

# 100GE 500m SMF Parallel and WDM links

K. Shrikhande, Dell

June 11, 2013

802.3bm SMF Ad Hoc presentation

# This talk

- Results from an (independent) SMF link cost analysis
  - Similar methodology to prior work in 802.3bm
- Extended to a more generic comparison of duplex and parallel SMF solutions
- Conclusions and closing thoughts

# Link cost analysis (1)

- Analysis method : similar to cole\_01b\_0213\_smf
- Total link cost ratio =  $(2 * \text{Duplex module} + 2f_{\text{DL}}) / (2 * \text{Parallel module} + 8f_{\text{DL}})$
- Double Link model as described by P. Kolesar
  - Exception: MPO-LC cassettes, MPO-LC cables (PSM module), LC-LC cables (duplex module) used at end points
- Assumed 24f trunk cables : carries 3 x PSM4 circuits or 12 x duplex circuits
- 2 cabling costs considered
  - #1) my low end : chose lower cost cabling components
  - # 2) my high end : chose higher cost cabling components
- Module relative cost used – next slide

# Module relative cost

C = cost of 100GBASE-SR10 CXP

100G	SR4	LR4	PSM4	CWDM	Future-gen WDM4
CFP4/ QSFP28	1.1C [1]	6C [2] 3.5C [3]	4C [1] 0.82C [3]	4.5C [4]	2.5C [5]
CFP2		12C [1] 8C [2]			

[1] petrilla\_03a\_0113\_optx : SR4 CFP4 (1.1C), LR4 CFP2 (12C), PSM4 CFP4 (4C)

[2] cole\_01\_0313\_optx : LR4 CFP2 (8C), LR4 CFP4 Gen3 (6C)

[3] welch\_01b\_0113\_optx : PSM4 QSFP28 (0.82C) and LR4 QSFP28 (3.5C) using SiP

[4] Assuming a 4-lane CWDM 100GE SMF module (Gen1) is 4.5C

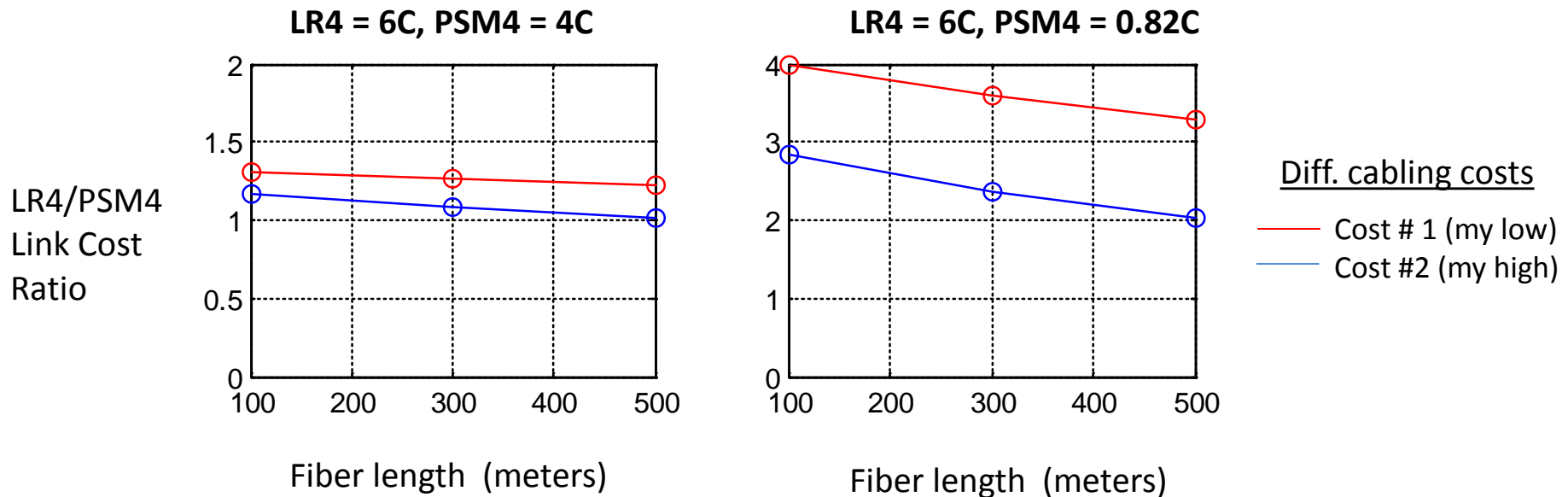
- Known uncooled CWDM to SR cost ratios ~ 4-5 (40G-LR4/SR4)
- shen\_01a\_0313\_smf, uncooled packaging =  $0.66 * LR4 = 0.66 * 6C \sim 4C$  (?)

[5] Assuming a potential future-gen 100GE SMF module is 2.5C

- Historical SMF / MMF module cost ratio (1GE, 10GE) of ~ 2-3
- shen\_01a\_0313\_smf : uncooled + COB/hybrid =  $0.38 * LR4 = 0.38 * 6C \sim 2.2C$  (?)

# LR4/PSM4 link cost ratios

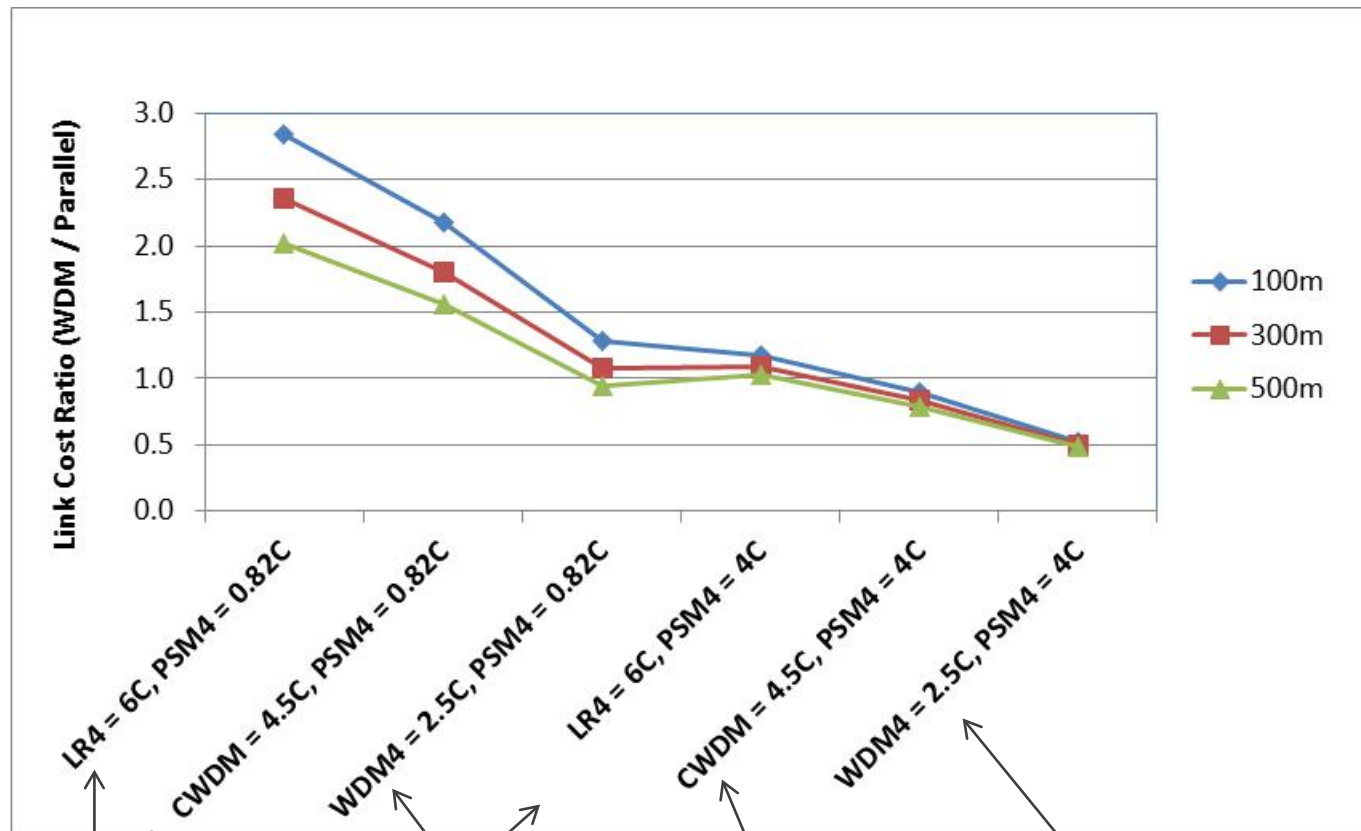
(with LR4 = 6C and PSM4 = 4C or 0.82C)



- LR4/PSM4 ratio ~ 1 (equal cost) for cable cost #2
- LR4/PSM4 ratio ~ 1.3 @ 300m for cable cost #1
- Cabling cost clearly matters, only a few presentations discussing cabling costs, compared to modules costs
- Results from cable cost #2 match other analyses in 802.3bm quite well (Cole, Kolesar) – cable cost #2 used for further analysis
- LR4/PSM4 ratio > 2 for both cable costs (PSM4 links significantly cheaper)

# Few WDM / Parallel Link Cost Ratio scenarios at 3 different link lengths

Cabling cost #2 is used



PSM4 significantly cheaper

PSM4 mostly cheaper ( $\leq 300\text{m}$ )

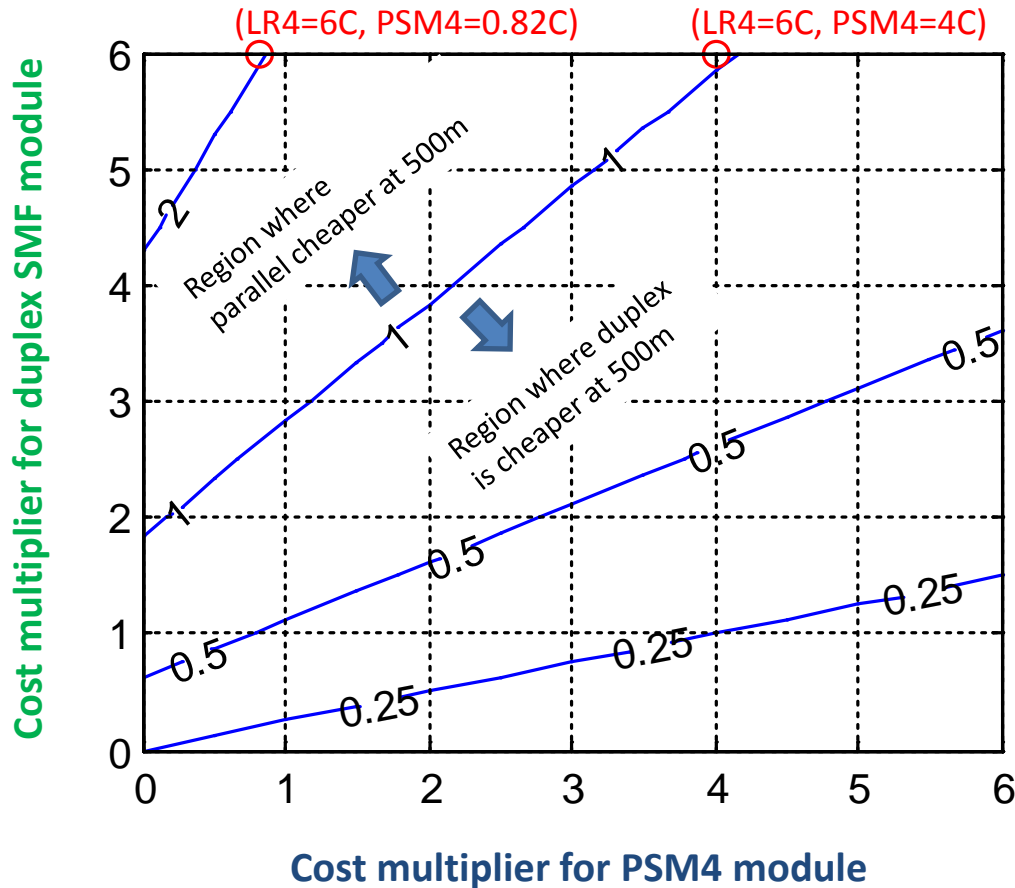
WDM cheaper

WDM significantly cheaper

## Link cost analysis (2)

- The cost ratio of a WDM (or any duplex) SMF link to parallel SMF link can be calculated more generally, as a function of the duplex module and parallel module costs
- Duplex module relative cost =  $X = C * (0, 0.5, 1.0, \dots 6)$
- Parallel module relative cost =  $Y = C * (0, 0.5, 1.0, \dots 6)$ 
  - Where  $C = \text{SR10 CXP cost}$
- Calculate matrix of link cost ratio (duplex/parallel) for above  $X, Y$  values of module costs
- From the matrix data, trace contour lines on a  $X$ - $Y$  plot
  - For e.g. contour lines where duplex/parallel link cost ratio = 0.25, 0.5, 1.0, and 2.0 are plotted on next slide for 500m cable length

# Contour plot for 500m SMF



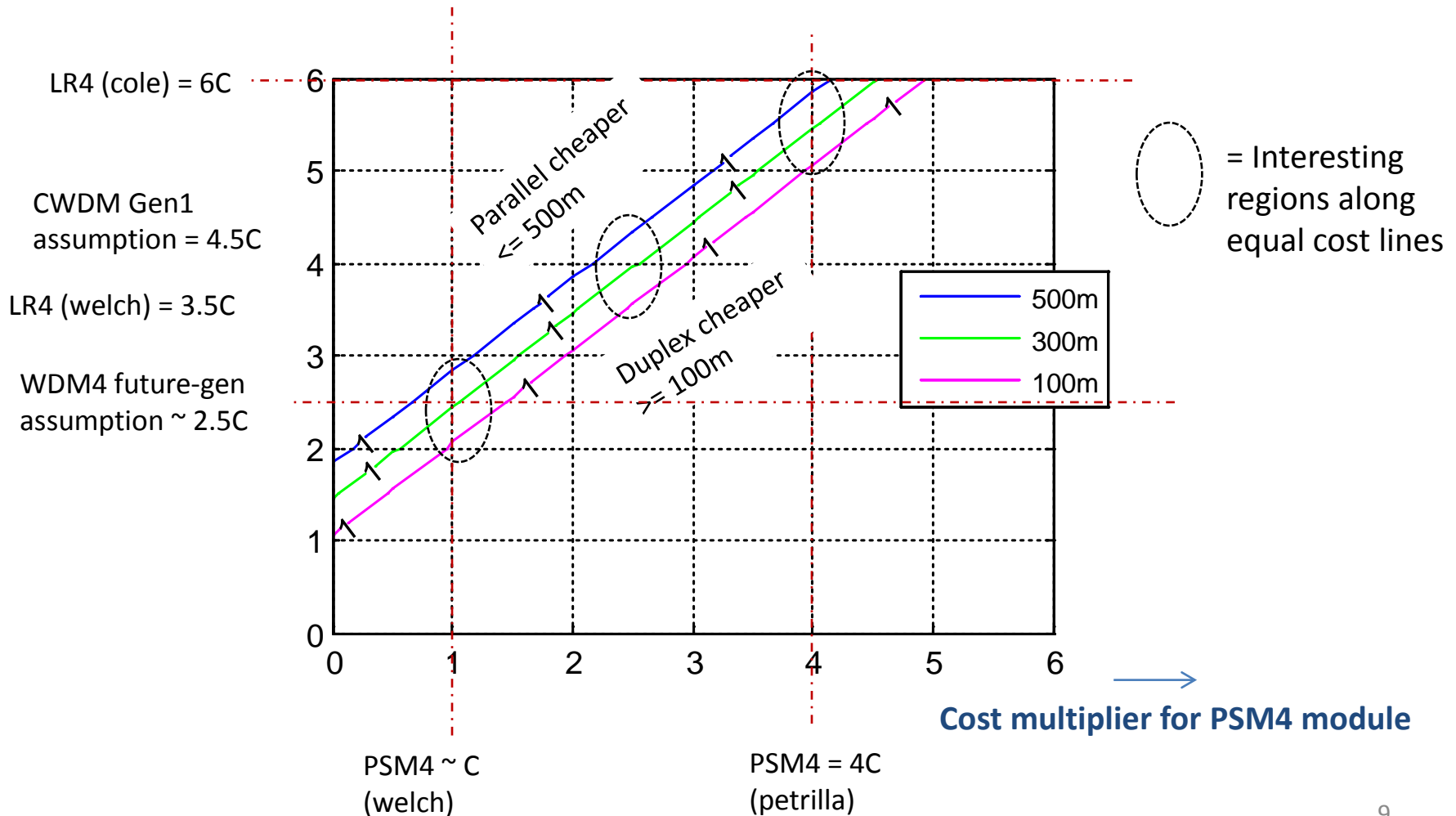
- As a reference, the two points (red circles) match the LR4/PSM4 ratio plotted on slide 5
- Line marked "1" is contour line of equal cost (duplex link = parallel link)
  - Parallel is cheaper above "1" line
  - Duplex is cheaper below the "1" line



# Equal cost contour lines for 3 lengths

Cabling cost #2 is used

↑ Cost multiplier for duplex SMF module



# Is 100GE PSM4 interesting ? Yes.

- Sufficient cost scenarios, especially in the nearer term, where PSM4 links are equal cost or cheaper than duplex
  - Above all, likely to be cheapest solution for >100/150m problem for a longer period of time
- Prefer to have PSM4 + LR4 over LR4-only
  - Breaks the large step in cost going from SR4/10->LR4 at 100/150m into 2 smaller steps : SR4->PSM4, PSM4->LR4
- PSM4 creates an additional choice with different cost-deployment trade-off for the DC operator
  - Use cheaper PSM4 modules when parallel is OK or investment in cabling makes sense
  - Use LR4 when duplex solution only is required
- PSM4 has broad support from module suppliers
- PSM provides an infrastructure for future upgrade to 400GE and breakout using 4x100GE

# Experience from 40GE

- There is acceptance for using multiple fibers to carry 40GE beyond 100/150m
  - ~300m MMF QSFP+ modules useful not only for 4x10GE but also 40GE once both ends support 40GE
- SMF parallel module technology is already here
  - 40G-PSM4 has applications for 4x10GE and for 40GE when link cost lower than 40G-LR4 (or cabling is already in place)
- 100GE-PSM4 looks similar to 40G-PSM4
  - However, cannot wait to get user feedback from 40G-PSM4 before deciding on 100GE-PSM4
- A large variety of PMDs in a common FF (QSFP+) is available – and users are liking it !
  - Opportunity to do the same in CFP4 / QSFP28 with 100GE: CR4, SR4, SR10, PSM4, LR4 and ER4-lite

# Should PSM4 be a standard?

- Yes, it should
  - Possibly the lowest cost, lowest power 100GE SMF module
  - Multiple module suppliers capable and interested
  - Distinct SMF PMD compared to duplex WDM 100G-LR4
  - Solution may get implemented anyway, possibly an MSA, why not standardize it and ensure inter-op ?
- No, it should not
  - Cannot be used for 2km (2 birds argument) ? But we already have 100G-LR4 for 2km !
  - Duplex SMF interface is a must for broad market? Parallel will happen, if not for 100GE, then for nx10G, nx40G and nx100 (so why not for 100GE point to point if cost makes sense)
- Carrier client, inter-DC, general SMF, and LR-budget link needs being met by 100GBASE-LR4
- 100GE 500m SMF objective created with intra-DC links in mind -- view PSM4 from that stand-point, standardize it, and let the market decide the extent and depth of 100G PSM4 usage

Thanks