Connectivity: Wiring Trends in Optical Data Centers

There are six key areas that affect performance, reliability and manageability. **BY RICK DALLMANN**

With recent trends toward 10 Gb/s multimode fiber networks, the data center cabling environment requires new design approaches and test assumptions. Information transport system (ITS) installers face real-world design and best practice challenges for these high-speed passive optical links Exploring new trunking solutions and creating a structured cabling environment while addressing six key areas are essential in today's workplace.

Trends for cabling infrastructure of high-performance optical data centers include looking at connectors, trunking, enclosures, management and documentation, data speeds, optical glass performance and proper specification. Some challenges are reducing cable inventory, procuring cabling products, cable management, extending the lifecycle of cabling plant and reducing overall costs while maintaining budgets and link-testing challenges.

Optical Fiber Connectors

Optical fiber connectors have evolved tremendously over the last few years. As ESCON connectors have given way to MT-RJ connectors and SC duplex connectors have given way to LC duplex connectors, it appears that massively parallel optical (MPO) connectors, generation IV, are the wave of the future.

Historically, optical fiber connectors had discrete ferrules for each fiber. Today, 12-fiber MT ferrules are the standard in high-density connectors. MPO/MTP® connectors can have 12 to 72 fibers in one MT ferrule.

The industry has been using the 12F MTP connector in the passive side of the cable plant for years now. As an option, some vendors ship processors and ESCON directors with MTP direct attach harness kits. The kits are basically a series of short 12F MTP/MT-RJ trunk cables that attach to the ESCON channel/port on the MT-RJ side and to a MTP mounting bracket on the MTP side. This attachment occurs inside the frame of the CPU or director. MT ferrules today are also widely used in OEM equipment from many manufacturers.

The cables coming out of the other side of the MTP bracket would have MTP connectors at the CPU/director (local) end, and any type of connector selected on the other side for connection to a patch panel or device. In the data center environment, the benefit to MTP is that it reduces the number of physical connections at the machine level from 256 to 43. At 30 seconds per connection, this can save up to 107 minutes or 1.78 hours in a push-pull effort, a measurable reduction in planned downtime.

Trunking Solutions

Traditional optical trunk solutions, utilizing distribution style or central tube ribbon cable, are too big and bulky for larger installations, and are hard for ITS installers to route due to cable memory and stiffness. Along with the latest generation of optical fiber connectors come radically new designs in optical fiber trunk cable that cut the connector's weight and diameter by more than 50 percent, yet enhances performance.

On the market today, there are 72 optical fiber trunk cables with technology that enables an 8 mm (0.33 in) diameter compared to 19 mm (0.76 in) for traditional tight-buffered distribution cable or 13 mm (0.52 in) for traditional central tube ribbon cable. Weight-wise, new technology enables these smaller trunk cables to be lighter and offer superior load capacity and bend radius performance.

Managing Increased Density within Enclosures

With increasing optical fiber connector density, enclosure systems also have to keep pace with the density improvements. Considering that port densities today are increasing dramatically, finding the right enclosure is essential. Three enclosure examples to consider are:

- 1U enclosures that support 48 duplex LC ports (96 fibers) with MTP plug-and-play capability.
- 2U enclosures that support 144 duplex LC connections (288 fibers) with MTP plug-and-play capability.
- 9U enclosures that support 256 duplex LC ports with a very shallow depth, allowing back-to-back storage in a single 4-post rack.

Cabling Methodologies

Two of the most common cabling methodologies are point-to-point (direct attach) and structured cable distribution (cross-connect). Two questions often associated with these two cabling methodologies are "Where are the problems occurring?" and "When is it time to add structure?"

In a point-to-point, or "homerun" topology, individual machine ports are directly attached to individual device ports with discreet jumper cables. This seems simple enough for the small data center and requires very little planning or investment. Unfortunately this approach becomes quite complex as switches and directors are applied to the hardware configuration.

In these cases, as new hardware is added to the infrastructure, it is simply connected by adding additional jumper cables. Or is it?

Suppose in a switched point-to-point topology each server has six channels, three channels connected to each of the two directors. Now add another director to the mix. To maintain a balanced number of redundant paths from each of the three servers, (remember, they still have a total of six channels each), you would now need to disconnect a cable from directors 1 and 2 from each of the three servers and move it to the new director. This would require getting under the floor, identifying the appropriate cables to disconnect and move, and doing so in an environment where there are likely hundreds, if not thousands, of cables present. After this has been accomplished, then you could run new cables from the new director's outbound ports to the storage devices.

If that seems pretty complicated, imagine trying to accommodate a new director in an environment where each director has 128 ports. Imagine adding two or three or four directors. It becomes an extremely challenging situation and almost guarantees a lengthy planned outage.

There are several other disadvantages of this methodology, including limited growth and systems modification, poor cable management, and less chance for visual cable identification.

Even in a situation where someone selected good components and tried to develop a systematic approach for building structure into the cable plant, without adequate cable management or the internal discipline to manage the physical environment, it will grow out of control.

Changing data center technologies adds expensive non-scalable cost structure, limited access, no ROI on jumpers and an increased risk of added under floor time. Point-to-point wiring is difficult to maintain over time, as sub-floor cable archaeology layers develop and jumpers can become very tangled, resulting in higher link losses. It is important to remember that when a site is not designed for the future and the cabling is not installed properly, the result is chaos.

History has shown that loss is not based on the design but on the installation. It is critical to choose the right high-quality factory-built components. There are more than 20 different tests to determine reliability and quality. Many vendors subject connector products to go through exhaustive tests, including tensile, ship and shock, temperature and humidity, crush, mating repeatability, and off-axis pull.

Cable Management Recommendations

To simplify equipment moves, adds and changes, a central patching location (CPL) structured cable highly scalable solution makes sense. What does this accomplish?

- Reduce the number of discreet cables by as many as 72 through the use of multi-fiber trunk cables.
- Eliminate the need to get under the raised-floor for every move, add or change. Working under the floor is required to accommodate growth, but there is no movement of connections at the active equipment level any more. Now only cables connected to a passive patch panel connection are moved. No chance of disturbing sensitive machine ports.
- Create specific pathways in which to route and protect optical fiber cable runs to locate a cable for troubleshooting, repair or removal—and locate it much more quickly.
- Consolidate the physical connectivity of all server, switch and input/output (I/O) ports into a single main distribution area, making it much easier to manage the overall data center connectivity in a holistic manner. Now there is a designated connectivity change area, and it is above the floor and away from active machine ports.

With a predictable, scalable system with a repeatable change methodology for adding and changing equipment connections, most cabling changes can occur before the scheduled outage time and helps reduce the downtime needed for equipment moves, adds and changes.

These improvements should result in reduced operation costs through saved time, shorter system outage windows, increased system availability and scalable growth path.

High-Density MTP Solutions Advantages

There are several advantages to high-density MTP solutions that save ITS installers time and money. By "future proofing," ITS installers can make their lives easier. This includes the elimination of cable slack problems with high fiber counts while allowing for more scalable and extendable cables. Moves, adds, changes or reconfigurations can be performed above floor.

In mainframe SAN, LAN or WAN applications, high-density MTP solutions offer ease and rapid deployment of a new hardware infrastructure. For example, if a SAN switch changes from SC to LC, it merely changes the harness. This prevents buying new expensive trunks. Trunk cables configured with MTP can be extended in length by simply attaching couplers to another trunk, which will result in substantial time and monetary saving for future moves, adds and changes.

Patch panels that are factory pre-cabled and tested for end-to-end decibel (dB) loss before being shipped to the installation site help minimize installation time. The modular design of MTP trunks, direct attached harness patch panels and cassettes provide maximum flexibility for the cabling plant. Equipment changes, cabling reconfigurations or systems upgrades are easily accomplished above the floor by simply unplugging and replacing the existing cassettes or harness to match the new equipment connector type.

Since MTPs are smaller in diameter compared to standard trunk-tight buffer cables, tray capacity can be increased by 66 percent. MTP trunks offer the perfect solution—simply unplug the damaged trunk and, in minutes, installation of the replacement trunks is completed. Future proof the cabling infrastructure with the ability to instantly change connectivity requirements as existing hardware is upgraded or new hardware is purchased. By future proofing the under-the-floor cabling infrastructure, ITS installers will incur a one-time expense in savings by eliminating the potential for future callbacks. Only the cassettes and harnesses will change as hardware changes are made—the result will be an overall lower cost.

CPU directors and patch panels can all be pre-cabled, and MTP technology will retain more than 70 percent of the monetary investment originally expensed in the cabling infrastructure along with the additional benefit of realizing a saving in time and labor as connectivity upgrades are made. Current technology trunk cabling systems will only retain approximately 30 percent of the original investment and incur additional expenses for labor and cutover time as connectivity is upgraded.

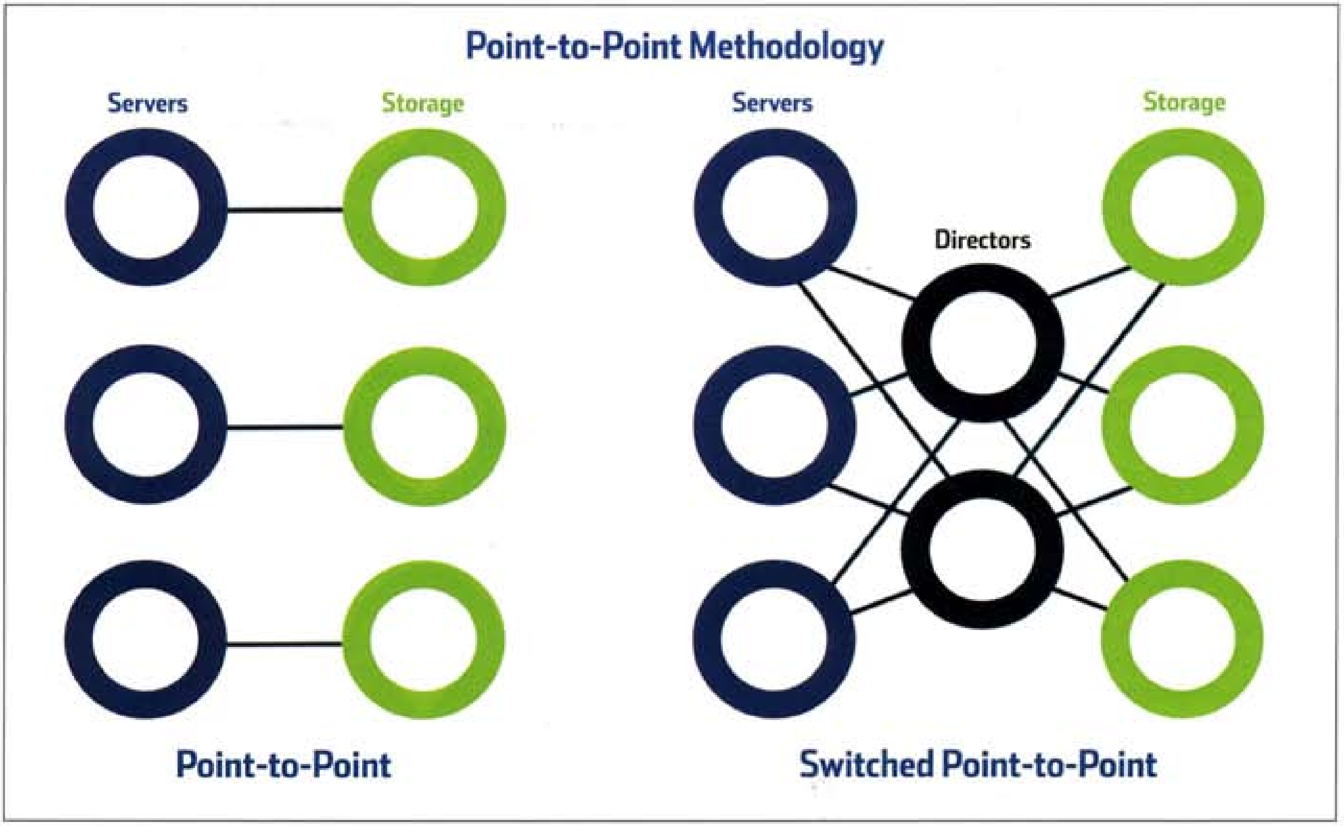
Monetary time and labor savings can be realized more than once as each new connectivity scheme is introduced into the data center environment. The benefit and advantages of the MTP can be realized and implemented for day one and is easily incorporated into existing current cabling schemes. The overall net effect is that the MTP solution is less expensive.

Labeling and Organization

Another important area is labeling and organization. There is port tracking software available to help document everything. It is important to remember that conveyance problems lead to high losses—you must create precise cable pathways even in retrofit environments. Organized conveyance equals consistent loss. Even in old sites, controlled routing is possible, yielding predictable losses.

Loss Budgets

Faster links have smaller loss budgets—connector assemblies and trunking products must have better loss performance. For example, the 10 Gb/s OM3 spec loss budget is 2.62 dB at 300 m (984 ft). Faster links require not only better glass for distance, but more precise polishing to keep mating losses to a minimum. Factory termination methods need a high level of production consistency to ensure losses are low (statistical average mating loss should be 0.25 dB).



Glass Fiber Evolution

Optical glass technology continues to improve for both singlemode and multimode applications. As multimode transceivers have migrated away from light-emitting diode (LED) light sources to vertical cavity surface emitting laser (VCSEL) sources, multimode glass design has improved significantly, which means lower losses and longer distances. For example, conventional 50/125 glass with 10 Gb/s Ethernet, 850 nm light source has a transmission distance of about 82 m (269 ft). High bandwidth 50/125 glass with 10 Gb/s Ethernet, 850 nm light source has a transmission distance of 300 m (984 ft) (OM3 glass). The ultra high bandwidth glass 50/125 with 10 Gb/s Ethernet and the 850 nm light source transmission distance is 550 m (1804 ft).

More Connection Points in Data Center Structures Pose Link Testing Challenges

How do we determine the statistical values of loss? Qualification testing forces these connector products to go through exhaustive testing. When testing OM3 (10 Gig 50/125 glass), we must understand the term encircled flux (EF). The 10 Gb/s Ethernet over multimode fiber specifies how much light power can be delivered to the fiber and where it is to be delivered.

What happens if the power is just meeting specification with 86 percent within the 38 micron circle versus another tester with 86 percent within a 32 micron circle? This is a huge difference. Losses for the link can be 30 percent to 40 percent lower when tested with different light sources. So, what's the point? Testing OM3 links is very dependent on the light source used in the tester. ITS designers and end users must understand this, especially when aggressive designs are implemented.

This information is designed to save ITS installers time and money when working on data center design practices. By addressing new trunking solutions and creating a structured cabling environment an ITS installer is on the way to achieving this goal. By keeping in mind the six key areas that affect performance, reliability and manageability, an ITS installer will be better able to manage in today's ever-changing workplace. ■

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Implement a Structured Cabling Topology