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Bi-Directional GPON over FSO employing Triple Play Services for 128 users

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***Abstract* - This papers presents the simulation work on Gigabit Passive Optical Network over Free Space Optical Communication channel for triple Play services proving access of Audio Data and Video to 128 Users. The System is simulated and results are taken in terms of Q- Factor and BER. Various investigations for system evaluation are also performed such as integration of amplifier into system. System is also investigated for number of users, data rate etc and recommendations are made as the results are at par using amplifiers and choosing correct variants of system.**

1. INTRODUCTION

Next generation access networks should meet increasing demand for large bandwidth. Passive optical network involving wavelength division multiplexing(WDM-PON) is most promising access network [1].Households prefer to consume triple-play bundles, i.e., bundles of voice, video and data on same network [2]. PON in fiber to the home (FTTH) networks is widely deployed to fully support triple play services. WDM-PON is a point to multipoint network which uses single fiber to serve multiple users [3]. Promising technique to support FTTH architecture is Gigabit-capable passive optical network (GPON). GPON offering various advantages like bandwidth efficiency, higher split ratios and low cost is regarded as one of the best choices for broadband access network in the future [4]. For making the above discussed technologies more flexible, Free Space optics is introduced as a promising technique. Free Space Optical communication is the technology in the optical communication system in which the light travelling in free space is used to transmit data wirelessly for computer networking or telecommunication. In fact, FSO is considered from ground-to-ground links, both for short (in the order of few meters) and for long (in the order of some km) range, up to inter-satellites or satellite-to-ground links, that are in the order of tens of thousands kilometers [6]. If compared to a radio link, the main advantage of FSO is represented by the greater bandwidth acheivable: commercial systems are able to provide optical connections guaranteeing up to some Gbps over a link distance in the order of some kilometers in a clear atmosphere, but a experimental connections was demonstrated with a Tbps capability [7]. Another key feature of FSO is represented by the spectrum, lying over frquencies around 200THz that is license free, resulting in an important reduction of capex costs.

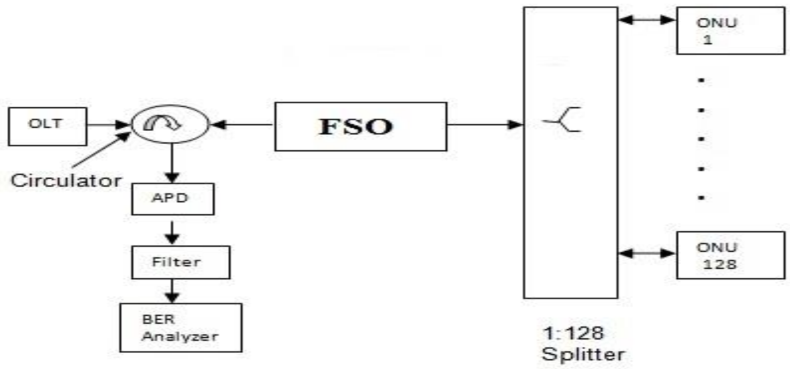

Fig.1. Simulation setup for 128 users for GPON carrying triple play services

In literature, various evaluations have been done on triple play services based passive optical networks. Fady I. El-Naha et al [5] demonstrated a bidirectional sub carrier multiplexed (SCM) WDM PON. Reflective filter and cyclic AWG were used where uplink/downlink data was obtained using single optical source. Successful results were obtained for Data rate of 1 Gb/s for 10 km of fiber link. D. Kocher[6] evaluated FTTH Gigabit Ethernet Passive Optical Network(GEPON) link design for 56 users at 2 Gbps bit rate covering distance of 20 km by using a boosting amplifier. Evaluation was performed for different values of data rate from a Central Office (CO) in terms of BER (Bit Error Rate). J malhotra[7] evaluated performance of downstream link for triple play services . Link was of high capacity, long reach, and 32 channels. To ensure that FTTH system covers longer distance non linear fiber of 80 km was used with 20 km of reverse dispersion fiber to nullify the chromatic dispersion. S.singh [8] reported the performance of bidirectional passive optical network (BPON) for triple play service. Traffic was symmetric and acceptable value of Q factor was obtained at 10 Gbps. The Q-factor results showed the acceptable performance at10 Gbps data rate accommodating 128 users at distance of 1000 m.

2. SYSTEM SETUP

Block diagram of simulation setup for GPON carrying triple play services for 128 users is shown in Fig.1. To differentiate between uplink and downlink a circulator is used. OLT modulates and multiplex signals over FSO channel.It consist of data/voice and video signals as shown in Fig. 2. Data/voice is transmitted at wavelength of 1490 nm and video at 1550 nm. RF video transmitter consists of 2 signal generators, summer, external modulator and laser source tuned at 1550 nm having input power of 0 dbm. Data/voice signal is generated by using PRBS gen which generates different data rates. NRZ modulator converts bits into electrical signals. MZM is used as an external modulator with extinction ratio of 30db.After Modulation video and data/voice signals are multiplexed and launched into FSO antenna.

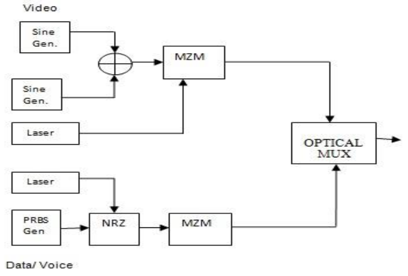

Fig.2. Internal components of OLT

Different configurations of EDFA and SOA amplifiers are used to boost signal to accommodate more number of users and to increase transmission distance. EDFA used has gain of 15 db and SOA has injection current of 0.45A.Results are obtained for different configurations and comparison is made between them. These amplifiers are used at transmitting and receiving ends. 1:128 splitter is used divide signals between ONU's. Splitter used is ideal with default value of 0 db loss. ONU consist of filters and photodetector as shown in Fig.4. Optical filter is used to detect whether it is video or voice/data signal. APD photodetector is used for conversion of data and video into original form.BER analyzer is used to visualize eye diagram, Q Factor and BER. To generate uplink signal PRBS generator is used and laser source is tuned at 1300 nm. By using MZM modulator data is transmitted towards OLT.

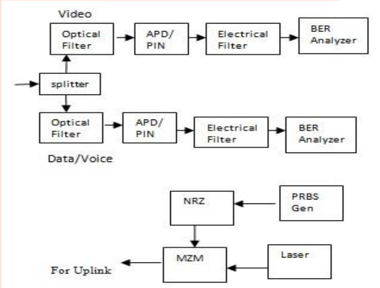

Fig.3. Internal architecture of ONT

3. RESULTS AND DISCUSSIONS

Data is transmitted at the wavelength of 1490 nm and the video is transmitted at the wavelength of 1550 nm. Fig.4. shows wavelength spectra of multiplexed data and video signal. When this multiplexed signal is transmitted over FSO there is degradation in signal due to attenuation of weather, dust particles etc which limits the distance and number of users covered.

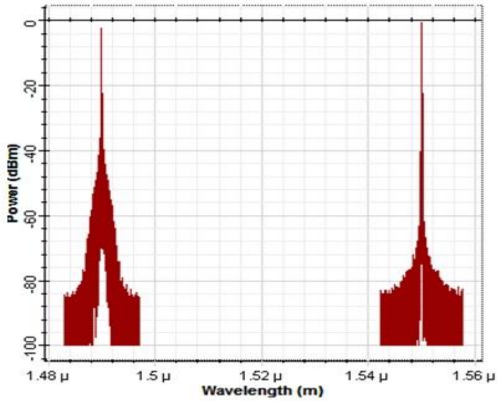

Fig.4. Spectrum of audio and video signal

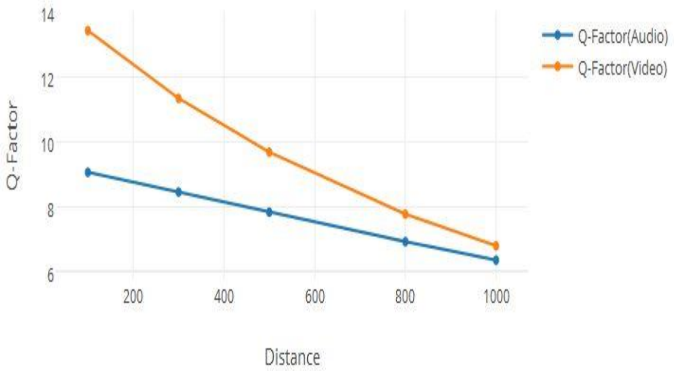

Fig.5. Plot of Q-factor Vs FSO link length for downstream without amplifier consideration

Similar graph for Log of BER is obtained and is shown in Fig.6 Acceptable value of Q factor 6.58 is obtained for 128 users at 15 Gbps at 1000 m of transmission distance for uplink transmission.

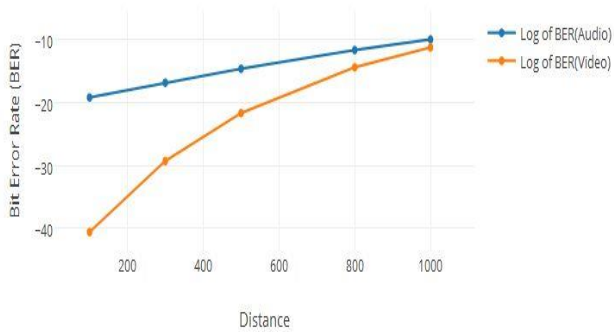

Fig.6. Plot of Log BER Vs FSO link length

Evaluation of eye diagram for audio and video signal at 1 Km has been shown in Fig.7. Eye of the signal represents the Q-factor, BER, eye height and value of jitter etc. Eye height of the signal decreases with the increase of the distance of FSO.

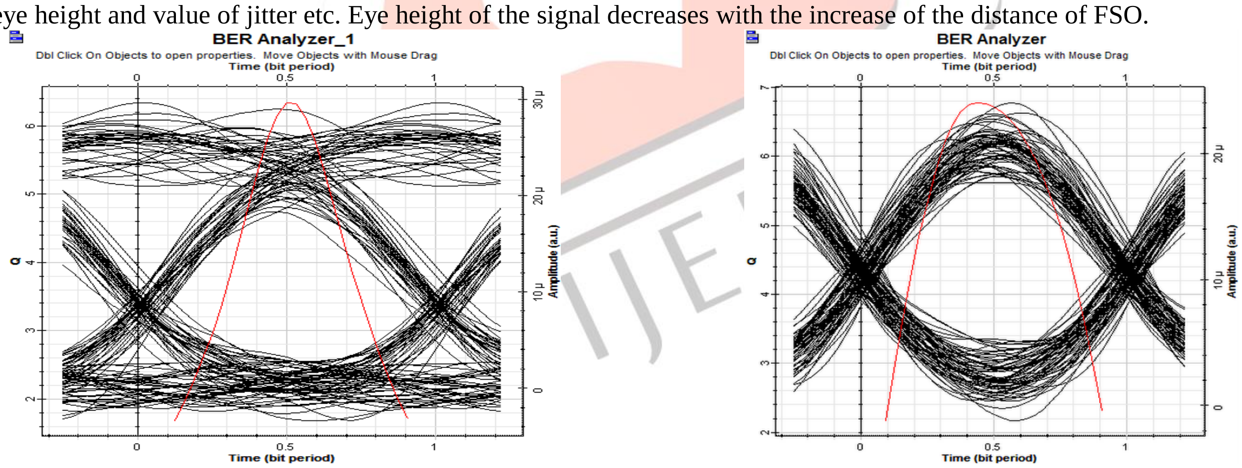

Fig.7 Evaluation of eye diagram at 1Km for (a)Audio signal (b) Video Signal

Figure 8 represents the performance of three different configuration of amplifiers in FSO PON for video signal.It is observed from the fig that SOA performs worst in terms of Q-factor and BER for varied transmission distance. Where EDFA alone performs better than SOA and works for 4000m FSO range. EDFA-SOA provides best results and prolongs the distance to 5000m within acceptable Q-factor value.

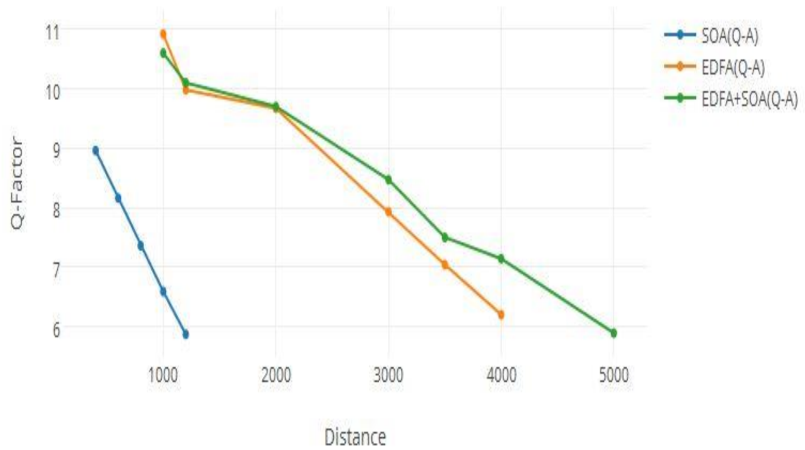

Fig.8. Plot of Q-factor Vs FSO link length for different amplifier configurations

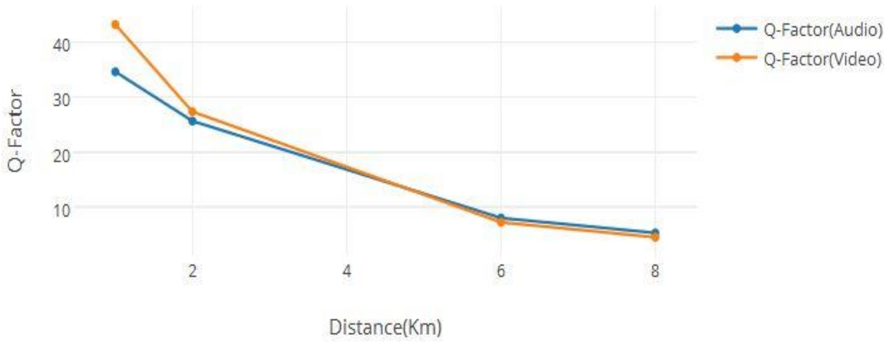

Fig.9 Distance Vs Q-Factor for 128 users Bidirectional PON(Audio/Video) with amplifier integration

4. CONCLUSION

Performance of GPON employing triple play services (voice, data and video) is investigated. Acceptable value of BER 4.21e-010 is obtained at 15 Gbps for 128 users upto 8km of transmission distance. There is increase in BER when there is increase in data rate, number of users and transmission distance. Comparison is also performed between EDFA and EDFA-SOA in terms of Q Factor. EDFA-SOA shows better performance than EDFA.

REFERENCES

[1] Xuejiao Ma,ChaoqinGan n, ShiqiDeng ,A novelcolorless WDM passive optical network delivering up/downstream signals and video broadcast signal simultaneously, Optical Switching and Networking 10 (2013) 100–105.
[2] Pedro Pereira, Tiago Ribeiro, João Vareda Delineating markets for bundles with consumer level data: The case of triple-play, International Journal of Industrial Organization 31 (2013) 760–773.
[3] S.-J. Park, C.-H. Lee, K.-T. Jeong, H.-J. Park, J.-G. Ahn, K.-H. Song, Fiber-to the-home services based on wavelength-division-multiplexing passive optical network, J. Lightwave Technol. 22 (2004) 2582–2591.
[4] S. Singh, R.S. Kaler, All optical wavelength converters based on cross phase modulation in SOA-MZI configuration, Optik-International Journal for Light and Electron Optics 118 (8) (2007) 390–394.
[5] Fady I. EL-Nahal, Abdel Hakeim M. Husein, Bidirecctional WDM- PON architecture using a reflective filter and a cyclic AWG, Optik 122(2011) 1776-1778.
[6] Deeksha Kochera, R.S. Kalera, Rajneesh Randhawa, Simulation of fiber to the home triple play services at 2 Gbit/s using GE-PON architecture for 56 ONUs, Optik 124 (2013) 5007– 5010.
[7] Jagjit Singh Malhotra, Manoj Kumar, Ajay K. Sharma, Performance optimization of high capacity long reach 32 channel FTTH downstream link employing triple play services, Optik 124 (2013) 2424– 2427.
[8] S. Singh, Performance evaluation of bi-directional passive optical networks in the scenario of triple play service, Optik 125 (2014) 5837–5841.
[9] Rakesh Goyal ,R.S. Kaler , A novel architecture of hybrid (WDM/TDM) passive optical networks with suitable modulation format, Optical Fiber Technology 18 (2012) 518–522.