



FTTX Architecture

Creating a Cost Effective Plug-and-Play FTTX Architecture



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In any FTTX deployment, the goal of network planners is to build the most flexible and reliable system possible in the least amount of time and at the lowest possible cost. ADC has been an industry leader in the development of cost-effective plug-and-play architectures that provide both time and cost savings while increasing the flexibility of the network. This paper will discuss the advantages of hardened connectors and drop cables using Multi-port Service Terminals (MSTs) for accelerated FTTX deployment and rapid service turn-up. ADC's plug-and-play architecture, by design, increases the network's reliability and flexibility – while still offering service providers cost effective solutions.

Furthermore, a plug-and-play architecture creates a more technician-friendly system by minimizing the need for highly skilled splice technicians in making drop connections to the residence. By reducing the number of splices required on the distribution side of the FTTX network, installation and maintenance can be accomplished quickly and easily. Additionally, easy access at the MST facilitates maintenance and troubleshooting by allowing technicians to simply unplug a connector rather than breaking a splice. It also eliminates the need to send a splice technician to the side of the home. Both installation and operational cost savings are realized by reducing the number of splices, splice technicians, and splice crews required to turn up customer service.



It all starts with connectors

A reliable and efficient FTTX architecture can only be possible with connectors specifically designed and tested for use in the outside plant (OSP) portion of the network. ADC has made great strides in the design, testing, and manufacturing of hardened connectors that enable customers the highest level of connector performance in OSP applications. Higher performance standards and manufacturing improvements have resulted in lower insertion and return loss, superior end face precision, and vastly improved factory termination methods.

As a result, the new hardened fiber optic connectors have been introduced – connectors that can withstand the rigors of the OSP environment while still providing the reliability and performance required. This rugged connector system consists of connectors and adapters that are hardened to protect against the most severe conditions, including extreme temperature, moisture, ultra-violet (UV) radiation, chemical exposure, and other harsh OSP conditions.

These connectors are watertight and can be installed on the external surface of an enclosure to provide easy access points in underground or above ground installations. Because hardened outdoor connectors provide a critical link in the distribution network, they must undergo a full suite of tests designed to ensure the highest performance and reliability for OSP applications.

Testing for OSP reliability

A full qualification program for these connectors includes an extensive sequence of harsh tests performed under the same real-world conditions likely to be found during the service life of the connectors. The connectors must meet Telcordia standards, such as GR-326, GR-771 and GR-3120, designed to test for robust and reliable environmental performance. To meet these and other standards, a battery of tests are conducted to expose the rugged connector and adapter to thermal aging, thermal cycling, humidity aging, humidity condensation cycling, and post thermal cycling. These components then undergo vibration testing and a full range of mechanical stress tests, including flex, torsion, proof, and transmission with applied load.

Further test requirements include impact and crush resistance testing to simulate normal incidental forces. Testing for water intrusion while submerged under 10 feet of water is also performed with mechanical stresses applied. The hardened connector system also undergoes additional tests to certify that it withstands cyclical freeze-thaw conditions while fully submerged. A variety of optical monitoring tests are also conducted to verify the ability of the connectors to withstand the rigors of the harsh testing environment while maintaining required insertion loss and reflection performance during and after the extreme exposure.

In addition to service life testing, a full regiment of reliability tests certify the longevity of the hardened connector system.

Products are exposed to specific harsh conditions for extended time periods including thermal aging, temperature cycling, humidity aging, chemical exposure, UV radiation, salt fog and bacterial/fungus exposure.

Plug-and-play application

Hardened connectors meeting OSP performance and reliability requirements are ideally suited to plug-and-play FTTX applications. The rugged connector system is comprised of hardened connectors and adapters. Hardened adapters are mounted on enclosures at the street outside the residence and at the Optical Network Terminal (ONT) at the residence. A hardened drop cable is used to connect between the enclosure at the street and the ONT at the residence. The drop cable is a factory-connectorized assembly with hardened connectors on each end and pre-tested and certified to meet performance requirements. Hardened connectors and adapters are protected by protective caps and plugs until they are ready to be put into service. Protective caps and plugs are removed allowing inner connector components to be aligned as the connection is completed. As the connector is engaged with the adapter it also is sealed to the adapter using a water tight O-ring seal. The factory-connectorized drop cables enable simple, non-technical field installation of the drop cable.

Cleaning techniques for these hardened connectors have also been simplified, enabling improved reliability and maintenance. Kits are available with easy instructions and materials for cleaning hardened connectors and adapters. To clean the connector and adapter, the dust caps and plugs are removed to expose the inner optical components. The adapter can then be cleaned simply using a standard swab and the connector can be cleaned using lint free wipes.

An additional plug and play feature of the hardened connector is the arrow on the connector that aligns with a notch on the adapter thus providing a key to ensure precise alignment of the connector into the optical port. This feature provides higher reliability and speed when mating a connector to a hardened adapter. The lower skill set required by the technician, easy cleaning, and flexible access all make the plug-and-play solution the most durable and reliable service connection for the OSP portion of the network.

The MST is also central to a plug-and-play architecture and typically sits between the fiber distribution hub (FDH) and the subscribers. The MST is a hardened enclosure terminated and sealed in the factory with fiber cable stubs and hardened adapters on the exterior surface. MSTs are designed for outdoor applications and can be installed in hand-holes and pedestals, mounted on utility poles or overhead cable, or secured to any flat surface. The MSTs are connected to the network by splicing the stub cable to a main distribution cable. Splicing the MST into the network is performed without any need to open the enclosure. A versatile mounting scheme for the MST makes almost any installation technique possible. MSTs are designed to withstand direct exposure to extreme temperatures and humidity. They are also resistant to water penetration, chemicals and corrosion.



Each MST uses hardened adapters for the optical ports and each port is sealed with a threaded dust cap to prevent the entry of dirt and moisture. MSTs are available in 2, 4, 6, 8, or 12 port configurations. These optical ports accept subscriber drop cables that are terminated with hardened connectors. By using factory-terminated drop cables, splicing is eliminated and connections can be made by less-skilled technicians – saving cost and ensuring rapid service turn-up.

Connecting FTTH drops

Once the MST has been secured, pre-connectorized drop cables provide easy connectivity from the MST to the optical network terminals (ONTs) at each subscriber location. If the MST is located in a hand-hole, the drop cable is installed in a 1.25-inch duct or direct buried with a tracing wire. An aerial MST application requires an all-dielectric or figure 8 drop from a pole or strand to each subscriber ONT.

Regardless of which mounting scheme is used for the MST, drop cables are quickly and easily connected using preconnectorized drops with hardened connectors and hardened adapter ports. Connecting the hardened connector to hardened adapters on the MST's external surface enables easy connections without opening the enclosure.

Operational cost savings

The MST hardened connector approach to any FTTX architecture provides huge operational cost advantages when compared to the installation costs of the traditional spliced architectures. Cost studies were conducted by ADC for a 192-home subdivision using both methods, and the MST approach proved significantly less costly.

Despite additional costs associated with adding more service terminals, the savings in fiber cable, cable placement, and splicing more than offset the added expense of the hardened connector system. ADC's study confirmed that the hardened connector approach incurs lower overall installed costs throughout the FTTX network.

ADC continues to develop new solutions to save time and to minimize installation and maintenance costs. A new Tethered Access Point (TAP) cabling system will further reduce the costs associated with optical access networks by providing pre-connectorized distribution cables enabling installation of fiber access points for an entire street along with the cable installation. The entire TAP cabling system is manufactured, tested, packaged, and shipped to the customer ready for deployment. The TAP system is a customized plug-and-play system designed specifically for pre-deployment of access points in advance of terminal installation. The TAP system uses tethered hardened connectors to eliminate fusion splicing during terminal installation and rapid connection of MST terminals to complete service connections for customers. The TAP system will significantly improve the speed and flexibility for access network deployment.

ADC continues to lead the way in making FTTX networks cost effective and user friendly while ensuring robustness, flexibility and reliability. The use of hardened connectors and adapters requires less-skilled technicians, eliminates splicing costs, and allows easy access for troubleshooting and maintenance. The ability to turn up services more rapidly and handle customer churn equate to huge operational savings for service providers. A simplified plug-and-play architecture, coupled with ADC's experience in cable management techniques and hardened connector technology, is enabling service providers to save time and cost in all areas of the access network.



Web Site: 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 web site.

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

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