LUMENTUM

Updated 1060nm Data

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802.3ds Task Force Ad Hoc Telephonic Meeting

Supporters

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- Jose Castro, Panduit
- Bill Simms, Nvidia
- Daniel Kuchta, Nvidia
- Chris Cole, Coherent
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- Jeffery Maki, Hewlett Packard Enterprise

This contribution

- Regarding 1060 nm optimized fiber bandwidth (a combination of modal and chromatic)
  - Previously presented “OM1060” which was screened OM2 for 1060 nm peak → ~3,000 MHz-km
  - Measured Lightera specifically 1060 nm optimized 50 μm core fiber (L1060) → ~5,200 MHz-km

    L1060 type fiber potentially can support 200G 50 m and possibly 100 m transmission

S21 of L1060 using 1060nm Lumentum VCSEL

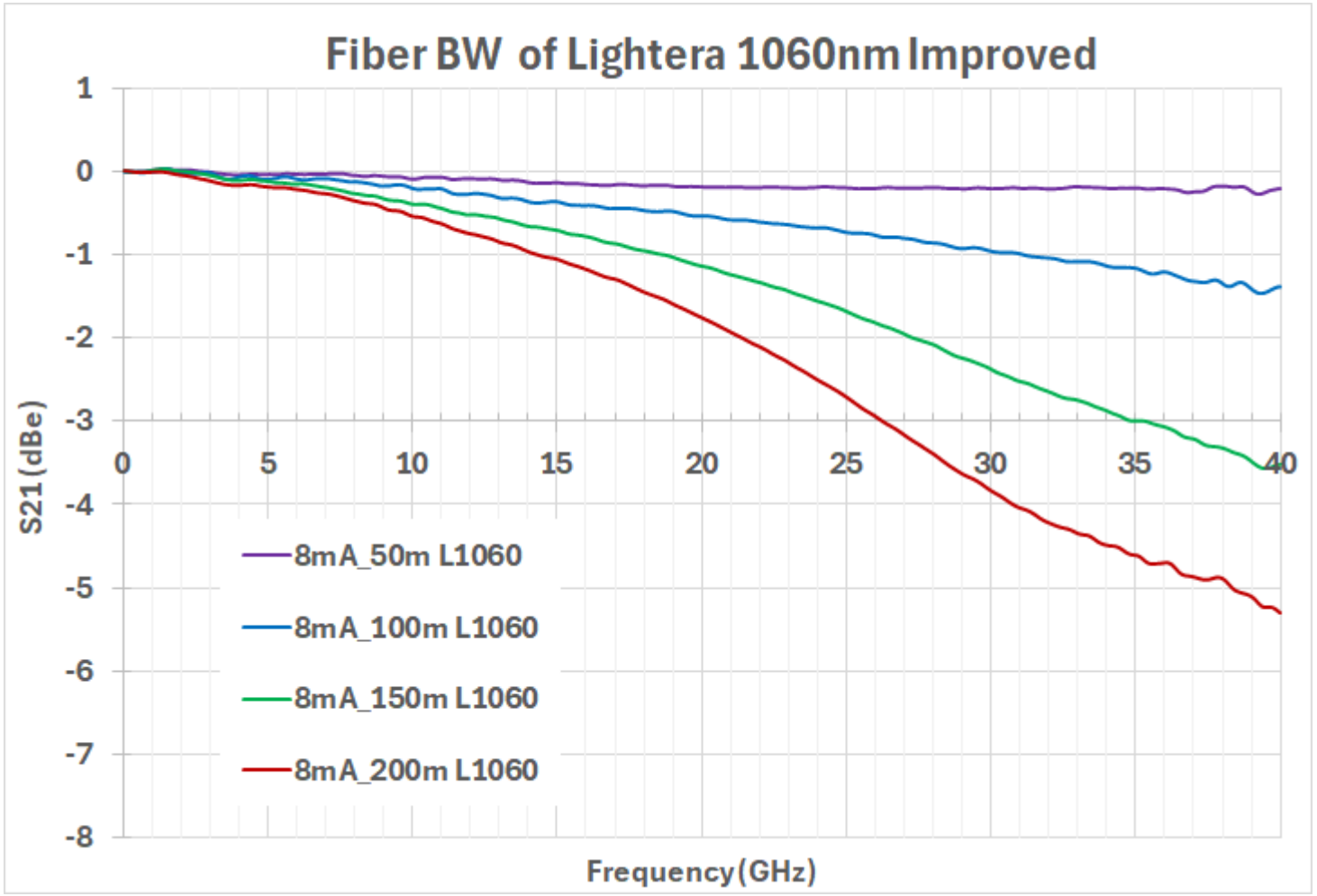
All fiber BW includes both modal and chromatic

Measurement Method

1. Lumentum 1060nm VCSEL with 0.45 nm RMS spectral width at Ibias 8 mA
2. Measured S_{21} using 1 m OM5
3. Measured S_{21} with different fiber lengths
4. Subtracted the 1 m OM5 S_{21} to remove component of laser and equipment

Results

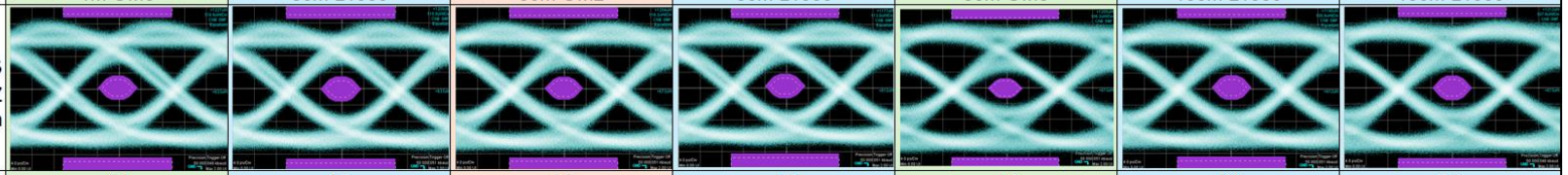
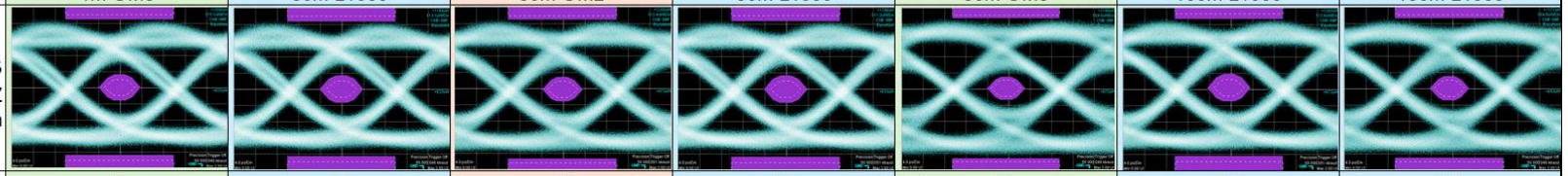
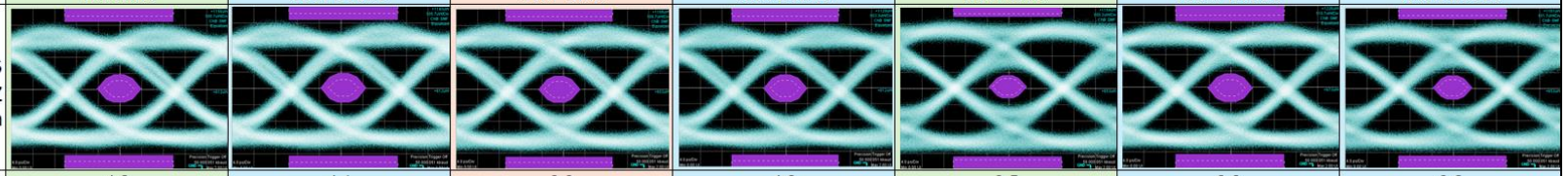
- ~5,200 MHz-km effective BW (-3 dBe)
- Minimal penalty over 50 m to 40 GHz



50Gbs NRZ transmitted by L1060

RMS Spectral Width 0.40nm

0.52nm

Temp. (C)	25C						
Fiber	1m OM5	30m L1060	30m OM2	50m L1060	50m OM5	100m L1060	150m L1060
8mA Ibias 50Gbs NRZ Eye Digram							
ER (dB)	4.4	4.3	4.0	4.3	3.7	4.1	3.8
Eye margin (%)	**12.0**	**13.2**	**10.6**	**13.7**	**6.8**	**12.7**	**12.5**
Tr (ps)	10.6	10.7	12.3	11.0	13.4	11.9	13.0
Tf (ps)	11.9	11.9	13.1	12.1	14.2	12.9	13.9
Crossing (%)	47.1	47.2	47.7	47.3	48.2	47.9	48.3
Fiber	1m OM5	30m L1060	30m OM2	50m L1060	50m OM5	100m L1060	150m L1060
9mA Ibias 50Gbs NRZ Eye Digram							
ER (dB)	4.3	4.2	3.9	4.2	3.6	3.9	3.7
Eye margin (%)	**15.3**	**17.5**	**12.9**	**17.2**	**10.5**	**16.6**	**11.9**
Tr (ps)	10.2	10.3	11.8	10.6	13.3	11.4	12.7
Tf (ps)	11.4	11.5	12.7	11.8	14.1	12.4	13.5
Crossing (%)	47.4	47.6	48.0	47.6	48.5	48.1	48.4
Fiber	1m OM5	30m L1060	30m OM2	50m L1060	50m OM5	100m L1060	150m L1060
10mA Ibias 50Gbs NRZ Eye Digram							
ER (dB)	4.2	4.1	3.9	4.0	3.5	3.8	3.6
Eye margin (%)	**18.8**	**20.2**	**16.4**	**18.6**	**10.5**	**19.6**	**12.7**
Tr (ps)	10.0	10.1	11.4	10.4	13.4	11.2	12.9
Tf (ps)	11.3	11.4	12.2	11.5	14.1	12.1	13.6
Crossing (%)	47.7	47.9	48.1	48.0	48.6	48.1	48.7

OM5
OM2
L1060

Eye-Margin at 50Gb/s NRZ same for Back-to-Back and 100m L1060 fiber

The case for 1060 nm optimized MMF

- MMF at 1060 nm has lower chromatic dispersion than at 850 nm
  - e.g. at 850 nm, D = -98.5 ps/nm/km and BWcd = 3,164 MHz-km
  - at 1060 nm, D = -36.3 ps/nm/km and BWcd = 11,462 MHz-km

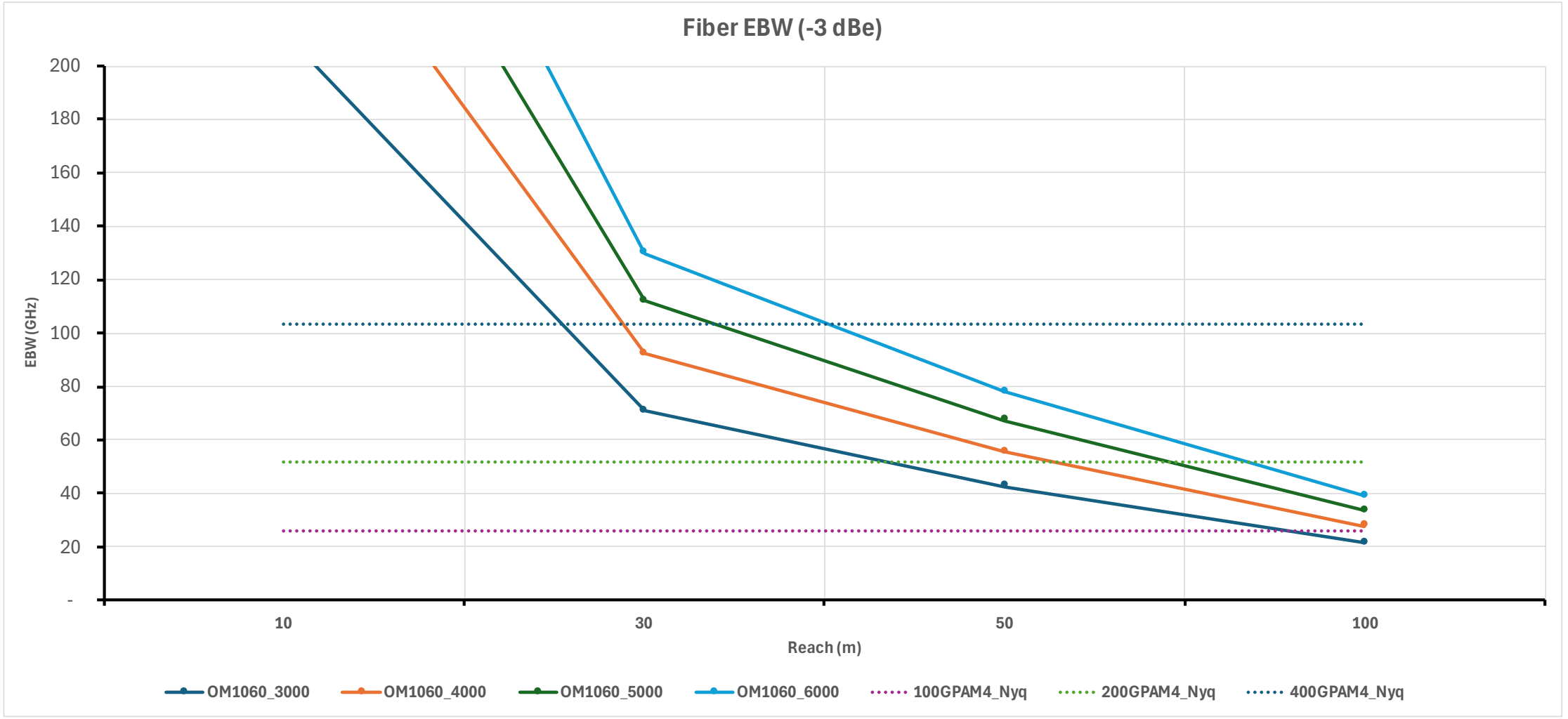
- This means that effective BW (BWeff) is higher for the same modal BW (EMB)
  - e.g. for EMB of 4700 MHz-km
    - at 850 nm, BWeff(optical) = 2,627 MHz-km, BWeff(elec) = 1,925 MHz-km
    - at 1060 nm, BWeff(optical) = 4,349 MHz-km, BWeff(elec) = 3,188 MHz-km

- This higher MMF bandwidth of 1060 nm optimized fiber means:
  - opportunity for lower EMB 1060 nm fiber with potentially higher yield
  - higher data rate capability for the same reach, or longer reach at the same rate
  - potential for higher data rates over useful reaches, e.g., 400G over 30 m?

Calculated Effective BW (-3dBe) for speculative 1060 nm fibers

Spectral width 0.45 nm, EMB 3000/4000/5000/6000 MHz-km

$$EBW\_GHz = \frac{0.733}{L} \times [BWcd^{-2} + EMB^{-2}]^{-1/2}$$



Proposed baseline tables for 1060 nm fiber

Table Cl#-aa Fiber optic cabling (channel) characteristics

Description	OM4	OM4+	OM1060	Unit
Operating distance (max)	50			m
Cabling skew (max)	39.5			ns
Cabling skew variation (max)	1.2			ns
Channel insertion loss (max)	1.7			dB
Channel insertion loss (min)	0			dB

Table Cl#-bb Optical fiber and cable characteristics

Description	OM4	OM4+	OM1060	Unit
Nominal core diameter	50		tbd	um
Nominal fiber specification wavelength	850	868	1060	nm
Effective modal bandwidth at nominal fiber specification wavelength (min)	4700	5200	tbd	MHz*km
Cabled optical fiber attenuation (max)	3			dB/km
Zero dispersion wavelength (λ0)	1297 <= λ0 <= 1328			nm
Chromatic dispersion slope (max) (S0)	-412 / (840(1-(λ0/840)^4))			ps/nm^2 km

Summary

- Measured Lightera 50 μm core MMF optimized for 1060 nm (L1060) → ~5,200 MHz-km
- Plan to measure 1060 nm optimized small-core (<30um) MMF from 2 suppliers over the next few weeks
- Proposed to add L1060 fiber to the 802.3ds baseline tables for optical fiber and cable characteristics