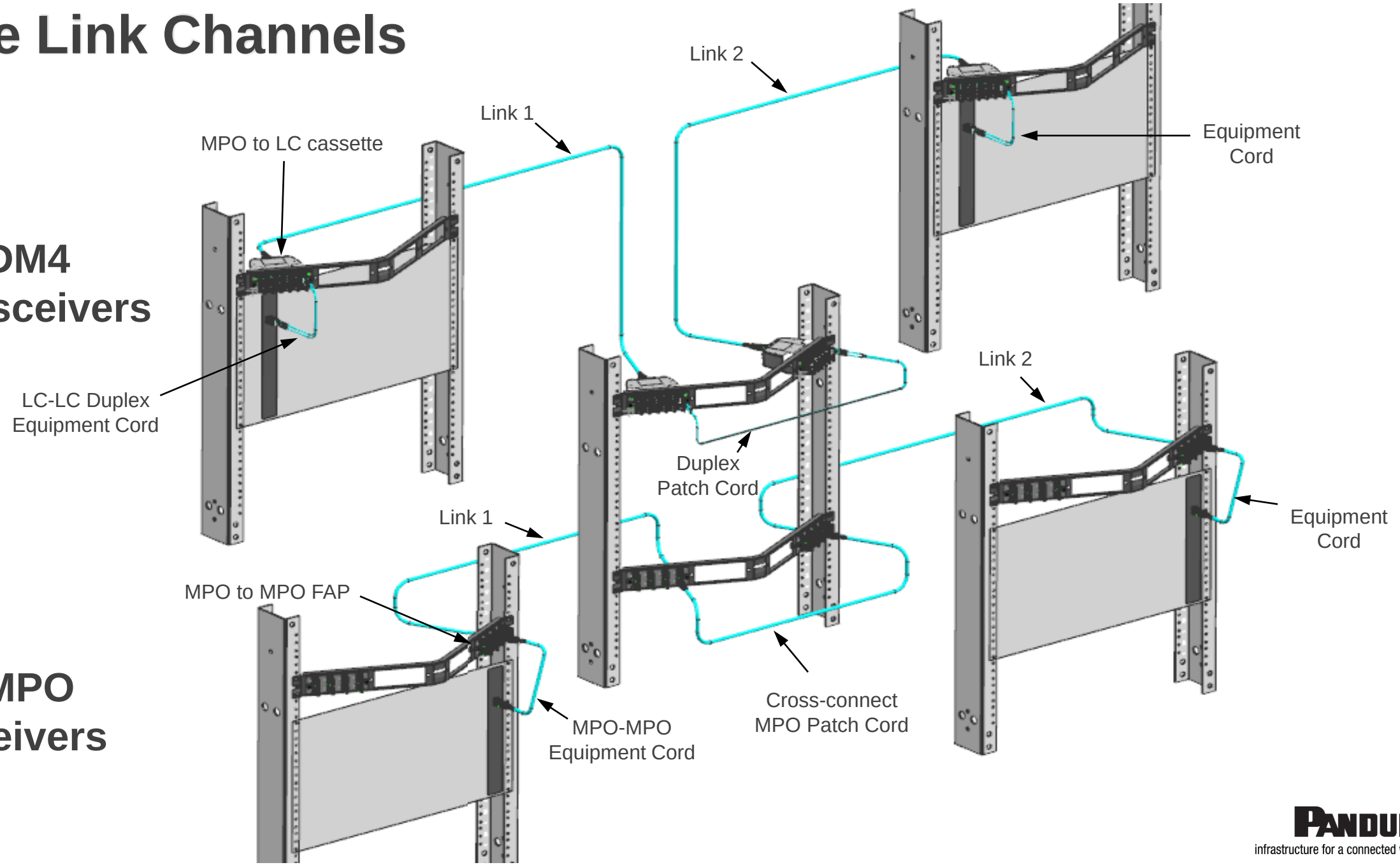
Double Link Channels

SWDM4 LC Transceivers

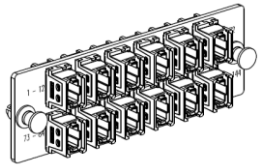
SR4 MPO Transceivers



Relative Costs of Structured Cabling Components

– Relative Costs = material and labor

PARALLEL OPTICS



MPO Fiber Adapter Panel

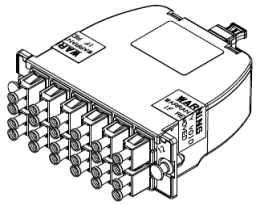
Relative Cost
0.51 W

MPO to MPO Patch Cord

Relative Cost
1.0 X

Pre-term Cabling	OM4
Termination	0.65 Y
Per meter adder	0.81 Z

DUPLEX FIBERS



MPO to LC Cassette

Relative Cost
1.0 W

LC to LC Duplex Patch Cord

Relative Cost
0.25 X

Pre-term Cabling	OM5
Termination	1.0 Y
Per meter adder	1.0 Z

Optical Channel Relative Component Costs

– *Double Link Channel*

Fixed components

- Cable termination =

  2 · (Number of links) · (Relative cost) · (Number of fibers used ÷ Total no. of fibers in cable)

- Patch cords =

  (Number of patch cords) · (Relative cost)

- Cassettes/FAPs =

  (Number of links) · 2 · (Relative cost) · (Number of ports used ÷ Total no. of ports)

Variable channel cost

- Cable cost =

  (Length in m) · (Relative cable cost per m) · (Number of fibers used ÷ Total no. of fibers in cable)

Relative Cost of 200Gb/s Transceivers

– *Based on estimated cost of 10GBASE-SR SFP+ transceiver = M*

10GBASE-SR data was estimated by reviewing publicly available cost information for components of compliant implementations. Readers of this slide should make their own cost estimates.

PARALLEL OPTICS

200GBASE-SR4 relative cost multiplier = n

- Relative cost of 200GBASE-SR4 = $n \cdot M$

DUPLEX FIBERS

200G SWDM relative cost multiplier = δ

- Relative cost of 200G SWDM = $(n \cdot M) \cdot \delta$
- Assumed $1.5 < \delta < 2.0$

12-Fiber Double Link Channel Cost Comparison

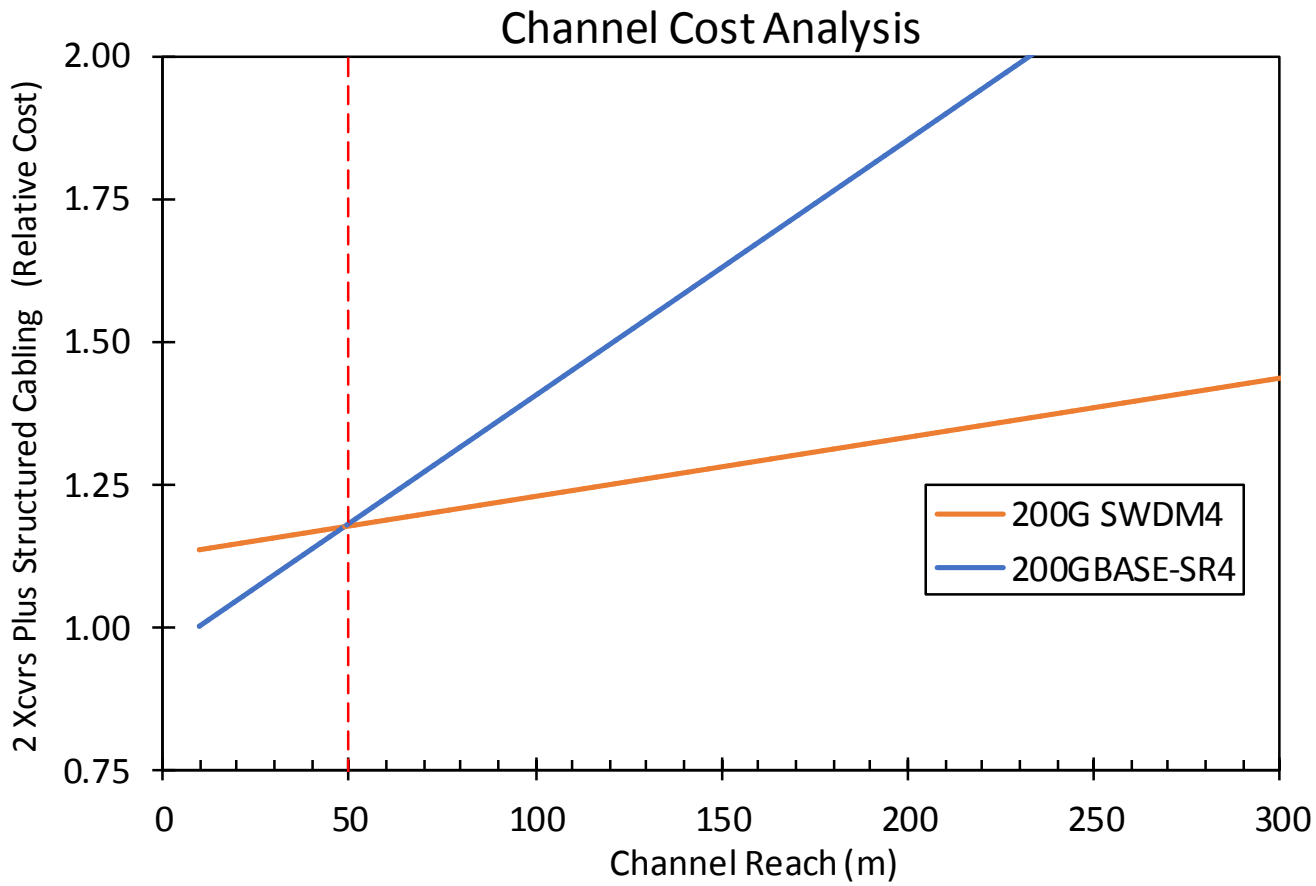
- 4 unused dark fibers

XCVR TYPES:	200GBASE-SR4	200G SWDM4
	n	δ
Cost multipliers =	4.0	1.75

STRUCTURED CABLING:	Parallel Cabling	Duplex Cabling
Fiber Type =	OM4	OM5
Cable fiber count =	12	12
No. of used fibers =	12	2
No. of channel links =	2	2
No. of patch cords =	3	3

	Normalized Standard Costs *Material + Labor*	
Cable Termination =	0.65 Y	1.0 Y
Per meter adder =	0.81 Z	1.0 Z
Adapter panel or Cassette =	0.51 W	1.0 W
Patch Cord =	1.0 X	0.25 X

Cost crossover = 50 m



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Panduit Fiber Solutions

Dark Fiber Migration Cassettes

- Run (3) 8-fiber SR4 links over 2 existing 12F cables
- Ensure 100% utilization of existing 12F cable plant
- Opticom and HD Flex form factors

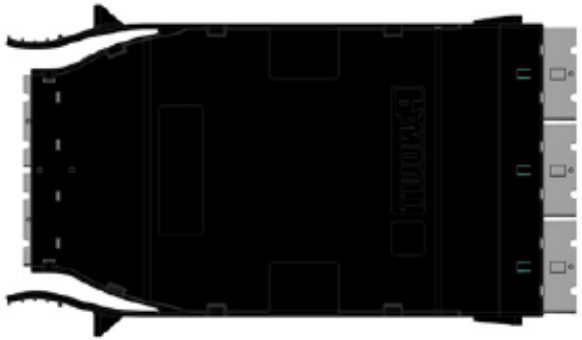
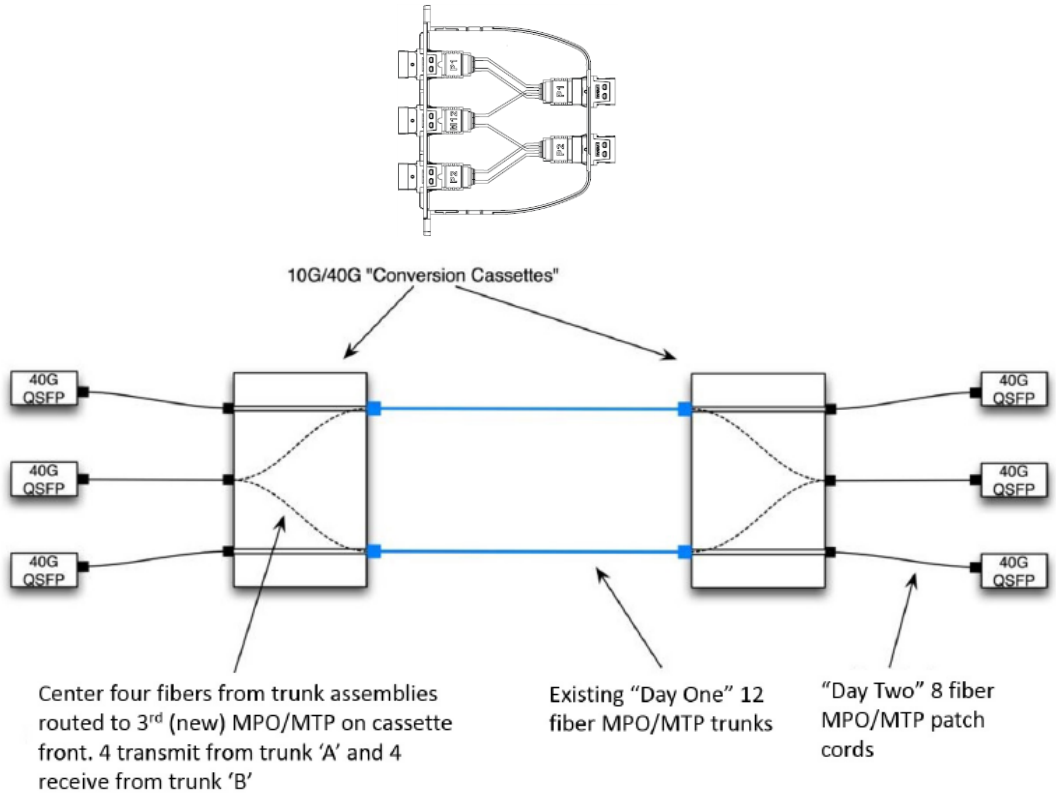


Figure 3a: Front and Rear Panels (4x6)

Figure 3: Front and Rear Panels (2x3)



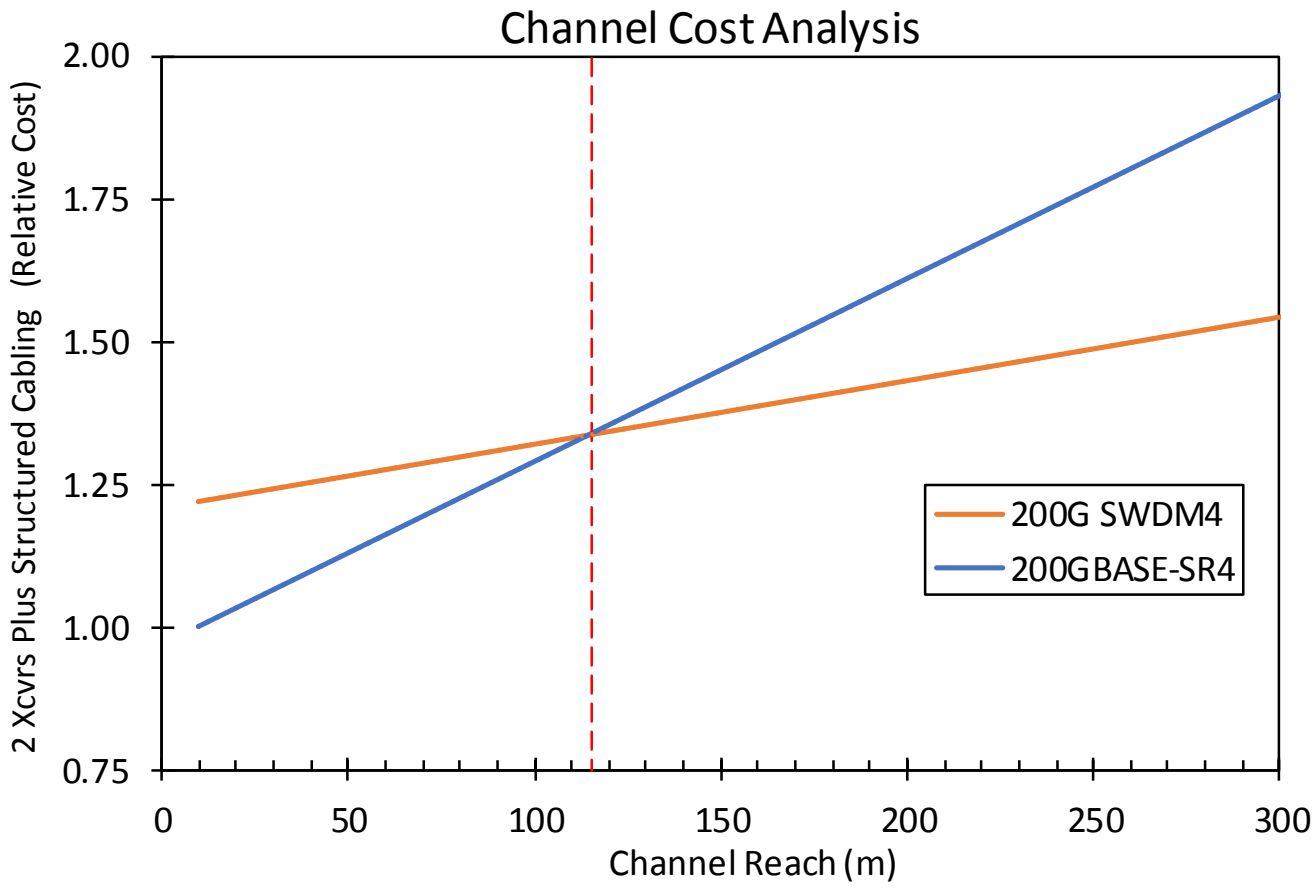
8-Fiber Double Link Channel Cost Comparison

XCVR TYPES:	200GBASE-SR4	200G SWDM4
	n	δ
Cost multipliers =	**4.0**	**1.75**

STRUCTURED CABLING:	Parallel Cabling	Duplex Cabling
Fiber Type =	OM4	OM5
Cable fiber count =	12	12
No. of used fibers =	8	2
No. of channel links =	2	2
No. of patch cords =	3	3

	Normalized Standard Costs *Material + Labor*	
Cable Termination =	0.65 Y	1.0 Y
Per meter adder =	0.81 Z	1.0 Z
Adapter panel or Cassette =	0.68 W	1.0 W
Patch Cord =	1.0 X	0.25 X

Cost crossover = 115 m



Note: Crossover reduces to 95 m for SWDM4 over OM4

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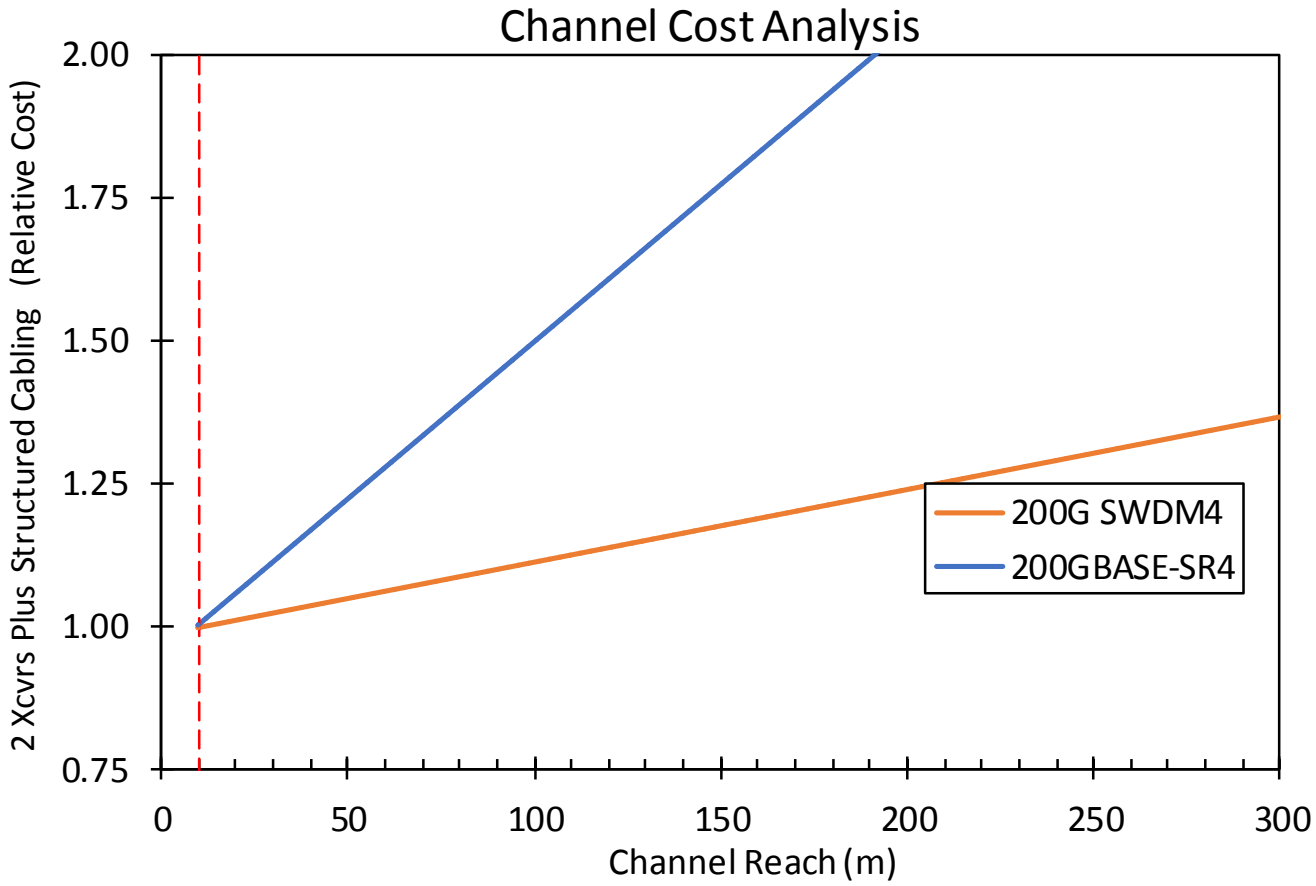
Relative Cost Benefit for 200G SWMD4 Double Link
- 4 unused dark fibers

XCVR TYPES:	200GBASE-SR4	200G SWDM4
	n	δ
Cost multipliers =	2.7	1.75

STRUCTURED CABLING:	Parallel Cabling	Duplex Cabling
Fiber Type =	OM4	OM5
Cable fiber count =	12	12
No. of used fibers =	12	2
No. of channel links =	2	2
No. of patch cords =	3	3

	Normalized Standard Costs *Material + Labor*	
Cable Termination =	0.65 Y	1.0 Y
Per meter adder =	0.81 Z	1.0 Z
Adapter panel or Cassette =	0.51 W	1.0 W
Patch Cord =	1.0 X	0.25 X

Cost crossover = 10 m



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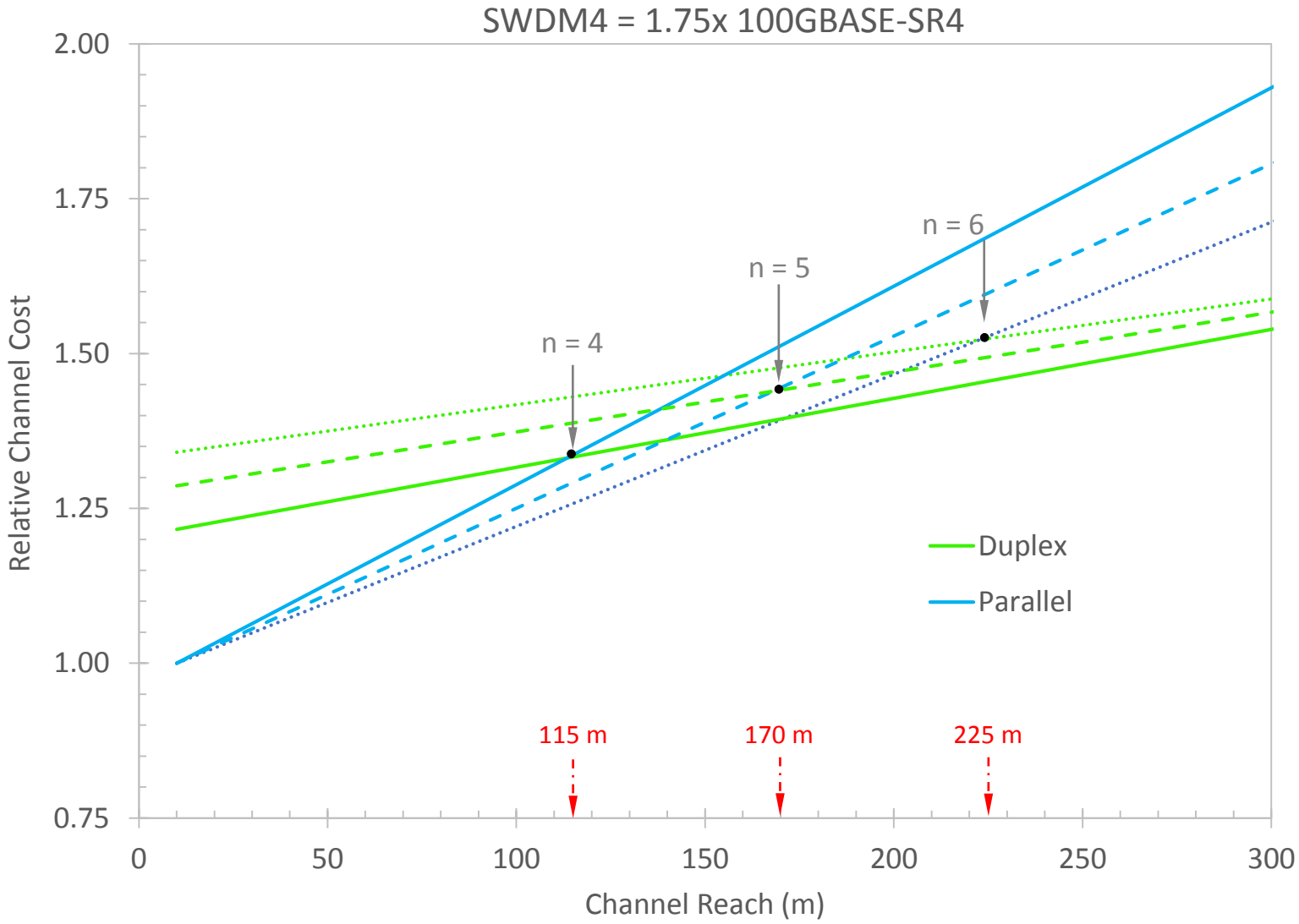
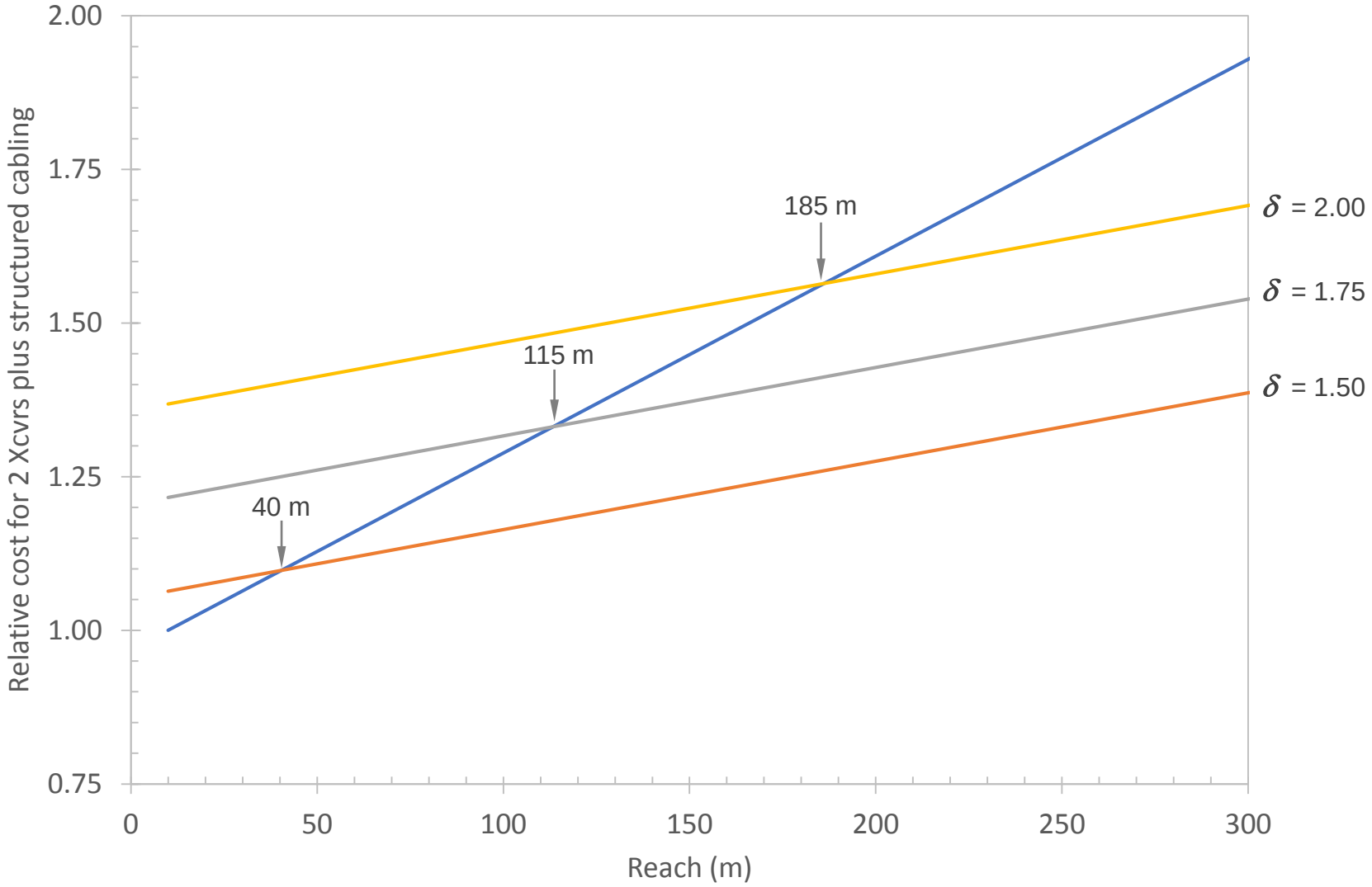
Relative Cost for 8-fiber Channel, *n* = 4, 5, & 6

Varying 200GBASE-SR4 cost multipliers for a double link channel



Relative Channel Cost for δ = 1.5, 1.75, & 2

*Varying 200G SWDM cost multipliers for a double link channel, **n** = 4*



Conclusions

- The cost of a MMF channel is dominated by the cost of the transceivers
  - Exactly analogous to the cost of single-mode vs. multimode channels
    - Single-mode fiber is lower cost than multimode fiber, and only utilizes a single duplex fiber pair
  - A 200GBASE-SR1.4 Xcvr will likely cost more than a 200GBASE-SR4 Xcvr
    - 200GBASE-SR4 (802.3cd) will likely be shipped in volume by the time 200GBASE-SR1.4 is standardized
    - 200GBASE-SR1.4 will not likely meet the CSD requirement for broad market potential (cost rules!)
- A 4-λ solution requires significantly higher VCSEL output power than SR4 for same reach
- Parallel optics provides an upgrade path from 10GBASE-SR duplex to:
  - 40 Gb/s over 4 fiber pairs
  - 25 Gbps duplex to 100 Gbps over 4 fiber pairs
  - 50 Gbps duplex to 200 Gbps over 4 fiber pairs
  - 100 Gbps duplex to 400Gbps over 4 fibers pairs
  - *Future 200 Gbps duplex to 800 Gbps over 4 fiber pairs*
- Parallel optics is widely deployed and utilizes standardized structure cabling
  - A 4-wavelength 200 Gbps solution does not support breakout
  - 200 Gbps requiring 4 wavelengths should move to a MSA