Innovative Insights

DATACOM

25-GBIT/S CONNECTIVITY: FAMILIARITY WITH COPPER BREEDS INNOVATION›

TOTAL INTEROPERABILITY REQUIRE PROPER COMPONENT SPECIFICATION, CLARITY COMPLIANCE METHODS, AND CONTINUED COLLABORATION

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Recent technological advances have made copper cable assemblies an even more viable option for high-speed applications. As Bishop & Associates noted, "Designers prefer to stay with familiar copper interconnect technology and are developing channel design, simulation and board layout expertise that continue to push the bandwidth. Few engineers are willing to predict the ultimate performance limit of copper interconnects."

Cable integration, power and thermal management are intrinsic challenges in today's data centers populated by enterprise servers and storage applications. Rising bandwidth demands dictate continuous increases in transmission rates. The introduction of 25 Gbit/s channels offers a potential game-changing solution. High-speed copper 25-Gbit/s enabled products in the prototype stage can now deliver a higher bandwidth alternative to traditional copper—at a lower-cost entry point than optical connectivity.

While optical fiber has become a popular medium for long-distance network communications, copper connectivity offers a cost-effective solution for short-to-midrange applications. From a design standpoint, optical media also poses intrinsic challenges, including thermal and power management. Passive copper cable fills the demand for low-cost, low-power, short-range (1 to 7-m) applications, and is often the best solution for stand-alone systems or between optical and structured copper cabling. Approximately 90% of applications are ≤3 m, which includes most data connections in high-performance computing systems.

Network system data centers frequently blend optical modules and copper cable assemblies. A savvy system designer can readily integrate and optimize a system to leverage the strengths of each. High-speed passive 25-Gbit/s copper brings a competitive cost and performance solution to data center cabling, including top-of-rack, middle-of-rack and for connections to data storage servers.

High-density cables must retrieve and transmit data from storage rapidly enough to meet variable and peak demand. Increasing front panel I/O bandwidth density can enable a data center to grow capacity without the need for additional floor and rack space. Higher speeds are achieved by increasing the port density at the panel. Currently, the passive copper speed for a single high-speed link is 10 Gbits/s, which requires 10 lanes to achieve 100 Gbits/s. Ratcheting each lane up to 25 Gbits/s reduces the lane requirement from 10 to four lanes, saving valuable real estate and creating a higher-density front panel I/O.

At these high-speed copper rates, every aspect of the system is critical. All aspects of the channel need to be assessed in terms of variation across time, process and temperature. The challenge of interoperable, high-speed electrical performance increases exponentially with linear increase in speed. While 10 Gbits/s allows margins of error in specifications, interoperability at 25-Gbit/s channels does not afford the same buffer, taking the challenge of universal interoperability to a new level, and across all elements.

The Molex iPass+ HSC CXP dual paddle-card (pluggable copper or optical) system was adopted as the InfiniBand CXP 12x QDR standard in July, 2008. This system was also adopted by IEEE 802.3ba, as the 100 Gbit/s Ethernet standard, providing 10 lanes of 10-Gbit/s data rates. The final standards for high-speed copper are expected to be substantially different from other IEEE 802 standards. While 802.3ba includes a specification for 100 Gbits/s, as yet, there is no standard to support Ethernet on backplane media at operating speeds of 100 Gbits/s. However, industry groups recognize the power of 100-Gbit/s backplane and twinaxial copper links to achieve the desired density, power and cost targets for computer network systems and equipment.

Since IEEE 802.3ba the market has seen significant improvements to connectors, paddle card design, connector launch, conductor termination and raw cable. Molex 25-Gbit/s copper assemblies integrate design improvements in almost every one of these critical areas. Demonstrated at DesignCon 2011, the Molex zQSFP+ small form factor, pluggable I/O system offers eight lanes (four in each direction) of 25-Gbit/s data rates. Utilizing a transceiver and BertScope to present transmission performance via eye pattern for a 3-m passive cable, the demonstration showed how next-generation 100-Gbit/s rate copper can support applications found primarily in data networking and telecommunications. To view the demonstration, click Molex 25-Gbit/s zQSFP+ Demo http://www.youtube.com/watch?v=d_oEPZDHgGI&feature=related%22

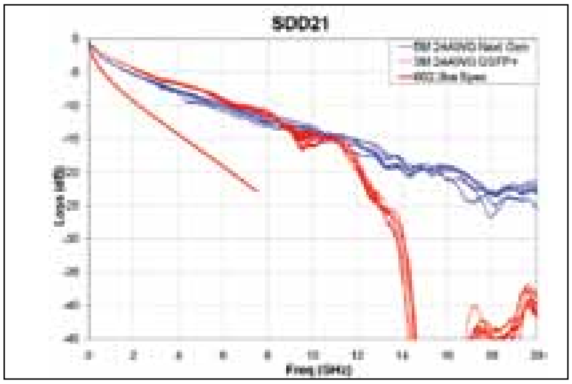

Fig. 1: Differential Insertion loss of next-generation 5-m cable assemblies is better through high frequencies than current-generation 3-m cable assemblies.

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In terms of performance, the differential insertion loss of next-generation 25-Gbit/s copper 5-m cable assemblies is better through high frequencies than current 10-Gbit/s copper 3-m cable assemblies (see Fig. 1). Next-generation cable assemblies offer improvements in crosstalk and will have approximately 50% less noise than current-generation comparable 3-m cable assemblies. Integrated Crosstalk Noise (ICN), as calculated by the 802.3ba, shows that noise levels in high-speed 5-m next-generation cables are approximately 50% less than 3-m current-generation counterparts (see Fig. 2). Improved ICN leads to improved signal-to-noise ratio (SNR), which improves interconnect signal integrity. These improvements give system designers flexibility that is unavailable in current-generation systems.

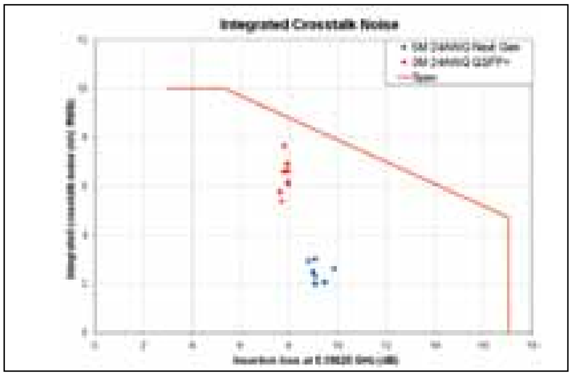

Fig. 2: Next-generation cable assemblies offer improvements in crosstalk and will have half or less noise than current-generation comparable 3-m cable assemblies.

Passive copper cable assemblies use vastly less power than optical interconnects. At <30 mA peak at 3.3 V (3 mA typ), the savings add up quickly. Lower power requirements equate to less heat being generated and a reduction in thermal-related performance problems. In short-range (1-5 m) applications, passive 25-Gbit/s copper has a natural market in LAN networks, data centers and storage applications. Energy consumption, for data centers in particular, represent a significant and increasing operating expense for large corporations.

A strong value proposition, passive copper may reduce the price per link by a factor of >3 compared to optical modules and fiber optic cables at ≤7-m lengths. In terms of design flexibility, copper passive cable assemblies contain only one electronic component (a single EEPROM) and hence can provide MTBFs that may be 10-50 times longer than an optical cable assembly.

Tradeoffs are inherent in connectivity selection and design, whether optical fiber or copper transmission, or some combination. Although fiber optics is favored for long runs, copper remains the preferred solution for shorter-cable-length applications. High-speed 25-Gbit/s bandwidth copper makes it an even more attractive alternative. However, there are still unmet challenges between the feasibility and the commercial viability of 25-Gbit/s copper connectivity. Key considerations for designers looking at 25-Gbit/s copper are high-frequency insertion loss and noise, with the primary consideration being the SNR margin. Component vendors are partnering to provide designers accurate and predictive component level models and end-to-end channel models to allow for the appropriate balance of price versus performance in new 25-Gbit/s systems. New Molex products currently under development will further reduce or eliminate noise, fluctuation and other common issues.

Manufacturers engaged in advancing high-speed copper—as well as industry analysts—recognize the important role of copper and how advanced signal conditioning has extended the serviceable life of existing components, while stimulating the development of next-generation copper interfaces that are viable for large volume production. Copper prototype products currently being vetted and tested and are expected to reach a broader market by year-end 2011, with volume production over the next 3 to 5 years. Total interoperability will require proper component specification, clarity of defined and accepted compliance methods and continued collaboration across all aspects of implementation. The proliferation of cloud, Internet, higher-performance computing applications, server virtualization, and converged networking will continue driving demand for higher-bandwidth blade and rack server connections—all sweet spots for cost-wise and energy-efficient 25-Gbit/s copper connectivity.

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