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DETAILED STUDY OF EFFECTIVE UTILIZATION OF BANDWIDTH WITH PASSIVE OPTICAL NETWORKS

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A R T I C L E I N F O

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A B S T R A C T

This paper gives us an overview of past and recent developments of Passive Optical Networks (PON's). Such networks in the present day world are receiving a lot of intention as a means to relieve the so-called last-mile bottleneck in today's broadband networks using optical fiber technology.

In the paper we have explained the utilization of network capacity with PON and various types of PON.

INTRODUCTION

The advancement of existing PON technology has been done with the inclusion of bandwidth utilization as well as improving the network throughput by utilizing the bandwidth. The PON system benefits with higher reliability of data communication in a Private Network. The reliability can be presented with lower packet loss. With the increased dependency on internet we require the technologies which can focus on un interrupted means of transmission .In order to meet the long term needs and challenges subsystems need a deep review for handling and increasing channel capacity for internet traffic. PON are the most favorable high performance access network solution and are also cost effective, it has been seen that with the increase in growing population, the need of computers and PDA's is rapidly growing in offices, education systems, shopping areas and warehouses. This will result in the need for flexible interconnection through the distributed or centralized data communication systems. The most important traditional ways to fullfill this requirement is to use physical connections in between transmitter and receiver. Wired physical connection provides seamless connectivity in between the users with some problems in setting up and in its expansion. Further, wired connections needs more space, time to setup, monetary investments in copper, maintenance etc. The only merit of wired connection is just to provide the higher security with seamless connectivity [1].

In wired communication systems, data can be sent through different mediums like coaxial cables, twisted pair cables, optical fiber cables etc. Out of all these twisted pair cables are ancient one, easy and cheap to install but they can easily be affected by electromagnetic interference which is same with coaxial cables. Thus optical fiber cables were left as only solution which uses optical light as source and total internal reflection as a principle for movement of light through the fiber. Optical network aims at high data rate connectivity between users. To achieve this architecture of a network is an important factor. From certain analysis it is proved that Passive Optical Network (PON) is the most favorable high performance access network solution and cost effective [2].

Passive Optical Network

Is a point to multipoint network, where signal have a path from Central Office (CO) to the users, consisting of

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passive splitters and combiners. The PON reach is approximately 20km but it can be increased by reducing number of Central Offices. Figure 1 depicts PON network in which there is a primary and secondary nodes which are AWG and splitter respectively. Wavelength's at the AWG output is given to optical splitter after time shared. The collision between the two wavelengths is avoided by OLT [3].

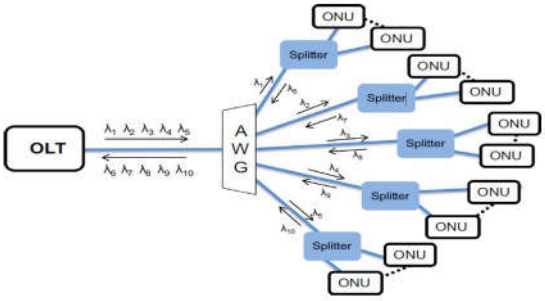

Figure 1 TDM/WDM PON architectures [3]

AON VS PON

Unlike Active Optical Network (AON) which uses an active devices and network elements to connect operator to end user, A PON is Green Technology that uses passive optical splitter to connect to end user device. The main difference between AON and PON is that AON uses electrically powered network devices in the optical distribution network (ODN) while Passive optical network as its name implies uses passive components (passive power splitter) in the distribution network to connect the user to the operator network (Figure 2) this means electrically powered components are available only at Central Office (CO) side Optical Line Terminal (OLT) and user side Optical Network Unit (ONU) [4].

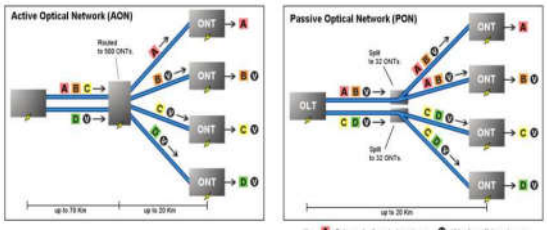

Figure 2 AON VS PON [4]

Types of PON and Bandwidth utilization

NG-PON

Passive Optical Networks evolution passed many steps toward NG-PON2. The previous technologies of PON were developed to meet user requirements of bandwidth .There are different PON technologies from FSAN, ITU-T and parallel efforts by IEEE. There are many implementations of PON technology like Asynchronous Transfer Mode (ATM) over Passive Optical Network (APON) standardised as G.983.1and G.983.2 at the year 1995 with155 Mbps upstream and 155 Mbps downstream, Broadband Passive Optical Network (BPON) with standards G.983.3 to G.983.5 at the year 2000 raising the data rates to 625 Mbps downstream, Gigabit Passive Optical Network (GPON) with 2.5 Gbps downstream and 1.25Gbps upstream standardized at the year 2001 as G.984.1 to G.984.4 and new amendments added at the year 2006. Ethernet Passive Optical Network (EPON) is standardised by IEEE in the year 2001 as IEEE 802.3ah to support symmetric 1Gbps upstream and downstream, Gigabit Ethernet Passive Optical Network (G-EPON) , 10 Gigabit Ethernet Passive Optical Network(10G-EPON) increased the upstream and downstream data rates to 10 Gbps and standardised as IEEE 802.3av at the year 2007 [5].

NG-PON1

NG-PON1 is the initial stage of next generation system. It is started by FSAN/ITU-T started at 2007 as standard G.987.x series with 10 Gbps downstream and 2.5 Gbps upstream data rate. The main task performed NG-PON1 was to build a PON that coexist with existing optical networks and they also have backward compatibility with GPON deployment. XG-PON1 provides per user data rates 10Gbps DS and 2.5 Gbps. US XG-PON2 provides per user data symmetrical rates 10Gbps DS and US [5].

NG-PON2

The new approach, NG-PON2, will increase PON capacity to at least 40 Gbps and deliver services of 1 Gbps or more with platforms and standards that could be deployable in 2015. It is designed to meet a broad range of communications needs, including business and mobile backhaul applications as well as residential access. This means that NG-PON2 can support increased capacity, higher light-to-port ratios, improved interoperability and enhanced services. After the completion of XG-PON1 project, FSAN and ITU-T started in the late 2010 to work on NG-PON2 by requirements assessment then in 2011 they studied the available proposals for implementations. Four proposals were under study [6].

TDM-PON

This proposal is to increase the downstream bit rate of the previously defined XG-PON1 from 10 Gbps to 40 Gbps. This solution requires very high data rate electronics that is not available yet with the need of more investment in new network devices.

WDM-PON

This approach provides a dedicated wavelength channel for each user with data rate 1 Gbps. The wavelength spectrum available should be used with high efficiency so ultra-dense WDM should be used to serve large number of users. The main problem of this approach is high cost of transmitters with precise laser output wavelength and receivers with precise filters. [7].

Digital OFDM-PON

It employee three types of OFDM-PONs each one applies QAM and FFT to generate digital OFDM signals.

TWDM-PON

In this approach four pairs of wavelengths is used to support aggregate 40Gbps downstream and 10 Gbps upstream data rate. This approach is chosen as the primary solution [7].

Optical Access Network Topologies

A network topology can greatly affects the number of users, bandwidth used, noise in the channel, output etc.

Following are some of the basic network topologies which can be used for PON network building.

Point-to-point configuration (P2P)

P2P is a direct dedicated link between central office (CO) and user equipment (UE). The user is mainly companies or business offices requiring huge data transfer with remote sites. In P2P topology the bandwidth is dedicated to user with very high cost. Maintenance and troubleshooting are some problems in the P2P topology.

Point-to-Multipoint configuration (P2MP)

Any network user does not use the network resources in the same manner the high speed link from CO can be shared between groups of users. This topology is suitable for home users and small offices .The shared fiber can carry TDM data or WDM data or hybrid directed to multiple users. Point-to-multipoint cost of implementation and operation less than Point-to-point because the shared portion cost will be shared between all the users served by the same fiber [8].

Advantages

With very high speed in gigabits, a PON also reduces the network cost as there is no electronics required between CO and customers [9]. Also it provides better encryption, preventing eavesdropping. But it has a drawback of lesser range than AON.

CONCLUSION

The study elaborated gives us a clear vision for higher bandwidth requirements for next generation and PONs are the best opinion as they deliver a maximum channel capacity. We have studied utilization of network bandwidth and to fulfill exponentially increasing user's demands. The various protocols which are needed to elaborate the complete PON structure are discussed and in future show the effective communication can be devised in being learnt in the paper.

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