Simulation and Performance Evaluation of BPON System

Dheeraj Singh Dohare, Saurbh Dubey, Ranjeet Singh, Saurabh Kumar

Abstract— **Broadband Passive optical network is technique in which a single fiber is used to support multiple customers. Broadband Passive Optical network is a network in which data rate range is 155-1244 Mb/s and coverage area is up to 20 km. BPON uses ATM as the protocol. The Broadband passive optical network (BPON) was the first attempt towards a PON standard. It is controlled by the ITU-T and is designated as ITU-T G.983. This paper provides an overview of BPON network and analyses network architecture, and evaluate the system performance in terms of BER and Q Factor of the BPON system. The performance of BPON System is evaluated using Opti system version 12.0.**

Index Terms—**ATM, ONU, OLT,**

I. INTRODUCTION

BPON (Broadband PON) is the most popular current Passive Optical Network application in the beginning. ATM work as the protocol of BPON. ATM is widely used for telephone networks in telephone exchange and the methods of transporting all data types (voice, Internet, video, etc.) are well known. BPON digital signals operate at 155, 622 and 1244 Mb/s ATM data rates. The coverage range of BPON is less than 20 kms. Downstream digital signals from the CO through the splitter to the home are sent at 1490 nm data rate. This signal carries both voice and data to the home. Video on the first PON systems are used the same technology as CATV, an analog modulated signal, broadcast the signal separately using a 1550 nm laser which may require a fiber amplifier to provide enough signal strength to overcome the loss of the optical splitter. Video service of PON could be upgraded to digital form of signal using IPTV, negating the need for the separate wavelength for video [1]. Upstream digital signals for voice and data are sent back to the CO from the home using an inexpensive 1310 nm laser. WDM couplers separate the digital form of signals at both the home and the CO.

II. PASSIVE OPTICAL NETWORK

Passive optical networks (PON) are probably the most attractive alternative for optical access networks. A Passive Optical Network does not contain any active components means there is no router and switches, i.e. components that require power, between the sender and the receiver [1]. Typically it is built using passive splitters to distribute the signal to several users, without using excessive amounts of optical fiber. Therefore, the cost of optical fiber installation and maintenance of fiber is low. The central node in a PON, which is the gateway to the main network, is called optical line terminal (OLT). The terminals at the user premises are called optical network units (ONU). Figure 1 shows the topology of a typical PON.

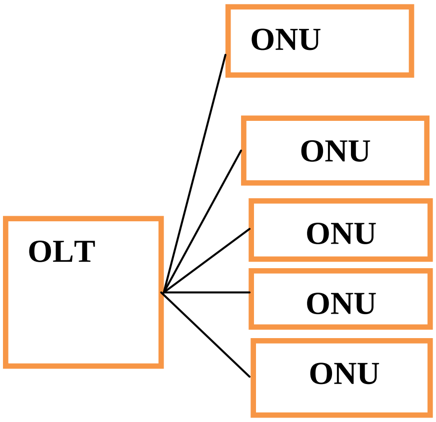

Figure 1 Basic block diagram of Passive Optical Network

III. ETHERNET PASSIVE OPTICAL NETWORK (EPON)

EPONs are currently being standardized by the IEEE. Since Ethernet is also being used in metro area networks (MAN), EPON is an economical way of using Ethernet in the access network to connect MANs and LANs. PON is a new physical layer for Ethernet with a shared medium, however, the medium access control will not be CSMA/CD based. Instead a centralized access control will be used, where the optical line terminal will send grants to the ONUs in order to coordinate the transmissions [2]. PONs can be divided into different types of network, but the functionality of EPON will be similar regardless of the higher layers. The common characteristics include the duplexing which is usually handled by wavelength division multiplexing (WDM). With the help of a operating wavelength of a EPON are 1.55 μm for the downstream and 1.3 μm for the upstream they can both be sent over the same optical fiber. The ITU standard supports up to 32 ONUs and covering distance of up to 20 km. Due to different distances between the Optical Line Terminal (ONU) and the different ONUs the power can vary as much as 15 dB between transmissions from the different ONUs. Therefore, the receiver's needs a dynamic range of received power at least 15 dB. The changes distances also need to be taken into account by the multiple access protocol, therefore a procedure is used to estimate the delay between the Optical Line Terminal (ONU) and each ONU [2].

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IV. Gigabit Passive Optical Network

The most recent PON standard is the ITU-T G.984 Gigabit Passive Optical Network standard, which offers approx. 2.5 Gbps bandwidth and direct support of both TDM(POTs & E1) and Ethernet traffic at the edge of the network with possible three play voice, data and video services on the same PON [3]. GPON can support ONUs that is located as far as 30 Km from the OLT. GPON offer higher split ratio of which results in an OLT reduction by more than a factor of 2 over EPON. Gpon was Initial deployments in North America and EMEA. For networking purpose no active switches in the network. GPON offers efficient gigabit transport for "triple play" suites of voice, video, and data services with guaranteed Quality of Service (QoS)[4].

System Model Description

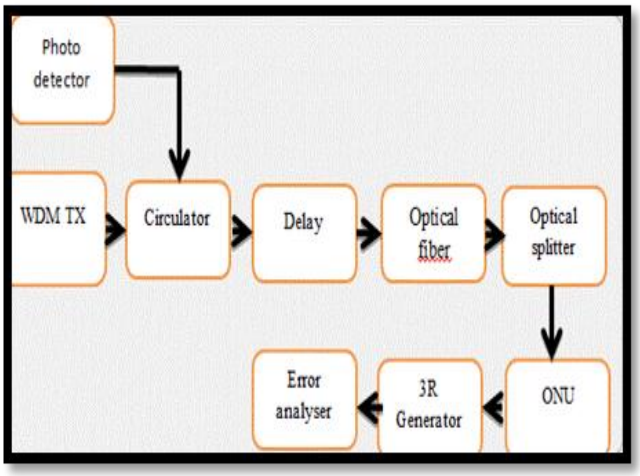


Figure 2 Block diagram of BPON

Photo detector: Photo detectors are used primarily as an optical receiver to convert light into electricity. A photo detector operates by converting light signals that hit the junction to a voltage or current of the photo detector. The junction uses an illumination window with an anti-reflect coating to absorb the light photons.

WDM Transmitter: The WDM transmitter requires a number of transmission lasers multiplexed into a single fiber. In WDM transmitter modulators and code generators are also available.

Circulator: A circulator is a passive non-reciprocal three- or four-port device, in which a radio frequency or a microwave signal entering any port is transmitted to the next port in rotation. An external waveguide is connected to the port.

Optical Splitter: An optical splitter is a passive optical fiber tributary device that connects an optical line terminal to an optical network unit (ONU). ONU can transmit packets using time division multiplexing (TDM) in the downlink and gather packets using the time division multiplexing access (TDMA) protocol in the uplink.

Error Analyzer: Error analysis is the study of kind and quantity of error that occurs, particularly in the fields of applied mathematics (particularly numerical analysis), applied linguistics and statistics.

Simulation Setup

In this paper, a system has been designed for the transmission of EPON. The designed system consists of three main blocks: Transmitter, Transmission Channel and Receiver.

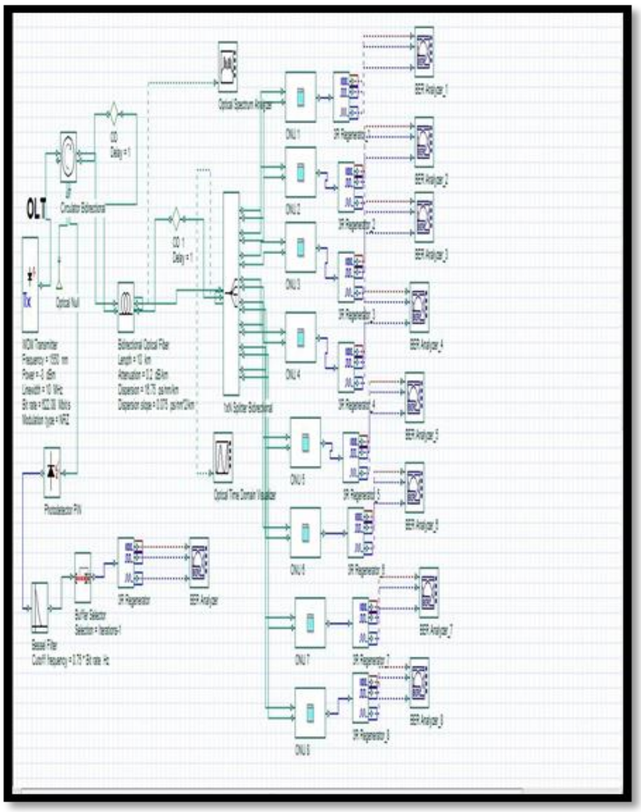
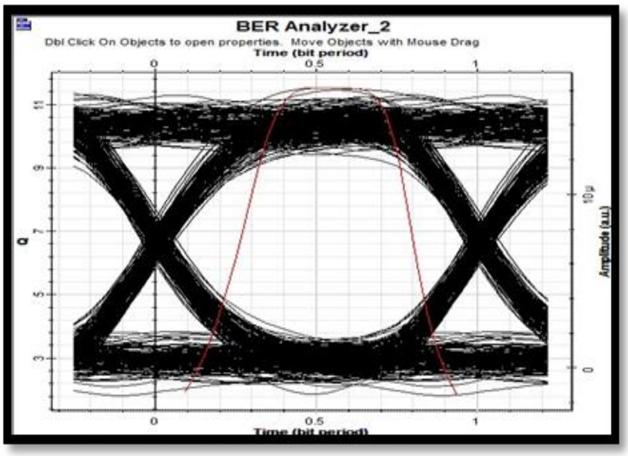


Figure 3 Simulation setup

The WDM transmitter block consists of a CW Laser, a User defined bit sequence generator, NRZ pulse generator, Mach-Zehnder modulator and Ideal DWDM multiplexer. The transmission channel used in this paper is bidirectional Optical fiber channel. The Fiber channel used here is of 10 Km range with attenuation of 0.2dB/Km. Transmitter and receiver aperture diameters are 5cm and 20cm respectively and the divergence on fiber channel is taken to be 2mrad. At the receiver end 1xN splitter is used to receive & separate the signals at different wavelengths. It generates various signals of different wavelengths, each of the signals generated is fed to the photo detector. Photo detector is used primarily as an optical receiver to convert light into electricity. Here, the APD is used as the photo detector. The properties of APD are set as: gain is set to 3, responsivity as 1A/W and dark current is taken as 10nA. The output of the APD is fed to the low pass Bessel filter centered at 7.5 GHz frequency. The filtered output is fed to a 3R regenerator.

V. Results and Discussion

The performance of an optical system is characterized through the bit error rate (BER). Although the BER can be defined as the number of errors made per second, such a definition makes the BER bit-rate dependent. It is customary to define the BER as the average probability of incorrect bit identification. Therefore, a BER of 10^{-6} corresponds to on average one error per million bits. Most optical systems specify a BER of 10^{-9} as the operating requirement; some even require a BER as small as 10^{-14}. The error-correction codes are sometimes used to improve the raw BER of an optical system. Performance of the system for different number of users has been observed using BER analyser and Eye Diagram.



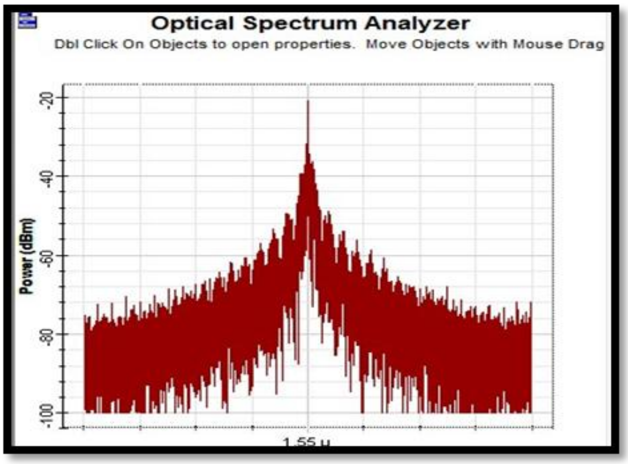


Figure 4 results in terms of BER

In this paper we observe that the max. Q factor is 11.5128, and min. BER is 5.67199x10^-31, whereas the eye height and threshold are 1.00564x10^-5 and 6.77405x10^-6 respectively. Above two figure shows the result of BPON network for evaluating the BPON Technique.

VI. CONCLUSION

The optical communication system is studied and problems are identified for the existing optical communication system. Simulated BPON system shows that the BER is reduced and system has good Q factor. Significant reduction in BER and improved Q- factor have been observed with increasing number of users up to certain permissible value of data rate and fiber length. The PON is one of the most successful access architecture that can provide high capacity and long reach.

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