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Central Office Implications for Deploying FTTP

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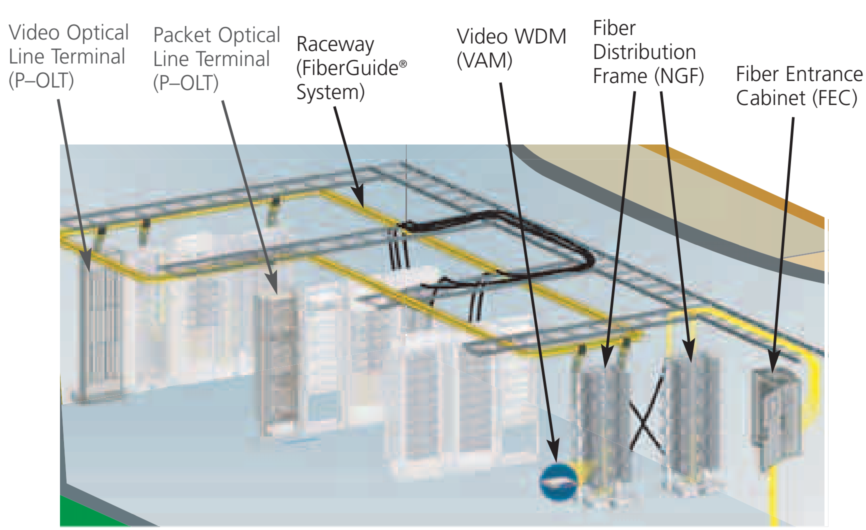
The successful deployment of any flexible, cost-effective fiber-to-the-premise (FTTP) network requires thoughtful decisions regarding all segments of the network, from the optical line terminal (OLT) in the central office to the optical network terminal (ONT) attached to each home and everything in between. While much attention is focused on the distribution and access elements within the outside plant (OSP) network, it's also important to consider the implications of FTTP architectures within the central office (CO).

Probably the biggest mistake any carrier can make is believing that an FTTP does not require the same flexibility as a transport network. However, a mindset that the FTTP network does not require the same level of access, flexibility, and protection given to other aspects of the network is too often the mindset of some network planners when first looking at deploying an FTTP network. In reality, however, FTTP architectures pose significant implications for the CO in meeting the same levels of performance required for transport segments.

First up – architecture decisions

Before specific product selections can be made, some critical network architecture decisions are necessary. These key decisions involve connection strategies, flexibility in terms of test access points, and WDM positioning. Deciding on a CO network architecture for FTTP networks requires the planner to perform a balancing act. The goal in any network is to minimize capital expenses and long-term operational expenses, while achieving the highest possible levels of flexibility within the network. The basic function of an FTTP network in the central office is to connect the OLT equipment to the OSP fibers, deploying WDM somewhere in the middle to enable voice and data signals to be combined with video signals.

Figure 1



As shown, the video WDM would be placed in a panel in the same frame as the OLT equipment. A patch cord connects the OLT equipment to the inputs of the video WDM. The common port on the video WDM is, in turn, connected to the back side of the equipment FDF, where a crossconnect patchcord connects OLT ports to the designated OSP ports. The obvious advantage is the need for only one patch cord running from the OLT frame to the FDF for every passive optical network (PON) circuit.

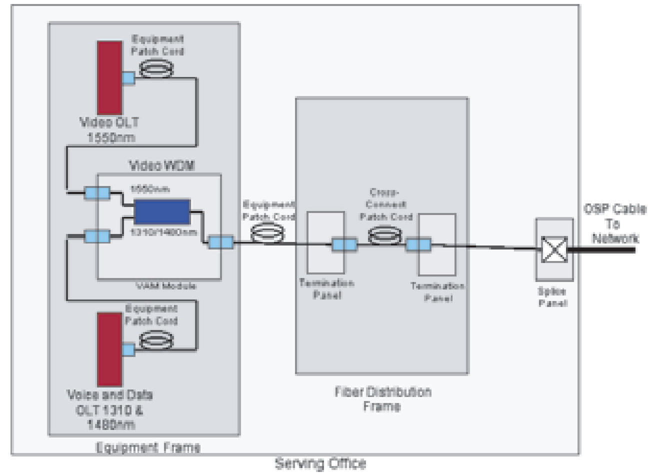
However, the down side to this architecture is that four connector pairs are required and network flexibility is greatly reduced. One critical assumption required for this strategy is that the voice/data OLT will be located very close to the video OLT associated with it. While this may seem easy in a field trial or small roll-out scenario, full-scale FTTP deployment may prove otherwise. The video WDM must be placed in a location that provides any voice/data OLT easy connectivity to any video OLT, regardless of its location in the CO.

A better approach to placing the video WDM at the OLT frame is to place it in the FDF line-up. This method offers many advantages to an FTTP network. Placing the video WDM in the crossconnect FDF line-up in the equipment frame provides the lowest overall cost, the minimum number of optical connectors, and the greatest amount of network flexibility, as shown below.

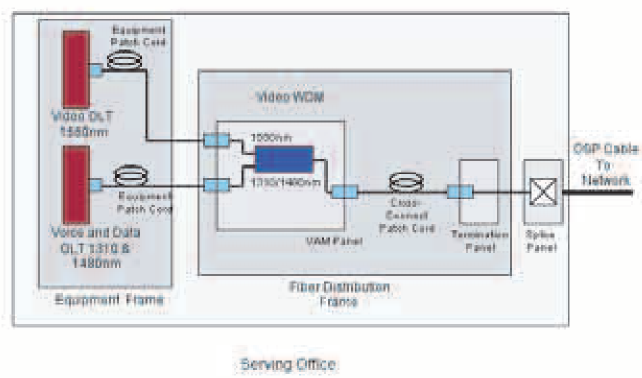
In the above scenario, the video WDM is placed in the equipment frame in the FDF line-up. Patch cords connect the OLT equipment to the inputs of the video WDM. A crossconnect patch cord is used to connect the video WDM common port to the designated OSP port. There is an immediate advantage of requiring only three connector pairs while maintaining maximum flexibility.

Since the video WDM is located at the FDF and all OLT patch cords are routed directly to the FDF, greater flexibility is provided regarding how the OLTs are combined and configured. Any OLT can be easily combined with any other OLT, regardless of its location in the CO. Now that the architecture decisions have been addressed, the connectivity product selection can begin.

- Potential Central Office Fiber Management System Layout Figure 2



- Ideal Central Office Fiber Management System Layout Figure 3



A look at the numbers

Before any true fiber connectivity product selection can occur, network planners must carefully consider the numbers involved with full-scale FTTP deployment. As discussed previously and outlined below, planning the network layout and product selections must be based on long-term needs rather than initial deployment numbers.

Consider the number of OLTs:

- Current and future possibilities
- 3200 homes passed will require at least 100 WDMs, more likely 120 or more
- Plan ahead by reserving floor space for future expansions or fewer homes per OLT

Considering incoming OSP fiber counts:

- OSP cable should be sized to meet future demands
- 3200 homes passed requires at least 100 fibers back to the CO, with up to 432 more likely depending on network strategy
- OSP cable fiber counts will be overbuilt to ensure future capacity requirements can be met without installing additional fiber
- Non-FTTP-related services on the cable

The incoming OSP cables used for the FTTP network will have large fiber counts for accessing as many homes as possible. Since a major expense to any network is burying the OSP cable in the ground, any OSP cable installed should be sized for future service needs. For instance, reaching a neighborhood of 3200 homes, an OSP cable would minimally require 100 fibers (1 per 32 homes) based on full utilization of the 1x32 optical splitters used in the OSP distribution cabinets. However, considering take rates, spare fibers, splitter usage, future service offerings, distance from C/O and other unknowns, the number of fibers in the OSP cable would more likely end up being closer to 1 per 8 homes.

Also, these OSP cables will likely pass several other areas, including businesses, providing even more opportunities over the same cable being used for the FTTP network. Potential business customers that can be serviced over the same cable cannot be overlooked. Therefore, back in the CO, each fiber needs to be easily accessible by all areas of the network – not just the FTTP-designated equipment. Additional flexibility, built into the central office, will enable the carrier to get the most out of the fiber, including the ability to use the same fiber to take advantage of any non-FTTP service opportunities that may arise.

Due to the large potential fiber counts in the C/O and floor space availability issues, FTTP networks will require high-density fiber distribution frames that enable the maximum number of terminations available in the least amount of space possible. While a high-density FDF system may be important for reducing physical space required for FTTP deployments, the density gain cannot be achieved at the sacrifice of fiber cable management within the frame.

Critical cable management

Any high-density fiber distribution frame must be functionally designed to accommodate the large number of incoming fibers and the maximum number of terminations associated with FTTP infrastructure – not simply a standard frame with more terminations added. Also worth mentioning is that unlike traditional OSP networks, FTTP networks are not protected – there is no diverse path to provide network redundancy in the event of a major outage. This fact changes the way services are provided and maintenance is accomplished within the CO for FTTP architectures.

For example, typical service outage windows may not be available for performing maintenance in an FTTP network. Rather, because there is just one link per customer, technicians may delve into the network any time of day to do required maintenance. This makes easy accessibility a critical attribute for servicing or reconfiguring the FTTP network with minimal impact on adjacent networks.

Creating a high-density FDF – defined as 1440 or more terminations – is technically very easy. Creating a functional high-density FDF with good cable management features that enables technicians to quickly and efficiently turn-up, test, and reconfigure the network is more complicated.

Telcordia's GR-449-CORE, Issue 2, July 2003, Generic Requirements and Design Considerations for Fiber Distribution Frames, contains design guidelines and test requirements for high-density FDF systems. These requirements help ensure proper functionality and performance of a high-density FDF system in a high fiber-count network.

There are four key aspects of cable management to consider when evaluating any FDF or panel product: bend radius protection, connector access, cable routing paths, and physical protection.

Bend radius protection – Proper bend radius protection as defined in Telcordia GR-449-CORE, Issue 2, requires all bends made by a fiber within the network to be protected with a radius of 1.5-inches or 10 times the outside diameter (OD) of the cable, whichever is greater. This protection is critical to ensure long-term optical performance and the ability to support future high-speed services.

Connector access – Physical connector access is very difficult to achieve in a high-density frame. The system must be designed to allow tool-less access to front and rear connectors without disturbing adjacent fibers or connectors. Easy front and rear connector access is needed for service turn-up and connector cleaning – very critical to an FTTP network, since much of the access for turn-up and troubleshooting will occur during normal business hours. Telcordia GR-449-CORE, Issue 2, provides testing requirements at OC-768 transmission rates to ensure a system provides good connector access without interfering with adjacent circuits.

Cable routing paths – Cable routing paths within any FDF-related system must be clear and easy to follow. The quality of the cable routing paths within the system will be the difference between congested chaos and neatly routed, easily accessed patch cords. In high-density FDF systems, the need to easily follow cable routing paths is magnified due to the large number of fibers present. Telcordia GR-449-CORE, Issue 2 also provides design and test requirements to validate the quality of the cable routing paths within a fiber distribution frame system

Physical safety – Laser safety must also be a concern in FTTP networks, since high-power lasers used in the analog video OLT can be potentially harmful to technicians. Since infrared lasers are not visible to the human eye, it's important to take precautions when exposure is possible. Fiber distribution frames need to have built-in laser eye safety features, ensuring connectors don't point directly at technicians minimizing the possibility of technician being exposed to high power laser radiation. Designs that have connector ports contained within a tray or other enclosure and pointing side-to-side, rather than straight out of the panel, help protect technicians, regardless of their level of training or awareness.

Success in the CO

It cannot be overstated that FTTP networks require similar if not more stringent cable management attributes as any OSP network that comes into the CO. Flexibility and accessibility are particularly important since, although FTTP may be the application of the day, non-FTTP applications cannot be overlooked as additional revenue sources over the same fiber.

Carriers are beginning to realize the full potential of FTTP networks and are embracing the fact that changes are imminent. Whatever is done today will be done differently tomorrow. Designing FTTP networks with proper care and planning will provide added benefits to the carriers -- maximum efficiency, easy access, high flexibility, and lower cost.

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