www.ijsrnsc.org

Available online at www.ijsrnsc.org

IJSRNSC

Vol.8, Issue.3, June 2020
Technical Paper

Int. J. Sc. Res. in
Network Security
and Communication

E-ISSN:2321-3256

# Design & Implementation of Triple play service over Optical Fiber Cable

**M. Satya Prasad**

Dept. of Bharat Sanchar Nigam Limited, Visakhapatnam, INDIA

*Author's Mail Id: spmalla31@gmail.com, 91-9490000137*

Received: 05/June/2020, Accepted: 20/June/2020, Published: 30/June/2020

***Abstract*** - The technical paper explains in detail about the basic design & implementation of Triple play service over Optical Fiber cable and its advantage over triple-play service using ADSL & VDSL technology using copper cable, global perspective about the triple-play services, detailed technical architecture of triple-play services to extend Voice, High-speed Data and Cable Television with IP & RF Cable TV head in detail including the concepts about Optical power budget and various line transmission levels of optical powers, different between EPON and GPON, about OLT, ONU, WDM EDFA, Optical Splitters, Cache server, Layer-3 switch, Various wireless devices, specifications, and it's standards, etc.

***Keywords -*** Optical Line Terminal Equipment (OLTE); Optical Network Unit (ONU); Erbium-Doped Fiber Amplifier (EDFA); Asynchronous Digital Subscriber Line (ADSL); Very High-Speed Digital Subscriber Line (VDSL); Digital Subscriber Line Access Multiplexer (DSLAM); Passive Optical Network (PON); Giga Passive Optical Network (GPON); Ethernet Passive Optical Network (EPON), Gateway router (GWR); Voice gateway (VGW); optical distribution network (ODN); Long Term Evaluation (LTE); Over-the-Top(OTT); Optical Distribution Network (ODN); Fixed-mobile convergence (FMC); Mobile Network Operators (MNO); customer premises equipment (CPE); Service Level Agreement (SLA).

## I. INTRODUCTION

In Copper cable technology VDSL2 is the most advanced standard of DSL broadband wire line communications, designed to support the wide deployment of Triple Play services and important benefits that carriers derive from the new VDSL2 standard is interoperability with existing products employing VDSL, ADSL, and ADSL2+. The DSL technologies had served the large majority of customers via copper wire pairs directly from the Central Office (CO) to the customer location. The average home needs in excess are 50 Mbps to satisfy the communication and entertainment lifestyle, which is sometimes hard to guarantee even in cities, but more often in the area with low-density infrastructure telecommunications networks. The major disadvantage of VDSL2 is it can provide high-bandwidth connectivity up to 50 Mbps at a range of around 300 to 500 meters between the customer and the DSLAM. Therefore DSLAM must be located closer to the subscribers for the deployment of high-speed data or Triple Play service. To overcome this problem, after extensive research Optical fiber technology with various PON models evolved in which triple service is one of the technology now days implemented globally. Triple Play service provides a unified solution that can serve any number of users. It is an integrated solution of voice, data, and video services that help to deploy services in a very cost-efficient way.

Increasing demand for high-speed internet is the key driver for the new access technologies which enable experiencing true broadband leading optical fiber networks. PON (Passive optical network) based FTTH access network is a point-to-multipoint, fiber to the premises network architecture in which unpowered optical splitters are used to enable a single optical fiber to serve multiple premises. Current networks use the Gigabit passive optical network (GPON) over 1Gbps. GPON architecture offers converged data and voice services up to 2.5 Gbps and enables the transport of multiple services in their native format; GPON uses generic framing procedure (GFP) protocol to provide support for both voice and data-oriented services.

## II. IMPLEMENTATION OF TRIPLE PLAY WITH RESPECT TO GLOBAL PERSPECTIVE:

The first triple-play deployment was by the US operator Cox Communications in 1997, delivered via a Hybrid fiber-coaxial network using digital and analog TV set-top boxes, digital telephony devices from Arris International, and a cable modem system from Motorola. Triple-play services in the United States are offered by cable television operators as well as by telecommunication operators, who directly compete with one another. Providers expect that an integrated solution will increase opportunity costs for customers who may want to choose between service providers, permit more cross-selling, and hold off the power companies deploying G.hn and IEEE P1901 technology with its radically superior service and deployment characteristics for at least another decade or so. Outside the United States, notably in Ecuador, Pakistan, India, Japan, and China, power companies have generally been more successful in leap frogging legacy technologies. In Switzerland and Sweden, dark fiber is available reliably to homes at tariff rates (in Switzerland four dark fibers are deployed to each home) supporting speeds above 40 Gbit/s—only to the local caches, however, as backhaul cannot typically support more than 10 Mbit/s connections to global services. Since 2007, access providers in Italy have been participating in an initiative called Fiber for Italy, which aims to build an infrastructure that can deliver 100 Mbps symmetrical bandwidth to consumers, to enable the delivery of triple-play.

## III. EPON vs GPON

The main difference between EPON and GPON is from a standards perspective. The IEEE defined EPON, while the ITU-T defined GPON. Both are built to be exploited for a long period and assure the high availability of services at any time. However, EPON was defined from the perspective of a corporate IT manager, while GPON was defined from the perspective of a telecom operator. The two perspectives are quite different.

GPON standards from a telecom operator perspective were built on the premise that the network must meet customer demands for service availability 24 hours a day, 365 days a year. The initial EPON specifications didn't contain a common management protocol for this level of performance, which led to proprietary implementations (a shortcoming the IEEE did address later through the development of a common platform).

GPON stands for Gigabit Passive Optical Networks. GPON is defined by ITU-T recommendation series G.984.1 through G.984.6. GPON can transport not only Ethernet but also ATM and TDM (PSTN, ISDN, E1, and E3) traffic. GPON network consists of mainly two active transmission equipment, namely- Optical Line Termination (OLT) and Optical Network Unit (ONU) or Optical Network Termination (ONT). GPON supports triple-play services, high-bandwidth, long reach (up to 20km), etc.

A single fiber from the OLT runs to a passive Optical Splitter (passive means, it does not require any power to operate) which is located near the users' locations. The Optical Splitter merely divides the optical power into N separate paths to the users. The optical paths can vary between 2 to 128. From the Optical Splitter, a single-mode (SM) fiber strand runs to each user. GPON adopts two multiplexing mechanisms- **a)** in the downstream direction (i.e. from OLT to users), data packets are transmitted in a broadcast manner, but encryption (AES) is used to prevent dropping, **b)** in the upstream direction (i.e. from users to OLT), and data packets are transmitted in a TDMA manner.

With increasingly advanced and mature technologies in a telecommunication network, Fiber to the Home (FTTH) has drawn much more attention from companies specialized in telecommunication nowadays. Generally, the FTTH broadband connections consist of two types of systems, known as Active Optical Networks (AON) and Passive Optical Networks (PON), and most of FTTH deployments are inclined to use a PON due to its low cost and high performance that can help to save a certain amount of money on fiber costs. A Gigabit Passive Optical Network (GPON) system generally contains an optical line terminal (OLT) at the service provider's central office. As one of the indispensable components of PON, an optical line terminal thus plays an essential role in the performance of the whole network connection.

The telecom operator perspective is why in the field GPON registers a lower number of incidents and allows co-existence with such next-generation PON technologies as XGS-PON and NG-PON2. These characteristics are key for a new telecom network deployment to be profitable, making GPON management better at addressing telecom operators' requirements.

## IV.DEFINITION

Triple Play is a combination of Internet access, voice communication (telephony), and entertainment services such as IP television and video on demand. The erosion of the traditional voice service, together with the ever-increasing competition between companies, is pushing the telecommunications industry towards a major shift in its business models. Customers want more services, more flexibly. Today, this shift can only be carried out by offering converged services built around the Internet Protocol (IP). Triple Play, a bundle of voice, video, and data services for residential customers, is the basis of this new strategy. The figure.1 shows basic schematic connectivity of triple play service over optical fiber cable.

**SCHEMATIC DIAGRAM OF TRIPLEPLAY SERVICE OVER OPTICAL FIBRE CABLE:**

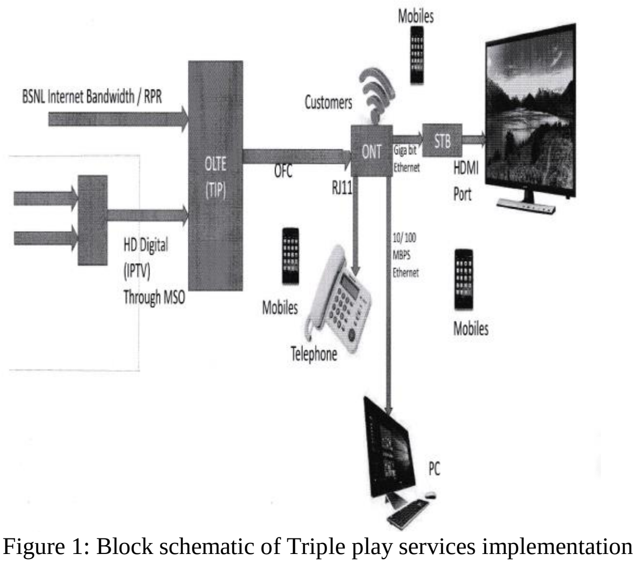


Figure 1: Block schematic of Triple play services implementation

## V. OLT

An **optical line termination** (**OLT**), also called an **optical line terminal**, is a device that serves as the service provider endpoint of a passive optical network. The OLT contains a central processing unit (CPU), passive optical network cards, and a gateway router (GWR), and a voice gateway (VGW) uplink cards. It can transmit a data signal to users at 1490 nanometers (nm). That signal can serve up to 1- 128 ONUs at a range of up to 20KM's by using optical splitters.

It provides two main functions:

- To perform a conversion between the electrical signals used by the service provider's equipment and the fiber optic signals used by the passive optical network.
- To coordinate the multiplexing between the conversion devices on the other end of that network (called either optical network terminals or optical network units).

### A) THE ROLE OF OLT IN GPON NETWORK:

As it was mentioned above there are two functions performed by OLT, and the main function of OLT is to control the information float across the optical distribution network (ODN), going both directions, while being located in a central office. OLT has two float directions: upstream (getting a distributing different type of data and voice traffic from users) and downstream (getting data, voice, and video traffic from the metro network or a long-haul network and send it to all ONU modules on the ODN.

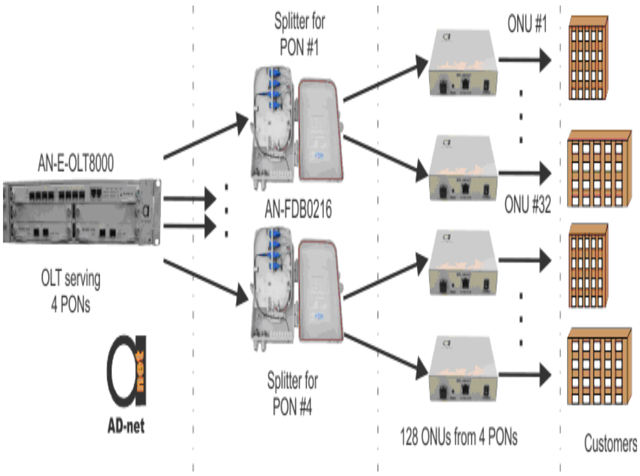


Figure 2: Functions of OLT

As from the above figure 2, OLT is designed for controlling more than one PON (in this example it serves four independent networks). We can see that if every PON has 32 connections, OLT can distribute data to 128 ONUs. OLT has a specific standard, so it would work with ONU from different manufacturers.

## VI. OPTICAL SPLITTER

The fiber optic splitter is also referred to as optical splitter as shown in the figure 3, which is an integrated waveguide optical power distribution device. It plays an important role in passive optical networks (EPON, GPON, BPON, FTTX, FTTH, and so on) by allowing a single PON interface to be shared among many subscribers. To achieve this, it is designed to split an incident light beam into two or more light beams and couple the light beams to the branch distribution as an optical fiber tandem device, which has the function to maximize the performance of the network circuits.

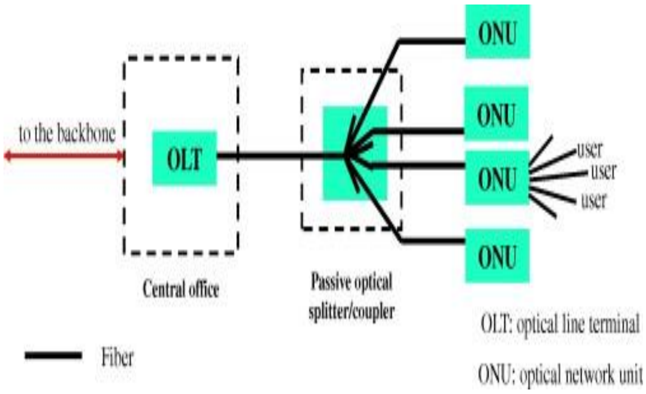


Figure 3: Optical splitter placement

### A) TYPES

According to the principle, fiber optic splitters can be divided into Fused Biconical Taper (FBT) splitter and Planar Lightwave Circuit (PLC) splitters.

FBT splitter is one of the most common. FBT splitters are widely accepted and used in passive networks, especially for instances where the split configuration is smaller (1x2, 1X4, 2x2, etc.).

The PLC is a more recent technology. PLC splitters offer a better solution for larger applications. Waveguides are fabricated using **lithography** ONU a silica glass substrate, which allows for routing specific percentages of light. As a result, PLC splitters offer accurate and even splits with minimal loss in an efficient package.

Passive Optical Network (PON) splitters play an important role in Fiber to the Home (FTTH) networks by allowing a single PON network interface to be shared among many subscribers. Splitters contain no electronics and use no power. They are the network elements that put the passive in Passive Optical Network and are available in a variety of split ratios, including 1:4, 1:8, and 1:16, 1:32, 1:64 & 1:128. PLC Splitters are installed in each optical network between the PON Optical Line Terminal (OLT) and the Optical Network Terminals (ONUs) that the OLT serves. Networks implementing BPON, GPON, EPON, 10G EPON, and 10G GPON technologies all use these simple optical splitters. In place of an optical splitter, a WDM PON network will use an Arrayed Waveguide (AWG). In FTTH and PON architectures, fiber optic splitter is an important component to share the optic network with multiple users. The basic principle of fiber optic splitter is to split one optic light beam into several parts at a certain ratio. According to different manufacturing technologies, fiber optic splitters can be divided into PLC splitter and FBT splitter. You may wonder about the differences between the two splitter types when choosing between them. This article aims at helping you to understand their distinctions and make better decisions.

### B) TWO COMMON TYPES OF OPTICAL SPLITTER – FBT & PLC

#### 1) FBT SPLITTER:

Fused Biconical Taper as shown in the figure 4, is a kind of traditional technology in which two or more than two fibers are welded closely together by applying heat. There are ample materials available used for making **FBT splitters,** such as the steel, fiber, hot dorm. They come at a low price, which explains the cost-effective feature of the device itself. As this technology has been developed over time, FBT splitters are more and more qualified for various applications. They are applicable for both single-mode and multi-mode fibers compliant with a variety of connector types, widely accepted and used in passive networks, especially for instances where the split configuration is smaller (1×2, 1x4, 2×2, etc.). FBT splitters only support three wavelengths (850/1310/1550nm).

Figure 4: FBT Splitter

#### 2) PLC SPLITTER

Planar Light wave Circuit splitters, which base on the more recent Planar Light wave Circuit technology, offer a better solution for applications where larger split configurations are required. They support wavelengths from 1260 to 1650 nm, a wide range appropriate for wavelength adjudication. Besides, the temperature range (-40 to 85 ℃) is workable for PLC splitters, allowing for their utilization in extreme climate. The drawback comes that PLC splitters are fabricated by using semiconductor technology (lithography, etching, developer technology) production, so it is more difficult and complex to manufacture them. Consequently, the price of **the PLC splitter** itself is higher. Figure 5 of a 1×4 Fiber PLC Splitter with Plastic ABS Box Package is below.

Figure 5: PLC Splitter

Both **FBT splitters and PLC splitters** have found their ways in passive optical networks with the rapid growth in FTTX networks.

The optical network that involves WDM (wavelength division multiplexing) currently gains in much popularity in existing telecom infrastructure, which is expected to play a significant role in next-generation networks to support various services with very different requirements. WDM technology, together with EDFA (Erbium-Doped Fiber Amplifier), allowing the transmission of multiple channels over the same fiber, that makes it possible to transmit many terabits of data over distances from a few hundred kilometers to transoceanic distances, which satisfy the data capacity required for current and future communication networks.

## VII.BASICS OF EDFA

The key feature of EDFA technology is the Erbium-Doped Fiber (EDF), which is a conventional silica fiber doped with erbium. EDFA consists of a length of EDF, a pump laser, and a WDM combiner. The WDM combiner is for combining the signal and pump wavelength so that they can propagate simultaneously through the EDF. EDFA can be designed that pump energy propagates in the same direction as the signal (forward pumping), the opposite direction to the signal (backward pumping), or both direction together. The pump energy may either by 980nm pump energy or 1480nm pump energy, or a combination of both. The most common configuration is the forward pumping configuration using 980nm pump energy.

### A) THE REQUIREMENT OF EDFA IN WDM SYSTEMS

When an optical signal transmitting over a long distance, the signal is highly attenuated. Therefore it is essential to implement an optical signal amplification to restore the optical power budget. This is what EDFA commonly used for. It is designed to directly amplify any input optical signal, which hence eliminates the need to first transform it into an electronic signal. It simply can amplify all WDM channels together as shown in the figure 6. Nowadays, EDFA rises as a preferable option for signal amplification method for WDM systems, owing to its low-noise and insensitive to signal polarization. Besides, EDFA deployment is relatively easier to realize compared with other signal amplification methods.

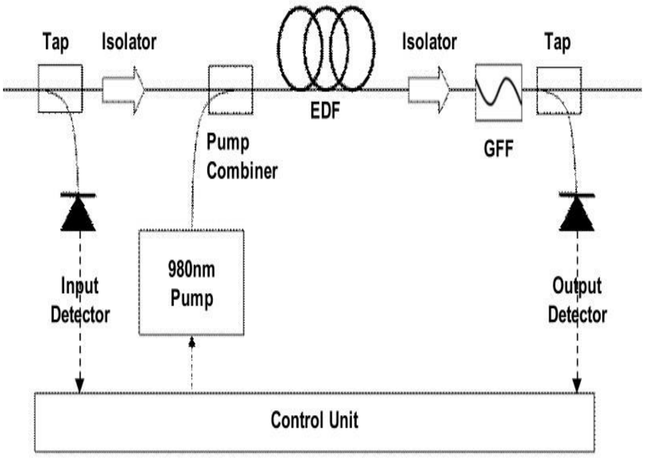


Figure 6: EDFA

**B) INPUT SIGNALS LEVEL FOR A WDM EDFA**

The main factor in the control room while using the WDM technology is that the cable TV signal and internet signal from OLT are combined in **WDM EDFA.** Then it comes out through a single fiber and split using the splitters and in customer end, nodes are used to separate both signals. Internet signal is forwarded to ONU and cable TV signal is forwarded to set of box. This is what happens in a WDM network.

As 1550nm is used for cable TV it needs to reach every customer end as 1550nm. In WDM EDFA 1550nm is mixed with 1490nm, this 1490 also reaches customer end nodes will make a noise. The unwanted noise will interrupt the cable TV services and maybe some channels will miss. So a filter node is essential which will filter 1490 and it only passes 1550. We need to use a filter node in the WDM network if the customer no needs the internet connection.

Later if a customer needs the internet, we need to change it to the WDM node where it gives an RF and Optical output. RF output will be connected to the set off the box and optical output to an ONU for the internet. That means within 5 or 10 minutes we can deliver the internet to the existing cable TV customers is the main attraction and the additional cost is only the cost of WDM node. So we can see the low cost and time saving is the main attraction of this WDM technology.

**C) PROCESS OF COMBINING THE SIGNALS:**

In the control room, it is needed to combine the signals in WDM EDFA from OLT. If we simply connect the OLT output to EDFA it won't work well. The thing we need to keep in mind is how much signal we are planning to give to the customer end or need to work on the customer end. The operator uses different levels, but professionally, for a signal working in 64com use -6db to -8db for cable TV and -22db to -25db for internet is a good practice. This method contains some reserve signals which will be applicable in some situation if the signal comes down.

Let's take an example if -6db cable TV and -22db as internet signal their difference is 16 dB. i.e. the difference between cable and internet should be 16db. In a fiber-optic network, almost all wavelengths will pass but different wavelengths have different losses and almost the same coupler loss. So for small networks like 5 – 10km distance the signals like 1550 and 1490 will be almost the same in transmission loss and splitting loss. So 16dbm difference can be maintained in the control room to the customer end.

If the EDFA with a 16db signal (1550), then the OLT signal to EDFA should be 0 dBm (1490) i.e. the mixed output is with 16db difference. Even if some difference is there using the reserve signal but considering some practical matters like mixing insertion loss of some EDFA of some vendors (Identify the loss by mixing the OLT after the switch of the EDFA) to consider that also if there is a considerable loss. Most probably all EDFA's are with less insertion loss.

**D) EXAMPLE**

Let's take an 8 port OLT with 6dbm minimum output in every PON module to convert this 6 dBm to 0 dBm uses ¼ splitters. That is 8×4=32 outputs, which means 32 0dmb outputs will be there. This 32 output is a good combination to 32 port 16dbm WDM EDFA. By thus to get the 32 outputs with internet so to maintain a -6db cable TV signal at customer end there will be -22 internet signals automatically. Another thing even if a 32 port 16db EDFA with -6db cable signal can give a 2000 cable TV FTTH connections but in terms of the internet, an 8 port GPON OLT can deliver 1024 connections. As said earlier an OLT is used to deliver 1000 connections, above 1000 connections a split OLT output using ½ splitter in place of ¼ and need to place next 8 port OLT and mix in the remaining 16 port which will fulfill 2000 connections. So initially this will be a good method than using a 16 port OLT because technology is changing day by day.

## VIII. CACHE SERVER

A cache server is a dedicated network server or service acting as a server that saves Web pages or other Internet content locally or IP TV channels database. By placing previously requested information in temporary storage, or cache, a cache server both speeds up access to data and reduces demand on an enterprise's bandwidth. Cache servers also allow users to access content offline, including rich media files or other documents. A cache server is almost always also a proxy server, which is a server that "represents" users by intercepting their Internet requests and managing them for users. Typically, this is because enterprise resources are being protected by a firewall server. That server allows outgoing requests to go out but screens all incoming traffic. A proxy server helps match incoming messages with outgoing requests. In doing so, it is in a position to also cache the files that are received for later recall by any user. To the user, the proxy and cache servers are invisible; all Internet requests and returned responses appear to be coming from the addressed place on the Internet.

## IX. LAYER-3 SWITCH

Simply put, a layer 3 switch combines the functionality of a switch and a router. It acts as a switch to connect devices that are on the same subnet or virtual LAN at lightning speeds and has IP routing intelligence built into it to double up as a router. It can support routing protocols, inspect incoming packets, and can even make routing decisions based on the source and destination addresses. This is how a layer 3 switch acts as both a switch and a router. Often referred to as a multilayer switch, a layer 3 switch adds a ton of flexibility to a network.

- The layer-2 switch fails when we need to transfer the data between different LAN and VLAN’s. This is where the Layer-3 switches come in the picture as the technique they use for routing the data packets to the destination is using IP addresses and sub netting.
- The layer-3 switches work at the 3rd Layer of the OSI reference model and perform the routing of data packets using IP addresses. They have faster-switching speed than the layer-2 switches.
- Layer-3 switches are even faster than the conventional routers as they perform the routing of data packets without using additional hops, thereby leading to better performance. Due to the functionality of this routing technique in the Layer-3 switches, they are implemented for network building of inter and intra networks.
- The layer-3 device at the source end firstly looks at its routing table which has all the information regarding the source and destination IP addresses and subnet mask. Later, based on the information that it gathers from the routing table it delivers the data packet to the destination and can pass along the data further between different LAN, MAN, and WAN networks. It follows the shortest and secure path to deliver data between the end devices. This is the overall concept of routing.

## X. OPTICAL NETWORK UNIT / OPTICAL NETWORK TERMINAL (ONU/ONT):

ONT is the same as ONU in essence. ONT is an ITU-T term, whereas ONU is an IEEE term. They both refer to the user side equipment in the GEPON system as shown in the figure 7.


**ONU**

Fig 7: Optical Network Unit

The optical network unit converts the fiber optic signal into the electric signal at the user side and enables reliable fiber optic Ethernet services to business and residential users through the fiber-based network infrastructure. These electrical signals are then sent to individual subscribers. In general, there is a distance or other access network between ONU and end user's premises. Furthermore, ONU can send, aggregate, and groom different types of data coming from the customer and send it upstream to the OLT. Grooming is the process that optimizes and reorganizes the data stream so it would be delivered more efficiently. OLT supports bandwidth allocation that allows making smooth delivery of data float to the OLT that usually arrives in bursts from the customer. ONU could be connected by various methods and cable types, like twisted-pair copper wire, coaxial cable, optical fiber, or Wi-Fi. The ONU is divided into an active optical network unit and a passive optical network unit. Generally, the devices equipped with optical receivers, uplink optical transmitters, and multiple bridge amplifier network monitoring equipment, are called optical nodes. The PON connects to the OLT, using a single optical fiber and the OLT connects to the ONU. ONU realizes "triple-play" applications by providing services such as data, IPTV (interactive network television), and voice (using IAD and Integrated Access Device).

**FEATURES OF ONU:**

The Optical Network Unit can:

1. Choose to receive broadcast data sent by the OLT;
2. Respond to the ranging and power control commands sent by the OLT, and make corresponding adjustments;
3. Cache the user's Ethernet data, send it in the uplink direction through the transmission window allocated by the OLT;
4. Fully compliant with IEEE 802.3 / 802.3ah standards;
5. Deliver up to -25.5dBm Receive sensitivity;
6. Provide up to -1 to + 4dBm Transmit power;
7. Realize "triple-play" applications by providing services such as data, RF / IPTV (that is, interactive network television), voice (using IAD, Integrated Access Device);
8. Deliver the highest rate PON: symmetrical 10Gb / s data uplink and downlink, VoIP voice and IP video services;
9. Provide Plug and Play" based on auto-discovery and configuration;
10. Offer the Advanced Quality of Service (QoS) functions based on service level agreement (SLA) billing;
11. Deliver the Rich remote management capabilities supported by OAM functions. (OAM is a set of functions that provides a system or network fault indication, performance monitoring, security management, diagnostic functions, configuration, and user provisioning.)
12. Provide High sensitivity light reception and low input optical power consumption;

 

13. Support Dying Gasp function. (A dying gasp is a message (or signal) sent by the customer premises equipment (CPE) to equipment managed by an internet service provider to indicate that the CPE has lost power).

## XI. WIRELESS ROUTERS

A **wireless router** is a device that performs the functions of a router and also includes the functions of a wireless access point. It is used to provide access to the Internet or a private computer network. Depending on the manufacturer and model, it can function in a wired local area network, in a wireless-only LAN, or a mixed wired and wireless network.

Generally, it refers to all Wireless Internet as Wi-Fi but, as with a lot of technical jargon, Wi-Fi as a term is often misused. Most of the people constantly asking: Why is my Internet or my Wi-Fi so slow? Very often, it is not the Internet provider's fault. Rather, it all comes down to the type of router at the point of the location used and the speed it offers.

### A) DIFFERENT WIRELESS STANDARDS:

The wireless standard presently using was formulated by the Institute of Electrical and Electronics Engineers or IEEE. IEEE 802.11 is a wireless networking standard created to keep manufacturers wireless routers and wireless networking devices (PS4, Laptops, Tablets, Smart TVs, Smart Phones, etc,) on the same page. These standards include IEEE 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac, and 802.11ad.

### B) WIRELESS-G & WIRELESS-N:

**Wireless-G and Wireless-N** is terms referring to 802.11g and 802.11n wireless networking standards set by the IEEE. 802.11g was a wireless standard that is on its way out of modern usage. It offered speeds of up to 54 Mbps and was quickly adopted due to its upgrade in speed over 802.11b.

For example, most coffee shop hotspot routers run on Wireless-G (54 Mbps) or even Wireless-B (11 Mbps). They are constantly being shared by many people so it can be somewhat slow to connect and surf the web.

**Wireless-N** was created to improve network throughput (maximum speed and transmission capabilities) over the two prior standards—802.11b and 802.11g.

**Wireless-N was a significant upgrade from Wireless-G for the following reasons:**

- Increased maximum data transmission rate from 54Mbps to up to 900Mbps
- Wider bandwidth capabilities to 40 MHz
- Increased security and improvement of stability and range

While these features may have been an upgrade from Wireless-G, Wireless-N is now being phased out with a new successor. But new routers and wireless standards will still support Wireless-N and older wireless standards.

### C) WIRELESS-AC:

Wireless-AC is the next iteration of the IEEE's wireless standards. The 802.11ac standard greatly improves nearly every aspect of Wireless-N. Wireless-AC has increasingly become more formalized and is essentially the minimum for every wireless-capable device.

Some improvements include:

- Increased maximum data transmission rates of up to 5300 Mbps
- Wider bandwidth capabilities of 80 MHz as well as an optional 160 MHz channel
- Additional 5 GHz frequency band for faster speeds and less wireless clutter

### D) WIRELESS-AD:

Wireless-AD is among the newest wireless standards to hit the consumer market. As with any new wireless standard, nearly every aspect has been improved and upgraded.

Some of these upgrades include:

- Increased maximum data transmission rates of up to 7200 Mbps
- Additional 60 GHz frequency band
- High-quality 4K movie downloads in mere minutes

### E) WIRELESS-AX:

Unveiled at CES 2018, Wireless-AX is the next step in wireless standards. Wireless-AX will be able to deliver as much as five times as much bandwidth as Wireless-AC. Current routers are equipped with 4×4 MU-MIMO (multi-user, multiple-input, and multiple-output). Wireless-AX routers will come standard with 8×8 MU-MIMO on both 2.4 GHz and 5 GHz bands. Essentially, Wireless-AX will support eight data streams up and down your network, doubling the previous standard. Other upgrades from previous standards include increased efficiency, reliability, and better coverage in large areas.

### F) WIRELESS-AC:

Hanging onto an older Wireless-G or Wireless-N router means, sacrificing overall speed and security while hindering the wireless capabilities for newer devices. Using a Wireless-G or Wireless-N router with an iPad may feel like trying to catching a fish with a stick. It may eventually work, but it certainly not the most efficient way to get the job done.

The following table shows various specifications of the wireless standards that are being used in ONU / ONT to connect the Internet in a limited area to connect multiple electronic gadgets.

Table 1: Types of Wireless Devices

| Type | Max Throughput (speed) | Maximum Wireless Range(Radius) (in Meters) | Wireless Channel Widths | Wireless Bands |
|---|---|---|---|---|
| Wireless G | 54 Mbps | 23 | 20 MHz | 2.4Ghz Single Band |

| | | | | |
|---|---|---|---|---|
| Wireless N | 900 Mbps | 60 | 20/40 MHz | 2.4Ghz /5Ghz Dual Band |
| Wireless AC | 5300 Mbps | 150 | 20/40/ 80/160 Mhz | 2.4 GHz / 5 GHz (x2) Tri-Band |
| Wireless AD | 7200 Mbps | 150 | 5/10/20 Mhz | 2.4 GHz / 5 GHz (x2) / 60 GHz Quad-Stream |
| Wireless AX | 10000 Mbps | More than 150 | 20/40/80/160 MHz | 2.4 GHz / 5 GHz (x2) Tri-Band |

## XII. IMPLEMENTATION OF TRIPLE PLAY SERVICE CAN BE CARRIED OUT IN TWO WAYS

A) Telephone, Broadband, and CATV in IP mode
B) Telephone, Broadband, and CATV in RF mode

### A) TRIPLE PLAY (WITH IP CATV MODE):

**CONNECTIVITY FROM THE CONTROL ROOM TO THE CUSTOMER**

As shown in the figure.8, the signals from the MPLS Cloud of Telecom Service Provider combined with IP TV Headend will be connected to L3 Switch, from the L3 switch it will be connected to 1Gbps Uplink port in the 8 Port OLTE. From IP TV Cache server through 10G uplink port it will be connected to 10G uplink port in the 8 Port OLTE. IP TV downstream from the EDGE server will be connected from the Cache server to the L3 switch which will help in the selection of the desired channel to view. The selection of particular channels will be stored/retrieved from the IP TV head-end as per the request from the viewers at the point of time. Hence the bandwidth of Uplink & Downlink usage depends on the numbers of users at a point of time and also the most viewed channel.

From respective PON port, the line side fiber will be connected in the desired direction and at the distribution point, it will be terminated on the splitter (1:4/1:8/1:16/1:32/1:64/1:128) as per the field condition, and after splitter, fiber will be laid up to individual customer ONU. Triple play services namely Telephone; Internet & IPTV will be routed through 3 different VLANS from PON to ONU. The ONU will have physical output interfaces, namely RJ-45 LAN port through which IP Telephone will be connected for Voice calls, RJ-45 port for Internet connectivity or Wi-Fi facility to access the internet through Wi-Fi and the IP TV connected through HDMI / USB port to physically connect the TV with a set - up box including android application if the TV is a conventional one or App-based connectivity if the TV is a smart TV.

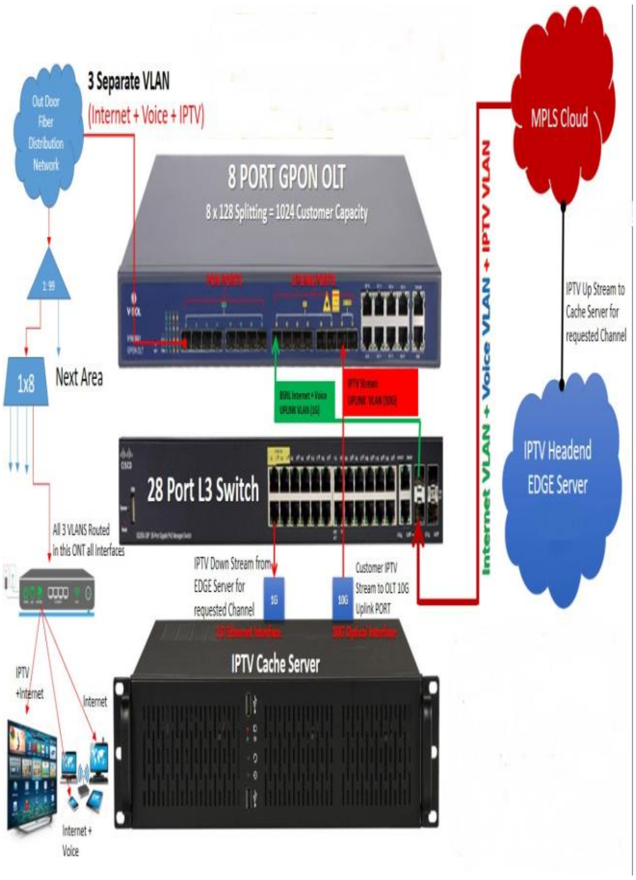


Figure 8: Triple play with IPTV

### B) TRIPLE PLAY (WITH RF CATV MODE):

**CONNECTIVITY FROM THE CONTROL ROOM TO THE CUSTOMER:**

As shown in the figure.9, the signals from the Telecom Service Provider Cloud will be terminated on 1Gbps Uplink port in the OLTE. The RF Cable TV head end signal will be connected to another 1GB uplink port available in the OLTE.

From respective PON port the line side fiber will be connected to WDM EDFA and the output port from EDFA will be connected to the line side fiber in the desired direction and at the distribution point it will be terminated on the splitter (1:4/1:8/1:16/1:32/1:64/1:128) as per the field requirement, after splitter, fiber will be laid up to customer ONU. Triple play services namely Telephone; Internet & Cable TV will be routed through 2 different VLANS up to ONU. The ONU will have output interfaces namely RJ-11 port for which conventional Telephone will be connected for making Voice calls, RJ-45 port for Internet connectivity or Wi-Fi facility to access the internet through Wi-Fi and the RF port WDM will be connected and the WDM output will be connected to respective MSO cable TV Setup box for viewing different channels either in SD / HD mode.

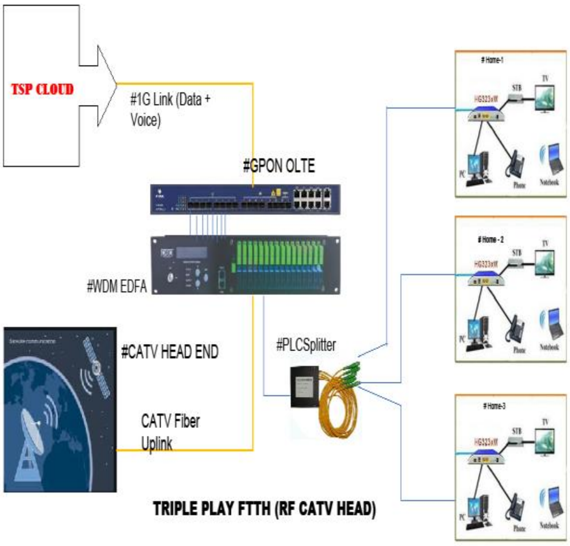


Figure 9: Triple play with RF CATV HEAD

Table 2: OPTICAL POWER LEVEL FROM OLTE TO ONT (Customer premises):

| **Name of the Device** | **Optical Power** | **Type of Connector** | **Wavelength** |
|---|---|---|---|
| OLTE (PON Modules) | 6.5 dBm | SC/UPC | 1490 |
| EDFA-OLTE-IN | 6 dBm | SC/UPC | 1490 |
| EDFA-CATV-IN | 6 dBm to 9 dBm | SC/APC | 1550 |
| EDFA-OLTE+CATV-OUT | 19 dBm at 1550, 6 dBm at 1310 | SC/APC | 1490+1550 |
| LIU+Splicing+Connector Attenuation | 0.5dbm | SC/APC | 1490+1550 |
| Overhead Transmission Attenuation | 0.5db/km at 1310, 0.3 db/km at 1550 | SC/APC | 1490+1550 |
| Splitter Attenuation | 1:2(3.5db); 1:4(7db); 1:8(10db); 1:16(14db); 1:32(18db); 1:64(21.5db) | SC/PC | 1490+1550 |
| Splicing in the Splitter | 0.2db | -- | |
| Splicing at the Last-mile Customer premises | 0.2db | -- | 1490+1550 |
| FWDM-IN(CATV Port) | WDM EDF output cover will cover these losses | SC/APC | 1490+1550 |
| FWD-OUT(ONT Port) | | SC/UPC | 1310(Max-24db) |
| RF OUT(F-Connector) | | COAXIAL | 50/35-MER |

## XIII.FUTURE APPLICATIONS

The next application of optical fiber convergence will be Quad play covers the services, telephony, television, fixed Internet and mobile Internet services. The advent of fiber broadband Gigabit Passive Optical Network (GPON) saw both POTs and GPON running alongside each other. With fiber broadband, service providers were able to offer TV content via IPTV services. This gave rise to service providers' triple-play offerings comprising telephony, IPTV, and fixed Internet services. Fiber broadband also enabled service providers to deliver voice services on IP (VoIP) and in an increasing number of premises, the new VoIP services saw the gradual phasing out of POTs service. With some service providers also launching their mobile services, all four services - telephony, IPTV, fixed Internet, and mobile voice and Internet came to be provided by a single provider, advancing triple play to quad-play.

Mobile Network Operators can also deliver quad-play services leveraging mobile data and fixed wireless access (FWA) technologies. This is enabled by its voice portfolio (circuit-switched voice, VoLTE, Voice over Wi-Fi and OTT voice) and the rollout of MNOs' own OTT TV services in addition to high-speed mobile data services such as LTE and LTE-A and its wireless broadband service, all of which allow Mobile Network Operators (MNO) to also offer telephony, voice, mobile Internet and fixed Internet services under a single plan.

## XIV.CONCLUSION

Triple play which can create service convergence synergies will become the flagship offering of TSP's and will transform the telecoms landscape. But triple play only takes integrated services so far. Fixed-mobile convergence (FMC) enables the deployment of quad-play, a full bundle of voice, data, video, and mobility. As triple play continues on its evolutionary path to quad-play, it is in itself a transition strategy rather than a longer-term goal for telecom service providers.

## REFERENCE

[1]. BSNL Technical Literatures related to Optical Fiber Cables and systems.
{2]. BSNL Triple play service implementation Technical details in Visakhapatnam (RF CATV head) & Kerala (IPCATV head)
[3].https://www.researchgate.net/
[4].https://www.engpaper.com/
[5].https://www.springer.com/
[6].https://onlinelibrary.wiley.com/
[7].http://www.technology-research.com/
[8].https://theresearchershub.com/
[9].https://telecom.economictimes.indiatimes.com/
[10].https://en.wikipedia.org/wiki/Telecommunication

 

## AUTHOR PROFILE

**Sri. MALLA SATYA PRASAD, ASSISTANT GENERAL MANAGER (Entrepreneur Business) in BSNL** Visakhapatnam. After Graduation in Electronics, completed Bachelors degree in Education and also Masters of Business Administration with specialization in Marketing & HRM. Presently doing Doctorate in Management in Andhra University, Visakhapatnam. Had a vast experience in the field of Telecommunications worked in various wings like IP Switching, Transmission, Mobile Communication, Data Communication, Marketing and Entrepreneur Business.

Installation and maintenance of all types of Transmission systems like PCM, Optical Fiber Cable construction, Installation & testing of all types of PDH, SDH, DWDM and FTTH equipments belongs to various vendors manufactured during last 25 years. Also had work experience of Erection of all types of Mobile Communication towers (GBT, RTT and Pole), equipment installation and testing including RF Engineering, Hardware testing, conducting of Drive test to optimize the Mobile Network.

**ACADEMIC EXPERIENCE:** Initiated first time in India Skill development MOU's with Universities and Engineering Colleges and signed good number of MOU's.

Nearly 7000 students were done interim ship/ project work in ECE Engineering stream from 2004 to 2019 under his guidance in Optical Fiber Communications, Mobile communications and in Wireless Technologies including the EETP programme sponsored by AICTE.

Nearly 230 students were done apprenticeship under his guidance in Diploma ECE branch in various sections for a period of 6 months up to the year 2018.

Nearly 100 students were done project work in Management (HRM&MKTG) for 4/6 weeks period in the year 2018.

Experience as a faculty for the **Employability Enhancement Training Programme (EETP)** sponsored for AICTE, SILVER, GOLD and PLATINUM and imparting soft and communication skills for 600 students between the years 2013 to 2015.

**PAPER PUBLICATIONS**

1) Published paper in the **International Journal of Socio Technology & Knowledge Development** on "**Customers' Satisfaction towards Mobile Prepaid Services: A Study of BSNL in Visakhapatnam District, Andhra Pradesh**" Volume 1| Issue 1| January – March 2018.

2) Published paper in the **International Journal of Research and Analytical Review (IJRAR) on "A COMPREHENSIVE STUDY ON BSNL REVIVAL CASE STUDY OF VOLUNTARY RETIREMENT SCHEME (VRS) -2019."** Volume 7 | Issue 1 | March 2020.

3) Published paper in the **"International Journal of Scientific Research in Network Security and Communication",** on **"BIRD'S EYE VIEW ON MOBILE NUMBER PORTABILITY".** Volume 8|issue2| April 2020.

 