International Journal of Soft Computing and Engineering (IJSCE)
ISSN: 2231-2307, Volume-2 Issue-2, May 2012

Quality of Service in Two-Stages EPON for Fiber-to- the-Home

Deepak Malik, Sonam Dung, Robin Walia

Abstract:- Passive optical network (PON) is thought to be the best candidate for fiber to the home (FTTH) to solve the access network bandwidth problem. We set up Ethernet PON (EPON) system model and analyze voice and video performance through the EPON simulation model. A service-classified and QoS-guaranteed triple play mode is tested in proposed EPON system model. We present results of the detailed experiments and propose the differentiated service with different QoS level.

Index Terms:- Bit Error Rate, Quality of Service.

I. INTRODUCTION

In recent years, the rapid development of high speed Internet, IP telephony, Video on demand (VoD), IP Television, interactive gaming and video conference etc. accelerate the requirement of bandwidth. The First Mile's bottleneck problem between high-capacity local area networks (LANs) and the backbone network is much serious one [1]. Passive optical network (PON) is the main trend of FTTH because of its merits: long transmission distance, high bandwidth, cost-efficiency and multiservice convergence etc. Therefore, PON is paid much attention to by carriers. PON systems can support triple play service: voice, video and data. Different service requests different features for latency and packet loss etc. Voice is sensitive to latency and video is sensitive to packet loss. Therefore, the services of triple play should be classified into different categories and assigned different priority to guarantee proper quality of service (QoS). Nowadays there is a rapidly growing demand for transporting information from one place to another. Optical communication systems have proven to be suitable for moving massive amounts of information over long distances at low cost. Fiber optic cables are made of glass fiber that can carry data at speeds exceeding 2.5 gigabits per second (Gbps). In these days almost all long haul high capacity information transport needs are fulfilled by optical communication systems. A new technology is required; one that is inexpensive, simple, scalable, and capable of delivering bundled voice, data and video services to an end-user over a single network. Ethernet Passive Optical Networks (EPONs), which represent the convergence of low-cost Ethernet equipment and low-cost fiber infrastructure, appear to be the best candidate for the next-generation access network. Ethernet provides the bidirectional transmission at the data rate of 1.25 Gbps. The maximum transmission distance of EPON is 20 Km and splitting ratio is of 1:16. To provide the longer distance transmission and more splitting ratios we have used the FEC (Forward Error Correction) technique. By using the FEC technique the data rate can be increased up to 2.5 Gbps. Thus by using the FEC technique the performance of the system can be improved. This paper is organized as follows. Section 2 is a background to motivate our work and the problems we find in the existing system. In section 3, we present an EPON system model based on simulation platform. Section 4 presents the detail simulation results about voice and video service. Section 5 concludes this paper.

Manuscript received on April 26, 2012.
Deepak Malik, ECE, MMEC, MMU Mullana, India 8059931238, (E-mail:ermalikmullana@gmail.com).
Sonam Dung, CSE, MMEC, MMU Mullana, India 9729270734, (E-mail:Sonam12588@gmail.com).
Robin Walia, ECE, MMEC, MMU Mullana, India 8059888020, (E-mail:robinwalia1@gmail.com).

II. SCENARIO DESIGN

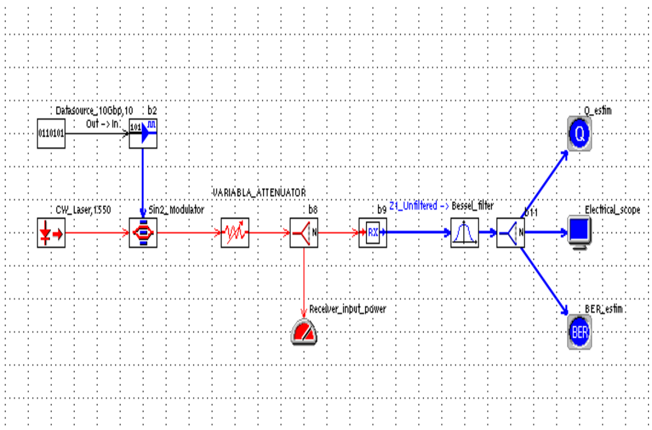

Figure 1. Simulation Scenario

Fiber to the home/curb/building (FTTH/FTTC/FTTB) technologies has been long envisioned as a preferred solution, and passive optical networks (PONs) have been widely considered as a promising technology for implementing various FTTx solutions. As one of the promising solutions is Ethernet Passive Optical Network (EPON). EPON combines low-cost Ethernet equipment and low-cost passive optical components and thus provide a number of advantages over traditional access networks, such as larger bandwidth capacity, longer operating distance, lower equipment and maintenance cost, and easier update to higher bit rates. EPON is the point to multipoint optical network. OLT with Central Office establish the transmitter part, fiber trunk forms channel and, Optical Network Terminal (ONT) forms the receiver part. Thus it is observed that EPON Scenario is divided in to three parts: transmitter, channel and, receiver.OLT (Optical Line Terminal) and ONU (Optical Network Unit) are the two components of the network. OLT is at transmitter side and ONU are at the

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

receiver side. Optical Network is operated for the downstream for data transfer. At transmitter side the video and data/voice signals are transmitted by the signal generator and PRBS generator at the wavelength of 1550 nm and 1490 nm. From the signal generator the video signals of different frequencies are taken as the input to the summer. Summer is used to combine the signals and then fed the output signal to the input of Laser. Laser is used to convert the signal into the optical signal and then amplify that signal. The output of the laser is taken as the input to the pre-amplifier. PRBS generator generates the binary sequences (0 and 1) which are taken as the input to the electrical generator. Here data/voice signal is converted into the electrical signal. Electrical generator then fed the electrical signal to the input of Laser. Laser then converts the electrical signal into optical signal. Thus with the help of pre-amplifiers both of these signals are fed to the input of optical multiplexer. Multiplexer is used to multiplexed or combined the different signals and then transmit the multiplexed signal over channel or medium. For travelling the optical signal will use the optical fiber as a medium. Optical fiber will be single mode fiber (SMF). SMF sustains only one mode of propagation. SMF is used for long distance transmission. From the scenario it is found that the fiber length is of 20 Km. But we have increased the fiber length up to 30 Km by using FEC technique. Splitter is the passive component used to split single fiber among various destination ports or optical network terminals. Splitter 1:16 is used to split the single fiber into 16 various fibers. One of the fibers from the 1:16 splitter then again split into two fibers through another optical splitter. From the optical splitter one output is taken as the input to the optical filter and second output is taken as the input to another optical filter. Optical filter is used to remove the unwanted frequency components from the optical signals. The outputs of the optical filters are taken as the input to the receiver. At the receiver optical detectors are used to detect the optical signals and convert the optical signal into electrical signal. The analysis tools such as signal analyzer, spectrum analyzer, BER tester, dispersion map and multiplot are used to analyze the signals.

III. SIMULATION RESULTS

This section presents selected results from our simulations of the network shown in Fig.1

With FEC technique

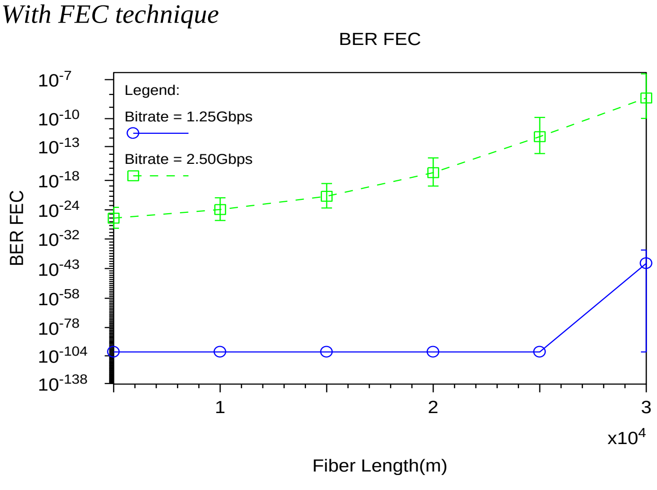

Figure 3.(a) BER with FEC

Figure 3.(a) shows that by using the FEC technique the performance of system can be improved. BER can be reduced by using this technique. Thus using this technique fiber length can be increased up to 30 Km and data rate can be increased up to 2.5 Gbps

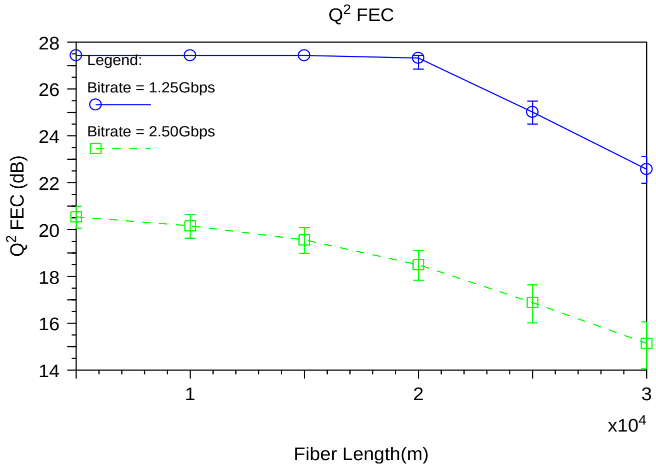

Figure 3.(b) Quality factor with FEC

Figure 3.(b) shows the simulation result with FEC technique. By using FEC technique the quality factor can be increased for the signal having bit rate of 2.50 Gbps even when the fiber length spans up to 30 Km.

Without FEC

Table I: BER, quality factor with FEC technique

Fiber Length	With FEC			
	1.25 Gbps		2.5 Gbps	
	BER	Q.F. (dB)	BER	Q.F (dB)
10 Km	2.69e-100	27.50	1.0386e-23	21.37
20 Km	2.69e-100	27.32	2.057e-17	18.50
30 Km	4.201e-42	22.53	5.217e-9	15.15

Table I shows the simulation results at different fiber lengths with FEC technique. It is observed that at the fiber length of 10 Km, BER and Quality Factor will be 2.69e-100 and 27.50 respectively for the bit rate of 1.25 Gbps. Similarly for the bit rate of 2.5 Gbps the corresponding BER and Quality Factor will be 1.0386e-23 and 21.37. At the length of 20 Km, BER and Quality Factor will be 2.69e-100 and 27.32 respectively for the bit rate of 1.25 Gbps. For the bit rate of 2.5 Gbps the corresponding BER and Quality Factor will be 2.057e-17and 18.50. For the fiber length of 30 Km and at the bit rates of 1.25 and 2.5 Gbps the corresponding BER, Quality Factor will be 4.201e-42, 22.53and 5.217e-9, 15.15 respectively. It is analyzed that when the distance increases from 10 Km to 30 Km then the BER increases and the Quality factor decreases. By using the

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

FEC technique, it is found that the system can perform well even at the distance of 30 Km and at the bit rate of 2.5 Gbps. Thus it is analyzed that by using the FEC (Forward Error Correction) technique the system performance can be enhanced even when the distance is of 30 Km.

WITHOUT FEC

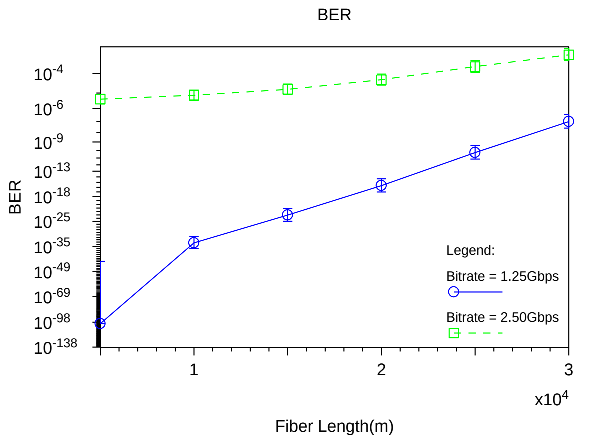

Figure 3.(c) BER v/s Transmission Fiber length (m)

Figure 3.(c) shows the simulation result without FEC. As the fiber length incerases then the corresponding BER increases. Thus BER will be different at the different bitrates of 1.25 and 2.50 Gbps. The BER will be more at 2.50 Gbps.

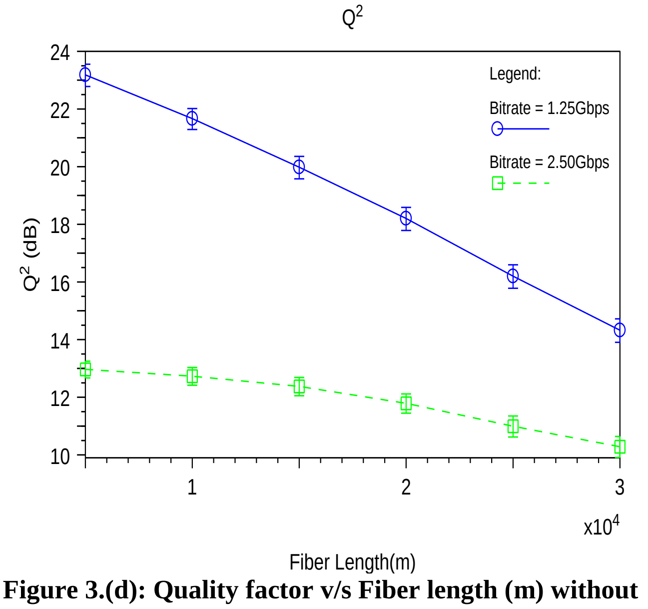

Figure 3.(d): Quality factor v/s Fiber length (m) without FEC

The graph shows the results for bitrates of 1.25 and 2.50 Gbps.This simulation result shows that when the length of fiber will increase then the corresponding quality factor will decrease. Without FEC technique the quality factor will become very less for the signal having bit rate of 2.50 Gbps when the fiber length will span up to 30 Km.

Table II: BER, Quality Factor without FEC technique

Fiber Length	Without FEC			
	1.25 Gbps		2.5 Gbps	
	BER	Q.F. (dB)	BER	Q.F.(dB)
10 Km	4.9186e-34	21.672	5.121e-6	12.83
20 Km	1.8657e-16	18.225	5.216e-5	11.80
30 Km	8.5476e-8	14.318	0.00053	10.27

Table II shows the simulation results at different fiber lengths without FEC technique. It is observed that at the fiber length of 10 Km, BER and Quality Factor will be 4.9186e-34 and 21.672 respectively for the bit rate of 1.25 Gbps. Similarly for the bit rate of 2.5 Gbps the corresponding BER and Quality Factor will be 5.121e-6 and 12.83. At the length of 20 Km, BER and Quality Factor will be 1.8657e-16 and 18.225 respectively for the bit rate of 1.25 Gbps. For the bit rate of 2.5 Gbps the corresponding BER and Quality Factor will be 5.216e-5 and 11.80. For the fiber length of 30 Km and at the bit rates of 1.25 and 2.5 Gbps the corresponding BER, Quality Factor will be 8.5476e-8, 14.318 and 0.00053, 10.27 respectively. Thus it is analyzed that as the distance increases from 10 Km to 30 Km then the BER increases and the Quality factor decreases. It is also found that BER will be for the data rate of 2.5 Gbps compared to the data rate of 1.25 Gbps. The performance of the system is poor at the distance of 30 Km. To improve the system performance a technique known as FEC will use.

IV. CONCLUSION

By analyzing the signal wavelength spectrum it is concluded that the power of the signals reduces as the distance varies from 10 Km to 30 Km. From the Table I and Table II it is observed that without FEC technique the performance of the system is poor as the distance varies from 10 Km to 30 Km corresponding BER increases and Quality factor decreases. Using the FEC Technique, it is concluded that transmission distance can be increased from 10 Km to 30 Km and data rate can be increased from 1.25 to 2.50 Gbps. Thus using this technique system performance can be increased even at the distance of 30 Km. From the Table 3 it is observed that when the distance will increase then the corresponding dispersion will increase and optical power will decrease.

REFERENCES

1. G. Kramer et.al, "Ethernet PON (EPON): Design and Analysis of an Optical Access Network," Photonic Network Communications, vol.3, no.3, July 2001, pp. 307- 319.
2. Paul W. Shumate, "Fiber-to-the-Home: 1977–2007," Journal of light wave technology, vol. 26, no. 9, May, 2008, pp.1093-1103.
3. Cedric F. Lam, "Passive optical networks: principles and practice," 2007, pp. 19-20.
4. Abdallah Shami, "QoS Control Schemes for Two-Stage Ethernet Passive Optical Access Networks," IEEE Journal on selected areas in communication, Vol. 23, No. 8, August 2005, pp.1467-1478.
5. Monika Gupta et.al, "Performance Analysis of FTTH at 10 Gbit/s by GEPON Architecture," IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 5, September 2010, pp.265-271.
6. Yoshinori Ishii et.al, "Optical Access Transport System GE-PON Platform,"FUJITSU Sci.Tech.J. Vol.45, No.4, October 2009, pp.346-354.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

7. Ahmad R. Dhaini et al, "Dynamic Wavelength and Bandwidth Allocation in Hybrid TDM/WDM EPON Networks," IEEE Journal of Lightwave Technology, Vol. 25, No. 1, January 2007, pp.277-289.
8. Kun Yang et al, "Convergence of Ethernet PON and IEEE 802.16 Broadband Access Networks and its QoS-Aware Dynamic Bandwidth Allocation Scheme," IEEE Journal on Selected Area in Communications, Vol. 27, No. 2, February 2009, pp.101-116.
9. Ahmad R. Dhaini, "Per-Stream QoS and Admission Control in Ethernet Passive Optical Networks (EPONs)," IEEE Journal of Lightwave Technology, Vol. 25, No. 7, July 2007, pp.1659-1669.
10. Michael P. et al, "Just-in-Time Scheduling for Multichannel EPONs," IEEE Journal of Lightwave Technology, Vol. 26, No. 10, May 2008, pp.1204-1216.
11. Mirjana R. Radivojevic et al, "Implementation of Intra - ONU Scheduling for Quality of Service Support in Ethernet Passive Optical Networks," IEEE Journal of Lightwave Technology, Vol. 27, No. 18, September 2009, pp.4055-4062.
12. Hiroki Nishiyama et al, "Inter-Layer Fairness Problem in TCP Bandwidth Sharing in 10G-EPON," IEEE System Journal, Vol. 4, No. 4, December 2010, pp.432-439.
13. S. P. Singh et.al, "Nonlinear Scattering Effects in Optical Fibers," Progress In Electromagnetic Research, PIER 74, 2007, pp.379–405.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication