

# 20 m MMF reach objective baseline proposal draft 0.3

March 2013

# Outline

- Baseline proposal of an unretimed PMD to address P802.3bm objective to ‘define a 100 Gb/s PHY for operation over up to at least 20 m of MMF’
  - 4 lane parallel, short wavelength based PMD for 100GBASE-SR4
  - 20 m reach without retimers is enabled by making use of the mandatory KR4 FEC defined in P802.3bj
  - Architecture, parameters and specifications for optical and electrical interfaces follow

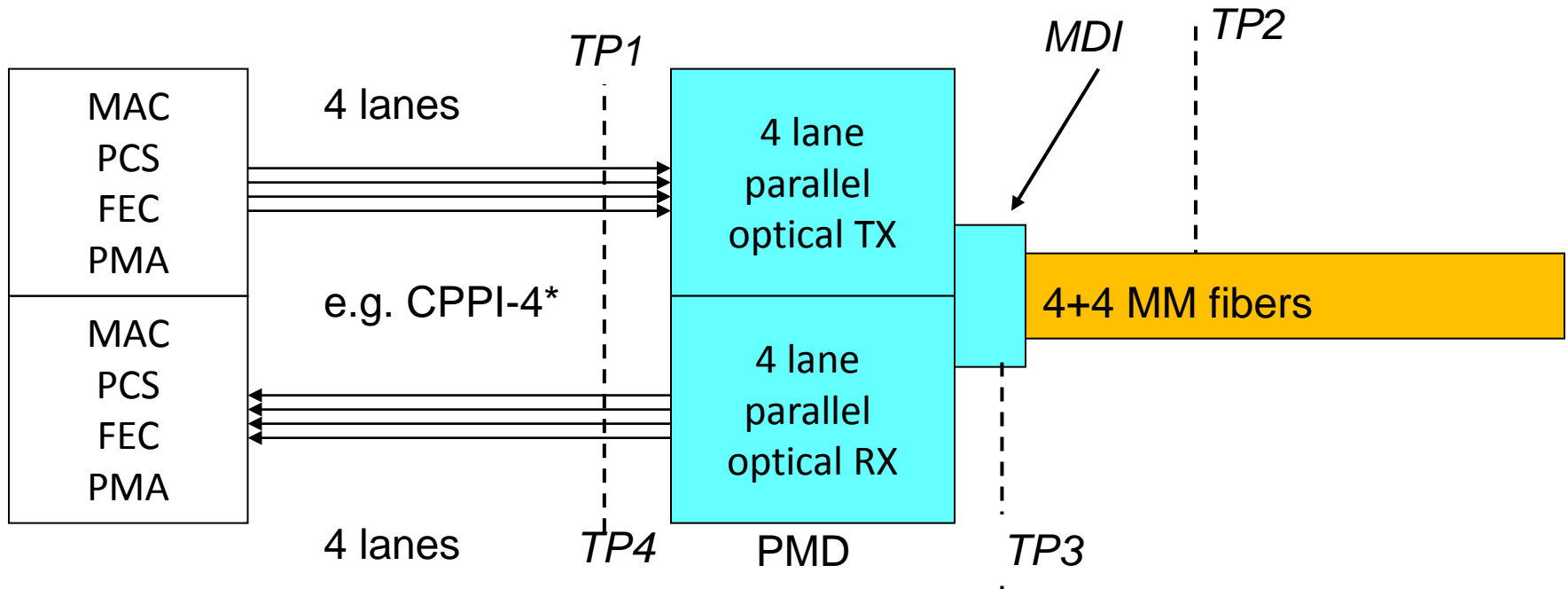
# Supporters and contributors

# Motivation

- 4 parallel links operating at 25.78125 GBd utilize low cost, high performing multimode fiber compatible optics and electronics
  - FEC supported unretimed interface enables a lowest power 20 m solution today
  - Makes use of an unretimed electrical interface “CPPI-4”
  - Uses existing, viable semiconductor technologies
  - Compatible with uncooled VCSEL
- The 4 optical lanes directly map the 4 electrical lanes, without requiring retiming, multiplexing, translation, or de-skewing inside the module
- *This proposal is supported by multiple vendors and users, and is economically feasible and competitive compared to other alternatives.*
  - *Lower module power than alternatives, enables higher port density*

# Proposal

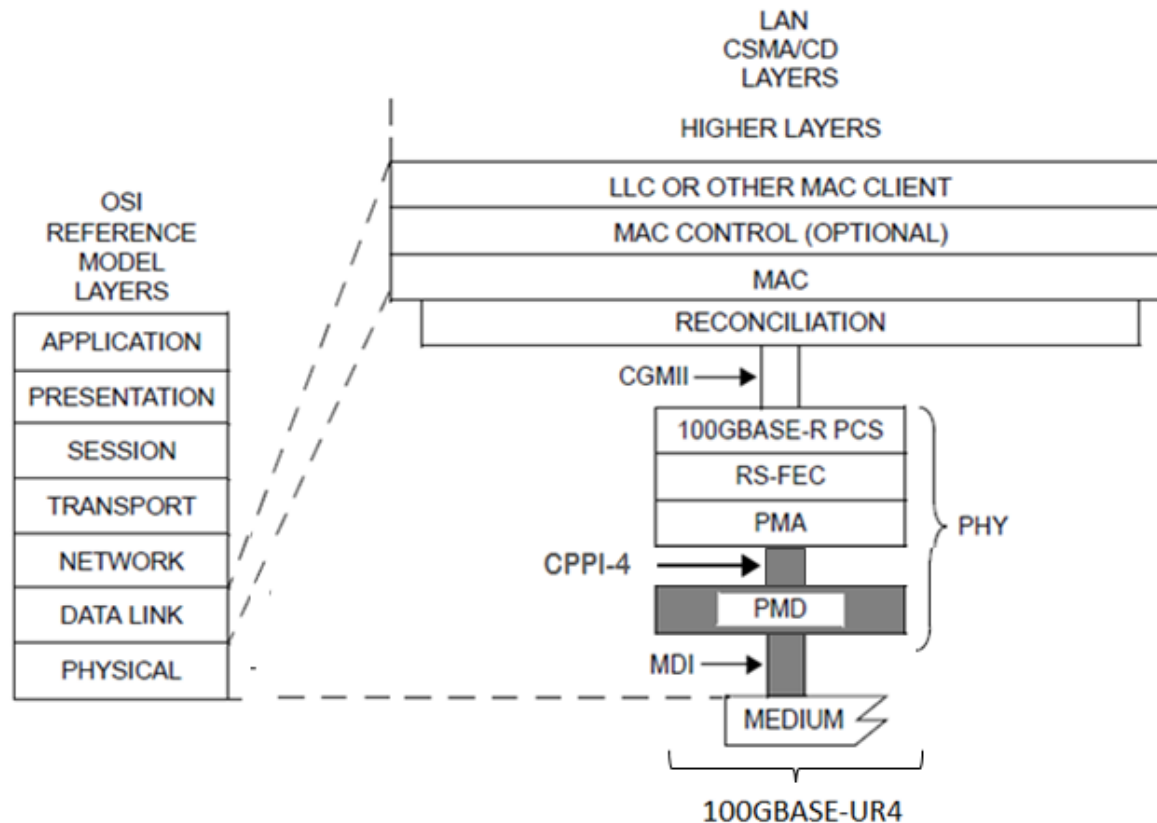
- 4 unretimed parallel lanes @ 25.78125 GBd for 100GBASE-UR4<sup>†</sup> over OM4 fiber
- 850 nm sources
- Uses 100GBASE-KR4 FEC being defined in P802.3bj



<sup>†</sup> 100GBASE-UR4 is a working name for the 100 GBd unretimed 20 m PMD

\*Definition of an unretimed interface ('CPPI-4') is required for the unretimed 20 m PMD

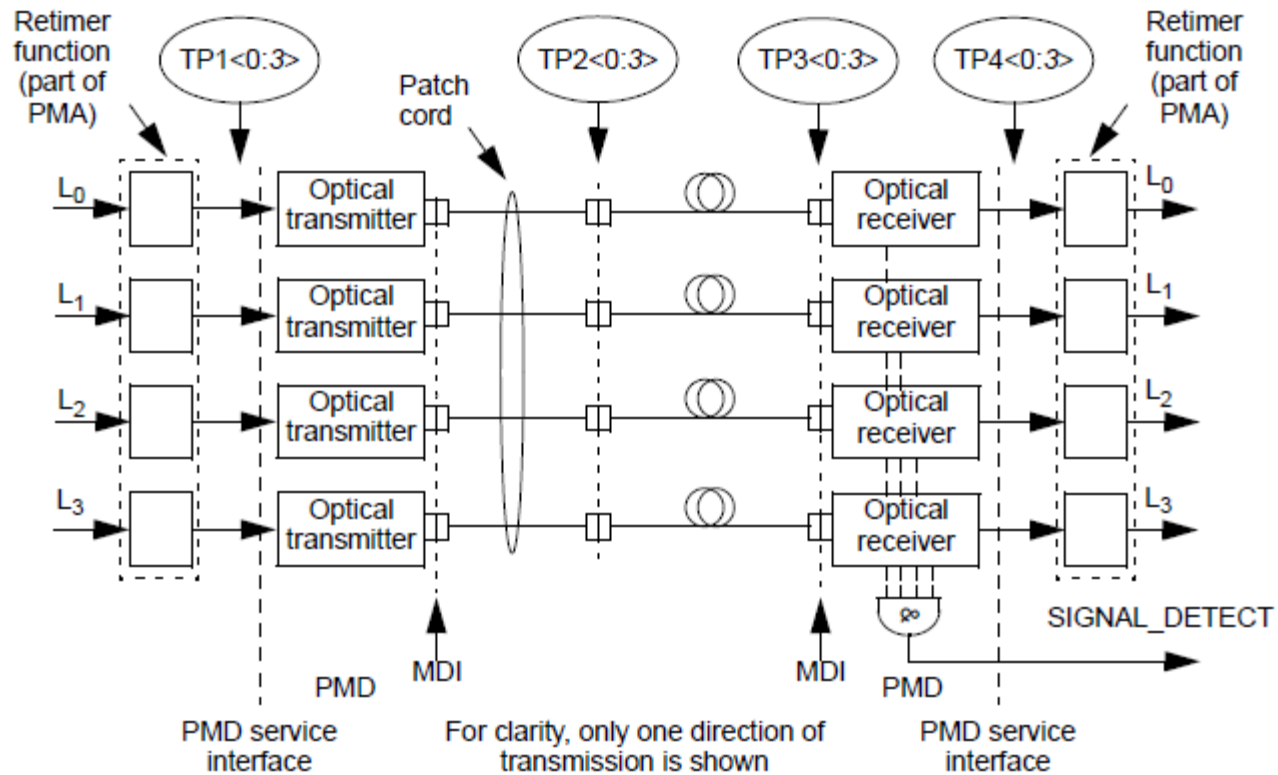
# Position in 802.3 architecture



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

# PMD block diagram



- TP1 and TP4 are reference points for the CPPI-4 electrical interface specifications

# Optical transmitter characteristics (each lane)

| Description  | Type  | Unit | Strawman                          |
|--|-------|------|-----------------------------------|
| Signal rate  |       | GBd  | 25.78125 ±100ppm                  |
| Center wavelength  | range | nm   | 840 to 860                        |
| RMS spectral width   | max   | nm   | tbc (0.6 to 0.8)                  |
| Average launch power   | max   | dBm  | 2.4                               |
| Average launch power   | min   | dBm  | TBD $\{T_{X_{OMAmin}}-2\}$        |
| Optical Modulation Amplitude (OMA)   | max   | dBm  | 3                                 |
| OMA  | min   | dBm  | TBD $\{T_{X_{OMA@TDP}}-TDP+1\}$   |
| OMA at max TDP ( $T_{X_{OMA@TDP}}$ )   | min   | dBm  | TBD $\{-3\}$                      |
| Launch power in OMA minus TDP  |       |      | TBD $\{T_{X_{OMA@TDP}}-TDP\}$     |
| Difference in launch power between any two lanes (OMA)   | max   | dB   | $(T_{X_{OMAmx}}-T_{X_{OMA@TDP}})$ |
| Transmitter and dispersion penalty (TDP) at target BER before FEC                              | Max   |      | TBD                               |
| Extinction ratio   | min   | dB   | 3                                 |
| Optical return loss tolerance  | max   | dB   | 12                                |
| Encircled Flux   |       |      | ≥ 86% @ 19 um,<br>≤ 30% @ 4.5 um  |
| Transmitter eye mask definition<br>{X1, X2, X3, Y1, Y2, Y3},<br>5×10 <sup>-5</sup> hits/sample |       |      | TBD {ffs}                         |
| Average launch power of OFF transmitter  | max   | dBm  | -30                               |

Values/expressions in {} are from 100 m baseline



# Optical receiver characteristics (each lane)

| Description                          | Type  | Unit | Strawman                       |
|--------------------------------------|-------|------|--------------------------------|
| Signal rate                          |       | GBd  | 25.78125 ±100ppm               |
| Center wavelength                    | range | nm   | 840 to 860                     |
| Damage threshold                     | min   | dBm  | 3.4                            |
| Average power at receiver            | max   | dBm  | 2.4                            |
| Average power at receiver            | min   | dBm  | TBD { $T_{x_{av\_min}} - IL$ } |
| Optical Modulation Amplitude (OMA)   | max   | dBm  | 3                              |
| Stressed receiver sensitivity in OMA | max   | dBm  | ffs                            |
| SRS test conditions                  |       |      | ffs                            |
| Receiver reflectance                 | max   | dB   | -12                            |

Values/expressions in {} are from 100m baseline

# Link and Cable Characteristics

| Parameter                 | Type | Unit   | Value                                      |
|---------------------------|------|--------|--|
| Supported fiber types     |      |        | 50 $\mu$ m OM4, (OM3 <sup>2</sup> )        |
| Effective Modal Bandwidth |      | MHz*km | 4700 <sup>1</sup> , (2000 <sup>1,2</sup> ) |
| Power budget              |      | dB     | TBD  |
| Operating range           |      | m      | 0.5 to TBD (20) <sup>2</sup>               |
| Channel insertion loss    |      | dB     | TBD (1.6)                                  |

*Note 1: With launch as specified in clause 86*

*Note 2: Reach on OM4; equivalent reach on OM3 is for further study in the task force*

# TP1a specifications (each lane)

| Description  | Type | Unit   | CPPI-4 Strawman   |
|--|------|--------|-------------------|
| Signal rate  |      | GBd    | 25.78125 ±100 ppm |
| J2 Jitter  | Max  | UI     | TBD               |
| J4 Jitter  | Max  | UI     | TBD               |
| DDPWS  | Max  | UI     | (no spec?)        |
| Equalized J2*  | Max  | UI     | TBD               |
| Equalized J4*  | Max  | UI     | TBD               |
| Equalized DDPWS*   | Max  | UI     | TBD               |
| CTLE peaking*  | Max  | dB     | TBD               |
|  | Min  |        | TBD               |
| Equalized eye mask definition<br>{X1, X2, X3, Y1, Y2, Y3},<br>5×10 <sup>-5</sup> hits/sample |      | UI, mV | TBD               |
| Peak-to-peak voltage   | Max  | mV     | TBD               |
| Qsq  | Min  | V/V    | TBD               |
| Single ended output voltage  |      | V      | TBD               |
| AC common-mode output voltage  | Max  |        | TBD               |
| Transition time, 20% to 80%  | Max  | ps     | TBD               |

*\* Similar methodology to CEI-28G-VSR; CTLE is part of the test equipment used to verify the electrical signal compliance*

# TP4 specifications (each lane)

| Description  | Type | Unit   | CPPI-4 Strawman  |
|--|------|--------|------------------|
| Signal rate  |      | GBd    | 25.78125±100 ppm |
| J2 Jitter  | Max  | UI     | TBD              |
| Equalized J2*  | Max  | UI     | TBD              |
| Equalized J4*  | Max  | UI     | TBD              |
| CTLE peaking*  | Max  | dB     | TBD              |
|  | Min  |        | TBD              |
| Equalized eye mask definition<br>{X1, X2, X3, Y1, Y2, Y3},<br>5×10 <sup>-5</sup> hits/sample |      | UI, mV | TBD              |
| Single ended output voltage tolerance **   |      | V      | TBD              |
| AC common-mode output voltage  | Max  | mV     | TBD              |
| Transition time, 20% to 80%  | Max  | ps     | TBD              |

\* *Similar methodology to CEI-28G-VSR; CTLE is part of the test equipment used verify the electrical signal compliance*

\*\* DC common-mode voltage is set by host

# Further work

- Compliance boards consistent with 100GBASE-CR4 and CEI-28G-VSR
- Return loss spec's (values TBD)
  - Differential-mode output return loss at TP1a and TP4
  - Common-mode output return loss at TP1a and TP4
  - Differential-mode input return loss at TP1 and TP4a
  - Mixed-mode return loss spec's TBD
- Host channel max and min insertion loss TBD
- Recommendation for host channel quality
  - e.g. ILD, noise, channel reflections TBD

# References

- Jonathan King et al., 100 m MMF reach objective baseline proposal, [http://ieee802.org/3/bm/public/jan13/king\\_02\\_0113\\_optx.pdf](http://ieee802.org/3/bm/public/jan13/king_02_0113_optx.pdf)
- Piers Dawe, Unretimed PHY for the 20 m MMF objective, [http://ieee802.org/3/bm/public/jan13/dawe\\_01a\\_0113\\_optx.pdf](http://ieee802.org/3/bm/public/jan13/dawe_01a_0113_optx.pdf)
- Piers Dawe, Jitter Budget for unretimed MMF PMD, [http://ieee802.org/3/bm/public/mmfadhoc/meetings/feb28\\_13/dawe\\_01a\\_0213\\_mmf.pdf](http://ieee802.org/3/bm/public/mmfadhoc/meetings/feb28_13/dawe_01a_0213_mmf.pdf)