Fiber Architectures
for Active Ethernet Networks

APPLICATION NOTE

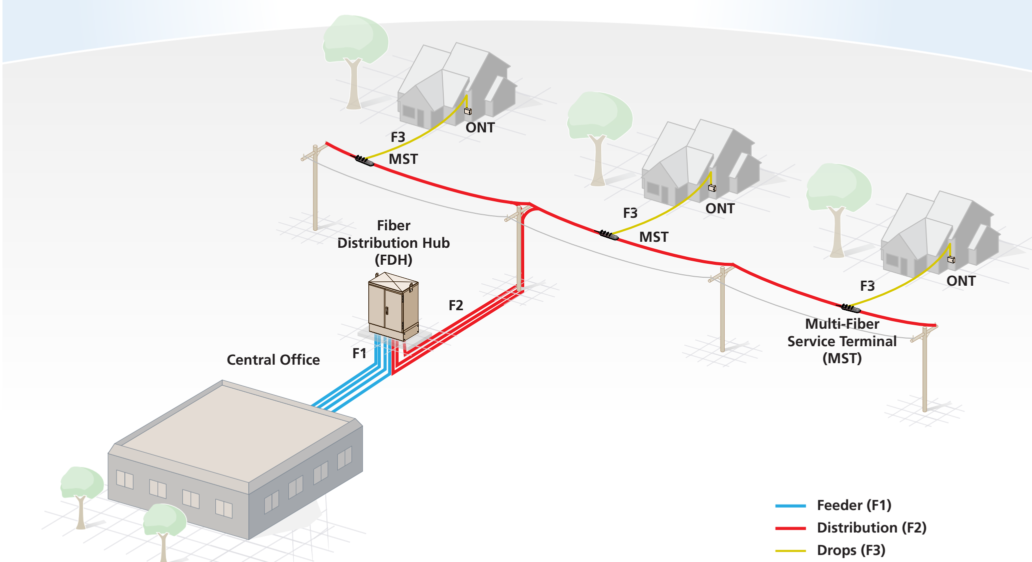
Introduction

Any service provider planning to build a fiber-to-the-home (FTTH) network must decide early on in the process the best way to take fiber all the way to the customer's premise. There are several topologies and technologies being deployed today and "the best way" to get that fiber to the premise depends entirely on the individual service provider's unique requirements. Those requirements include:

- the capex/opex budget;
- the size and physical characteristics of the operating territory;
- the size and demographics of the existing and potential customer base;
- bandwidth requirements for planned service offerings;
- the types and locations of existing outside plant; and, of course,
- the required return on investment.

When it comes to topology, service providers can choose between a point-to-point network (i.e. active Ethernet) or a point-to-multipoint network (i.e. PON). This application note will focus on three common fiber architectures being used in the active Ethernet network layout, and discuss the advantages and disadvantages of each.

Point-to-Point Architecture



Service providers opting for an active Ethernet network deploy the active or powered optical electronics at selected network locations, depending on their individual choices in fiber architectures. Such a network offers each subscriber a dedicated connection at rates of 100 Mbps or 1-Gbps.

The service provider's decision on where to deploy the active electronics determines the fiber architecture best-suited for that provider's FTTH network. The choices are: home run from the central office (CO) or hut; in a cross-connect cabinet in the outside plant (OSP); or in an active cabinet in the OSP. Regardless of which fiber architecture a service provider uses, a successful FTTH network depends on selecting the appropriate fiber termination and cable management solutions.

Three Fiber Architectures Defined

For service providers of all sizes and budgets, one of the most attractive characteristics of active Ethernet technology is its flexibility. A service provider can tailor the configuration of an active Ethernet FTTH network to satisfy the geographic and demographic characteristics of the operating territory and the provider's capex/opex budget. As mentioned earlier, there are three types of fiber architecture for active Ethernet networks:

Home Run – This architecture is a basic star configuration in which a fiber runs directly between the CO or OSP hut and each customer premise. There are no active electronics between the CO and customer premises.

Cross-Connect Cabinet in the OSP – This architecture runs fiber from the CO to one or more cross-connect OSP cabinets and from each cabinet to multiple customer locations. In a network configuration of this type, one cross-connect cabinet typically serves 400-1,000 customer locations.

Active Cabinet in the OSP – Here, the service provider basically deploys the active electronics closer to the customer, that is, in a temperature-controlled OSP cabinet, with a pair of fibers coming in from two different directions to create a ring. This method is generally used to extend the overall reach between the CO and the subscriber.

There are, of course, advantages and disadvantages with each architecture, depending on a given service provider's unique requirements.

Fiber-rich Providers Go for the Home Run

The direct CO/hut-to-the-home fiber run may be the ideal network configuration for service providers that already have deployed a lot of fiber--or which have the capex budget to do so. It works especially well in a small serving area with a high density of customers, for example, a small town, with each customer located close to the CO and a dedicated, relatively short fiber running to each end-user location.

The home run architecture also simplifies operations, administration and maintenance (OA&M) chores for the service provider. With all fiber terminations and active electronics located in the temperature-controlled CO, the service provider can perform testing and do adds/moves/changes in one central location. In addition, when it is time to upgrade the electronics, this architecture gives the service provider easy centralized access to all fiber terminations and electronics.

Ensuring ease of access requires service providers to make yet another choice when deploying the home run architecture--whether to interconnect fibers at the optical distribution frame (ODF) in the CO or to establish a cross connect. The interconnect approach may save some money, but it does limit the service provider's flexibility with adds/moves/changes and network upgrades. In those instances, the service provider has to run temporary cables, take all customers down, make the required changes and then turn each customer back up, one at a time. By contrast, a cross-connect at an ODF such as ADC's Next Generation Frame (NGF), may cost a bit more, but it allows the service provider, when upgrading the network, simply to put in new blocks, wire the electronics and move the cross connects. The cross connect at the ODF ensures a much smoother network-migration path; there is minimal service disruption during the time required to disconnect and move the cross connect from one block to the new one when rolling service onto the new platform.

Cross-Connect OSP Cabinet Reaches Large Clusters of Customers

When serving a larger geographical area--for instance, a sub-division--in which most customers are located farther from the CO than in a small town, many service providers opt for the tree/ star fiber architecture. To serve each cluster of customers, the service provider deploys a cross-connect cabinet adjacent to each sub-division or neighborhood. By using a cabinet with a built-in cross connect, such as ADC's FDH 3000, service providers obtain the flexibility they need to scale the network in a pay-as-you-grow strategy. Available in a variety of sizes, such cabinets accommodate anywhere from 72 to 864 fibers.

When rolling out FTTP, the service provider obviously does not expect a 100-percent take rate right from the start. Consequently, a service provider often decides to deploy a maximum-capacity cabinet, say, 864 fibers, but equips it initially at less than maximum capacity, basically reserving "room to grow" in the cabinet. The service provider can increase or decrease the number of fibers on the customer side, depending on actual take rate, by cross-connecting subscriber fibers and simply running the remaining fibers back to the CO. As the take rate increases, the service provider has the option of increasing the fibers on the customer side and, as necessary, installing additional 72-fiber panels in the cabinet. A cabinet with cross-connects clearly gives the service provider far more flexibility than is available from splicing feeder fibers with distribution fibers right from the start.

Another major advantage of the cross-connect OSP cabinet architecture is that it simplifies troubleshooting and maintenance. With the cabinet deployed between the customer cluster and the CO, the service provider can, in the event of a problem, look back toward the CO and down to the customers to identify the problem and correct it.

Active Cabinet in the OSP for Sparsely-Populated Areas

For service providers serving rural areas with a relatively low population density, a fiber architecture based on an active OSP cabinet often is the most cost-effective choice. By pushing the electronics as close as possible to the customer, the service provider can serve more customers more cost-effectively with a smaller network. With the active electronics much closer to the customer, the service provider requires smaller-count feeder fibers than with the other two architectures and has relatively shorter fiber runs from the cabinet to the customer. In some cases, service providers are even retrofitting old digital-loop-carrier (DLC) cabinets and installing, along with the electronics, fiber patch panels, such as ADC's LSX solution.

Effective Cable Management Critical to Each Fiber Architecture

As service providers choose the appropriate fiber architecture for their active-Ethernet FTTH networks, they obviously make those choices according to planned service portfolios, capex/ opex budgets, customer demographics and other factors. Regardless of which of the three FTTH network configurations is the best choice for a given service provider, all service providers must tackle another issue: how to terminate the growing numbers of network fibers in a way that 1) delivers reliable service both now and in the long term and, 2) ensures maximum flexibility in the network.

Some service providers believe the answer is to combine bulkhead-style fiber frames with direct connections/interconnections. Unfortunately, this approach creates more problems than it solves--problems which become worse over time, simply because it does not take into account cable management issues.

Solutions with built-in cross-connect capabilities, such as ADC's NGF and FDH 3000, future-proof the network by not only accommodating additional fiber terminations but also by providing a built-in cable management system. Effective cable management, which is important on both the fiber distribution frame and in the actual active equipment racks or cabinets, has a direct impact on network reliability, performance and cost. It also can affect network maintenance and operations, as well as the ability to reconfigure and expand the network, restore service and implement new services quickly. Unless they plan for cable-management issues and then choose fiber-termination solutions designed to handle those issues, operators inevitably will experience less and less flexibility as the network itself--and the associated costs--continue to grow.

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Four Principles of Effective Cable Management

Doing it right means deploying fiber termination systems with built-in cable management capabilities that are based on industry standards and sound cable management principles. These principles specify four such capabilities: bend radius protection; intuitive cable routing paths; cable accessibility; and physical protection of the fiber network. If executed correctly, such a cable management system helps the network operator to achieve operational and financial objectives.

Bend radius protection – Simply put, fibers bent beyond the specified minimum bend diameters can break, causing service failures and increased network operations costs. In general, the minimum bend radius should not be less than ten times the outer diameter of the fiber cable. Thus, a 2.0 mm cable should not have any bends less than 20 mm in radius.

Intuitive cable-routing paths – If well-defined, they give the technician no option but to route the cables properly and consistently. Leaving cable routing to the technician's imagination leads to an inconsistently routed, difficult-to-manage network, as well as increased congestion in the termination panel and the cableways.

Accessibility – Well-defined routing paths also ensure easy access to installed fibers, which is critical for enabling technicians to install or remove any fiber without inducing a macrobend on an adjacent fiber. Accessibility also can mean the difference between a network reconfiguration time of 20 minutes per fiber and one of over 90 minutes per fiber.

Physical protection Fibers routed between pieces of equipment without proper protection are susceptible to damage sometimes caused by technician accidents and their equipment, which can significantly affect network reliability.

Because cable-management challenges will only get bigger as the active-Ethernet network grows, regardless of the fiber architecture in question, leading service providers want solutions with greater flexibility and, at the same time, satisfy their capex/opex budgets. By investing in solutions such as those offered by ADC, these service providers can maximize their return on active Ethernet network investments and thereby ensure long-term success in todays competitive marketplace.

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