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Optical Fiber and PMD

Reach and Economics for EFM

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EPON P2MP

- Reach calculated for SSMF, ZWPF, NZDF, NDF
- Based on MPN and ISI dispersion-induced limitations at rate up to 1.25 G baud
- Economic Comparison Shown
- *Conclusion:* EFM should reference Standard Single Mode and Zero Water Peak G.652 Fibers

Fiber P2P

- EFM lacks low cost short reach PMD for drop and MDU distribution
- *Conclusion:* Existing MMF Ethernet PMDs should be referenced for short reach P2P.

Optical Fiber and PMD Reach Performance and Economics for EFM

SSMF – Standard Singlemode Fiber

- Low chromatic dispersion at **1310 nm**
- ITU - G.652

ZWPF – Zero Water Peak Fiber

- Same as SSMF, PLUS has **1360 – 1460 nm band for future use**
- ITU – G.652.C

NZDF – Non Zero Dispersion Shifted Fiber

- Low chromatic dispersion at **1550 nm**
- ITU – G.655

NDF – Negative Dispersion Fiber

- Low **negative** chromatic dispersion at **1550 nm**
- ITU – G.655

Optical Fiber and PMD Reach Performance and Economics for EFM

Analysis Assumptions:

MPN power penalty	1.8dB ;
ISI power penalty	1dB
Bitrate	1.25Gb/s ;
BER	10^{-12}
MPN factor	0.8

Fiber dispersion @ 1550nm :

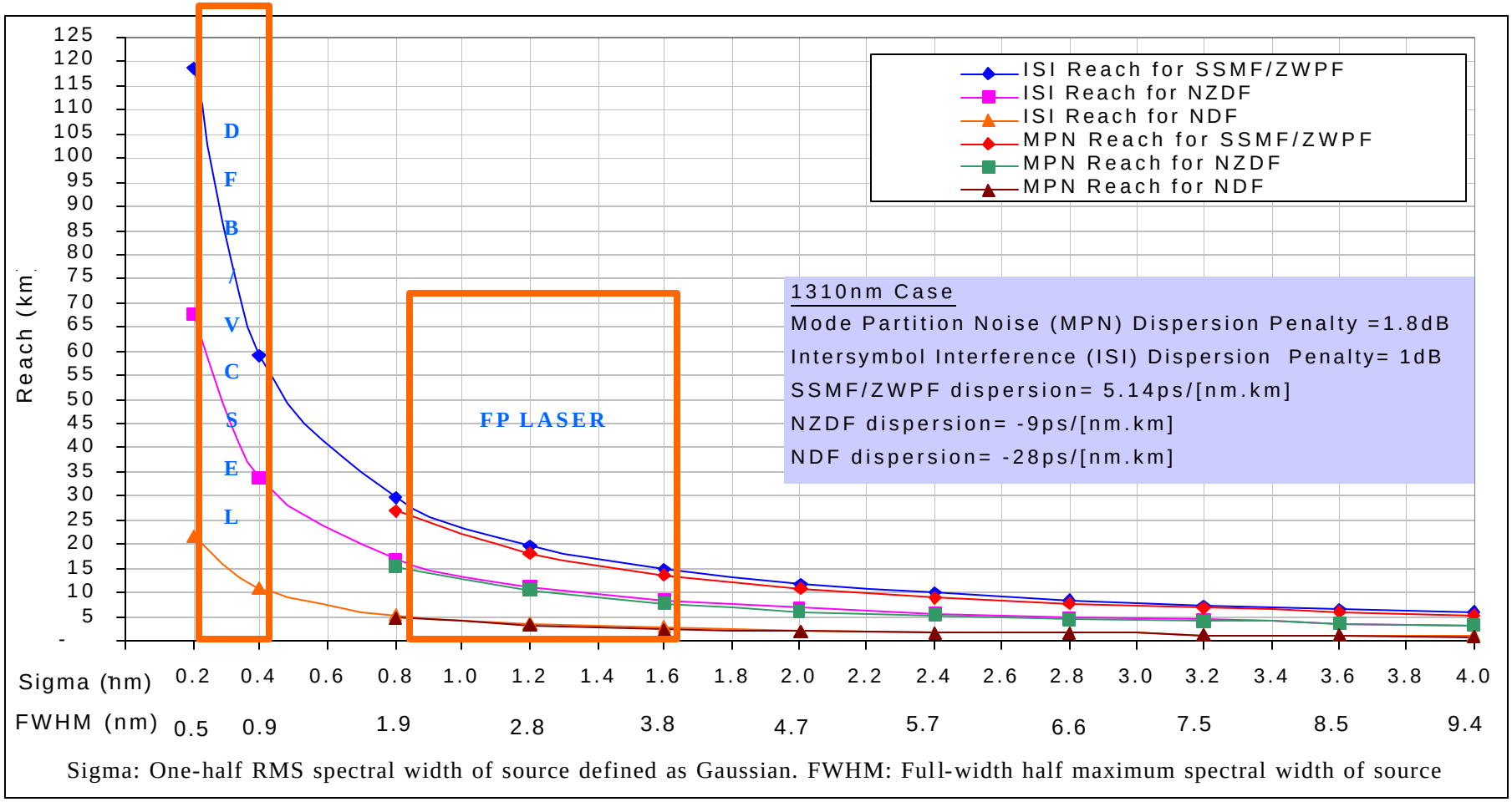
SSMF/ZWPF	17ps/[nm.km]
NZDF	6ps/[nm.km]
	(reduced slope of 0.045 ps/[nm^2.km]
NDF	-8ps/[nm.km]

Fiber dispersion @ 1310nm :

SSMF ZWPF	5.14ps/[nm.km]
NZDF	-9ps/[nm.km] (reduced slope)
NDF	-28ps/[nm.km]

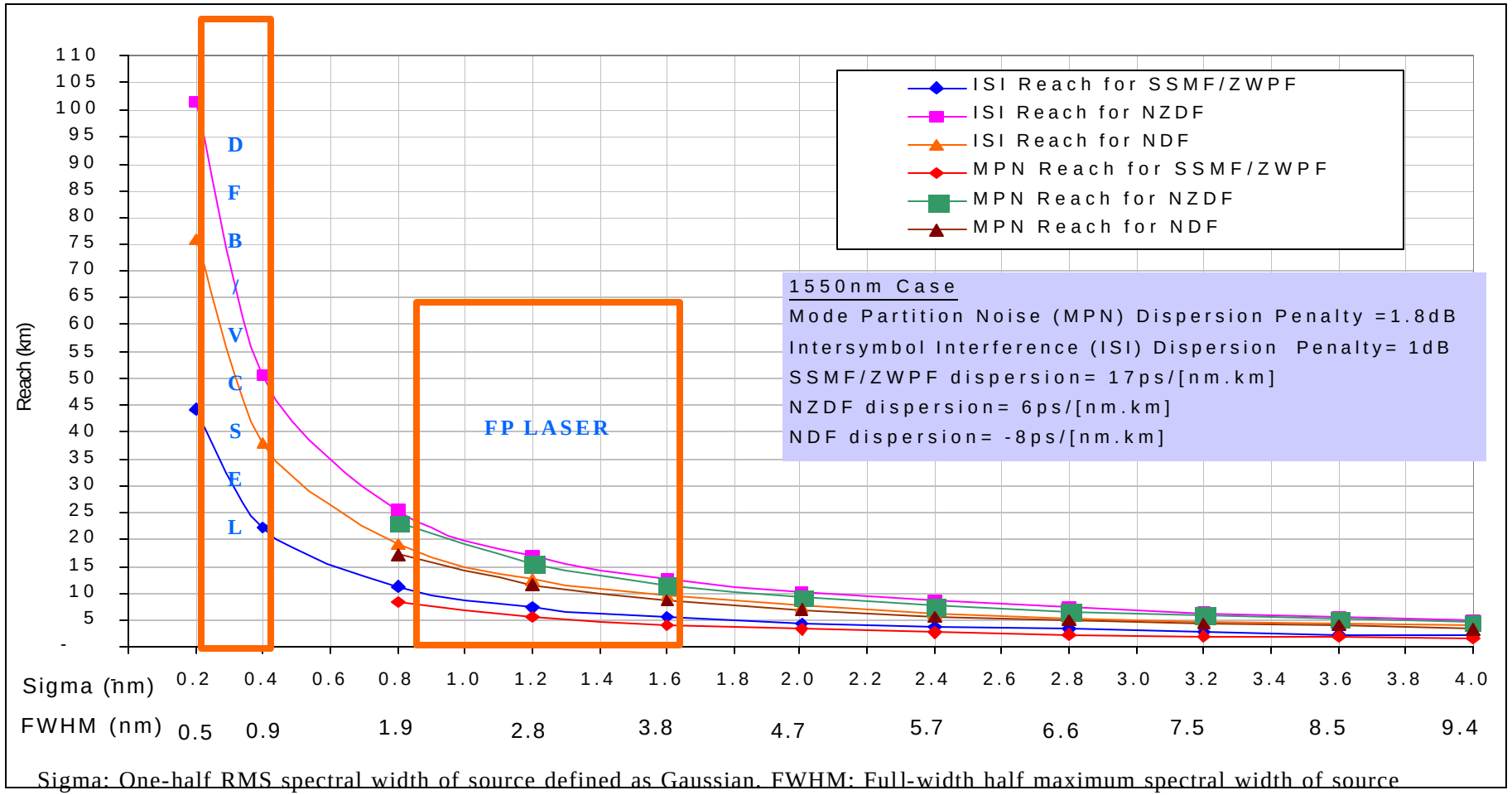
In this analysis, the FWHM spectral width of the DFB/VCSEL source is assumed to vary from ~ 0.5nm – 0.9nm, and for the FP laser, the FWHM spectral width varies from ~2nm – 4nm. Therefore, for the DFB/VCSEL source, Sigma (One-half RMS spectral width of source defined as Gaussian) varies from ~ 0.2nm – 0.4nm. And for the FP laser, Sigma varies from 0.9nm – 1.7nm.

1310nm Case



Sigma: One-half RMS spectral width of source defined as Gaussian. FWHM: Full-width half maximum spectral width of source

1550nm Case



Sigma: One-half RMS spectral width of source defined as Gaussian, FWHM: Full-width half maximum spectral width of source

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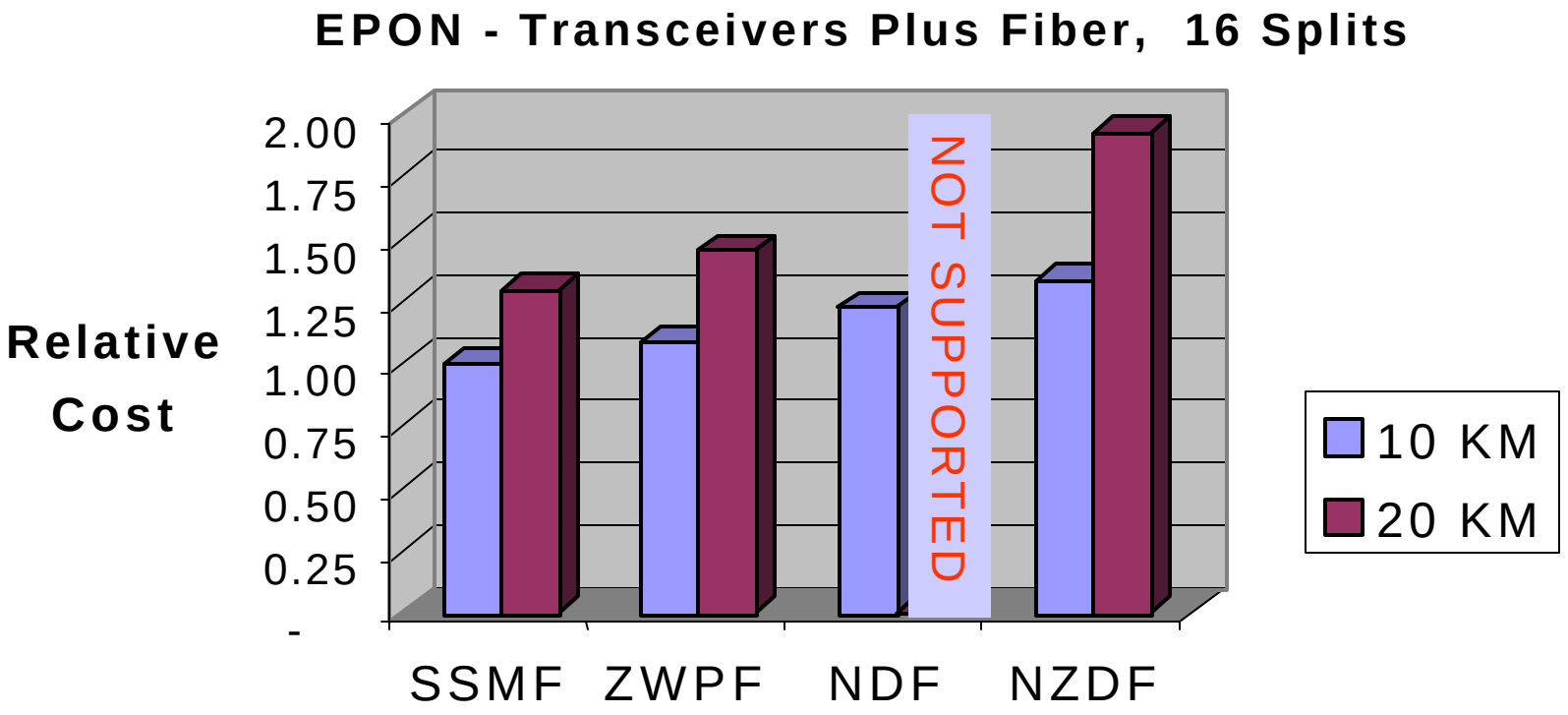
Modeling Results

Worst Case Reach - Dispersion Limited (KM)

	SSMF and ZWPF G.652, G652.C	NZDF G.655	NDF G.655
1310 nm			
DFB/VCSEL	55	32	10
FP	14	8	2
1550 nm			
DFB/VCSEL	21	50	37
FP	4	12	9

- Reaches are dispersion limited for cases below 20 KM and 32 splits.
- SSMF and ZWPF support 1310 FP 10 KM PON.

Optical Fiber and PMD Reach Performance and Economics for EFM



- Downstream 1550 nm DFB in all cases
- Relative Cost per Transceiver

http://grouper.ieee.org/groups/802/3/efm/public/jul01/presentations/diab_1_0701.pdf

- NDF and NZDF fibers ~2X cost of SSMF/ZWPF

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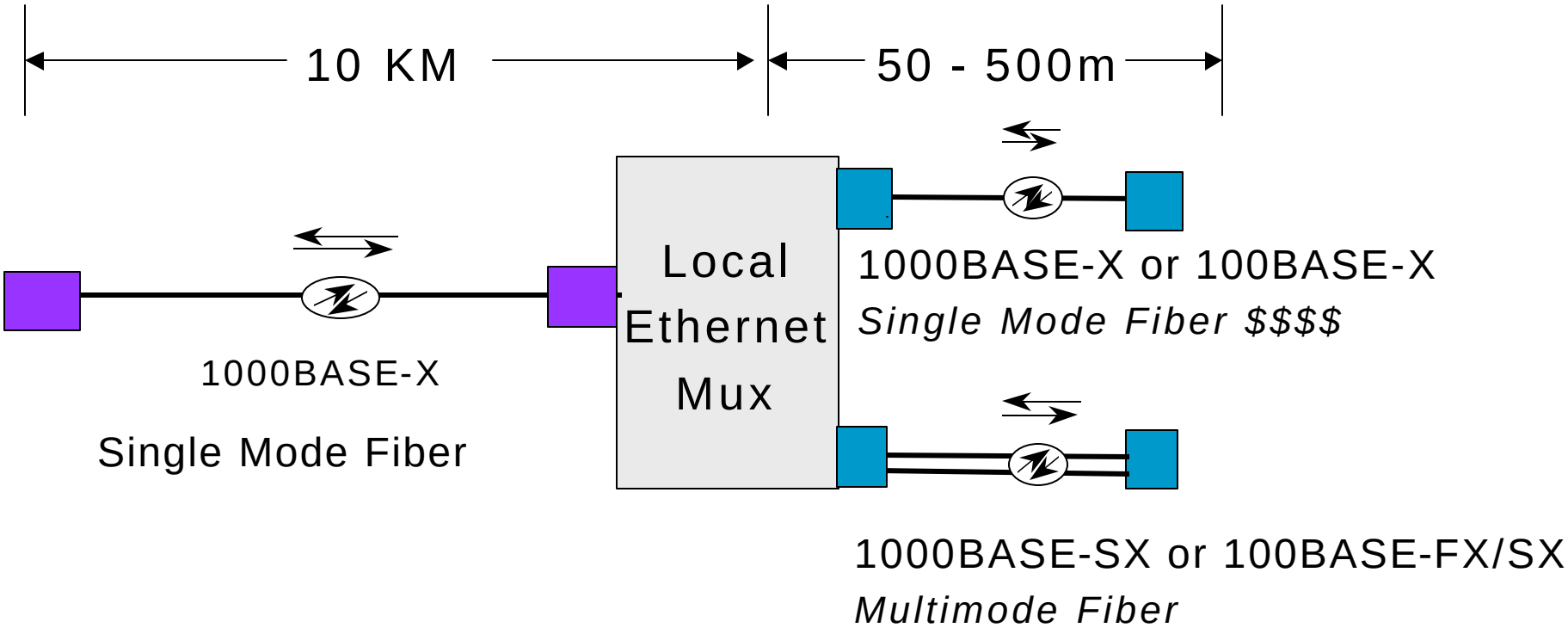
Conclusion

- SSMF and ZWPF provide lowest transceiver plus fiber cost vs NZDF or NDF
- SSMF and ZWPF only solution supporting 1310 nm FP to 10 KM objective
- NDF does not support 20 KM PON
- ZWPF opens E – Band (1360 – 1460 nm) to support future services for both EPON and P2P.
(Low cost WWDM, using 1310, 1400, 1550 nm, 4 additional CWDM channels)

Recommendation

•802.3ae should normatively reference ITU G.652 (SSMF) and ITU G.652.C (ZWPF) as supporting P2MP and P2P EFM Networks

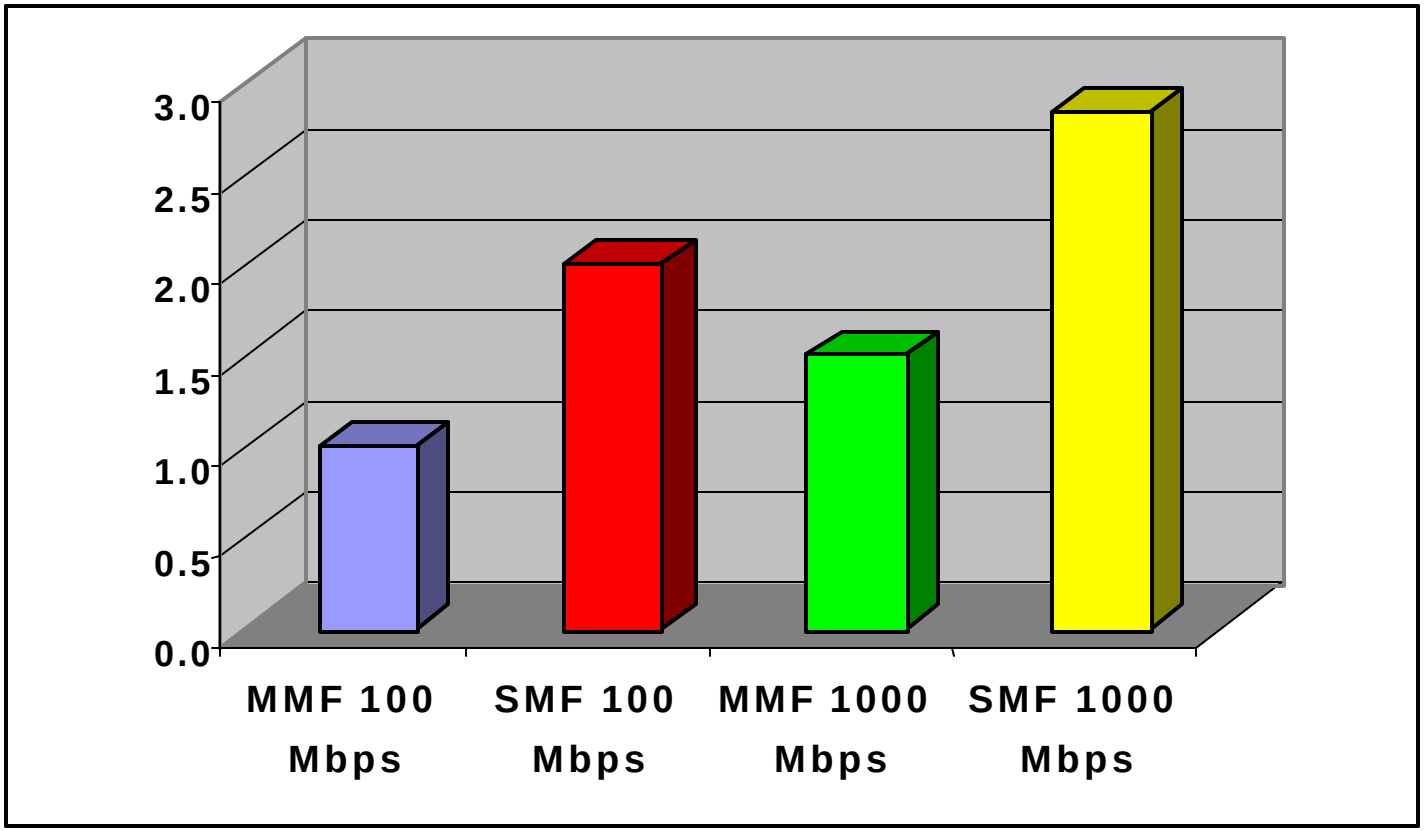
EFM Distribution in MDU Campus and FTTH Drops



EFM should provide lowest cost short reach 100 - 1000 Mbps for MDU campus distribution and drops from local Ethernet Switch

Relative Transceiver Plus Fiber Cost for 100 meter P2P

(2 Transceivers plus fiber cable and connectors)



MMF – LED / VCSEL for 100/1000 Mbps at 850 nm, 2 fiber

SMF – FP or VCSEL at 1310 nm, BIDI 1 fiber

Optical Fiber and PMD Reach Performance and Economics for EFM

Utilize existing IEEE 802.3 PMDs

No "New" PMDs required

	MMF Type	Reach (meters)
100BASE-FX	50 Micron 500/500 MHz-km	2000
100BASE-SX	" "	300
1000BASE-SX	" "	550

Recommendation

•802.3ah should adopt above existing 802.3 100 and 1000 Mbps PMDs to support short reach EFM drops and MDU distribution.