System OEM design guidelines for chip to module interfaces

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Topics

1) Reach considerations for chip-to-module electrical interfaces
2) Implications of reach considerations for both retimed and un-retimed module interfaces
3) Systems considerations related to the inclusion of FEC for NG PMDs

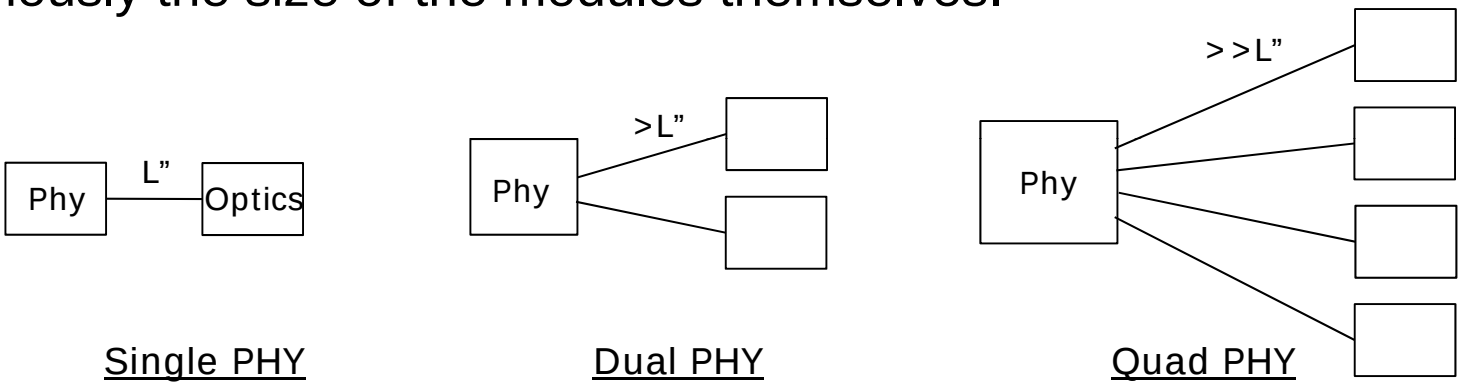
Reach Considerations for chip-to-module electrical interfaces

Background

- There have been discussions within the Next Generation 100Gb/s Optical Ethernet Study Group around two new 4 lane chip-to-module electrical interfaces and possible objectives:
  - CAUI-4 (4x25G retimed)
  - CPPI-4 (4x25G un-retimed)
- One of the key discussion points around any electrical interface is the (minimum) host reach requirements
- This presentation leverages previous IEEE and OIF contributions, to provide some basic system OEM guidelines for the host (PCB) reach requirements of any new chip-to-module electrical interface.

Host Distance Requirements

- A key consideration for chip-to-module distance requirements is related to the number of modules that need to be directly connected to a single host chip (be that a PHY, MAC, Framer, etc), and obviously the size of the modules themselves.

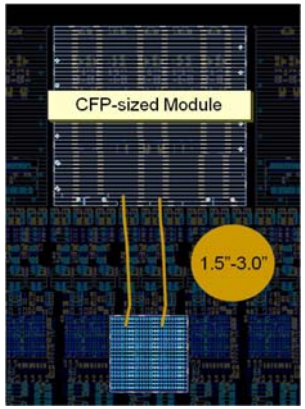


Single PHY Dual PHY Quad PHY

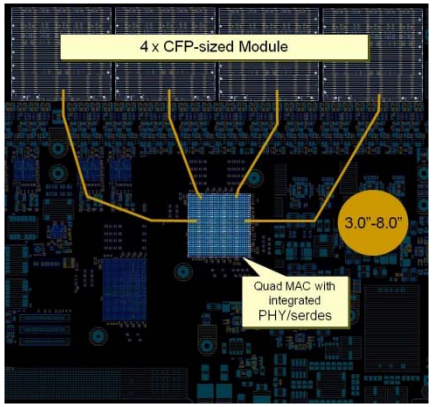
- Implementations tend to start with a single phy solution, but migrate to higher order PHYs over time, to meet density demands.
- Often to move to higher order PHYs is accompanied with a move to the next gen (smaller) module form factor
- As a general rule any new chip-to-module interface should support, as a minimum, evolution to a Quad PHY implementation

802.3ba – nAUI/nPPI recap

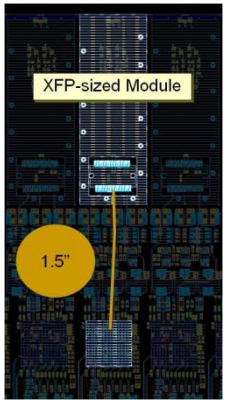
- Distances for nAUI/nPPI were primarily driven out of nicholl_01_0708



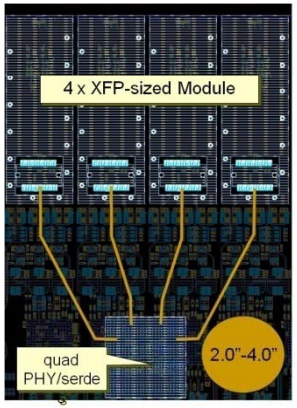
1 port CFP



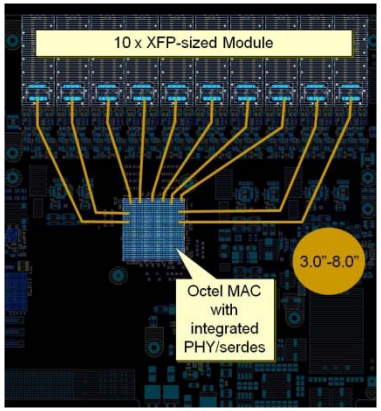
4 port CFP



1 port 'XFP'



4 port 'XFP'



8/10 port 'XFP'

CFP sized module (Retimed)

1 port: 1.5" - 3"
4 port: 3.0" - 8.0"

CXP/QSFP sized module (Unretimed)

1 port: 1.5"
4 port: 2.0" - 4.0"
8 port: 3.0" - 8.0"

- In keeping with the 'Quad Phy' rule-of-thumb, 802.3ba targeted 8" for nAUI (retimed) and 4" for nPPI (unretimed)

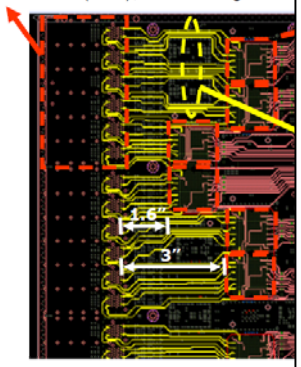
OIF CEI-28G-VSR Activities

- The OIF kicked of the CEI-28G-VSR project in Jan/10.
- The project was aimed at defining a 4 lane electrical interface for use with next generation 100G optical modules
- One of the underlying goals of the project, was that the work could (would) eventually be picked up by a future IEEE study group as the basis for a CAUI-4 chip-to-module interface.
- A lot of the same discussions arose as in 802.3ba, relating to the (minimum) host reach requirements
- The following slides (taken from OIF2010.132.01) were submitted to help the group define:
  - ❖ Host distance requirements (primarily driven by component placement and routing)
  - ❖ Channel loss requirements

OIF2010.132.01 - Distance Analysis

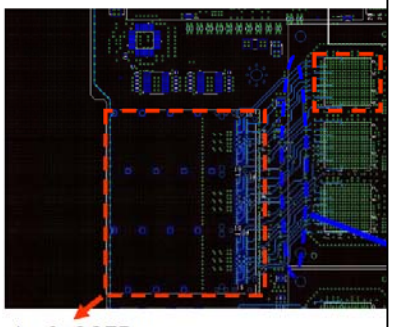
SFP+ Example (n p

Stacked (2x6), SFP+ cage



- Example of a high density
- One Phy chip connected
- The longest routed net is around a power block).

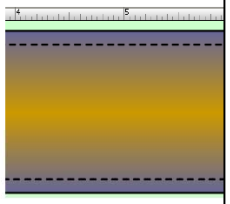
QSFP Example (n port



1 x 3, QSFP cage

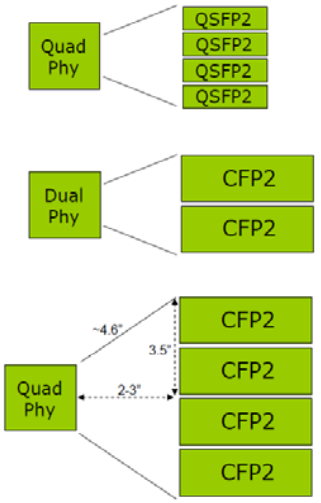
- Example of a lower density line car
- One Phy chip connected to one (nc
- Longest trace is 2.2"

28G VSR Example (G



- Preliminary placement analysis fo
- A single PHY (10:4 gearbox) con
- Longest trace is estimated to be ~
- Expected to represent the minimu

28G VSR Example (Gen 2)



- Quad Phy to 4 x QSFP2
- Same as "nicholl_01_0708.pdf"
- 4" should be sufficient
- Dual Phy to 2 x CFP2
- essentially the same as above
- 4" should also be sufficient
- Quad Phy to 4 x CFP2
- trace length > 4"
- not supported by 28G-VSR ?

Channel Distance Recommendation

Based on:

1. A review of existing channel lengths on shipping product (all be it at lower rates)
2. A review of the nPPI objectives and associated analysis in .ba, and
3. A preliminary placement analysis on several 100G QSFP2 / CFP2 applications

We recommend the following target channel distances:

Min Channel distance = 0.8 "
Max Channel distance = 4 "

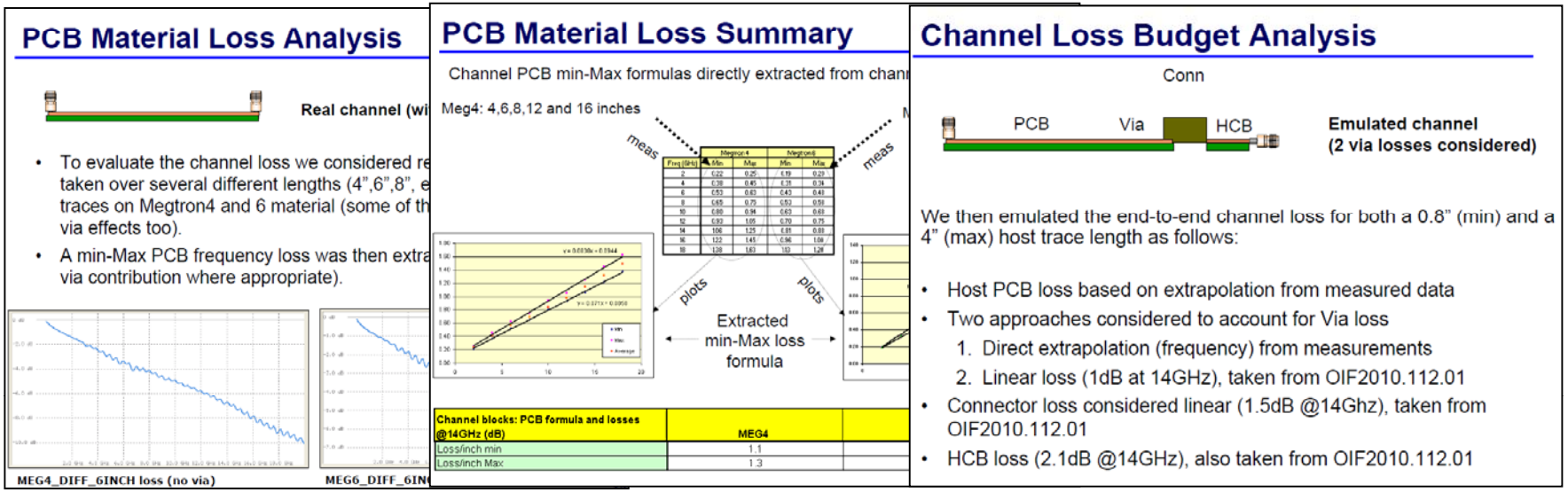
Conclusion:

- Similar analysis to nicholl_01_0708 performed, looking at both CFP2 and CFP4/QSFP2 form factors
- Again based on 'Quad Phy' rule a target distance of 4" was chosen

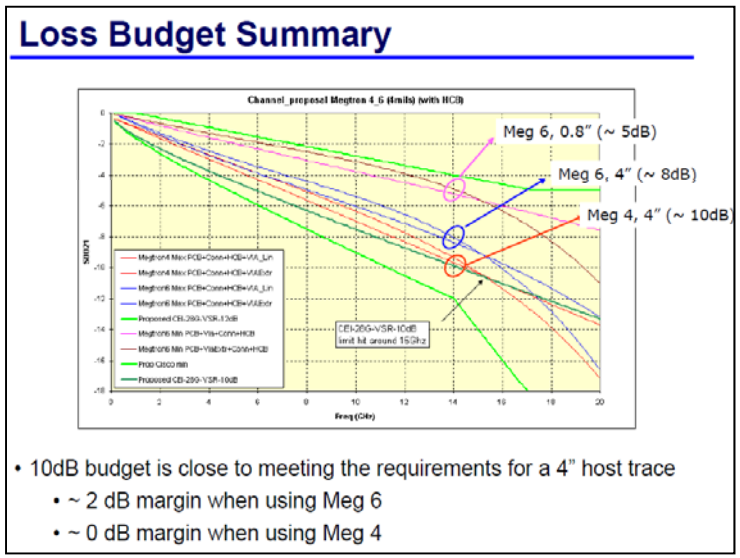
Distance versus Loss

- To define the electrical specification, the distance requirement must first be mapped to a channel loss requirement
- This mapping is obviously dependent on a number of parameters and assumptions, such as PCB material, stripline versus microstrip, connector loss, etc
- ☺☺ More debate and discussion ☺☺
- General philosophy is that the distance to loss mapping used in defining a standard, should be based on typical (mainstream) design approaches:
  - ❖ A poor design using higher loss board materials will likely not meet the distance requirement.
  - ❖ A state-of-the-art design, using state-of-the-art board materials and connector technologies, will likely exceed the minimum distance requirements by a significant margin

OIF2010.132.01 – Loss Analysis



Extrapolated channel loss from measured data on different board materials



Conclusion:

10dB (@14G) is a good candidate proposal to meet a 4" host channel:

- ~ 2dB margin for Meg 6
- ~ 0dB margin for Meg 4

Summary – Host Reach Considerations

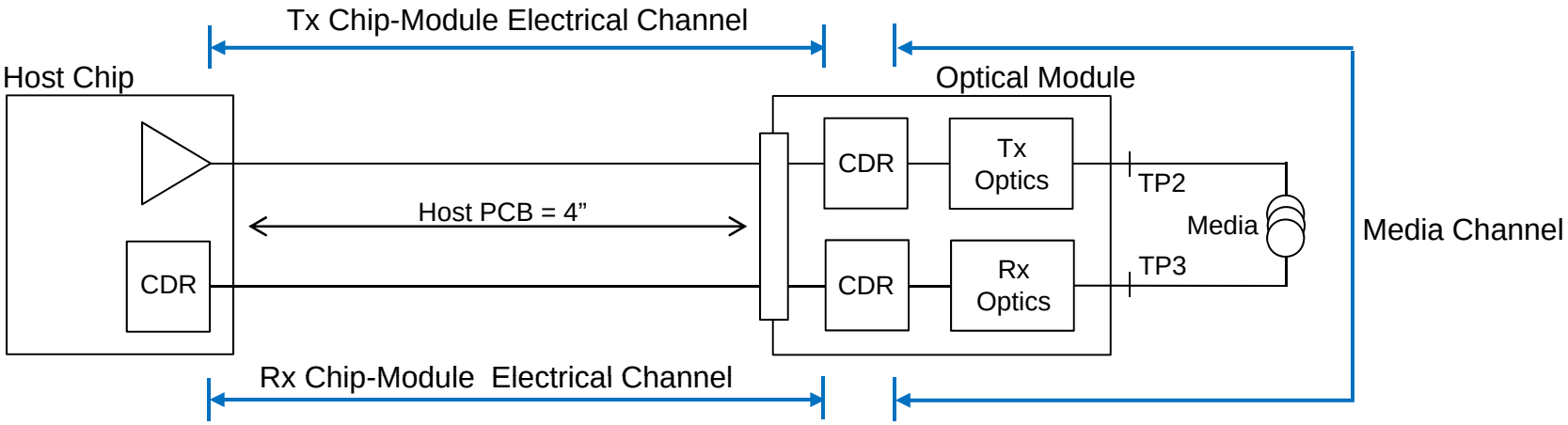
- Recommend targeting a (minimum) distance of 4” for any next gen, 4 lane chip-to-module interface.
- Recommend that a loss budget of 10dB (@ Nyquist) is a good starting objective for a chip-module electrical channel targeting a host distance of 4” (note, this includes host PCB trace loss + connector loss + module PCB trace loss)..

Implications of host reach for both Retimed and Un-retimed optical module interfaces

Background

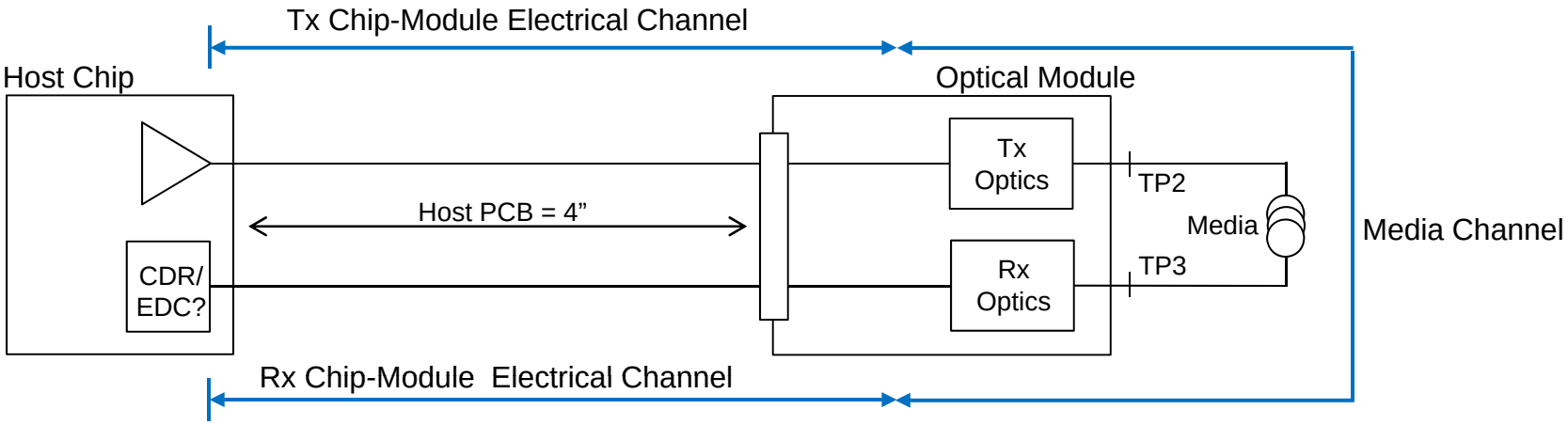
- If/once we agree to define a chip-to-module electrical interface, we need to separately consider the implications for:
  1) Retimed interface (CAUI-4 ?)
  2) Un-retimed interface (CPPI-4 ?)

Retimed Module Interface



- Chip-Module electrical channel is symmetrical (Tx = Rx)
- Chip-Module electrical channel is essentially decoupled from media channel (can therefore be defined independently)
- Can leverage OIF-28G-VSR work, as evidence for technical and economic feasibility
- Recommend a 10dB (@ Nyquist) loss budget for a retimed chip-module electrical channel (CAUI-4)

Un-retimed Module Interface



- No clear demark between chip-module electrical channel and media channel. Cannot define chip-module electrical channel in isolation from media channel (reach)
- Host chip must accommodate 2 x chip-module channel + media channel (e.g. 2 x 10dB + media channel loss)
- Need to define target PMD reach objectives(s), to assess a un-retimed module interface

FEC Considerations for next gen PMDs

Background

- FEC is one option being considered to address reach requirements for some of the next gen PMDs (e.g. SR4)
- Some discussion about extending FEC to other PMDs, and potentially to legacy PMDs such as 100GBASE-LR4, etc (thereby potentially creating FEC and non-FEC versions)

FEC Considerations

- From a system vendor perspective FEC is not ‘free’.
- A decision to introduce FEC should not be taken lightly.
- There are a number of system issues/implications to consider, not least of which is compatibility with 40GE/100GE ports already shipped (e.g. if a new PMD requires FEC how would it be supported on a ‘legacy’ platform which does not implement FEC?)

FEC Recommendations

If the group believes that FEC is ultimately required, then the following guidelines should be adhered to:

- If FEC is required for a new PMD, then it should not raise any (media) interop issues due to options.
- No proliferation of existing PMDs due to FEC variants.
- Solutions should be compatible with existing host designs supporting currently defined PMDs.

Next steps

- Recommend the development of a retimed chip-to-module interface (CAUI-4)
  - 10dB (@ Nyquist) loss budget
  - Leverage OIF CEI-28G-VSR

- Pending agreement on optical reach objectives, further contributions are required regarding technical and economic feasibility of an un-retimed chip-to-module interface.

References

- nicholl_01_0708: ‘Distance Requirements for XLAUI/CAUI and PMD Service Interface’ http://www.ieee802.org/3/ba/public/jul08/nicholl_01_0708.pdf
- OIF2010.132.01: ‘VSR Channel Distance and Loss Budget’

Note: As the author for OIF2010.132.01, I will make it available upon request.