Considerations for Active Cables for Higher Speed Ethernet

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Background

- **40G Ethernet Copper Objective:**
  - Support at least 10 meters over a copper cable assembly
  - Support a BER better than or equal to $10^{-12}$ at the MAC/PLS service interface.

- Currently interconnect and cable technology available to support serial 10 Gbps data transmission over up to 10m of twin-axial cable

- Technology of 10GBASE-KR may be leveraged here.

- System designers need the flexibility to implement longer reaches (<10 meters), while using thinner cable gauges – to reduce cable weight, improve cable management, increase airflow in the data centers.

- Active cables have proven to be an economical, low-power, low-latency and high-performance option to support longer reaches and thinner wire gauges.

- Growing use by the industry in the InfiniBand, 10GBASE-CX4, PCIe, QSFP and other application. Several silicon vendors have products.

- Consider keeping the active cable option open for 40GE/100GE
Background: Attenuation in Cable Assemblies

10M of 24-26AWG cable assemblies can be made to match the 10GBASE-KR channel model, anything longer and/or thinner will be difficult (SDD21 for a 10M 24AWGQSFP assembly shown).
Matching Attenuation is not enough: adapting 10GBASE-KR signaling (64b/66b) to cable assemblies will run into the Group Velocity Dispersion Issue (graph courtesy of Patrick Casher, Molex)
Background: Group Velocity Dispersion

- A well designed active cable can help mitigate the Group Velocity Dispersion problem.
- Example: 10m 30 AWG Cable: Group velocity dispersion compensated down to 20 MHz (plot courtesy of Andrew Kim, Quellan).
Active Cable Overview

Active Cable Reach Extension
Active Cable Overview

- How active cables improve the channel (Two-Fold Improvement of SNR):
  - Boost received signal
  - Reduce Crosstalk (NEXT) impact by placing the equalizer inside the cable assembly:

![Diagram showing cable crossover and connector NEXT](image)

- **Cable Crosstalk** (generally small)
- **Connector NEXT** (minimized in active cables)
Active Cable Overview

Comparison of SNR for passive (red) and active (green) 10m 30AWG cable assemblies
Active Cable Overview

Comparison of 10 Gbps eye diagrams of passive (a) and active (b) 24AWG QSFP cable assemblies
Interconnect Options Supporting Active Cable

- A power delivery option to the plug connector
- A twin-ax type cable
- There are two connector candidates for a 4x10G Solution already supporting this

QSFP

InfiniBand/CX4
Signaling Options Supporting Active Cables

- Most NRZ signaling protocols are compatible with active cables
- The signaling, transmitter and receiver characteristics defined in 10GBASE-KR should work well with active cables
- Active cables with group velocity dispersion compensation can actually help in improving transmission of stressful (long bit sequence) data patterns, such as 64b/66b of 10GBASE-R
Summary

- Active cables can be a viable technology to support the copper objective in 40G Ethernet

- Current growing use in the industry demonstrates the feasibility of active cables for allowing longer reach and smaller wire gauge

- Two connector standards that are possible candidates for the 4x10G solution (QSFP and CX4) already support the active cable option by providing power delivery.

- The option to allow active cables should be kept open for longer-reach and thinner-cable applications, and to provide margin for future requirements.
Thank You!