WHITE PAPER

The Flexible Architecture Series:
Connectorization in the Central Office

ADC

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Building a next generation fiber network that is flexible, reliable and long-lasting requires service providers to balance three factors: technology, finances and operations. One of the basic technology decisions is whether to use splicing or connectors when creating junction points in the network, and that choice is especially critical because it directly affects long-term financial and operational considerations as well. After comparing the capital/operating expenditures (CAPEX/OPEX) incurred by both strategies, and after gaining some experience with both splicing and connectors in terms of moves/adds/changes, service turn-ups and troubleshooting, more and more service providers are opting to use connectors throughout their fiber networks, beginning with the central office (CO).

Connector interface points inside the CO have been delivering operational and financial benefits to service providers for more than a decade. These include the ability to:

- quickly deploy flexible, reliable fiber infrastructures
- reduce the number of splices, splice technicians and splice crews required for installation and maintenance
- lower their operating expenditures (OPEX)
- turn up services quickly
- deliver bandwidth cost-effectively
- speed up return on investment

Comparison of Upfront Costs and Long-Term OPEX

Despite the demonstrated advantages of using connectors throughout the network, some service providers around the world still prefer fusion-splicing, arguing that it is less expensive in terms of CAPEX. While it is true that splicing canbe less expensive in terms of initial equipment costs, it does entail significant CAPEX of its own. For example, a splice machine carries a price tag of $25,000 to $30,000 (USD), and may have additional maintenance and operational costs associated with that purchase. In the long term, service providers have discovered that splicing's upfront savings are not sustainable because splicing-related issues often incur greater OPEX than connectors, including higher labor costs. Equally important, splicing reduces the network's overall flexibility, and that can translate into even more costs, both financial and competitive.

Connectors Enhance Flexibility in the CO

One of the most dynamic segments of the next generation networks is the CO, where service providers constantly need to make changes--removing or adding components and upgrading both passive equipment and active electronics, such as the optical line terminals (OLTs). Higher fiber densities in the OLTs mean service providers have to manage more fibers; they also have to add more frames to the bay line-ups to support those higher densities. As a result, operational flexibility and rapid scalability in the CO are crucial, as is the need to conserve physical space whenever possible. "Plug-and-play" connectors help service providers achieve all those objectives.

One of the most valuable aspects of a connectorization strategy within the CO is the multi-fiber push-on (MPO) connector. Using an MPO connector, a technician can terminate multiple fibers with one connection, rather than needing an SC connector to terminate each individual fiber. Although the MPO connector first appeared several years ago, its use generally was limited to multimode fiber applications within data centers. It is relatively new to the CO, in part because of the higher initial costs of connectorization, relative to splicing. However, as mentioned earlier, these higher up-front costs often are offset by the lower OPEX that results from having to make fewer splices and needing only one MPO connector to make multiple connections on the back of a panel. The MPO connector now is an industry standard, and the Telcordia GR-1435 specification defines the baseline requirements for MPO performance levels.

Because of the CO's limited physical space, which necessitates single-mode applications, service providers are looking for a small form factor footprint. In response, vendors such as ADC produce 8- and 12-fiber MPOs, thereby making high-performance connectorization possible for much of the active equipment. In fact, ADC produces MPOs for use in applications at both ends of the CO, using large MPO connectors in distribution-type cables to house higher fiber counts. The interconnect cables, which typically contain 8 or 12 fibers, function as single-ribbon patch cords. Original equipment manufacturers (OEMs) use MPO connectors as well, including inside the passive panel used for fiber management and in a termination panel on a large frame containing a switch or router.

Another plug-and-play strategy in the CO involves a "breakout style" assembly, which is a more rugged cable that plugs directly into the active equipment on one side, with the frame on the other side. Resembling a patch cord, the breakout cable assembly offers a fiber count up to 24 fibers. Because it plugs directly into a transceiver or fiber blade, such as with video equipment, with only one cable required for each shelf, this connectorized approach makes it very easy to configure the fiber network.

Emerging Trends in the Connectorized CO

As technology advances and connectorization becomes more prevalent in the CO, service providers will have more options for using connectors--options which will deliver additional benefits. For example, with higher fiber counts going to the active electronics, service providers now are turning up more circuits at a given time. Rather than running 24 individual patch cords between the active electronics and the ODF frame to bring up a service, they can run one multi-fiber cable assembly and use one MPO connector to bring up multiple fibers/ circuits at a time.

This connectorization strategy significantly reduces the time required to turn up fibers--or to turn up the CO as a whole. That translates into lower OPEX and, with faster service turn-ups, it also enhances the service provider's ability to attract and retain customers. Further, if a problem occurs--for example, if a fiber breaks in the CO--the service provider does not have to call a technician to bring a splice machine and splice in a new pigtail. By simply running a jumper cable and plugging it in, the service provider can have the system back up and running much faster than with a splicing approach.

To obtain additional flexibility and to conserve physical space, service providers are beginning to use multi-fiber cable assemblies and MPO or MTP (mechanical transfer pull-off) connectors much more widely in the CO. For example, in a point-to-point active-Ethernet FTTP architecture, the connectorized multi-fiber cable assembly, rather than individual patch cords, provides the connectivity between the OLT and the ODF. This configuration allows the service provider to run one cable, rather than multiple single fibers (single or dual jumpers); it also eliminates the need for a dedicated fiber-management system, allowing the service provider to route the cable through a dedicated ladder system.

In this particular application, a 24-fiber cable runs between the OLT and the ODF. On the ODF end, 900-micron breakout fibers run to the back of a block or a panel on the frame. At the other end, the cable is broken out and unjacketed to a 2-mm fiber, which the service provider terminates onto OLT.

Service providers also are starting to use MPO cable, that is, a cable assembly with an MPO on one end and a SFF on the other, instead of a cable with SFF connectors on both ends. This type of cable assembly offers two distinct advantages. First, it allows the service provider to plug in only one connector for, say, every 12 fibers at the ODF, thereby simplifying and speeding up connectivity. Secondly, compared with a 24-fiber cable, which is 11.6 mm or more in diameter, a 12-fiber cable is only 3 mm in diameter, so the service provider can run it through a fiber-guide system and store excess slack in that system's built-in storage area. This eliminates the need to engineer specific cable lengths, as a regular breakout-cable assembly requires.

Another emerging connectorization trend in the CO centers on an MPO bulkhead application, in other words, a tie-panel application in which the service provider establishes a cross-connect in the ODF and an interconnect panel in the active-equipment bay. From the front of an MPO bulkhead panel, the service provider runs a shorter cable assembly to the active equipment. This configuration can support a go-as-you-grow approach because it only requires a cable assembly for the circuits which the service provider actually is turning up. A standard assembly available off the shelf, a bulkhead panel with the MPO connector supports very-high-density rack units, up to 288 fibers.

Reliable Connectors Help Build a Reliable FTTP Network

In addition to their concerns about the higher initial costs of connectorization, relative to splicing, some carriers have been worried about its potential impact on their loss budgets. However, technology advances in the connectors themselves have persuaded many to change their strategy.

It is true that for every connector in a fiber network, there is loss, yet as FTTP equipment volumes increase, vendors have significantly improved connector quality and performance in the network. More stringent performance standards, such as the Telcordia GR-326-CORE specification, combined with improved manufacturing processes, have resulted in:

- lower insertion and return loss
- automated tuning
- superior endface workmanship and
- vastly improved factory-termination methods.

ADC, for example, does the same performance testing on indoor connectors as it does on those destined for the OSP. With connectors today proving their reliability in the OSP, which obviously is a more extreme environment than the temperature- and humidity-controlled environment of the CO, they clearly can deliver the reliability that service providers demand throughout the network.

Splice Where It Makes Sense to Do So

For service providers around the world that have used a splice-only approach in their existing COs but now are persuaded of the benefits of using connectors, it is important to stress that the choice between splice and connectors should be made on a case-by-case basis. Although using connectors at many locations within the CO definitely adds value in terms of flexibility and lower OPEX, there is one location where splicing is the necessary option: at the CO's fiber-entrance facility, specifically between the outside plant (OSP) cable and the indoor cable. That IFC cable, which runs between the splice point and the back of a pre-terminated panel on an optical distribution frame (ODF), generally is considered permanent cabling.

Except for this particular application, more and more leading service providers have concluded that connectors are a more cost-effective and flexible solution within the CO. Of those that have used a splice-only approach in the past, most now have begun to migrate toward a connectorization strategy. By adopting a cap-and-grow approach, many service providers now plan to use connectors not only in the CO but plan to extend that connectorization strategy into the OSP.

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Website: www.adc.com

From North America, Call Toll Free: 1-800-366-3891 • Outside of North America: +1-952-938-8080

Fax: +1-952-917-3237 • For a listing of ADC's global sales office locations, please refer to our website.

ADC Telecommunications, Inc., P.O. Box 1101, Minneapolis, Minnesota USA 55440-1101

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