

Marrying Copper and Optical

Mike Dudek Qlogic
Chris Cole Finisar
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- **Advantages of common host port supporting copper and optical PMD's with a pluggable interface.**
 - Potential to ship partly populated switches for future upgrade (lower initial cost)
 - Flexibility of medium at installation
 - Less quantity of different switches to cover the applications
- **Successful Examples**
 - SFP at 1Gb/s,
 - SFP+ at 10GB/s
 - QSFP at 40Gb/s

- **PAM2 Backplane Serdes Shown to Operate over**
 - 1m backplane channel with approx 30dB loss at 12.9GHz (Patel_01_0911, Dudek_01a_0911, hatab_01_0911)
 - Copper cable channels both 3m and 5m with approx 30dB loss at 12.9GHz (Meghelli_01a_0911)
 - Using a zero overhead FEC the link loss can be extended to 35dB. (Meghelli_01a_0911)
 - Using a 6% overhead FEC the link loss can be extended to 36dB (Bhoja_01_0911)
- **Same PAM2 Serdes will meet CAUI-4 retimed interface with similar specifications to the chip to module OIF-CEI-28G-VSR Implementation Agreement**

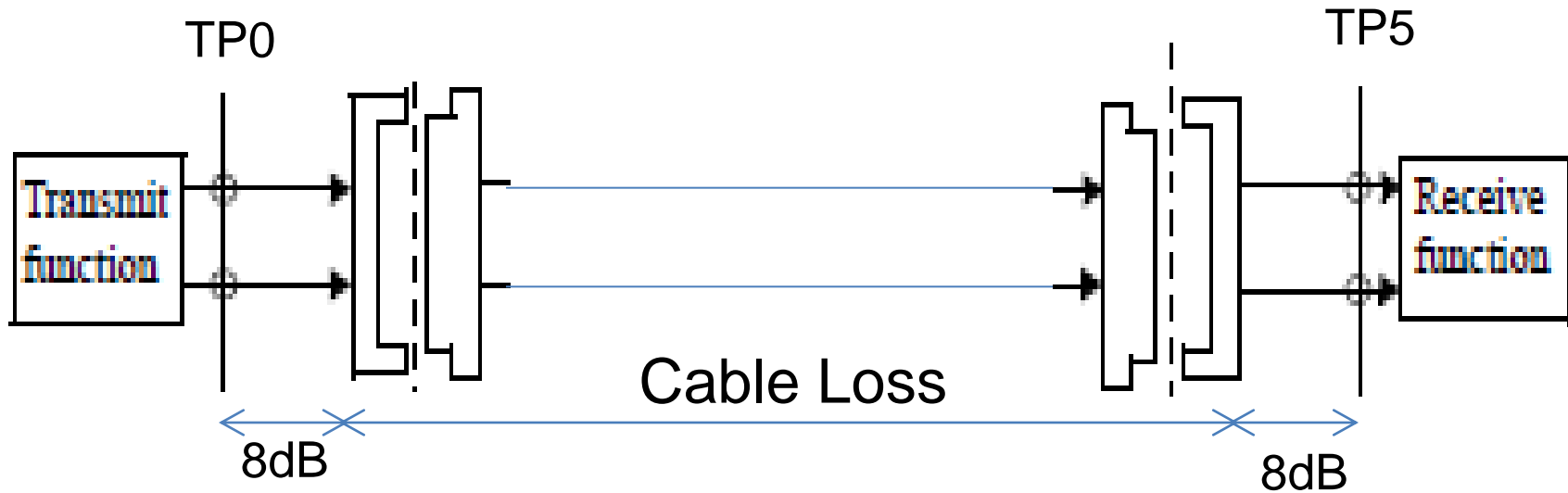
- **Little or no Tx de-emphasis**
- **Simple Rx CTLE**
- **Loss budget host chip to module chip = 10dB**
 - 7.3dB for host
 - 1.2dB for connector
 - 1.5dB for module traces and capacitors.
- **PAM2 Backplane Serdes doesn't need all its capabilities to meet OIF CEI 28G VSR**
 - Turn off some for power saving
 - Higher loss host traces

- **FEC benefits both Copper and Optical links.**
- **Copper links tend to create burst errors - Need a code with good burst properties**
- **Optical links performance at 25G is likely to deteriorate faster than copper with increased symbol rate**
- **Zero overhead code simplifies implementation of optional FEC by not requiring dual rate re-timers**
- **Higher overhead codes offer larger coding gain with lower latency**

Passive Cable Losses

- **5m 24AWG 18dB including connector and paddle cards (Diminico_01_0511)**
- **3m 26AWG 13.82dB including connector and paddle cards (Diminico_01_0511)**

Loss budget Example.



30dB without FEC Allows Cable loss of 14dB ie 3m AWG26

35dB with FEC Allows Cable loss of 19dB ie >5m AWG24

- **Linear Active cables**
 - Fixed CTLE at the Rx end (Fixed appropriate for the cable attenuation) potentially meets the spec for passive copper cables. (maybe need to trade ILD rms for noise)
 - Doesn't interfere with training algorithm.
- **Retimed Active cable**
 - Will operate same as modules.
- **Limiting Active cable**
 - Will need an additional specification
 - May be difficult to close jitter budget

Advantages of this approach.

- **One Serdes useable for**
 - **Backplane interface**
 - **Copper Cable interface**
 - **Interface to Optical modules**
- **Common port useable for**
 - **Optical modules**
 - **Passive copper cables**
 - **Active copper cables.**