Fiber To The Home Technology

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Abstract

Optical fiber communication systems date back to 1970's, to the optical semaphore telegraph invented by French inventor Claude Chappe. In 1880, Alexander Graham Bell patented an optical telephone system, which he called the Photophone. In April 1977, General Telephone and Electronics tested and deployed the world's first live traffic through a fiber-optic system running at 6Mbps, in Long Beach, California. They were soon followed by Bell in May 1977, with an optical telephone communication system installed in the downtown Chicago area, covering a distance of 1.5 miles. Fiber optic cable has a much higher potential bandwidth capacity than the other transmission media. Today more than 80 percent of the world's long distance voice and data traffic is carried over optical-fiber cables. Fiber to the home (FTTH) refers to the provisioning of narrow band and broadband services to the residential customer over an optical cable rather than traditional copper wiring. FTTH systems involve the installation of optical fiber from homes to a central point. The technology promises speeds up to 100M bit/sec and can bring high-speed service to homes at a greater distance from a central switch. FTTH technologies fall into two categories: active or passive. Standard work for FTTH technologies has been taking place in two different organizations: the Institute of Electrical and Electronics Engineers (IEEE) and the Telecommunication Standardization Sector of the International Telecommunication Union (ITU-T).

Keywords: *Active optical network, Fiber optic cable, passive optical network, optical line terminal, optical network unit.*

1 .INTRODUCTION

Optical Fiber is new medium, in which information (voice, Data or Video) is transmitted through a glass or plastic fiber, in the form of light, following the transmission sequence give below

- Information is encoded into electrical signals.
- Electrical signals are converted into light signals.
- Light travels down the fiber.
- A detector changes the light signals into electrical signals.
- Electrical signals are decoded into information.

ADVANTAGES OF FIBER OPTICS:

- Optical Fibers are non conductive (Dielectrics)
- Electromagnetic Immunity
- Large Bandwidth (> 5.0 GHz for 1 km length)
- Low Loss (5 dB/km to < 0.25 dB/km typical)
- Small, Light weight cables.
- Available in Long lengths (>2 kms)
- Security

APPLICATION OF FIBER OPTICS IN COMMUNICATIONS:

- Common carrier nationwide networks.
- Telephone Inter-office Trunk lines.
- Customer premise communication networks.
- Undersea cables.
- High EMI areas (Power lines, Rails, Roads).
- Factory communication/ Automation.
- Control systems.
- Expensive environments.

2. NEED FOR FTTH

The flexibility and capacity of Fiber to the Home enables providers to "future proof" their infrastructure. With technology moving so fast, the future demands on the network are uncertain. Yet Fiber to the Home networks can accommodate future applications and bandwidth demand more easily than other network architectures. The capital costs of deploying local access networks are very high. Therefore, incumbents and new entrants wish to build networks that have the capability, or ready upgrade capability, to meet the bandwidth and application demands for the next ten to even twenty years.

The advantage of FTTH networks over other telecommunications networks is their extensive capacity and flexibility. Fiber optic cable has a much higher potential bandwidth capacity (especially upstream) than other transmission media. The rise of Internet usage is already driving an increase in demand for bandwidth in the residential market. Although current broadband access technologies such as DSL and cable modem are sufficient for applications such as Web surfing and email, one can foresee increasing demand for bandwidth outstripping the supply. The Internet enables bandwidth-intensive applications such as streaming media, video on demand, video telephony and peer-to-peer applications. In turn, these applications drive up demand, especially for upstream bandwidth. Another promising aspect of fiber is that it can provide almost unlimited capacity through the use of Wave Division Multiplexing (WDM) technology. WDM technology enables operators to increase the bandwidth of a fiber network by allocating multiple wavelengths. Currently this technology is used only in long haul backbone networks.

However, this technology may eventually be used in local access networks as optical and electronic equipment evolves and becomes less costly. Providers can increase network capacity by replacing equipment, an easier option than replacing the transmission lines.

Over the past ten years, backbone and metropolitan area networks have been upgraded in order to increase capacity. As the rest of the network capacity has increased, the local loop has become the bottleneck in providing bandwidth to users.

An all fiber network would provide the greatest bandwidth and relieve this bottleneck. The use of fiber encourages the deployment of a flexible, general communications platform. The network can be designed to be general-purpose: to support voice, video, and data services as well as new services as they are developed. Transmission innovations such as fiber optics encourage the development of integrated networks capable of carrying a diverse set of voice, data, and video services.

The existing cable TV and telephone networks were designed to support specific applications: plain old telephone service (POTS) and broadcast television. The implementation of new digital technologies such as broadband Internet access is constrained by the existing network architectures. In contrast, the flexibility of fiber means the network can accommodate but not be limited by older applications and technologies.

In conjunction with the Internet, FTTH networks provide a flexible communications infrastructure. Fiber optic technology enables convergence at the physical layer of the infrastructure in a way that is analogous to how the Internet Protocols enable convergence at the logical layer of the communications infrastructure.

Past applications, such as analog cable TV and phone, can be supported on the same network as enhanced digital services, such as video over IP, voice over IP, digital TV, and "ultra" high-speed data (> 2 Mbps).

Fiber to the Home has been proposed for years. FTTH technology has been around for a decade or longer but has not been deployed sooner because of the significant expense involved in rebuilding the entire last mile of the network.

Only recent have applications emerged that demand broadband access, and it is unclear how

much consumers would be willing to pay for services that would take advantage of the further capabilities of Fiber to the Home. Therefore, the viability of FTTH has always been primarily a question of economics rather than technology.

3 .Fiber to the X (FTTX)

It is a generic term for any network architecture that uses optical fiber to replace all or part of the usual copper local loop used form telecommunications. Today, fiber networks come in many varieties depending on the termination point i.e. FTTx.

- Fiber To The Node/Network (FTTN)
- Fiber To The Curb or Cabinet (FTTC)
- Fiber To The Buildings (FTTB)
- Fiber To The Home (FTTH)

3.1 Fiber To The Node/Network (FTTN):

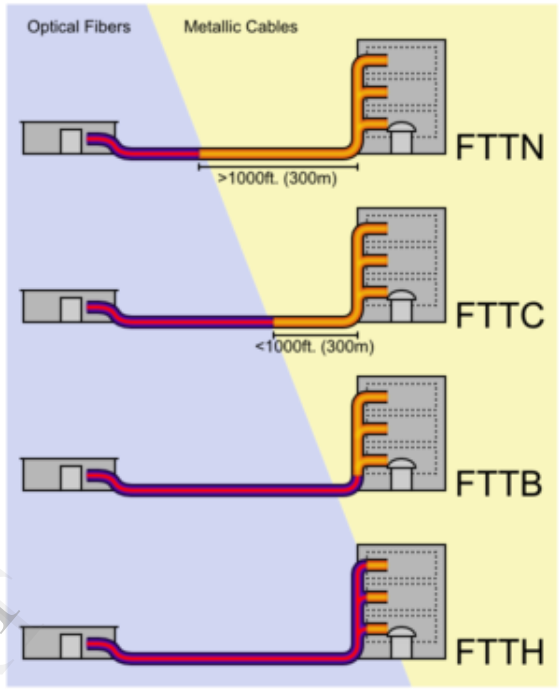
Fiber is terminated in a street cabinet, possibly miles away from the customer premises, with the final connections being copper. FTTN is often an interim step toward full FTTH and is currently used by AT&T, Deutsche Telecom, Telecom Austria, Belgacom and Swisscom to deliver advanced triple-play services. The area served by the cabinet is usually less than 1500m in radius and can contain several hundred customers.

3.2 Fiber To The Curb or Cabinet (FTTC):

This is very similar to FTTN, but the street cabinet or pole is closer to the user's premises, typically within 1000 feet, within range for high-bandwidth copper technologies such as wired Ethernet or IEEE 1901 power line networking and wireless Wi-Fi technology. FTTC is occasionally ambiguously called FTTP (fiber-to-the-pole), leading to confusion with the distinct fiber-to-the-premises system. The area served by the cabinet is usually is around 300m from the customer premises.

3.3 Fiber To The Building (FTTB):

Fiber reaches the boundary of the building, such as the basement in a multi-dwelling unit, with the final connection to the individual living space being made via alternative means, similar to the curb or pole technologies, but also allowing shorter-range technology like Thunderbolt.



3.4 Fiber To The Home (FTTH):

Fiber reaches the boundary of the living space, such as a box on the outside wall of a home. It is currently used by Telefonica in Spain's biggest cities and by LUS Fiber in Louisiana, with speeds of up to 100 megabits per second. Passive optical networks and point-to-point Ethernet are architectures that deliver triple-play services over FTTH networks directly from an operator's central office.

4. OPTICAL NETWORKS

There are two competing optical distribution network architectures

4.1 Active optical networks (AONs):

Active optical networks rely on some sort of electrically powered equipment in Optical distribution Network (ODN) to distribute the signal,

such as a switch or router. Normally, optical signals need O-E-O transformation in ODN. Each signal leaving the central office is directed only to the customer for whom it is intended.

Incoming signals from the customer avoid colliding at the intersection because the powered equipment there provides buffering. As of 2007, the most common type of active optical networks are called active Ethernet, a type Ethernet in the first mile (EFM). Active Ethernet uses optical Ethernet switches to distribute the signal, thus incorporating the customers' premises and the central office into one giant switched Ethernet network.

Such networks are identical to the Ethernet computer networks used in businesses and academic institutions, except that their purpose is to connect homes and buildings to a central office rather than to connect computers and printers within a campus. Each switching cabinet can handle up to 1000 customers, although 400-500 is more typical.

The IEEE 802.3ah standard enables service provides to deliver up to 100Mbps full-duplex over one single-mode optical fiber t the premises depending on the provider. Speeds of 1Gbit/s are becoming commercially available.

4.2 PASSIVE OPTICAL NETWORKS

The key interface points of PON are in the central office equipment, called the OLT for optical line terminal and the ONU, for optical network unit and ONT for optical network terminal. Regardless of nomenclature, the important difference between OLT and ONT devices is their purpose. OLT devices support management functions and manage maximum up to 128 downstreams links. In practice, it is common for only 8 to 32 ports to be linked to a dingle OLT in the central office, on the other hand the ONT devices in the CPE support only their own link to the central office. Consequently, the ONT/ONU devices are much led expensive while the OLTs tend to be more capable and therefore more expensive.

1. OLT:

The OLT resides in the central office (CO). The OLT system provides aggregation and switching functionality between the core network (various network interfaces) and PON interfaces. The network of the OLT is typically connected to the IP network and the backbone of the network operator. Multiple services are provided to the access network through the interface.

2. ONU/ONT:

This provides access to the users i.e. an External plant/ customer's premises equipment providing user interface for many/single customer. The access node installed within user premises for network termination is termed as ONT. Whereas access node installed at the other locations i.e. curb/cabinet/building are known as ONU. The ONU/ONT provide, user interfaces (UNI) towards the customers and uplink interfaces to uplink local traffic towards OLT.

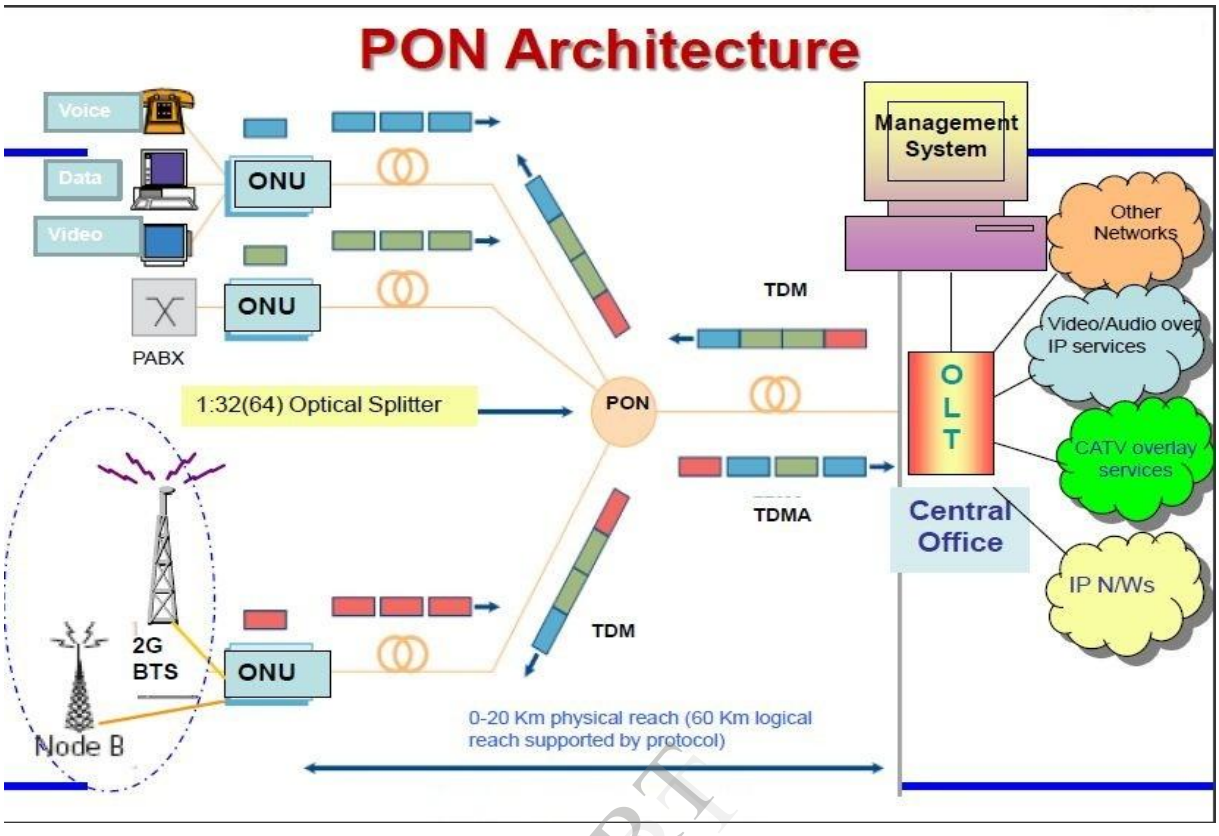
3. PON:

Distributed or single staged passive optical splitters/combiners provides connectivity between OLT & multiple ONU/ONT's through one or two optical fibers. Optical splitters are capable of providing up to 1:64 optical split, on end to end basis. These are available in various options like 1:4, 1:8, 1:16, 1:32 and 1:64.

4. NMS:

Management of the complete PON system from OLT.

- One OLT serves multiple ONU/ONTs through PON
- TDM/TDMA protocol between OLT&ONT
- Single fiber/Dual fiber to be used for upstream & downstream
- Provision to support protection for taking care of fiber cuts, card failure etc.
- Maximum split ratio of 1:64.
- Typical distance between OLT& ONT can be greater than 15 Km(with unequal splitting u tot 35Km).



- Downstream transmission i.e. from OLT to ONU/ONT is usually TDM.
- Upstream traffic i.e. from ONU/ONT to OLT is usually TDMA.
- PON system may be symmetrical or asymmetrical.

5. FLAVOURS OF PON

5.1 Broadband Passive optical network (BPON):

Historically, the Broadband Passive Optical Network (BPON) standard was introduced first. It was accepted by International Telecommunication Union (ITU) in 1999. The standard was endorsed by a number of network providers and equipment vendors which cooperated together in Full Service Network Access (FSAN) group. The FSAN group proposed the Asynchronous Transfer Mode (ATM) protocol should be used to carry user data hence sometimes access networks based on this standard are referred to as APONs. The underlying ATM protocol provides support for different types of service by means of adaption layers. The small size of ATM cells and the use of virtual channels and links allow allocating available to the end users with a fine granularity.

5.2 Gigabit Passive Optical Network (GPON):

The progress in the technology, the need for lager bandwidths and the unquestionable complexity of ATM forced the FSAN group to revise their approach. In the outcomes a new standard called Gigabit Passive Optical Network (GPON) was released and adopted by ITU in 2003.

The GPON's functionality is heavily based on its predecessor, although it is no longer reliant on ATM as an underlying protocol. A big advantage of GPON over other schemes is that interfaces to all the main services are provided in GFP enabled networks packets belonging to different protocols can be transmitted in their native formats. The functionality

is provided which allows seamless interoperability with other GPONs or BPONs. As in modern networks the security of transmitted data is a key issue.

5.3 Ethernet Passive optical network (EPON):

The Ethernet Passive Optical Network (EPON) standard has been endorsed by the EFMA. The final version of the new protocol and necessary amendments to the existing ones were accepted by Standard Body and released as IEEE 802.3ah in September 2004. The main goal was to achieve a full compatibility with other Ethernet based networks. Hence, the functionality of Ethernet's Media Access Control layer is maintained and the extensions are provided to encompass the features of PONs. The achieved solution is simple and straightforward, and the legacy equipment and technologies can be reused similar as in 100BASE–X and 1000BASE–X networks.

6. Advantages of FTTH.

There are several advantages associated with FTTH:

- It is a passive network, so there are no active components from CO to the end user. This dramatically minimizes the network maintenance costs and requirements as well as eliminating the need for a DC power network
- It is a single fiber to the end user, providing revenue-generating services with industry standard user interfaces, including voice high speed data, analog or digital CATV, DBS and video on demand.
- FTTH features local battery backup and low power consumption.
- FTTH is reliable, scalable and secure.
- The FTTH network is a future-proof architecture.

7. Conclusion:

The desire for two-way, video-based services such as interactive television distance learning, motion picture-quality video conferencing and videophones is expected to continuously increase. In fact, some observers believe that there is already a worldwide demand for these futuristic services today. The capability to meet this demand and continuously add new services at mouse-click speed is creating enormous competitive pressures.

Such capability also offers tremendous revenue potential. Service providers who are able to offer these services to an ever growing customer base can double or even triple their revenue in a short period of time.

As a result, demands for fiber technologies such as FTTH are on the rise. Technology advancements in the area of WDM are expected to further refine and enhance the technology, enabling more service providers to justify the investment in FTTH.

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