100GBASE-CWDM Baseline Proposal Update

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INTRODUCTION

After IEEE May meeting in Victoria, a wide consensus is done among CWDM supporters and end users, a significant step to further reduce cost was agreed**: it is to add FEC.**

- This will reduce DML based CWDM cost and improve yield.
- Reducing power consumption of MZ or EA based transmitter

This presentation provides a updated baseline specification proposal for a retimed PMD to address the P802.3bm objective:

Define a 100 Gb/s PHY for operation up to at least 500 m of SMF

Pervious baseline 100GBASE-CWDM proposal has been proposed

vlasov_01a_1112_optx
vlasov_01_0113_optx
vlasov_01a_0313_optx
vlasov_01a_0413_smf
vlasov_01a_0513_optx

INTRODUCTION (CONT'ED)

Baseline 100GBASE-CWDM proposal summary update:

- ✓ 4 lane CWDM, 25.78125 GBd/lane, **with FEC**, Single mode optical PMD, Retimed, 500m;
  - ✓ 100G KR4 100G FEC in clause 91, threshold at BER=5e-5, is on host board, it will not add extra cost and power consumption to module.
  - ✓ 100G KR4 100G FEC in clause 91 is also proposed in SR4 IEEE standard meeting.
  - ✓ 2.5dB power budget gain is achieved by adding 100G FEC in clause 91
- ✓ Technical Feasibility: proposed and supported by multiple optical module suppliers
- ✓ Economic Feasibility: independent cost analysis showed potential to reduce cost over 60% vs cost-reduced 100GBASE-LR4
- ✓ Broad Market Potential: CWDM optical modules can be deployed for several markets as datacenters, carrier IP, server backplanes, etc. Proposal is supported by multiple component and systems suppliers.

INTRODUCTION (CONT'ED)

CWDM PMD has been discussed extensively:

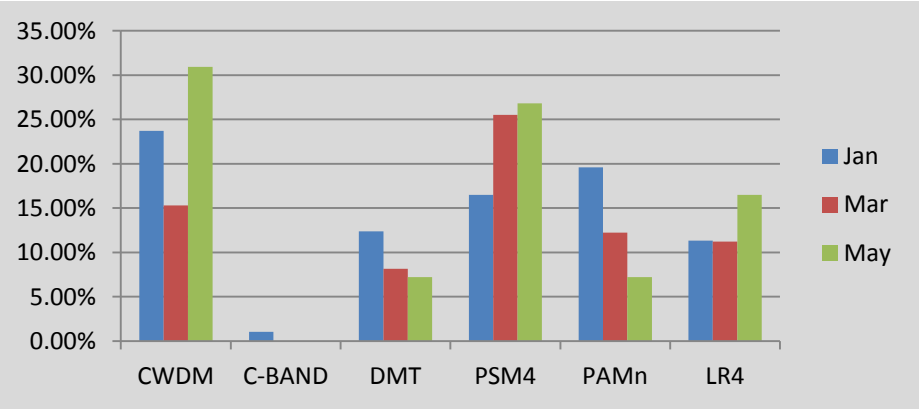
Extensive discussion at 802.3ba:
examples: traverso_03_0308
traverso_02_0308
traverso_01_0308

Study Group NG100G:
anderson_01_1111_NG100GOPTX
way_01a_0112_NG100GOPTX
vlasov_01_0312_NG100GOPTX

802.3bm Task Force:
martin_01_0712_optx
weirich_01_0712_optx
martin_01_0912_optx
martin_02_0912_optx
gill_01b_1112_optx
martin_01_1112_optx
vlasov_01a_0113_smf
shen_01_0113_optx
shen_01_0113_smf
yu_01_0313_optx
shen_01a_0313_smf
shen_01_0313_optx
petrilla_02a_0413_smf
martin_01_0513_optx
mok_01_0513_optx
shen_01_0513_optx

CWDM PMD has gained considerable support:

Straw Poll #1: I would support a baseline proposal for a SMF PMD bases on:



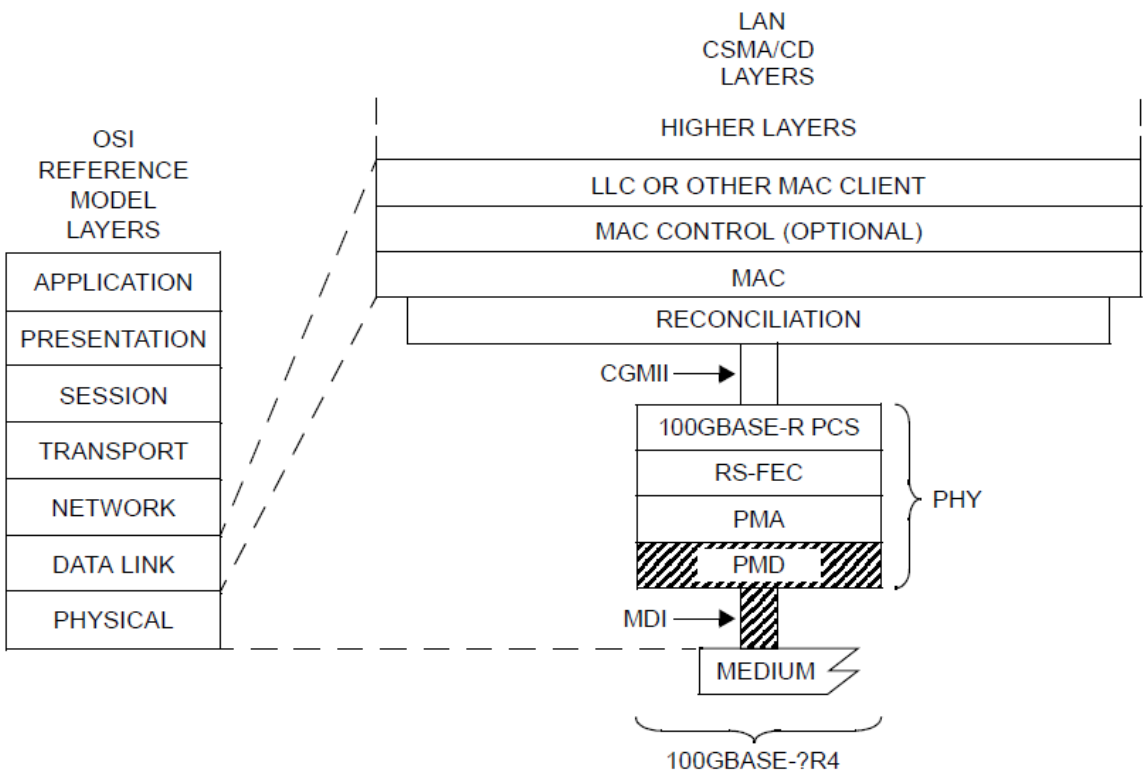
Results of three consecutive straw polls

Draft Clause 96

- Draft Clause 96 language will be provided to the Task Force Chair for a complete wording of the CWDM specification. The following 8 pages of this contribution provide excerpts of the key points of the consensus built baseline proposal.

- The TBD values in the proposed baseline language will be determined by technical contributions and consensus building by the entire task force once the CWDM approach have been adopted.

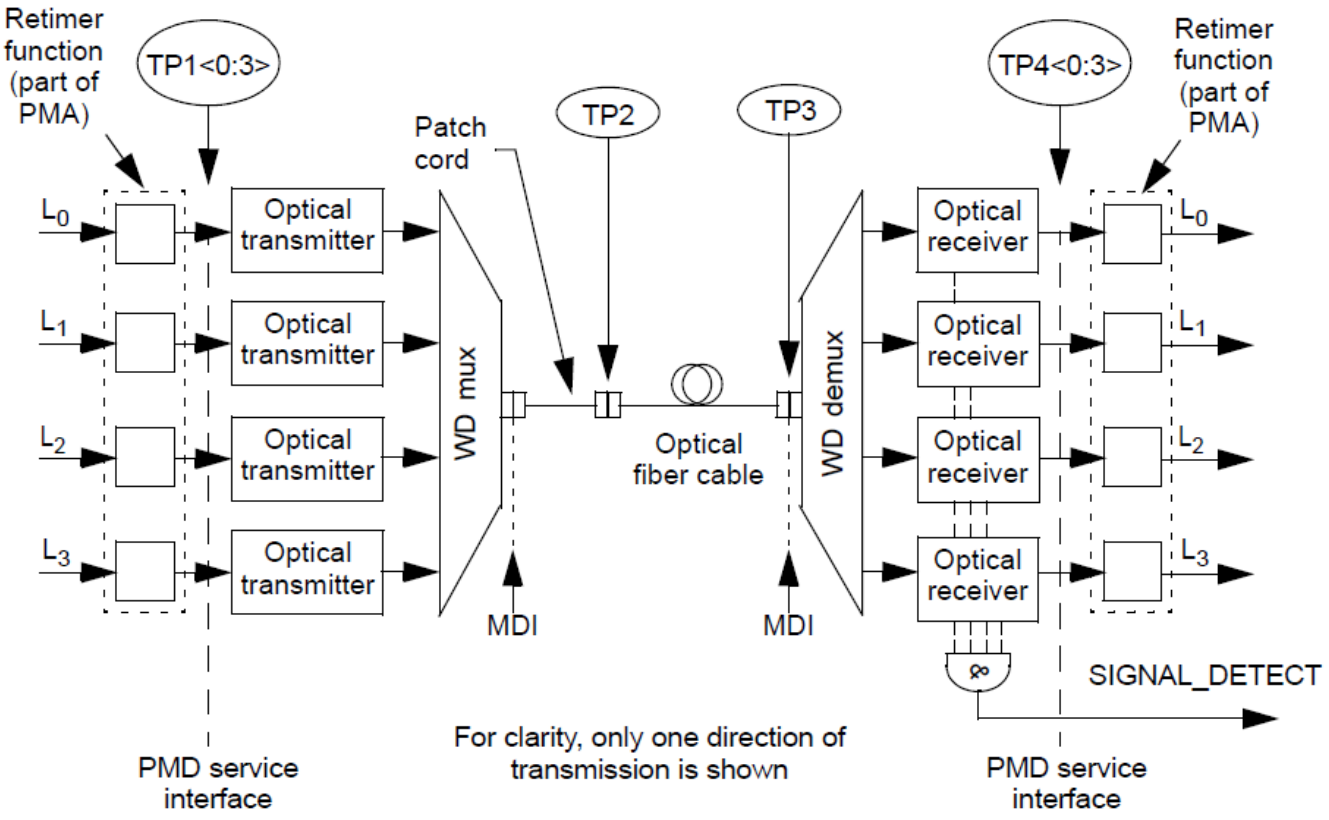
Proposed Position in 802.3 Architecture



CGMII = 100 Gb/s MEDIA INDEPENDENT INTERFACE
LLC = LOGICAL LINK CONTROL
MAC = MEDIA ACCESS CONTROL
MDI = MEDIUM DEPENDENT INTERFACE
PCS = PHYSICAL CODING SUBLAYER
PHY = PHYSICAL LAYER DEVICE
PMA = PHYSICAL MEDIUM ATTACHMENT
PMD = PHYSICAL MEDIUM DEPENDENT
RS-FEC = REED-SOLOMON FORWARD ERROR CORRECTION
?R = PMD FOR SINGLE-MODE FIBER — 500 m

Figure 96–1—100GBASE-?R4 PMD relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model and the IEEE 802.3 CSMA/CD LAN model

Proposed link architecture



WD = Wavelength division

NOTE—Specification of the retimer function and the electrical implementation of the PMD service interface is beyond the scope of this standard.

Figure 96–2—Block diagram for 100GBASE-?R4 transmit/receive paths

100GBASE-CWDM lane assignment and operating range

Table 96–5—Wavelength-division-multiplexed lane assignments

Lane	Center wavelength	Wavelength range
L_0	1271 nm	1264.5 to 1277.5 nm
L_1	1291 nm	1284.5 to 1297.5 nm
L_2	1311 nm	1304.5 to 1317.5 nm
L_3	1331 nm	1324.5 to 1337.5 nm

Table 96–6—100GBASE-?R4 operating range

PMD type	Required operating range
100GBASE-?R4	500 m

100GBASE-CWDM illustrative link power budget

96.7.3 100GBASE-?R4 illustrative link power budget

An illustrative power budget and penalties for 100GBASE-?R4 channels are shown in Table 96–9.

Table 96–9—100GBASE-?R4 illustrative link power budget

Parameter	Value	Unit	Comment
Power budget (for maximum TDP)	**7.3**	dB	4 dB link loss + 3.3 dB TDP
Operating distance	0.5	km	
Channel insertion loss [a]	4.0	dB	
Maximum discreet reflectance	-26	dB	Transmitter reflectance is -12 dB; Rx reluctance is -26 dB; penalty from MPI is <1 dB at worst case scenario.
Allocation for penalties [b] (for maximum TDP)	**3.3**	dB	This is based on upper-bound calculation based on the worst cases scenario for all parameters. Statistical sum of signal method, gives a smaller value TPD: <2.7 dB at the same conditions.
Additional insertion loss allowed	0	dB	

[a]The channel insertion loss is calculated using the maximum distance specified in Table 96–6 and cabled optical fiber attenuation of 0.47 dB/km at 1264.5 nm plus an allocation for connection and splice loss given in 96.11.2.1.
[b]Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

100GBASE-CWDM transmit characteristics

96.7.1 100GBASE-?R4 transmitter optical specifications

The 100GBASE-?R4 transmitter shall meet the specifications defined in Table 96–7 per the definitions in 96.8.

Table 96–7—100GBASE-?R4 transmit characteristics

Parameter	Value	Unit	Comment
Signaling rate, each lane (range)	25.78125 ± 100 ppm	Gbd	
Side-mode suppression ratio (SMSR), (min)	30	dB	
Total average launch power (max)	9	dBm	
Average launch power [a], each lane (max)	3	dBm	
Average launch power [a], each lane (min)	**-5.15**	dBm	At Max TDP; OMA (min) would be **-7.45** dBm at **1 dB** TDP as in LR4
Optical modulation amplitude (OMA), each lane (max)	3	dBm	
Optical modulation amplitude (OMA), each lane (min)	**-2.15**	dBm	At Max TDP;OMA (min) would be **-4.45** dBm at **1 dB** TDP as in LR4
Difference in launch power between any two lanes (OMA), (max)	4	dB	
Launch power in OMA minus TDP, each lane (min),	**-5.45**	dBm	
Transmitter and dispersion penalty (TDP), each lane (max)	**3.3**	dB	
Average launch power of OFF transmitter, each lane (max)	-30	dBm	

100GBASE-CWDM transmit characteristics (cont'ed)

Parameter	Value	Unit
Average launch power of OFF transmitter, each lane (max)	-30	dBm
Extinction ratio (min)	4	dB
$RIN_{20}OMA$ (max)	-130	dB/Hz
Optical return loss tolerance (max)	20	dB
Transmitter reflectance [b] (max)	-12	dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}	

a. Average launch power each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be complaint; however, a value above this does not ensure compliance.
b. Transmitter reflectance is defined looking into the transmitter.

100GBASE-CWDM receive characteristics

96.7.2 100GBASE-?R4 receive optical specifications

The 100GBASE-?R4 receiver shall meet the specifications defined in Table 96–8 per the definitions in 96.8.

Table 96–8—100GBASE-?R4 receive characteristics

Parameter	Value	Unit	
Signaling rate, each lane (range)	25.78125 ± 100 ppm	Gbd	
Damage threshold (min)	**5.5**	dBm	
Average receive power , each lane (max)	3	dBm	
Average receive power , each lane (min)	**-9.15**	dBm	At Max. TDP; OMA (min) would be **-11.45** dBm at **1 dB** TDP as in LR4
Receive power, each lane (OMA) (max)	3	dBm	
Difference in receive power between any two lanes (OMA), (max)	4	dB	
Receiver reflectance (max)	-26	dB	
Receiver sensitivity (OMA), each lane [a] (max)	**-9.45**	dBm	
Receiver 3dB electrical upper cutoff frequency, each lane (max)	31	GHz	

a. BER sensitivity =5e-5

Relevance to 802.3bm Distinct Identity

"The amendment will define a new 100 Gb/s SMF PMD in addition to these if it can be shown that a SMF PMD with a shorter reach than 100GBASE-LR4 has sufficient cost, density, or power difference to justify an additional SMF PMD type."

The CWDM baseline proposal :

- meets a required significant cost reduction (potentially over 60% vs cost-reduced 100GBASE-LR4) for reaching the 802.3bm TF objective;
- provides a significant module power reduction;
- provides a significant reduction of a module form-factor;
- WDM concept is extendable to 400GbE and beyond.

CONCLUSION

- An updated 100GBASE-CWDM PMD baseline proposal is presented supporting SMF 500m objective of 802.3bm TF
- 2.5 dB power budget margin is achieved by 100G FEC in clause 91, transmitter depended minimum OMA is proposed, which further reduce cost of components in 100G transceiver.
- Current draft of baseline values is the result of consensus building between several component and systems suppliers.
- It is proposed to move this proposal forward to become a baseline for 100GBASE-?R4.

THANK YOU!