How multifiber push-on connectors can be a data center's best friend

white paper

EXFO

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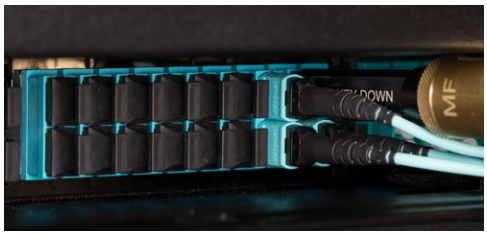
By eliminating the exponential causes of possible downtime and network failure associated with multifiber connectivity, data center operators, installers, and technicians can now move ahead with unprecedented confidence in the 10G/40G/100G/400G migration.



According to Cisco, total annual global data center IP traffic in 2015 hit 4.7 zettabytes (ZB), or approximately 1 trillion gigabits! That number is forecasted to grow to a whopping 15.3 zettabytes by the end of 2020—more than a 3-fold increase. By 2020, installed data center storage capacity will increase nearly five times to 1.8 ZB, up from 382 exabytes (EB) in 2015. Industry analysts, including Infonetics Research, predict that internal data center traffic will grow threefold within the next five years, and a recent Dell'Oro Group report concludes that "Cloud Data Centers are forecasted to drive the transition toward 400 Gbps by 2019." In a sign of the times, Finisar already demonstrated its 200G QSFP56 (4x50G PAM4) and 400G CFP8 transceivers earlier this year.

Multifiber push-on connectors are fast emerging as the de facto infrastructure for data centers.

These statistics, which testify to the monumental growth of bandwidth and data traffic as well as the ever-increasing transmission speeds needed to support them, aren't reserved solely for hyperscale and webscale data centers and colocation facilities; they also impact enterprise data centers of all sizes and in all vertical industries. The pressures on data center network infrastructures are intense, driven by bandwidth-hungry cloud computing and file-sharing applications, virtualization, rich content production, 4k HD video (with 8k on the horizon), the BYOD (bring your own device) trend, IoT devices, 5G wireless and other emerging technologies.

Given these bandwidth-hungry technology services, data center managers must adapt to rapid changes and challenges. They include increasing port densities to support new leaf-spine network topologies; supporting applications demanding higher lane speeds and ultra-low millisecond-latency performance; and building a scalable 40/100G and beyond network at the lowest possible cost of ownership.

Along with rapid-fire technological change, IT network managers and operators must also deal with demands from customers, who are justifiably intolerant of even a moment of network downtime. According to the Poneman Institute, the average cost of a data center outage has steadily increased from $505,502 in 2010 to $740,357 today (a 38% net change).

To meet these pressing challenges, multifiber push-on (MPO) connectors are fast emerging as the de facto infrastructure for data centers, thanks to the many benefits they provide. As with all technologies, however, there are downsides. In an MPO or MPT® [1] connectivity infrastructure, each connector represents a potential point of network failure (as do all connectors), but the risk is multiplied exponentially due to the MPO fiber packing density of 12-, 16-, 24- and 32-fiber configurations.

[1] MTP® is a registered trademark of US Conec Ltd.

Why MPO connectivity?

To date, MPO is the only connector solution that supports all TIA and IEEE standards for the 40G to 400G migration path while at the same time meeting crucial high-fiber-density requirements for data centers. Other advantages of MPO connectivity include:

- Support for both duplex LC-MPO and parallel optic MPO-MPO applications
- Scalability to serve all emerging high-speed networks
- Compatibility with many fiber geometries (SMF, OM2, OM3, OM4, and OM5), as well as with wavelength-division multiplexing (WDM) technology
- Optimization of valuable patch panel and rack space, which prevents congestion and improves air-flow and cooling efficiency
- Reduction of time and labor costs associated with single fiber installations and moves, adds, and changes (MACs)

Typically, singlemode fiber is used mainly for the network's redundant spine or backbone, which ultimately connects the MDA (main distribution area) to telecommunication providers and the HDA (horizontal distribution area), also referred to as the IDA (intermediate distribution area). The area between the HDA/IDA and the EDA (equipment distribution area), where the top of row switches and servers reside, is most relevant, since singlemode fiber is typically replaced by multimode fiber where interconnection distances are 150 meters (approximately 500 feet) or less. This is also the area where many ports and thousands of fiber links and connectors are housed within the patch panels and rack. Hyperscale, colocation and large enterprise data centers are increasingly opting for all singlemode fiber due to its bandwidth capacity, distance and outstanding transmission capabilities, especially now that singlemode transceivers are much less expensive.

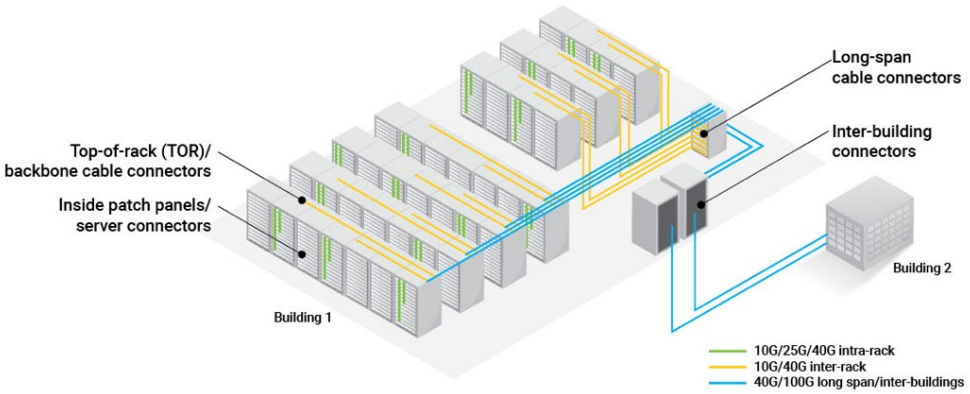


Figure 1. Typical locations of MPO connectivity

In the case of colocation facilities and multi-tenant buildings, MPO trunks and cross connects are also typically used in the two meet-me rooms located at the far ends of the facility where the data center connects to multiple telecom carrier(s)/service provider(s), and subsequently connects directly to client suites.

At larger data centers, thousands upon thousands of connectors may conceivably exist within the center infrastructure. To understand how multifiber connectors optimize valuable rack space and reduce the number of connections, Figure 2 shows a comparison of single fiber LC connectivity and MPO connectivity in the increasingly popular spine-leaf topology, which in some cases is replacing traditional distributed (3-tier) data center architecture. Notice that multifiber connectivity requires 6,912 fewer preterminated jumpers, saving on both space and cabling costs. With connectors on each end of the jumpers, that translates into 13,824 fewer potential failure points.

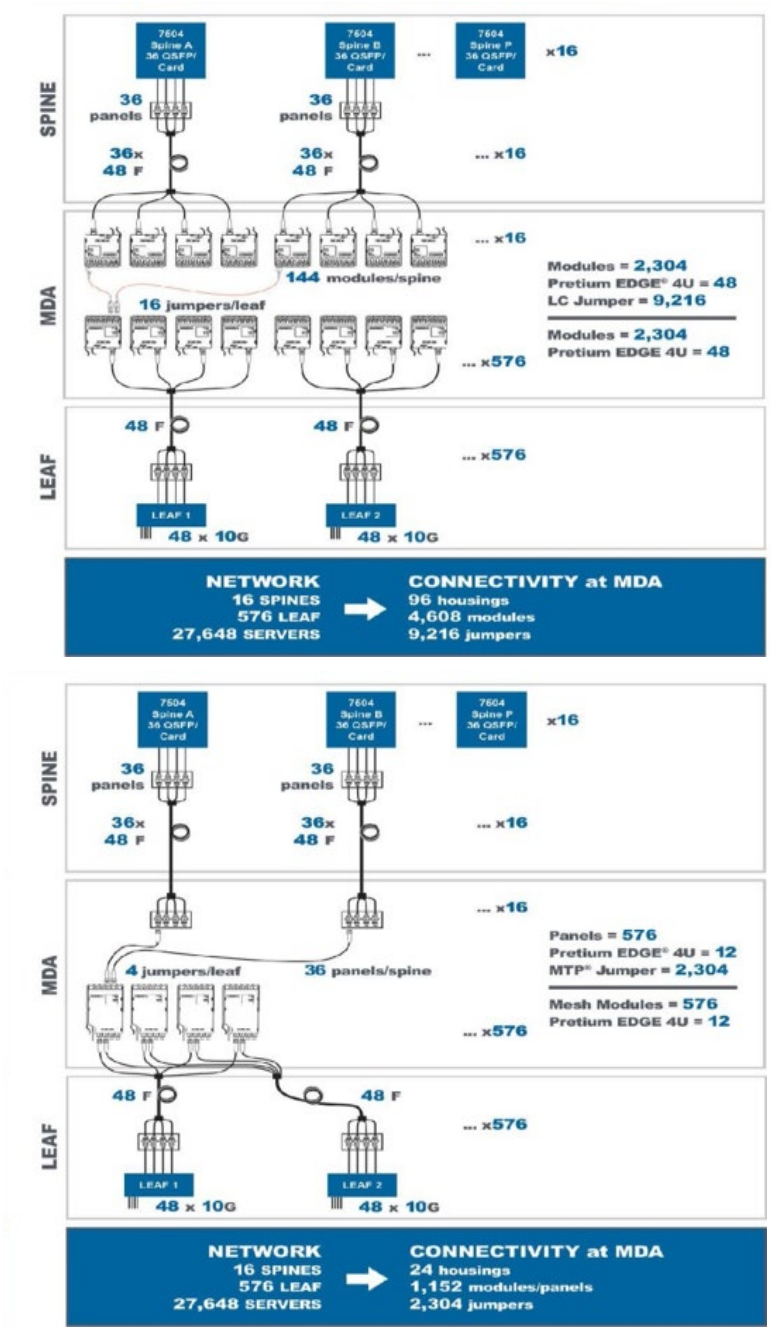


Figure 2. Comparison of single fiber LC connectivity and MPO connectivity in spine-leaf topology
Source: BICSI Presentation, Data Center Trends for Fiber Optic Infrastructure, June 2016, Max Prangnell

Today's evolving data centers require 21st century inspection and testing equipment and a new mindset for quick, easy, and efficient best practice procedures. Until the introduction of EXFO's new (no scanning knob) automated multifiber connector inspection solution, MPO inspections were conducted manually or often not at all, due to the difficult, time-consuming and mistake-prone inspection process. By exploring the whys of MPO connectivity, the causes of potential connector failures and the versatile features of this multifiber inspection tool, network managers now have the assurance that their data center's connectivity infrastructure will be up and running with zero-downtime performance.

The problems with legacy multifiber inspection

Ironically, the impressive capability of MPO connectors to fit 12, 24 and even 32 fibers into basically the same real estate as a single fiber connector can be problematic as well. Industry consensus identifies connector contamination and damage as the leading root causes of fiber optic network failures, as the well-known NTT Advanced Technology study in Figure 3 confirms. Contamination can easily occur from microscopic dust, dirt, particles and even fingertip/hand oils from connector handling, potentially causing serious connector endface and fiber damage that can prevent proper mating of connectors. Poor physical connectivity can result in high bit error rates, potential packet loss and latency that can lead to serious downtime and actual network failure.

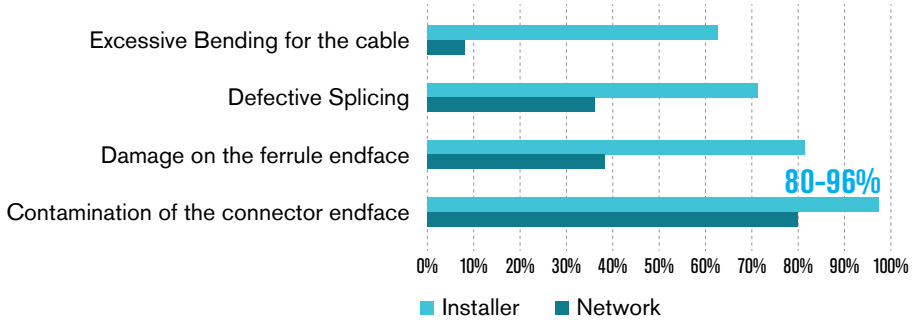


Figure 3. Leading causes of optical fiber network downtime and failures
Source: NTT Advanced Technology Study

Essentially, the most popular MPO connectors can be divided into two fiber-row MT ferrule configurations:

- 12-fiber row (1x 12 for a total of 12 fibers and 2x12 for 24 fibers)
- 16-fiber row (1x16 for a total of 16 fibers and 2x16 for 32 fibers); the 32 fiber MPO supports IEEE's current 400G standards [1]

In these MPO connector configurations, the chances of encountering a failed connector are 12 to 32 times greater, which exponentially increases the likelihood of serious downtime or network failure.

[1] There are 72-fiber MPO connectors, but they do not meet loss budget criteria; more recent 8-fiber MPO connectors are also gaining popularity due to the use of all fibers for certain applications.

Technicians and installers often skip the time-consuming, tedious and fallible legacy MPO inspection process.

To adequately inspect multifiber connectors, it's necessary to inspect all connector endfaces and each individual fiber in the array (including unused ones). As Figure 4 shows, the fibers in an MPO connector are spaced only a few micrometers apart, requiring inspection accuracy within microns. Legacy inspection tools that scan the connector with turns of the scanning knob cannot come close to this level of precision, leaving technicians and installers frustrated with the time-consuming and already error-prone process of manually scanning each fiber with an inspection tool already ill-suited to adequately detecting dirt, fiber scratches, chips or any other serious, often microscopic damage. Furthermore, given many data centers' already congested panels, technicians lack the space to enter and manipulate the scanning knobs.

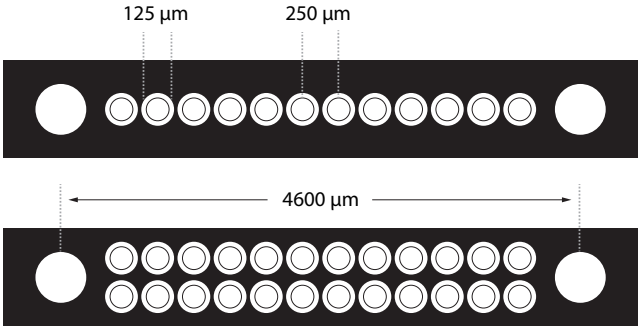


Figure 4. 12- and 24-fiber MPO with tight spacing between fibers

In practice, EXFO has found that technicians and installers often skip the time-consuming, tedious and fallible legacy MPO inspection process and proceed directly to link loss testing, assuming that if insertion loss results are good and within the loss budget, there is no need to inspect.

With a more constrained link loss budget and its "push on" feature, tests have shown that MPO connectors can fail at rates above 10G due to their higher sensitivity to poor reflectance. Oil contamination from a technician's fingertips when manipulating the connector resulted in major changes to return loss (10dB to 12dB at 10G) in the singlemode fiber example shown below. The oil does not create an air gap at 10G so it does not impact insertion loss, but even at 25G the return loss could be enough to cause serious network failure due to significant degradation of bit-error-rate test (BERT) performance.

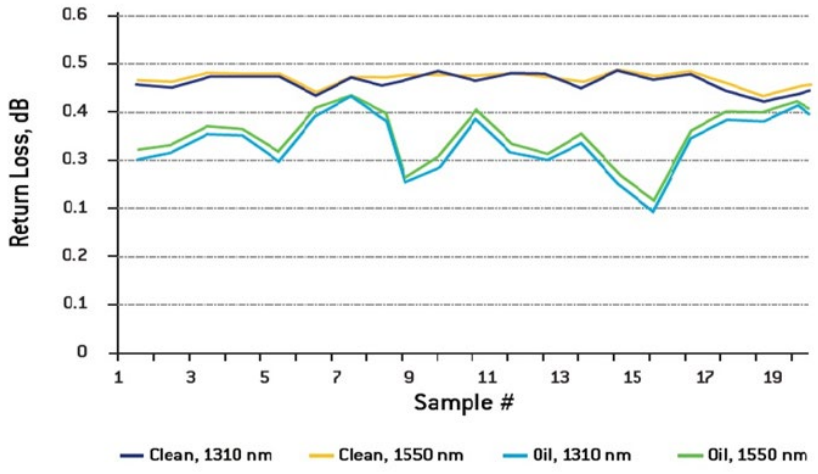


Figure 5. Return loss of clean versus oil-contaminated connector (10dB –12dB average difference in return loss)

By inspecting first, thousands of dollars in cleaning supplies could be saved.

It's also important to note that proper inspection of an MPO connector will yield a sharp image of the connector endface and all fibers. If there's dirt, you'll see it; if it's chipped, you'll see it. Inspection, therefore, allows technicians to pinpoint issues that may have gone unnoticed with a source and power meter in traditional insertion loss testing.

Some technicians have made a habit of systematically cleaning every connector without first inspecting it, even if the connector may not have needed cleaning. By inspecting first, thousands of dollars in cleaning supplies could be saved. To put things in perspective, imagine 10,000 connectors systematically cleaned at $.50* per cleaner click; the unnecessary costs could add up to $5,000. It is also important to understand that some contaminants will require different methods involving a solvent to properly clean the endface. However, a damaged connector cannot be fixed by cleaning it; cleaning a connector does not guarantee it will be considered to be in good condition. Inspection is a key step in ensuring good connector quality.

Best practice procedures for MPO and all connectors are as follows:

- Inspect first to identify any contaminants or damage.
- If dirt or contaminants are found, clean the connector(s) thoroughly using manufacturers' cleaning products and processes. For more information, please visit http://www.usconec.com/products/cleaning_tools.htm.
- Inspect again, repeating the above process until the connectors, including all fibers and end faces, are deemed spotless.
- Resume link loss testing or other tests based on your specific application.

As this section has shown, best practice procedures for MPO connectors up until now have been difficult, time-consuming, and error-prone. But the launch of EXFO's new automated multifiber connector inspection solution changes all that.

Automated multifiber inspection now possible

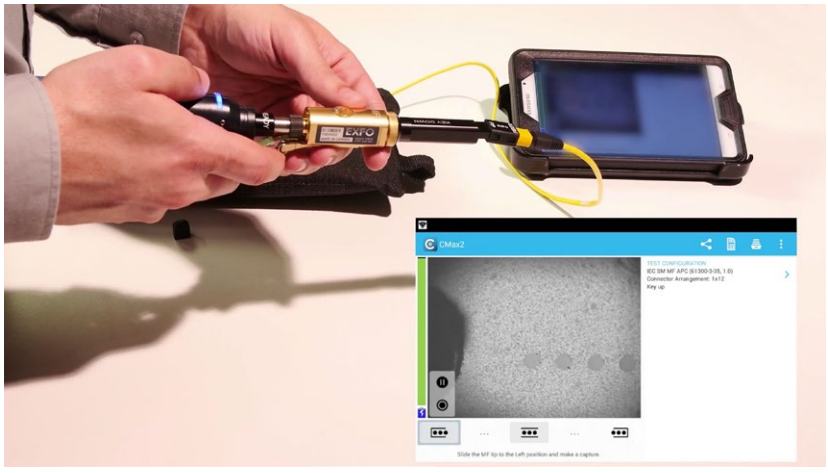
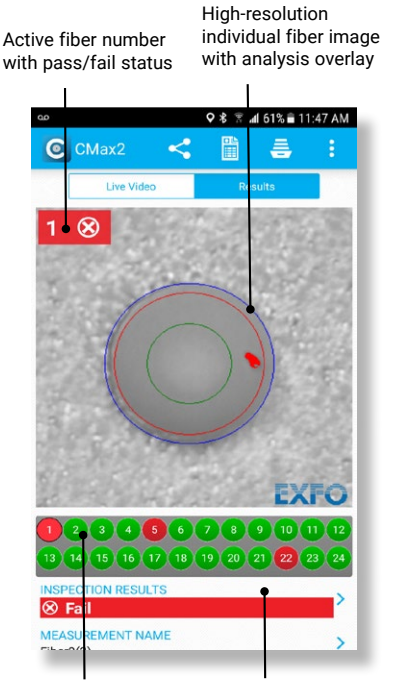


Figure 6. EXFO's automated multifiber connector inspection solution reduces the likelihood of network failure and costly downtime.

* Hypothetical numbers – does not reflect actual cost of cleaning supplies

By working closely with data center customers and listening to their needs, EXFO has addressed all of the limitations of legacy multifiber connector inspection with the launch of the Automated Multifiber Connector Inspection Tip.

Figure 7. EXFO's Automated Multifiber Connector Inspection Tip, the FIPT-400-MF



This multifiber solution has numerous features and benefits, including:

- Fast and easy automated multifiber connector inspection without the hassle of manipulating scanning knobs
- Full inspection for both single and multifiber connectors, with an interchangeable nozzle for fast conversion from MPO to LC and other connector types
- One probe for all of your single- or dual-row MPO (12/24 or 16/32) inspection with the pull of a trigger
- Individually numbered fibers to avoid confusion and mistakes
- Singlemode and multimode fiber inspection
- Slim design and rotation capabilities for dense and recessed patch panels
- Automated photo capture and pass/fail LED indicator
- Compatibility with mobile and smart devices via ConnectorMax2
- Major time and labor savings: eliminates human error, troubleshooting, and unnecessary cleaning supply costs associated with legacy "switch knob" inspection probes

MPO or MTP connectors may have always been the best friends of data center managers thanks to rack space savings and compliance with 40/400G migration specs. Now, thanks to multifiber connector inspections done each and every time—minimizing the likelihood of dreaded downtime or network failure— they just may become installers and technicians' best friends, too.

For the most advanced automated MPO and MTP characterization test solution, including crucial reflectance measurement for 10G networks, learn more about the iOLM-based TK-Switch MPO and MTP Kit at EXFO.com/MPO.