WILLIAM WONG | Technical Editor

High-Speed Interfaces Push OPTICAL CONNECTIVITY

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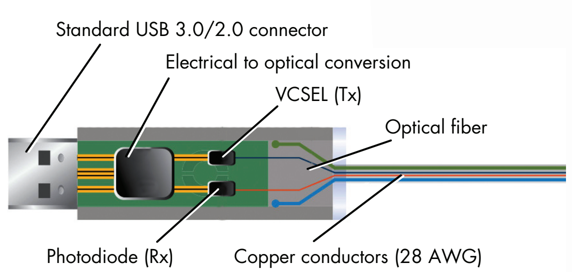
Being somewhat expensive, fiber-optic cables have traditionally been utilized where their advantages—like long distance—were worth the cost, such as servers and long-haul connections. But now, higher-speed connectivity requirements are pushing optical technology into more common use, even in consumer applications, as well as pushing multiple fiber connections to build out the cloud to meet Internet of Things (IoT) demands.

Optical systems are simple, in theory. There's a light source at one end and a detector at the other. Light goes through optical cable and is not affected by electromagnetic noise, like a wired connection. While there is signal loss, it's much less than a wired connection, making fiber the preferred method for long-distance connections.

Laser diodes or LEDs are the usual light source. Lasers include Fabry-Perot (FP), distributed feedback (DFB), and vertical cavity surface-emitting lasers (VCSEL). Detectors include silicon photodiodes and germanium or InGaAs (indium gallium arsenide) photodetectors. Optical cabling is divided into single- and multi-mode types. The former has a smaller diameter and is normally used with a laser source supporting higher bandwidths and longer distances.

1. Active fiber-optic cables include transceivers at both ends. Some include copper connections to provide power since it is often sourced at only one end of the cable. ***(Courtesy of Corning)***



Courtesy of Thinkstock Images

2. Corning's USB 3.0 uses standard USB connectors that incorporate transceivers at both ends. Two embedded fiber cables are used for data transmission, and a pair of copper connections provides power between transceivers.

FIBER OPTICS AND CONSUMERS

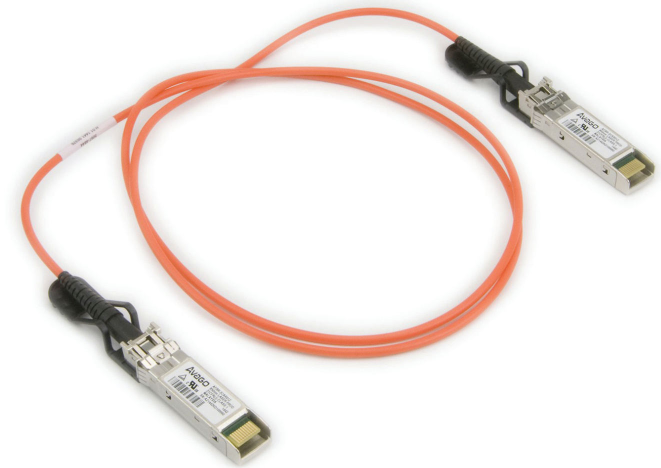
Fiber-optic cables have tended to be used in specialty consumer applications such as digital video recording, where the connection quality and longer distances offset the cost. The typical connections include high-speed serial interfaces such as USB, Thunderbolt, and PCI Express. Fiber connections are also available for display technologies like DisplayPort and HDMI. In addition, fiber has been used in digital audio applications. S/PDIF (Sony/Philips Digital Interface Format) jacks are common on audio boards and components, including amplifiers and high-definition TVs.

S/PDIF utilizes a passive fiber-optic cable, with the emitters and detectors embedded in the devices. Most other fiber-based systems employ an active cable with electronics at both ends. The typical example is Corning's USB 3.0 cables, which include a pair of fiber-optic links and a pair of copper links with interface logic at both ends *(Fig. 1)*. This approach eliminates the need for specialized fiber optic support at either end of the connection, since most applications assume a copper connection. This does increase the cost of the cable, but allows the technology to be used with existing systems. Typically the copper cables are passive.

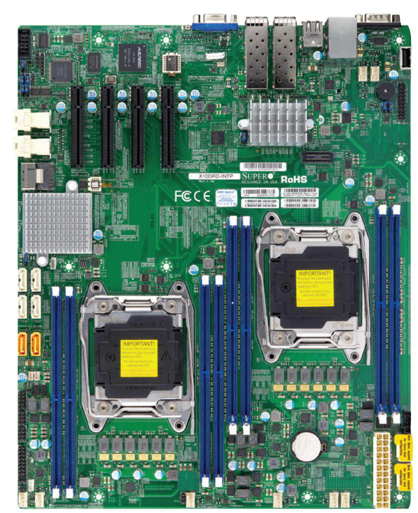
Corning is a major supplier of fiber-optic technology; it sells optical USB 3.0 *(Fig. 2)* and Thunderbolt cables in 10, 15-, 30-, and 60-m lengths. Its ClearCurve ZBL (zero bend loss) technology essentially allows the cable to be tied in knots without breaking or signal degradation. Optical cables used to be less robust.

So what exactly is changing? In a word, the Type-C connector *(see "USB 3.1 Type C Connector Is Reversible" on electronicdesign.com)*.

3. Dell's S4810 10-/40-Gb/s Ethernet switch has 48 ports 10 Gb/s SFP+ and four 40-Gb/s QSFP+ uplink ports.

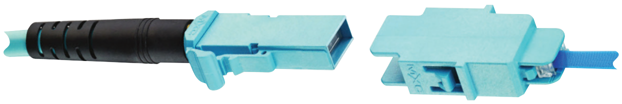


4. Super Microcomputers' 10-Gb/s SFP+ patch cable includes a pair of SFP+ modules with a short fiber-optic cable.



5. SuperMicro's X10DRD-LTP sports a pair of 10-Gb/s SFP+ Ethernet ports.

6. The MXC connector has an array of 64 fibers that can handle up to 1.6 Tbits/s ***(Source: Corning)***



7. TE Connectivity's provides MXC cable and connectors with an LC-style latch for easy insertion and removal.

USB 3.1 was the initial driving force behind the reversible Type-C connector. USB 3.1 Gen 2 runs at 10 Gb/s. It is already being tapped for 40 Gb/s for Thunderbolt 3.

The cables are also intelligent, often including redrivers on at least one end of the cable to handle the challenges of using copper connections that are normally under 3 m. This moves copper cable costs closer to optical. Optical cables are still going to cost more, but the mass market should help reduce these costs—especially as higher bandwidths are utilized.

FIBER OPTICS AND THE ENTERPRISE

Networking has been the main use of fiber-optic cable in the past. This is typically Ethernet, but other networking and storage technologies like FibreChannel and InfiniBand support optical connections. Another new architecture is Intel's Omni-Path fabric, which targets the cloud and high-performance computing (HPC). It is designed to scale to tens of thousands of nodes with connection speeds of 100 Gb/s. Speeds continue to move ever higher, and there is even 400-Gb/s Ethernet on the drawing board. Optical connections will be key.

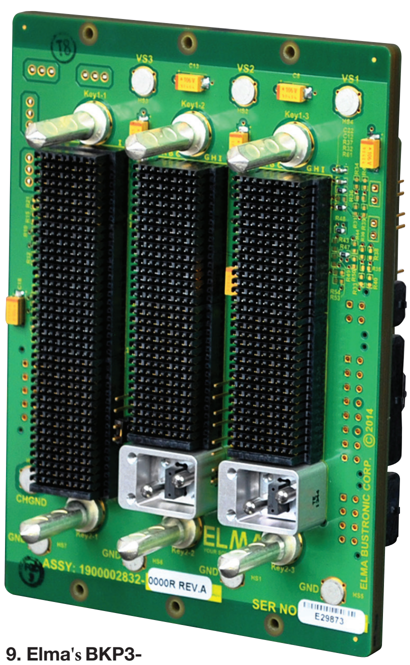
Most of these network adapters and switches embed the transceivers in the hardware or provide a small-form-factor pluggable (SFP) interface. SFP was only the starting point. There is now SFP+ and QSFP+ handling 10-Gb/s and 40-Gb/s interfaces. Dell's S4810 10-/40-Gb/s Ethernet switch *(Fig. 3)* has 48 10-Gb/s SFP+ ports and four, 40-Gb/s QSFP+ uplink ports.

SFP modules include the optical transceivers and optical connections. Modules can support different passive cable connections, including ST, FC, SC, and LC. This allows the cable lengths to be tailored to the installation. Super Microcomputers' (SuperMicro) 10-Gb/s SFP+ patch cable shows a pair of SFP+ modules with a short fiber optic cable *(Fig. 4)*. Unlike Corning's USB 3.0 cables, the SFP+ modules draw power from their host, typically a switch or network adapter board, and they are linked to a pair of passive fiber-optic cables. SFP+ sockets can also be found on motherboards like SuperMicro's X10DRD-LTP *(Fig. 5)*, which sports a pair of 10-Gb/s SFP+ Ethernet ports that handle the networking for a pair of Intel E5-2600 Xeon processors.

Using a pair of optical cables has sufficed for most needs thus far, but higher performance requirements are always on the horizon. This is where the new MXC connector *(Fig. 6)* comes into play. It has 64 fibers, translating into 32 bidirectional links. MXC is designed to use 25-Gb/s VCSEL technology to drive multimode fiber at distances up to 300 m. The connection delivers a total of 1.6 Tb/s of bandwidth.

The connectors are designed to require only seven components instead of more than 25 for existing parallel connections. MXC connectors and cable is available from a number of suppliers, like TE Connectivity *(Fig. 7)*, Corning, Molex, US Conec, and Rosenberger.

8. Pentek's Model 5973 Flexor Virtex-7 Processor and FMC Carrier board supports the optical VITA 66.4 standard.



9. Elma's BKP3-CEN03 backplane links a pair of VPX VITA 66.4 cards together.

RUGGED FIBER OPTICS

The enterprise is not the only place optical connections are critical. Standards like VITA 66.4 specify rugged board and backplane connections. Boards like Pentek's 3U, Model 5973 Flexor Virtex-7 Processor and FMC Carrier board *(Fig. 8)* supports VITA 66.4. The Xilinx Virtex-7 is linked to the FMC connector and the VPX-P2 VITA 66.4 connector. The latter is done through an optical transceiver.

Pentek's board could be used with Elma's BKP3-CEN03 backplane *(Fig. 9)* that links a pair of VPX VITA 66.4 cards together. Elma's motherboard is for development or small-form-factor systems. Usually VPX backplanes are customized for each application and there may be any number of VITA 66.4 connections.

VITA 66.4 may not have the density or throughput of MXC, but it is designed for a much more rugged environment. Still, many of the underlying components are the same or use similar technology, such as the optical transceivers.