

Performance Analysis of FTTH at 10 Gbit/s by GEPON Architecture

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Abstract

Gigabit Ethernet passive optical network GEPON is becoming technology of choice for meeting increasing bandwidth demands in optical networks.This study establishes analysis, simulation and performance evaluation of GEPON FTTH system(with and without dispersion compensation) with triple play with video broadcast at 1550nm and voice over IP and high speed internet at 1490nm at 10 Gbps data link downstream configuration with 1:16 splitting and distance of 20km and 30km.

Keywords: *FTTH, PON, DCF,GEPON*

1. Introduction

In today's information age, 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. As internet traffic capacity is increasing,this increase has lead to future capacity upgrades.Fiber optic cables are made of glass fiber that can carry data at speeds exceeding 2.5 gigabits per second (Gbps). Today almost all long haul high capacity information transport needs are fulfilled by optical communication systems[1-2]. For next generation of optical communication systems,fiber-to-the-home(FTTH) using passive optical network(PON) system design is required to improve transmission performance. GEPON is a perfect combination of Ethernet technology and passive optical network technology.

1.1 Passive Optical Networks(PON)

PON is classified into APON (ATM PON), EPON (Ethernet PON) and GPON (Gigabit Capable PON) on the basis of protocol method. APON provides transmission at 622Mbps and uses ATM(Asynchronous Transfer Mode) protocol. Later, APON has been renamed as BPON(Broadband PON) since it is misunderstood that APON provides only ATM service. Passive optical network(PON) is a technology viewed by many as an attractive solution to the first mile problem[3,4].A PON is a point to multipoint optical network with no active elements in the signal's path from source to destination. There are two competing optical distribution network architectures: active optical networks (AONs) and passive optical networks (PONs). Active optical networks rely on some sort of electrically powered equipment to distribute the signal, such as a switch, router, or multiplexer. Passive optical network (PON) is a point-to-multipoint, architecture in which unpowered optical splitters are used to enable a single optical fiber to serve multiple premises. In the earliest PONs, the synchronous transfer mode(STM),the asynchronous transfer mode(ATM),and subcarrier frequency division multiplexing(subcarrier FDM or SCM)were all demonstrated for multiplexing subcarrier traffic[5][6][7]. PON systems use optical fiber splitter architecture, multiplexing signals with different wavelengths for downstream and upstream[8][9][10].PON means passive optic network, EPON is integrated with Ethernet technologies, and GEPON is a Gigabit EPON. GEPON system is designed for telecommunication use. GEPON devices are fully compliant to IEEE802.3ah.This series products features high integration, flexible application, easy management, as well as providing QoS function.

2. System description of GEPON FTTH

The GE in GEPON stands for gigabit Ethernet. EPON based FTTH was adopted by IEEE standard IEEE802.3ah in September 2004[11]. Adopting Ethernet technology in the access network would simplify network management. EPON standards networking community renamed the term 'last mile' to 'first mile' to symbolize the importance and significance of the access part of the network. EFM introduced the concept of Ethernet Passive Optical Networks EPONs, in which a point to multipoint P2MP network topology is implemented with passive optical splitters.

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GEPON System Architecture

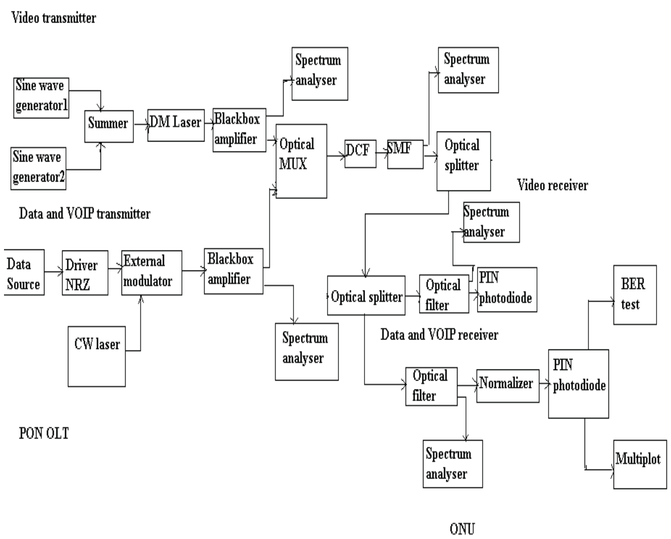


Figure 1 System configuration for FTTH GEPON with 1:16 splitter

The simulation model consists of three sections: 1) OLT 2) Distribution network and 3) ONU.

The network between the OLT and the ONUs is passive, meaning that it doesn't require any power supply. The presence of only passive elements in the network decreases its operational and maintenance costs once the infrastructure has been laid down.

The schematic diagram consists of a PRBS generator which is producing the bit stream and is directly fed to the NRZ electrical driver, now the output of the electrical driver is goes to the modulator and finally get amplified.Then we also combine data with video.For video, we have two sine wave generator having different frequencies and goes to the input of the summer, then summer mixes both the frequencies and finally goes to modulator and then amplifier. The outputs of both amplifiers are fed to multiplexer ,both video and the voice/data combines and transfer on optical fiber. Now at end of the receiver side,every ONU has a particular receiver for both the reception of the video and the voice/data. Before the reception a splitter is used to differentiate the particular user.

The optical signal from CO travels through fiber and arrives at optical network termination unit.At the subscriber here,the optical signal demultiplexes into data/voice and video components.Data/voice is transmitted at wavelength of 1490nm and video at 1550nm.The high speed internet component is represented by a data link with 10Gbps.The voice component can be represented as VOIP service (voice over IP),which is gaining popularity as an alternative to traditional PSTN(Public switched telephone network) at the customer end.

3. Simulation Analysis of GEPON FTTH System with 1:16 splitting and reach of 20km and 30km at 10 Gb/s

Data/Voice

Data/Voice

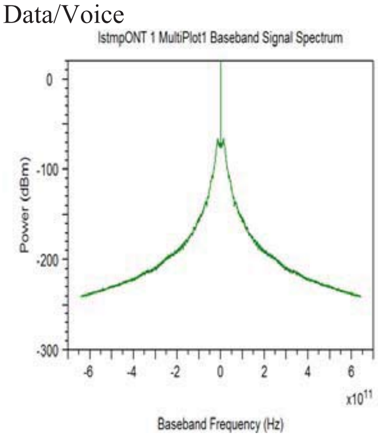
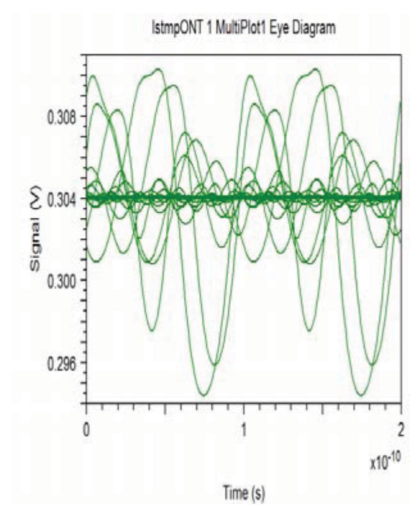


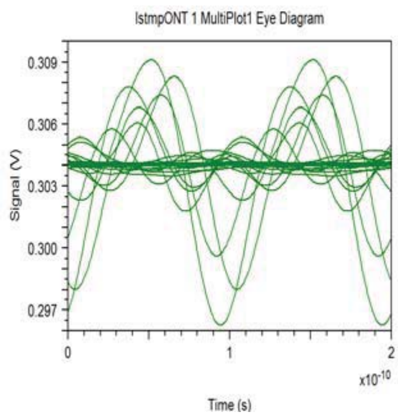
Figure2 Received data spectrum

1) With DCF

Eye Diagram



(a)



(b)

Figure 3(a) Data/Voice eye diagram with DCF at 20km
(b)Data/Voice eye diagram with DCF at 30km

BER Values

Table 1 BER value with DCF

DISTANCE	BER WITHOUT FEC	BER WITH (RS255,239)	BER WITH (RS_CONCAT _CODE)
20KM	2.9369e -022	1.0000e-122	1.0000e-122
30KM	4.3978e -005	5.5379e-018	1.0000e-122

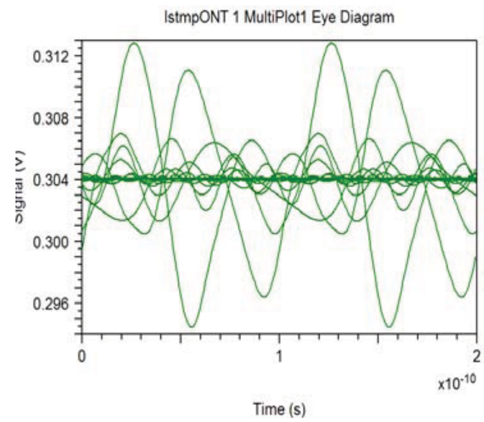
Q Factor

Table 2 Q factor with DCF

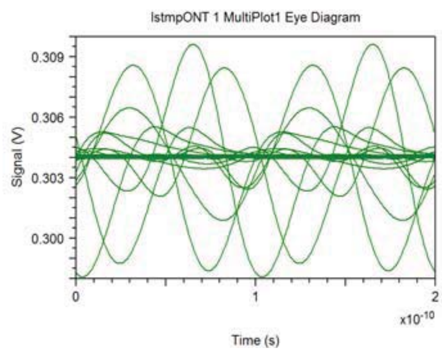
DISTANCE=20KM	DISTANCE=30KM
9.6317e+000	3.9216e+000

2) Without DCF

Eye Diagram



(a)



(b)

Figure 4(a) Data/Voice eye diagram without DCF at 20km
(b) Data/Voice eye diagram without DCF at 30km

BER Values

Table 3 BER value without DCF

DISTANCE	BER WITHOUT FEC	BER WITH (RS255, 239)	BER WITH (RS_CONCAT _CODE)
20KM	5.4987e-007	9.4557e-035	1.7541e-076
30KM	7.1805e-003	1.0599e-002	1.3067e-002

Q Factor

Table 4 Q factor without DCF

DISTANCE=20KM	DISTANCE=30KM
4.8729e+000	1.4625e+000

Video

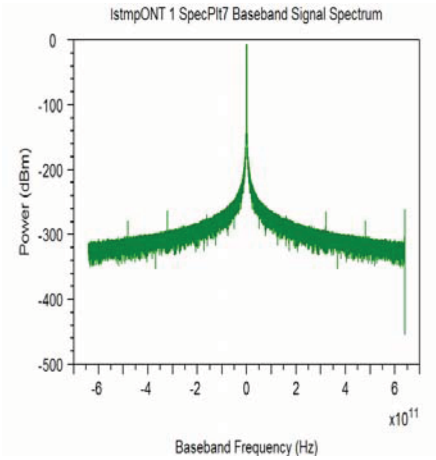


Figure5 Received video spectrum

4. Conclusion

From simulation results, we conclude that BER value and Q factor are much better with the use of dispersion compensation. Also as distance varies from 20 to 30 km, BER value and Q factor variation is high ,BER increases and Q factor decreases.

References

[1] P.R. Trischitta and W.C. Marra, "Global undersea communication networks", IEEE Communication Magazine, vol.34, no.2, February 1996, pp. 20-21.

[2] N.S. Bergan, "Undersea communication systems", in Optical Fiber Telecommunications IVB Components, Chapter 4,Academic Press, ISBN 0-12-395173-9, March 2002.

[3] G.Pesavento and M. Kelsey, "PONs for the Broadband Local Loop," Lightwave, vol. 16, no. 10, Sept. 1999, pp.68-74.

[4] B.Lung, "PON Architecture Futureproofs FTTH," Lightwave, vol.16, no.10, Sept.1999, pp.104-7.

[5] J.R.Stern et al., "Passive optical networks for telephony applications and beyond- TPON", Electron. Letts., vol.23, no.24, Nov.1987, pp.1255-1257.

[6] N.Tokura et al., "A broadband subscriber network using optical star couplers," in Proc.Globecom'87, 1987, pp. 1439-1443.

[7] T.E.Darcie, "Subcarrier multiplexing for multiple access lightwave networks," J. Lightwave Technol., vol. LT-5, no. 8, , Aug. 1987, pp. 1103-1110.

[8] K. Kitayama, T. Kuri, J. J. Vegas Olmos, and H. Toda, Fiber-Wireless networks and Radio-over-Fibre Techniques, in Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference and Photonic Applications Systems Technologies, OSA Technical Digest (CD) (Optical Society of America, 2008), paper CThR4.

[9] Jong-Won Kim, Broadband Communications Department, An Optimized ATM-PON Based FTTH Access Network, International Conference on Information, Communications and Signal Processing ICICS '09.

[10] Jaehyoung Park, Geun Young Kim, Hyung Jin Park, and Jin Hee Kim, FTTH deployment status & strategy in Korea, FTTH & U-City Research Team, Network Infra Laboratory.

[11] Ethernet in the First Mile, IEEE Standard 802.3ah, 2004.

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