Approach for 40km PMD

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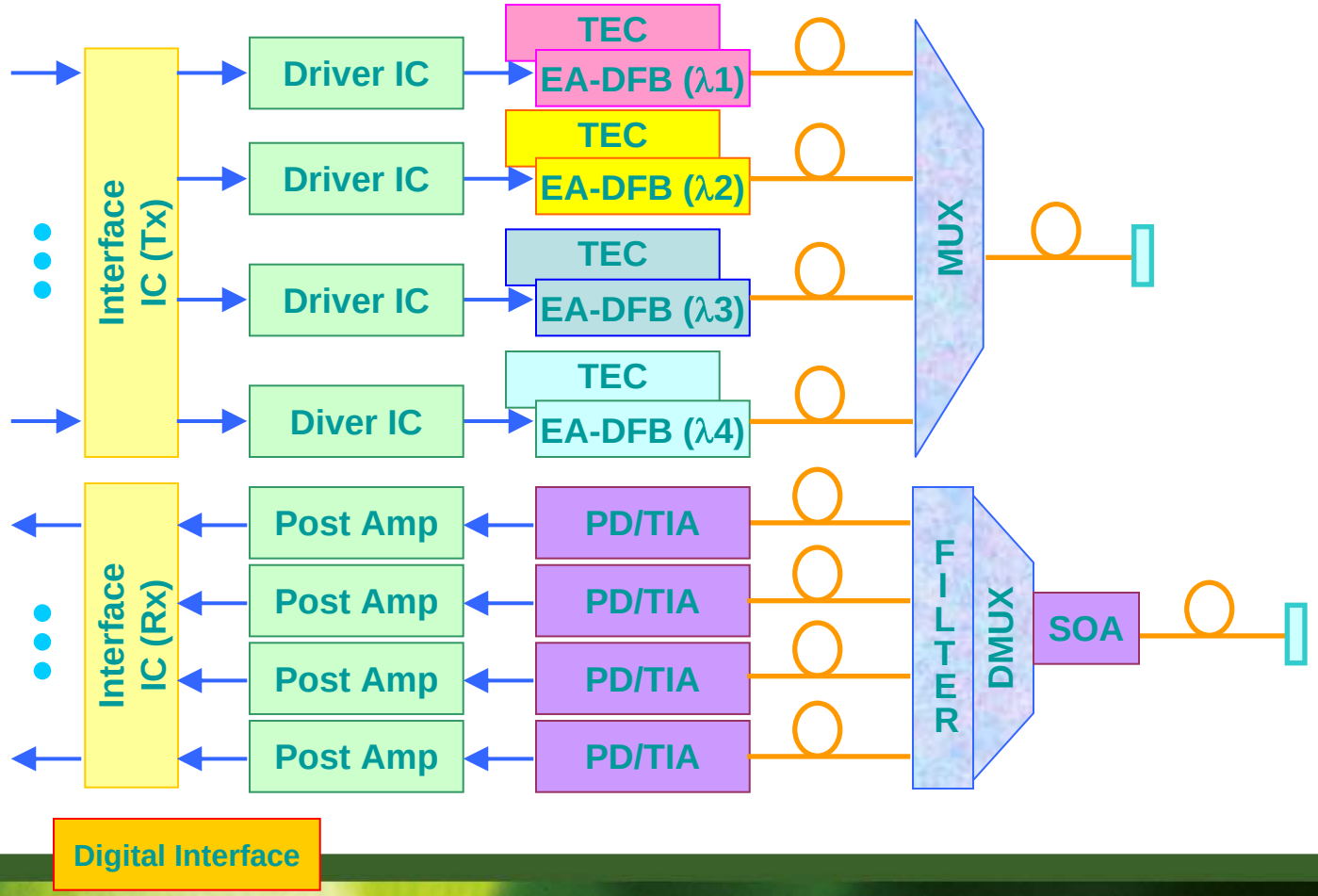
Philosophy for 40km PMD

- Borrow key block diagram items from 10km Module
- Leave 1550nm band for implementation of WAN
- Use 1310nm band near the zero dispersion point for standard single mode fiber
- Build amplification into the PMD receiver to compensate for attenuation
  - Combination of SOA or APD example technologies that could be used in the Rx chain
- This presentation assumes a 4 λ solution

Module Structure for ≥40km 100GbE Application

Use temperature controlled lasers for improved transmission characteristics and tighter wavelength spacing. Use single SOA & filtering to reduce complexity while minimizing crosstalk.

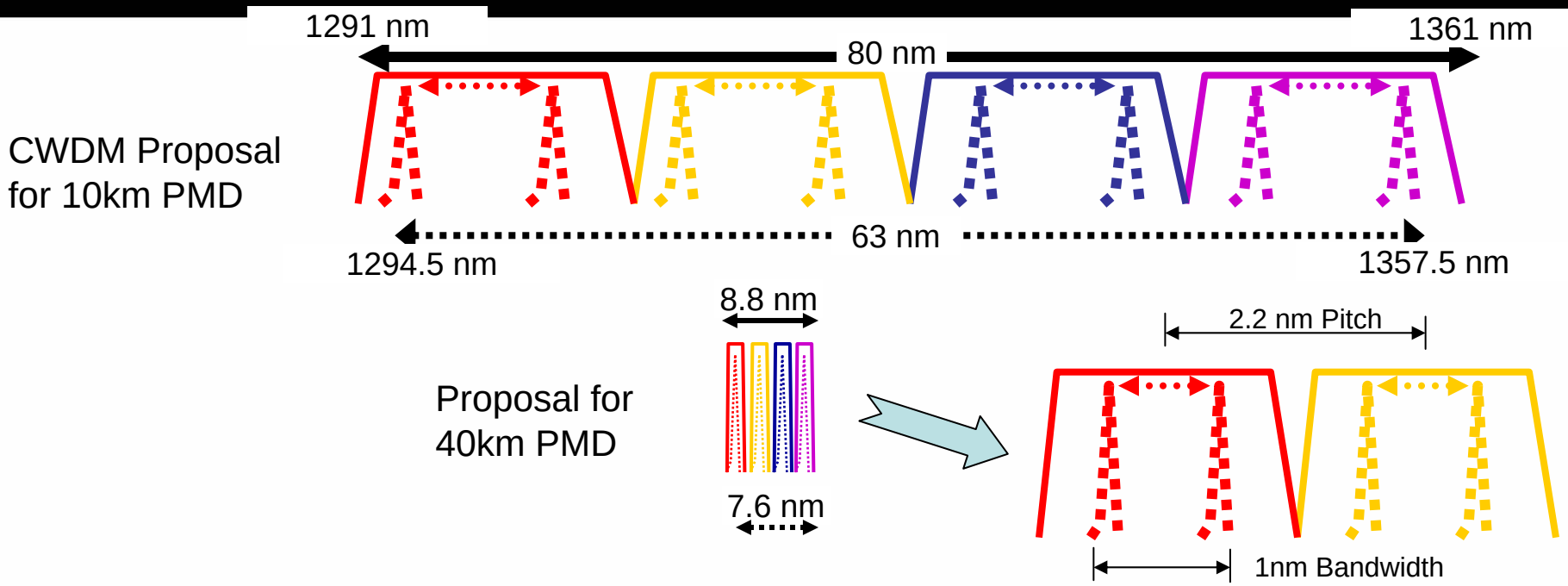


Wavelengths

- Select narrower channel spacing, eg. 400GHz (2.2 nm) – no active wavelength locker
- Center channels near lambda zero of SMF-28 for best chromatic dispersion performance
  - Use G.652 clause 7 tables for values for Sellmeier constants:
- Requires use of cooled light source
- Open to alternate wavelength proposals – these chosen to be centered about G.652 lambda-zero
- Open to alternate spacing – tight spacing makes future integration somewhat simpler

Unit = nm	200GHz Spacing
CH0	1308.7
CH1	1310.9
Ch2	1313.1
Ch3	1315.3
Channel pitch	2.2
Channel bandwidth	1.0

Wavelength Range



- Pitch of 2.2 nm allows for stronger filtering to eliminate crosstalk among lanes
- Bandwidth of 1 nm allows for no active wavelength locker – smaller transmitter package
- Entire spectral range of 7.6 nm allows for ease of monolithic integration

Receiver Sensitivity

- Hypothesis
  - Commercial available 10Gbit/s receiver *OMA* is around -14.9dBm$_{max}$ (This is equivalent to -17.0dBm P_{avg} sensitivity with 10dB extinction ratio. Typical 10Gbit/s receivers record sensitivities from -17.0 to -19.0 dBm)
  - Sensitivity decrease from 10 Gbit/s to 25Gbit/s is calculated to be 4 dB (*1)
  - Optical DMUX loss is 3.5 dB$_{max}$ + Splicing loss in the PMD is 0.2 dB
  - Aging degradation + Accuracy of measurement is 0.5dB$_{max}$ + Interoperability penalty is 1.0 dB

Per lane	*OMA* (dBm)	Loss (dB)	
10 Gbit/s	-14.9		BOL max
25 Gbit/s	-10.9	(4.0)	Using Approximation
DMUX/Filter + Splice		3.7 (*2)	
Aging + Accuracy + Interoperability		1.5	
Internal Gain		-17	SOA
TP3	-22.7		EOL

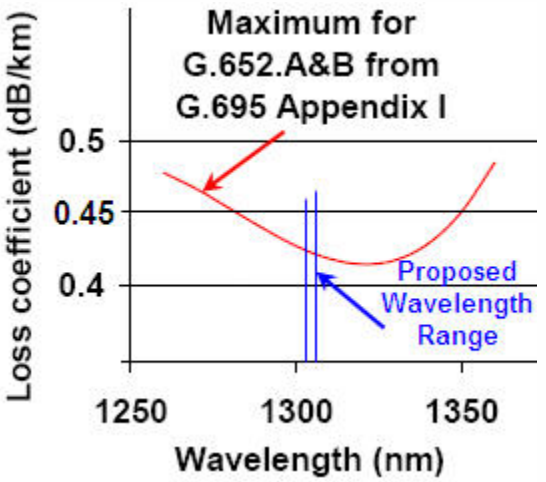
(*1) Using bipolar TIA that the sensitivity is proportional to the bit rate.

(*2) Refined DMUX loss to include additional 1dB for filter loss

Transmit Power Output

- Hypothesis
  - Receiver sensitivity *OMA* is -3.3 dBm_{max}
  - Channel inserstion loss is 20 dB (18dB for 40km & 2dB for connectors)
  - Dispersion penalty is 1.0dB
  - Optical MUX loss is 2.5 dB_{max} + Splicing loss in the PMD is 0.2 dB
  - Aging degradation + Accuracy of measurement is 0.5

Per lane	*OMA* (dBm)	Loss (dB)	
TP3	-22.7		EOL
TP2 connector		0.2	
Link loss		20.0	0.45 dB/km
Penalty		2.0 (*1)	Dispersion etc.
TP2	-0.5		EOL
MUX + Splice		2.7 (*2)	
Aging + Accuracy		1.0	
EML out	+4.2		BOL



(*1) Increased Path Penalty to 2.0 dB

(*2) Reduced Link Loss to correspond to G.652 0.45 dB/km

Transmit Power Output

- Transmitter

	min	Proposal	10GBASE-L	10GBASE-LX4
T_OMA min , per lane	dBm	+0.5	-5.2	-6.25
T_OMA max , per lane	dBm	+3.5	NA	-1.25
T_Avg max , four lanes	dBm	+9.5 (*1)	0.5	5.5
Er min	dB	7.0	3.5	3.5

- Receiver

	min	Proposal	10GBASE-L	10GBASE-LX4
R_OMA min , per lane	dBm	-22.7	-12.6	-14.45
R_OMA max , per lane	dBm	TBD	NA	NA
Dispersion Penalty max	dB	2.0	(1.0)	(1.0)

- Link Budget

	min	Proposal	10GBASE-L	10GBASE-LX4
Link Power Budget	dBm	22.2	7.4	8.2
Channel Insertion Loss	dBm	20.2	6.2	6.2
Margin for Penalty min	dB	2.0	1.2	2.0

Note (*1): Limited by Eye safety