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CABLING INFRASTRUCTURE

Push past the standards

Too often, IT managers assume that all products that meet a particular standard are equal. Higher-performing products that exceed the standards are available, however, and can provide more channel insertion loss (CIL) budget to handle flexibility in the design of the network. This is especially critical in 1- and 10-Gigabit Ethernet applications, where maximum performance and reliability are required, since CIL power margins for these systems are lower than previous applications.

One example of design flexibility involves using low-cost 10GBASE-SR optical modules operating at 850 nm. These modules can support 300 meters over a cabling system using ISO/IEC OM3 fiber, known in TIA standards as 850 nm laser-optimized 50-micron fiber.

In this 10-Gbps link, there are two keys to performance that are affected by the choice of fiber, cabling system and connectors. The first is CIL, which is the end-to-end loss resulting from all connections and splices in the link, plus the loss of the cable itself. The second factor is intersymbol interference (ISI), where bits of data run together due to high differential mode delay (DMD), which causes low bandwidth in the fiber.

According to the link model, 75% of the link power penalty is caused by insertion loss (34%) and ISI (41%). Therefore, power margin can be created by improving CIL and/or ISI power penalties.

Certain network configuration and connection assumptions were made by IEEE to establish a CIL power budget for 10GBASE-SR at 300 meters. Based on the TIA-structured cabling standard, TIA-568B, each connection has been budgeted for a maximum 0.75 dB loss per connection, for a total connection loss of 1.5 dB. For cable attenuation, a 3.5 dB loss per kilometer at 850 nm was assumed; at a 300-meter distance, that equates to a loss of 1.1 dB. The total CIL budget, therefore, is 2.6 dB.

The ISI power penalty at 300 meters is 3.0 dB and is guaranteed by meeting the effective modal bandwidth requirement of 2000 MHz-km at 850 nm. Other penalties total 1.7 dB and are mostly composed of transceiver parameters, with a small amount of margin left over.

The most significant way of increasing CIL budget is to reduce the actual ISI penalty of the link by using a high-bandwidth fiber, so that a designer can trade off ISI penalties for CIL.

For example, many designers are specifying the use of laser-optimized 10-Gbps multimode fibers in data centers. In this case, the fiber is used at distances shorter than its maximum rating. At these short distances, the ISI penalty is reduced, and the "liberated" power can be devoted to increasing the CIL budget. The result is that designers of data centers or LANs using plug-and-play connectivity solutions can support the high loss of these systems, while supporting bandwidth and reach requirements.

Consider an 850-nm solution supporting 10 Gbps using a fiber that reaches up to 550 meters under typical standard conditions. If this fiber is used for shorter distances, a total of 4.5 dB of CIL is available. This can now be devoted to the high-loss connections that are necessary with a plug-and-play design in a data center or LAN.

Secondly, consider improving CIL directly by improving cable attenuation and connection loss. By reducing CIL directly or by trading off ISI penalty for CIL, the designer has greater flexibility and reliability in network design.

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