# Performance Evaluation of Gigabit Ethernet Passive Optical Network in the Presence of Forward Error Correction Techniques

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## ABSTRACT
In this paper, Performance evaluation of Gigabit Ethernet Passive Optical Network in the presence of Forward Error Correction techniques has been observed. It has been observed that Q2 value lies in the range of 13 to 7dB and 20 to 7dB at 2.50 Gbps in the absence and presence of FEC at transmission distance of 10 to 40 km in GEPON. Similarly the BER lies in the range of 10-5 to 10-2 and 10-23 to 10-2 without and with FEC at transmission distance of 10 to 40 km. Hence with FEC technique, we have achieved BER of 10-13 at 30 km with bit rate of 2.50 Gbps in GEPON.

## Keywords
Forward Error Correction, Passive Optical Networks, Optical Distribution Networks, Optical Network Termination, Optical Line Terminal.

## 1. INTRODUCTION
Passive Optical Network (PON) was invented at British Telecom in the late 1980s. The original concept was to use time division multiplexing to divide the available link bandwidth over many subscribers. The fiber network between the central office equipment and the customer's equipment would be entirely passive. This was strongly motivated at the time by the relatively high cost of lasers (costing well over US$1000 at that time) and the low rate of users bandwidth (telephony was the main application). For this reason, a great amount of research was initiated to study PONs. PONs has long been seen as an important part of many Fibers to the Home (FTTH) strategies. Primarily, PONs is attractive because they economize on fibers leading from the central office out to the served communities, and reduce the number of optoelectronics at the central office, bringing direct and indirect savings. However, a long time has elapsed since the original development of PON until the large deployments happening today. There are both technical and economic reasons for this. Passive optical networks are economically attractive because several users can share common resources. Typically, up to 64 users can share a PON port on an OLT.

The per-user cost of the OLT decreases as more users share the same port. Depending upon optical splitter placement, various portions of outside plant (OSP) resources like fiber material and splicing costs may also be shared among multiple users. By increasing the sharing of OSP resources, certain splitter architectures decrease the OSP per-user cost. However, these architectures limit the sharing efficiency of OLT resources
resulting in a net increase in total per-user cost [1-6]. Presently there are three major PON technologies under consideration as the basis for FTTH deployments: Broadband PON (BPON), Gigabit PON (GPON) and GE-PON. As we know that 2.4 Gbps transceivers are very expensive today, FEC is the better solution for this problem in GEPON before development of cheap transceivers. With the help of FEC technique, we can increase the transmission speed as well as transmission length of GEPON system. The paper is organized as follows: Section 2 contains the system description. Section 3 discusses the results of GEPON system. Finally, Section 4 summarizes and concludes this paper.

## 2. SYSTEM DESCRIPTION
Gigabit Ethernet Passive Optical Network (GEPON) is a point-to-multipoint optical network. It consists of an OLT located at the Central Office (CO) and a group of Optical Network Termination (ONT) at remote nodes located at the customer's premise. The connection between the OLT and ONT is realized by a single fiber and the use of one or more optical splitters. The network between the OLT and the ONT is passive. The presence of only passive elements in the network makes it relatively more faults tolerant, and decreases its operational and maintenance costs once the infrastructure has been laid down. The ONT resides at or near the customer premise. It can be located at the subscriber residence, in a building, or on the curb outside [7].

In the simulation, we considered the triple-play service realized as a combination of data, voice, and video signals. The high-speed internet component is represented by a data link with 1.25 Gbps downstream bandwidth. The voice component can be represented as VoIP service (voice over IP, packet-switched protocol) and can be combined with data component in physical layer simulations. In this case we have considered data/voice link. To optimize the bandwidth in PON the transmission through the optical fiber path employs the CWDM technique with data/voice component transmitted at wavelengths in the range of 1480-1500nm.In this design Data/voice transmitter consist of 1.25 Gbps PRBS generator, Electrical Generator, DM laser at 1490 nm wavelength, and Pre amplifier. Here, the triple-service of ONT consists of Data/VoIP and video receivers. Data/Voice receiver consists of optical filter, and PIN.

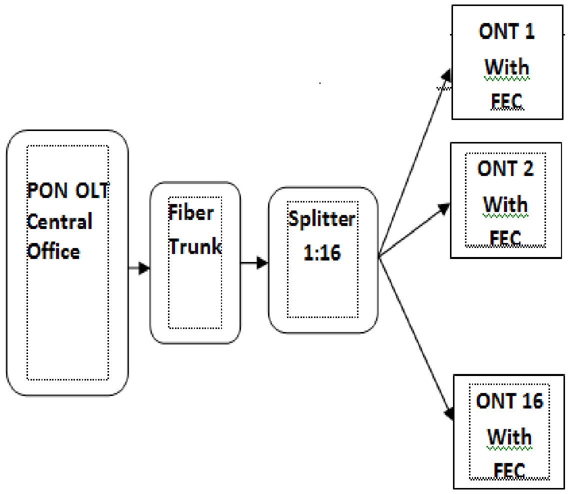



**Fig 1 GEPON for 16 users**

## 3. RESULTS AND DISCUSSION

In this paper, forward error correction technique is applied in GEPON and its performance has been observed with and without FEC [8-9].Comparative study has been carried out for GPON at bitrates of 2.5, 3.75 and 5Gbps with and without FEC.

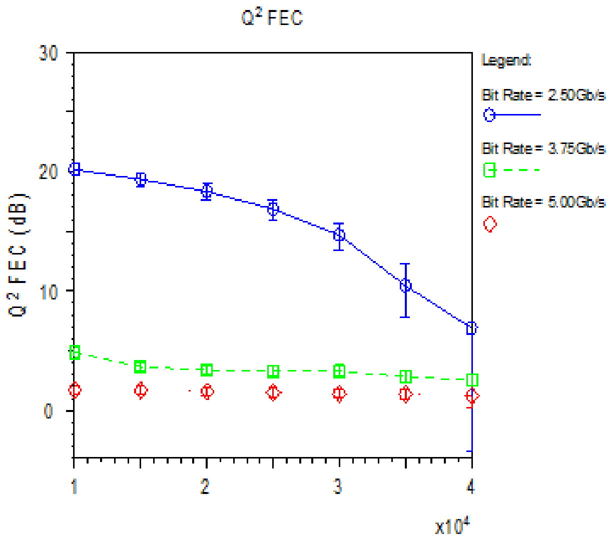



Fig.2 (a) and (b) indicate the graph between $Q^2$ value versus the fiber length at different bitrates with and without FEC. From results it has been observed that there is significant increase in the value of Q factor, which lies within [15, 4 & 3] and [10, 3 & 3] for transmission distance of 30 km in case of 2.50, 3.75 and 5 Gbps respectively with and without FEC. Fig. 3 (a) and (b) indicate the graph between BER value versus the fiber length at different bitrates with and without FEC. From results it has been observed that there is significant increase in the value of BER, which lies within [$10^{-10}$, $10^{-1.5}$ &$10^{-1}$] and [$10^{-3.5}$, $10^{-1.5}$ & $10^{-1.5}$] for transmission distance of 30 km in case of 2.50, 3.75 and 5 Gbps respectively with and without FEC.

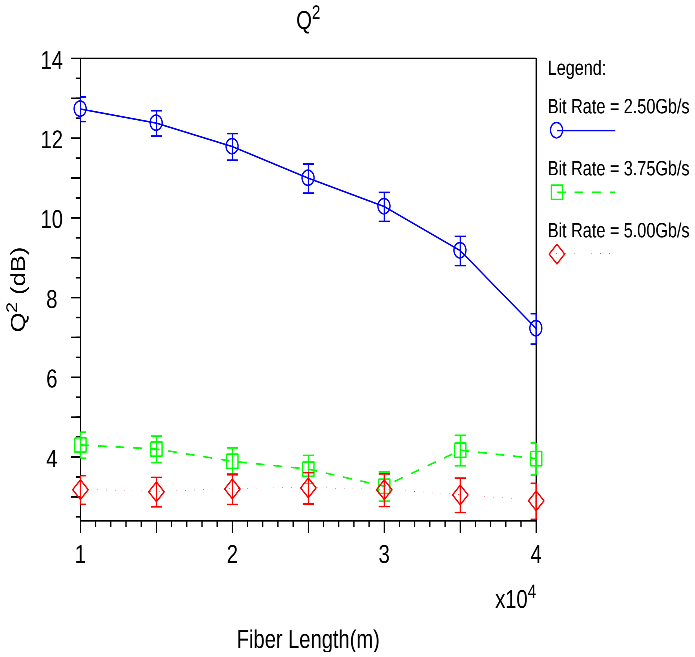
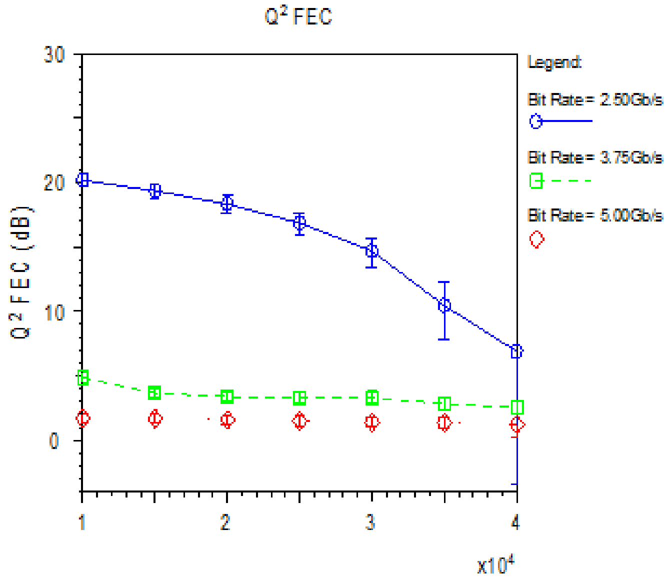


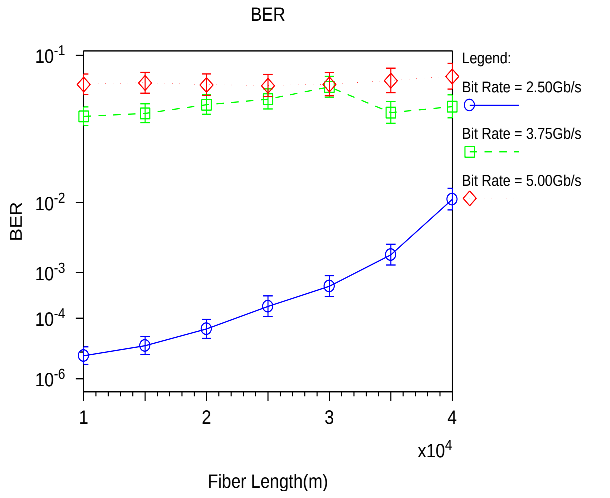

**Fig 2 $Q^2$ value (a) without FEC and (b) with FEC**




It is known to all that 2.4 Gbps transceivers are very expensive today. In present scenario of GEPON operate on 1.25 Gbps up to 20 km. while using proposed method of FEC in GEPON at operating bit rate of 2.50 Gbps the transmission distance can be enhanced up to 30 km. Hence through FEC technique, we increased the transmission speed as well as transmission distance of GEPON systems.

## 4. CONCLUSION

This paper targets the impact of with and without FEC in GEPON systems for different bitrates. It has been observed that $Q^2$ value without and with FEC lies in the range of 13 to 7dB and 20 to 7dB at bit rate 2.50 Gbps for 10 to 40 km respectively. There is significant improvement in BER with FEC in GEPON. But in higher bit rate, it is not permissive. Hence in presence of FEC technique the achievable BER is $10^{-13}$ at bit rate 2.50 Gbps for 30 km respectively. It has been concluded that Forward error correction technique yields the highest $Q^2$ value and lowest BER in GEPON systems.



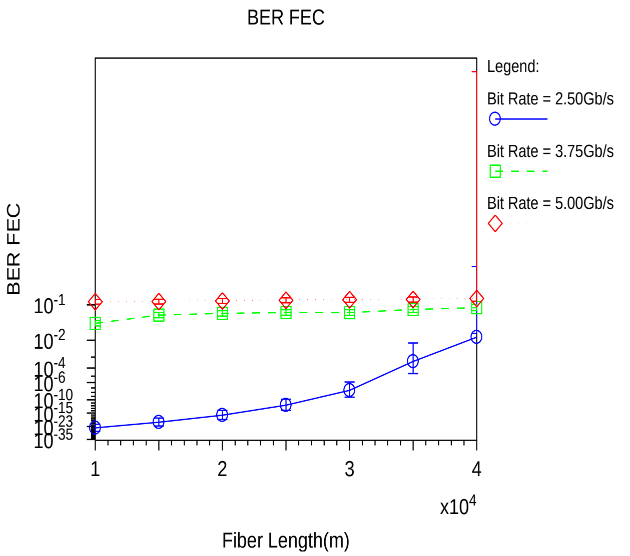




**Fig 3. BER value (a) without FEC and (b) with FEC**

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