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New Category Proposal: 2km SMF link

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Proposal Objectives

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Objective

- *To propose cheaper solution for very short reach*
- *In this material we propose 2-km 1310nm SMF link*

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Transceiver and Optical Devices

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Possible optical devices

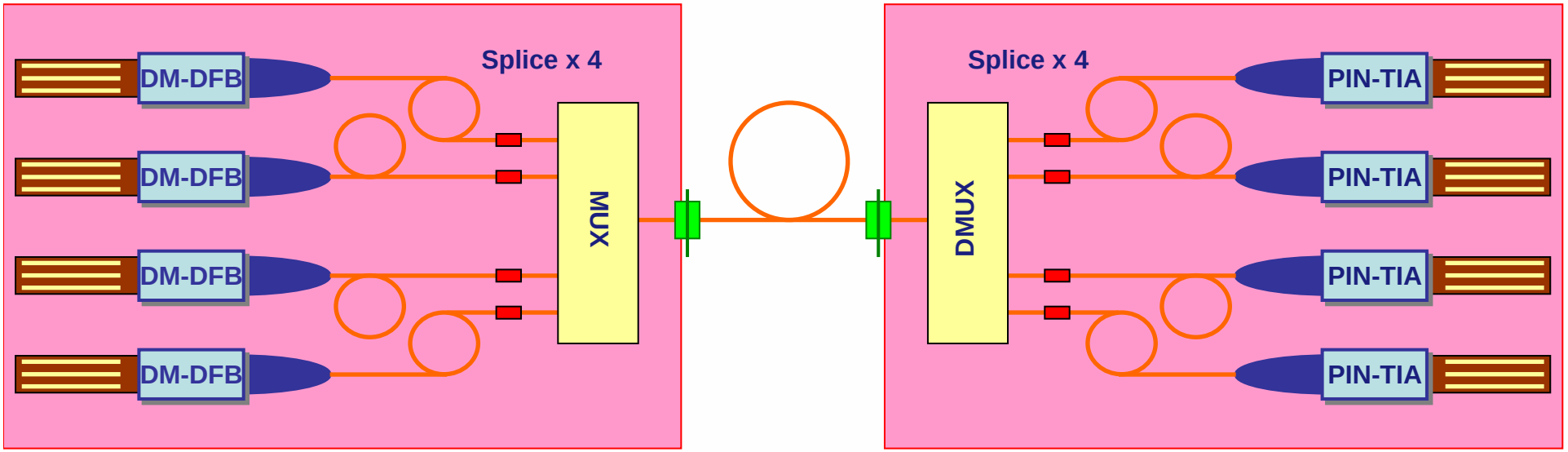
- ***DM-DFB (Direct modulation DFB laser)***
  - ***10 Gbit/s 1310 nm DM-DFB is available in the market***
  - ***40Gbit/s DM-DFB waveforms have been demonstrated at a research level***
  - ***25Gbit/s 2km DM-DFB is possible using current material .***
    - ***We need breakthrough to achieve 10km transmission (see the next foil)***

Why our proposal is 2km?

- ***Breakthrough is required for 10km transmission***
  - ***Especially to achieve lower chirp with higher relaxation frequency (~2.5 times) that is determined mainly quantum well material of active layer. We may have to develop new material.***
  - ***Using established current material for 10Gbit/s, we can achieve 2km transmission.***

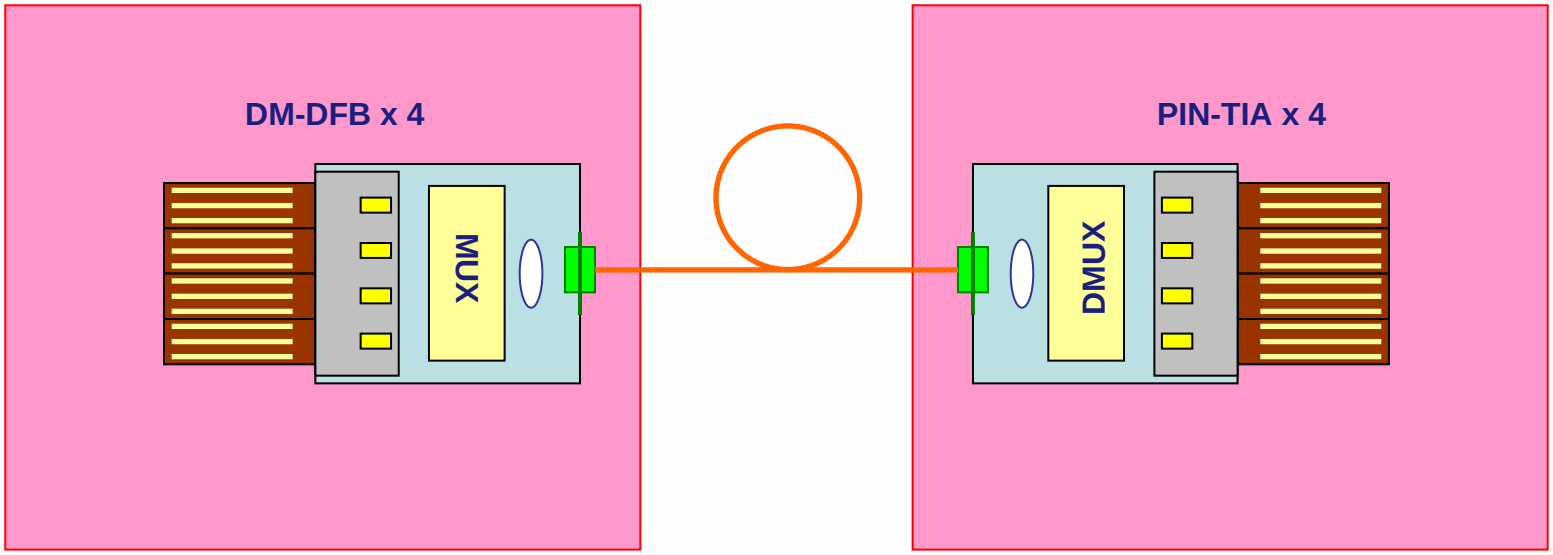
Possible Transceiver

- ***The most commercially available solution today and maybe 2009***
  - ***Use of discrete (separate) 1310nm DM-DFB components***
  - ***Use of discrete (separate) PIN-TIA components***
  - ***Use of Optical MUX/DMUX connected using fiber splicing to optical components.***



Ultimate Future Transceiver

- ***The most aggressive scheme is multi-channel uncooled integrated optical components***
  - ***Challenge (Breakthrough): Low cross-talk multi-channel packaging***
  - ***Easier packaging than EA-DFB because DM-DFB has one electrode device while EA-DFB is two electrode one.***



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Optical Specifications Proposal

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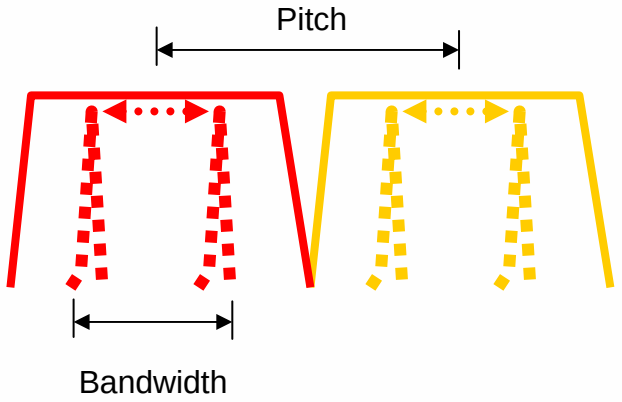
Wavelengths

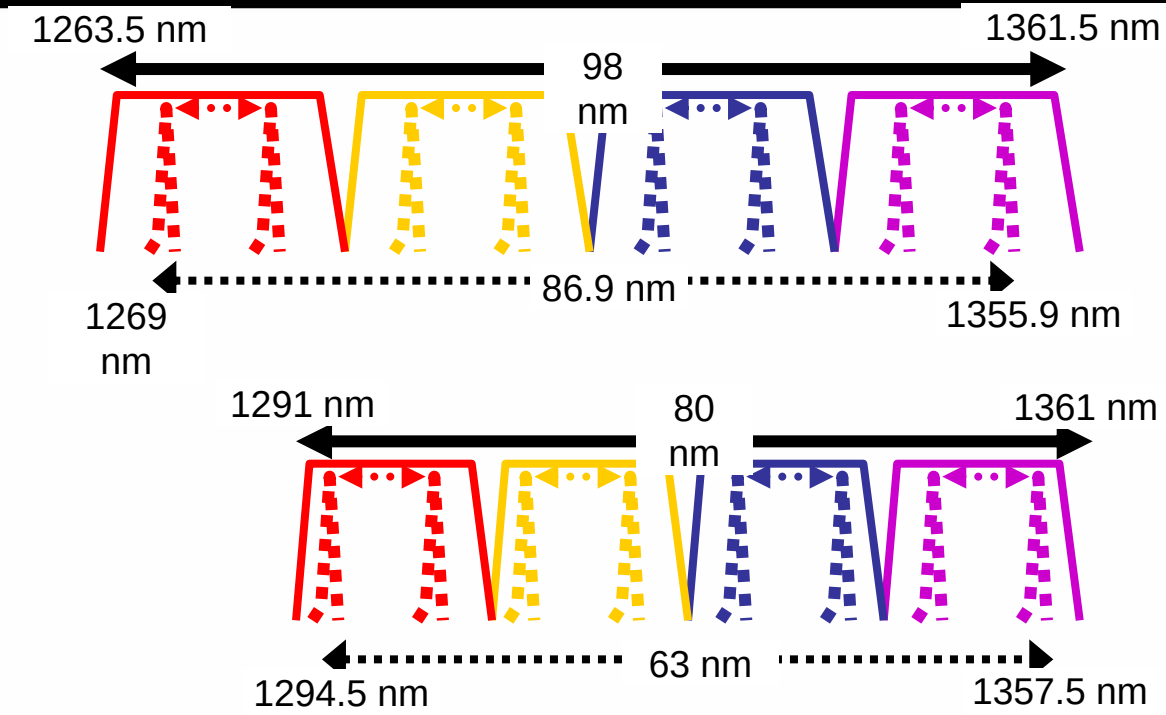
- We recommend ITU-T CWDM wavelengths as proposed for 10-km link
  - To keep compatibility with 10km
  - To allow to use same receiver as 10km
  - To use the same optical MUX/DMUX as 10km

Unit = nm	CWDM	LX4
CH0	1291	1275.7
CH1	1311	1300.2
CH2	1331	1324.7
CH3	1351	1349.2
Channel pitch	20	24.5
Channel bandwidth	13	13.4



- Good rule of thumb is 0.1nm wavelength drift per degree C
- ITU/CWDM spacing allows for 130 degC operating range
- LX4 wavelength spacing allows for 134 degC operating range

Wavelength Range



- Two primary factors in the emitted wavelength of a DFB
  - Active Layer Gain Region
    - Very difficult to grow a spectrally very wide gain region -- 63nm is easier than 87nm
  - DFB grating pitch:
    - Precise control allows for narrow spectral linewidth and “native” wavelength
- Dispersion tolerance correlates to the wavelength spread
  - ITU wavelength spacing minimizes distance from the lambda-zero point of G.652 fiber

Dispersion Penalty

- Using high chirp DM-DFB and wide wavelength range, we believe that dispersion penalty should be consider if we will use DM-DFB with current material.
- We propose dispersion penalty of 2dB.

IEEE Related Specification (I)

- Test Point (TP2, TP3) [1] Figure 52-2, “Std 802.3ae-2002”

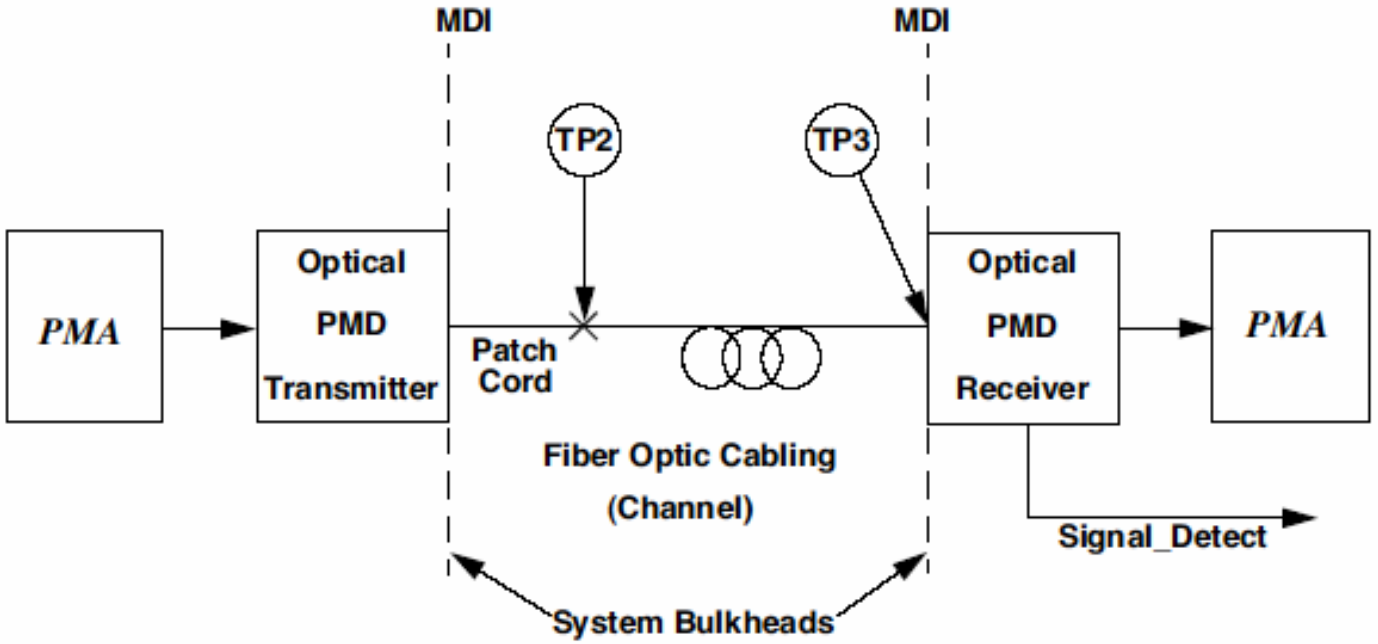


Figure 52–2—Block diagram

IEEE Related Specification (II)

- The Channel insertion loss is 2.8dB for 1310nm 2km link cabling based on 52.14.2 Optical link connection in “Std 802.3ae-2002”
  - “the 0.4 dB/km attenuation for optical fiber cables is defined in ITU-T G.652.”
  - “2 dB total connection and splice loss at 1310 nm”
  - Thus 0.4 x 2 + 2 = 2.8dB

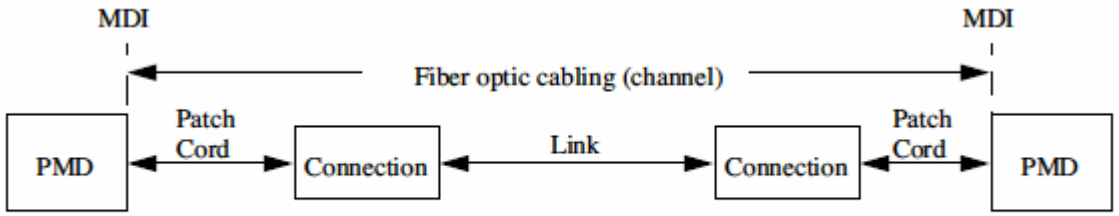


Figure 52–14—Fiber optic cabling model

Receiver Sensitivity

- We propose the same level as 10km, which allow the same design and keep upgradeability.

	Proposal for 2-km link		10-km proposed		
Per lane	*OMA* (dBm)	Loss (dB)	*OMA* (dBm)	Loss (dB)	
10 Gbit/s	-14.9		-14.9		BOL
25 Gbit/s	-10.9	(4.0)	-10.9	(4.0)	
DMUX + Splice loss		2.7		2.7	
Aging + Accuracy + Interoperability		1.5		1.5	
TP3	-6.7		-6.7		EOL

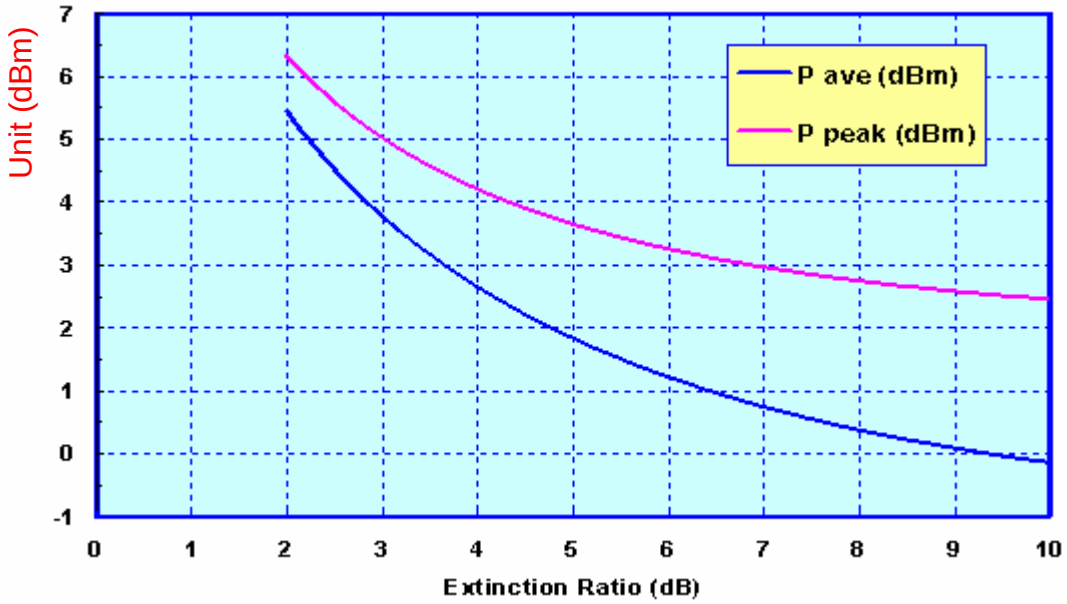
Transmitter Output Power

- We propose the same level as 10km except connection loss and penalty.

	Proposal for 2-km link		10-km proposed		
Per lane	*OMA* (dBm)	Loss (dB)	*OMA* (dBm)	Loss (dB)	
TP3	-6.7		-6.7		EOL
TP2 connector		0.2		0.2	
Connection loss		2.8		6.0	
Penalty		2.0		1.0	
TP2	-1.7		+0.5		EOL
MUX + Splice		2.7		2.7	
Aging + Accuracy		1.0		1.0	
DM-DFB out	+2.0		+4.2		BOL

Extinction Ratio

- Transmit OMA of +2.0 dBm is equivalent to output peak power depending on extinction ratio (Er) shown below.
- Er equal or larger than 3.5 dB is obtained with realistic average output power of BOL=3 dBm with 1dB margin.



Link Budget Summary

- Transmitter

	min	Proposal	10km proposed	10GBASE-L
T_OMA min , per lane	dBm	-1.7	+0.5	-5.2
T_OMA max , per lane	dBm	+2.3	+4.5	NA
T_Avg max , four lanes	dBm	+9.5 (*1)	+9.5 (*1)	0.5
Er min	dB	3.5	7.0	3.5

- Receiver

	min	Proposal	10km proposed	10GBASE-L
R_OMA min , per lane	dBm	-6.7	-6.7	-12.6
R_OMA max , per lane	dBm	+2.3	+4.5	NA
Dispersion Penalty max	dB	2.0	1.0	(1.0)

- Link Budget

	min	Proposal	10km proposed	10GBASE-L
Link Power Budget	dB	5.0	7.2	7.4
Channel Insertion Loss	dB	3.0	6.2	6.2
Margin for Penalty min	dB	2.0	1.0	1.2

Note (*1): Limited by Eye safety