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Investigation of 80GBPS Optical Access System for 1600 Clients

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Abstract: The hardware of an access system plays an essential part in its performance. Coming age systems must have the capacity to give high data transfer limit for a large no. of clients while guaranteeing a good Quality of service (QoS). This paper proposes a passive optical network (PON) system with enhanced data rate up to 80 Gbps. The system is investigated on the basis of different parameters like Q-factor, Eye diagram analysis, waveform spectrum analysis. Information signal is transmitted with an input power of 10 dBm and 15 dBm. Information is communicated without the use of any reach extender devices like amplifier reducing the overall cost of the network. Also, the system under evaluation is analyzed for different receiver filters. It is observed that Bessel filter performs better among different filters. The evaluated system transmits signals up to around 60 Km for 1600 users with acceptable Q-factor of 7.

Keywords: Optical access system, Passive optical network (PON), Q-factor, Eye diagram.

1. Introduction

The fast development of Internet and its associated services, for example, multimedia communication and voice-over-IP (VoIP) is quickening interest for the broadband access system. While most broadband information around the globe are conveyed by means of copper cable systems, optical technology has been accessible for a number of years and is being used extensively in a few nations [1]. Whenever optical access system is installed, passive optical networks (PONs) are employed because the communicating fiber and the associated hardware can be shared by a more no. of clients [2]. PON is an innovation seen by numerous as an appealing answer for the last mile issue. A PON is generally a point to multipoint optical system with no active or dynamic components in the information across the communicating channel. The components utilized as a part of PON are inactive couplers, combiners, and splitters [3, 4]. PON can be deployed in a no. of topologies like hierarchical (tree), tree-and-branches, ring or transport topology with the tree being employed frequently. All communication in a tree-based system is performed linking an optical line terminal (OLT) with optical network units (ONUs). The OLT dwells in the central office (CO), interfacing the core system with the access system [5, 6]. The ONUs resides in the client place for processing of multimedia traffic. Though splitter have a 1×32 split ratio, but ratio of 1×16 and 1×8 are are utilized. New measures are calling for the much bigger split ratio of 1×64 and 1×128 or more than this [7]. Benefits of utilizing PON for a client network comprise of large reach, lessened fiber installation, the diminished tariff of preservation (due to inactive equipment) and easy shift to large transmission rate [8]. PON gives various services for access system at minimal tariff (close to that of digital subscriber line (DSL)) and less power (virtually cutting by half of lifetime discharges) by communicating through common fiber links and hardware appliances among various clients [9,10].

Different types of PON are defined in the literature: Ethernet PON (EPON) is standardized as IEEE 802.3ah [11], while Asynchronous transfer mode (ATM) PON (APON) also called as broadband PON (BPON) as ITU-T G.983, and gigabit PON (GPON) is defined in the ITU-T G.984. EPONs are considered to be more encouraging than APONs for information carrying systems. EPON were presented by Ethernet in the First Mile (EFM) in which a P2MP topology was executed with optical splitters [12, 13]. GPONs, by utilizing GEM rather than ATM, maintain a strategic distance from the wastefulness of division and reassembly [14]. The next version of GPON is defined as XGPON, in this term X describes various information rates like 10 Gbps or more than that. XGPON utilizes NRZ modulation plan same like GPON [15]. Another concept to extend the reach of the system was utilized by using an amplifier. Generally Erabium Doped Fiber Amplifier (EDFA) is used because of its more gain and output power. EDFA posses a no. of problems also, like it is bulky because of which it utilize more power [16]. This problem is a major hindrance in the use of amplifier; also it pushes up the cost of the system. In this paper, we have proposed a Passive optical access system which can transmit at a high rate of 80 Gbps. The simulated model communicates with a separation of 60 Km. This paper is systemized as follows. Segment 2 portrays the proposed architecture with Section 3 clarifying the results obtained and toward the end Section 4 summarizes the conclusion.

2. Proposed System Architecture

Passive optical access network comprises of OLT, ONU and splitter which is passive in nature [17]. In our proposed optical access architecture shown in figure 1, an OLT which is associated with the optical network unit (ONU) through an optical fiber of variable length at the client premises. The data is communicated at a wavelength of 1350 nm. In the proposed system, transmitter consists of OLT equipments. ONU terminals are placed in client premises. Sixteen hundred ONUs can access information. Tree and branch design is utilized for dispersal of data utilizing optical fiber link. Information from the OLT is delivered to the client ONU using a communication channel. Optical fiber cable is used as a communication channel in our system. For the investigation, distance between transmitter section and receiver section can vary from 45 kilometers to 100 kilometers. ONUs receives the signal from power splitters. Power splitter 1, splits the incoming signal into two hundred packets. Further, these packets are bifurcated into eight data packets by power splitter 2. The same procedure is carried out by power splitter 3 to 201.

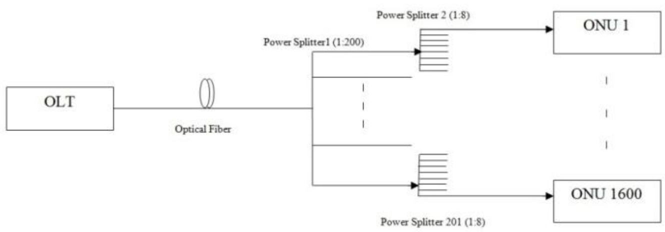

Figure 1. Proposed Architecture.

OLT comprises a data generator which produces the information to be communicated. This useful information is transformed into the electrical signal with the assistance of electrical signal generator. The signals so generated are then changed over into optical form before its communication over fiber cable. This transformation is done utilizing a light source which is the soul of an optical transmitter section. In this work, we have utilized Continuous Wave (CW) laser as the source of light. Signals produced by the electrical signal generator are modulated with the yield of LASER utilizing an optical modulator. The power of the laser is varied. The signal is transmitted with variable power of 10 dBm and 15 dBm. The stream of signals is communicated through single mode fiber with expanded ranges of 45-100 km. At the other end of communication channel, information signals are split by the power splitters and focus them to ONUs. Information is received by 1600 ONUs. The primary component of recipient is a photo detector. In our proposed system, avalanche photodiode (APD) is employed. APD has increased sensitivity because photocurrent is multiplied before confronting the thermal noise generally affiliated with the circuit of receiver. Photodiode outputs the electrical signal, which goes through a low pass filter and a 3R regenerator. Low pass filter reduces the peak overshoot and re-generator reestablishes and recuperates the information signal, which is provided to BER analyzer where the output wave is evaluated.

3. Result & Discussion

In this segment, the results of the proposed architecture of a PON system are reported. In this design, data is transmitted at various data rate extending from 60Gbps to 80 Gbps. For electrical modulation, we have utilized NRZ modulator. NRZ modulation format is picked because that it has been reported that the most reasonable information format for PON system is NRZ [18]. The signal is transmitted with a power level of 10 dBm and 15 dBm. The deviation of the quality factor versus distance for the previously mentioned information rate appears in figure 2. Q-factor estimates the quality of information signal at the receiver in terms of Signal to Noise Ratio (SNR). Higher the estimation of the Q-factor superior will be the SNR and better is the quality of received information. A system with the high Q-factor informs that it has low BER which demonstrates that the system execution is better [19, 20]. The goal is to have a Quality factor of 7 which is considered as a reference for XG-PON [21]. This is clear from results; depicted in figure 2 that quality figure diminishes with increment in the information rate and separation. Information is communicated to receivers with a power level of 10 dBm. The Q factor is seen to deteriorate with increasing information rate and separation. The proposed system works well up to 75 Km with a measured value of Q-factor to be 8.44039 for information rate of 60 Gbps. Alternatively, when the information is communicated at a rate of 80 Gbps, the system gives an acceptable quality factor value of 7.72124 for a distance of 55 km.

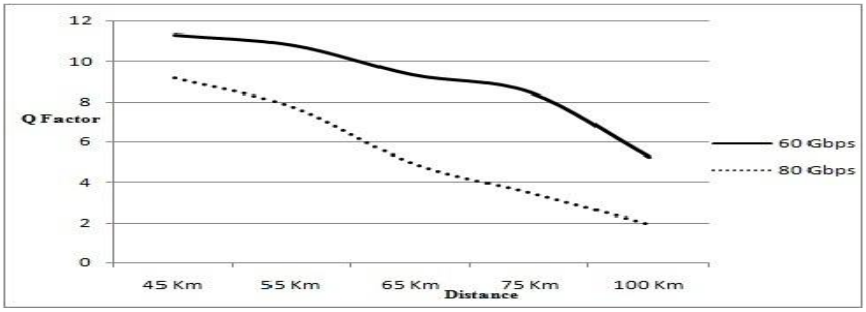

Figure 2. Q Factor vs. Distance for variable data rate.

In figure 3, the quality factor is plotted against distance for various levels of transmitted power. Information is transmitted at a rate of 80 Gbps. It is noticed that Q-factor improves from 7.72124 to 8.31754 for a distance of 55 km. So; the information is transmitted to a longer distance with improved quality if the power of transmitted signal is increased. In [22] the OADM based ring system was simulated by changing the recipient filters to be specific Butterworth, Chebyshev & Bessel filter were used. Chebyshev was noted to give better performance among all. We stretch forward this work for our proposed network and examine its execution for various filters namely Butterworth, Bessel, Gaussian and Chebyshev. For simulation, information is

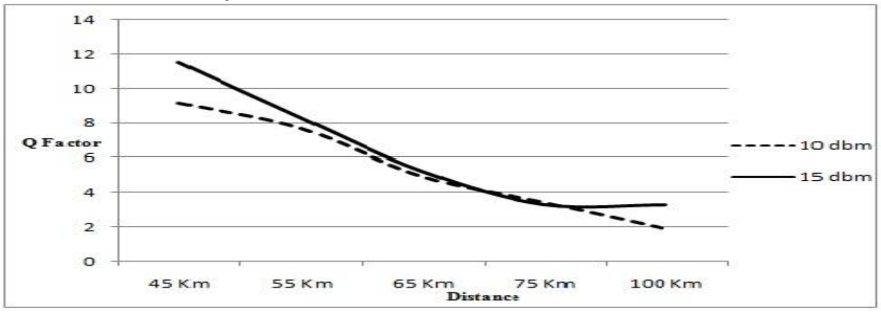

Figure 3. Q Factor vs. Distance for different input power levels.

communicated at a rate of 80 Gbps. The distance between transmitter and receiver is kept at 45 Km. The quality factor for Butterworth filter is 10.3332 and for Bessel filter is 11.2903. It is noted that Bessel filter is the best filter among all. The system performance is enhanced by using this filter; results are demonstrated in figure 4.

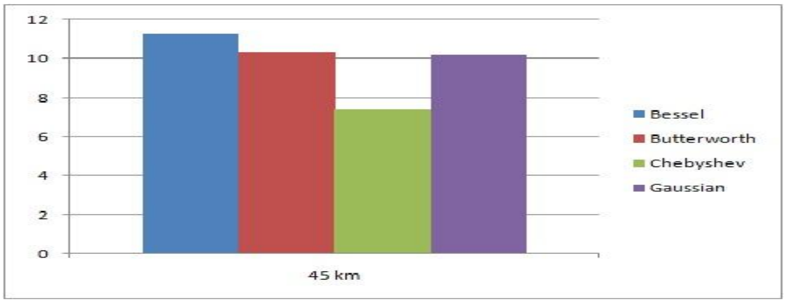

Figure 4. Q Factor for different electrical filters at 45 km.

Eye diagrams of proposed passive optical network system for a distance of 45 Km at 80 Gbps for a power level of 15 dBm as shown in figure 4. By utilizing eye diagram, we can rapidly assess system execution and pick up understanding into the way of channel deformities that can cause errors when a recipient tries to translate the estimation of a bit. We noted from the results that the eye opening is decreasing from 0.071176 to 0.021452 with the increase in power level from 10 dBm to 15 dBm.

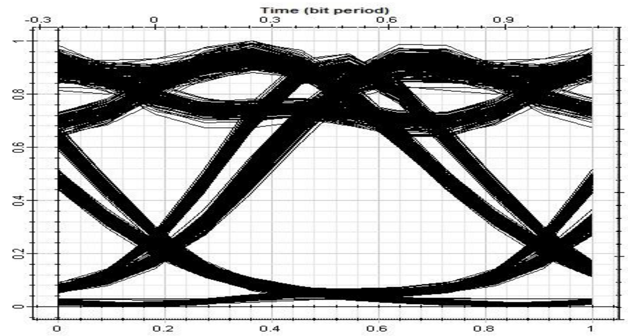

Figure 5. Eye diagram at input power level of 15 dBm.

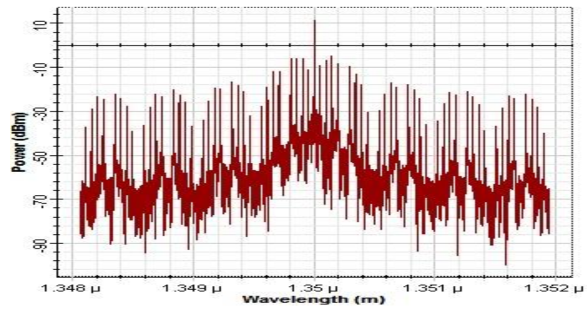

Figure 6. Input spectrum.

The wavelength spectrum of proposed passive optical access system is displayed in figure 5 and 6. As information is communicated across the fiber, it may encounter dispersion due to the Inter symbol Interference (ISI). This may add deformities in the signal. These deformities are due to the effect of noise [23, 24]. Wavelength spectrum analyzer examines over a span of wavelengths and gives a show demonstrating the power of information signal at every wavelength. The spectrum of proposed passive optical system at a separation of 45 km with 1600 users is demonstrated in figure 5 & 6 respectively. Information is transmitted at a rate of 80 Gbps. The signal power is about 8db at transmitter. The received power is about -22db.

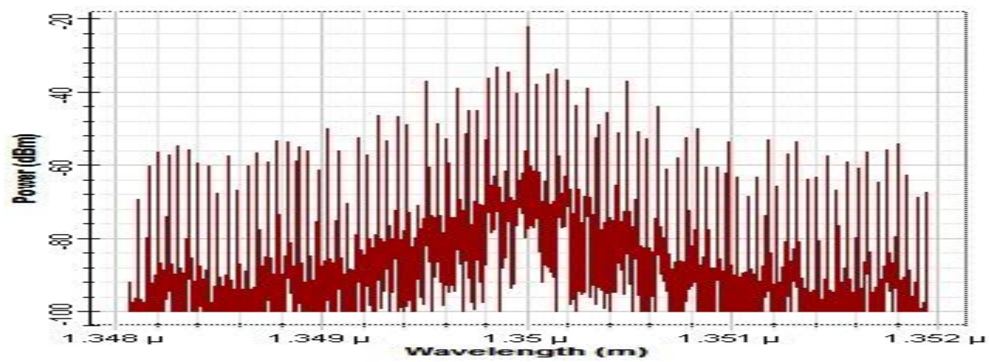

Figure 6: Output Spectrum after 45 Km

This power drop in the information signal at the separation of 45 km which is brought about by the unwanted signals called noise.

4. Conclusion

In this paper, diverse PON models for higher separation have been examined. The proposed access system has been designed and investigated to give subscribers information at the more noteworthy separations. The proposed architecture work has emphasized that execution of the PON enhances for longer reach at a higher transmission rate without the assistance of optical amplifiers. The optimum performance of the simulated system is achieved for 80 Gbps for a distance of 60 Km. It is also observed that by increasing the transmitted power the range of the network can grow. The number of clients receiving information with a satisfactory quality has grown manifold. This makes the system cost effective as the information is transmitted to more users without any additional hardware requirement.

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