

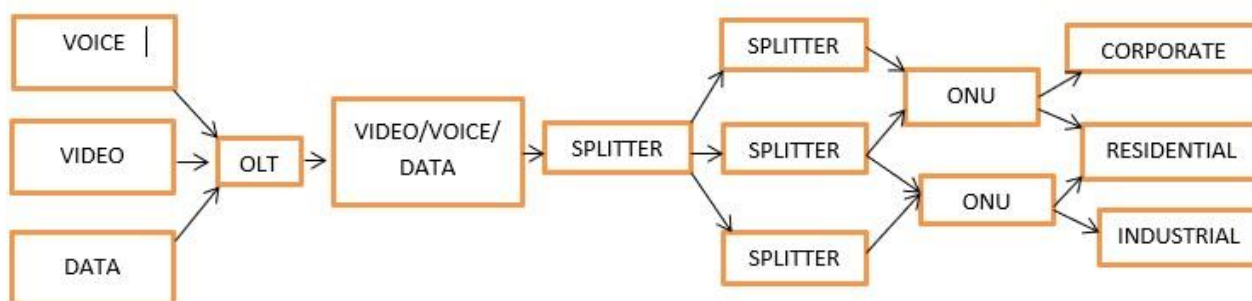
# Passive optical networks: A futuristic approach

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## ABSTRACT



APPLICATIONS OF PON

This paper is to know about the meaning of passive optical network's and its architecture. It explains the different types of passive optical networks and its uses for the present as well as future of the communication. Passive optical networks provide the huge bandwidth for the data transmission for triple play (video-voice-data) simultaneously. Requirement for the high-speed communication networks is the high bandwidth for the data transmission without interruption. Passive optical networks provide this facility very effectively.

**Keywords:** PON, APON, BPON, EPON, GPON, NGPON

## INTRODUCTION

Passive optical network (PON) research and technology have matured in recent years and firmly established PONs as a key component for high-speed Internet access. In many instances users' private networks do not directly connect to PONs, but rather connect to PONs through other intermediate access technologies, such as DSL or cable networks. A PON consists of an optical line terminal (OLT) at the service provider's central office (hub) and a number of optical network units (ONUs) or Optical Network Terminals (ONTs), near end users.<sup>1-4</sup> The optical networks that evolved over the past decades in support of communication over the Internet can be classified into core networks, metro networks,

and access networks..

## CORE NETWORK

Many researchers now days focused on to the increase the speed of core network. Capacity of the core network is basically shared by the large numbers of users depend upon the requirements. Basically in the optical communication we always use the optical electrical optical techniques for transforming the information in the form of optical<sup>2</sup>. Basically core network uses the mesh topology operated with the WDM. In the passive optical network optical flow switches uses which allow the end to end user connections with the off band signaling<sup>3</sup>. Another recent technology is waveband switching in this multiple wavelengths operated at 100gbits. It operates basically multiple cross connect architecture.

Now a day's software defined networking is a concept originally developed for switching and routing<sup>5-6</sup>.

## 1.1 METRO NETWORKS

A basically metro networks use for the metropolitan networking where metro cities are connected and avoid the shortage of bandwidth uses in the metro area. SONET/SDH is the technology uses in the metro cities for carrying the voice call<sup>7</sup>. In these basically uses the wavelength reuse technology for

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transforming the triple play services<sup>8</sup>. Initially it is based on the passive star coupler to transfer the signal from one location to the multiple locations.

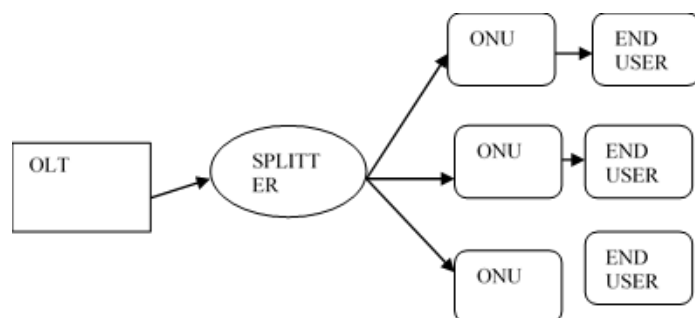


FIGURE 1.1 PASSIVE OPTICAL NETWORK.

## 1.2 ACCESS NETWORK

it is directly connected to the individual user's such as like private home, businesses and many other services directly to the metro network. It is access relatively small set of users in a particular region where few traffic flows are used. Otherwise traffic is very busy for the networks<sup>9-13</sup>. Pon have a typical tree structure with a central office transmitting downstream traffic to distributed optical network units (ONU'S). Other research directions have focused on improving the quality of services parameters<sup>14</sup>.

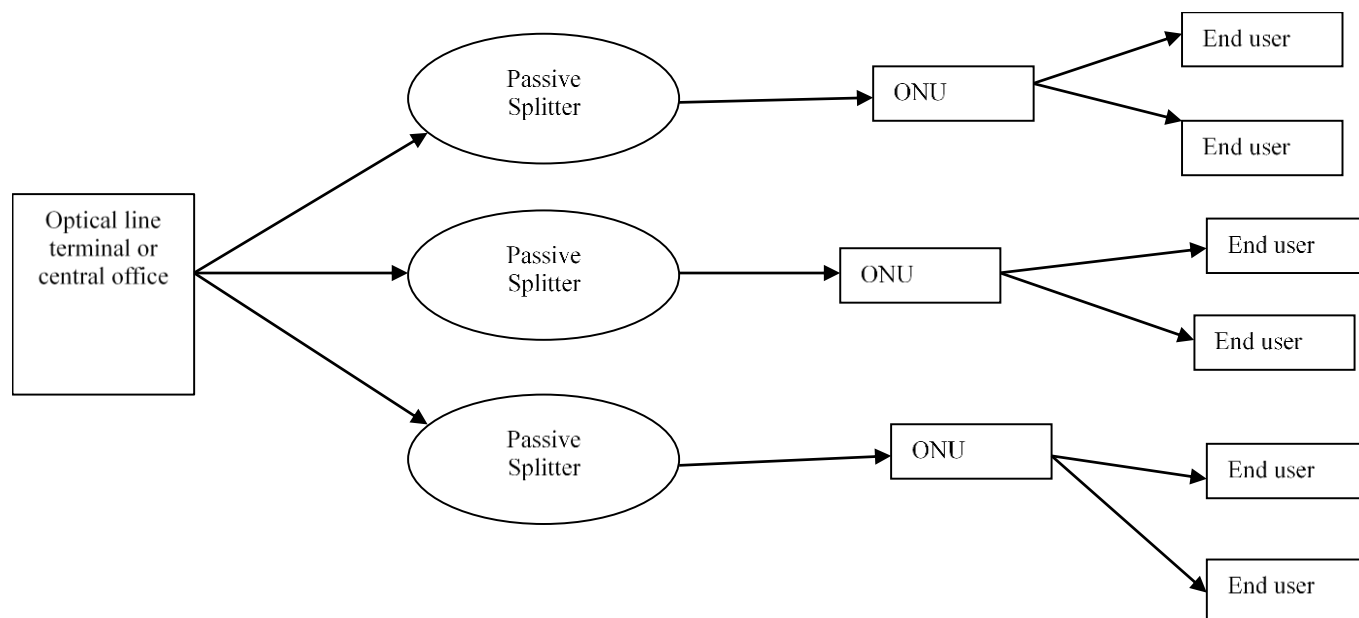


FIGURE 1.2 PASSIVE OPTICAL NETWORK ARCHITECTURE.

## 2. PASSIVE OPTICAL NETWORK ARCHITECTURE:

Starting in 1995, work on to the fiber to the home architecture was done by FSAN working group provided by the ITU. It is basically used to the concept of FTTH. It can be transfer the signal from the network to the home or office directly without any interception. In the passive optical network uses the optical line

terminal or central office to transfer the signal to the splitter<sup>17</sup>. Splitter is converting the signal into the multiple users. In the passive optical network uses the passive splitter not active. Due to this signal is divided into the multiple wavelengths like wavelength division multiplexing process to the transfer the signal individually. Passive optical is basically a 1: N network channel. It is directly connected to the optical network unit's. it is provided the information to the end user directly<sup>18-20</sup>. in the passive optical network basically no active medium required so the cost of the PON is much lesser as comparison to the Active medium's.

## 3. PASSIVE OPTICAL NETWORK CONFIGURATION'S

### 3.1 APON.

ATM PON or Broadband PON connects up to 32 subscribers to the PON. It gives a high speed of 622Mb/s downstream and 155Mb/s upstream. Cell based ATM multiplexing is used in the downstream. And a TDMA is used in the upstream. In both directions ATM cells are sent which are called APON packets. Network transport related functions and for synchronization purpose each ATM cell is added with a small packet overhead. To maintain the payload capacity, special attention is given to minimizing the size of the APON packet overhead. The burst mode synchronization is used in the APON that a guard time is left between the consecutive bursts. It gives the sufficient time to the receiver to quickly recover the right clock for each burst coming from different nodes.

By taking care of these technical issues APON/BPON can be

successfully implemented<sup>18-22</sup>. The major characteristics of the APON as shown:

- Standard: It follows the ITUG.983. This is the international standard provided by the government body or international organisation.

- Data Packet Size: APON uses the 53 bytes of the data packets for the data transmission purpose.
- Bandwidth: bandwidth allocation for the APON is lies in between the 155 mbps to 622 mbps.
- Traffic Modes: it shows the transfer of the signal in the ATM mode.
- Distance: it covers 20km and splits the pon upto 32.
- Average Bandwidth Per User: 20mbps is usually give to the individual user in the APON.

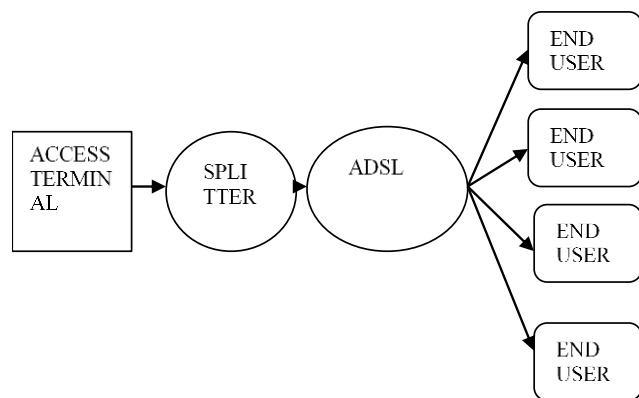


FIGURE 1.3 ATM PASSIVE OPTICAL NETWORK

### 3.2 EPON

Ethernet PON works on point-to-multipoint (P2MP) topology. Subscribers can see the traffic from the CO or OLT, but they cannot see the traffic from other subscribers. CO/OLT allows only one subscriber at a time to transmit, using TDMA. And a peer to peer connection is formed between the CO and subscriber. Multi-Point Control Protocol (MPCP) is used to control the P2MP Fiber Network. This protocol is implemented in the MAC layer and performs bandwidth assignment, polling, auto-discovery and ranging. ONU performs auto-discovery and synchronizes to the OLT timing. OLT generates the global time signal for reference in the network. The 802.3 frames are sent in downstream, which are extracted by the logical link ID at ONUs. And 64B messages are sent downstream to assign upstream bandwidth. And in the upstream control, time slots are used which can carry multiple 802.3 frames. ONU sends ONU state information in a 64B REPORT message to the OLT in their respective time slot. EPON is the attractive access solution and suitable for Fiber to the Home/ Building/ Business Applications with voice, video and data <sup>23-28</sup>.

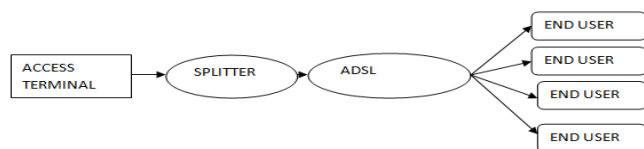


FIGURE 1.4 EPON NETWORK

- Standard: It follows the IEEE802ah.
- Data Packet Size: EPON uses the 1518 bytes of the data packets for the data transmission purpose.
- Bandwidth: bandwidth allocation for the EPON is lies in between the 1.2gbps to 1.2gbps.

- Traffic Modes: it shows the transfer of the signal in the Ethernet mode.
- Distance: it covers 20km and splits the Pon up to 32.
- Average Bandwidth Per User: 20mbps is usually give to the individual user in the APON.

### 3.3. GPON

Gigabit PON is high capacity PON as compare to the APON and EPON. GPON can transport Ethernet, as well as ATM and TDM traffic by GPON encapsulation method (GEM). GPON standard has defined different transmission rates for downstream and upstream. But most often vendors offer 1.2 Gb/s upstream and 2.4Gb/s downstream. And operating wavelength range for upstream is 1260-1360 and for downstream is 1480-1500. And the wavelength range 1550-1560nm can be used for video distribution. In GPON upstream bandwidth allocation is done with Transmission containers (T-CONT). T-CONTs are used to carry the data from ONU and maintain the quality of service as well as improve the bandwidth. OLT allocates the bandwidth to ONUs for the upstream operation. GPON has overcome EPON in many areas of services, line rate options and security. It has the best support of all PONs for variety networks. But it cannot be greater cost efficient than EPON due to complex physical requirements<sup>29-32</sup>.

- Standard: It follows the ITUG.984. This is the international standard provided by the government body or international organisation.
- Data Packet Size: GPON uses the 53 to 1518 bytes of the data packets for the data transmission purpose.
- Bandwidth: bandwidth allocation for the GPON is lies in between the 1.2 to 2.4 gbps.
- Traffic Modes: it shows the transfer of the signal in the ATM/TDM, Ethernet mode.
- Distance: it covers 20km and splits the pon upto 64.
- Average Bandwidth Per User: 40mbps is usually give to the individual user in the APON.

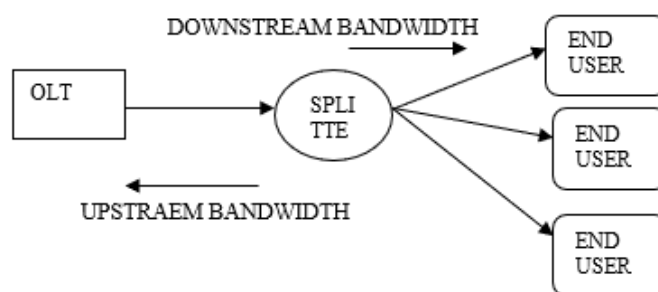


FIGURE: 1.6 GPON NETWORK

### 3.4 D.NGPON.

Ng-Pon (Next-Generation Passive Optical Network is a 2015 telecommunications network standard for a passive optical network (PON). The standard was developed by ITU and details architecture capable of total network throughput of 40 Gbps, corresponding to up to 10 Gbps symmetric upstream/downstream speeds available at each subscriber. NG-PON2 is compatible with existing PON fiber by replacing optical line terminal (OLT) at the central office, and the optical network unit (ONU) near each end-

user. Unique to this standard is the use of both active filters and tunable lasers in the ONU<sup>33-38</sup>.

Standard: It follows the IEEE802.3AV. This is the international standard provided by the government body or international organisation.

- Data Packet Size: NGPON uses the 1518 bytes of the data packets for the data transmission purpose.
- Bandwidth: bandwidth allocation for the NGPON is lies in between the 2.4 to 2.5 gbps.
- Traffic Modes: it shows the transfer of the signal in the Ethernet mode.
- Distance: it covers 10km and splits the pon upto 128.
- Average Bandwidth Per User: 20mbps is usually give to the individual user in the NGPON.

## 6. CHARACTERISTICS OF PON

Table 1.1 shows the different parameters used in to the passive optical networks. Passive optical network is most widely used for the triple play services in everywhere for the communication purpose. It is provide the one of the best optical network for the fiber to the home as well as fiber to the office services so that's why now a days passive optical network techniques is most widely employed.

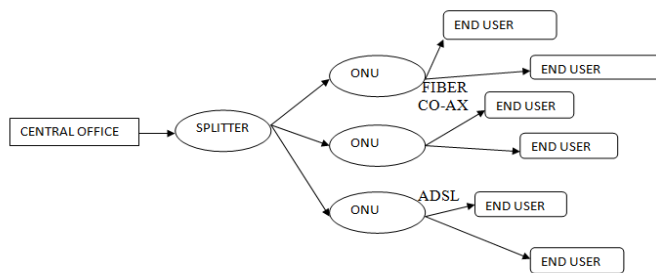


FIGURE 1.6 NGPON NETWORK

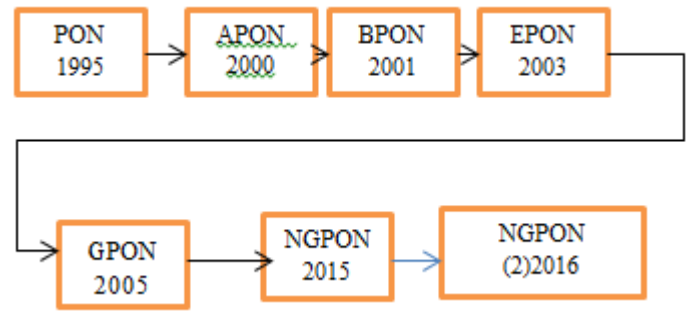


FIGURE 1.7 PON CONFIGURATIONS

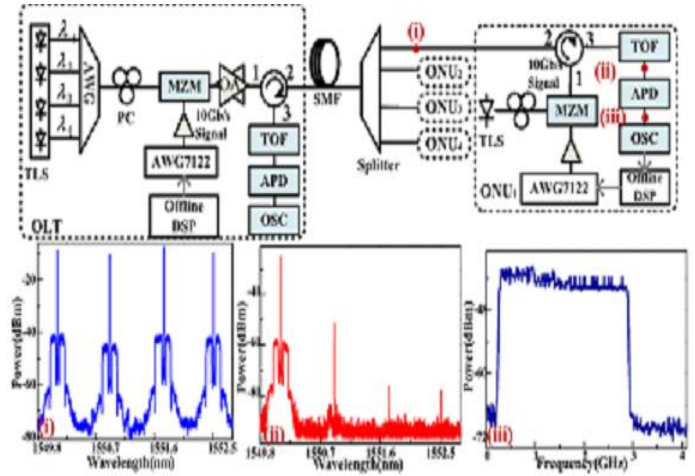


FIGURE 1.8 EXPERIMENTAL RESULTS OF WAVELENGTH STACKED PON SYSTEM<sup>48</sup>

	A/BPON	EPON (GEAPON)	GPON	10 GEAPON	WDM PON
Standard	ITU G.983	IEEE802ah	ITU G.984	IEEE P802.3av	ITU G.983
Data Packet Cell Size	53 bytes	1518 bytes	53 to 1518 bytes	1518 bytes	Independent
Maximum Downstream Line Rate	622 Mbps	1.2 Gbps	2.4 Gbps	IP; 2.4 Gbps, Broadcast; 5 Gbps On-demand; 2.5 Gbps	1-10 Gbit/s per channel
Maximum Upstream Line Rate	155/622 Mbps	1.2 Gbps	1.2 Gbps	2.5 Gbps	1-10 Gbit/s per channel
Downstream wavelength	1490 and 1550 nm	1550 nm	1490 and 1550 nm	1550 nm	Individual wavelength/channel
Upstream wavelength	1310 nm	1310 nm	1310 nm	1310 nm	Individual wavelength/channel
Traffic Modes	ATM	Ethernet	ATM Ethernet or TDM	Ethernet	Protocol Independent
Voice	ATM	VoIP	TDM	VoIP	Independent
Video	1550 nm overlay	1550 nm overlay/IP	1550 nm overlay/IP	IP	1550 nm overlay/IP
Max PON Splits	32	32	64	128	16/100's
Max Distance	20 Km	20 Km	60 Km	10 Km	20 Km
Average Bandwidth per User	20 Mbit/s	60 Mbit/s	40 Mbit/s	20 Mbit/s	Up to 10 Gbit/s

Table: 1.1 different parameter's used in the passive optical network  
integrated researchn advances



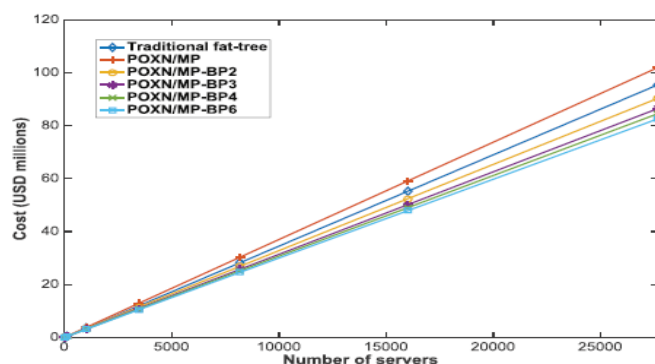


FIGURE 1.9 COST COMPARISON OF TRADITIONAL PON TREE<sup>49</sup>

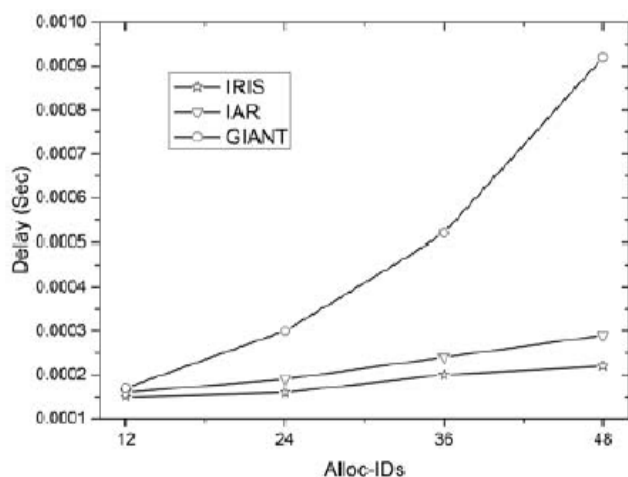


FIGURE 1.10 AVERAGE DELAY IN THE ONU IN PON<sup>50</sup>

## 7. APPLICATION OF PON:

Now a days everywhere passive optical networking using with the help of internet for voice calling, video calling and data transmission with the help of passive optical network. Most widely offices and metro cities passive optical network is used for the data transmission purpose because easy to install and no energy wasted due to passive splitter is connected for the data transmission purpose.

## 8 OPEN RESEARCH ISSUES IN PASSIVE OPTICAL NETWORKS:

In the passive optical network major issues are use the bandwidth according to the requirement's is important. In passive optical network bandwidth utilization, bandwidth reuse and bandwidth allocation is one of the major issue.<sup>43-48</sup> So different different algorithm used now a days used for the bandwidth utilization and allocation as well reuse of bandwidth. Some other major issues in the passive optical network is that the traffic grooming and traffic routing for the data transmission as well as information transfer from one location to the other location. So these are the few issues

now days for the transmission of proper signal as well as data. In the passive optical network bandwidth allocation with the downstream bandwidth is major issue because bandwidth allocated the data is transmitted but after certain time period

bandwidth goes in to the ideal state and that time data lost and bandwidth also not utilize so this is one of the major research issue now a days for the bandwidth utilization and allocation as well as reuse of the bandwidth. Another issue is to traffic used by the passive optical network for the data transmission is also important issue because traffic grooming and traffic routing is important for the data transmission but in case of passive optical network it is difficult to find and access that which terminal is use for the data transmission without queuing delay so this is also one of the major issue for the passive optical network.

## 9. CONCLUSION:

This work presents different aspects of the passive optical network. It tells us the different configuration used now days in the different category. In the passive optical network different characteristics used in the different manner and utilize the different bandwidth for the communication. In this paper explain the evaluation of the passive optical network. This paper shows the major issues in the passive optical network which will overcome near future in the latest NGPON techniques. It also explain the different area of the communication in the field of triple play services (voice, data, video). In this paper shows the different chacterstics of the passive optical network with the specific bandwidth used for the different Passive optical networks.it is also explain the applications of the Passive optical network use now a day.

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