Adding wideband MMF to 400GBASE-SR16

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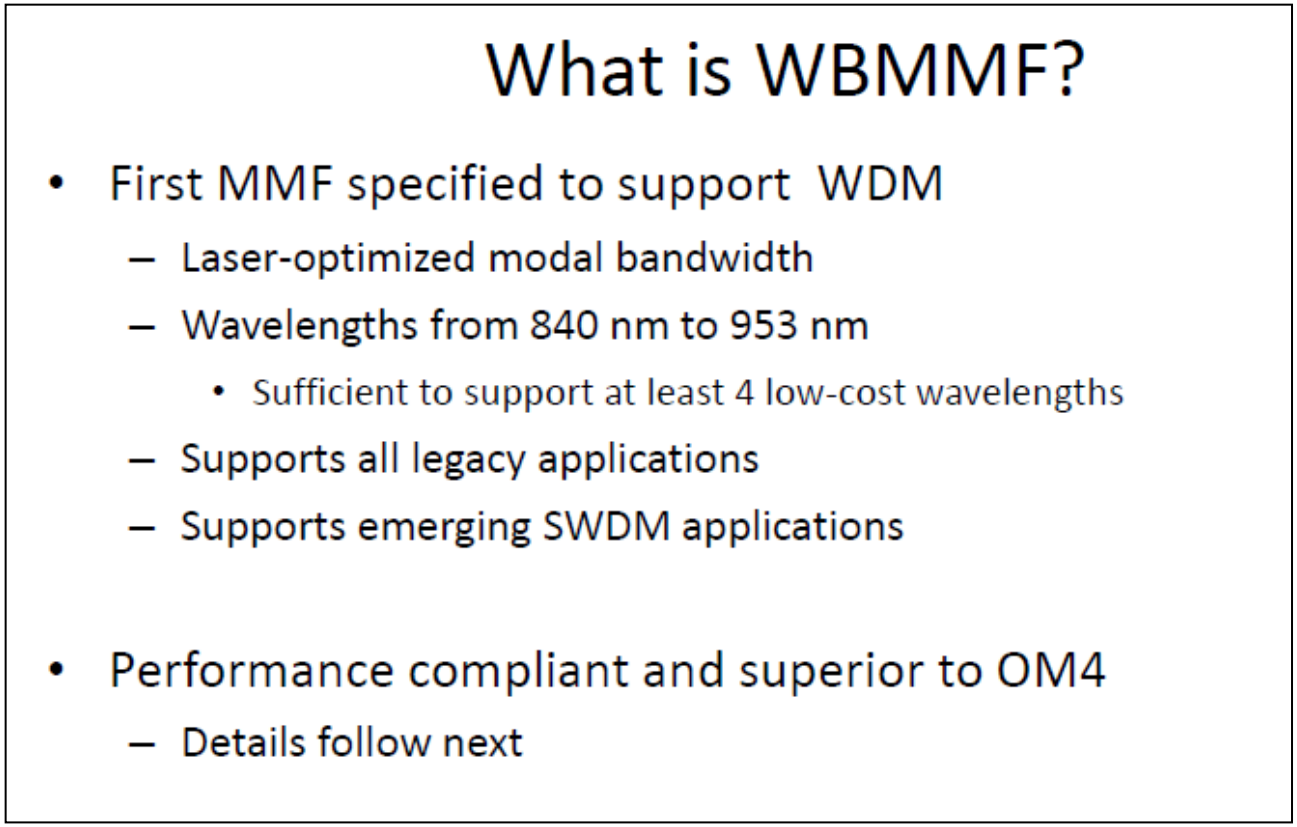
Introduction

- As reported in July, in kolesar_3cd_01_0716, the TIA has published its specification for wideband MMF, TIA-492AAAE.



  - Supports all legacy 840 to 860 nm products with performance equivalent or superior to OM4

* www.ieee802.org/3/cd/public/July16/kolesar_3cd_01_0716.pdf

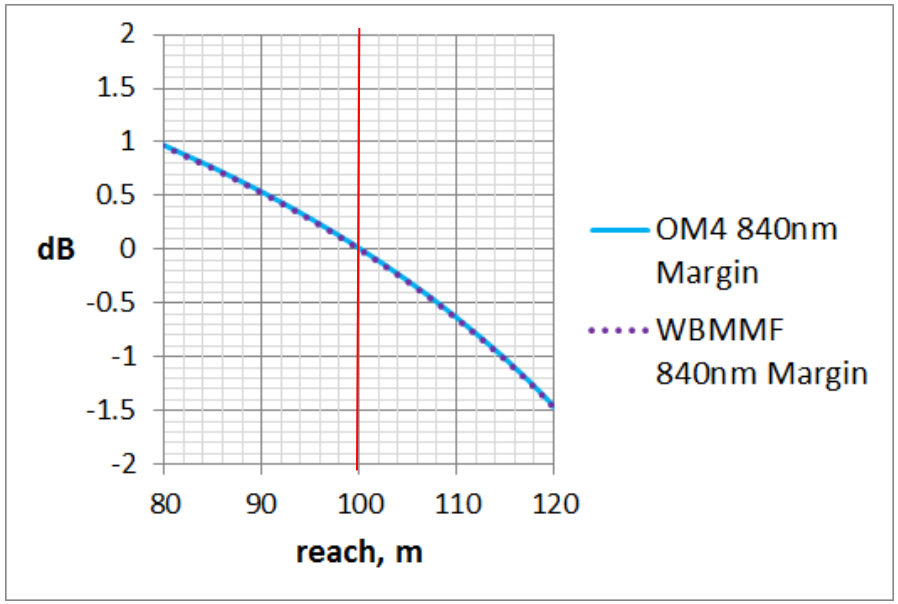
Summary

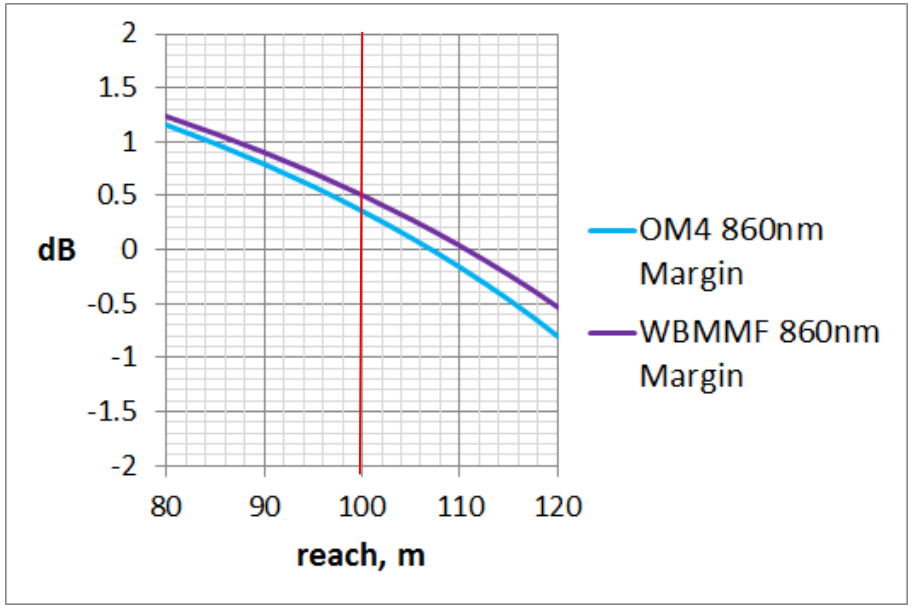
- Published spec's for wideband MMF used to confirm link closes for 400GBASE-SR16 over 100 m of wideband MMF
  - Spreadsheet link model, mirroring adopted link model for Clause 95, and Clause 123
  - Inputs to model:
    - EMB and chromatic dispersion values for wideband MMF taken from kolesar_3cd_01_0716 (which summarizes the technical detail in TIA-492AAAE)
    - Same Tx and Rx parameter values as were used for 400GBASE-SR-16 modeling

- **Conclusion**:
  - Current link model approach predicts 400GBASE-SR16 specs will permit a max reach of at least 100 m on wideband MMF

OM4 and wideband MMF with 400G-SR16 specs

- Link margin vs reach for OM4 and wideband MMF





- At 840 nm, wideband MMF matches OM4 performance.
- At longer wavelengths, wideband MMF has slightly better link margin than OM4.

Changes to 802.3bs Draft 2: Amendment to Clause 1.3

- Add TIA-492AAAE to the list of referenced normative standards in clause 1.3:

- TIA-492AAAE:2016 Detail Specification for 50-µm Core Diameter/125-µm Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers with Laser-Optimized Bandwidth Characteristics Specified for Wavelength Division Multiplexing

Changes to 802.3bs Draft 2: Clause 123.7

- Add wideband MMF fibre type to '123.7 PMD to MDI optical specifications for 400GBASE-SR16':

- In Table 123–5, add a row '0.5 to 100 m for wideband MMF'

Table 123–5—400GBASE-SR16 operating range

PMD type	Required operating range[a]
400GBASE-SR16	0.5 m to 70 m for OM3
	0.5 m to 100 m for OM4

Changes to 802.3bs Draft 2: Clause 123.10

- In Table 123–6, add a column for wideband MMF with the entries
  - 'Operating distance' 100 m
  - 'Channel insertion loss (max)' 1.9 dB
  - Channel insertion loss (min) 0 dB

Table 123–6—Fiber optic cabling (channel) characteristics for 400GBASE-SR16

Description	OM3	OM4	Unit
Operating distance (max)	70	100	m
Channel insertion loss[a] (max)	1.8	1.9	dB
Channel insertion loss (min)	0		dB

[a]These channel insertion loss values include cable loss plus 1.5 dB allocated for connection and splice loss, over the wavelength range 840 nm to 860 nm.

Changes to 802.3bs Draft 2: Clause 123.11

- In Table 123–7, add spec column for wideband MMF cabling characteristics
  - Head of column title 'Wideband MMF[c]'
  - Footnote 'c' becomes 'TIA-492AAAE'
  - Add footnote 'd' 'When measured with the launch conditions specified in Tale 95-6'
  - 'Nominal core diameter' 50 um
  - 'Nominal fiber specification wavelength' 850 nm
  - 'Effective modal bandwidth' 4700 MHz.km
  - 'Cabled optical attenuation' 3.5 dB/km
  - 'Zero dispersion wavelength (λ_0)' $1297 \le \lambda_0 \le 1328$ nm
  - 'Chromatic dispersion slope (max) (S_0) $\le 4(-103)/(840(1-(\lambda_0/840)^4))$ ps/nm^{2}km

Table 123–7—Optical fiber and cable characteristics

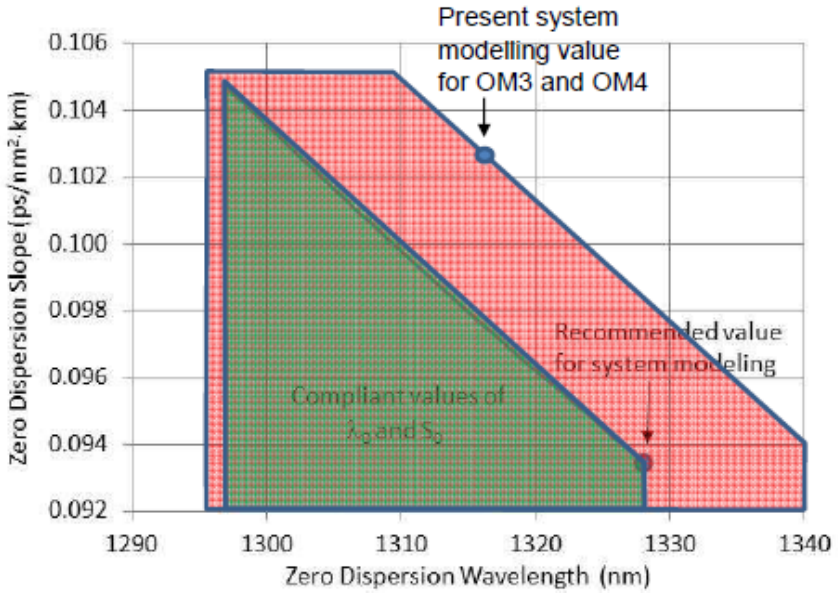
Description	OM3[a]	OM4[b]	Unit
Nominal core diameter	50		µm
Nominal fiber specification wavelength	850		nm
Effective modal bandwidth (min)[c]	2000	4700	MHz.km
Cabled optical fiber attenuation (max)	3.5		dB/km
Zero dispersion wavelength (λ_0)	$1295 \le \lambda_0 \le 1340$		nm
Chromatic dispersion slope (max) (S_0)	0.105 for $1295 \le \lambda_0 \le 1310$ and $0.000375 \times (1590 - \lambda_0)$ for $1310 \le \lambda_0 \le 1340$		ps/nm^2 km

[a]IEC 60793-2-10 type A1a.2
[b]IEC 60793-2-10 type A1a.3
[c]When measured with the launch conditions specified in Table 95–6

Back up

WBMMF – chromatic dispersion specs

Improved Chromatic Dispersion Spec



Chromatic dispersion specification for wide band fiber tightened from the red region (OM3 & OM4) to the green region.

Increases chromatic bandwidth by 5%, reducing ISI, MPN and Pcross penalties.

The following values recommended for system modeling:
λ_0 = 1328 nm
S_0 = 0.093477 ps/nm^2 ·km
(worst case for all relevant wavelengths)

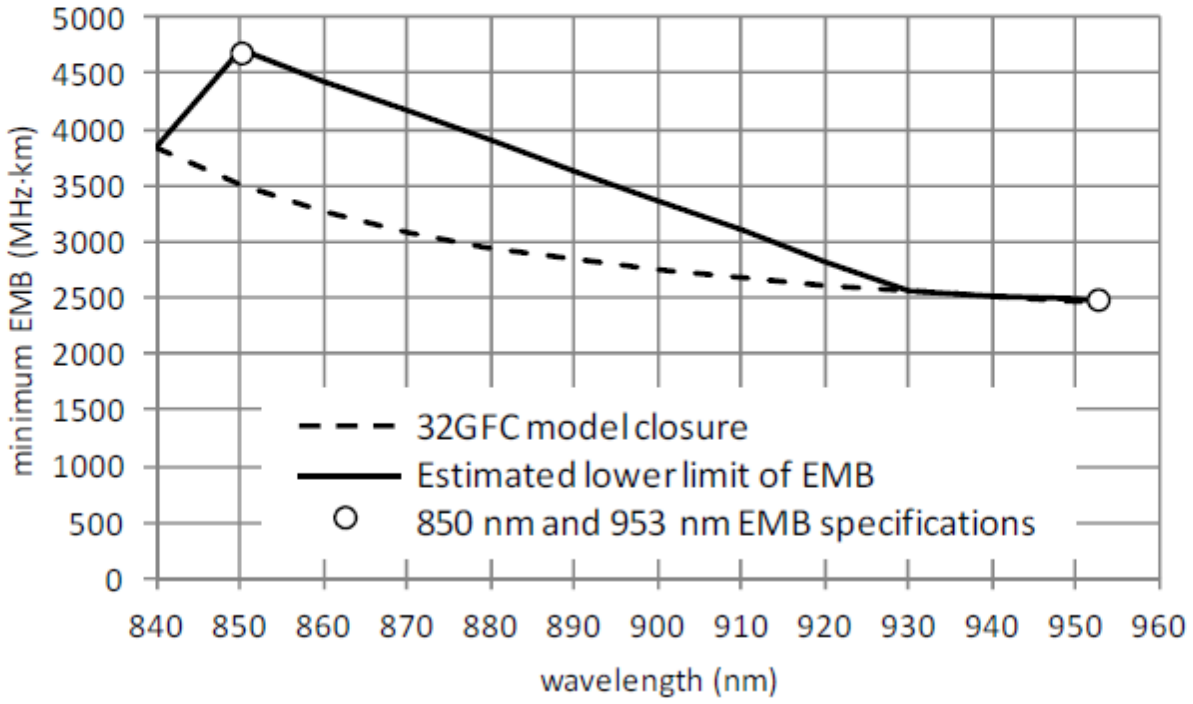
Specification limits:
ZDW (λ_0): $1297 \le \lambda_0 \le 1328$ nm
ZDS (S_0): $S_0 \le 4(-103)/(840(1-(\lambda_0/840)^4))$ ps/nm^{2}km

Extract from kolesar_3cd_01_0716

WBMMF EMB

Effective Modal Bandwidth Characteristics

- Informatively and conservatively specified over full wavelength range



Extract from kolesar_3cd_01_0716

Tx and Rx inputs to link model

Parameter	Value	Units	Notes
Signaling rate	26.5625 +/- 100ppm	GBd	
Centre wavelength range	840 to 860	nm	
Spectral width	0.6	nm	
Rise fall time	21	ps	Input to link model, not a spec *
Tx OMA at max TDP	-3	dBm	Input to link model, not a spec *
$RIN_{12}OMA$	-128	dB/Hz	
RIN coefficient	0.7		
MPN coefficient	0.3		
Extinction Ratio	3	dB	Input to link model, same value used in Clauses 95 and 123 *
Tx reflectance	-12	dB	
Modal noise penalty	0.12	dB	Same value used in link model for Clause 123 *
Receiver sensitivity	-11.5	dBm	at BER of 2.4×10^{-4}
Receiver bandwidth	18.047	GHz	Input to link model, not a spec *
Target Q	3.492		For target BER of 2.4×10^{-4}

* see for example 802.3bs web pages, MMF ad hoc records for April 15th 2015 "Scaling 100G SR4", petrilla_01_0415_mmf