Effect of Passive and Active Copper Cable Interconnects on Latency of Infiniband DDR compliant systems.

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Background Information/Assumptions

- Assuming short cable interconnects (less than 3 meters) typical latencies for a 4X Infiniband DDR system run in the 1.5 to 3 μSec range.
- To allow data center managers to efficiently lay out an Infiniband DDR cluster, copper cable interconnects of up to 30 meters are required.
- 12 meter passive copper cable interconnects can be manufactured meeting the DDR specification called for in InfiniBand™ Architecture Specification Volume 2 Release 1.2.1.
- For lengths greater than 12 meters, “Active” copper cable assemblies have been added to the portfolio of Copper Cable interconnects offered in the Infiniband market.

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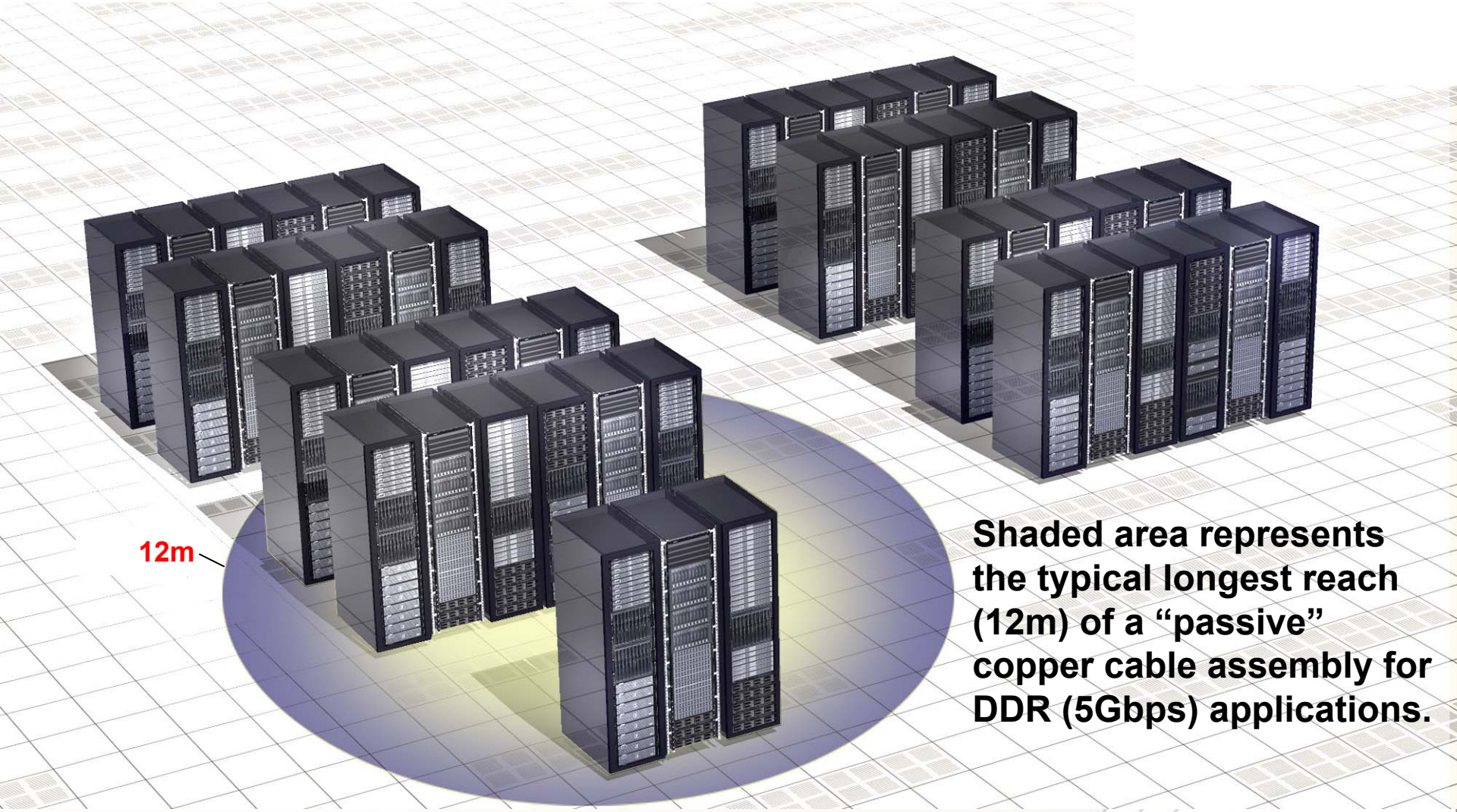
Passive Cables Limited for Infiniband DDR Clusters



Shaded area represents the typical longest reach (12m) of a "passive" copper cable assembly for DDR (5Gbps) applications.

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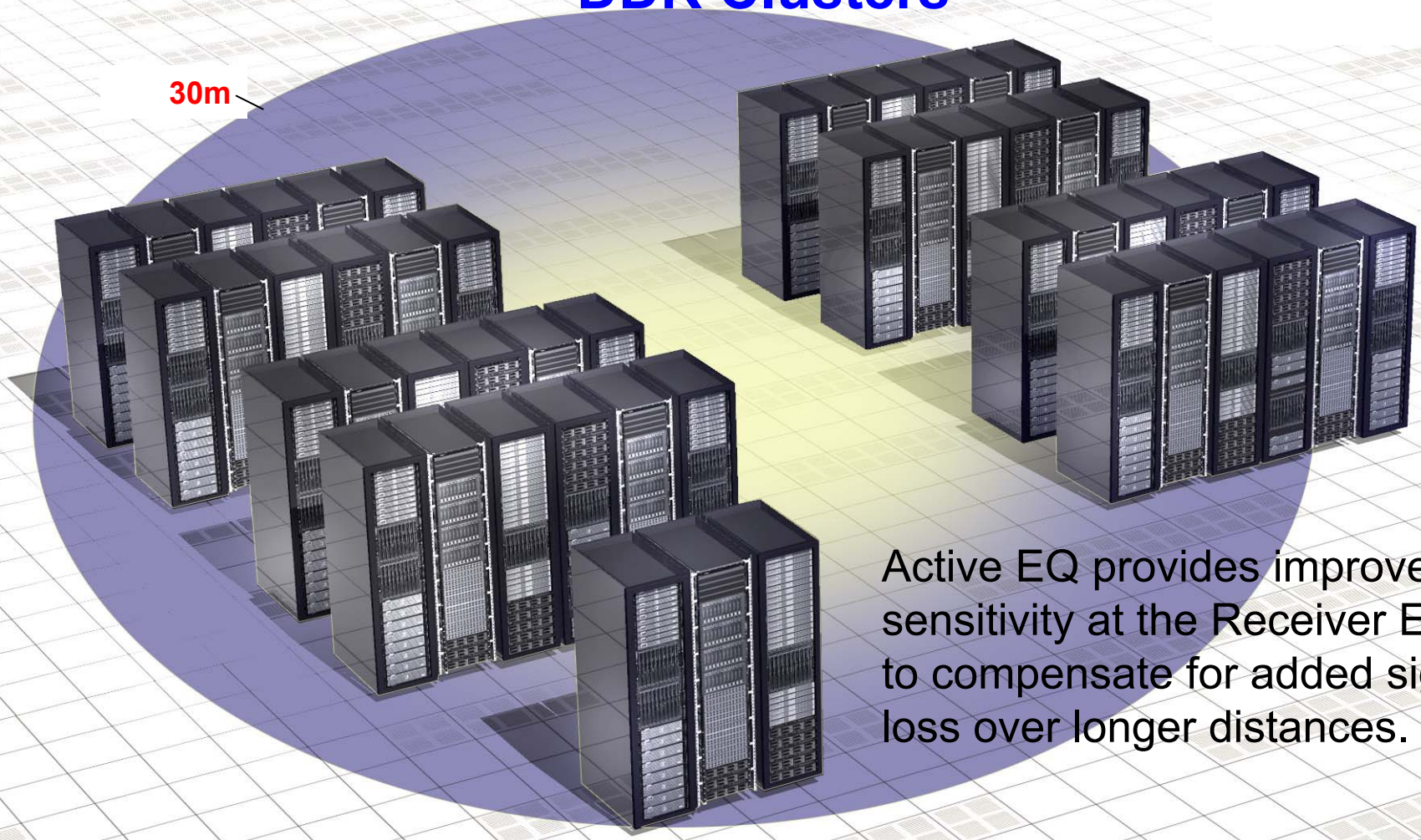
“Active EQ” Extends Cable Reach for Infiniband DDR Clusters



Active EQ provides improved sensitivity at the Receiver End to compensate for added signal loss over longer distances.

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Latency adder for passive copper cable interconnects

- The time of flight (TOF) or propagation delay of a passive copper cable interconnect is a direct contributor to the overall latency of on Infiniband link.
  - The TOF of any passive copper cable interconnect is a function of the following:
    - Dielectric material used on the bulk cable
    - Connection media used to the cable connector system (typically a very short PCB trace with a length less than 25 mm)
    - PCB trace runs to the board mounted connector receptacle on the system side. (Varies by system type but for sake of argument we will use 0.5 meters).
- We will address each component in turn

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Latency adder for passive copper cable interconnects continued

- Bulk cable and board level Dielectric Materials
  - The propagation delay of the transmission lines on a passive copper cable interconnect or board level copper trace is a function of the dielectric constant of the insulation material used in cable manufacturing.
    - Typical insulation materials are listed below along with the dielectric constant and time delays.

	Dielectric Constant	Propagation delay (nS/meter)
ePTFE	1.4	3.9
Foamed PE	1.6	4.2
PTFE	2.1	4.8
PE	2.26	4.9
FR4	4.2	6.7

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Latency adder for passive copper cable interconnects continued

- Using the values of propagation delays shown in the table shown earlier the TOF for a passive copper cable interconnect would be as follows:

Length of Cable	Bulk Cable Propagation Delay (nS) (assume ePTFE dielectric)	Propagation Delay of 0.525 meters of FR4 trace (nS)	Total Propagation Delay (nS)
1 m	3.9	2.2	6.1
3 m	11.7	2.2	13.9
5 m	19.5	2.2	21.7
8 m	31.2	2.2	33.4
10 m	39	2.2	41.2
12 m	46.8	2.2	49.0

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Latency adder for passive copper cable interconnects: Conclusions

- Looking at the Propagation Delay of even a 12 meter passive copper cable interconnect, we see a total of 49.0 nS (0.049 μS). This represents only a 3% adder to the total system latency. Given this low level, the latency of the passive copper cable interconnect can be treated as negligible.

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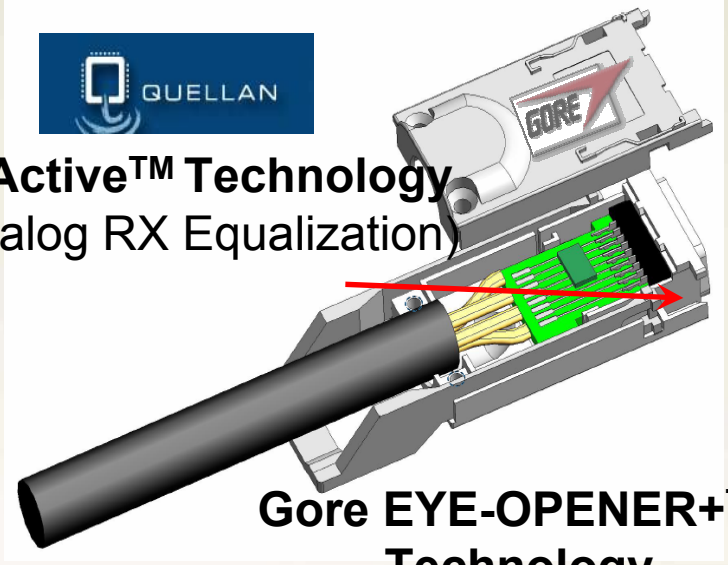
Latency adder for “active” copper cable interconnects



Q:Active™ Technology
(Analog RX Equalization)

Gore EYE-OPENER+™ Technology

Gore Extended Reach Cable Assemblies

- As previously discussed, for efficient data center architectures, Cable interconnects are required up to 30 meters
- Passive copper cables can extend to 10 to 12 meters. To fill the void from 12 meters to 30 meter cable offerings, “active” cable assemblies have been developed.
- The Analog RX Equalization technique used in the example shown, adds a maximum of 0.5 nS of latency to the copper cable link.

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Latency adder for passive copper cable interconnects continued

- Using the values of propagation delays shown in the table shown earlier the TOF for an active copper cable interconnect would be as follows:

Length of Cable	Bulk Cable Propagation Delay (nS) (assume ePTFE dielectric)	Propagation Delay of 0.5 meters of FR4 trace (nS)	Propagation Delay of Analog RX Equalization (nS)	Total Propagation Delay (nS)
12 m	46.8	2.2	0.5	49.5
15 m	58.5	2.2	0.5	61.2
20 m	78	2.2	0.5	80.7
25 m	97.5	2.2	0.5	100.2
30 m	117	2.2	0.5	119.7

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Latency adder for passive active cable interconnects: Conclusions

- Looking at the Propagation Delay of even a 30 meter active copper cable interconnect, we see a total of 119.7 nS (0.1197 μS). This represents only an 8% adder to the total system latency. Given this low level, the latency of the active copper cable interconnect can also be treated as negligible.

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