STRUCTURE ANALYSIS AND DESIGNING OF PASSIVE OPTICAL NETWORK

Submitted in Partial Fulfillment of the Requirement for the Degree of

MASTER OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING

By

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CERTIFICATE

This is to certify that the project work entitled **"Structure Analysis And Designing Of Passive Optical Network "** submitted by **Vinod Sharma**as **Major Project –II (CO-801)** for partial fulfillment of the requirement for the award of the degree Master of Technology (Computer Science and Engineering) is a record of the candidate work carried out by him under my supervision.

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DECLARATION

I hereby declare that Major Project-II (CO-801) work entitled **"Structure Analysis And Designing Of Passive Optical Network"** which is being submitted at Delhi Technological University, in partial fulfillment of requirements for award of the degree of Master of Technology (Computer Science and Engineering) is a bonafide work carried out by me. To the best of my knowledge, the project work has not been submitted to any university or institution for award of any degree.

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FTTH	Fiber To The Home
FTTN	Fiber To The Node
FTTB	Fiber To The Building
FTTC	Fiber To The Curb
FTTP	Fiber To The Premises
PON	Passive Optical Network
GEPON	Gigabit Ethernet Passive Optical Network
BPON	Broadband Passive Optical Network
GPON	Gigabit Passive Optical Network
CO	Central Office
DSL	Digital Subscriber Line
DSLAM	Digital subscriber line access multiplexer
CATV	Cable Television
VDSL	Very high bit rate DSL
AON	Active Optical Network
P2P	Point to Point
P2MP	Point to Multi Point
OLT	Optical Line Terminal
ONU	Optical Network Unit
RN	Remote Node
ITU	International Telecommunication Union
TDM	Time Division Multiplexing
WDM	Wavelength Division Multiplexing
SCM	Sub Carrier Multiplexing
OCDM	Optical Code division Multiplexing
FSAN	Full Service Access Network
AES	Advanced Encryption Standard
MAC	Media Access Control
SOA	Semiconductor Optical Amplifier

Abstract

High bandwidth is required with continuously increasing network traffic because of increasing the internet users and online applications. Fiber based access network can be a solution to provide the high bandwidth. With increase in online server client based Application architecture it is more required to have good bandwidth with less delay. FTTH is experiencing great public acceptance throughout the world. The existing FTTH network is necessary for up gradation. Here we propose the implementation of passive optical network only with passive components without using active component and deliver high bandwidth network to the end users. Fiber access architecture is consider for the last mile connectivity at low cost and with better efficiency. Need of reliable access network for better service with efficient fault management mechanism that was provided in Passive Optical Network In the whole project we analysis the structure and design of Passive Optical Network with the simulation of Triple play system

Architecture is the main target for deliver high speed, and communication between the users and the service provider. Triple play (data, voice and video transmit) with less buffer at the end users is required.

CHAPTER 1

INTRODUCTION

Continuouslyincreasing the advancement of communication, there is a need of large bandwidth to share more data at high speed. The Home users demands high speed network for media sharing but at our business users demand broadband infrastructure in organization for increase the LAN area with high speed internet service. This demands require a new network with high capacity at low cost, as well as it increase the ability to transmit faster over long distance.Optical network will be required fast and efficient wavelength convertor, optical splitter/ combiner with high speed arithmetic processing capability. It will increase the functionality and the efficiency and the maintenance of the network and increase high reliability. This technology is more flexible on PON architecture for current and future network like E-PON support to current technology and G-PON able to support both, current and Future networks. We will assume the future network offer more data transfer capacity network as compare to current network.

1.1 High capacity Fibernetwork

The growth of internet traffic increase day by day and the demand of bandwidth also increased on a year basis. The development and innovation continuously move on in future. This change is increase the ability to transfer information and media over the high speed network very quickly over long distance. The transfer of information over the long distance and it has been expanded with our technological development in Optical fiber. It provide high data rate, and it will faster with passive component like multiplexer splitter, combiner and optical amplifier. Therefore for long distance communication we are using passive component but the degradation of transmit signal increasing with amplifier without any conversion from optical to electrical or vice-versa. The amplifier is used as a repeater in linear mode but it work as non-linear mode in routing switches and optical gate.

In outdated communication network follow a categorizedconfiguration, and it can differentiate in local access network and wide area networks. FTTH networks will provide the complete solution related to high capacity bandwidth. The optical network define the exact meaning of high bandwidth data transfer from initial to last mile distance. Fiber network provide the high performance and high efficiency solutions at long distance. So far the metro Politian network form an intermediate part between access and core network, due to this trend in the direction ofmerging and metro infrastructure could replace with long distance Fibernetwork andextended to provide high speed network to the end users.

In wide area the switched Optical provide auspicious solution to understandmassivebandwidth demands.

1.2 Optical networks

Its means of communication that uses signals encode in light to transmit information between various nodes of a telecommunications network. They operate from the limited range of a local-area network (LAN) or over a wide-area network (WAN), which can cross metropolitan and regional. Optical communication that dependent on optical amplifiers, lasers or LEDs and wave division multiplexing (WDM) to transmit bulk of data, through fiber-optic cables till national, international and transoceanic distances.This technology enable option for high speed Internet and the heavy bandwidth communication networks that transmit the majority of all human and machine-to-machine information [1].

The Various components is required for providing the optical network like Fiber (Multi-mode or single-mode), Laser or light source, multiplexer, demultiplexer, filter, or prism. Optical switch, Optical splitter, optical attenuator and Optical amplifier.

With technology advancement, the wide range services can be provide by the service provider i.e. online gaming, on demand video, long distance video surveillance, VoIP services along with traditional data services. But in opposite side bandwidth demands

for new application and new technology's needs high capacity bandwidth network. This networks provide minimum ten times more bandwidth with respect to traditional network. Also it require to be a cost effective solution to increase the user base. With new application the ease of doing work is increased and users get more benefited with the network. Hence more users are get attractive towards this which decrease the overall cost of implementation of this technology. It starts with leased line connectivity between the central office and end users for providing the internet connectivity .And it was migrated to high speed network on the same cost. When the bandwidth requirement increase, the network traffic increase the capacity of network the cost per unit capacity verves down further.

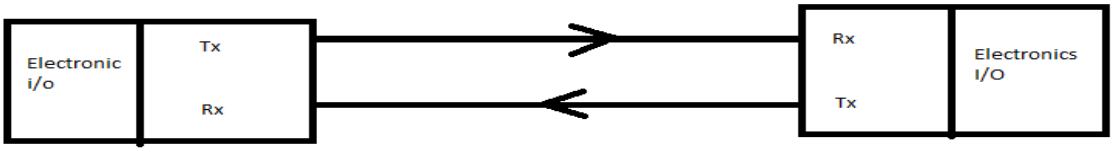

Fig 1.1 OpticalFiber communication

Still Today exist several broadband technology like DSL, wireless networks and Fibernet works. In the copper base technology the speed of networks goes from 100 to 10 Gbps. The copper technologies still used in many countries. This traditional technologies is slightly a burden on the users and the service providers. Through Optical fiber network all these service like (Voice, video and data) can be get from the same service provider [2-6]. This technology propose high capacity network bandwidth at low cost with long distance communication. Basically Optical Fiber networks architecture had developed in different access networks can be classified as [8-10].

- Active Optical Networks(Mainly Point to Point)
- Passive Optical Networks(Mainly Point to Multipoint)

PON is reflected as the most encouraging solution for low deployment cost and high capacity with better resource reuse effectively. The PON networks works on the base of two different sharing technologies i.e. TDM (Time division multiplexing) and WDM (Wavelength Division Multiplexing) [11]. We described three different type of PON

architecture like TDM-PON (Time Division multiplex passive optical network, WDM (Wavelength Division Multiplex-passive optical network and the last hybrid passive optical network (TDM/WDM-PON).

1.3 TYPE OF SWITCHING

Optical switching is simply a switch which accept photonic receive at one of its port and transmit to another port on the based routing table. Here two type of switching methods are available like O-E-O and OOO.

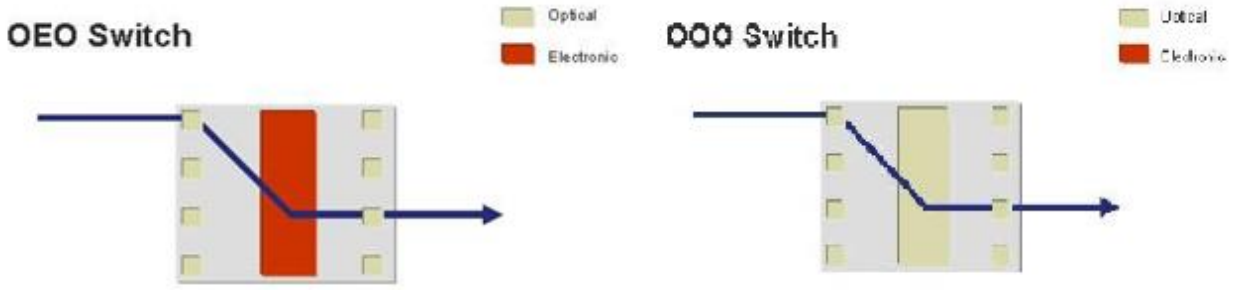

Fig 1.2 (a) O-E-O Switch and (b) O-O-O Switch

Optical Switch is used on the parameter of feature like bit rate , protocols and modulation, it show independence in Optical networks and it is provide transparent networks based on TDM - WDM technology seem to most encouraging solution for low deployment cost and high capacity with resource efficiency[12].most of the Optical Network Approved directly on the base on switching functionality, moreover photonic signal can be transmit from one Fiber to the other Fiber according to its routing table without any conversion from optical-to-electrical or vice-versa. Different type of optical switching technology is used to refine the optical technology with various switching methods.

- ✓ Circuit switching(CS),
- ✓ Burst switching(BS),
- ✓ Packet switching(PS),

1.3.1 Circuit switching (CS)

Switching circuit is used in the traditional telephone networks for a long time. In traditional methodology, physical track is complete when the transmitter and receiver is connected properly. But in this connection few resource not shared. The optical switching work on the base of space and time.The combination of both switching style[12]. But in the Optical circuit switching model mostly work on wavelength level technique and to provide high bandwidth in the core network. This method provides high capacity bandwidth with a coarse granularity. Optical circuit switching also referred to as wavelength routed network and it provides point-to-point optical channels between the transmitter and the receiver.

1.3.2 Burst switching (BS)

A burst can defined as a contiguous set of data bytes or packet.it can be short few microseconds or long as serval hours.

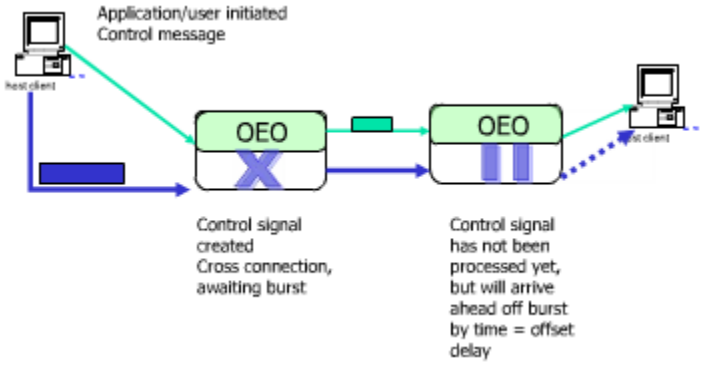

Fig 1.3 OBS Service Managements

The Optical burst switching based on statistical multiplexing to increase the efficiency of network resources [13]OBS has the own potential like high bandwidth, low latency with no buffering transport required for high demand application , and the transmission with ultra-fast between the users and the application. OBS mainly use two type of switching nodes edge and core. The function of edge to gather the data from the client in the form of IP(internet packets), burst assembly, Routing & wavelength Assignment with computation of offset time for control packet. Every node associated the control packet.

Each node is separated by interval offset time from the control packet and the main functions of node is assemble or disassemble, the decision is depend on the offset time and burst size. The optical burst is monitored. Each node associate with performance of control packet, lookup and optical cross connections the comparison of edge node and core node in the structure.

1.3.3 Packet switching (PS)

Packet switching works on packet sheltering and routing it provide the best solution in high capacity network for current and future scope. OPS network face the challenges due to the lack of optical ram. OPS facing difficulties when it executes complex computation and logical operations using optical and photonics without OEO conversion. The service differentiates for the best performance in term of loss probability by following access of restriction and packet dropping when expands the implementation complexity. It work on self-routing for providing high capacity networks including multiplexing [18]. The packet header is decoded when it can be encoded with lower bit rate and the switch reconfigures to provide performance very fast in nanosecond synched with OPS node to take action.

CHAPTER 2 LITERATURE REVIEW

2.1 Network Architectures of Optical Network

Fiber is introduced in access networks during the 1990s. It has been almost two decades in the provisioning of high-speed commercial/enterprise customers. During 90s service providers found that replacing large bundles of copper by a few Fiber strands could improve service reliability and it is lowering the craft cost also.

The traditional access Fiber architecture has been the Fiber remote. Fiber remote is a high-speed Fiber trunk (SONET or Ethernet) that terminates in an electro-optical multiplexer. In analogue phone days, these were called "digital loop carriers" (DLCs), and now a days "new generation DLC" was used, but most such devices deliver DSL services today and usually called "remote DSLAMs. A remote DSLAM's primary benefit is that it shorten the access copper and allow higher DSL speeds and improved reliability.

Pushing Fiber close to the consumer is called "deep Fiber". To indicate how deep Fibers are various acronyms are being used. FTTH means "Fiber to the home," it is the extreme of giving every user an optical-electrical termination. FTTC means "Fiber to the curb," it is serving a group of homes and FTTN means "Fiber to the node" or "neighbourhood." FTTN allows each Fiber remote to serve a larger population.

Now a days FTTH network implementation is adopted by most of service provider. In few countries already taken experience of optical network like US, Europe, and few parts in Asia. Due to Higher growth in FTTH network residential customers and business users gather high speed connection from the broadband provider. Users demand increase transmit and receiving of bulk data. This high demand in bandwidth is mostly driven by a number of factors, including the massive access of Internet video streaming services,HDTV and the currently increasing the popularity of online social media sites. With the internet service people meet, collaborate and more importantly exchange their emotions and feelings with other people by sharing of photos, video, and

audio. [19] The massive demand of many service providers are planning networks providing at speed of 100-200 Mbps or higher, according to the network requirement and the users. Now a day currently existing service provider, Provide network Internet on DSL, Wireless and on fiber. But only fiber complete the requirement of the user to providing high bandwidth capacity and high speed network [19-21].

2.2 Point – to –point Architecture

Implementation of optical fiber on the base of Point –to- Point architecture. In P2P network deployed a dedicated fibre line between the central office and the end user for the communication Fig. 2.1 [20].But is not cost efficient because the every end user connect directly to the central office.P2P architecture has its advantages as well as certain major drawbacks. One advantage is the opportunity to provide the ultimate capacity, and satisfy each customer's requirements completely. Individual fiber pair also means greater flexibility in providing services to customers. However some major disadvantages with the P2Parchitecture high implementation cost, laying of dedicated fiber cable to each user and requirement of more devices. On the other side OLT, the need for hub equipment will scale with number of ONUs(i.e. homes or subscribers). Besides the cost of acquisition, these equipment's may also cause problems in connection with space and power consumption. P2P solution also requires many fiber pairs, and with these all the installation and maintenance. Let assume n number of end user want to connect to the central office then it must central office need n network post to connect with the N number of users and each Fiber network have two Fiber one for transmission and other for receiver. It means central office required 2N and if it will calculate with the reference of distance is 2NXD(where D is the distance from central office to user end).

Fig.2.1 Fiber access network architecture

2.3Active Optical Network

Aon architecture electrical switch is used near to the end users as a remote node in the AON only single Fiber is user between the central offices to active node as compare to simple Fiber network. Active Ethernet Network, since equipment needed to provide TV, telephony and Internet are connected through the common Ethernet standard. Remote node contains an active element, which processes the data frames that are sent from the central office switch to the remote node, and forwards only frames to the respective network units. Compared to the P2P architecture, the AON architecture's main benefit is that it is only used a single common fiber to cover a certain area, thus reducing the fiber cost.In the Active optical Network N user connect with remote node and remote node connect with the central office through a single Fiber Trans receiver. In the AON Network one user active at a time. The selection of end user is depends remote node[21].

If N numbers of end users available the transceiver need N+1 for electrical switching at the remote node. As the optical fiber had two line of fiber one for transmit and other for receiving so the requirement of AON architecture needs 2N+2.

So, Electrical power required at the remote node for performing the node selection process. The cost of AON operations in access network on the base on supply and maintenance of electric power.

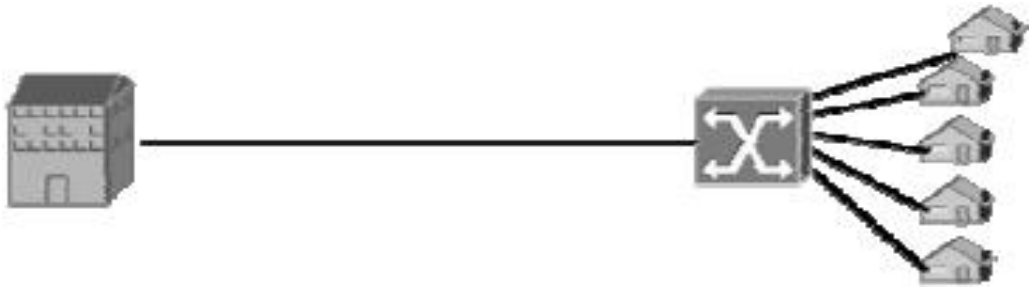

Fig. 2.2 AON ARCHITECTURE

Therefore the cost of AON network increase due to the operational cost increases for save this cost we propose the PON network scenario for performing the same operation.

2.4 Passive Optical Network

It work on point to Multipoint network without any active component. In their Passive Optical components is used to distribution of signal from central office to end users with passive component these passive component are splitter, combiners Optical fiber and optical amplifiers. Fig 2.3. At the comparisons of P2P and AON architecture both are required 2n+2 but with the use of passive component it will reduced to N+1. Even PON have used for more flexible for resource allocation by the use of single fiber optics for communication between the central office to the end users and it also arrange some protection for cost efficient in order to increase dependability as compare to P2P scenario. The PON reflect or provide more efficient solution for the future networks

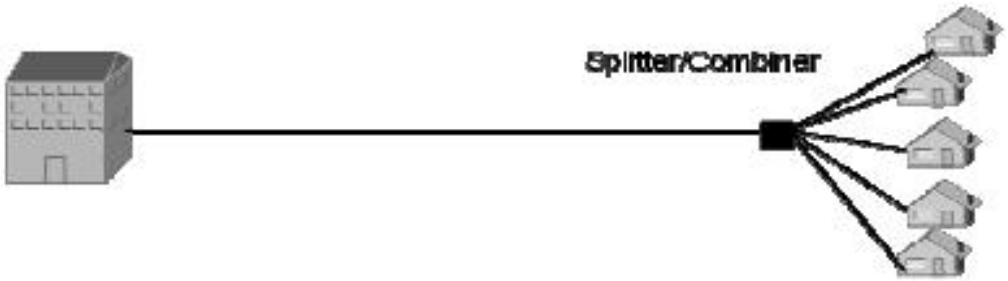

Fig. 2.3 Passive Optical Network architecture

CHAPTER 3

3.1 Passive Optical Networks

It is provide better solution for accessing the broadband network, point to multipoint communication with only use of passive component without any active component interface. The central office and the users connect with the single fiber, the OLT implemented at the side of central office and OUNs at the end of Users. The advantage

of transmit information in optical form is the very large bandwidth and loss losses linked with single optical fiber.

It is realized that with an all-optical network where optical signals can flow between users across the network without being converted to electronic signals within the network, the tens of terahertz of bandwidth available in optical fibers can be accessed in a more flexible and economic way. The benefits and advantages of being able to optically access the very broad bandwidth of optical fibers will permit a high-capacity, high speed network to be established for carrying data or information such as text documents, music, medical and scientific images, movies, and E-mail from one location to another.

Some fundamental requirements that an all-optical transmission network should satisfy to realize the attainable benefits are as follows:

- the network must be universal in that it will accommodate an enormous diversity of applications, services, interfaces, protocols and signal formats.
- it must be scalable in terms of the number of users, the data rate supported and the geographic span of the network.
- the cost and complexity of network nodes, the optical network must be "transparent" to high rate users so that the flow of their optical signals.

The communication between OLT and OUNs works as Backbone. The ONUs works as interface card between users and the service provider. The user interface converts the optical signal into electrical signal. After conversion of this signal end user access the service of the service provider [21].

3.2 PON Topologies

The PON topologies issame as the copper network Topologies. The network topologies are Tree, Bus and ring.

In tree topology, the structure of topology have a single splitter node is provide protection for the PON. The single Fiber between the OLT and the Remote Node. In the tree topology have a separate Fiber allocation for each ONU which is connected in the Network. In the whole process splitter is only perform at a single point. Due to this single point of communication provide similar power, it means all Tx and Rx approx. The same optical signal Power and same quality.

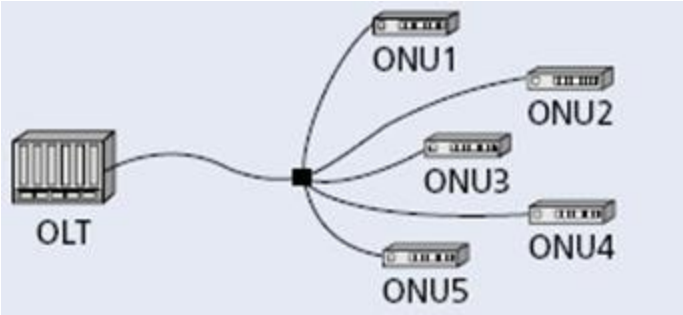

Fig. 3.1 Tree Topology

Bus topology In their various ONU is connected with tap coupler and this tap coupler can extract power which is sent by the OLT on the network and it can considered as a superior case of tree network. The Advantage is minimum use of Optical Fiber and it is more flexible to increase or adding more ONUs at the end. But the main problem the signal passes through the tap couplers in a networks and these couplers extract the power due to this issue the network become degrade and weak. The number of ONUs is connected on the bus topology is depend on the signal power strength and the distance covered by the networks.

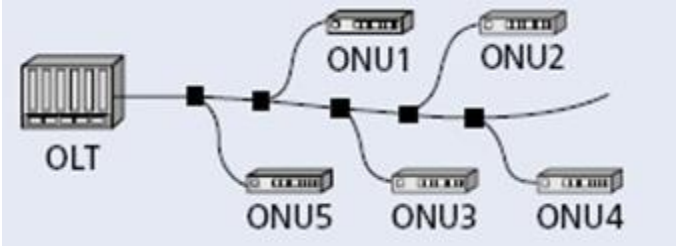

Fig. 3.2 Bus Topology

As the name of ring topology the signal transmit from the OLTs. The both end of the Fiber are connect with the same OLT and the Onus are connected with the tap couplers

.the number of ONUs are connected with ring topology again same as the bus. It means it's depend on the signal power strength. The signal passed several couplers in the same network and it became degrade and attenuates the signal. The ring topology is connected with limited ONUs.

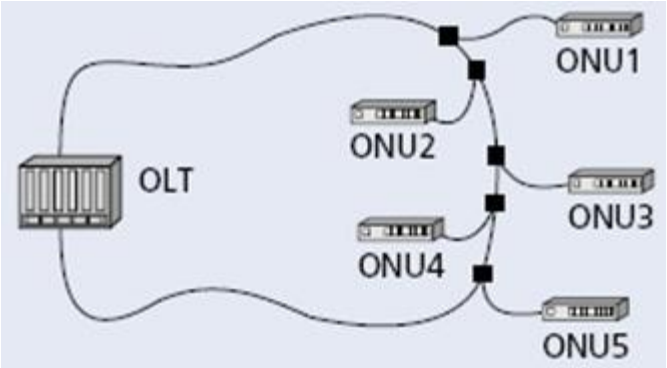

Fig. 3.3 Ring Topology

3.3 PON Resource Sharing

TDM (Time Division multiplexing) is a technique in which transmission resource is shared in time slot. it is increase the capacity of transmission channel for sharing or transmit the data. With the TDM, multiplexing the resource is divided into multiple time slot and each user have its own time to sharing the resource. This type of technology is mainly used in the broadcast area for broadcasting the signal transmission. In the radio and electrical transmission work through frequency but in Optical network it work on wavelength and each wavelength channel is divided for different users.

WDM (wavelength-division multiplexing)multiple users can transmit the signals in parallel in time domain, Basically there are two type of resource sharing technologies in an Optical Fiber based network, here we discussed about three types of PONs for resource sharing ,such as TDM, WDM and Hybrid of TDM and WDM PON[23].

Traditional single-wavelength PONs provided by optical Fiber with the low installation and maintenance cost of a passive infrastructure. The optical carrier is shared by means of a passive splitter among all the subscribers. The number of ONUs is limited

because of the splitter attenuation and the working bit rate of the transceivers in the central office (CO) and in the ONUs. Current specifications allow for 32 ONUs at a maximum distance of 20 km from the OLT and 64 ONUs at a maximum distance of 10 km from the OLT.

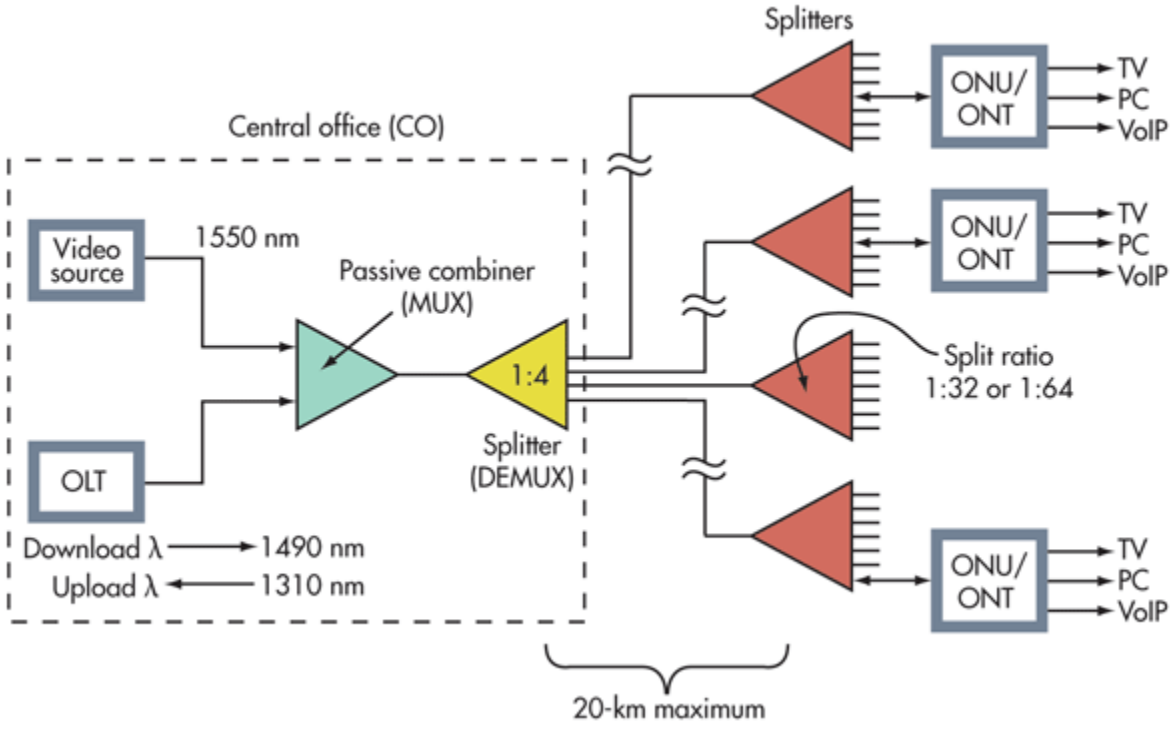

Fig 3.4 PON Configuration

WDM-PON efficiently work on the same fiber infrastructure to be used, which is allow to each service provider to access full wavelength of network such as 1,250 Mbps is currently available. Here lot of changing done to required enabling that change. First of all 1:32 splitter is used in the against of 1 X 32 de-multiplexer. That's provide for 32 different wavelengths for transmitted down the common fiber, and after that each users have its own wavelength.

Advantage of WDM

1. Most of the bandwidth available to the service provider for providing to the new are upcoming users.
2. WDM-PON networks provide high scalability and security due to which each users received only its own wavelength signal. No more wavelength interchange or accessing or other users wavelength signal. It's more secure as compare to TDM technology.
3. It will provide P2P connectivity between OLT and ONUs and not necessary need of media access controller which is available on other PON networks

WDM-PON approach directly with the end users due to this not suffer with power-splitting losses, this straightforward approach to create a high bandwidth network for each users for accessing the upstream and downstream directions

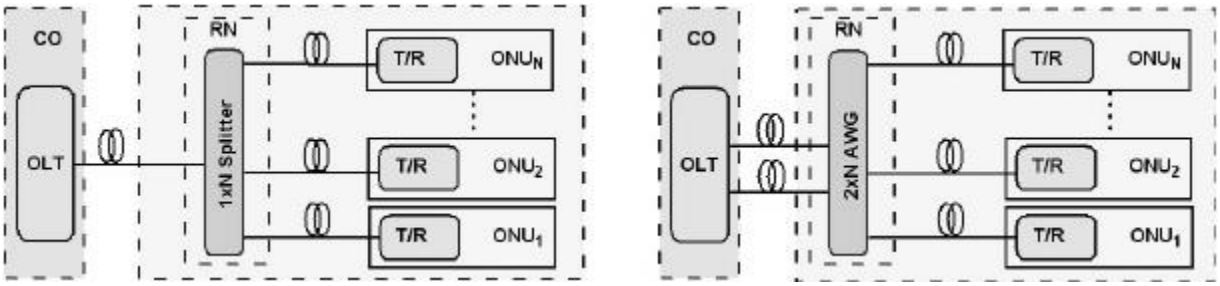

Fig 3.5Tree (a) TDM PON or WPON and (b) WRPON

3.4Ethernet PON (E-PON)

In EPON, the both upload and download streaming at the rate of 1025 Gbps, but the modulated of encrypt data is broadcast at the rate of 1 Gbps. Transmission the guard time between two channel time slots is to differentiate form the various ONUs. It is processed the laser on off time, automatic gain controller and data recovery. The EPON have more guard time as compare to G-PON [6].

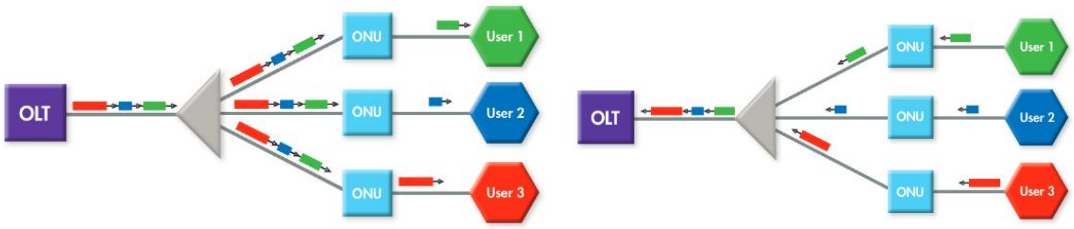

Fig 3.6 (a) Downstream of E-PON and (B) Upstream Of E-PON

3.5 Gigabit PON(G-PON)

Streaming rates up to 2.488 Gbps are specified in the G-PON N and its defined in the ITU-T G.984.x series of references to the bit rates is predictable at TDM structures [7].The guard time conceder laser on-off time, preamble and delimiter. The guard time is much smaller than the E-PON.

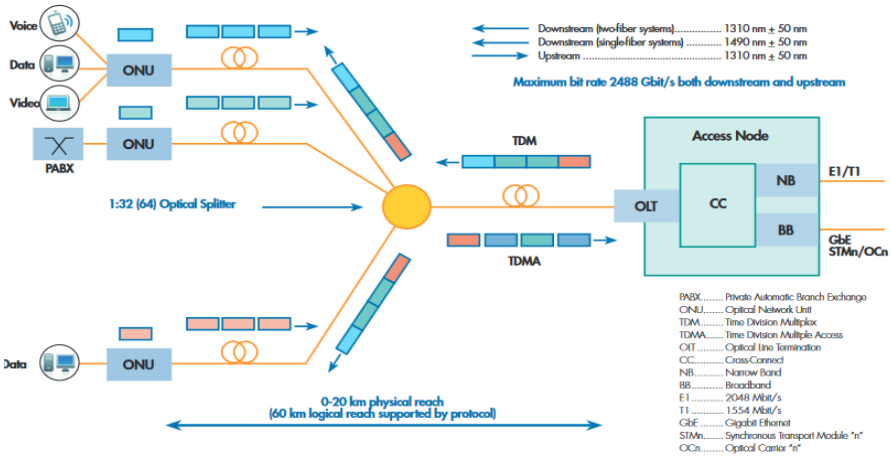

Fig 3.7 Up Stream and Downstream of G-PON

Table 3.1 shows the comparison between EPON and GPON standard

A COMPARISON OF CURRENT EPON AND GPON STANDARDS

	EPON		GPON		
Line rate	Downstream	1.25 Gbps	Downstream		1.24416/ 2.48832 Gbps
	Upstream	1.25 Gbps	Upstream		155.520Mbps/ 622.08Mbps/ 1.24416Gbps/ 2.48832 Gbps
	Bit rate before 8B/10B line coding	1 Gbps	Bit rate before scrambling line coding		155.520Mbps/ 622.08Mbps/ 1.24416Gbps/ 2.48832 Gbps
Guard time	Laser on-off time	512 ns	Laser on-off time		≈25.7 ns
	Automatic Gain Control (AGC)	96 ns, 192 ns, 288 ns and 400 ns	Preamble & Delimiter		70.7 ns
	Clock-and-Data Recovery (CDR)	96 ns, 192 ns, 288 ns and 400 ns			
Frame size	Ethernet frame	64 -1518 bytes	General Encapsulation Method (GEM)	GEM header	5 bytes
				Frame fragment	≤1518 bytes
Overhead for bandwidth allocation	GATE/REPORT	64 bytes (Smallest size of Ethernet frame)	Status report message		2 bytes

Table 3.1

3.6NG-PON (ITU-T G.987)

GPON, ITU-T/FSAN has since been exploring next-generation PON (NG-PON) with higher bandwidth establishment. The growth of NG-PON is separated into two phases: NG-PON1 and NG-PON2. NG-PON1 and it focus on PON technology that are compatible with GPON standards as well as the current optical supply network.NG-PON1 is complete compatible with existing fiber installations, and tries to smooth high bandwidth providing with large split ratio, and extended network. But the motive of NG-PON2 is provide an independent PON system, without being controlled by the GPON standards and NG-PON1 requires both asymmetric and symmetric 10G-PONs

Asymmetric 10G-PON, also mentioned to as XG-PON1, offers the download data streaming rate at 9.95 Gbit/s and the uploading data streaming at rate of 2.48Gbit/s. This architecture upgrades the downstream link capacity to 10 Gb/s. The main problem of this architecture to providing 10 Gb/s and it is enable the burst mode time-division multiple access which is operate at 10 Gbps.

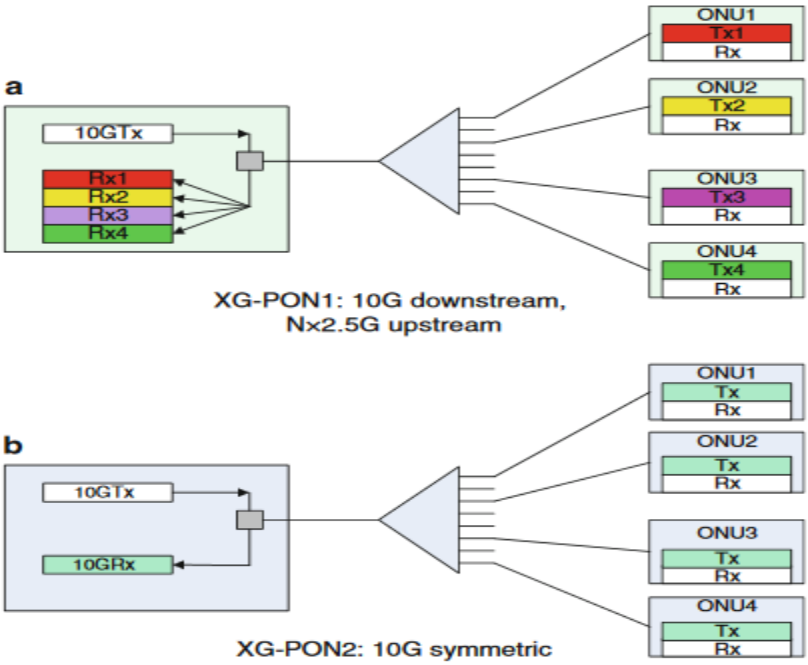

Fig. 3.8 XG-PON Architecture

Symmetric 10G-PON, referred to as XG-PON2, reaches 10 Gbit/s in both upstream and downstream. Yet, XG-PON2 needs cost-inefficient burst-mode transmitters at ONU sides to bring the upstream transmission speed. When strategies are capable of a 10 Gb/s burst mode become commercially available, the architecture with both the downstream and upstream transmission presence of upgraded till 10 Gb/s

3.7WDM PON

WDM provide the better solution for next generation PON system in competition with the 10G-EPON and NG-PON1. The WDM increase the capacity of network without extremely changing the Fiber infrastructure. WDM PON architectures enjoy several advantages over traditional TDM PON.

- Every users being dedicated with one or more wavelength. It allows each user access full bandwidth.
- It provides better security and scalability because each Users receive its own wavelength.

- WDM PON is control at MAC layer for more simplified as compare to TDM PON. Because WDM PON provide P2P Connections between OLTs and ONUs.

WDM supports 32 ONUs and it must transmit on no less than 32 different wave length and each ONUs operate on its own wavelength.

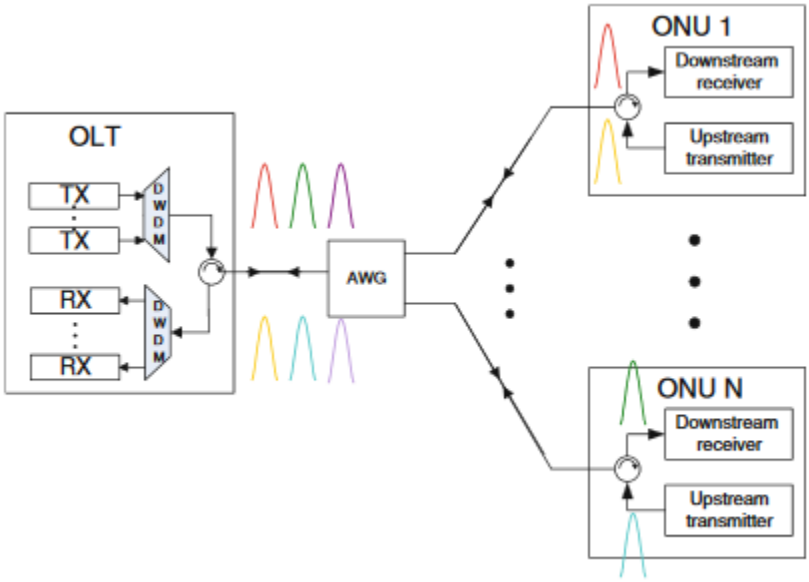

Fig. 3.9 WDM PON Architecture

Two types of WDM PON architecture is designed such as wavelength broadcast and wavelength routed WDM PON (WRPON). WPON standard is similar to the TDM PON as shown Fig. 3.7. with use of power splitter and combiner at the remote no debut WDM component is located at the OLTs and ONUs

In WRPON, Array Waveguide Grating (AWG) at Remote Node is exchange the power splitter which is used in WPON and it . The main advantages of WRPON are the improved the power for full duplex transmission. In their every ONU can need a different laser source, growing very the complication on for reducing the flexibility of WDM allocation.

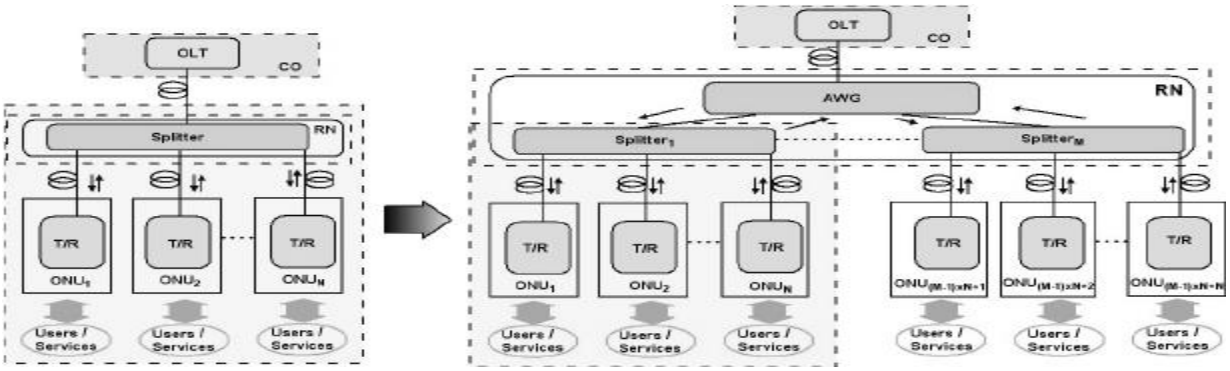

Fig 3.10 TDM PON to hybrid WDM/TDM PON

The main benefit for the hybrid WDM/TDM PON is:

1) Migration from the current PON to the future PON by using of WDM technology;

2) Supportive for maximum number of ONUs. With large Splitting Ratios.

3.8PON: Resource Allocation

Network traffic in access network are not uniform all the time it depends on the different physical condition, depend on the services going to be used on it and multiple QoS providing needs to be satisfied. Hence it is required to design the arrangement algorithm for flexible resource allocation.

Clarification of TDM PON resource allocation is as below with the description of Single level and hierarchical scheduling for dynamic bandwidth allocation.

3.9Allocation Bandwidth:

TDM PON technology is the main lashing factor for using the procedure for resource distribution that concentrations time slot allocation for uses of high bandwidth consumption. In TDM PON, OLT connected with ONUs in downstream traffic but in the upstream direction an intercession mechanism is required, as it’s a shared channel only one ONU and it provide a fix time slot for data transfer.. This structure is usually categorise in two types: Static and dynamic bandwidth allocation.

SBA (Static Bandwidth allocation): It is not able to adopt the traffic demands but time slot is allocate for broadcast for each ONUs

DBA (Dynamic Bandwidth allocation): In it time slot is allocated for the broadcast and it can be adjust according to the network traffic. The main advantages of DBA over SBA:

(1) Flexible,

(2) Maximum utilization of bandwidth;

(3) Provide QoS provide to each traffic class.

It is intensively used and studied than SBA for bandwidth allocation Pattern. With some minor changes DBA algorithms for EPON can be applied to GPON also.

CHAPTER 4

PROPOSED WORK

4.1 PROPOSED WORK DISCRITION

As a Professional we are providing the better service to the client and the service related to the client requirement we are provide the best solution at minimum cost, we are not related to service only but we plan to create a long term relationship with my client and we are providing the better consultancy to our existing and new clients. Before taking this topic we are already work on this project and plan to implement optical network for the client, this is real time implementation at the client side, so we plan to make project on the Optical Fiber network and plan to discussed the problem which is observed in the real time scenario and plan to provide simulation in this project. But the simulation is too costly due to this reason we are attached the block diagram and the output of our project in the simulation part. As per my project “Structure Analysis and Designing of Optical Fiber Network” we discussed on the structure of ONU an ONT. The designing part Fig.4.1 show the block diagram of Optical network which is implemented at the client side and , according to my thesis we are simulate FTTH project on optisim simulator, In simulate, we observer the capacity of signal transfer in Fiber optical network, BER testing output waveform between the users vs. BER and distance vs. users.

As in mind I want to show the transmission of data voice and video through a single Fiber, with their block diagram and outputs. In this technology still research in going on with maximum speed data transfer and multiple signal transmit with single light source on single Fiber with low cost consumption with minimum error for long distance.

In the introduction of PONs is a huge research area. In some network, the OLT will take decisions not only about allocating time slots to ONUs but also choose an appropriate wavelength to transfer the signal. As the difficulty occur in system is much higher, and the problems tackled by the bandwidth allocation algorithm is really hard to resolve. Using the simulation tool we proposed the optical Fiber architecture and help to perform

a large system network in under critical conditions. But finally I achieved my goal and simulate my task.

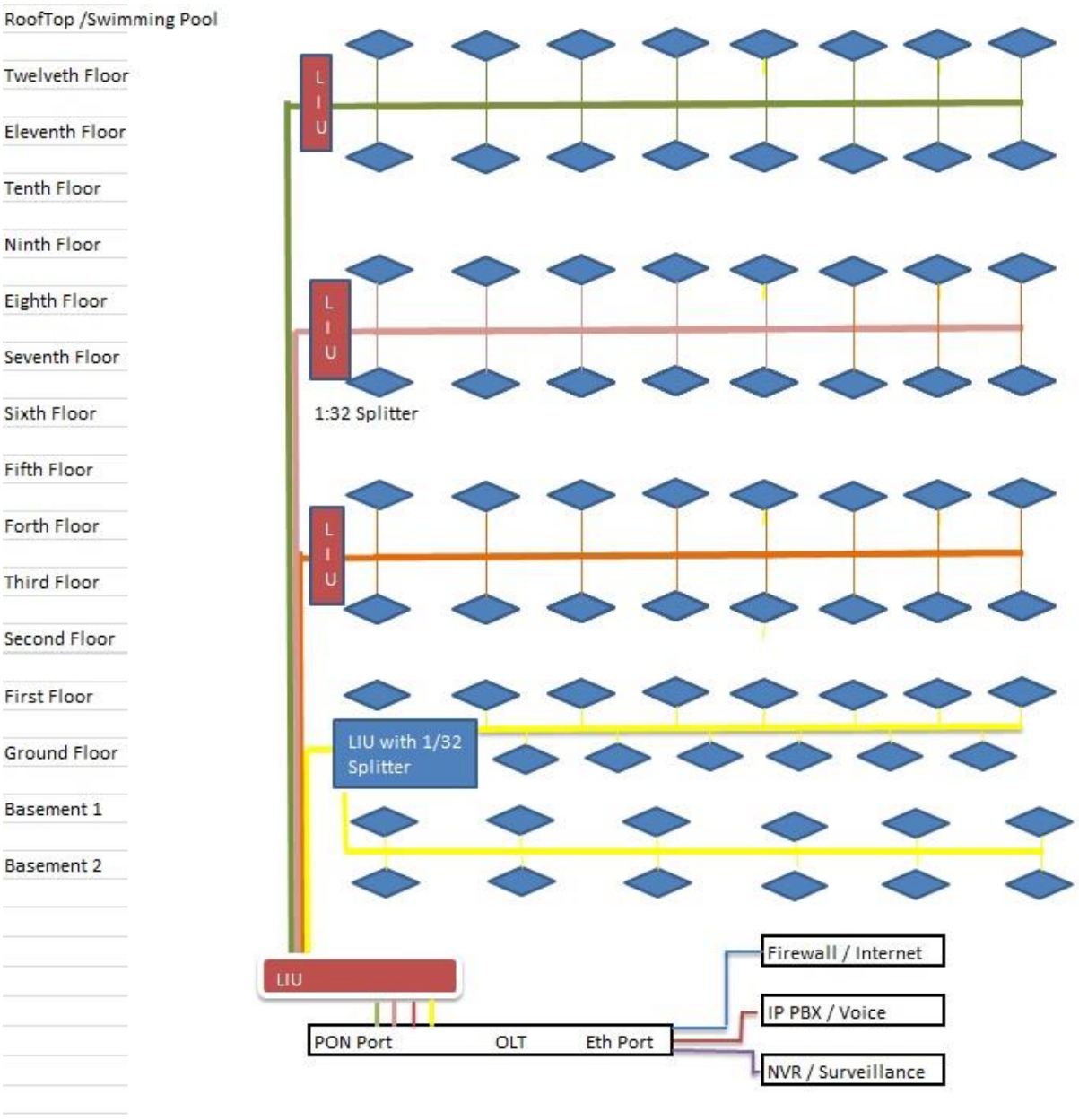

Fig. 4.1 Fiber Network Blue Print

CHAPTER 5

Simulations

Simulation Setup and Result Analysis

Triple Play Services at 2 Gbps using GE-PON architecture for 56 ONUS

In this simulation we processed FTTH on GE-PON (Gigabit Ethernet Passive Optical Network). The designing for 56 users at 20 km and the speed of 2Gbps.In their used 1:56 splitter to create communication between central office (co) to each ONUs and amplifier is used to boosting the signal. Amplifier before the Fiber length is decrease the BER (Bit Error Rate) and allows more ONUs to accommodate. This Architecture is design and analysis for different users from CO to evaluate the number of user increase beyond 56 users the BER comes acceptance level and if further increase data rate then observes a sharp increasing in BER.

5.1INTRODUCTION

Next generation needs compatible with today's bandwidth needs and also provide flexible bandwidth for future growth high capacity network expansion. the optical technology proves to provide large bandwidth capacity and it appear between backbone and access network. In FTTH the Fiber network provides to the end user it means optical network starting from the central office to ONUs. FTTH 100% deployment in access network and it provide the main requirements: -

- ✓ Reliability
- ✓ High performance
- ✓ Low cost

It is imperative to understand the proposed optical networks meets low cost and reliability, optical networks deployed passive optical component at the customer premise. PON also use tree topology to cover maximum distance with minimum uses of splits. Several architecture proposed of TDM-PON(Time Division Multiplexing provides

broadband Passive Optical Network(B-PON) with down speed 622Mbps, EPON(Ethernet passive Optical Network) with 1.25 Gbps down speed and G-PON(Gigabit PON) with 2.54 Gbps Download speed. GPON technology basically support to the next Generation PON(NX-PON) to support full service, high efficiency , multiple speed rate and other benefits. In future GPON is one of the best access networks for broadband connectivity.

The low cost increase the deployment of optical network to delivered Fiber to the home to increase the high bandwidth to the end user but in many cases extended reach some extra according to the extra hardware require in increasing coverage area, these cost comes in the form of amplifier with come additional losses. In order to increase the transmission distance of network coverage area, an amplifier introduce somewhere between the transmitter and the splitter. Analysis of the amplifier and addition losses can be determined by evaluate of Q- factor or BER of the system.

P. Chanclou&Z. Belfqihet al.: - the standard G-PON already deployed in many country and they are encouraging technology for cost effective access network PON technology offer to solve to increase the splitting ration. The fixed and mobile service also MERGES with this optical network In order to optimize system location. THE HIGH speed at 10 Gbps have a strong impact on metro city networks concerning with architecture and connectivity. Even if 100Mbps or 1Gbps interface feature is available in the FTTH users from the bottleneck could come with high speed connectivity to the end user. The delivery of high speed interface come with access anywhere in the domestic area.

Chang al-Hee Lee et: - Traffic pattern in access network involve with voice and text oriented service to video and image based service. These change required new access network to support to high speed data transmission at more than 100 Mbps, in symmetric with guaranteed bandwidth for the future high definition TV quality. The future comes on the base of internet with high speed bandwidth. The required bandwidth over a 20 km transmission distance on a single mode optical Fiber is currently used and deployed in many countries. For the minimum cost of FTTH implementation we are approach to TDM and WDM PON, TDM-PON share or

transmitted single transmission with multiple subscribers but in WDM-PON provides point to point coupling between the subscribers. TDM provide satisfactory solution for current bandwidth demands and it will have combined with WDM technology in future Fiber based access networks.

Bernard HL Lee at al:- Investigation at 2.5 Gbps FTTH-PON network architecture in which booster is used for future network as AWG and achieve its cyclic routing table, it is possible by Free Spectral Range(FSR). It will compare with a conventional network.

In this simulation consider maximum 32 users and 10 users connect with 1 OLT, we observed no error found transmission over 25 km with 32 splitter with 9 dB standard on 7 km. speed of 155Mbps observer at 12 users.

In GPON architecture for bit rate of 2Gbps using optical amplifier for 56 users and consistently the value of BER obtained according to the no of users and that is optimized value.

5.2Simulation setup

The transmission through the optical Fiber path utilize with coarse wavelength Division Multiplexing (CWDM) technique with voice and data is transmitted in range of 1480 - 1500nm, and video wavelength range 1550-1560 nm.

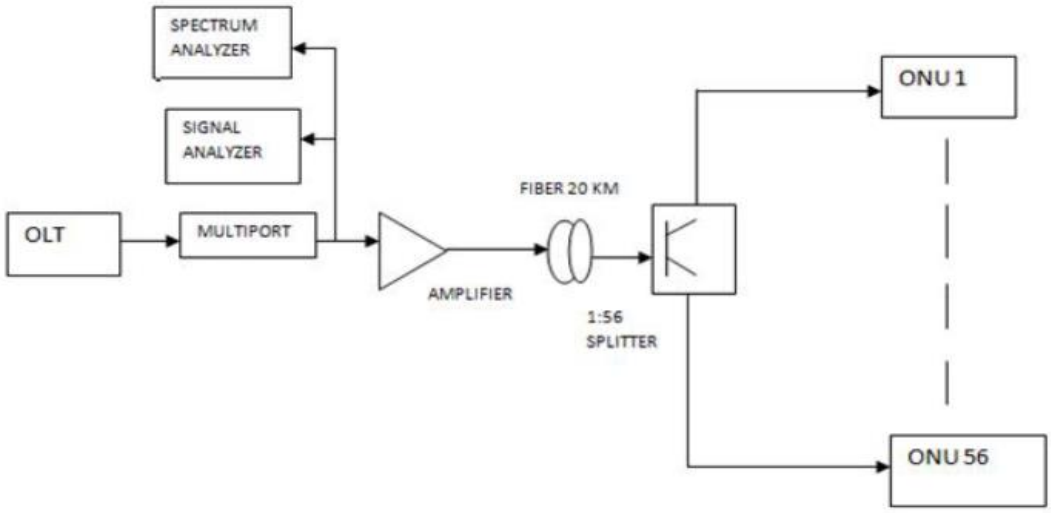

Fig 5.1 Block diagram of simulation setup for 56 users

Represents the block diagram for simulation setup of GEPON architecture and now we show the simulation setup in the OptiSim simulator.

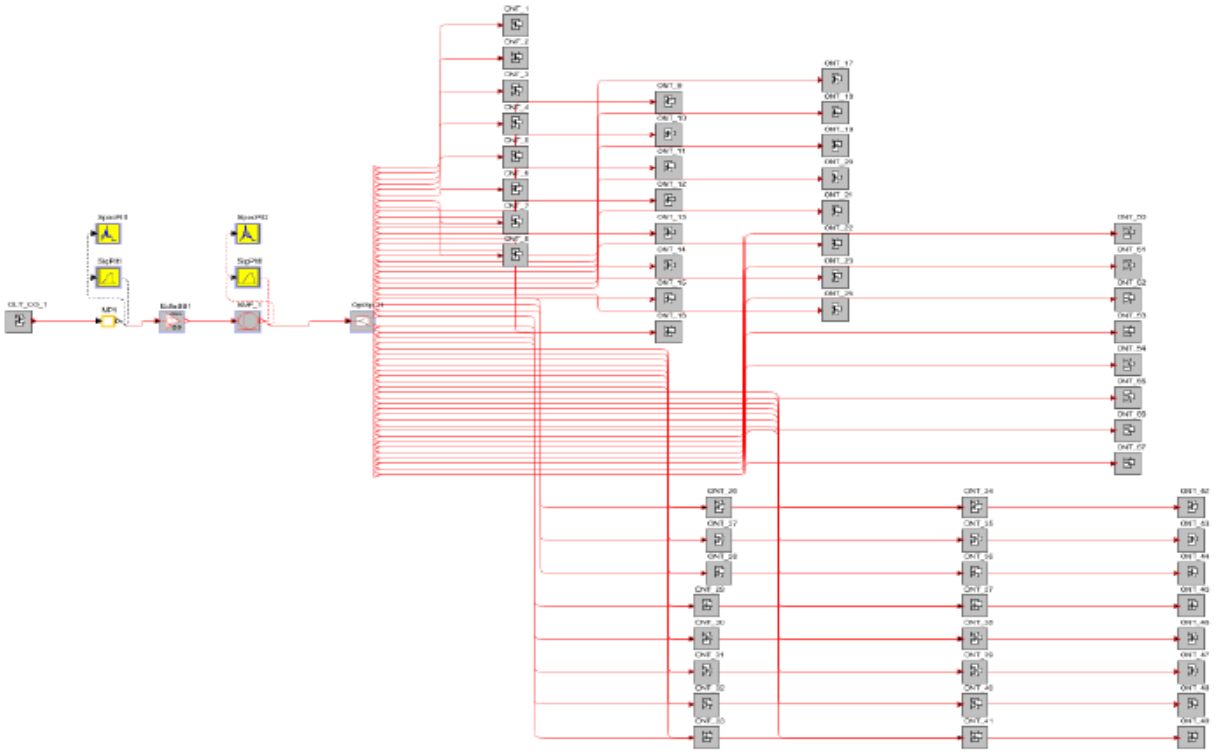

Fig. 5.2 Simulator Setup of 56 users GEPON architecture

The data /VoIP transmitter module with pseudo- random data generator, NRZ module drivers, direct modulated laser and optical amplifier for signal booster. The block diagram include Data/VoIP and video. The video components modulated as Sub-carrier multiplexed with RF links with 2 channels for simplicity the signal form the two signals generator goers to the summer and then move towards to modulation with the convertor to laser. The radio frequency video transmitter comprises of two electrical signal generator, pre-amplifiers and modulated laser. The data/VoIP multiplexed with video by multiplexer and transmit into long distance Fiber. The distance considers 20km. before transmit the signal, pre amplifier is used to boost the signal strength before travelling in Fiber. The boosted signals also increase the BER. The pre-amplifier maintain the constant gain at 30 dB at output from the Fiber channel and it goes to 1:56 splitter and then to individual user at the end. The individual users ONTs consist of splitter and receivers for data and video. Optical Fiber, PIN Receiver and BER tester configure at data receiver and video receiver involve optical filter, PIN receiver and electrical filter. The colour filled yellow block is a measurement instrument to measure the signal strength and visualize the optical spectrum like waveform, eyes diagram etc.

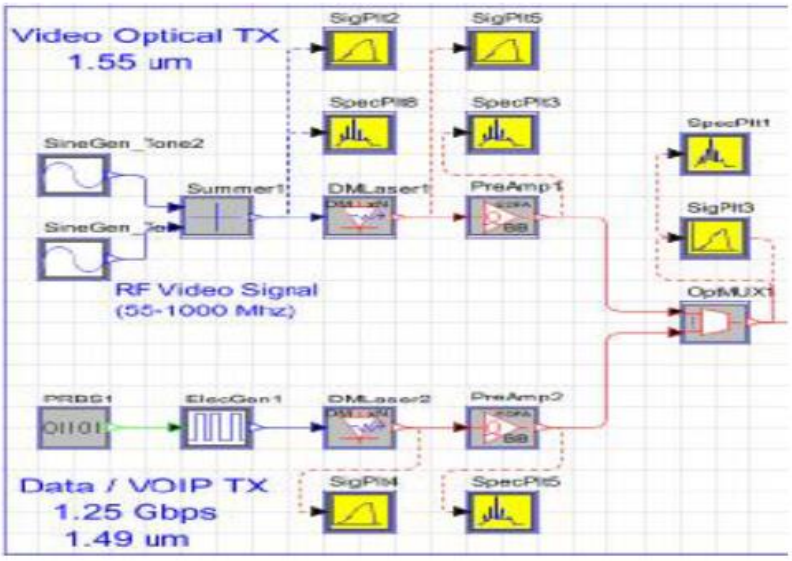

Fig 5.3 OLT components for GEPON based architecture

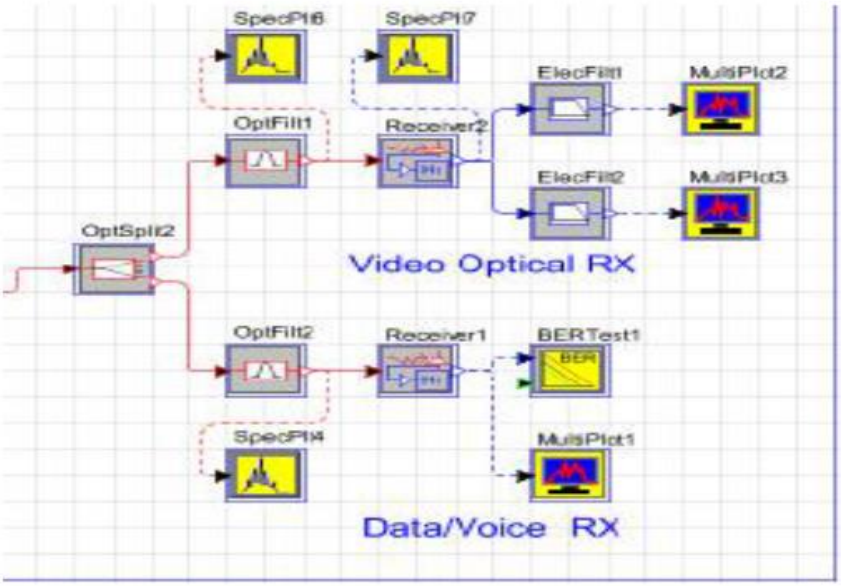

Fig. 5.4 ONT components for GEPON based architecture

At the end of transmitter transmit the signal now in ONT obtained the data/VoIP and split the video signal. The optical splitters transmit the signal to optical filter for split the data and the video signal extract from the modulated signal. The optical filters pass the signal of specific range which is distinguee for the video and the data. At the optical filter 1 receiver receive the signal and the again forwards to electric filter to access the exact video signal and same as receiver2 extract the Data/VoIP signal. The convert the data and video again in the original form, we are use a high sensitivity receiver and detector which perform the both function, both of receiver work on same phenomena is repeated and done simultaneously for different user at the same time. For the measurement of the spectrum of voice and data we are use spectrum analyser. But we are know that data is transmitted in the digital form and in optical Fiber data travel in light form means in light pulse, so when the data is transmitted in the Fiber in this transmission such type of noise is produced like symbol interloping noise due to this effect some error should occurred. The measurement of these error we applying BER tester instrument. We have the knowledge of standards and according the input guess the output results as well as some standards also made to accept which type of error occurred and the reasons of

errors by ITU-T Standard. Finally at the end of receiver side every ONT receive both data and voice. Optical splitter module simulates an Ideal Optical Splitter and balanced with some reduction on each output. The attenuation value set by default 0 dBIn This module implements ideal splitter without any insertion loss and it's perfectly split the incoming signal.

PIN Photodiode actually it is a photodiode for detection the light signal. Output current generated by photo diode detection and these output depends on the input optical power & on dark current. This parameter is 193.42 THz/1650nm with reference parameter of frequency /wavelength.

5.3Result

As the use of Optical splitter as a passive device at the end of ONT, on the basis of these factors of results. The data is and video both are transmit on the different wavelength on a single Fiber(1490 for data and 1550 for video) both are reached at the destination with low attenuation , each user have a separate but slightly different wavelength of data and video. When increasing the number of ONUs the occurrence of error also increases for these errors we are used BER tester to calculate the error increasing/ decreasing rate. A graph is represented the effect of number of user on BER.

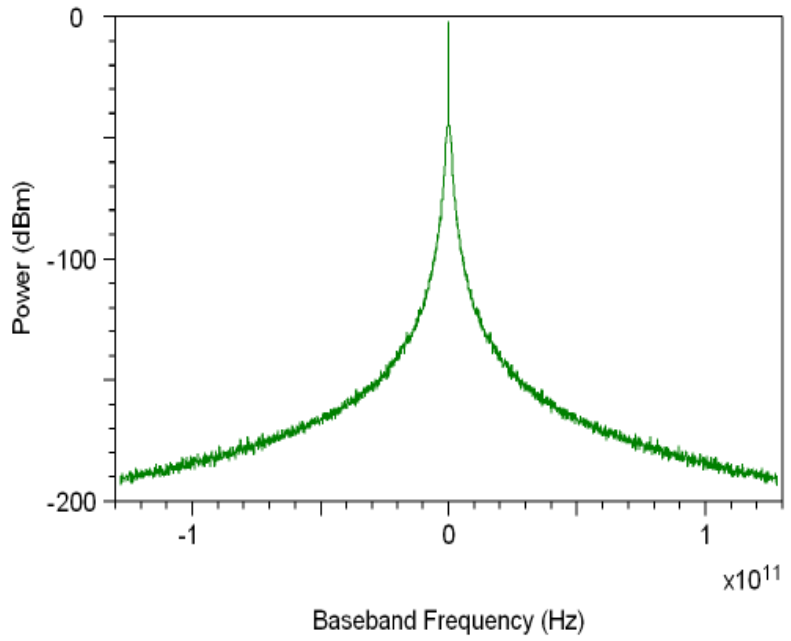

Fig 5.5 Received voice and data signal frequency spectrum at 20km

In the representation or this above graph of frequency spectrum of 1 user for data and voice signal. Spectrum is observer at receiver end and data and video are in modulated by MZ modulator then transmit over the optical Fiber. In optical channel also insert some error in the noise form which era observed by BER tester and observe the effect of noise over modulated signal. Due to noise the value of BER observed with and without amplifier used. The amplifier is installed at the receiver path with the transmit data rate at 2Gbps. we obtained the BER of 5.9452e-008 without amplifier and with amplifier the same BER decrease to 3.9032e-013 with same specification.

Table 5.1 Table for BER for various users

Number of Users	BER
16	3.9032e-013[a.u]
24	2.5963e-012[a.u]
32	1.9576e-011[a.u]
40	1.0608e-010[a.u]

48	6.9243e-010[a.u]
56	4.2596e-009[a.u]
64	2.2065e-008[a.u]

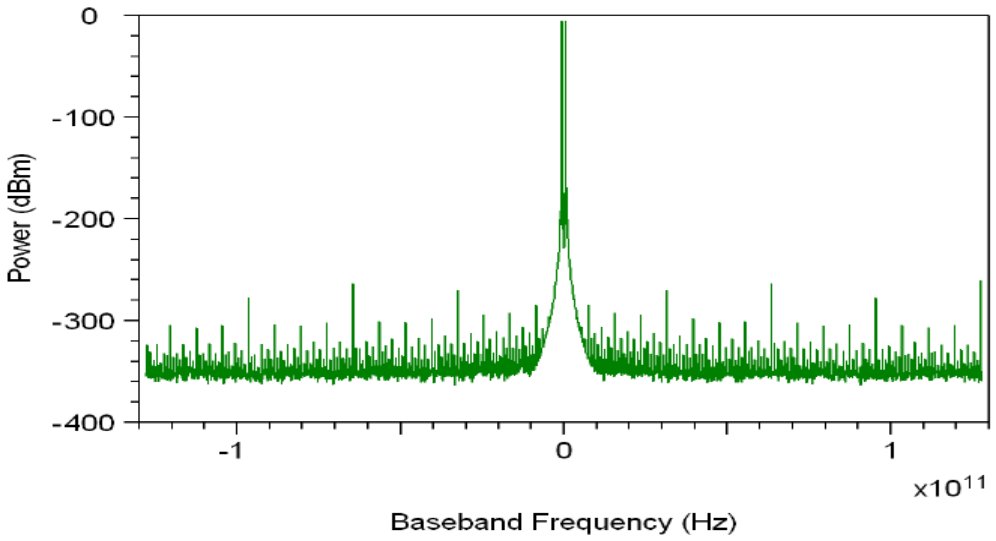

Fig 5.6 Received frequency spectrum of video signal at 20 km

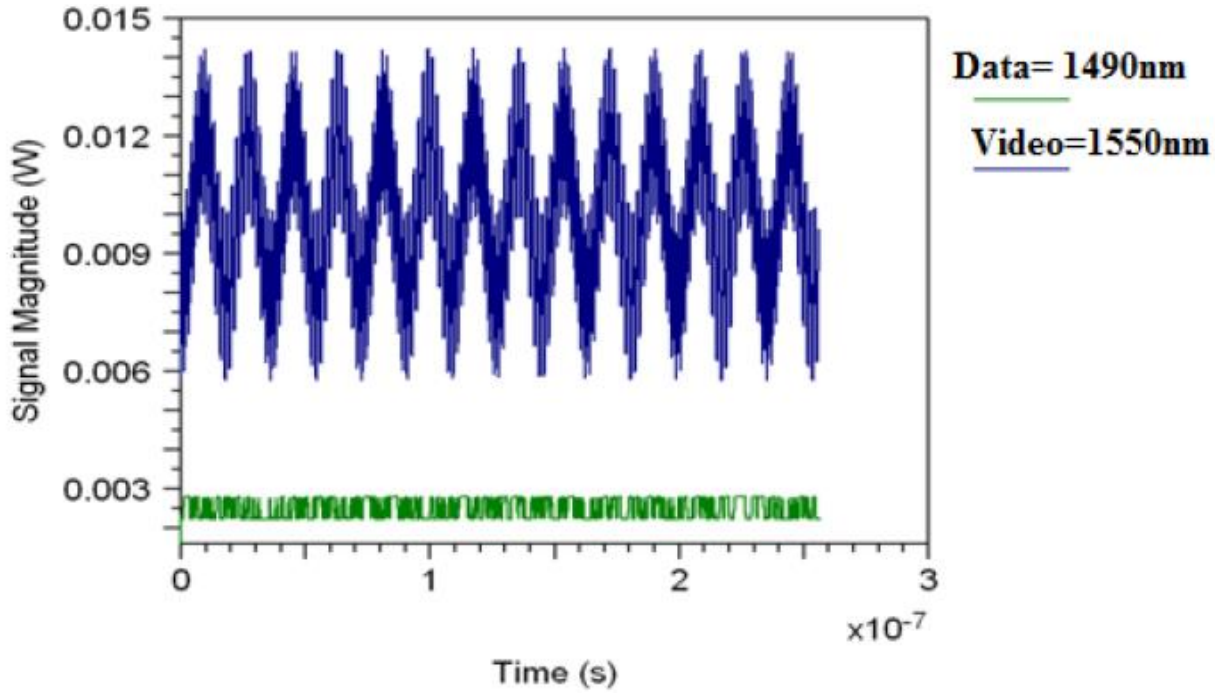

Fig 5.7 Output waveform for data and video at OLT

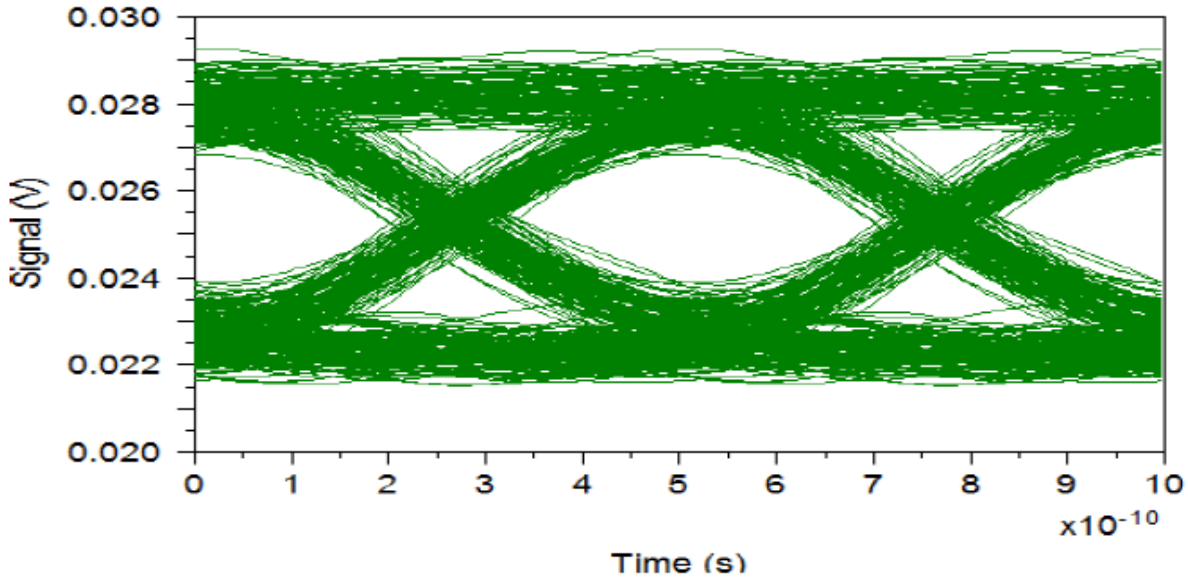

Fig 5.8 Eye Diagram of data and voice

Now here we increase the Number of user using Optical splitter. The simulator shows the relation between users and BER in the form of graph. As Per graph we increase the number of users and according distortion will increase, due to this increasing of distortion become error full.

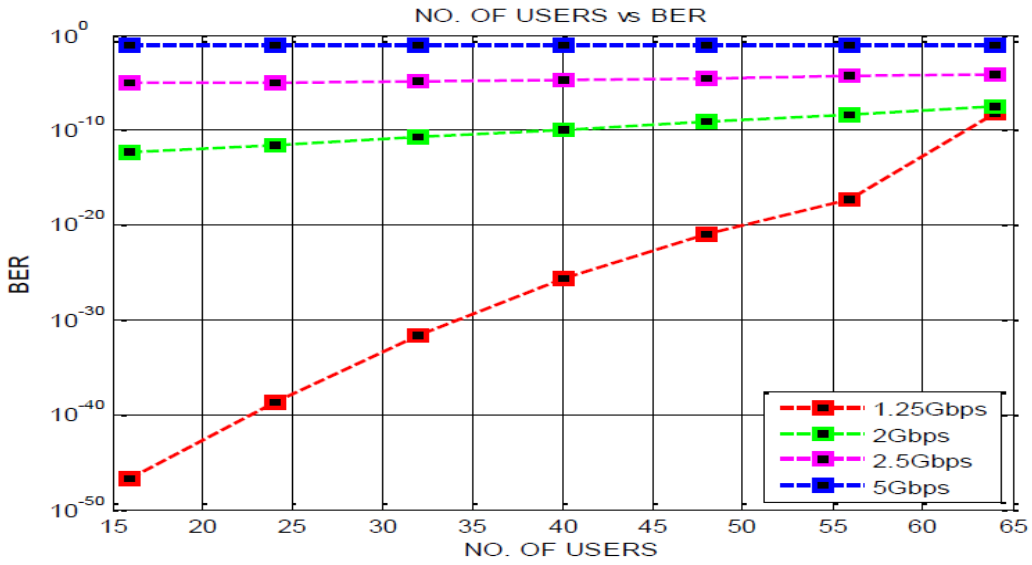

Fig 5.9 Comparing with users and BER

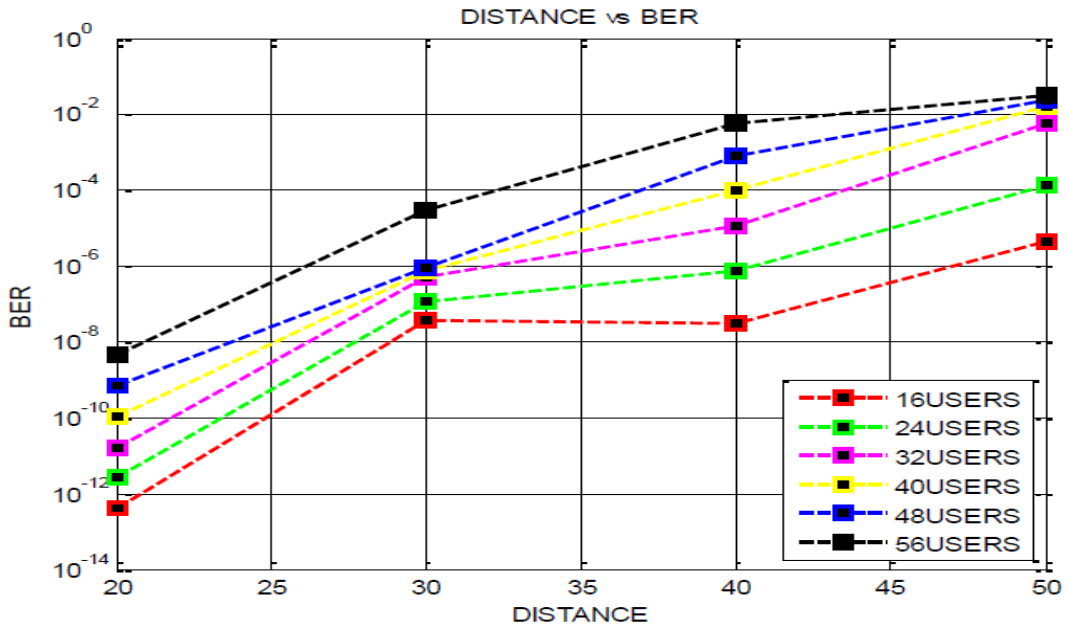

Fig 5.10 Comparison between Distance Vs. BER

The above graph Fig 5.10 represent the comparison between the distance and the users and the effect on BER, when the increasing the data rate, BER also increase gradually, but for the less users. The BER decrease when the number of user increase .same as effect observed when increasing the distance with same number of user suddenly BER increase sharply.

5.4Result Analysis

The simulation to optimized GE-PON based Fiber to the home access network to provide triple play system where send data, voice and video for a specific distance and according the effect of BER as well as on distance factor. The simulator help to observe optical Fiber network complete our requirement in future for provide high capacity bandwidth at minimum low cost. As well as it describe the losses will occurs according the distance. In this simulation initially transfer the data from 20 km with 56 users but try to show the effect in both way like effect on increasing and decreasing of number of users along with increasing the distance from 20km to 50 km with their effect.

CHAPTER 6

6.1 CONCLUSION

In this chapter we provide the summary of our research work done. In their show comparison of the FTTH network architecture and optimized the problem of planning and designing of the Optical network as well as highlights the feature of Optical Network along with difference between the architecture. We plan to show the advantage of Optical network and how it will provide the high capacity bandwidth provide to the end users with resource allocation and time sharing .here I discussed with my conclusion and the future scope of the Optical Fiber network and the result of my demonstrate of FTTH at the end.

In demonstrate, GE-PON architecture design with maximum 56 users with the distance of 20 km, along with splitter 1:56 is used as well as an amplifier. The maximum number of users is depends on the number of splitter is used in demonstrate, here we are using 1:56 splitter it means we are using 56 users and the amplifier is user to amplify our optical signal to helps to reach the maximum distance. The distance will decrease or increase. The effect of amplifier is show in the BER tester, that's was discussed in this thesis when I show the BER tester table. Once I collect the data without amplifier and after that we implement the amplifier in the network and then again collect the data at BER tester. Same as we discussed the effect of distance on BER value. When we transmit the signal to 20 km with users (56), then same transmission with 50 m the BER is increase according the distance increase.

Chapter 7

7.1 Future Scope

It is envisioned that is our incoming future, access based on the Passive Optical Networks will be dominant. Mainly this technology is growing very fast, it is implemented at low cost and the cost is afforded by the customer, when they will get high capacity bandwidth for our future. Now in current market lot of number of HDTV channel are available it will growing fast according to the requirement as well as user want a very service available from one subscriber like voice, video, and internet and the demand of HD channel increase day by day. These all service require more bandwidth so development of Optical Fiber based WDMA mode and this technology complete cover all market with in a next couple of year. The optical Fiber market rapidly growth and it provide bandwidth according to our market requirements as compare to DSL or Cable technology, now it is in initial stage but it will provide high capacity bandwidth.

As per the demanding for more bandwidth and increasing the number of user we plan to design multiple signal through a single light source with the help of prism. With this planning we are transmit multiple data with single light source. It means multiple signal transmit through single channel.

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