Broad Market Potential and Economic Feasibility of PSM4

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CommScope
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IEEE P802.3bm “Next Gen 40G and 100G Optical Ethernet”

Purpose and Approach

- Purpose
  - To demonstrate
    - Broad Market Potential of 100GBASE-PSM4 proposals
    - Economic Feasibility of 100GBASE-PSM4 proposals

- Approach
  - Use input from
    - Customers that employ MPO-terminated single-mode cabling → for B.M.P.
    - Several distributors & manufacturer quote of transceiver costs → for E.F.
    - Previous contributions to Next Gen SG and P802.3bm
  - Compare total channel costs (cabling + two PMDs)
    - Over channel length
    - Over time

Broad Market Potential

Survey of CommScope Customers

- A four-question survey was distributed
  - Via our sales personnel
  - Targeting customers with installed base of MPO-terminated cabling
- Questions designed to gauge customers'
  - Awareness of their cabling infrastructure and its capabilities
  - Willingness to deploy parallel single-mode solutions if at lower cost than 2-fiber solutions
  - Quantities of 12-fiber cabling subunits

Survey Questions

Q1) Are you aware that you have single-mode cabling terminated with MPO array connectors in your cabling plant?

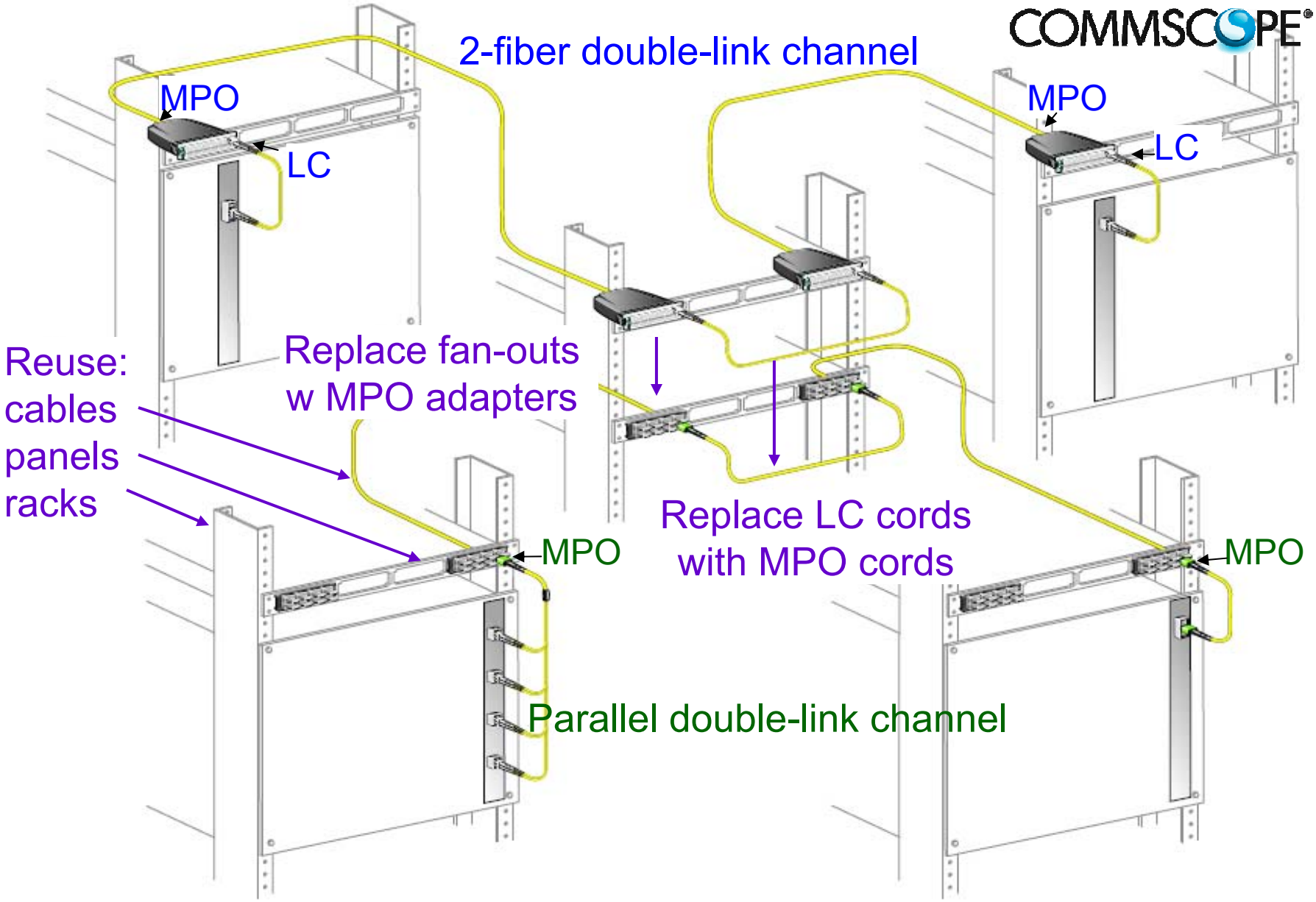
Q2) Are you aware that such cabling can be converted to support parallel optic applications by replacing the fan-outs with MPO adapters?

(See next slide for illustration of conversion.)

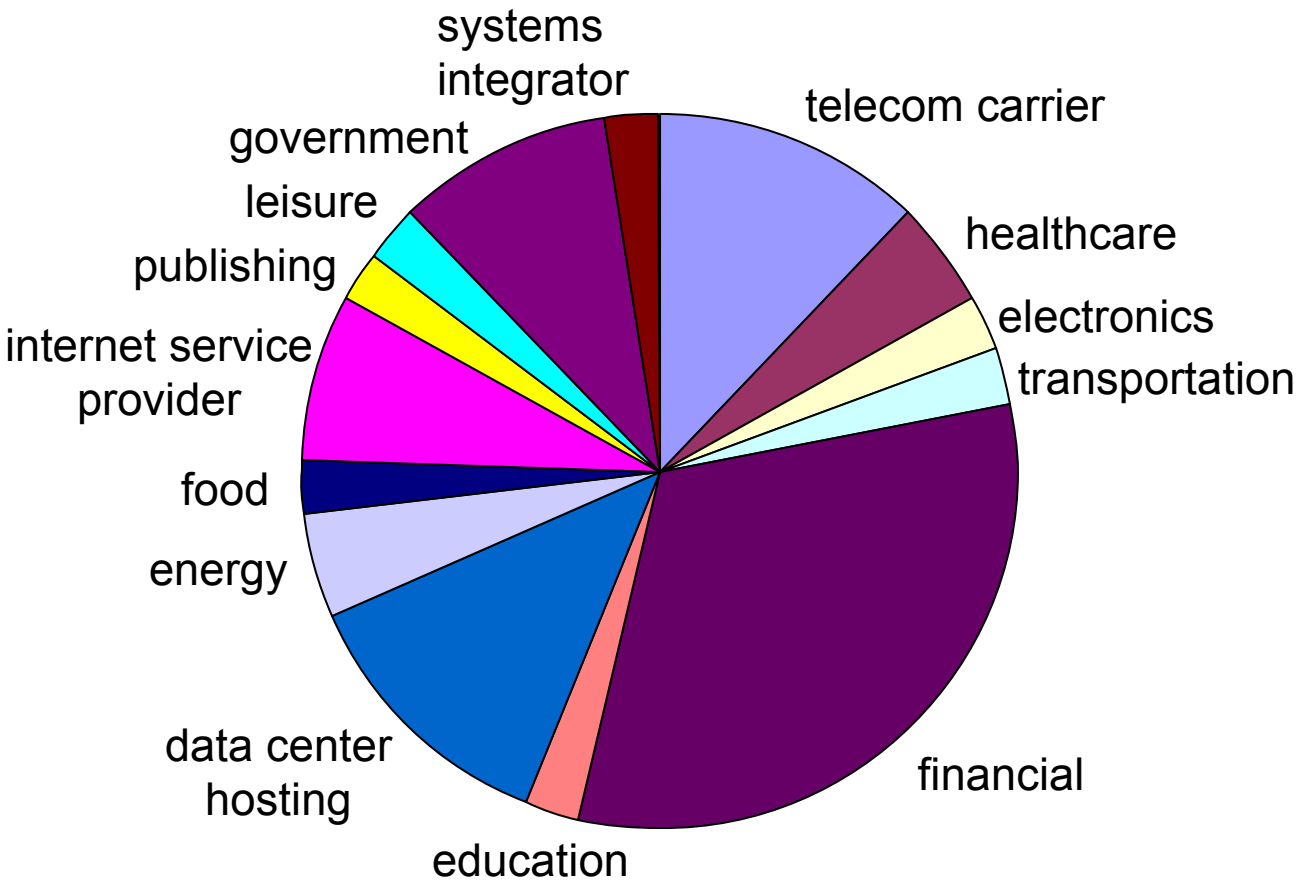
Q3) Would you convert your existing array-terminated single-mode cabling or deploy new array-terminated single-mode cabling to support future parallel optic applications if those applications were lower in total cost compared to 2-fiber single-mode applications?

Q4) What is the approximate number of MPO-terminated 12-fiber single-mode cables in your installation?

Converting 2-fiber to Parallel Cabling

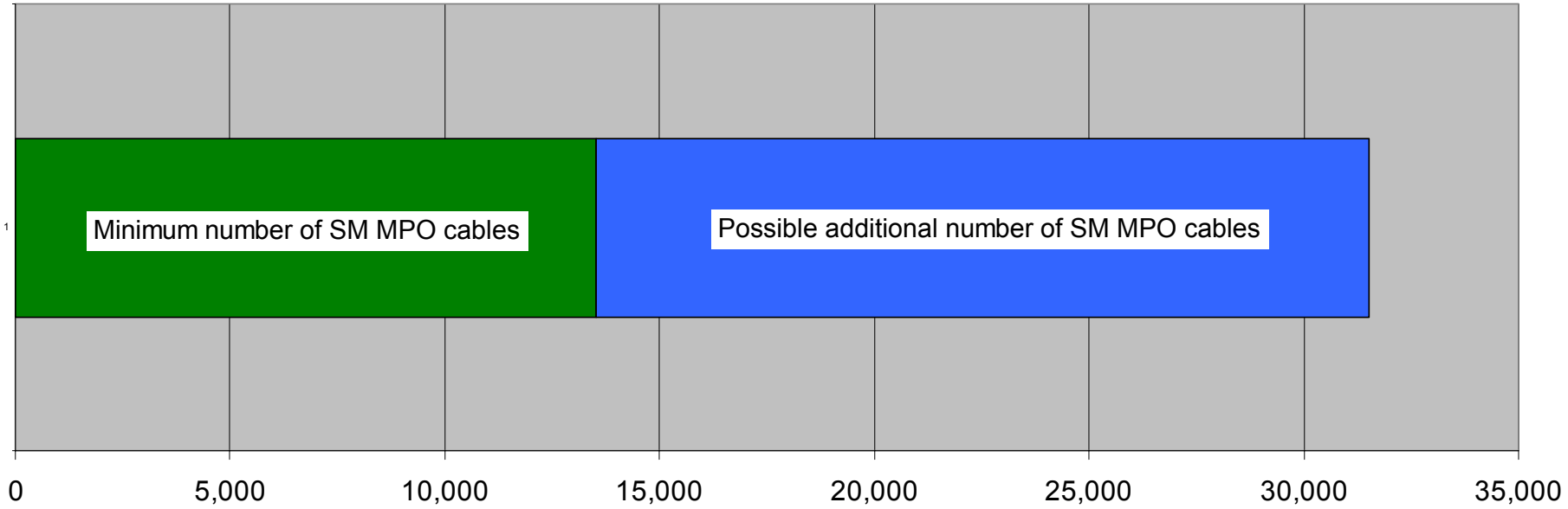


Survey Respondent Profile



41 respondents
representing a diverse cross-section of businesses

Q4) Number of 12-fiber SM Cables



At least 13,500 12-fiber cables in survey.

Up to 18,000 possible additional cables.

Large upside uncertainty due to nature of some responses.

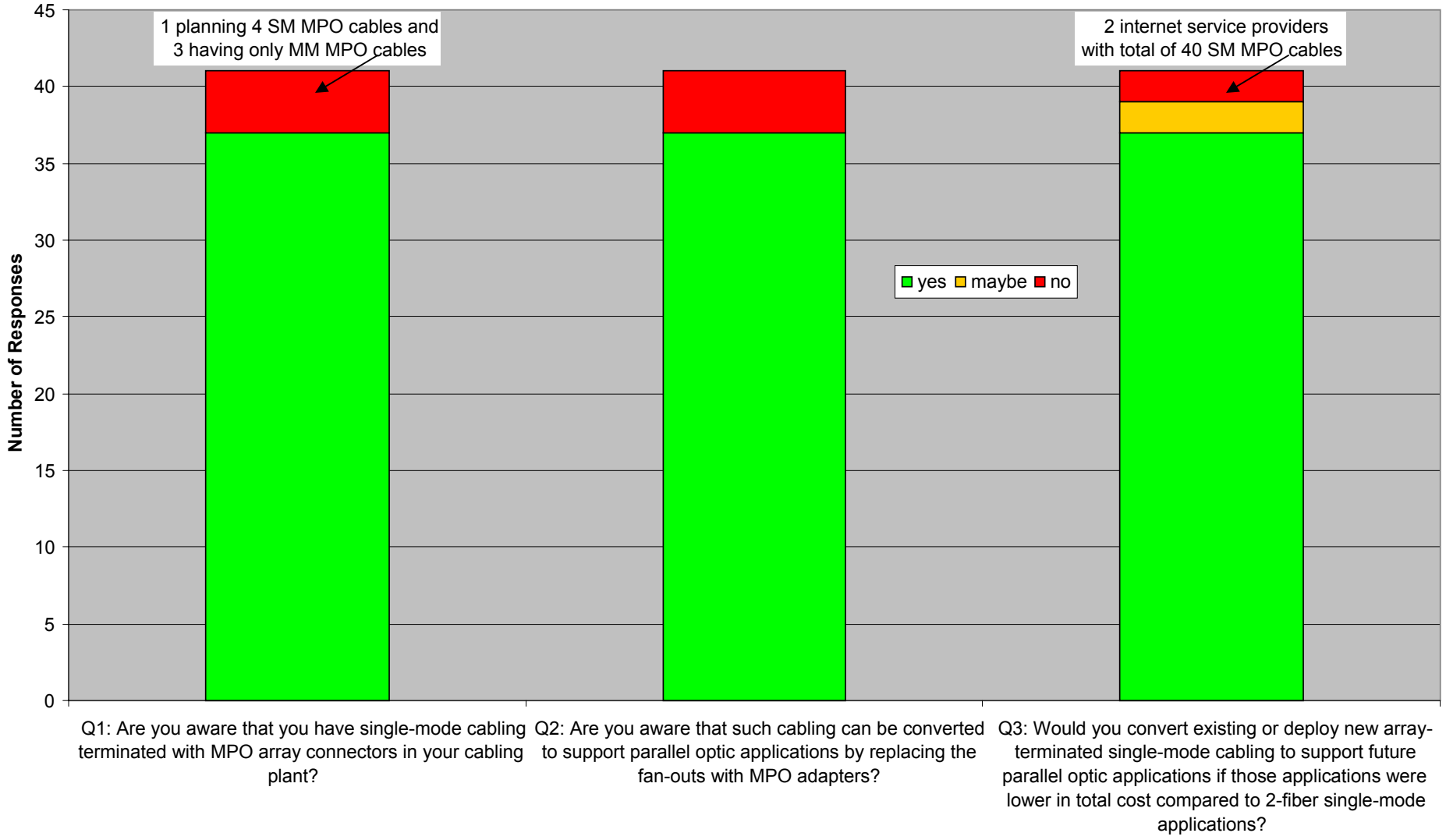
"Hundreds" credited as 200

but may represent up to 1,000.

"Thousands" credited as 2,000

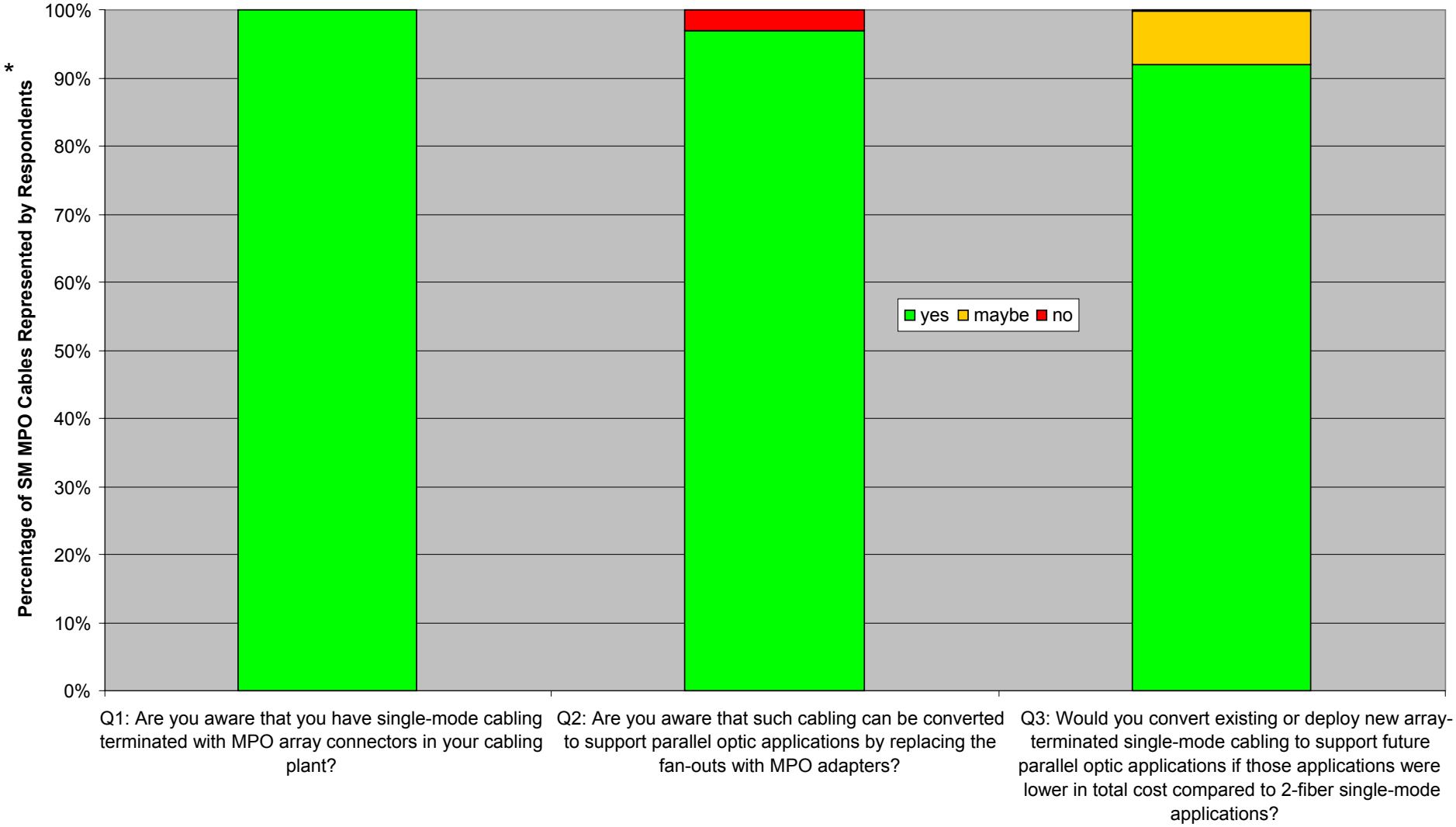
but may represent up to 10,000.

Q1, Q2, Q3 by Number of Responses



All questions received > 90% positive response rate

Q1, Q2, Q3 by Percentage of 12-fiber Cables



Negative responses to Q3 represent < 1% of cables

* Using minimum number of cables reported earlier

Economic Feasibility

Input Cost Ratios

- Extracted from compilations in cole_01_0313

100GE PMD Relative Cost

SR10 CXP = 1x	SR4	PSM4	LR4 Gen1	LR4 Gen2	LR4 Gen3
Form-factor	CFP4/ QSFP28	CFP4/ QSFP28	CFP	CFP2/ CPAK	CFP4/ QSFP28
petrilla_02a_0112 [1]	1.2x	3x to 4x			
nicholl_01_0112 [2]		4x [3]	14x	6.5x	
cole_02a_0312	1.2x	3x to 4x	16x	8x [4]	5x to 6x
anderson_01_0113 [5]	<4x	4x [6]		9.3x	Wow!!! LR4 will be dirt cheap
petrilla_03a_0113 [5]	1.1x	4x		12x	
welch_01a _0113 [5]		0.82x			3.5x

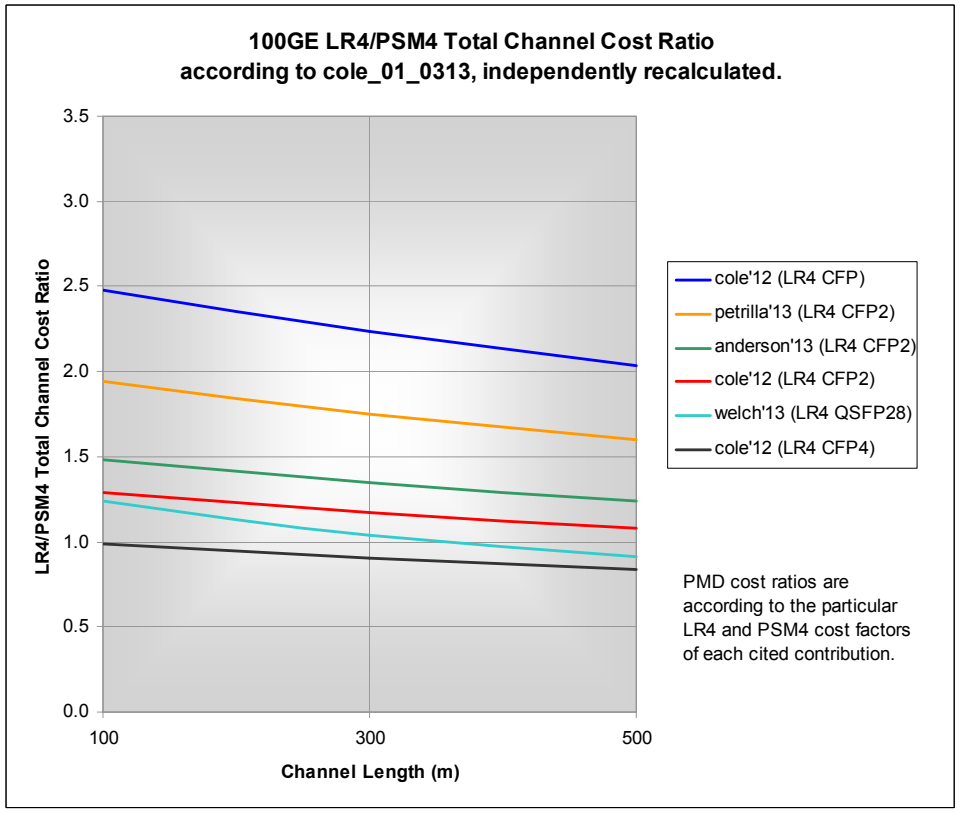
[1] Anderson and Petrilla numbers only
[2] Confirmed in welch_01a_0113
[3] Normalized to anderson_01_1111
[4] Confirmed by actual CFP2 BOM cost
[5] Confirmed in anderson_01_0213_smf
[6] Normalized to petrilla_02a_0112

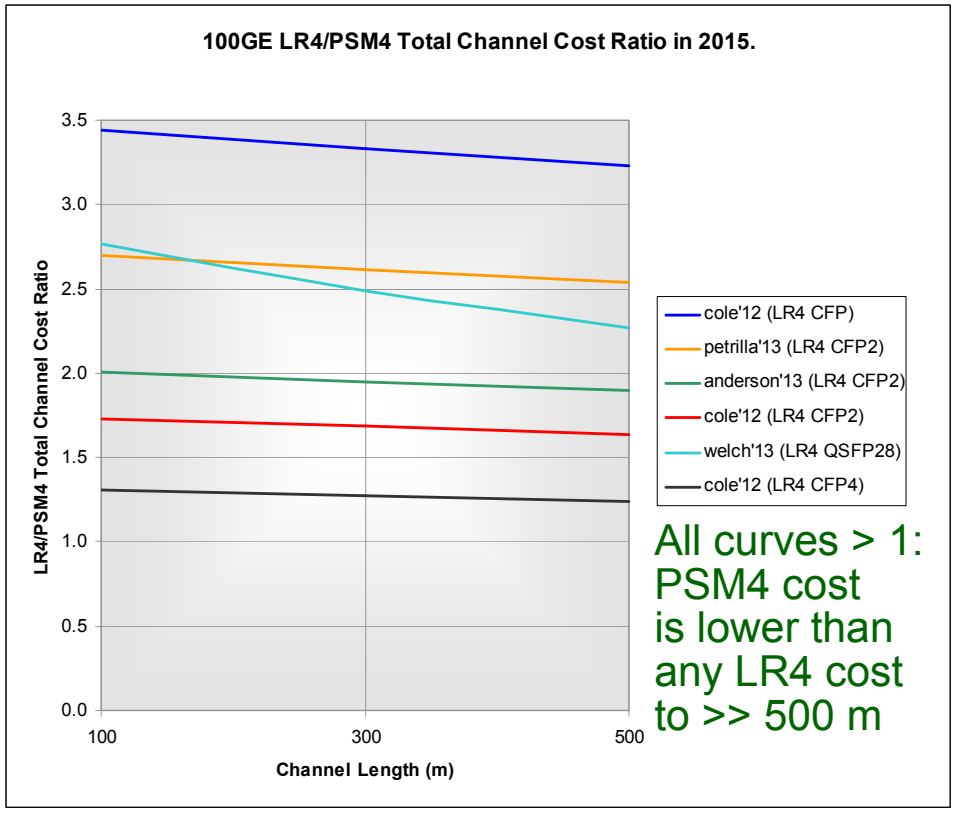
Cabled Fiber Link Relative Cost

Channel Type	Double-Link (DL)		
Reach	100m	300m	500m
DL 2f OS2 SMF	1.5	2	2.5
DL 8f OS2 SMF	6	8	10

Fiber connectivity cost ratios only (no transceivers) from cole_01_0512 (Abbott, Cole, Coleman, Kolesar, Swanson)

Total Double-link Channel Cost with New Cabling



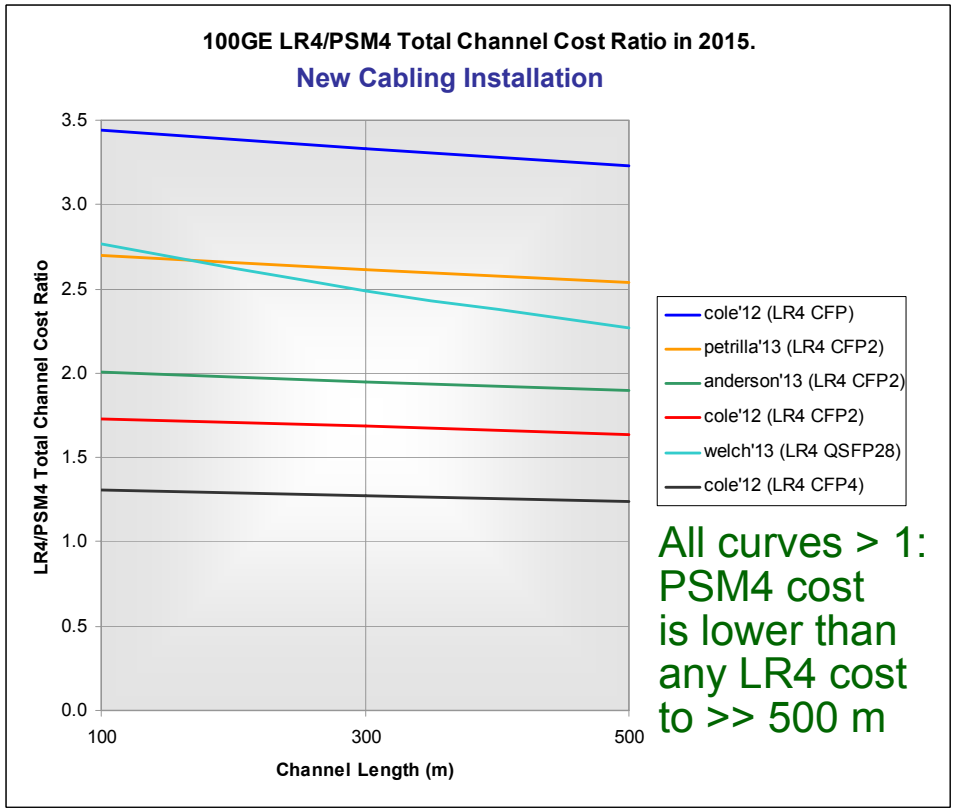


Cole_01_0313 combines “direct” transceiver and “external” cabling costs. But direct sales are atypical in mature market.

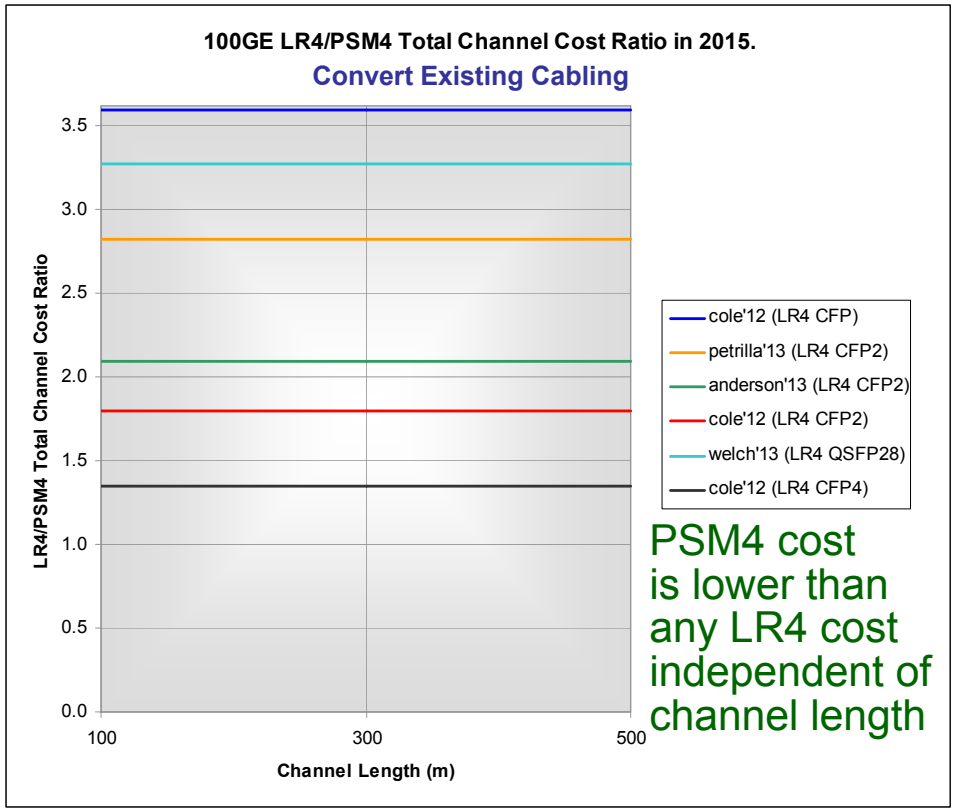
Cole_01_0313 adjusted by using cost at typical common point in supply chain for transceivers and cabling.

Double-link channels are examined because they have the highest cabling costs, thereby establishing a worst-case scenario for PSM4

Total Double-link Channel Cost: New vs Existing Cabling



All curves > 1: PSM4 cost is lower than any LR4 cost to >> 500 m



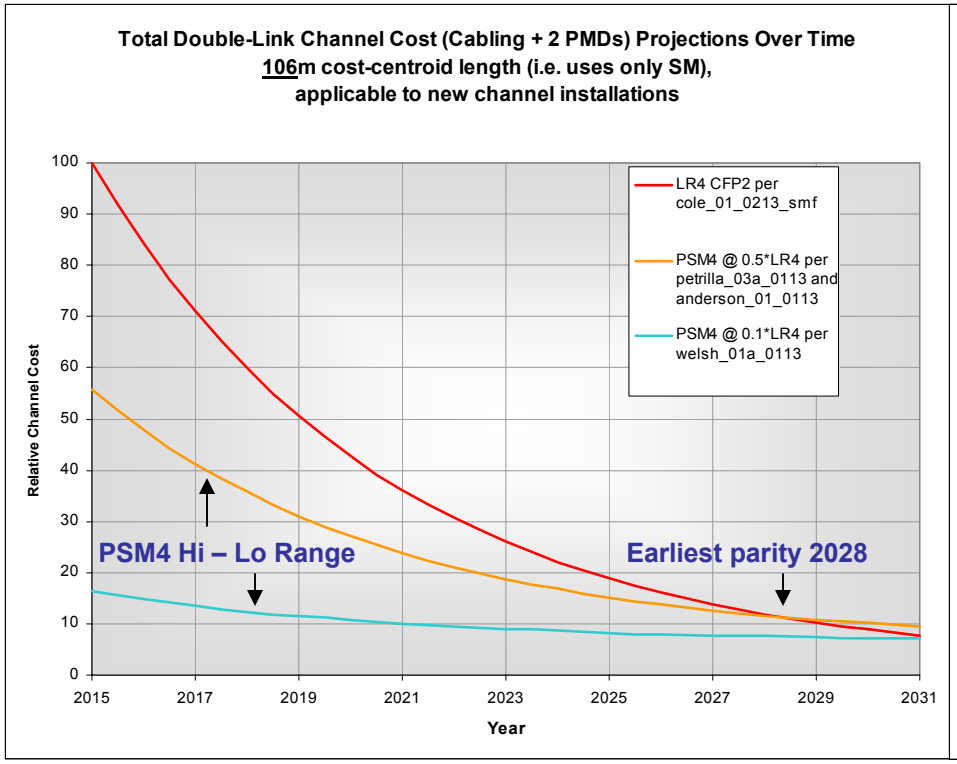
PSM4 cost is lower than any LR4 cost independent of channel length

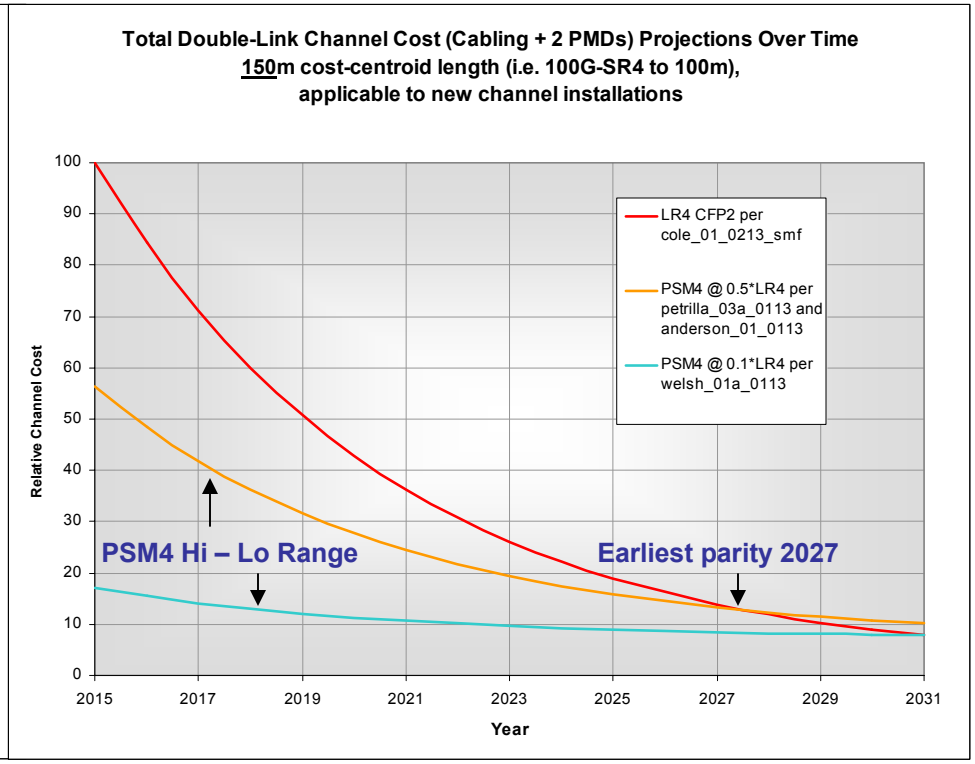
From previous slide

Conversion scenario includes the cost of changing existing 2-fiber channels to parallel for PSM4:
1) Replacement of fan-outs with MPO adapters
2) Replacement of LC cords with MPO cords
Note: no length-dependent cost factors

Given the lack of sensitivity to near-term costs over length,
let's next examine what happens over time...

Total Double-link Channel Cost Over Time: New Cabling

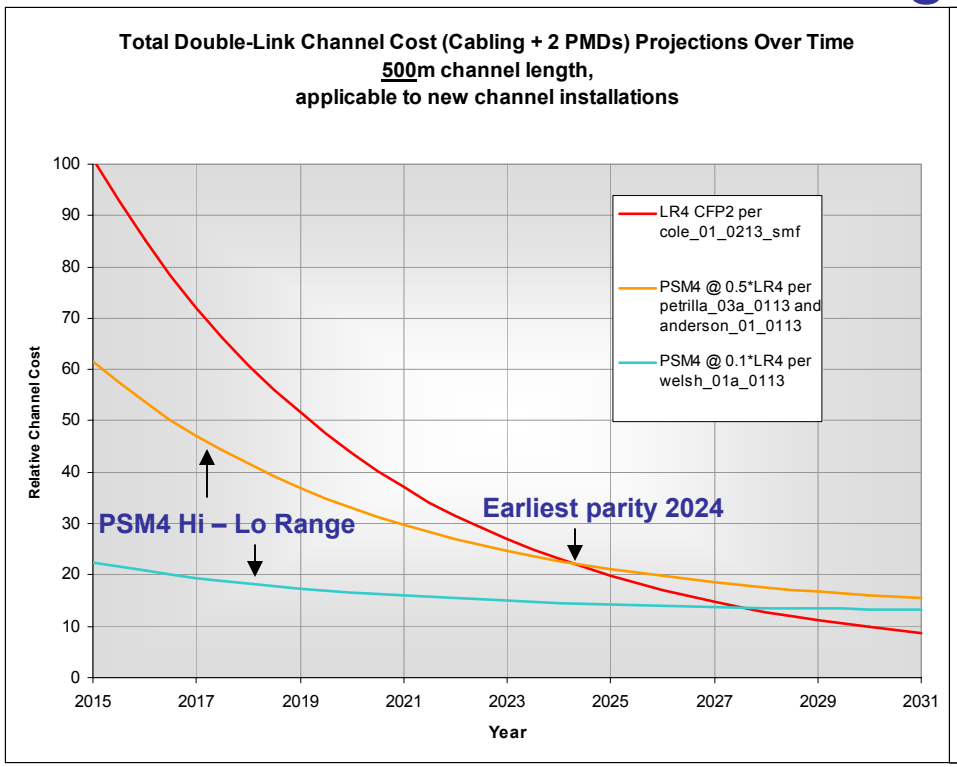


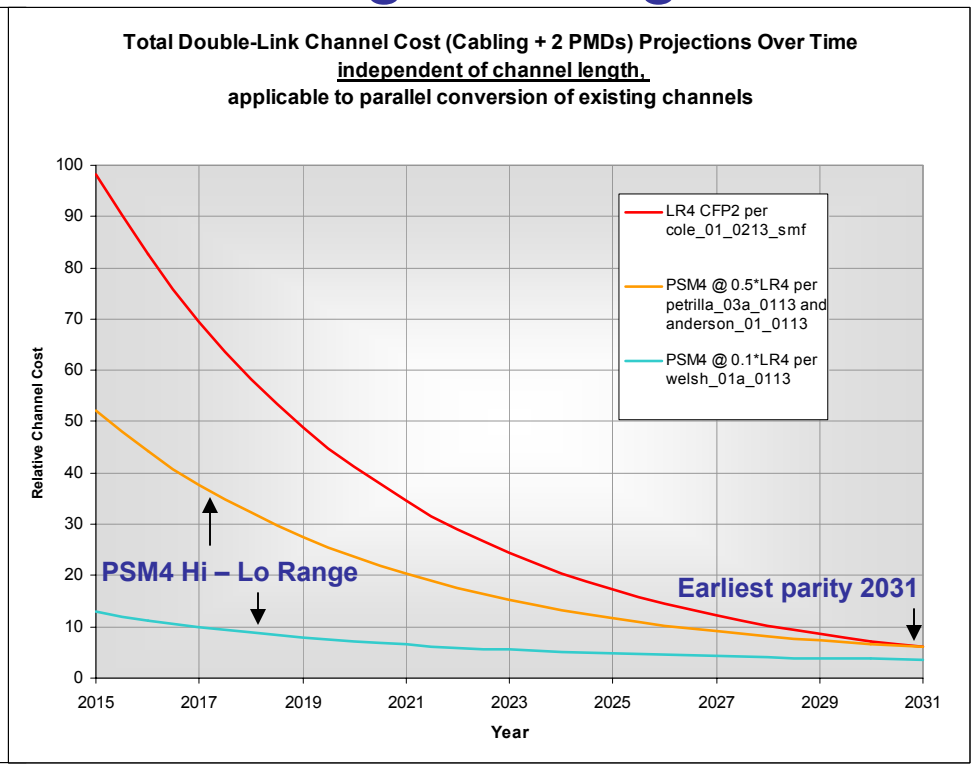


	Length Selection	Server-to-Switch Channels		Switch-to-Switch Channels		
		Post-2012	Pre-2008	Single Link	2:1 Mix Link	Double Link
User installs only SM PMDs:	All Lengths	16	24	59	75	106
User installs SR4 to 100m:	> 100m	n.a.	n.a.	150	150	150
	> 150m	n.a.	n.a.	200	200	200

Here we examine relevant cost-centroid lengths from kolesar_01b_0512

Total Double-link Channel Cost Over Time: 500 m New Cabling vs. Existing Cabling



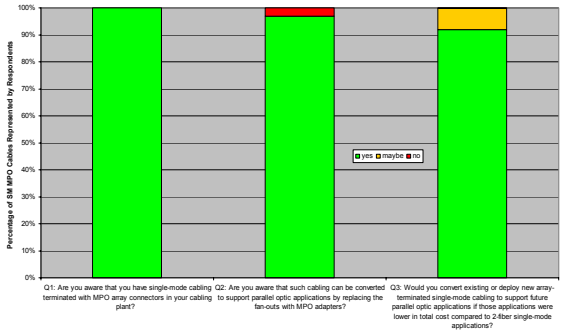


Using historic PMD cost decline factor, we see that while cabling costs do set a higher floor under the cost of PSM4 channels, it will take more than a decade for this to cause parity for the highest PSM4 PMD cost estimates, even at 500 m channel length.

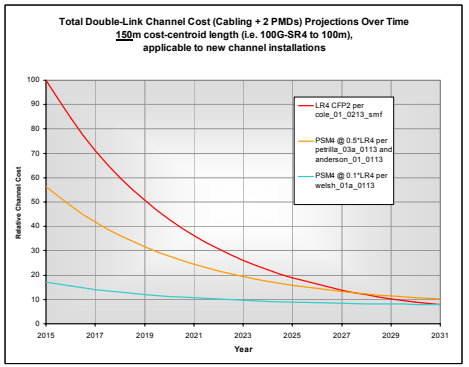
At the more relevant cost-parity length of 150 m shown on previous slide,
that crossover is pushed out another three years,
and for converted cabling another seven years independent of channel length.

Summary and Closing Perspectives

- Survey clearly demonstrates customers' willingness to deploy parallel SM solutions if lower in cost
  - Supports Broad Market Potential of PSM4



- The cost structure of 100G-PSM4 channels will be lower than 100G-LR4 channels for more than a decade
  - Supports long-term Economic Feasibility of PSM4



- Standardizing PSM4 will
  - endorse the simplest approach with undisputed Technical Feasibility*
  - accelerate growth of 100GE deployments
  - broaden the Ethernet market overall
  - seed the cabling infrastructure needed for higher data rates

*January's Technical Feasibility poll Y: 62, N: 0.

Q & A