

# FTTX NETWORKS

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## Abstract

Fiber network architectures have evolved to a point that when coupled with specific optical components both active and passive and when used with customized transmission systems are now capable of providing cost effective FTTX service to customers requiring large quantities of bandwidth. New fiber networks are being constructed by most service providers and are expected to provide profitable service for at least 20 years.

## Keywords

FTTx (Home, Premises, Desk, Building, Curb / Cabinet, Node, Antenna), Splitters, Taps, (C/D)WDM, xPON, P2MP, P2P, DAS (Distributed Antenna System), Ethernet, Wavelength, Switch, Router, 1000Base -T, -FX, -PX10-20.



## General

Fiber network architectures have evolved to a point that when coupled with specific optical components both active and passive and when used with customized transmission systems are now capable of providing cost effective FTTX service to customers requiring large quantities of bandwidth. New fiber networks are being constructed by most service providers and are expected to provide profitable service for at least 20 years.

FTTX architectures have used various network topologies as building blocks for their design. Network design has introduced issues for consideration by the designer with respect to optical components, fiber medium, and system costs:

- Passive optical splitters and combiners
- Passive optical taps
- (C/D)WDM devices
- Optical amplifiers
- Use of fiber that can be used at all wavelengths or with specific transmitters.

FTTX has included the following loop plant fiber networks:

- FTTN/FTTLA - Fiber-to-the node or last amplifier.
- FTTC/FTTK - Fiber to the curb, closet or cabinet. Reaches more than 300 mtrs - 1000 feet of the client.
- FTTB - Fiber to the building business, basement. Fiber reaches the boundary of the building.
- FTTH - Fiber to the home. Fiber reaches the boundary of the living space.
- FTTP - Fiber to the premises it includes FTTH and FTTB.
- FTTD - Fiber to the desk.
- FTTA - Fiber to the antenna. DAS and 3G to NextGen mobile networks.

Recently, FTTX is usually spoken of for systems that bring fiber directly to the client such as FTTB, FTTH, FTTP, and FTTD.

In general, FTTX Systems can be either point-to-point systems or point-to-multipoint systems. There are some major differences between these two systems as can be seen by observing Figures 1 through 4 and as summarized in this document.

The publicly switched telephone network and the Internet Services are combined with the optical FTTX at the Optical Line Transmitter (OLT) in the CO. In a point to point network, voice and data are transmitted downstream at 1310 nm on the same fiber as video is being broadcast at 1550 nm. In the upstream direction, on a second fiber, voice and data are transmitted at 1310 nm.

In a point to multipoint (P2MP) PON a single fiber is used for both upstream and downstream pathways. Downstream voice and data are transmitted at 1490 nm. In the upstream direction, voice and data are transmitted by the customer at 1310 nm. Video is overlaid in the fiber using a signal at 1550 nm in the downstream direction.



1 Discussed in Sterlite White Paper, WP0002 and the Sterlite Applications Note, Network Topologies.

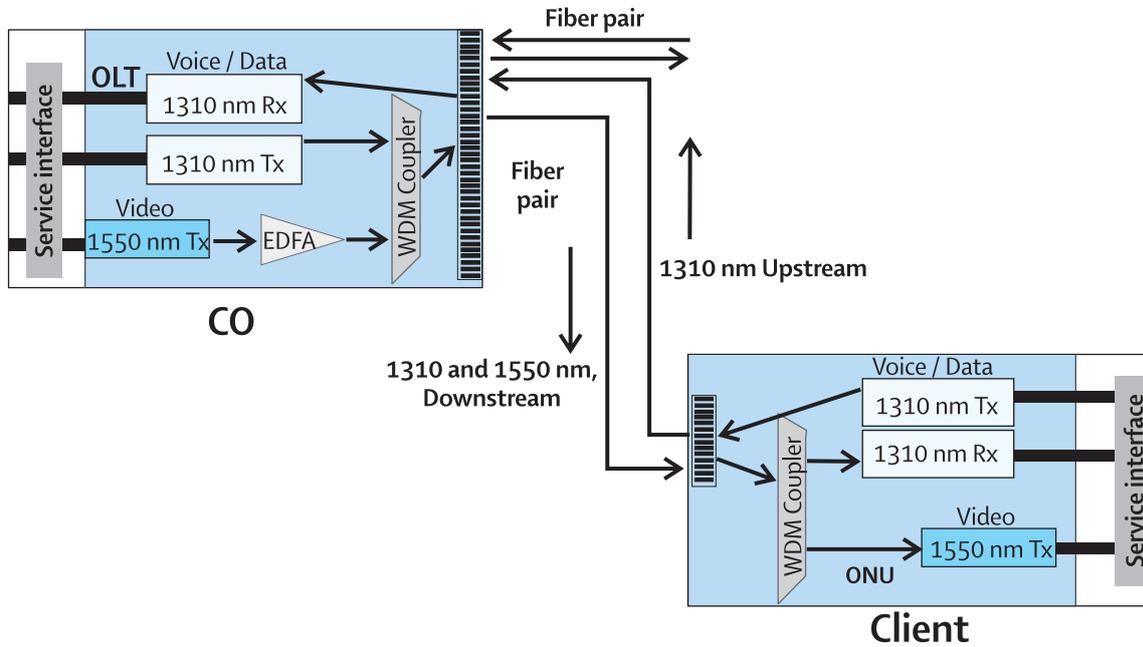


Figure 1- Point to Point Active Network

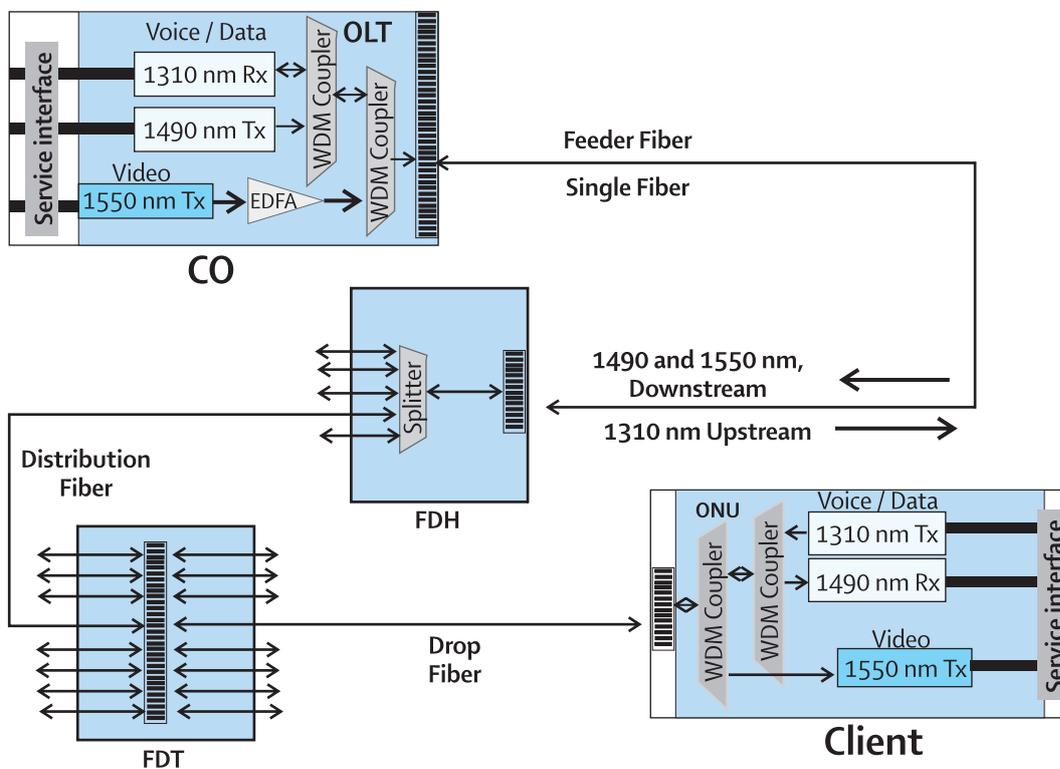


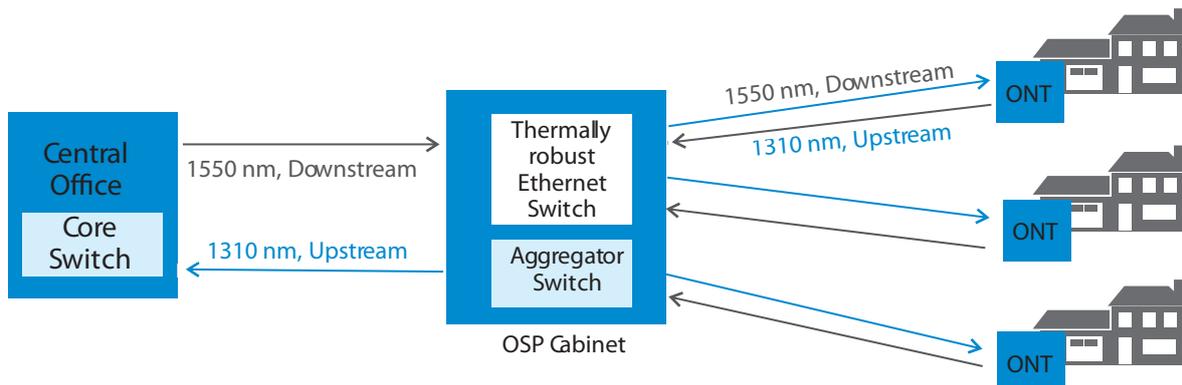
Figure 2 - Point to Multipoint Point Passive Optical Network.



## Active And Passive Optical Networks

As optical signals traverse a fiber in a FTTX system, there needs to be a way to separate it so that it gets to the proper destination. There are two important types of systems that make fiber-to-the-home broadband connections possible: active optical networks and passive optical networks. Each offers ways to separate data and route it to the proper place, and each has advantages and disadvantages when compared to the other.

An active optical system uses electrically powered switching equipment, such as a router or a switch aggregator, to manage signal distribution and direct signals to specific customers. This switch opens and closes in various ways to direct the incoming and outgoing signals to the proper place. In such a system, a customer may have a dedicated fiber running to their house.



**Figure 5 – Active Ethernet Network**

One of the most attractive features of Ethernet is its flexibility. Because the distances from the central office to the remote sites are known, estimation of the power budget and troubleshooting the faults in the network is easier. Transmission in P2P configuration is more secure, since all transmissions are physically separated by fiber. Only the end points will transmit and receive information, which is not mixed with that of any other customer.

## Active Network Architecture and Components

The main building blocks of a P2P network are:

- Core switch,
- Aggregation switch
- Optical Network Terminal (ONT).

The core switch is a high capacity Ethernet switch that communicates to aggregator switches using standard GbE optical signals. The aggregator switch interfaces this data stream directing appropriate traffic to individual gateways to the customer's premises called Optical Network Terminals (ONT). Each ONT interfaces up to a 1 Gb/s (nominal) signal in a standard 1000 Base-FX format, which is 1000 Base T Ethernet format on an optical fiber. The core switch interfaces multiple content and service providers over an MPLSbased Metro or Regional network to deliver data, video, and voice services to the customers on the access network.

The aggregator switch can reside in the standard CO, a building entrance, or outside plant cabinets to meet the environmental needs of the network provider. The aggregator switch delivers traffic to the subscriber in accordance with the specific bandwidth requirements from 1 Mb/s to 1 Gb/s (symmetrical) per subscriber. A typical connectivity diagram of Active technology in the access network is shown in Figure 5.



## Passive Optical Network

Passive Optical Network or PON architecture is similar to the switched architecture, but it requires no OSP electronics. Instead, an optical splitter is used in place of the OSP switch. The splitter divides the light coming from the OLT, and it combines the light coming from the ONTs. This greatly reduces the cost of OSP aggregation since the splitter is inexpensive, requires no power and very little, if any maintenance. The maximum number of subscribers is generally limited to 32 per fiber (with a 32 port splitter) delivered to the CO. BPON, EPON, and GPON are common types of PON networks in use today. 10G EPON and 10G GPON are new technologies to be deployed in the next few years.

**Table 1- Summary of Popular PON Characteristics**

A 1000 BASE-PX10 Ethernet System can provide service for up to 10 km and 1000 BASE-PX20 will provide service for up to 20 km.

Homerun:

- Used by fiber rich companies.
- Effective for small, high density serving area. Each customer is close to the CO.

PON	Characteristic	Transmission Rate 3Mbps	Specification	Protocol
BPON	Broadband	1244.16 / 622.08	ITU-T G.983	Uses ATM
GPON	Giga-bit	2488.32 / 2488.32	ITU-T G.984	Uses ATM or GEM <sup>4</sup>
EPON	Ethernet	1250 / 1250	IEEE-802.3ah-2004	Uses MPCP <sup>5</sup>

- Companies with good capital budget.
- Simplifies operations.
- All terminations and equipment are in a temperature controlled central office.

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- 2 Up to 64x and even 128x splits are possible
  - 3 Downstream rate/Upstream rate
  - 4 Can use forward error correction (FEC).
  - 5 EPON is specified in IEEE 802.3 ah - 2004, where it was designed to be a simple packet based transmission system. It is used for both upstream and downstream communications. Multipoint media access control (MAC) protocol (MPCP) used in EPON controllers access to a point to multipoint networks.

## Additional information

If there are additional questions on this topic or other fiber optic issues, please contact Sterlite Technologies at:

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