Interconnect Solutions For FTTH Drop Cable Installations

Choosing the right interconnect solution for FTTH drop cables can have a great impact on a provider's installation and operating costs.

By Jerry D. Jackson ■ *3M Communication Markets Division*

Consumer demand for bandwidth-intensive data and video services will continue to drive fiber-to-the-home deployment around the world well into the foreseeable future. Designers of FTTH networks put much thought into choosing the right architecture for each job. However, the hardware used to implement the design is equally important.

Choosing the right drop cable interconnect solution, for example, directly affects network reliability, operational flexibility and the economics of FTTH deployment. Failed connections can lead to costly service interruptions, so proven reliability ranks high on the list of "must haves" when a designer selects a connectivity solution. In addition, communications service providers strive to keep capital expenditures down so they can offer competitive rates. Therefore, the price tag of any hardware purchase (including the installation cost) is also a key consideration.

In determining the best solution for a particular FTTH deployment, a provider must first decide between splices and connectors and then choose the best splice or connector for the particular circumstances of a deployment. This article explores the available interconnect solutions for FTTH drop cables and discusses their advantages and disadvantages in the context of varying deployment circumstances.

SPLICE OR CONNECTOR?

Before deploying a FTTH network, a provider must first decide whether to use splices, which are permanent joints, or connectors, which can be easily mated and unmated by hand. Decisions must be made for both the distribution point at one end of the drop cable and the optical network terminal (ONT) or network interface device (NID) at the other. Both splices and connectors are widely used at distribution points. At the customer premises, connectors are almost always used because ONTs are commonly equipped with connector interfaces to facilitate plugging and unplugging for installation and testing. However, some ONT and NID solutions involve a combination of connector and splice.

Splices are permanent joints and more suitable for connections that will not be changed. Connectors can easily be mated and unmated.

Splices

Pros: Splices can provide excellent optical performance. Their reliability has been proven by many years of successful deployment in optical networks. Splicing eliminates the possibility of an interconnection point's becoming damaged or dirty, which would potentially compromise signal integrity – as may happen to a connector end face that is handled while unmated. Contaminants can cause high optical loss or even permanently damage a connector end face.

Another advantage of splicing is that it enables a transition from 250µm drop cable fiber to jacketed cable.

Cons: The major drawback of splicing is its lack of operational flexibility. To reconfigure a drop at a distribution point (for example, when one subscriber cancels FTTH service and another one adds it) requires removing one splice, rearranging fibers and splicing two new fibers. This requires a technician to carry special splicing equipment for simple subscriber changes. In addition, the fiber-handling process may disrupt other customers' service.

At distribution points, most cables contain 250µm fiber, which is easy to bend. Bending can cause high optical loss or even break the fiber. If a splice is used at an ONT, there must be space for a tray to hold and protect the splice.

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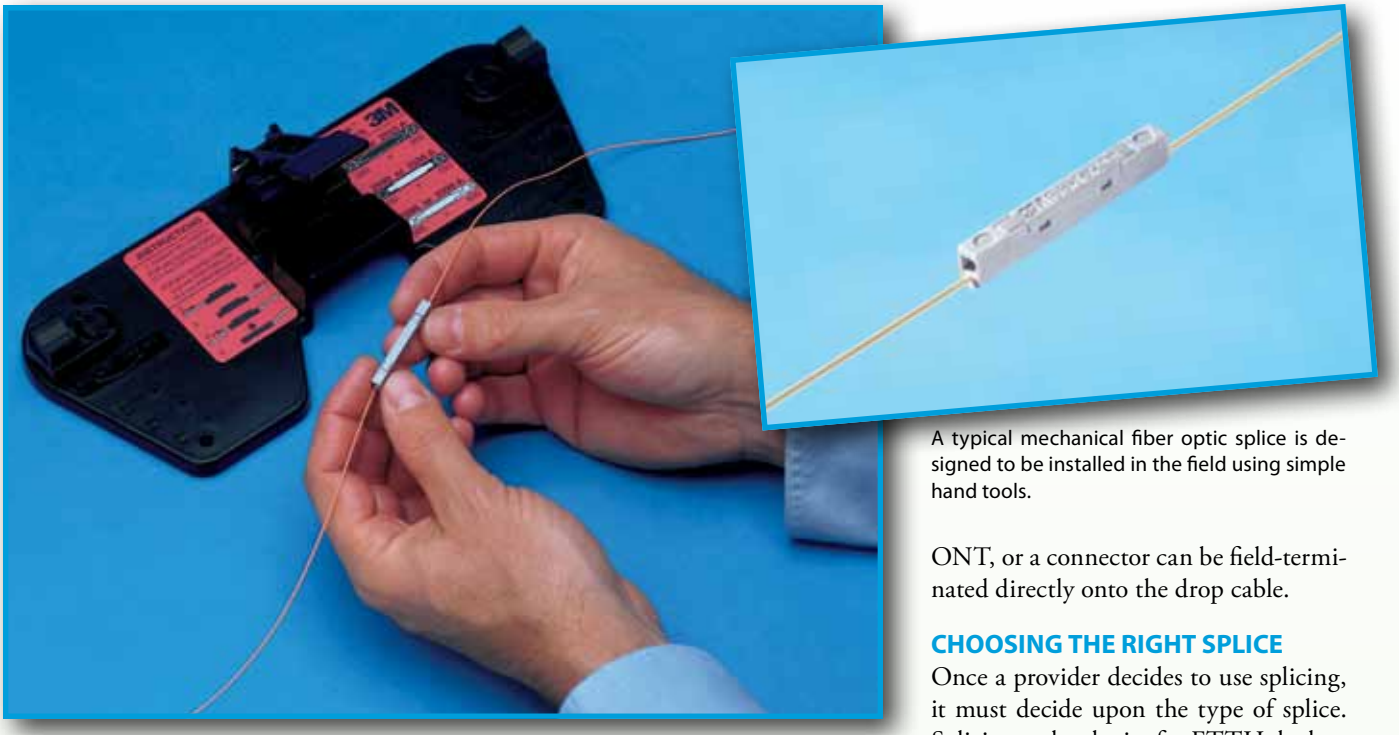


A typical mechanical fiber optic splice is designed to be installed in the field using simple hand tools.

This increases the size and potentially the cost of an ONT.

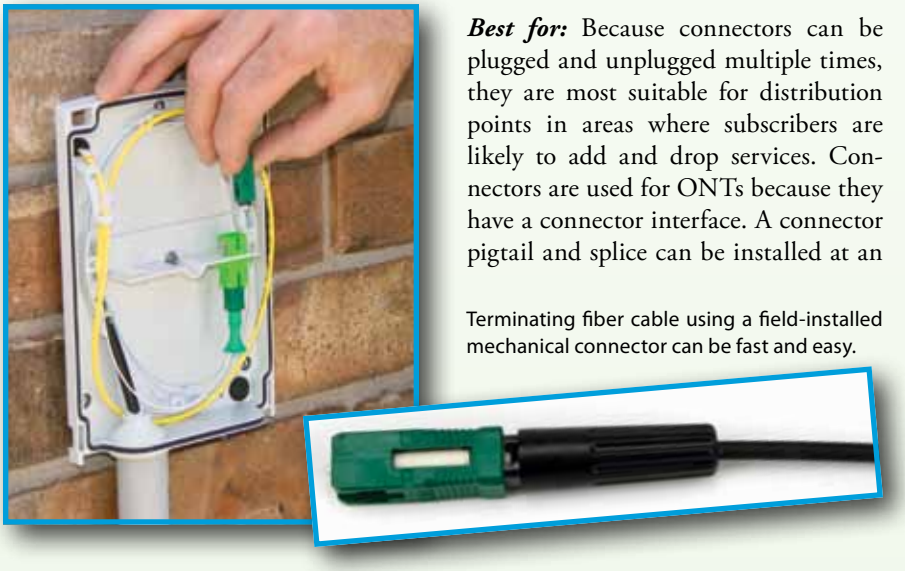
Best for: Splices are most appropriate when drops are dedicated to particular living units and no future fiber rearrangement will be necessary. This situation is typically seen in new construction, where a service provider can easily install all the drop cables during living-unit construction.

Connectors

Pros: Connectors provide greater network flexibility because they can be mated and unmated repeatedly, allowing them to be reused over and over again. A technician can easily connect or disconnect subscribers without using any tools. A connector also provides an access point for network testing.

Cons: Materials cost is the most obvious downside for connectors. They cost more than splices, although network rearrangement is much cheaper. Providers must weigh the materials cost of connectors, along with their potential for contamination and damage, against their greater flexibility and lower network management expense.

Best for: Because connectors can be plugged and unplugged multiple times, they are most suitable for distribution points in areas where subscribers are likely to add and drop services. Connectors are used for ONTs because they have a connector interface. A connector pigtail and splice can be installed at an ONT, or a connector can be field-terminated directly onto the drop cable.



Terminating fiber cable using a field-installed mechanical connector can be fast and easy.

CHOOSING THE RIGHT SPLICE

Once a provider decides to use splicing, it must decide upon the type of splice. Splicing technologies for FTTH deployment fall into two major categories: fusion and mechanical.

Fusion splicing

Fusion splicing is the de facto standard for fiber feeder and distribution networks. Fusion splicers have also been considered to be a solution for FTTH drop splicing, especially because they provide high-quality splices with low insertion loss and reflection.

However, the initial capital expenditures, maintenance costs and slow installation speed of fusion splicing hinder its status as the preferred solution**.** Chief among its drawbacks is the need to equip technicians with fusion splicing machines. Fusion splicers present a number of drawbacks:

- They cost thousands of dollars each, requiring a heavy investment to equip each technician in the field.
- They require specially trained technicians to operate them.
- They require electrical power, usually from batteries, which may lose charge in the field, adding time and cost to the process.
- They take time to set up and break down before and after installation, adding to labor cost. This can significantly impact installation time,

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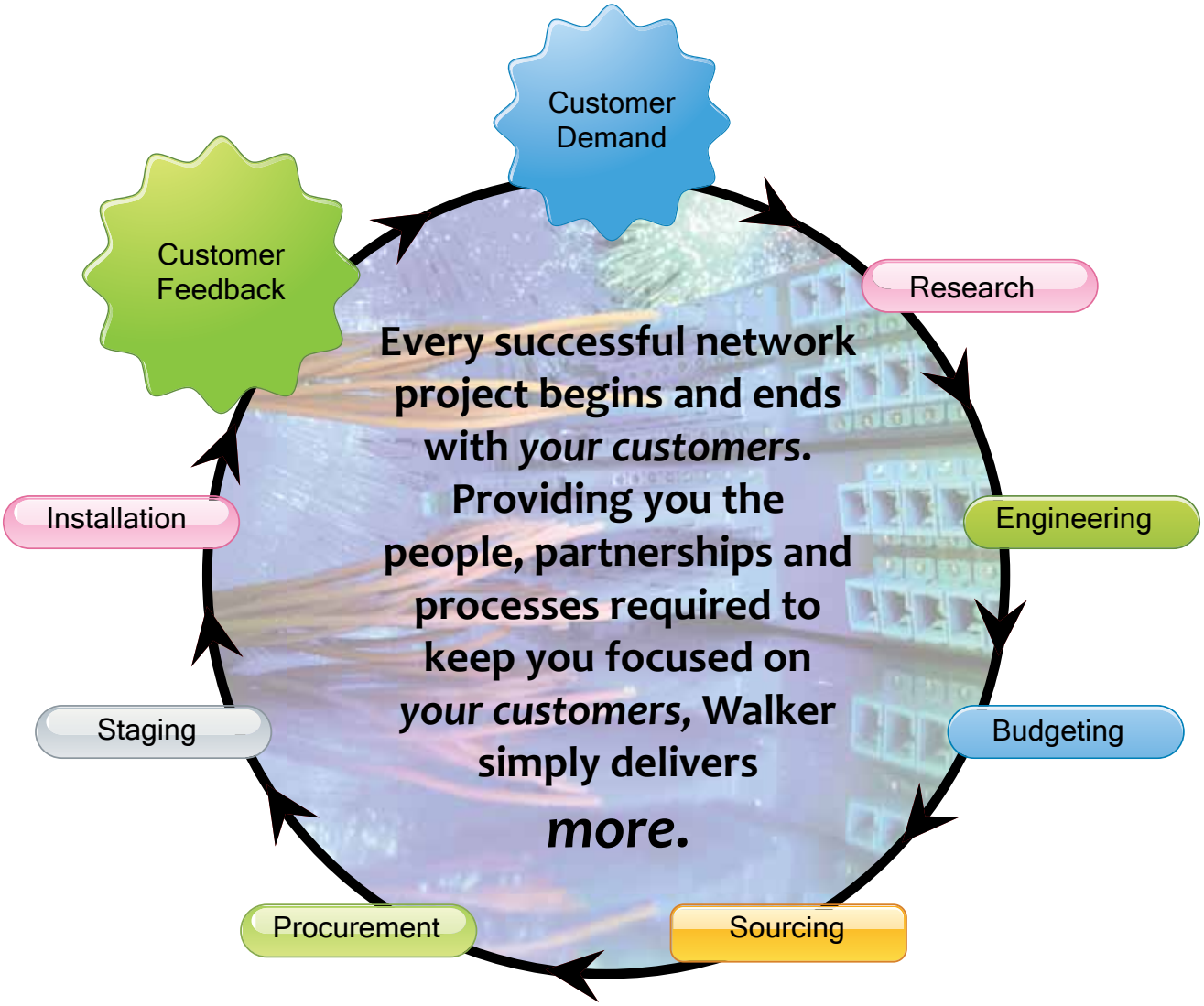

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A spliceless, gel-free connector combines the performance of fusion splice-on connectors with the speed of mechanical splice connectors.

especially because at many locations, including ONTs, only one splice is installed.

- They take time to warm up and heat the sleeves that protect the splice, further slowing installation.

From the standpoint of installation time, fusion splicing can make sense at distribution points, where many splices are performed at one time and installation equipment is unpacked and repacked only once. Fusion splicing is best suited, of course, for companies that have already invested in fusion splicing equipment and do not need to purchase additional splicing machines.

Mechanical splicing

Mechanical splices and connectors are successfully deployed in FTTH installations around the world. According to FTTH Council statistics, 70 percent of global FTTH subscribers live in China, Japan and Korea. Those countries primarily use mechanical connectivity solutions.

Historically, mechanical splicing has not been popular in the United States, because many providers share a concern that the index matching gel inside the splices can yellow or dry out, resulting in service failures. Over the last 20 years, the industry has made great strides in improving gel performance and longevity.

A typical mechanical fiber optic splice includes a small plastic housing with an aluminum alloy element to precisely align and clamp fibers. An index matching gel preinstalled at the fiber connection point maintains a low-loss optical interface, which results in an average insertion loss of less than 0.1dB.

Testing shows that the improved gel used in newer mechanical splices can perform well in temperatures from -40 to 167 degrees Fahrenheit. Global deployments of mechanical splices – millions are installed in indoor and outdoor locations – have shown that they can perform well in many environments.

CHOOSING THE RIGHT CONNECTOR

A provider that chooses to use connectors must decide between factory-terminated and field-terminated products.

Factory-terminated connectors

Factory-terminated drop cables can provide high-performing, reliable connections. The controlled manufacturing process ensures consistent fiber end-face geometry, which results in low optical loss. Factory termination also keeps labor costs low by reducing installation time.

An excellent application for a factory-terminated connector is a patch cord that connects a desktop ONT to a wall outlet box inside a living unit. Not infrequently, end users accidentally break these fibers. If this occurs, a patch cord with factory-terminated connectors can be easily replaced.

However, factory-terminated cables can be expensive compared with field-terminated alternatives. By nature, they are available only in predetermined lengths. Technicians must carry many different cable lengths to be sure they'll have the

right length for a job. That can mean a hefty investment in inventory, especially for outdoor cables that have special, hardened fiber optic connectors. Because nearly all factory-terminated cables are longer than needed, they require cable management systems to store slack cable in a curbside cabinet or in a home.

Finally, if a connection goes bad, an entire patch cord must be replaced, not just a connector. This may be acceptable for indoor patch cords, but replacing outdoor drop cables can be expensive because of the cost of aerial or buried installation.

Field-terminated connectors

The high costs associated with factory-terminated cable – inventory expense, the need for slack storage and the preterminated cables themselves – have caused many providers to opt for field-terminated connectors, which allow technicians to customize installations by using a reel of cable and connectors.

Hybrid connector solutions that are factory-terminated at the distribution point and field-terminated at the ONT are gaining popularity.

Fuse-on connectors: Fuse-on connectors use the same technology as fusion splicing to provide the highest level of optical performance for a field-terminated connector. Incorporating a fusion splice inside a connector eliminates the need for a separate splice tray. However, fuse-on connectors share many of the same drawbacks as fusion splicing. They require expensive equipment, highly trained technicians, packing and unpacking time and a power source – all of which ratchet up installation costs.

Mechanical connectors: Mechanical connectors provide alternatives to fuse-on connectors for field installation of drop cables. Two configurations are available: mechanical splice connectors and field-finished connectors without splice, gel or adhesive.

A mechanical splice connector is installed with a simple, handheld tool that does not require an electrical power source. Terminating fiber cable by using these connectors is fast and easy and requires little training. A single-fiber termination can be completed in less than three minutes, greatly decreasing installation time compared with fusion splicing.

A spliceless, gel-free connector combines the performance of fusion splice-on connectors with the speed of mechanical splice connectors. The

The range of connectivity solutions for ONTs has expanded to include field-terminated connectors with internal splices and spliceless connectors that are hand-polished in the field.

installation process is faster and less craft-sensitive than the common field-installation method of fusion splicing. Technicians can quickly and easily install the connectors at a distribution point or a NID or ONT in five minutes or less, using only simple hand tools.

Hybrid connectors

Depending upon service provider requirements and living-unit configuration, a hybrid solution with a factory-terminated connector on one end of a drop cable and a field-terminated connector on the other end may be optimal. In this case, a technician plugs the factory-terminated end into a distribution terminal, trims the other end to length and installs a field connector. This enables custom installations that avoid slack cable storage and require installing only one connector in the field. This solution uses less labor than field installing both ends, but it does entail the extra cost of the scrap of cable cut off.

ONT Solutions

ONT and NID solutions deserve special consideration. Traditional solutions use either a factory-terminated fiber connector, which does not require a splice, or a field-terminated solution that consists of a pigtail connector and a splice.

More recently, suppliers have introduced field-terminated connectors that have internal splices and spliceless connectors that are hand-polished in the field using simple tools. This newer generation of connectors combines the ease of installation that makes factory-terminated connectors popular with the economy of field-terminated solutions.

CONCLUSION

The drop cable interconnect solution is a key component of an FTTH network. Reliable broadband service depends upon robust connections at distribution points and at NIDs or ONTs. Choosing the right connectivity product can result in cost savings and efficient deployment and ensure reliable service to customers. Globally, most FTTH drop cable installations have been and continue to be field-terminated on both ends of the cable with mechanical connectivity solutions. ❖