# 100GBASE-WDM4 Baseline Proposal

*Contributors*


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# Supporters

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# Introduction

- One of P802.3bm adopted objectives – July 2012, 802.3 WG :
  *"Define a 100 Gb/s PHY for operation up to at least 500 m of SMF"*

- WDM PMD has been discussed as a cost-efficient solution
  anderson_01_1111_NG100GOPTX, vlasov_01_0312_NG100GOPTX, martin_01_0712_optx, weirich_01_0712_optx, martin_02_0912_optx, martin_01_0912_optx

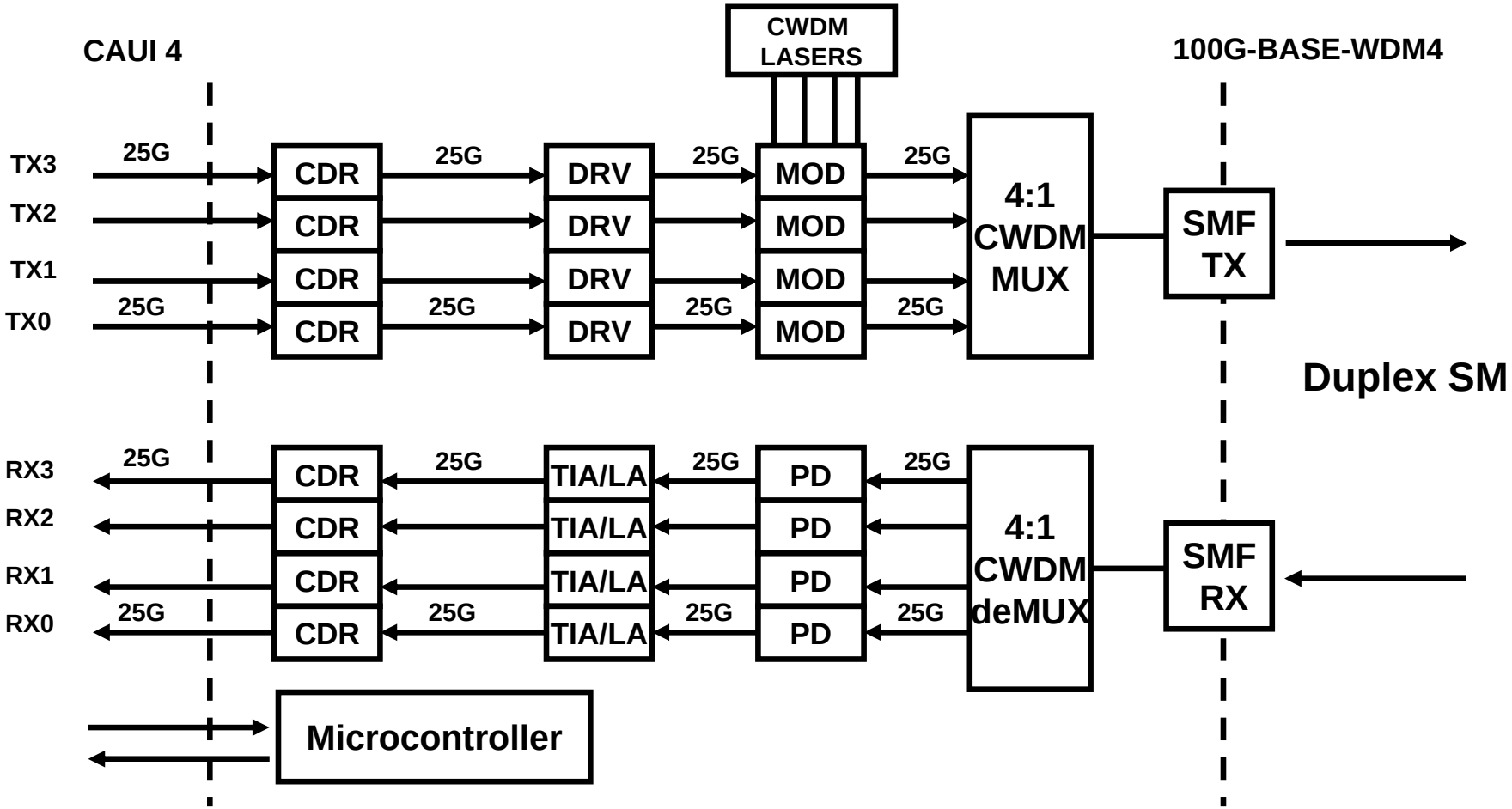
- 100G-BASE-WDM4 PMD has been proposed as a cost-effective solution for the optical specification based on 4x25G CWDM single mode optics
  vlasov_01b_1112_optx

- 100G-BASE-WDM4 proposal has been further discussed
  gill_01_1112_optx , shen_01_0113_smf , vlasov_01a_0113_smf
  followed with discussion documented in IEEE 802.3 100GNGOPTX Email Reflector

- Several interested parties developed a revised consensus proposal for the 100GBASE-WDM4 PMD

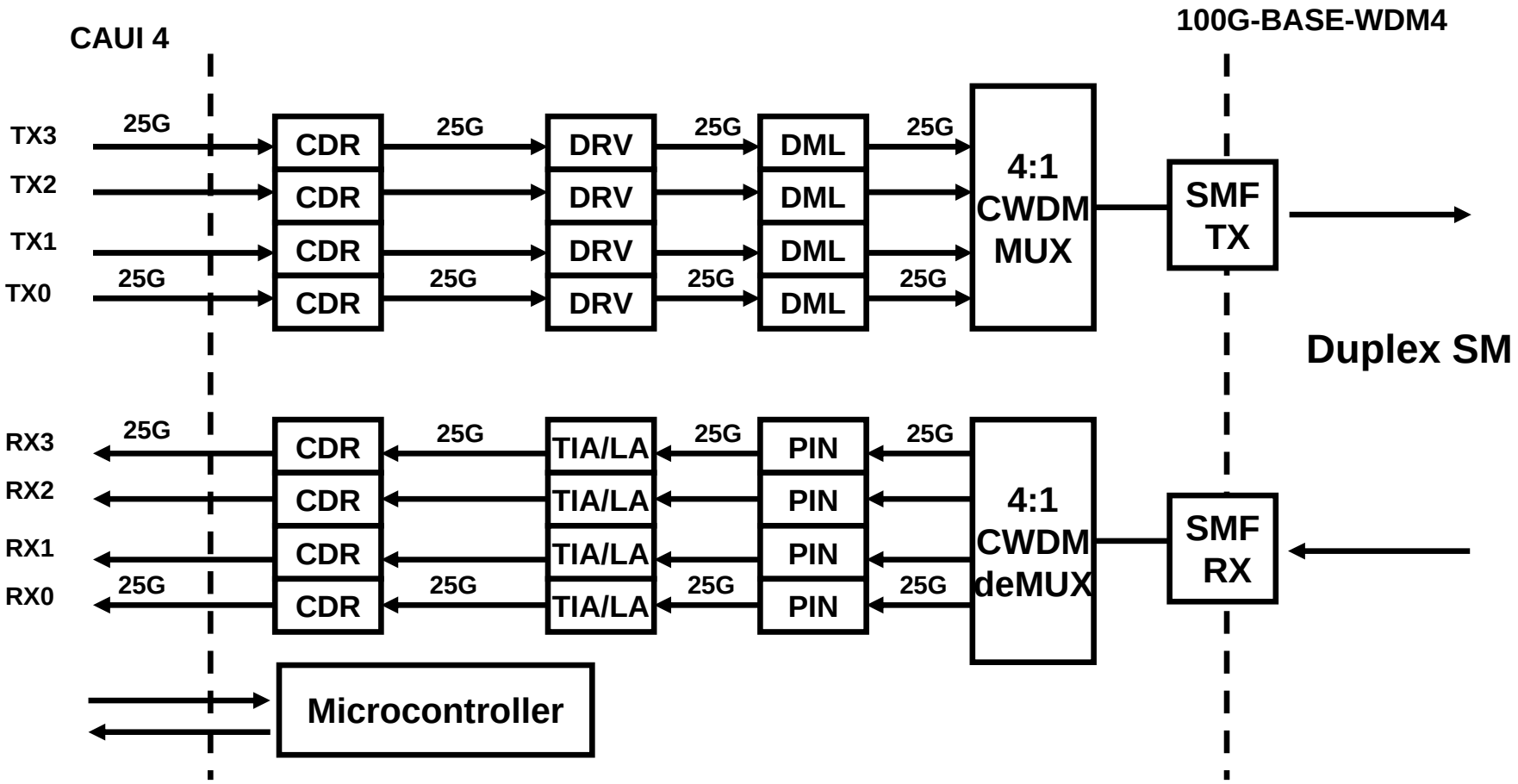
- This contribution provides a consensus view on WDM4 optical specification

# 100GBASE-WDM4 block diagram




- Uncooled
- Retimed
- Various technology implementations feasible - Si Photonics, EML DFB, etc.

# Alternative 100GBASE-WDM4 block diagram




- Various technology implementations feasible:
  - 4 CWDM DML DFB lasers
  - 4 channel CWDM DML DFB laser array

# Link transmit and receive characteristics

1. To satisfy the TF objective the reach of up to at least 500m is considered

2. The channel insertion loss is defined following the 10GBASE-LR, 100GBASE-LR4 and 40GBASE-LR4 methodology:
   - The maximum link distance is based on an allocation of 2 dB total connection and splice loss.
   - The channel insertion loss is calculated using the specified maximum distance and cabled optical fiber attenuation

3. The channel insertion loss is calculated using maximum distance of 500m and fiber attenuation of 0.47dB/km at 1264.5nm plus an allocation for connection and splice loss of 2.0dB

4. Correspondingly, the maximum channel insertion loss is 2.3dB

5. Minimal launched power ($OMA_{min}$-TDP) is reduced to -3.0dBm to decrease maximum module total dissipated power

6. Sensitivity is reduced to -6.0dBm (OMA) to accommodate additional insertion loss on WD demux

# 100GBASE-WDM4 SMF 500m reach transmit characteristics

| **Parameter** | **IEEE Std 802.3ba 100GBASE-LR4** 10km | **vlasov011112optx 100GBASE-WDM4** 2km | **Consensus 100GBASE-WDM4** 500m | Unit |
|---|---|---|---|---|
| Signaling rate, each lane (range) | 25.78125 ± 100 ppm | 25.78125 ± 100 ppm | 25.78125 ± 100 ppm | Gbd |
| Lane wavelength (range) (nm) | 1294.53 to 1296.59<br>1299.02 to 1301.09<br>1303.54 to 1305.63<br>1308.09 to 1310.19 | 1264.5 to 1277.5<br>1284.5 to 1297.5<br>1304.5 to 1317.5<br>1324.5 to 1337.5 | 1264.5 to 1277.5<br>1284.5 to 1297.5<br>1304.5 to 1317.5<br>1324.5 to 1337.5 | nm |
| Single-mode suppression ratio (SMSR), (min) | 30 | 30 | 30 | dB |
| Total average launch power (max) | 10.5 | | | dBm |
| Average launch power, each lane (max) | 4.5 | | | dBm |
| Average launch power, each lane (min) | -4.3 | | | dBm |
| Optical modulation amplitude (OMA), each lane (max) | 4.5 | | | dBm |
| Optical modulation amplitude (OMA), each lane (min) | -1.3 | | | dBm |
| Difference in launch power between any two lanes (OMA), (max) | 5 | | | dB |
| Launch power in OMA minus TDP, each lane, (min) | -2.3 | -2.5 | -3 | dBm |
| Transmitter and dispersion penalty (TDP), each lane (max) | 2.2 | | 2.2 | dB |
| Average launch power of OFF transmitter, each lane (max) | -30 | -30 | -30 | dBm |
| Extinction ratio (min) | 4 | 4 | 4 | dB |
| $RIN_{20}OMA$ (max) | -130 | -130 | -130 | dB/Hz |
| Optical return loss tolerance (max) | 20 | 20 | 20 | dB |
| Transmitter reflectance (max) | -12 | -12 | -12 | dB |
| Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} | |

# 100GBASE-WDM4 SMF 500m reach receive characteristics

| **Parameter** | **IEEE Std 802.3ba**<br>**100GBASE-LR4**<br>10km | **vlasov011112optx**<br>**100GBASE-WDM4**<br>2km | **Consensus**<br>**100GBASE-WDM4**<br>500m | Unit |
|---|---|---|---|---|
| Signaling rate, each lane (range) | 25.78125 ± 100 ppm | 25.78125 ± 100 ppm | 25.78125 ± 100 ppm | Gbd |
| Lane wavelength (range) (nm) | 1294.53 to 1296.59<br>1299.02 to 1301.09<br>1303.54 to 1305.63<br>1308.09 to 1310.19 | 1264.5 to 1277.5<br>1284.5 to 1297.5<br>1304.5 to 1317.5<br>1324.5 to 1337.5 | 1264.5 to 1277.5<br>1284.5 to 1297.5<br>1304.5 to 1317.5<br>1324.5 to 1337.5 | nm |
| Receiver sensitivity (OMA), each lane (max) | -8.6 | -6.0 | -6 | dBm |
| Receiver 3dB electrical upper cutoff frequency, each lane (max) | 31 | 31 | 31 | GHz |
| Stressed receiver sensitivity (OMA), each lane (max) | -6.8 | | | dBm |

# 100GBASE-WDM4 SMF 500m reach illustrative link power budget

| Parameter | IEEE Std 802.3ba 100GBASE-LR4 10km | vlasov011112optx 100GBASE-WDM4 2km | Consensus 100GBASE-WDM4 500m | Unit |
|---|---|---|---|---|
| Power budget (for maximum TDP) | 8.5 | 5.7 | 4.4 | dB |
| Operating distance | 10 | 2 | 0.5 | km |
| Channel insertion loss | 6.3 | 3.5 | 2.3[a] | dB |
| Maximum discreet reflectance | -26 | -26 | -26 | dB |
| Allocation for penalties (for maximum TDP) | 2.2 | 2.2 | 2.2 | dB |
| Additional insertion loss allowed | 0 | 0 | 0.7[b] | dB |

[a] The channel insertion loss is calculated using maximum distance of 0.5km and fiber attenuation of 0.47dB/km at 1264.5nm plus an allocation for connection and splice loss of 2dB

[b] 0.7dB additional insertion loss allowed for additional TDP, cable loss, splice loss or extension reach.

# WDM4 Cost, Power , Form factor and Latency Considerations

- Duplex SMF cable
- No TEC
- No FEC
- Laser options:
  - ✓ CWDM laser
  - ✓ DFB array
- COB package
- Integrated single-die

Options for significant cost saving

- No TEC
- No FEC

Potential power savings

- No TEC
- COB package
- Integrated single-die

Smallest form factor

- No FEC

Lowest latency

# Summary

- 100GBASE-WDM4 PMD baseline proposal is presented supporting 802.3bm SMF 500m objective
- The proposal meets a required significant cost reduction for reaching the 802.3bm TF objective
- WDM4 PMD provides a significant module power reduction
- WDM4 PMD potentially can provide smallest form-factor
- WDM4 PMD provides smallest add-on latency
- Various implementation options have been presented confirming feasibility