PSM4 technical feasibility and relative cost updates

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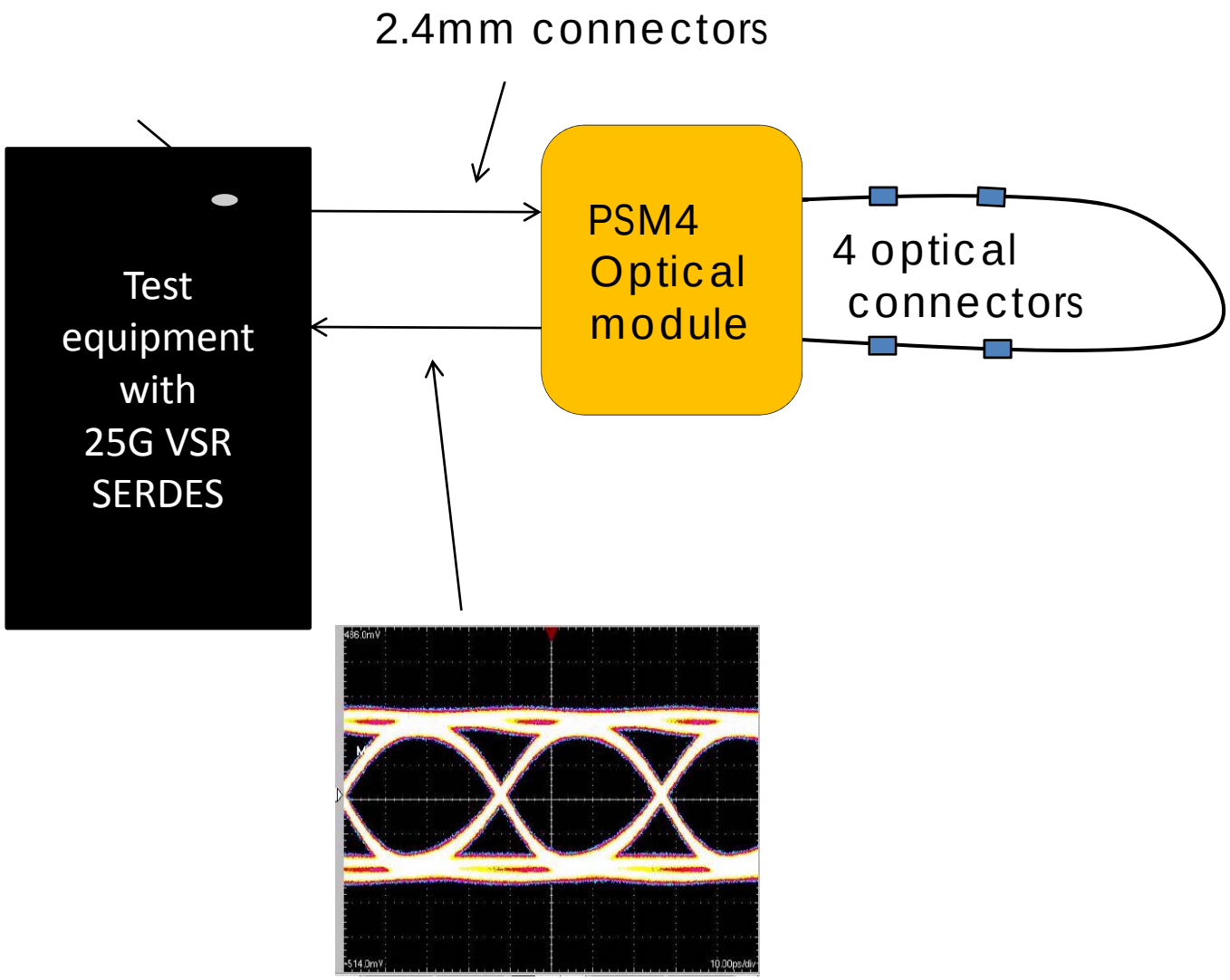
Minneapolis,

Land of big mosquitoes and beautiful people

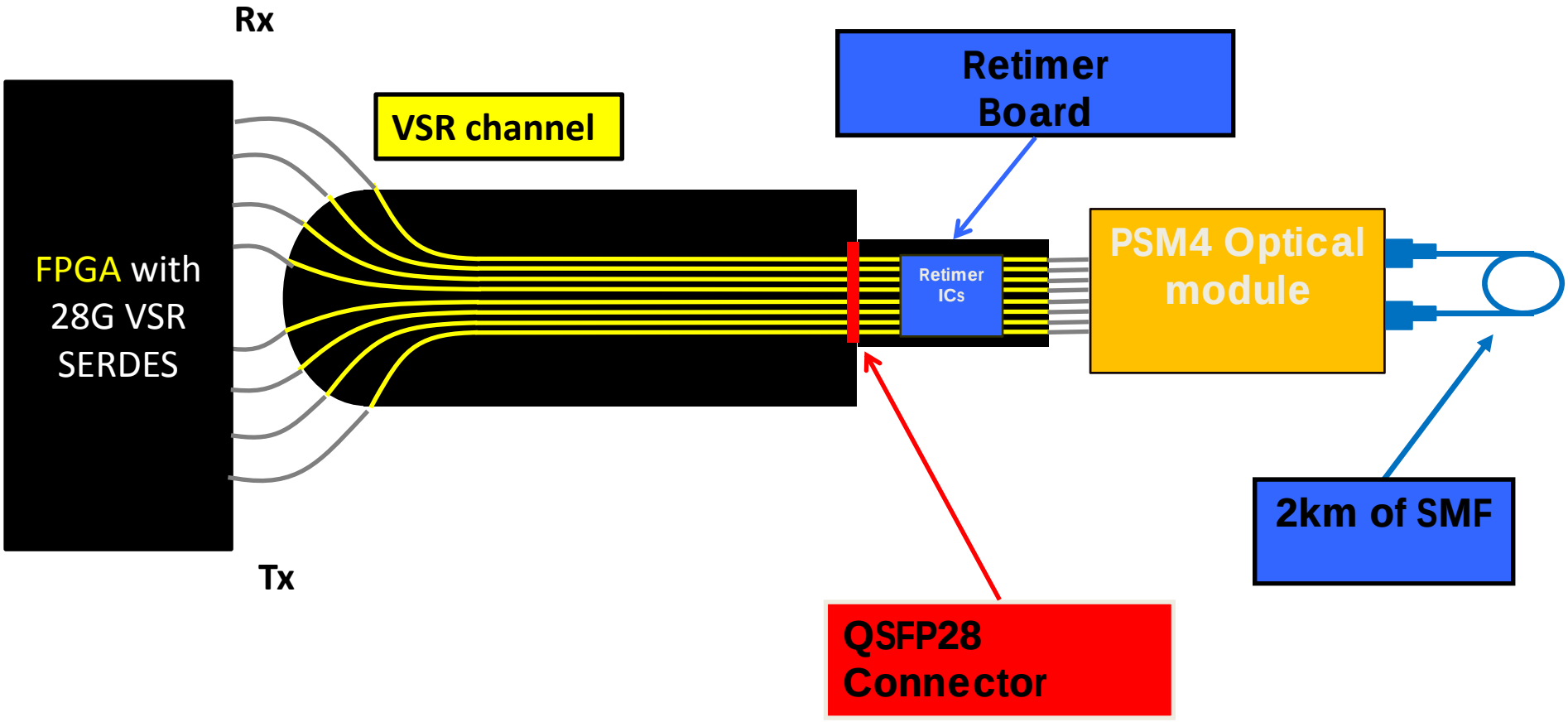
Agenda

- Technical feasibility demonstrations
- Relative Link, fiber and module cost comparisons
- Low cost requires common MDI
- Summary

PSM4 technical feasibility demonstrated at OFC with 4 connectors

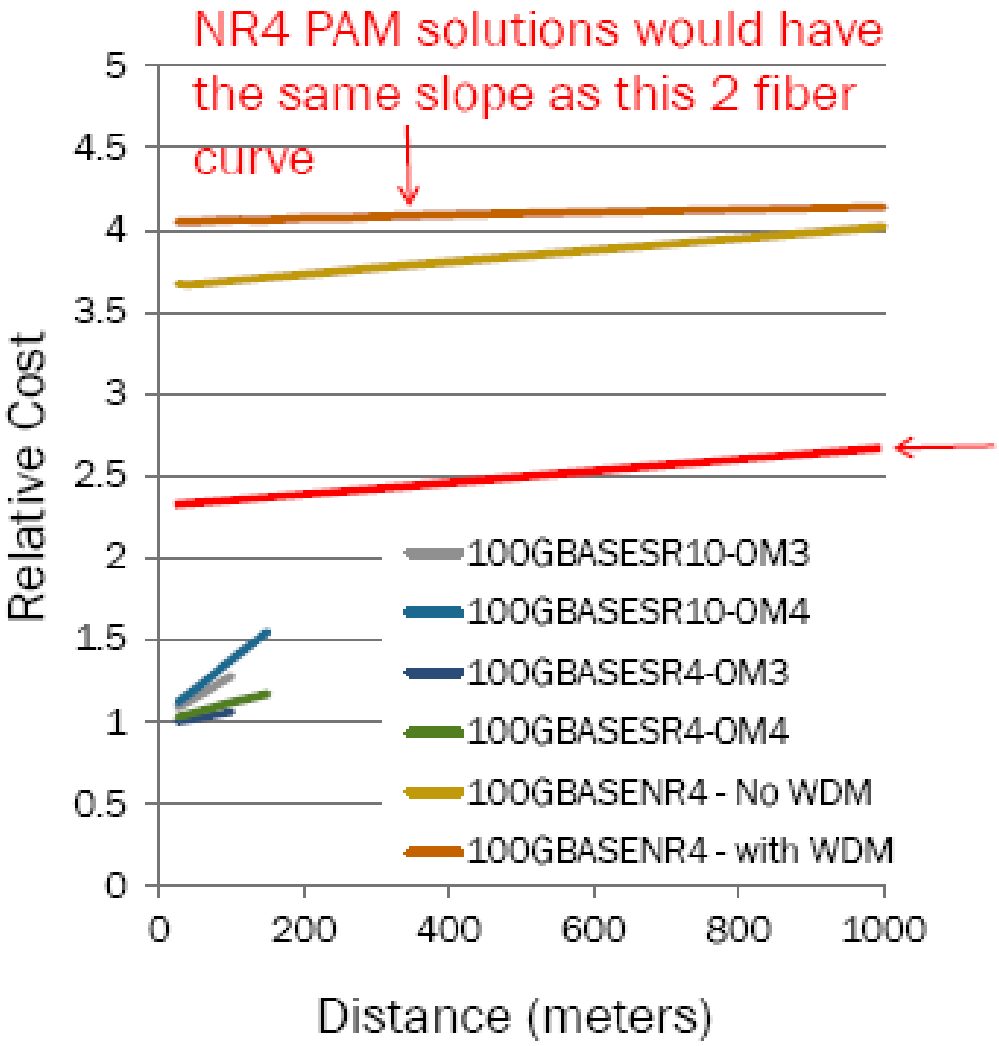


Technical feasibility of PSM4 demonstrated at OFC 2012 with 2km distance



NR4 WDM vs No WDM for 100GBASE-NR4

(From Kipp_01_0112)



NR4 no WDM (8 fibers) is assumed to be 20% less cost than NR4 with WDM (2 fibers). The NR4 no WDM is less cost up to 1000m.

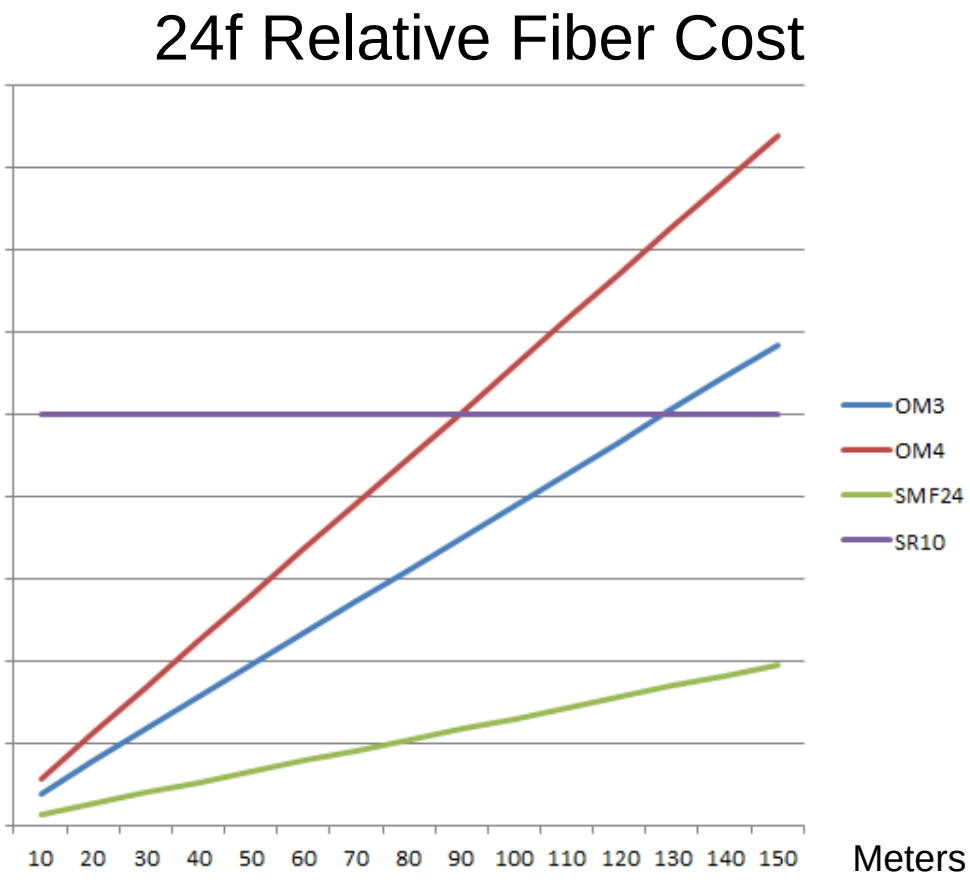
This line shows where the cost of the link would be when NR4 no WDM is about half the cost of NR4 with WDM or 3X the cost of SR4 modules.

CORNING

Fiber Cost Comparison

Density	Fiber Type	Relative Cost
24f	OM3	3.0
24f	OM4	4.3
24f	SMF	1
Duplex	SMF	2.0*

Source: Jan 2012 quote from cable vendor
LC or MTP Termination costs not included.
* Cost to derive 12 - duplex pairs



24-Fiber SMF cable is half the cost of 12 duplex SMF cables, 1/3 the cost of 24f OM3 and 1/4 the cost of 24f OM4

Connector cost comparisons

- MT Ferrules for SMF will approach 1.2x MMF
  - Fiber is much cheaper
  - Connector is slightly more expensive
  - Microsoft Hawaii attemped to make the same point

MT Ferrules for SMF (US Conec)

	MM MT Elite® Multimode MT Ferrule	Standard Multimode MT Ferrule	SM MT Elite® Single-mode MT Ferrule	Standard Single-mode MT Ferrule
Insertion Loss	0.1dB Typical (All Fibers) 0.35dB Maximum (Single Fiber)[2,3]	0.20dB Typical (All Fibers) 0.60dB Maximum (Single Fiber)[2,3]	0.10dB Typical (All Fibers) 0.35dB Maximum (Single Fiber)[1]	0.25dB Typical (All Fibers) 0.75dB Maximum (Single Fiber)[1]
Optical Return Loss	> 20dB	> 20dB	> 60dB (8° Angle Polish)	> 60dB (8° Angle Polish)

Relative costs (US Conec) ➔ (rough) 1.0X >2X* 1.2X*

* in MMF-like volume

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Avago, Opnext, Luxtera & Molex: MR definition, comparisons and reach objective

Low cost = common MDI for copper, SR and MR optics

- QSFP form factor is critical to achieving cost goals.
  - Common industry form factor
    - Infiniband, Fibre Channel, 40GE, 100G-SR4, CR4

Summary

- Technical feasibility demonstrated
- Relative cost of SMF links vs MMF links is similar:
  - SMF fiber is lower cost than MMF
  - SMF connectors are 1.2x more expensive vs MMF
- Common MDI is critical to achieve low cost