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A Survey of FTTH Elements Based on Broadband Access Network

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ABSTRACT

Fiber to the home (FTTP) networks has always been the ultimate solution to a future proof, broadband access network. In the past, the major obstacle to implementing FTTH has been cost, coupled with the lack of symmetrical, bandwidth intensive applications. In recent years, however, there have been several technological, commercial and regulatory developments that brighten the outlook on FTTH. This paper outlines these changes, and presents architecture that may be deployed in the near future. First, the current motivation driving FTTH, including high bandwidth, high reliability, and low operation cost, are discussed. This is then be followed by a review of various FTTH systems. This emphasis key developments and trends that are influencing present system configuration.

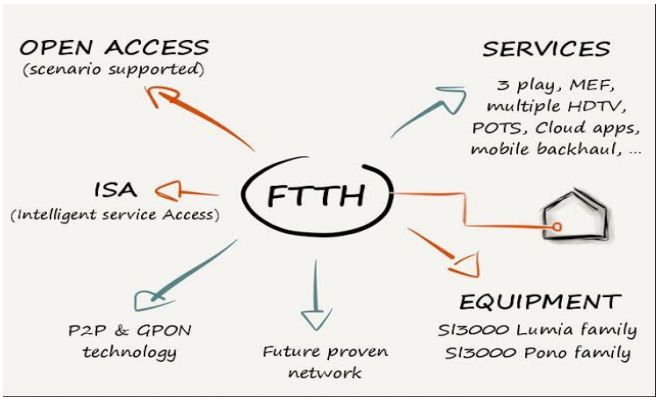
Keywords: Optical network, Fiber to the home (FTTH), Optical line terminal (OLT) and Optical Network Terminal (ONT).

1. INTRODUCTION

FTTH means optical fiber will reach to the home instead of all conventional copper cables for services such as broadband internet telephone & cable TV. To deliver new bandwidth consuming services such as IPTV, Video on demand, IP surveillance and many more including above services. It is an unlimited capacity high speed carrier is deployed.

What is FTTH?

FTTH is now a cost-effective alternative to the traditional copper loop. "Fiber to the Home" is defined as a telecommunications architecture in which a communications path is provided over optical fiber cables from an Optical Line Terminal (OLT) unit located in telecommunications operator's switching equipment connects to an Optical Network Terminal (ONT) at each premise. FTTH consists of a single optical fiber cable from the base station to the home.



Why FTTH are used?

FTTH provides end-users with a broad range of communications and entertainment services, and faster activation of new services.

Deploying a fiber optic cable to each premise will provide an extraordinary amount of Bandwidth for future services. FTTH provides carriers with an opportunity to increase the average revenues per user (ARPU), to reduce the capital investment required to deliver multiple services, and to lower the costs of operating networks.

FTTH provides the community in which it's located with superior communications which enhance the efficiency of local business and thus deliver economic advantage for the community.

Around the world FTTH is viewed as strategic national similar to roads, railways, and telephone networks.

FTTH network box

The FTTH council points out that when it comes to premises (houses, large and small businesses) drop cables typically terminate onto the structure and externally route to a termination box. This box consists of following equipments.

FTTH Network equipment

FTTH deployments require a lot of planning and elements to expand the access node to the subscribe premises. In fiber optic network there are two basic elements: 1) An **Optical Line Terminal (OTL)** located at the ISP side. 2) An **Optical Network unit (ONU)** placed at the customer's premises.

The connection between these two elements is made with both optical, non -optical equipment and components.

Optical elements: splices, couplers, adapters, connector, fiber cables, splitters, patch cards, drop cables and drop terminals.

Non- optical elements: Hardware, cabinets, patch panels, fiber closures, pedals.

ODF/ODR: Optical Distribution Rack (ODF) is rack that houses the ODFs. A good fiber guiding system is crucial to keep high amount of fibers entering the ODR well organized. Optical Distribution Frame (ODF) enabling the fibers from the outdoor cables to become available on an individual fiber level for flexible patching with the active transmission equipment.

Fiber cable: Installing fiber optic cables is one of the most expensive procedures when deploying a PON network. Cable installation can be underground (burial), inside ducts and on poles and towers (aerial).

Closures: Cable joint closures are installed where different cables are connected/spliced onto each other. They are used to organize the joints, and to protect the joints. The closures must be accessible in order to add or adjust fiber connections, or to test and repair connections.

Connector: Simplex connectors are the most used in FTTH deployments. Most common used are 1) SC/APC, 2) ST/APC, 3) LC/APC. The most common connector type used in PON network is APC (Angle Physical Contact) connector, because its eight degree polish ferrule minimizes loss. Multifiber is also acquiring popularity, because they can hold from 4 to 72 fibers at the same time, being the MTO the most popular one.

Manholes: These are typically concrete chambers that are covered by a metal lid, and are intermediate locations in the network that allow access to ducts and/or cables. They can also host closures. Small manholes are sometimes called handholes. They are typically introduced at locations where access to ducts or cables is required, for example for blowing or pushing extra cables through ducts.

Cabinets: Cabinets installed at flexibility points in order to allow easy access to the fibers, Cables and ducts, while offering protection against environment (weather, vandalism…). Mostly above ground, but sometimes in manhole. If above ground, need to find locations with

sufficient room for accessing, not too vulnerable, permitted by authorities, while minimizing costs.

Splice: A splice can be defined as two or more conductors joined with a suitable connector, reinsulated, reshielded and rejected with compatible materials applied to a properly prepared surface. Long splice uses a lot of line. Almost no reduction of line strength will go through a block/sheave. Unalay 15 tums of line before starting a long splice. Marry the lines just as you do for short splice.

FTTH Access Networks: The deployment of FTTH access network has come a long way before subscribers use optical fiber instead of copper lines to achieve broadband internet access. FTTH is a form of fiber optic communication delivery that reaches one living or working space. There are two common systems available in FTTH networks**: AON (A**ctive Optical Network) and **PON (P**assive Optical Network).

Active Optical Network: The AON arrangement is a point to point structure (PTP), meaning that each user has is own dedicated fiber optical line terminated on an optical concentrator. In an active optical system, environmentally electrical switching equipment is deployed, such as a router or a switch aggregator, to manage signal distribution and route data to proper places. The following figure shows an AON system.

Passive Optical Network: Passive optical network, just as its name shows, it only uses fiber and passive components like amplifiers, repeaters, or shaping circuits. Its arrangement is a point to multipoint network. That is to say a passive optical network shares fiber optic strands for portions of the network. In passive optical system, a single fiber from a central office optical line terminal (OLT) is connected to optical network terminals (ONTs) or optical network units (ONUs) at customer premises. The image below is a PON system.

An OLT terminate the optical signals and distributes IT and internet services to as many as 16 to 128 customers pre fiber line. An optical splitter, also called PON splitter, is either fitted in or outside the subscriber's premise to divide a single optical signal into multiple equal but lower power signals and distribute the signals to user. An optical network unit (ONU) terminates the PON at the customer home. The ONU usually communicates with an optical network terminal (ONT), which may be a separate box that connects the PON to TV sets, telephones, computers, or a wireless router. ONU and ONT is basically the same device.

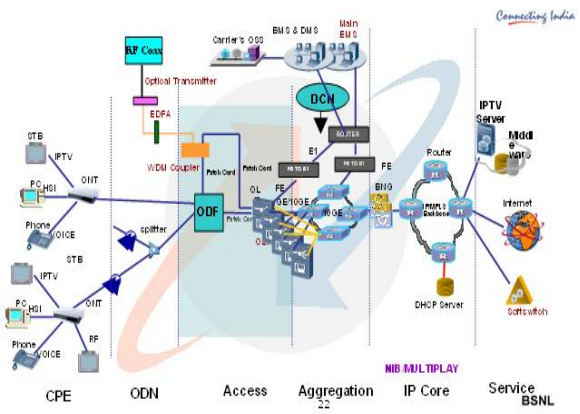
2. AON Vs PON

Each system has its own virtual points and shortcomings. As for AON subscribers, the bandwidth is each port is dedicated to each individual without sharing of it. Thus, higher bandwidth per port is possible through AON compared with PON. IN addition, because of its dedication to specific individual, it is easier to detect fiber faults or problems in AON. However, an AON system requires active equipment to manage signal transmission, which means power supply and potentially higher costs.

On one hand, a PON system is free from active parts or electronics, so it is less possible that passive parts go wrong in their normal operation, giving rise to a lower cost relative to maintenance of PON system. Besides, PON efficient since each fiber optic strand can serve up to many users. On the other hand, because the bandwidth in PON is not dedicated to individuals, it is more difficult to figure out failures when disturbances of fiber occur. What's more, the share of fiber optic strands for portions of the network needs PON subscribers to be geographically closer to the central source of the data, likely that subscribers enjoy a slowdown data transmission with a distance limitation up to 20km.

Both AON and PON provide feasible solutions for FTTH network connection. They are growing in popularity as the demands for greater bandwidth increase. FS.COM offers several PON equipment for FTTH network, such as PON splitters, OLTs, ONUs, ONTs.

3. BSNL FTTH ARCHITECTURE



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Fiber to the home also called as "fiber to the premises" is the installation and use of optical fiber from a central point directly to individual buildings such as residences, apartment buildings and business to provide high speed internet access. Why FTTH premises connection speaks of upto 100mega bits per sec. 20-100 times as fast as a typically cable modem are DSL(digital subscriber line) connection implementation FTTH on a large scale will be costly because it will recover installation of new cable sets over the "last links" from existing optical cables to individual users. Some communities currently enjoy "fiber to the curb" service, which refers to the installation and use of optical fiber cable to the curbs near home or business with a "copper" medium carrying the signals between the curb and the end users.

New network architecture have been developed to reduce the cost of installation high bandwidth services to the home, often lumped into the acronym FTTX for "fiber to the X". These include FTTC for fiber to the curb, also called FTTN or fiber to the node, FTTH for fiber to the home and FTTP for fiber to the premises, using" premises to include homes, apartments, condos, small businesses, etc. Reasonly we have even added FTTW for fiber to wireless. Let's begin by describing this network architecture.

Cost Considerations

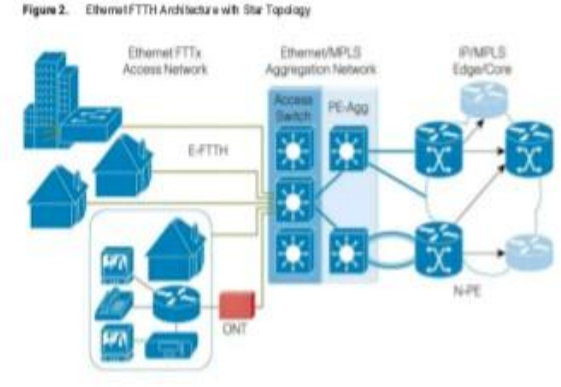
Constructing an FTTH network is very labor intensive and, therefore, costly. Experience tells us that the dominant part of an FTTH deployment goes into civil works, with a relatively small part related to the actual optical fiber cables. This implies that when civil works have to be carried out it does not really matter how much fiber is being deployed.

Furthermore, while the electronic elements in an FTTH network have a life cycle of few years, the fiber plant and the optical distribution network has a longer life cycle of at least 30 years. This longevity and the high cost of labor required in physical construction places strong demands on proper design of the fiber plant. Once it is in place, it is quite costly to change or update.

FTTH architectures that have been deployed can be classified in three broad categories:

- Ring architectures of Ethernet switches
- Star architectures of Ethernet switches
- Tree architectures using PON technologies

Ethernet-Based Architectures



The requirements for rapid time to market and low cost per subscriber have favored network architectures based on Ethernet switching. Ethernet transmission and switching have become commodities in the enterprise networking market and have led to attractive costs, mature products, and rapid innovation cycles.

Initial Ethernet FTTH projects in Europe have been based on architectures where switches located in the basements of multi-dwelling units have been interconnected by Gigabit Ethernet in a ring structure.

Such a structure provides excellent resilience against fiber cuts and can be built cost-effectively, but it has the disadvantage of sharing a bandwidth over each access ring (1 Gbps) that is comparatively small in relation to long-term requirements, thus providing a challenge for scalability of the architecture.

More recently, primarily Ethernet star architectures have been used as shown in **Figure 2**. Star architectures provide dedicated fibers (typically single-mode single fiber with 100BASE-BX or1000BASE-BX Ethernet transmission) from every endpoint to the point of presence (POP), where they are terminated on an Ethernet switch. Endpoints can be single family residences, apartments, or multi-dwelling units where a switch in the basement fans out to the apartments using any appropriate transmission media technology.

Benefits of Ethernet FTTH Architecture

The Ethernet FTTH network architecture solution has many business and operational benefits that should be taken into consideration when deploying residential and business services.

Virtually Unlimited Granular Bandwidth

A direct fiber can provide virtually unlimited bandwidth, which offers the ultimate flexibility for future service deployments as bandwidth needs increase. Ethernet FTTH enables a service provider to guarantee bandwidth for each subscriber and to create bandwidth profiles in the network on a per-customer basis. Each residential or business user can be provided with any amount of bidirectional symmetric bandwidth that they desire at any time.

Long Reach

Typical deployments of Ethernet FTTH access networks use inexpensive single-fiber 100BASE-BXor 1000BASE-BX technology with a specified maximum reach of 10 km. To support long distances, there are optical modules available on the market that allow for a higher optical budget, and also duplex fibers with Ethernet optical transceivers that may be inserted into any Ethernet line card interface. Very sparsely populated areas can be covered employing individual types of Ethernet FTTH optics without affecting other customers on the same Ethernet switch.

Flexible Growth

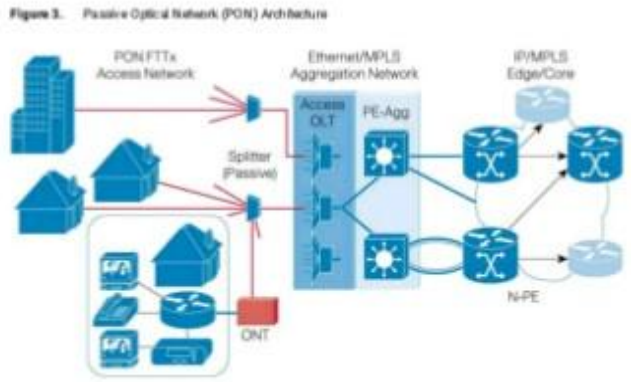
Only customers that have a subscription with their service provider occupy ports on the Ethernet FTTH access switch. In this case, as the customer base is growing, additional Ethernet line cards and customers can be added with a very

fine granularity. In the PON architecture, instead, the first customer connected to a tree requires a more expensive OLT port and the associated cost per subscriber is only improved by adding customers to the same PON tree.

Passive Optical Network (PON) Architectures

PON architectures for FTTH deployments are characterized by passive optical splitters to distribute the fiber to each customer using splitting ratios ranging up to 1:64 or even 1:128.

The physical PON FTTH architecture typically supports the Ethernet protocol. In some cases, an additional downstream wavelength is overlaid in order to distribute traditional analog and digital TV Services to each user without the need for IP set-top boxes. **Figure 3** illustrates a typical PON network that employs an Optical Line Termination (OLT) device that feeds a variety of optical network terminations (ONTs) or optical network units (ONUs). ONTs are usually dedicated to an individual end user. An ONU typically is located in a basement or even on a curbside and shared by a limited number of users. Voice, data, and video services are distributed over appropriate transmission media within the customer premises from the ONU or ONT.



Currently there are three different standards for PON, summarized in Table 1. The bandwidth figures are indicating the aggregate bit-rate in upstream and downstream directions. This bit-rate has to be shared by 16, 32, 64, or 128 customers, depending on the deployment scenario.

	BPON	**EPON**	**GPON**
Standard	ITU-T G.983	IEEE 802.3	ITU-T G.984
Bandwidth	Downstream up to 622 mbps upstream 155 mbps	Symmetric up to 1.25 Gbps	Downstream up to 2.5 Gbps Upstream up to 1.25 Gbps
Downstream wavelength	1490 and 1550 nm	1550nm	1490 and 1550 nm
Upstream wavelength	1310 nm	1310 nm	1310 nm
Transmission	ATM	Ethernet	Ethernet, (ATM, TDM)

BPON can be considered a legacy technology that is still being deployed by few U.S. service providers but is quickly being superseded by the other technologies and architectures. Whereas EPON has been designed for lowest cost using Gigabit Ethernet technology, GPON was designed for higher downstream bitrates, lower overhead, and the possibility to carry ATM and TDM. These ATM/TDM capabilities, however, are hardly used in typical service provider deployments. Instead, GPON is predominantly used as an Ethernet transport platform for residential services.

Advantages of FTTH

Internet speed: One of the biggest advantages of FTTH is the improved internet speed. Internet is continuously becoming the backbone of most communications, around the world. Whether people want to stream videos, download files, or even have video-chats-internet speed is the deciding factor. By enhancing the internet speeds that people received, FTTH is making it possible for people to stay in touch. Moreover, an increasing number of people ate working from home, and faster internet speeds help them stay connected at all times.

Technology: When we consider the traditional copper, they make use of analog lines that generate signal through the connected telephone device. As the description suggests, this technology is less defined, especially when you compare that with fiber optic.

Upcoming applications: There are various ne applications coming up for FTTH. Hence, by having FTTH- household's star connected with the latest in technology.

Vectors: It is easy to find vendors for fiber to the home, and that is another benefit of having this all new technology.

Disadvantages of FTTH

1. The only disadvantage of having FTTH cable is the cost associated with having the cable and having it installed. Many households might not be able to afford the same. However, there is another concept called fiber to the premises (FTTP), which brings fiber to a particular locality. That is cheaper to be installed as compared to fiber to the home (FTTH).

2. In short, FTTH cable is transforming the way we communication in the past and it will soon become the norm.

3. Ashish poly is an expert in the field and a strong proponent of modern technology. He is a big fan of FTTH technology.

Application

1. CATV Optical receiver: FTTH CATV optical receiver is designed for PON FTTH broadband analog or digital RF/CATV services. Including various types of features, is suiting for different applications.

2. Home gateway & IP Terminal: This home gateway/IP terminal series page included wireless VoIP home gateway, IP phone, IP camera etc. With the help of IP camera, we can easily build a prefect security and intelligent monitoring system by one cable. IP phone if offering us VoIP call, voice/video conference, IMS service, UC (Unified Communication)

3. EPON OLT: An all-in-one access platform that provides integrated access, FOR EPON OLT series helps simplify network architecture and enable seamless migration in FTTx network.

4. CONCLUSION

Fiber-based access networks are being deployed today based on different architectures and technologies. Mature standards for these technologies and availability of the necessary for a low-risk deployment of service provider networks. Their success creates considerable dynamics in the industry. It can be expected that competitive pressure from these networks will cause the incumbent service providers to invest more in fiber-based access networks. In North America, incumbent service providers (most notably Verizon) are deploying PON technologies, primarily due to their existing infrastructure, consolidation, potential reduction of many POPs, and projected high take rate for multiple services from subscribers. In Japan, EPON is currently the most deployed architecture, mainly because virtually all the deployment in Japan is aerial, which restricts the size of the cables that can be deployed. Elsewhere in the world, particularly in Europe, deployments are mainly based on Ethernet FTTH in point-to-point topologies and Ethernet ring deployments. At this point, PON architectures have made little headway in Europe because most European FTTH projects have been driven by municipalities, utilities, and housing companies. Key factors in many Ethernet FTTH deployments are the flexibility of the business model and the ability to support future services.

Fiber deployment to residences is a huge investment that should last for the next 30 to 40 years. Although every deployment scheme for FTTH has its own merits, there is a high risk that short term savings in the fiber infrastructure from PON FTTH deployments will significantly impact the future use of the expensive fiber infrastructure without major follow-on investments. Point-to-point fiber deployment should clearly be the preferred solution due to its obvious advantages. Tree-shaped fiber topologies should only be used where there are compelling reasons to save fiber or some real estate for fiber management in the POPs. Looking ahead DWDM PONs appear to be the most attractive way of utilizing a tree-shaped fiber topology instead of TDMA-based mechanisms. Overall, the discussion is no longer about whether FTTH will happen, but only about when and at what pace.

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