

Technical Feasibility of 40km SMF 100GE Transceivers

IEEE 802.3 Higher Speed Study Group

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Outline

- Applicable HSSG Fiber Optic Ad Hoc SMF study alternatives
- 2x50G 1550nm DQPSK Transceiver alternative
- 10x10G 1550nm EML Transceiver alternative
- 4x25G 1310nm EML Transceiver alternative
- Summary

Disclaimer: This presentation was put together during the afternoon of 1/18/07 to assist in the HSSG discussion of a 40km reach objective on 1/19/07. Consequently the review of the material has been brief.

Reach (Technical) Feasibility of 100GE alternatives

| SMF | 10km 1310nm | 40km 1310nm | 10km 1550nm | 40km 1550nm |
|----------------------|--|---|---|---|
| 10x10G DML | yes (10λ span can not be uncooled) | yes (need new DML, RX APD or SOA) | yes (need new DML) | maybe (need new DML) |
| 10x10G EML | yes | yes (need RX APD or SOA) | yes | yes |
| 5x20G / 4x25G DML | yes (need new DML) | maybe (need new DML & RX SOA) | maybe (need new DML) | no |
| 5x20G / 4x25G EML | yes (need new EML) | yes (need new EML & RX SOA) | yes | yes (need RX DC) |
| 2x50G DQPSK ML | yes (need I/Q ML) | yes (need I/Q ML & RX DC & OA) | yes (need I/Q ML & RX DC) | yes (need I/Q ML & RX DC) |
| 1x100G TDM ML | yes (need new ML & maybe RX DC) | yes (need new ML & RX DC & OA) | yes (need new ML & RX DC (& OA?)) | yes (need new ML & RX DC (& OA?)) |

Green shading designates alternatives under detailed study by Fiber Optic Ad Hoc contributors.
Red ovals designate alternatives which are subjects of this presentation.

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Cost (1/Economic Feasibility) of 100GE alternatives

| SMF | 10km 1310nm | 40km 1310nm | 10km 1550nm | 40km 1550nm |
|----------------------|------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| 10x10G DML | low | mid | low | mid |
| 10x10G EML | mid | mid | mid | mid |
| 5x20G / 4x25G DML | low | mid | low | not feasible |
| 5x20G / 4x25G EML | mid | mid | mid | not economically feasible (RX DC) |
| 2x50G DQPSK ML | high | not economically feasible (RX DC) | not economically feasible (RX DC) | not economically feasible (RX DC) |
| 1x100G TDM ML | high (RX DC?) | not economically feasible (RX DC) | not economically feasible (RX DC) | not economically feasible (RX DC) |

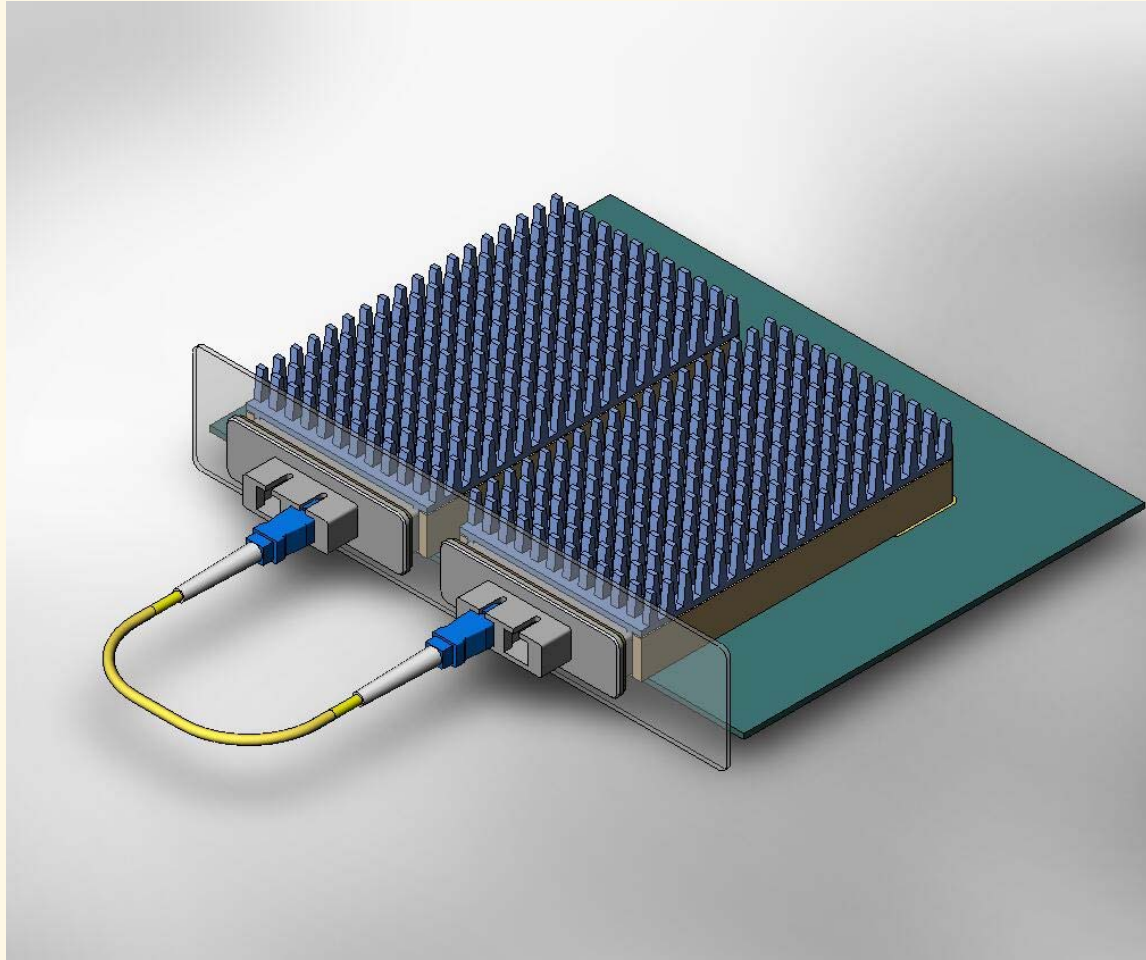
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40km 2x50G DQPSK Transceiver Optical Link

- 10GE-ER link values are used for the 100GE 40km link to maintain a 15dB Power Budget.
- 1550nm TP2 to TP3 link budget (single λ)
 - Max output power: 4.0dBm
 - Min output power: -4.7dBm
 - Min OMA = -1.7dBm
 - Receiver sensitivity: -15.8dBm
 - Receiver sensitivity in OMA: -14.1dBm
 - Stressed receiver sensitivity in OMA: -11.3dBm
 - Max penalty: 4.1dB
 - Link budget: 10.9dB (8dB fiber + 2.9dB other loss)
- The 4.1dB max penalty requires the use of Receiver Dispersion Compensation (RX DC.) Depending on the RX DC and interferometer losses, and 50G receiver sensitivity, an OA may also be required to maintain the 10.9dB link budget.
- The cost and size of the RX DC (and OA if required) impacts Economic Feasibility for LAN applications.
- The 40km 1550nm 2x50G DQPSK 100GE Transceiver is extendable to 80km, 120km, and metro DWDM applications.

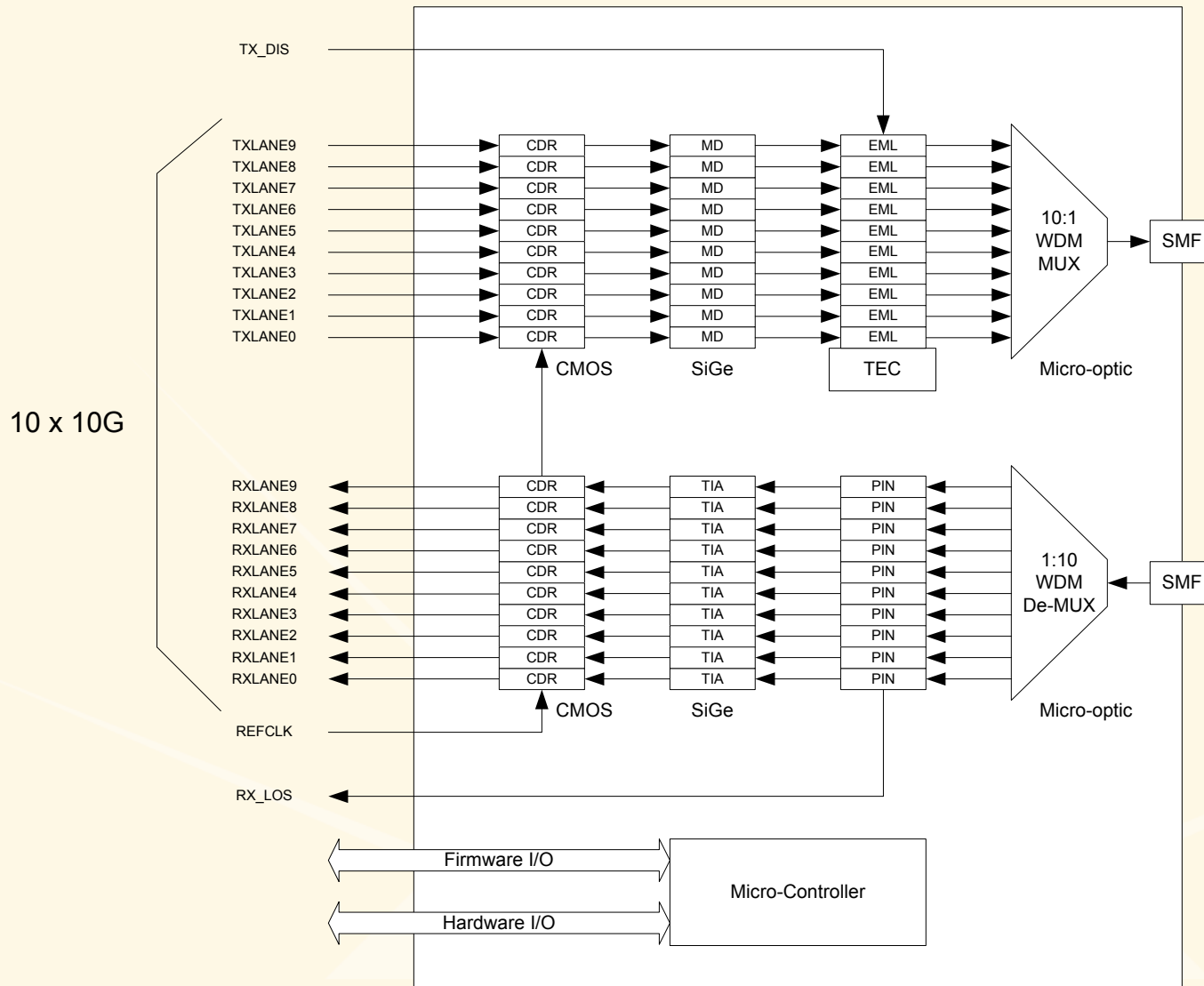
40km 2x50G Transceiver Mechanical Concept



- Possible approach to packaging 100GE DQPSK solution requiring RX DC, in a pluggable form factor compatible with LAN applications.
- One module contains RX DC (and associated OA if required.)
- Second module contains the main TX and RX chains.

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40km 10x10G EML Transceiver Architecture



40km 10x10G EML Transceiver Optical Link

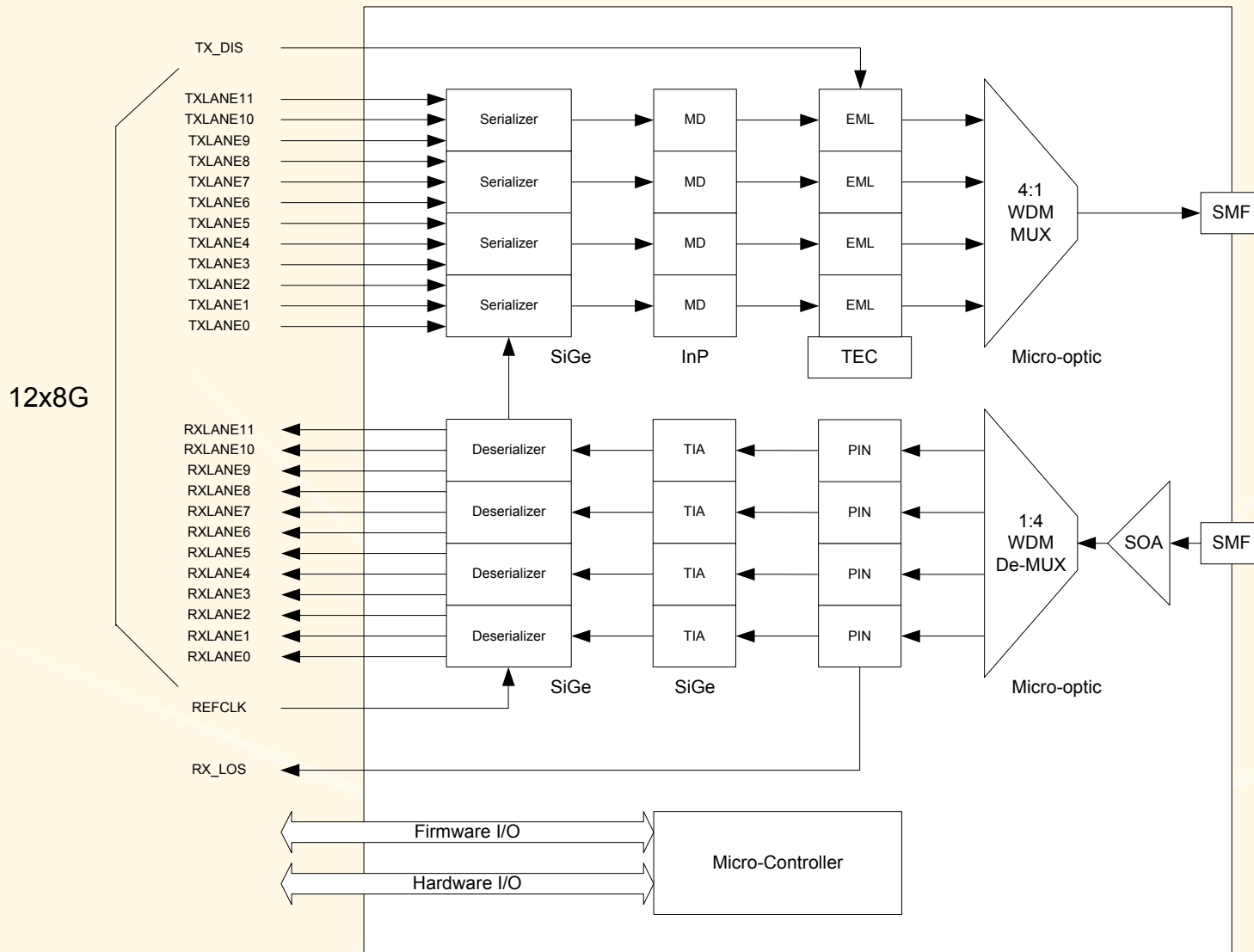
- 10GE-ER link values are used for the 100GE 40km link, except all power values are reduced by 6dB to meet AEL Class 1 eye safety, and preserve the 15dB Power Budget.
- 1550nm TP2 to TP3 per λ link budget
 - Max output power: -2.0dBm
 - Min output power: -10.7dBm
 - Min OMA = -7.7dBm
 - Receiver sensitivity: -21.8dBm
 - Receiver sensitivity in OMA: -20.1dBm
 - Stressed receiver sensitivity in OMA: -17.3dBm
 - Max penalty: 4.1dB
 - Link budget: 10.9dB (8dB fiber + 2.9dB other loss)
- There is additional loss after TP3 through the DeMux before the receiver. To meet the required receiver sensitivity an APD receiver array (or SOA) is needed (not shown in the diagram on page 7.)
- The 40km 1550nm 10x10G EML 100GE Transceiver without an APD (or SOA) meets the Optical Link budget for a 10km 100GE Transceiver.

40km 10x10G EML Transceiver Power

| 10GE-ER XENPAK Component | Power Watts | 40km 10x10G Transceiver Component | Power Watts |
|--------------------------------|-------------|---|-------------|
| XAUI (SiGe) | 2.2 | 10x Bi-directional CDRs (CMOS) | 6 |
| Mod Driver (InP) | 0.5 | 10x MD (InP) | 5 |
| EML + TEC TOSA | 1.5 | 10x EML + TEC TOSA w/ WDM micro-optic Mux | 9 |
| PIN/TIA ROSA | 0.3 | 10x PIN/TIA ROSA w/ WDM micro-optic DeMux | 3 |
| other ICs | 0.3 | other ICs | 0.5 |
| Maximum operating power | ~5W | Maximum operating power | ~24W |

A 10x APD (instead of PIN) ROSA would result in higher power value.

40km 4x25G EML Transceiver Architecture



40km 4x25G EML Transceiver Optical Link

- 10GE-ER link values are used for the 100GE 40km link, except receiver sensitivity values are reduced by 8dB to give a 23dB Power Budget.
- 1310nm TP2 to TP3 per λ link budget
 - Max output power: 4.0dBm
 - Min output power: -4.7dBm
 - Min OMA = -1.7dBm
 - Receiver sensitivity: -23.8dBm
 - Receiver sensitivity in OMA: -22.1dBm
 - Stressed receiver sensitivity in OMA: -19.3dBm
 - Max penalty: 4.1dBm
 - Link budget: 18.9dB (16dB fiber + 2.9dB other loss)
- There is additional loss after TP3 through the DeMux before the receiver. To meet the resulting receiver sensitivity, a SOA is required.
- The 40km 1310nm 4x25G EML 100GE Transceiver without a SOA meets the Optical Link budget for a 10km 100GE Transceiver.

40km Technical Feasibility Summary

- 2x50G 1550nm DQPSK Transceiver alternative
 - Requires RX DC (and possibly OA)
 - The alternative is extendable to 80km, 120km, and metro DWDM applications.
- 10x10G 1550nm EML Transceiver alternative
 - Requires APD or SOA
 - The alternative without an APD or SOA is a 10km 100GE Transceiver.
- 4x25G 1310nm EML Transceiver alternative
 - Requires RX SOA
 - The alternative without a SOA is a 10km 100GE Transceiver.