

SYSTIMAX®
SOLUTIONS

Cost analysis of MMF variants

Paul Kolesar
IEEE 802.3 HSSG, January 2007

Purpose and background

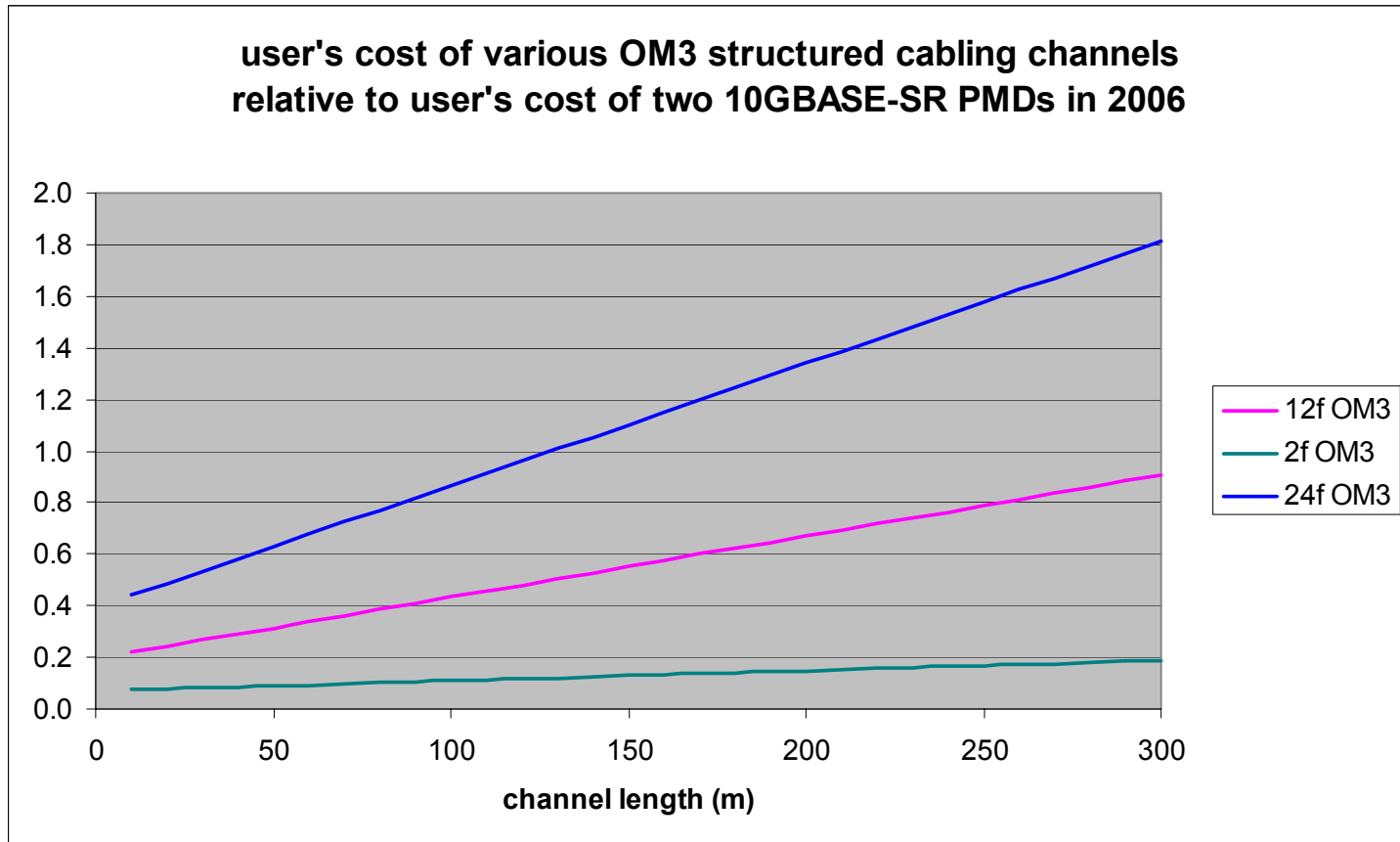
- Examine alternatives for short reach objective (i.e. at least 100 m on OM3) from a cost perspective
- Consider SDM and WDM technologies
- Project total channel cost (i.e. installed media + 2 PMDs) as a function of distance and year
- Derive typical channel cost by convolving with distance distribution of Kolesar_01_0906
- Provide insight to guide PMD selection for optimal economic feasibility

Interesting solutions near 850 nm

<u>Configuration</u>	<u># Chan</u>	<u>Coding</u>	<u>Rate</u>	<u># λs</u>	<u># fibers</u>
10 SDM	10	64/66b	~10Gb/s	1	20 of 24
5 SDM x 2 WDM	10	64/66b	~10Gb/s	2	10 of 12
12 SDM	12	8B10B	~10Gb/s	1	24 of 24
6 SDM x 2 WDM	12	8B10B	~10Gb/s	2	12 of 12
4 SDM x 3 WDM	12	8B10B	~10Gb/s	3	8 of 12
10 WDM	10	64/66b	~10Gb/s	10	2

Solutions in bold font are examined in cost models

Cabling costs



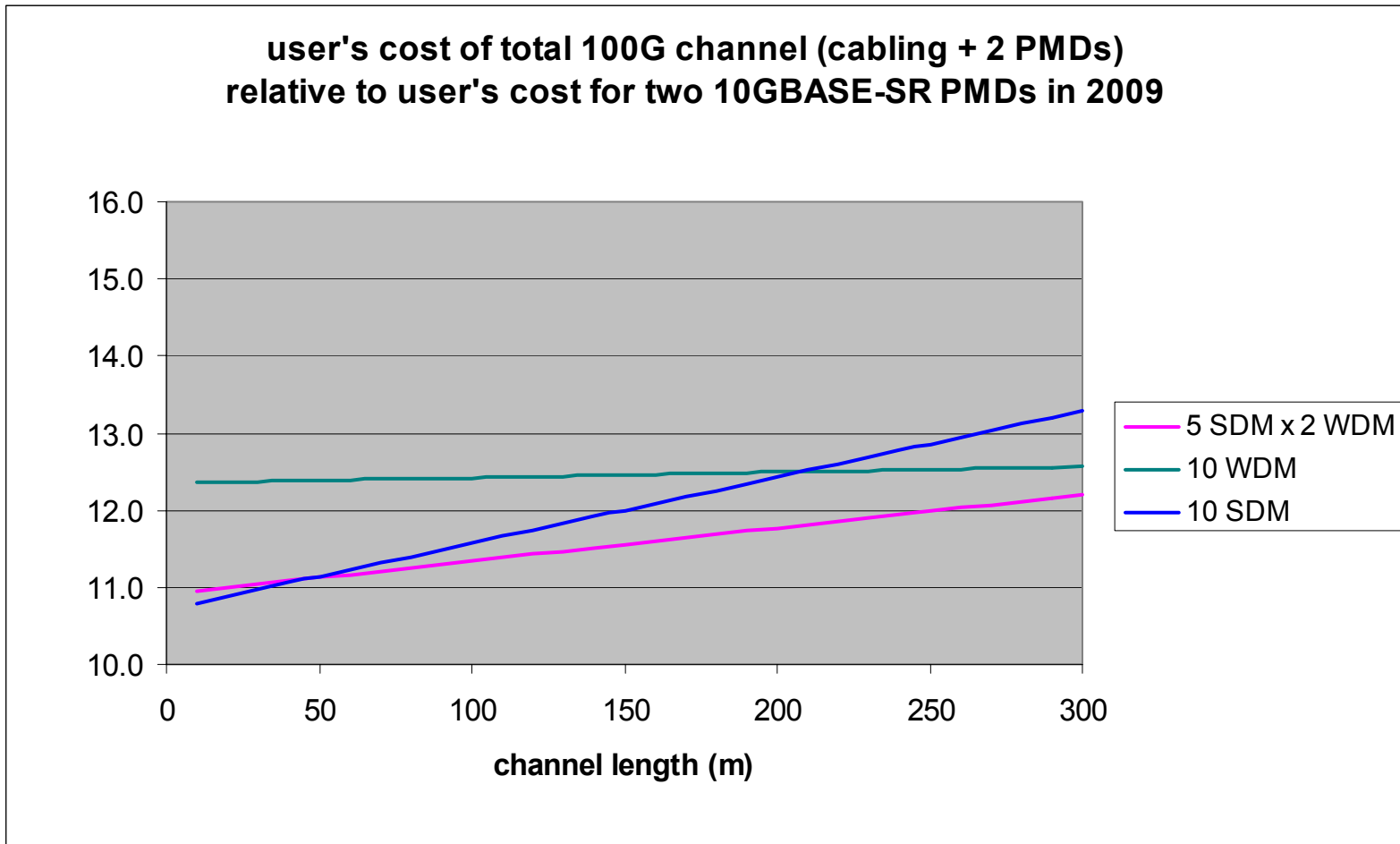
Short length delta
driven by connection cost:
duplex v array

Long length delta
driven by fiber cable cost:
duplex v array

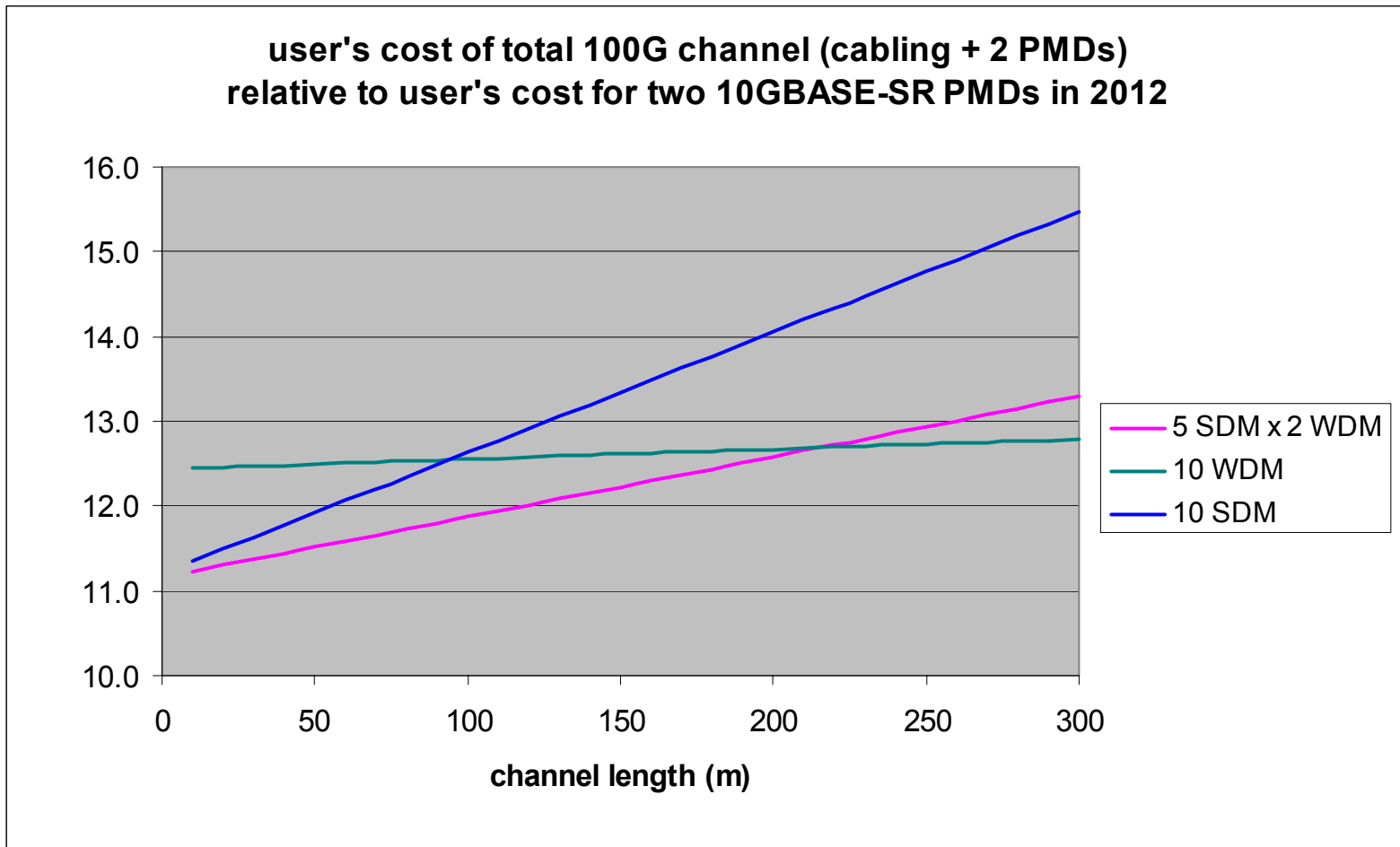
Channel costs

- **Includes installed media and optics (PMDs) on each end to form complete simple structured cabling channel (PMD-cord-cable-cord-PMD)**
- **Assumptions on cost directions:**
 - Labor rates increase 3% / year
 - Cabling costs decline 3% / year
 - 100G optics costs decline 18% / year
- **Costs are relative to 10GBASE-SR cost**
 - Cost of 10GBASE-SR declines 18% / year

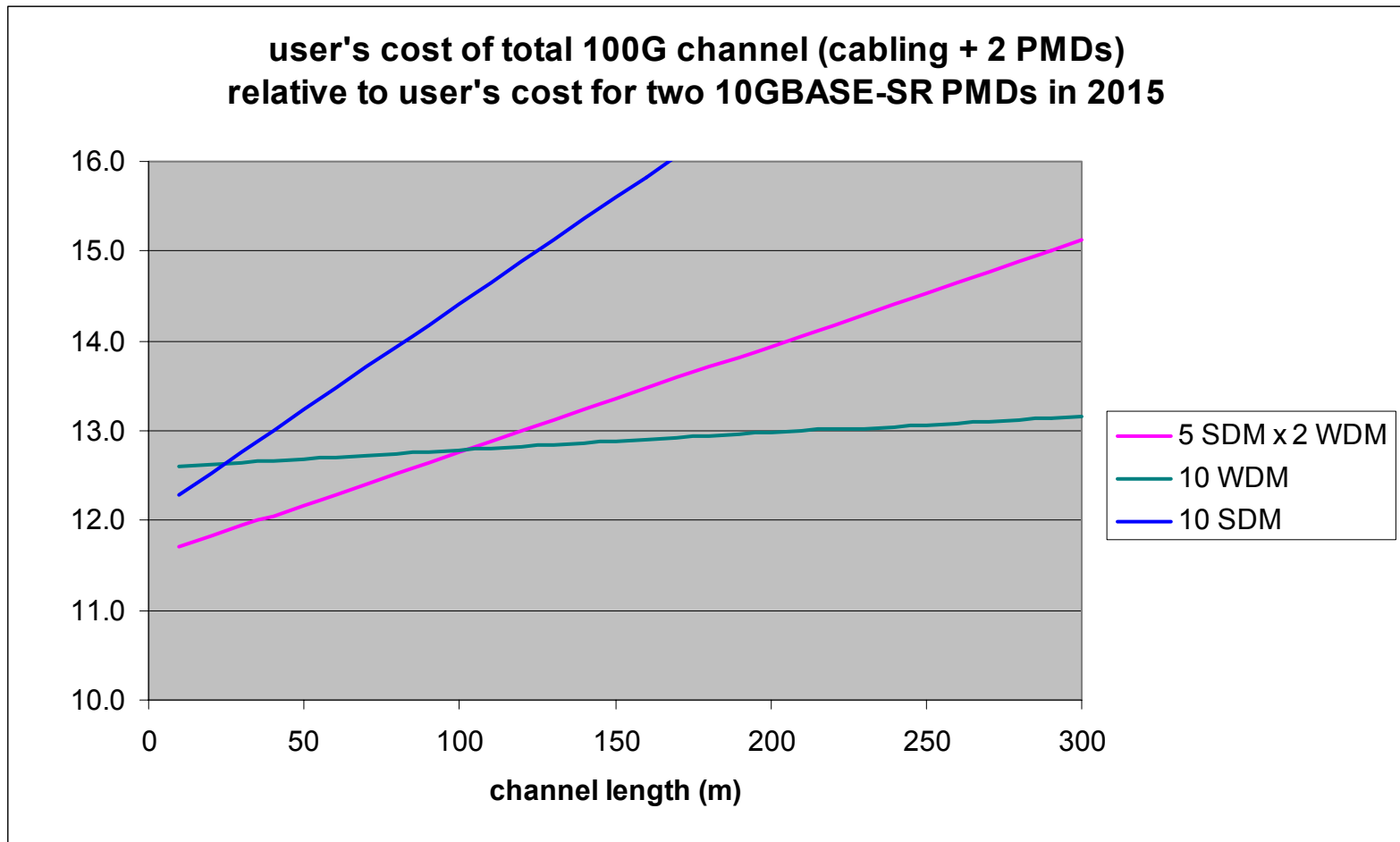
Channel costs in 2009



Channel costs in 2012



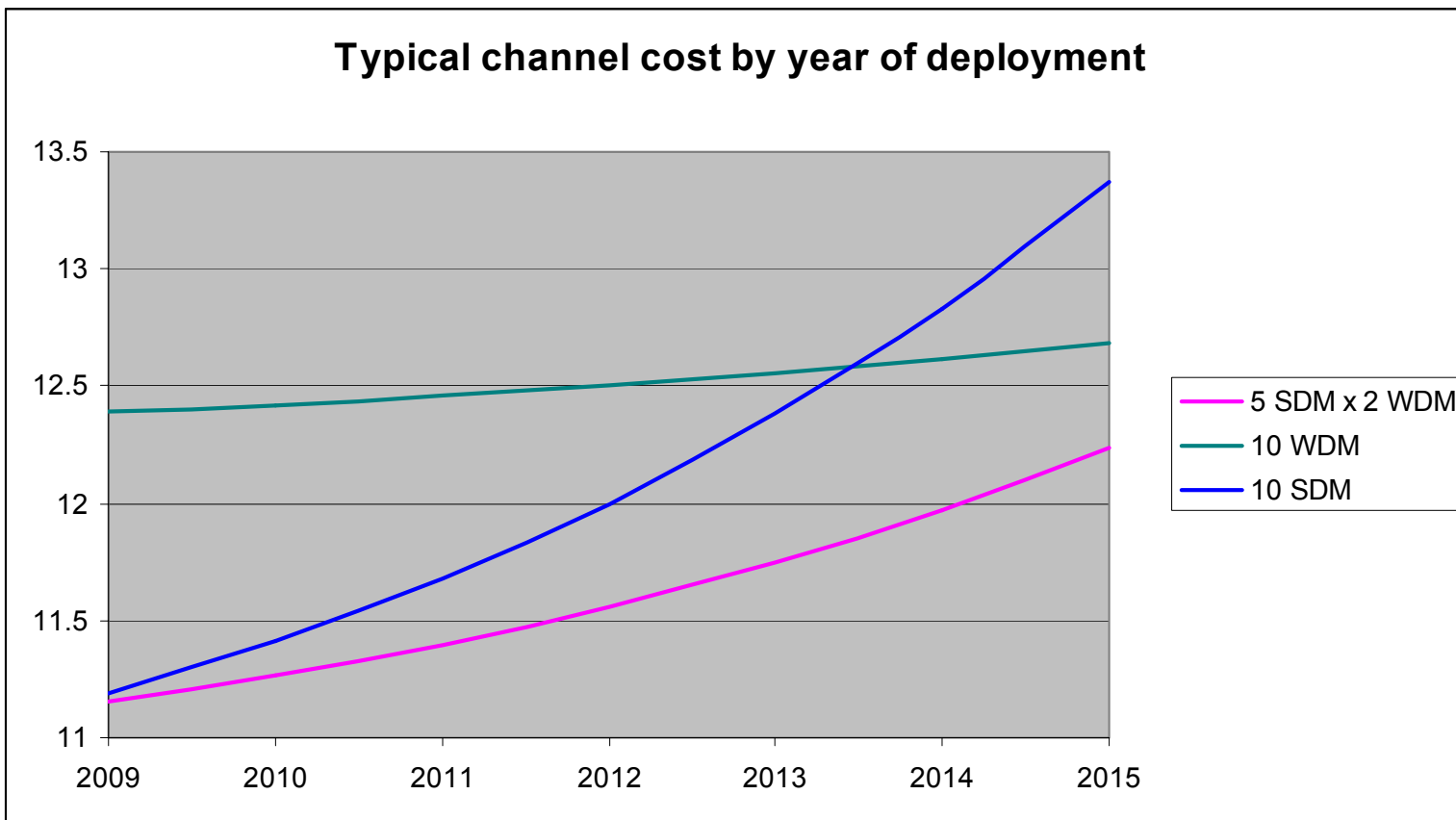
Channel costs in 2015



Convolving w channel length distribution

- Derive typical channel cost by convolving with distance distribution of Kolesar_01_0906.
- The weighting effect of the length distribution places the cost of the typical channel near the cost of ~55 m channel.
- The data center channel length distribution from swanson_01_1106 includes 3-trunk topologies that extend the distribution, so would increase the typical channel length and amplify the trends.

Typical channel cost trends

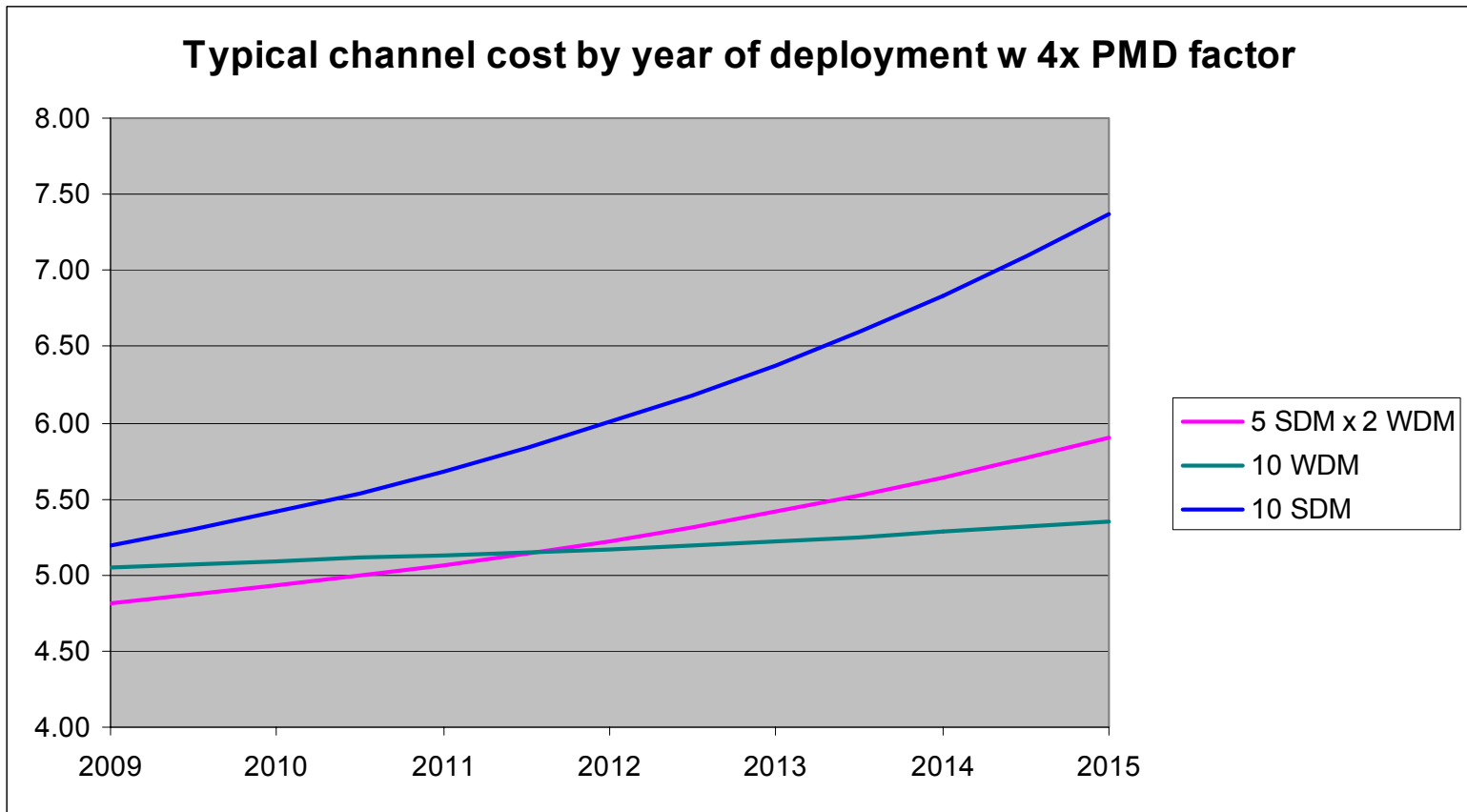


Observations and conclusions

- 5 SDM x 2 WDM attains lowest cost early and maintains it for the critical years of 100G market growth
 - *Best for general Data Center distribution*
- 10 SDM is cost advantaged for non-structured cabling that uses only two patch cords as channel (analysis not shown, but case is clear since its cabling costs are less than that of 12-fiber structured cabling)
 - *Best for Super Computing and Co-located Eqmt.*
- If we define 10 SDM now, will we need to define 5 SDM x 2 WDM later??
 - A PMD proliferation decision
 - Both have their optimal purpose. Which one is best?
 - *Depends on which application(s) we wish to optimize.*

Backup material

Typical channel cost trends – assuming 100GBASE-S = 4 x 10GBASE-S



Note: Previous trend on slide 10 assumed 10 x PMD factor

Effects not included

- **Effect of additional cabling costs from complex topologies**
 - **Only cost of simple cord-cable-cord topologies included**
 - **Including more complex (concatenated cable) topologies would amplify trends**
 - **Increases connection costs (terminations and panels)**