

# Marrying Copper and Optical

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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**

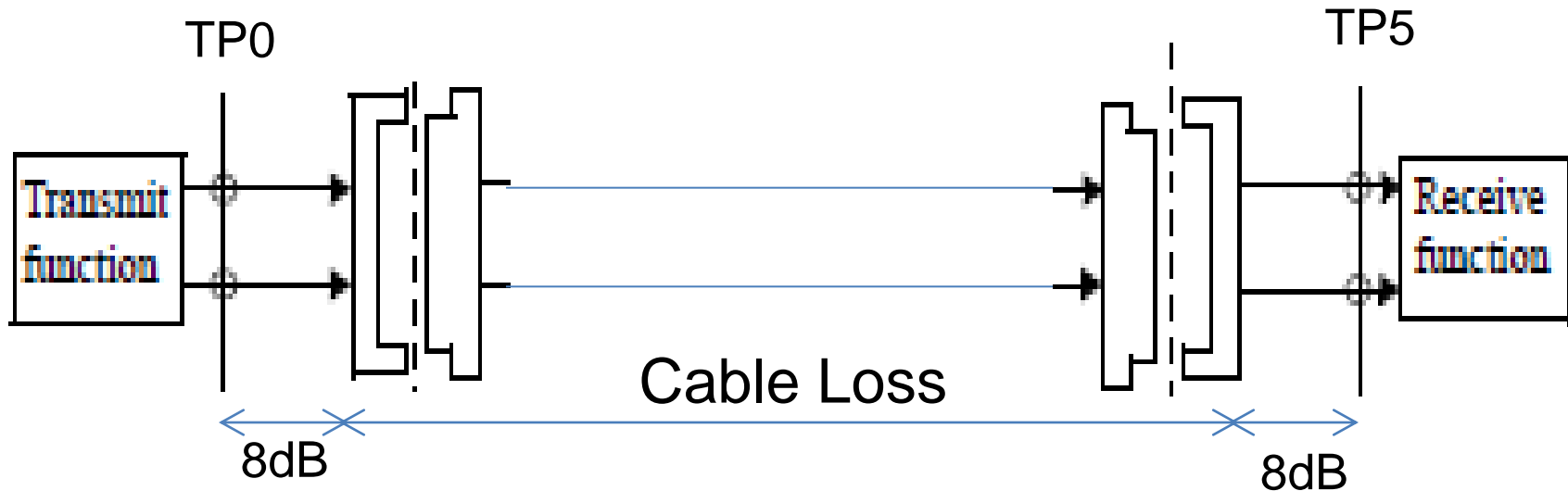
- **Little or no Tx de-emphasis**
- **Simple Rx CTLE**
- **Loss budget host chip to module chip = 10dB**
  - 7.3dB for host
  - 1.2dB for connector
  - 1.5dB for module traces and capacitors.
- **PAM2 Backplane Serdes doesn't need all its capabilities to meet OIF CEI 28G VSR**
  - Turn off some for power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