The CAT’s out of the Bag
The Story of the Category

PLUS
+ How Safe is the Cloud?
+ Modernizing Health Care
+ Shedding Light on a New Market
Given the migration to 100 gigabit and beyond, as well as the increased optical fiber required at each step of the migration process, the speed of the MPO splice-on connector can offer significant benefits, including immediate scalability and fast, precise connectivity that can support the need for immediate MACs, repairs and restorations of the mission critical data center.

Joshua Seawell is the director of the Lightwave Network Products Division for Sumitomo Electric Lightwave, where he oversees product development, manufacturing and distribution of Sumitomo’s OEM, carrier network and 4th level enterprise network and data center solutions. He can be reached at jseawell@sumitomoelectric.com.

Electronic reprint with permission from BICSI News Magazine-January/February 2013 Issue
The MPO splice-on connector can help minimize valuable data center space, pathway congestion and costs, while advancing the critical deployment speed of MPO connectivity. The MPO splice-on connector has been already successfully installed in prominent Tier 4 data centers, passing the most stringent tests for optimum performance and reliability. Explaining the MPO splice-on connector technology and evaluating its performance provides network and data center decision managers with the information required to choose their next generation connectivity solution.

**How They Work**

Today’s compact, easy-to-use 1 to 12 optical fiber mass fusion splicer with the appropriate fiber/connector holders is required to install the MPO splice-on connector. As backwards compatibility with existing fusion splicers allows for more widespread adoption of this technology, connector jigs have been developed to retrofit on many existing mass fusion splicers. Affordable splicer rentals are sometimes used on a project-by-project basis, minimally impacting overall project costs. Over the years, fusion splicers have dramatically improved in performance, while steadily decreasing in cost.

The latest touch-screen mass fusion splicers are designed for the confined spaces of the enterprise network and data center. Despite a footprint of only 120 millimeters (mm [4.72 inches (in)]) wide x 154 mm (6.06 in) deep x 126 mm (4.96 in) high and a weight of merely 2.0 kg (4.6 lb) with the battery, these splicers boast automatic features that virtually eliminate human error. The latest advancements include automatic clamp force adjustment and real-time clamp force calibration to minimize fiber-to-fiber offset when ribbonizing loose tube fibers or splicing on MPO connectors on round cord loose tube cables. With a typical splice time of 14 seconds and a 55 second heater cycle time, the latest mass fusion splicer can achieve a 12 fiber ribbon splice in under 70 seconds.

The major components of the MPO splice-on connector are essentially the equivalent components of an MPO factory-terminated connector, including:
- A high-precision mechanical transfer (MT) subassembly that has been pretested at the factory for reliability
- Protection sleeve with spring to guard against fiber damage
- Rear housing and a removable outer housing

Since the fusion splicer completes the connection operation with precision, all the technician needs to do is to move the MPO splice-on connector from the splice area, move the heat shrink protection sleeve over the splice and place it in the curing oven on the splicer. Assembly of the final connector is accomplished with these simple steps (see Figure 2):
1. Maneuver the spring and rear housing toward the MPO ferrule
2. Assemble the outer housing to the rear housing
3. Secure strength yarn and outer jacket under the screw-on collar
4. Maneuver the strain-relief booth over the rear housing
What You Get

The result of the MPO splice-on connector process is a termination that is the equivalent of a high-performance factory preterminated cable assembly at the exact length required, without logistic delays and without the risk of damaging connectors from pulling cables through conduit.

Preterminated factory cable assemblies have been tested to meet attenuation performance and reflectance standards that the MPO splice-on connector also meets. They also do not require any skill, other than connector cleaning. However, preterminated assemblies can have higher material costs. Over time, they can also result in too much slack—even when the lengths are carefully premeasured, there is always a small amount of extra cable length.

When preterminated cables are needed in emergency repair situations, they must be ordered from the factory, often at a premium for same day or next day delivery. Significant downtime of the optical fiber path is possible when waiting for delivery of the assembly. Similarly, the lead times required for preterminated cables can slow data center MACs. While inventory can be kept on site for these occurrences, correct lengths of every jumper must be stored, which can result in higher inventory costs.

With the MPO splice-on connector process, if a new optical fiber link needs to be established or an old one repaired, one end of an optical cable can be quickly connectorized. The cable can then be easily routed to the termination point within the data center. The opposite end can then be terminated at the exact required length so there is no additional slack that needs to be stored. This MPO splice-on connector process eliminates the need to rerun cables and prevents potential damage to the connectors.

By bringing the factory into the data center with MPO splice-on connector technology, exact cable builds ensure quick and easy repairs, restorations and MACs crucial to the data center with on-site polarity management and precision in real-time. The MPO splice-on connector complies with EIA/TIA-604-5, FOCIS 5 and IECX-61754-7 standards. In fact, MPO splice-on connector performance and reliability is equivalent to that of the factory ordered cable assemblies (see Table 1).

A Comparative Analysis

The data center is a unique environment within the enterprise network. Speed, reliability, security and optical fiber performance must remain uncompromised at all times. This is true during initial installations of optical fiber links, as well as during any repairs and restorations, rerouting or MACs that may occur over the life of the data center.

There are inherent advantages to the use of the fusion splicer, including reduced attenuation and the elimination of reflectance. Due to the fusion splicer’s automated alignment and calibrated loss estimation features, installers receive immediate feedback of the connector’s performance.

The traditional puck and polish connectivity method requires installers to hand polish the end face of the ferrule to precisely the correct angle. This is a time consuming method that is going by the wayside. On the other hand, the mechanical connector method aligns a cleaved fiber with a pre-polished stub and uses a cam or crimp mechanism to mechanically...
splice the fibers. The advantages of this termination method include installation speed, low skill set and the factory polished and inspected end face. Unlike the puck and polish method, these relatively expensive connectors offer various end face polishes from the factory, which are tested prior to use. The disadvantages to this method include the potential for a blind splice, which requires additional time and testing equipment, and reflectance and attenuation issues.

Index matching gel is used with mechanical connectors to ensure reflections do not occur. However, the refractive index of index matching gel is temperature dependent. Figure 3 shows the relationship between temperature and the return loss as a function of the refractive index of the gel. When the data center systems are operating normally, the performance of index matching gel is a low risk.

If the data center should experience a temperature excursion, the gel may not be able to maintain optical integrity or could even begin to flow out of the connector. Fusion splicing eliminates the need for epoxies and index matching gel used in the puck and polish and mechanical splicing methods.

Notice in Figure 3 that at temperatures above 20°C (68°F), the refractive index lessens. At 40°C (104°F), the return loss has increased by about 10 percent from its room temperature value. While a data center may never see these temperatures, it is prudent to design the optical network where this will not be a possible outcome of a temperature excursion during loss of cooling capability. Due to these concerns, field installable mechanical connectors have emerged that eliminate gels. However, these connectors require a polishing tool that can yield a blind splice with unknown optical performance until tested. They are also susceptible to human error and environmental conditions where dust and particles can compromise the polishing process and the quality of the termination.

Given the migration to 100 Gb and beyond, as well as the increased optical fiber required at each step of the migration process, the speed of the MPO splice-on connector can offer significant benefits, including immediate scalability and fast, precise connectivity that can support the need for immediate moves, adds or changes (MACs), repairs and restorations of the mission critical data center. For example, with MPO splice-on connectors, terminating 12 fibers simultaneously versus terminating 12 individual LC connectors can save approximately 86 percent on installation time. Figure 4 illustrates a comparison of installation times using an MPO splice-on connector versus...
single optical fiber connections on a 3 mm cable and on a 900 micron (μm) optical fiber.

Using the formula $XG/10G \times 2 = \text{Number of Fibers per One Channel}$ for transmission and receiving, a four times increase in optical fiber count is required to migrate from 10 to 40 Gb/s. When migrating from 10 to 100 Gb/s, a twelve times increase in optical fiber count is necessary (see Table 2).

In analyzing the efficiency, time saving and space minimization attributes of the MPO splice-on connector, consider that a 48-count optical fiber 40 GbE network requires 48 LC duplex patch cords versus only six 12-fiber MPO splice-on connector array cords. As illustrated in Table 3, one rack unit has greater efficiency when migrating from 10 Gb/s to higher network speeds by moving from duplex LC or SC configured cassettes or modules to MPO configured cassettes and modules. The MPO splice-on connector is immediately scalable and supports this migration with the 12-fiber termination speeds demanded by today’s dynamic and evolving data centers.

The performance evaluation for the MPO splice-on connector is the ability to meet IEEE 802.3ba specifications. Table 4 lists the allowable connection loss budget that comprises a cumulative loss based upon fiber, lengths, channel insertion and other specific characteristics (e.g., the total loss of a mated pair of connectors). All connector methods used in data centers need to meet these specifications to allow for seamless system upgrades to next generation speeds and to ensure that the network will work reliably over the installed optical fiber optic link. The last column of Table 4 shows the maximum expected connector loss for the MPO splice-on connector—ample headroom exists for additional splices in the system while still meeting the end-to-end loss budgets required for 40/100 Gb/s transmission.

### Closing Thoughts

Next generation data centers require next generation connectivity solutions. By bringing the factory into the data center with MPO splice-on connector technology, installers and network managers are provided with the flexibility, freedom and control of their optical fiber infrastructure onsite in real-time with the speed, performance, reduced operating costs and scalability to immediately respond to the need for MACs and restoration, ultimately keeping their networks up and running. MPO splice-on connector technology supports the data center migration and the enterprise’s vision for the data center today and tomorrow.

---

*Table 3: Rack space comparison between duplex LC and MPO *8 x 12 MPO – MPO Module*

<table>
<thead>
<tr>
<th>Network Port Speed</th>
<th>Fibers /Channel</th>
<th>Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>10G</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>40G</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>100G</td>
<td>20</td>
<td>2</td>
</tr>
</tbody>
</table>

*Table 4: Network specifications as they relate to limiting case MPO splice-on connectors*

<table>
<thead>
<tr>
<th>Data Rate</th>
<th>Designation</th>
<th>Mb/s</th>
<th>Fiber Type</th>
<th>Number of Fibers</th>
<th>Max Link Length (meters)</th>
<th>Max Channel Insertion Loss (dB)</th>
<th>Allowable Connection Loss Budget (dB)</th>
<th>MPO SOC Maximum Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 GbE</td>
<td>40GBase-SR4</td>
<td>40,000</td>
<td>OM3</td>
<td>8</td>
<td>100</td>
<td>1.9</td>
<td>1.5</td>
<td>≤ 0.70</td>
</tr>
<tr>
<td>40 GbE</td>
<td>40GBase-SR4</td>
<td>40,000</td>
<td>OM4</td>
<td>8</td>
<td>150</td>
<td>1.5</td>
<td>1.0</td>
<td>≤ 0.70</td>
</tr>
<tr>
<td>100 GbE</td>
<td>100GBase-SR10</td>
<td>100,000</td>
<td>OM3</td>
<td>20</td>
<td>100</td>
<td>1.9</td>
<td>1.5</td>
<td>≤ 0.70</td>
</tr>
<tr>
<td>100 GbE</td>
<td>100GBase-SR10</td>
<td>100,000</td>
<td>OM4</td>
<td>20</td>
<td>150</td>
<td>1.5</td>
<td>1.0</td>
<td>≤ 0.70</td>
</tr>
</tbody>
</table>