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Applications
Engineering Note

Parallel Optics

AEN 123, Revision 2

Parallel optic interfaces (POIs) are a fiber optic technology primarily targeted for short reach multimode fiber systems (typically less than 300 meters), and high data rates, ≥ 10 Gigabits per second (10G). POIs differ from traditional fiber optic communication in that data is simultaneously transmitted over multiple optical fibers and received over multiple optical fibers.

Duplex fiber serial transmission is the sequential transmission of signal elements of a data group. The characters are transmitted in a sequence over a single fiber, rather than simultaneously over two or more fibers, as in parallel transmission. A directly modulated 850nm VCSEL has been used to date for data rates up to 25GbE (Gigabit Ethernet) and 32 GFC (Gigabit Fiber Channel). POIs are economical because they are able to utilize multimode fiber, optimized for use with VSCEL sources. This means that for speeds faster than 25GbE and 32GFC, parallel optics becomes the most practical, cost effective solution. Current and future protocols that are expected to use parallel optics include Gigabit Ethernet speeds of 40, 100, 200, 400, InfiniBand and Fibre Channel speeds 128G and higher.

Parallel optics transmission technology spatially multiplexes or divides a high data rate signal among several fibers that are simultaneously transmitted and received. At the receiver, the signals are de-multiplexed to the original high data rate signal. A multi-fiber connector such as MTP®/MPO is used throughout the parallel optic link and interfaces into the transceiver module. There are three common forms of commercially available products for POIs. The first is a four-channel transceiver that is capable of transmitting four channels and receiving four channels in one link. Like the first, the second and third forms use 10 and 12 channels respectively. Figure 1 illustrates the channel configurations for 4X, 10X and 12X protocols. The IEEE 802.3 Task Force is currently developing a standard to cover both 200 and 400GbE transmission. This standard will specify the use of parallel optics for 200 and 400GbE transmission over OM4 multimode fiber. It is likely that 200GbE transmissions will use eight 25G channels to transmit and eight 25G channels to receive over a 16-fiber link. Likewise, 400GbE is likely to use sixteen 25G channels to transmit and sixteen 25G channels to receive over a 32-fiber link.

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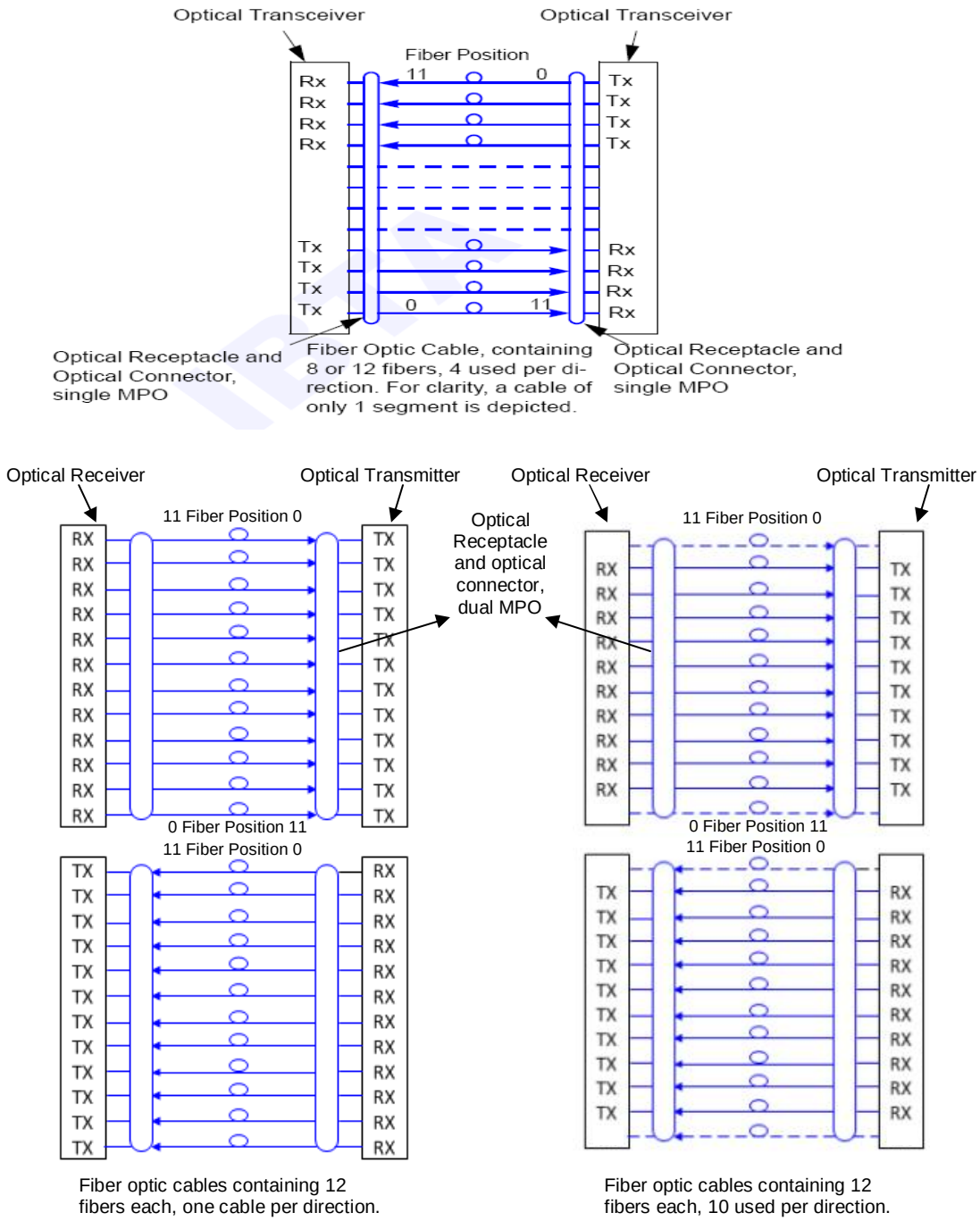

Figure 1: Parallel Optic Link

The MTP®/MPO connector is the connector of choice for parallel optic applications because of the connector's high density and array design (See Figure 2). Multimode OM3/OM4 fiber will be the most cost effective solution for short reach systems because of the ability to use VSCELs at 850 nm as opposed to the more costly Fabry-Perot parallel laser configurations. VSCELs can be manufactured with sub-micron precision from a single silicon substrate. This allows the arrays to precisely align with the fiber spacing of a MTP®/MPO connector. Fabry-Perot lasers are edge-emitting lasers. In order to create an array, each individual laser must be manufactured, aligned and set in parallel, leading to their relatively high cost when compared to VSCEL's.

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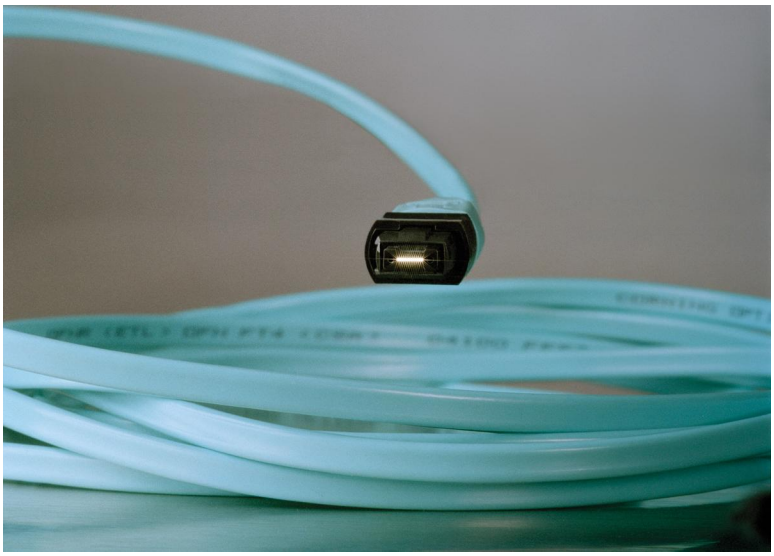

Figure 2: MTP®/MPO Technology

Parallel optics creates some unique challenges to the fiber optic backbone. Channel insertion loss budgets will continue to shrink requiring the need for MTP solutions with superior loss performance. Optical skew, which is the difference in propagation time between multi-lanes of a parallel transmission system, is a factor unique to parallel optic applications that should be considered during the migration to parallel interfaces.

Since parallel optics relies on spatial division multiplexing, in which a signal is spatially divided among multiple fibers and simultaneously transmitted across those fibers, too much skew can result in bit errors. Cable designs with low skew performance will be required for a successful migration path to faster network speeds utilizing parallel optics. Optical skew is currently specified to a maximum 0.75 ns skew for the optical cable assembly. The cable assembly includes the optical cable with MTP/MPO optical connectors at each end of the cable. Optical skew requirements continue to evolve as parallel solutions are developed.

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