Fiber Splicing and Termination Considerations for FTTH Networks

By Mark Boxer

Careful review of deployment methods can contribute to a low cost installation and reliable long-term network.

Now that Fiber-to-the-Home (FTTH) deployments are gaining momentum around the country and around the world, network builders are looking for ways to decrease the time and expense of the cable drop to the home, the most costly aspect of the installation. A typical Passive Optical Network (PON) network builder has several options to take the service to the home using drop cables. These include field splicing pre-connectorized pigtails and splitters, mechanical splices, field connectorization of cables at the Network Interface Device (NID), and pre-connectorized cables. It is very important that the network builder carefully consider the options for both performance and the cost component of the installation.

FTTH networks typically include the "triple play" of voice, data, and video services. In many cases, the revenues from each of these services are needed in order to make the deployment financially viable. Video systems are notable in that they are sensitive to back reflections. This sensitivity decreases the attractiveness of both mechanical splices and field connectorization. For systems that do not deploy video, field connectorization may be an option. The majority of network operators in the United States deploy mechanical splices for restoration purposes only, due to concerns about performance and reliability in environmentally exposed field deployments.

One of the largest costs of an FTTH deployment is the installation labor for the drop from the final splitter in a PON network to the home. Deploying angle-polished pre-connectorized cables is an option that has been considered to decrease the labor cost. These cables are often purchased to a set of pre-determined lengths, usually incremented in lengths of 50 to 100 feet. Although simply connecting pre-connectorized cables saves time over splicing, overall savings is not captured because more costly materials are needed for connectorizing - including connectors, packaging, and scrap resulting from material handling in the field. In addition, the time-savings is eroded by the additional labor needed to manage the extra cable due to the mismatch in cable length that is seen in the field. Pre-

connectorized cables are typically ordered in "standard" lengths, as opposed to specific lengths cut to match the distance from the splitter to the home. The extra cable length that results must be coiled or somehow otherwise managed in the field. Significant additional cost is incurred by the extra packaging needed to protect the connectors during installation in conduit or overhead. If the cable is pre-connectorized on the splitter end as well as the home end, the connectorized splitter closure is significantly more expensive than a standard splitter module and closure. Taken together, the costs of labor and materials are often significantly greater for pre-connectorized cables versus fusion splicing.

Alternative: Fusion Splicing

Fusion splicing typically works out as the preferred method of performing connections at the splitter and at the house for performance, reliability, and economic reasons. However, to fully reap the benefits of fusion splicing, the splicer must be reliable enough to be able to perform good splices, every time. Given the fact that an additional truck roll to repair a poorly installed drop can cost hundreds of dollars in follow-up labor, it is imperative that the splice be done right the first time. A splicer that performs active alignment of the cores is clearly the preferred method. These splicers are easy and forgiving enough that relatively unskilled operators can make successful splices every time. Most typical active alignment splicers on the market today can reliably make very low loss splices every time, and give appropriate error messages to prevent a bad splice.

Investment in a fusion splicer should also be considered with care. Certainly, low cost is attractive, and it can be tempting to use a splicer with less features. Low cost, fixed v-groove splicers can be effective in the hands of skilled craftspeople. However, the network builder should keep in mind that on a total cost per subscriber basis, the cost of the splicer itself is very small relative to the cost of the labor required for performing a splice. The labor associated with an additional truck roll due to an improper splice far outweighs the incremental cost of the splicer, as the cost of the splicer will be spread out over multiple years of operation and potentially hundreds of thousands of splices. The labor cost must be absorbed as it occurs.

What kinds of splicer features are most important for ensuring good splices every time? Splicers that actively align the cores of the fibers are the most reliable. Lower priced splicers, which use fixed v-grooves to align the fibers (as opposed to active alignment), pose a higher level of risk for poor splices and additional truck rolls, especially if testing is not performed to verify splice loss. Another feature that should be considered in a splicer is the inclusion of viewing capability of both axes of the fiber. Viewing in both axes helps to ensure appropriate cleave angles and more appropriate loss estimations and eliminate the potential for bad splices by alerting the user to excessive fiber core offsets. Automatic environmental compensation is a necessity to ensure appropriate arc parameters to minimize splice loss.

As was mentioned earlier, the video portion of the typical FTTH network is sensitive to back reflections. Although most network designers consider this when selecting connector types, back reflections also need to be managed in the splitters in PON networks. The business case for FTTH often dictates that customers are connected to the network as they subscribe to the service, as opposed to providing hookups for everyone during the initial network deployment. This means that splitters in the field will often be left unterminated. These unterminated splitters can provide a significant level of back reflection that should be managed to ensure no network problems. The most popular way of managing this back reflection is to crush the fiber ends. However, crushing the fiber ends results in highly variable performance for back reflection control. AFL Telecommunications' tests have shown that crushing the ends, either with pliers or popular brands of fiber

strippers results in less than 20% of the ends meeting a -65 dB back reflection specification. There are no industry-sanctioned specifications for unterminated splitters, since this issue is relatively new on the scene. It is a reasonable assumption that this performance will be unacceptable during mass FTTH deployments.

A fusion splicer designed for factory use can be used to make a low cost termination for splitters. This termination is very low cost, and can easily be incorporated into a splitter so that all ends are pre-terminated. Typical performance is much better than -65 dB, and performance is not significantly impacted through the -40° C to +80° C temperature range. Pre-packaging the termination on the splitter leg ensures that all ends are protected, and that there will be no back reflection issues. When the technician is ready to splice a cable for a new customer, he breaks off the termination and prepares the fiber for splicing per normal procedures.

FTTH systems offer one of the most exciting opportunities in the telecommunications area today. There are numerous options available to the FTTH network designer, especially as related to the drop to the home. The network designer is wise to look at both the labor and material cost components of the installation, and make deployment choices that minimize the overall cost of the installation while ensuring long-term system performance. Careful planning of deployment methods can contribute to a low cost installation and reliable long-term network.

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