© 2015 IJEDR | Volume 3, Issue 2 | ISSN: 2321-9939

Investigation on Triple Play FTTH PON 10Gb/s for 156 ONUs

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***Abstract* - In this work investigation has been done for 156 users triple play passive optical network at 20 km of distance at 10 Gbps data rate. Here 1:156 splitter is used as a passive optical element which helps in creating communication between central office and end user. Also the performance of 156 users are studied at varied input power, distance and number of users. It is observed that results are better for 96 users and degrades as increase in user to 128 or156. Similarly with a variation in a distance is there is a decrease in the quality factor of the system. As input power increases the quality factor increases sharply.**

***Keywords*– FTTH, passive optical networks.**

I. INTRODUCTION

With the advancement in communication technology the need for high speed internet is increasing day by day which further demands high data rate and large bandwidth. So our future technology is required to be adaptable to offer large bandwidth and to support large number of new applications. To solve this problem fiber optic technology has been developed which uses optical light as a transmission medium. Optical fiber provides us adequate solution to solve the problem of access network[1]. Optical fiber technology offers us a combination of low error probability, high bandwidth and large transmission capacity[2].

Access networks are made out of copper and were based on twisted pair and coaxial cables. The three main requirements of access network are they must be cost efficient, they must have high reliability and better performance. Passive optical network(PON) requires only passive components i.e it doesn't require continuous supply of electricity , therefore power issues and heat are not considered. Passive optical network has low maintenance cost since it requires less components[3]. Fiber based networks are cheaper to operate. copper based networks requires lot of maintenance and repair as compared to optical network, which is less prone to outside conditions could lead to important operational savings for operation in long run[4]. Thus to provide broadband services to the end users several FTTH and FTTP network has been proposed. FTTH is 100% deployment of optical fiber[5].

As the signal travels through the fiber its power decreases due to the presence of various non linearities in the fiber[6]. Therefore amplification of signals are required to overcome additional losses. To transmit the optical signals over thousands of km's EDFA has been used as booster and inline amplifiers[7]. Raman amplifier improves noise figure and improves non linear penality of fiber system and thus improves overall system performance and thus allow us longer amplifier span, higher bit rate and closer channel spacing[8]. Semiconductor optical amplifiers(SOA) have low cost and low power consumption[9]. Evaluation of bit error rate (BER) of the system and quality factor determines the effectiveness of an amplifier.

Joonho choi et al.[10] determined three main factors for efficient video-on-demand(VOD) services in passive optical networks(PON) which is very efficient for bandwidth saving, practical use of user storage facilities and for best possible use of deployed network bandwidth. To attain these objectives they proposed efficient algorithms namely video adaptive streaming(VAST), video greedy adaptive streaming(VGAST) and video greedy adaptive streaming with pro-active buffering(VGAST-PB). Numerical results proved that when available network bandwidth is reduced below the required level due to background traffic, the efficient algorithm can considerably reduce the average user waiting time and the number of waiting request.

Morant et al.[11] evaluated the performance of multi-service provisioning employing orthogonal frequency division multiplexed (OFDM) signals in fiber-to-the-home(FTTH) networks integrating hybrid fiber-coax in-building of Bratislava, Slovakia. They analyzed optical link budget performance on a single mode fiber strand of length 35.8 km including hybrid 100-m fiber and 20-m coax in building distribution transmitting a five-in-one multiservice bundle. They investigated optical attenuation level supported by the network so as to evaluate splitting ratio and maximum capacity of network. Final application was confirmed experimentally with the transmission of multiservice OFDM signal in towercom FTTH network including 1:8 splitter.

Saliou et al.[12] presented the main results for reach extension in passive optical network technologies. They calculated both active and passive architectures combining several multiplexing techniques. Extender boxes based on optical amplification and optical-electrical-optical (OEO) repeaters are analyzed over a standardized gigabit-Passive Optical Networks(GPON) system. With this technique the optical budget of class B+ access network can be increased to achieve a total budget of 65 dB. By using remotely pumped optical amplification for wavelength division multiplexing/time division multiplexing (WDM/TDM) topology the optical budget of class C+PON could be increased by an additional 22 dB amounting to total budget of 55 dB.

Skubic et al.[13] reported that energy efficiency is an important aspect for designing access network due to increased network cost related to energy consumption. Comparing access, metro and core network access network is the important part of the subscriber network energy consumption and is the bottleneck for increased network energy efficiency. The combination of large contribution to overall network power consumption and low utilization implies large potential for CPE power saving modes when functionality is powered off during periods of idleness.

This research work examines FTTH with GEPON network architecture for a bit rate of 10Gbps for 156 users. Quality factor is determined for varied number of users for e.g 96,128 and 156. Simulation result reported that for 96 users we get an optimized value of quality factor but as number of user increases quality factor decreases. Similarly with increase in distance quality factor decreases. Gigabit Ethernet provides us a bi-directional transmission at a data rate of 10 Gbps. This technique utilizes 156 10Gbps signals. This technique can improve system performance. The proposed scheme is capable for future deployment of passive optical network with high quality of service.

II.SYSTEM DESCRIPTION

To optimize the value of BER in passive optical network the signal is transmitted in optical fiber through DWDM technique. Data/audio component is transmitted at 1490 nm and video is transmitted at 1552 nm. Fig 1 shows the block diagram for simulation setup for GEPON architecture.

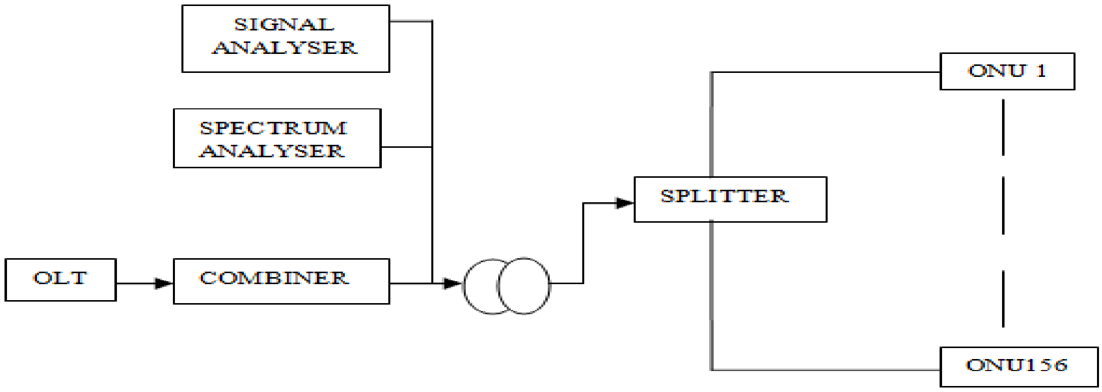

Fig.1. –Block diagram for simulation setup for 156 users GEPON based FTTH architecture

OLT which is a transmitter block consists of data/audio and video components. To transmit video signals we have two sine wave generators operating at a freq of 5000 Mhz and having a phase of 90 degree. The output of both the sine wave generator goes to the input of adder where adder mixes both the frequencies and then it goes to the modulator which is a machzender modulator where the signal is modulated and converted into an optical signal.To transmit the audio signal we have PRBS generator ,NRZ pulse generator and machzender modulator. The output of PRBS generator goes to the NRZ pulse generator and then its output goes to the machzender modulator where the electrical signal is converted into an optical signal. OLT component is shown in fig 2. Then both the video and audio signals are multiplexed and is launched into an optical fiber of length 20 km. the output of an optical fiber goes to the power splitter which is 1:156 splitter and then to the individual user.

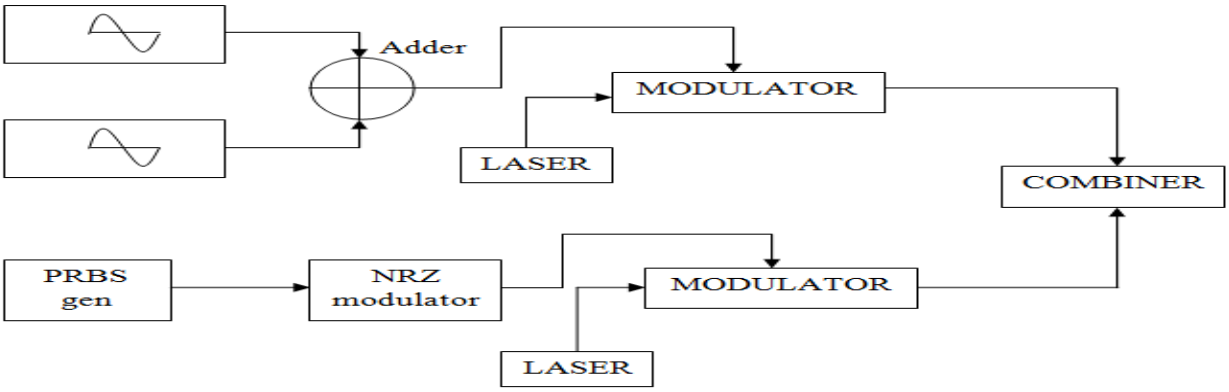

Fig.2. – OLT component for simulation setup for FTTH architecture

ONT consists of splitter, audio and video receivers. Both video and audio receiver consists of optical filter, APD receiver and low pass Bessel filter and various measuring instruments. Every ONT at a receiving end has a particular receiver for both the reception of audio and video signals. Before the reception of signals splitter is used to differentiate between every user. Optical splitter is used with the insertion loss of 0 dB. It acts as an ideal splitter without any insertion loss i.e it perfectly splits the input signal. The high sensitivity receiver converts the data/audio and video again into an original format. It checks whether the video and audio signals are again converted in the form of electrical signal. Here the receiver we used is APD. ONT block diagram is shown in fig.3

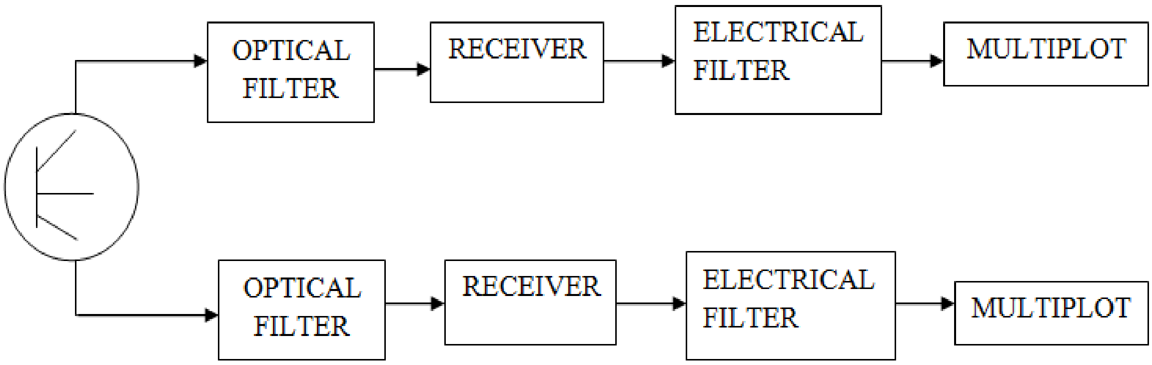

Fig.3.- ONT component for FTTH architecture

At the receiving end Spectrum analyzer is used to measure the spectrum of voice and data. As the data is transmitted in the fibernoise also gets introduced e.g intersymbol interference which leads to the introduction of error. To measure the error we use BER analyzer at the receiving end.

XI.RESULTS AND DISCUSSION

FTTH PON network came into existence to satisfy the customer demand for multimedia triple play services and applications. It enable the service provider to provide variety of services to the end user such as direct broadcast satellite (DBS) and bidirectional video based services. All these services are provided to the end users via single optical fiber . FTTH employs passive optical component at user end so it is known as passive optical network. FTTH uses splitter which acts as a passive device .Transmission of video and audio takes place at a wavelength of 1552 nm and 1490 nm. Both these wavelengths are selected because it is a low attenuation window. FTTH uses separate channels to transmit both video and audio . Each user has separate wavelength spectra for audio and video. Increase in the number of users leads to decrease in the quality factor as shown in table 1

Table 1- Quality factor for varied number of users at a varied distance

Distance	No of users 96		No of users 128		No of users 156	
	audio	video	audio	video	audio	video
5	16.46	21.33	13.80	16.28	13.78	14.32
10	14.41	18.77	12.59	12.90	10.48	11.20
15	13.40	15.87	10.03	10.03	8.69	9.04
20	10.83	12.39	8.33	7.80	7.15	7.50
25	9.50	9.16	6.73	6.46	5.55	6.18

As the number of user increases the quality factor decreases and BER increases. Table has been shown for varied distance and for varied number of users. At a distance of 5 km for 96 users the quality factor for audio is 16.46 and for video is 21.33. But for the same user at a distance of 10km the quality factor of audio reduces to 14.41 and for video it reduces to 18.77. This proves that there is a realtionship between number of users, distance and quality factor.

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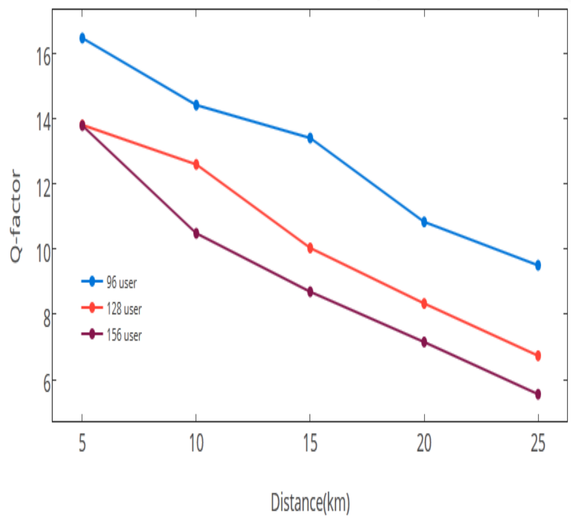

Fig.4.-quality factor for audio at varied distance for varied users

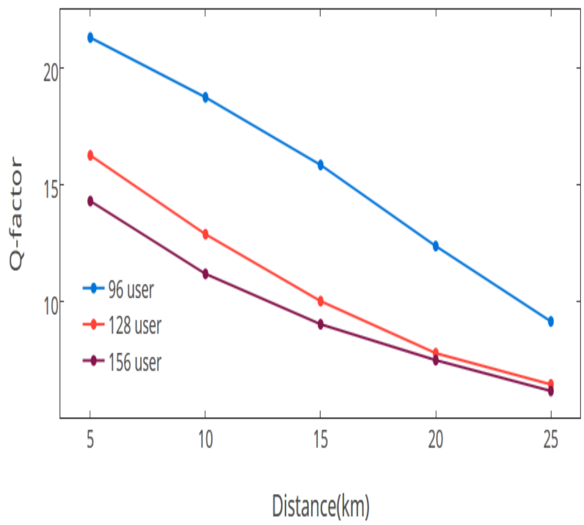

Fig.5-quality factor for video at varied distance for varied users

Fig.4 and Fig.5 represents the relationship between distance, number of users and quality factor.

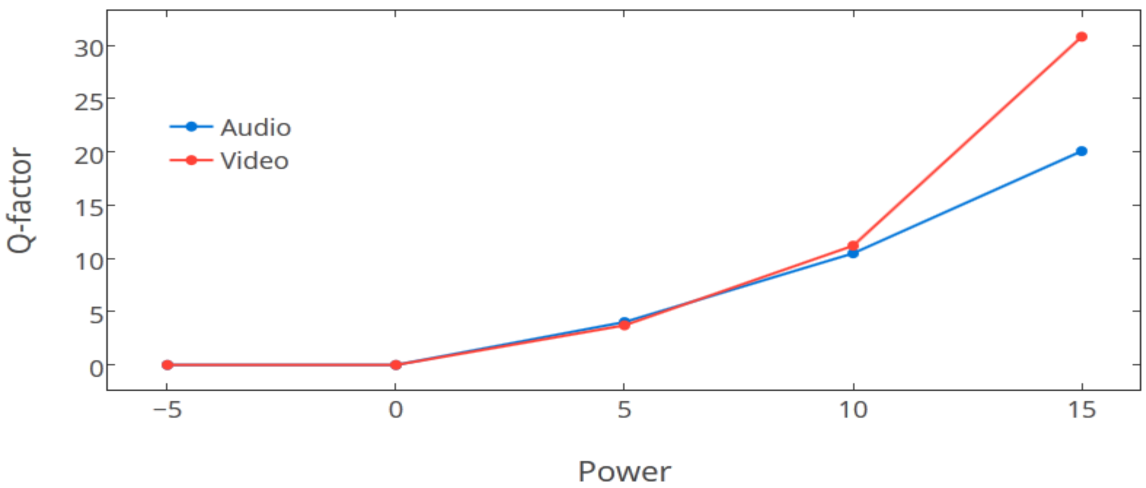

Fig.6-Comparison of system Quality factor at varied power

Fig.6 depicts that as power increases the quality factor also tends to increase for both audio and video at some constant distance. It is shown that when a power of -5dBm the quality factor for both audio and video is 0 but as power increases to 10dBm the quality factor also audio is 10.29 and for video is 10.75. If further power is increased to 15dBm the quality factor for audio is 20.38 and for video is 30.43. There is tradeoff between power and quality factor. This simulation also describes the relationship between distance, BER and quality factor. If we increase the distance then our audio and video signal became distorted due to the presence of various nonlinearities in the system which leads to the introduction of error.

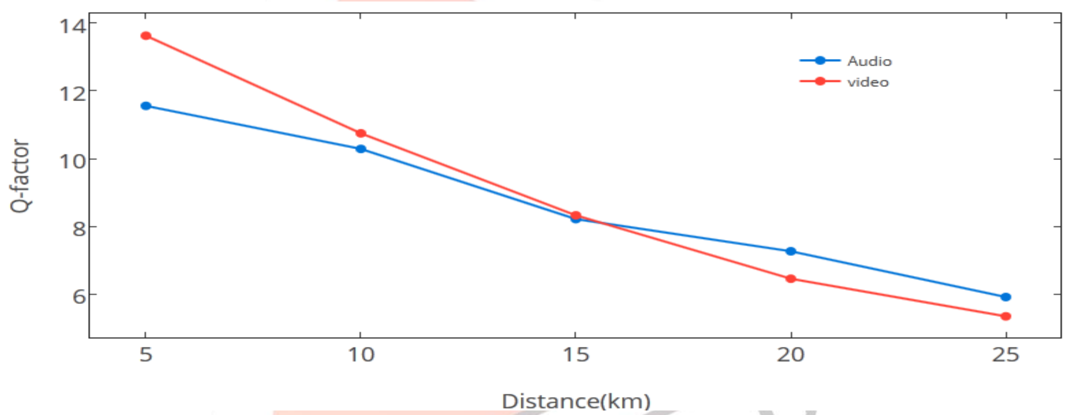

Fig.7- comparison of system Quality factor at a varied distance

Here it is shown that as distance increases quality factor decreases. At a distance of 5 km the quality factor for audio is 11.56 and for the video is 13.33. as the distance is increased to 10 km the quality factor for audio became 10.29 and for video it became 10.75. further if distance is increased to 20km then quality factor audio became 5.92 and for video it became 5.35. Increase in distance also leads to the increase in BER of the system. It is shown by the eye diagram.

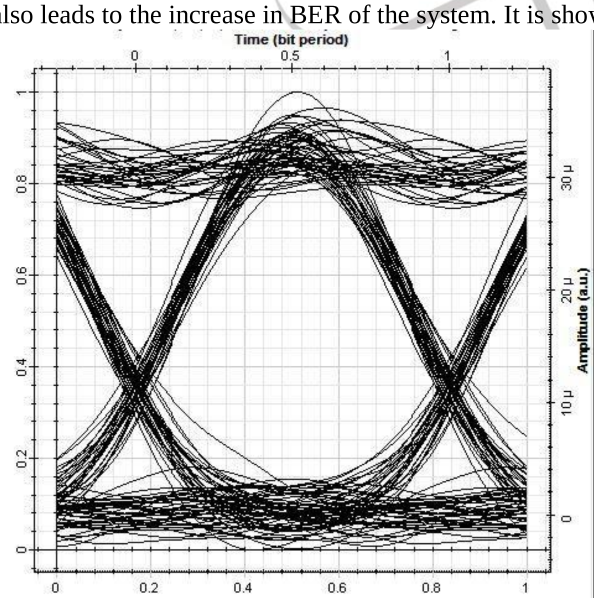

Fig.8-Audio signal eye diagram at 10 km of distance

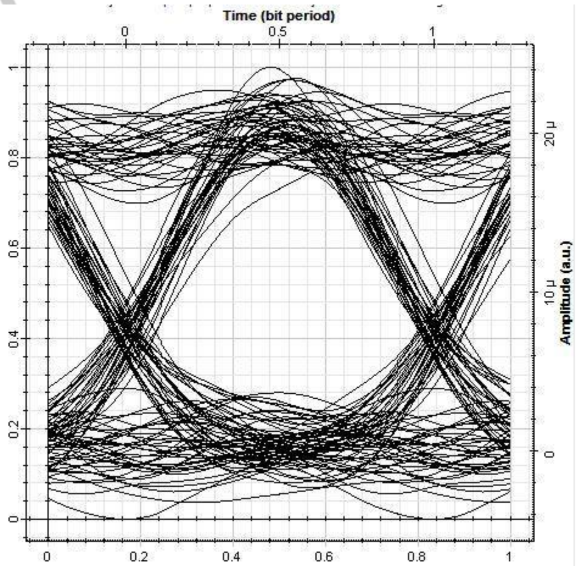

Fig.9- Audio signal eye diagram at 20km of distance

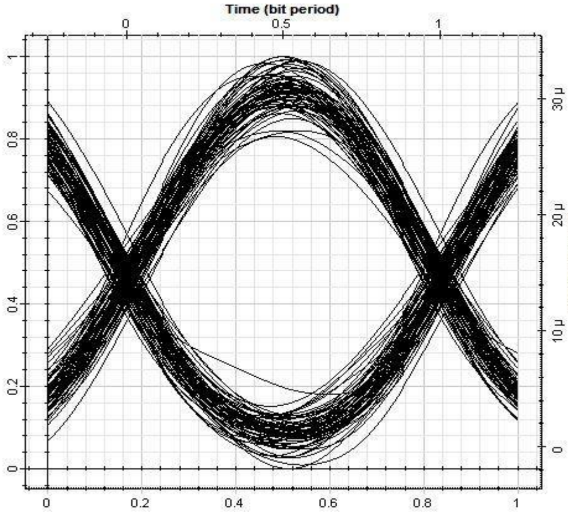

Fig-.10-Video signal eye diagram at 10 km of distance

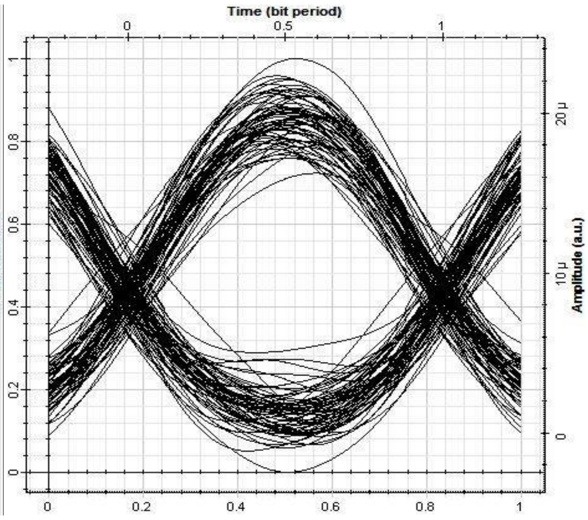

Fig.11-Video signal eye diagram at 20 km of distance

XII.CONCLUSION AND FUTURE SCOPE

This simulation uses an optimized GEPON FTTH technology to provide bidirectional triple play services to the residential subscribers. We describe the requirements of GEPON FTTH architecture and to satisfy these requirements we simulated an optimized architecture and described the function of major elements. The result at 10 Gbps system between BER and number of users illustrate that as the number of user increases BER also increases. If we increase the distance then also BER increases but quality factor decreases. Increase in the power leads to increase in quality factor of the system. By using an optical modulation formats we can increase the distance as well as number of users.

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