Comparative Analysis of GPON and EPON Optical Communication Network

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Abstract- ***PON which simply means passive optical network, it is the main technology for implementing FTTH. It provides a point to multipoint fiber access. It consists of the OLT optical line terminal on other side and the optical network unit on the other side. GPON is the new generational broadband passive optical integrated access standard based on ITU-TG.984x standard. It has many advantages such as high bandwidths and high efficiencies. The EPON is an Ethernet based PON technology that uses a point to multi point architecture t, passive optical fiber transmission and provides multiple services over Ethernet. The major problem with the EPON is it has a lower bandwidths and lower efficiency. The idea of the developing the GPON was to have an improved version of the EPON but with a higher bandwidths and higher efficiencies. From the result, it is shown that the GPON has a higher efficiency, higher performance higher bandwidths when compared to the EPON though the EPON has a better rising time and costing.***

Indexed Terms- ***PON, EPON, GPON, OPTICALS, TRANSMISION***

I. INTRODUCTION

Recent years of developments in both wired and wireless communication technologies demands for flexible, promising and low cost solution to satisfy tremendously increasing high internet traffic data. The advances of computing and applications such as HDTV, video on demand, broadband mobile networks also require good quality of services. Passive optical network (PON) is a good choice for such applications as it serves a large number of users. PON is a combination of network elements called ODN (Optical Distribution Network) that includes an optical line termination (OLT) and multiple optical network units (ONU). GPON is a variant of PON technology which can support higher data rate (2.5 Gbps) using a point to multipoint access mechanism. Here, passive splitters are used that enables single feeding fiber from the provider's central office to serve multiple homes and small business. Radio over fiber networks comes into picture when requirement of high data rate can not be satisfied by decreasing cell size or by allocating more bandwidth because both these methods lead to increased complexity of base band station. RoF system is integration of wireless and fiber based technology. The main goal of RoF system is the distribution of broadband signals to distributed base stations for wireless access using an optical access network. Internet traffic patterns and applications caused congestion in the local loop between a customer and the local exchange. In order to overcome this problem, Ethernet passive optical network (EPON) is seen as one of the most suitable technologies at the moment as the devices are ubiquitous from the home network all the way through to regional, national and worldwide backbone networks, implementation of EPONs can be highly cost-effective.

II. LITERATURE REVIEW

2.1. PON evolves in following steps

A. APON

It is the first ATM based passive optical network used to connect communication network to homes and business. Information flows in the form of packets and the addressing information in packets show the destination address of respective ONU for which the information is intended [1].

B. BPON

It is the successor of APON known as broadband passive optical network. This standard supports more broadband services, including high-speed Ethernet

and video distribution. It is ITU-T G.983 standard and uses an speed of 600 Mbps and 150 Mbps for downstream and upstream, respectively [1].

C. EPON

It is defined for IEEE 802.3ah. It is also a point to point emulation operating at 1490/1310 nm for 10 km and 20 km, respectively. It is a more secure technology with dynamic bandwidth allocation

D. GPON

Its ITUT G.984.1 standard, operates at downstream wavelength of 1490 nm or 1550 nm and upstream wavelength of 1310 nm. It has advantage of supporting both types of traffic modes ATM and Ethernet [2]. More specifically they are defined in section

E. Next Generation PON PON evolution comes under next generation PON. The candidates of next generation PON works for greater speed and satisfies more bandwidth requirements. It is defined in two phases NGA1 and NGA2. NGA1 is compatible with GPON architecture and also extendible. XGPON1, XGPON2, and WDM PON are the candidates of next generation PON [3].

ii. Optical Transmitter

It is situated at central office which generates an optical signal. The optical signal from the laser is modulated in accordance with the incoming RF signal. The modulation of the laser can be done either by direct method or indirect method using external modulator [6]. In the direct modulation scheme, the driving current to a directly modulated (DM) semiconductor laser is varied according to the data to be transmitted [4][5]. In the external modulation scheme, the laser is subjected to a constant bias current emits a continuous wave (CW) while an external modulator switches the optical power on or off according to the data stream [7]. For higher data rate (> 2.5 Gbps), external modulators are used in order to avoid non- linear effects such as chirping and turn on delay. Therefore, in our analysis we are using external modulator i.e., Mach Zehnder modulator (MZM) which can be modulated to any modulation schemes: PSK, QPSK, DPSK, MSK.

A. Distribution Network

It consists of power splitter that splits the power among multiple base stations. For GPON, 1: 64 optical splitter is used for a distance of 60 km.

B. Optical Access Network

Optical access network can be any passive optical network. For this study, GPON is used. The downstream operating wavelength used is 1550 nm.

C. Base Station and Mobile Receiver

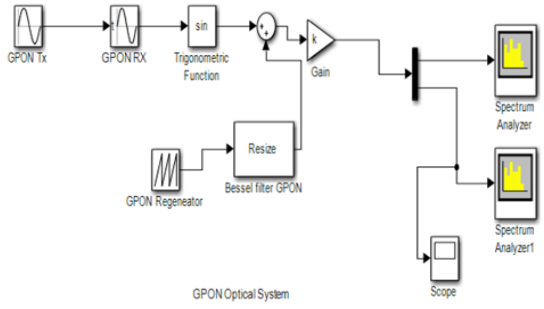
Base station converts the optical signal to electrical signal. It consists of amplifier, filter and photo detector. On the other hand, mobile receiver receives the original signal [8].

The EPON study are normally done using simulations [8], but simulation method is not able to capture the nuances and non-linear effect of a real network. In order to study the dynamics of EPON, a testbed is required. At the moment, the EPON testbed is designed either using application-specific integrated circuit (ASIC) [5] or field-programmable gate array (FPGA) [8].

III. METHOD

3.1 GPON and EPON Simulations

This section of the research work used Matlab/Simulink to design the model of the GPON and EPON in order to observe the behavior of the system. From the simulation, we can see the transmission of the GPON transmitter to the GPON receiver the system also makes use of the conventional modulation techniques to transmit signals. The same procedures was used in the EPON but different results was achieved due to the bandwidths of the EPON



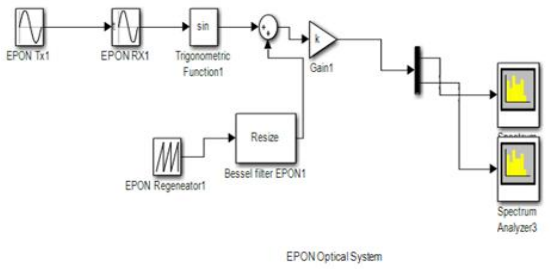


Fig 1a and Fig 1b The EPON and GPON Simulation

IV. RESULTS AND DISCUSSIONS

4.1 EPON and GPON Rising Time Analysis

From the fig 2, it is shown that the GPON has a lower rising time rate and as that, it supports multiple rates 2.5Gbps or 1.25Gbps downstream and upstream 1.25Gbps though the EPON has a higher chances due to it fixed time of 1.25Gbps at up and downlink which is actual 1Gbps. From the result it is also shown that the GPON has a rising time rate of 1.04 ns The GPON in no doubt has the higher bandwidths that EPON and has excellent performance when compared to the EPON.

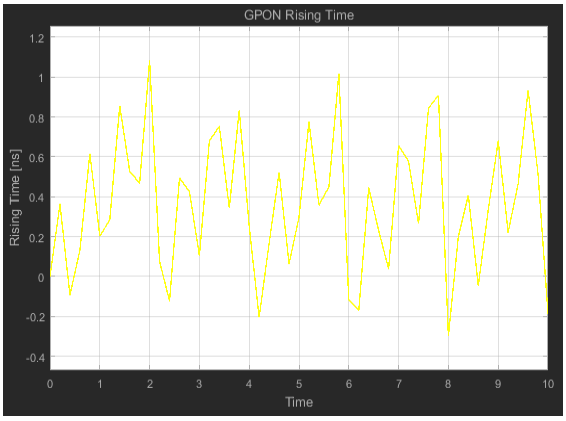


Fig 2 GPON rising time

The result in the fig 3shows the signal and the rising time of the EPON. From the signal its shown that the rising time of the EPON is between 1 and 1.08 ns. The EPON has a very fast rising time due to it low bandwidths when compared to the GPON.

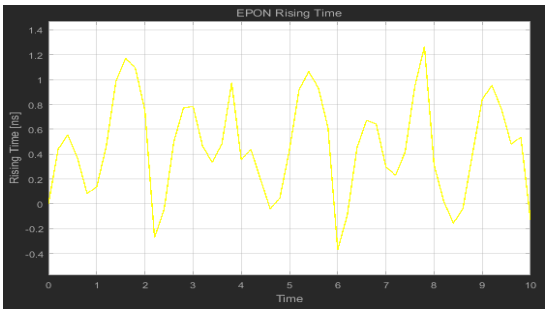


Fig 3 EPON rising time

4.2 EPON and GPON Bandwidths Comparative Analysis

The EPON operates within the rand of 1.24 GHz. The results has shown that the EPON has a smaller bandwidths when compared to GPON though it actually uplink and downlink time is fixed to 1Gbps. But however, it major challenge is having a lower operational bandwidths, which reduces it capabilities.

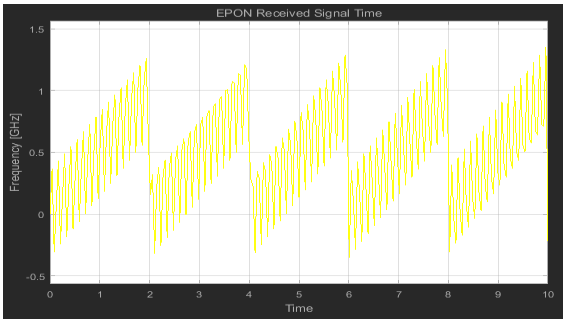


Fig 4 EPON Bandwidths

The GPON graph optical results shows the behavior simulated signal behavior. From the signal, it can be shown in fig 5 that the GPON operates under a 2.4GHz spectrum respectively and which also have an improved rising time when compared to EPON.

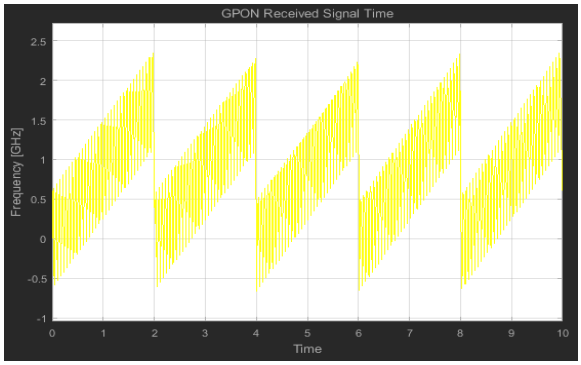


Fig 5 GPON Bandwidths

4.3 EPON and GPON Comparative Efficiency Analysis

From the result in the fig 6 below, it is shown that the GPON has a higher advantage than that of the EPON optical communication techniques. Even though there might be some reports that says the EPON has a better cost price but when it comes to the optical communication job, the GPON is way ahead of the EPON even with it robust bandwidths sizes is an added advantage.

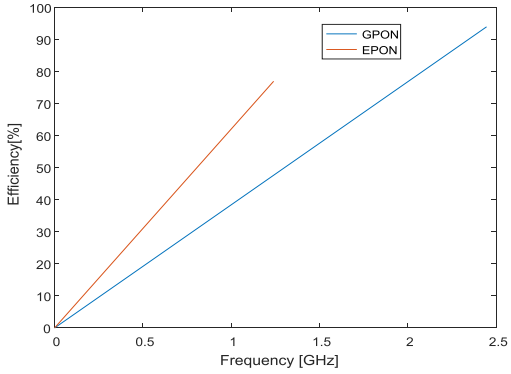


Fig 6 EPON VS GPON Efficiencies

4.4 EPON and GPON Split Ratios

The EPON standard defines a split ratio of 1:32. And the GPON Split ratio defines a ratio of 1:32, 1:64 and 1:128. Technically, EPON systems can also achieve higher split ratios such as 1:64 and 1:128 respectively. From the table 1 the split ratios of EPON and GPON can be seen.

EPON split ratios	GPON Split Ratios	EPON Distance	GPON Distance
1:32	1:32	10km	10km
1:16	1:16	20	20
	1:64		
	1:128		

CONCLUSION

In this research work, in order to carry out a clear comparative study on both EPON and GPON, a simulation was carried out to observe the performance of both optical communication systems. The simulations also reviewed the operational bandwidths of both systems and there rising time. From the result it is also shown that the GPON has a better performance that that of the EPON communication system. The GPON has a higher efficiency rate it the comparative analysis and was designed to perform very well under higher split ratios though the EPON can also be upgraded to operate at same split ratios with GPON but the GPON has a higher performance. This paper also considered the rising time of each of the optical communication system.

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