Design and Simulation of Hybrid WDM/TDM Passive Optical Network

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ABSTRACT
Due to the expansion of internet and multimedia services, such as Passive Optical Network (PON) come to the forefront of the research field. Network service provider mostly deploy Time Division Multiplexing (TDM) based PON because it is cost effective. The main limitation with TDM-PON is its limited bandwidth. So in order to provide increased bandwidth Wavelength Division Multiplexing (WDM) based PON is used. But the main limitation with WDM-PON is its high cost. Therefore the advantages of TDM-PON and WDM-PON mitigate with each other and we propose the architecture of hybrid WDM/TDM PON. In this paper, we evaluate the performance of hybrid WDM/TDM PON in terms of Q-factor and Bit Error Rate (BER).

Keywords: Passive Optical Network (PON), Optical Line Terminal, Optical Network Unit, Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), Bit Error Rate (BER), Quality Factor.

1. INTRODUCTION
A Passive Optical Network is a point to multipoint optical network, where an Optical Line Terminal (OLT) located at the Central Office (CO) is connected to many Optical Network Units (ONUs) located at the customer's premises through one or multiple 1: N optical splitters as shown in fig.1. The network between the OLT and the ONU is passive, i.e., it does not require any power supply [1-2].

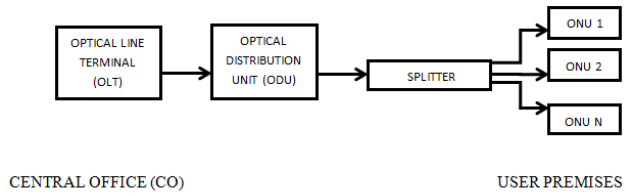

Fig.1: Block diagram of Passive Optical Network

WDM-PON is a technique in which each ONU uses a different wavelength, i.e., a unique wavelength, in each direction to communicate with the OLT. The TDM is a technique in which a particular time slot of a finite duration is allocated to each station in the network for its transmission in a given time interval. When we use the WDM/TDM integrated concept, each ONU uses a different wavelength which is allotted to them by using time division multiplexing either statically or dynamically. Hybrid WDM/TDM PON is a promising next generation broadband access scheme. In this paper, previous work has been extended by evaluating the performance of hybrid WDM/TDM PON in terms of Q-factor and BER [3].

2. SYSTEM ARCHITECTURE
The schematic architecture of WDM/TDM PON is shown in fig.2. In this, the concepts of WDM and TDM are combined to enhance the efficiency of a PON. Each ONU uses a distinct wavelength in each direction to communicate with the OLT. The simulation of hybrid WDM/TDM PON is done in OPTISYSTEM.

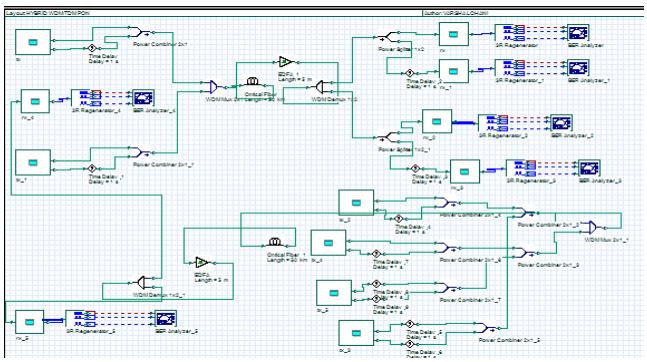

Fig.2: Schematic architecture of hybrid WDM/TDM PON

Erbium Doped Fibre Amplifiers (EDFA) is used in designing of hybrid WDM/TDM PON. EDFA are very much reliable for long distance transmission using single or multi-wavelength sources because of their wide bandwidth and optimum BER [4].

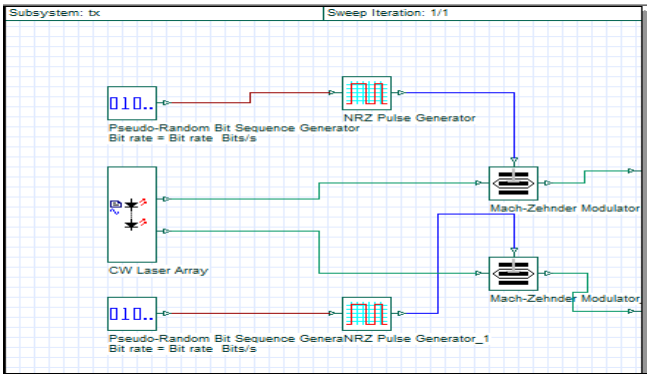

Fig.3: Hybrid WDM/TDM PON Transmitter

The transmitter of above architecture is shown in fig.3. The pseudo random bit sequence generator will generate bit sequences (either 1 or 0) in random manner. We assume that this is the information that is to be transmitted. This bit sequence generator is then fed into a NRZ pulse generator which transforms the bit sequences into NRZ pulses. These pulses are modulated using a Mach-Zender Modulator with the carrier power coming from the laser sources (laser frequency to be 193.8 THz since it corresponds to 1550nm which is an ideal operating wavelength for optical communication) [3].

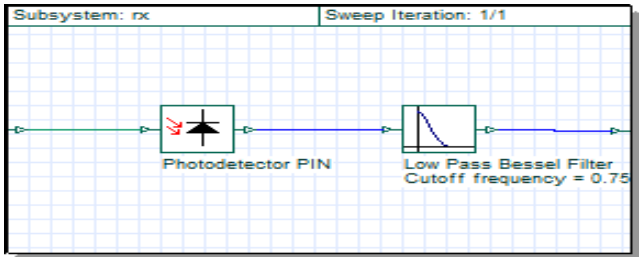

Fig.4: Hybrid WDM/TDM PON Receiver

On the receiver side as shown in fig.4, the photo detector converts the optical signal into electrical signal. This signal is then passed through a low pass Bessel's filter and then through a 3R regenerator. The Bessel's filter considerably reduces the peak overshoot. The regenerator reconstructs and regenerates the signal and feeds it into a BER analyser where the output signal can be visualised [3].

3. RESULTS

The output of BER analyser is shown in fig.5 and 6 where the output curves of the receivers in the OLT and ONU respectively, plotted between Q-factor and bit period.

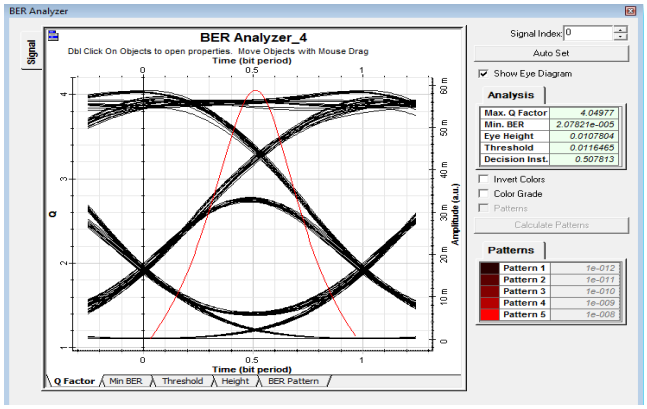

Fig.5: Eye diagram of hybrid WDM/TDM PON at OLT side

Fig.6 shows the eye diagram with NRZ modulation format at ONU side with Q-factor 4.03206.

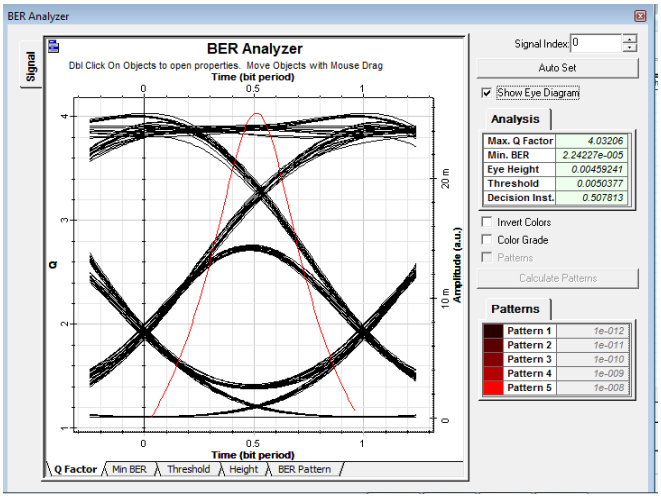

Fig.6: Eye diagram of hybrid WDM/TDM PON at ONU side

4. CONCLUSION

In this paper the performance of hybrid WDM/TDM PON is evaluated in terms of Q-factor and BER. The Q-factor and BER at OLT side is 4.04977 and 2.07621e-005 and at the ONU side is 4.03206 and 2.24227e-005. So good Q-factor and less eye closure is achieved as compared other existing PON. The cost is also reduced and bandwidth is high as compared to TDM and WDM PON. Further work that can be done is to provide long distance communication. So in order to provide long distance communication we need to deploy DWDM/TDM PON [5-6].

5. REFERENCES

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