MWIS
A new Interconnect System in Motion @ Consortium On Board Optics

Multimode Waveguide Interconnect System

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Multi-mode Waveguide Interconnect System

GOAL
1. High-Bandwidth
2. Power Efficiency

Three fundamental building blocks:
- MA: Very thin EO and OE converters named MA (Media Adapter)
- MMWG: Embedded Optical Waveguide in PCB
- Existing copper SERDESes with very short electrical trace to drive MAs

Matured MMWG Technology Embedded in Multi-Layered PCB (by Courtesy of TTM Inc.)

Source: COBO MWIS Whitepaper
MA Termination: Optical waveguide is always terminated by a pair of MAs (MA\textsubscript{TX} and MA\textsubscript{RX})

Electrical Interface: From SERDES to MAs, it allows very short, or zero copper trace

MA Structure: MA consists of ‘Thin’ optical engine with optical waveguide connector

The channel performance of the bandwidth and power consumption will be assessed in the electrical domain with the optical channel inclusive.
Embedded Optical Path

C2M MWIS

NPO-like MWIS
SoC/switch
Soldered
ASIC
Soldered
Optical Engine/MA
OE/ED
Soldered
Optical Engine/MA
MMWG
Conventional Pluggable Optic
Fiber
Host PCB

C2M (Conventional)
NPO
SoC/switch
Soldered
ASIC
Soldered
Optical Engine/MA
OE/ED
Soldered
Optical Engine/MA
MMWG
Passive Connector
Fiber in the Air
Host PCB

C2M Conventional
CPO
SoC/switch
Soldered
ASIC
Soldered
Optical Engine/MA
OE/ED
Soldered
Optical Engine/MA
MMWG
Passive Connector
Fiber
Host PCB

C2C MWIS
CPO-like C2C
SoC/switch
Soldered
ASIC
Soldered
Optical Engine/MA
OE/ED
Soldered
Optical Engine/MA
MMWG
Passive Connector
Host PCB

Optical path embedded in PCB
Two Questions:

- Can power savings be achieved by adding OE/EO?
- How much bandwidth will be expected with MM waveguide rather than SM?

Copper Channel Model

- $Z_0$
- Cu trace, via, connector...
- IL, RL, Xtalks / VEC, ERL, COM,... = function (tap#, freq)

- IL ↑ power ↑
- #of Taps ↑ power ↑
SERDES of 100Gbps/lane power efficiency

EPB (Energy per Bit) vs SERDES subclasses length for 100G/lane technologies*:

EPB Slope = ~ 0.35pJ/bit/dB
From previous chart EPB Slope = 0.35pJ/bit/dB
Example: 1dB copper for MWIS with pair of MAs will consume 0.7 (= 0.35+0.352) pJ/bit vs 6~10pJ/bit of LR
1. Extracting Optical S-Parameter to get Ein vs Eout (S21)
2. Apply practical misalignment condition $d_{\text{MIS}} > 0$
Finite Impulse Response vs $d_{\text{MIS}}$(um)

$L_{\text{MMWG}} = 250\text{mm}$

$L_{\text{MMWG}} = 500\text{mm}$
Link Modeling & Simulation
PCB embedded, optical Multimode Waveguide with the very thin EO and OE converter called MA (Media Adaptor), together with the very short copper trace forms a newly proposed interconnect system called MWIS (Multimode Waveguide Interconnect System).

MWIS architecture has been reviewed as a future proof solution of a new PCB interconnect system in the power consumption and bandwidth breakthrough perspective.

- MWIS channel can be implemented with extremely lower energy consumption even with the addition of eo/oe module.
- Optical S21 is extracted with misalignment variation and reviewed through the channel Impulse Response to assess the modal impairment.
- Eye diagram with linear electrical filter shows promising results however NLTV filters can be further applied as an encouraging next topic where Electrically equivalent S21 is to be formulated for standard and industry activity.
- With the SERDES for MWIS channel, there seems no fundamental bandwidth limit up to Lightwave carrier frequency (200~300Thz).