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An Analysis of 16 Channel 64 User Hybrid WDM/TDM Topology in the Optiwave Simulation Environment

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***Abstract*— The aim of the present work is to demonstrate the concept of a packet- interleaved WDM system i.e; hybrid optical access network, which serve as the important candidate of next generation access networks. The entire network topology design was simulated in the OPTIWAVE development environment, consisting of transmitter, channel and receiver section. Each section is elaborated, while the analysis of measured values from topology is presented in the last part of the article.**

Keywords- Hybrid PON, WDM, TDM, APD.

I. INTRODUCTION

Currently, Network operators are adapting their broadband access networks for offering emerging bandwidth hungry applications such as high-definition (HDTV), interactive gaming, videoconferencing, high speed internet, online gaming ,VOIP, etc. etc[1]. Optical fiber networks with it high bandwidth are considered the most future-proof next generation access (NGA) technologies. This access Network encompassing the elements between a local office and the subscriber, are very often called as PON (passive optical network). The motivation of passive optical network (PON) technology is to provide a cost-effective, interference-free and high-bandwidth, access mechanism to the end-user. The general PON topology consists of optical line terminals (OLTs) situated at the CO (Central Office) and the optical network units (ONUs) with an optical distribution network (ODN) situated at the customer premises[2].

Time division multiplexing (TDM) and wavelength division multiplexing (WDM) techniques are both associated with their pros and cons . TDM and WDM are compliments of one another[3]. Introduction of WDM dimension on top of a TDM PON is called as Hybrid PON. The high capacity delivered by WDM and the inherent sharing capacity of a TDM , and it is an important candidate for next-generation optical access (NGOA) networks[4].

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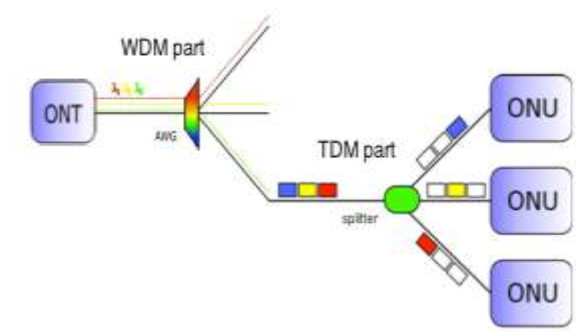

Figure 1. Hybrid passive optical network. (© ESBCO information services)

A. Contribution

This paper demonstrates the concept of a packet-interleaved wdm system i.e; hybrid optical access network. The effect of the performance of network at different data rates and transmission distance is studied. The effect of APD and PIN on the quality factor at the receiver is also observed.

The remainder of paper is organized as follows. In Secion 2, WDM/TDM PON simulation setup(in optiwave environment [5]) is provided in which OLT connecting line between CO(central office) and ONUs are described. Section 3, includes the analysis of simulated network. Section 4 concludes the paper.

II. HYBRID WDM?TDM PON ARCHITECTURE

Simulated architecture of Hybrid PON ,consisting of transmitter ,channel and receiver section, is shown as;

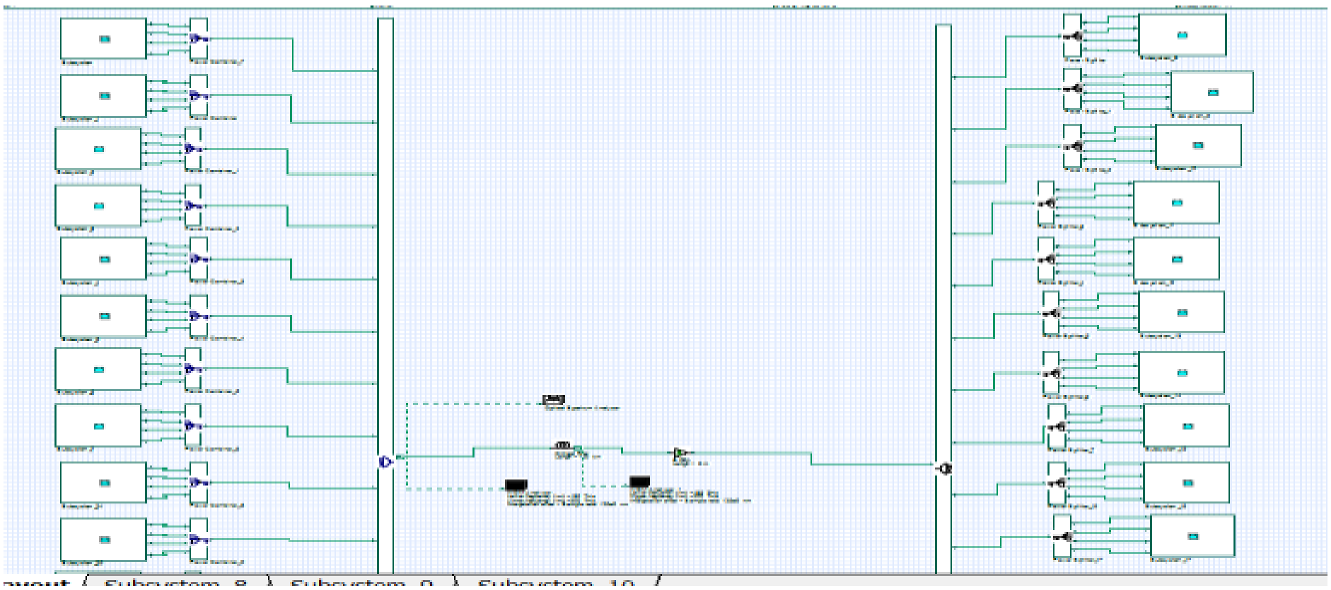

Figure 2. Simulation setup of Hybrid PON

A. Transmitter

At transmitting end, 16 continuous wave (CW) lasers with 6dBm output power, frequencies from 193.1THz to 194.6THz with spacing of 100THz, were used. Each frequency is given to power splitter (1:4) for modulation of four data sources. Time delay is used to implement TDM of four data sources. The power from four modulators is again combined. RZ coding scheme is used with MZ optical modulator.

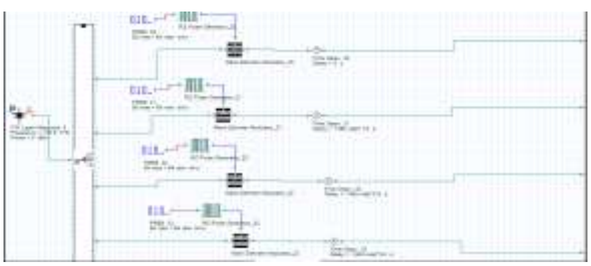

Figure 3. Transmitter subsystem

B. Channel

Simulation was done on fiber lengths 50km (for 1Gbps data rate) and 100km(for 1,2,3Gbps data rate).EDFAwas used with length of 6 meters.

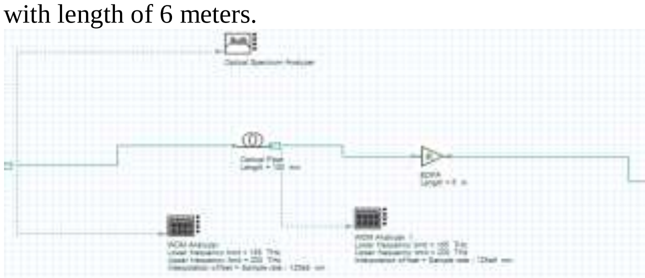

Figure 4. Channel

Following are main parameters of ofc used.

Table I Parameters of fiber

parameter	value	unit
Length	50,100	km
dispersion	16.75	Ps/nm/km
Attenuation	0.2	dB/km
Diff. group delay	0.2	Ps/km

C. Receiver(ONU)

After demultiplexing each frequency (wavelength) ,each output of WDM DEMUX is given to power splitter(1:4).Each output of power splitter is given to APD, low pass Bessel filter and3R generator as shown below.
Time division demultiplexing done by introducing same time delay as that of transmitter section.

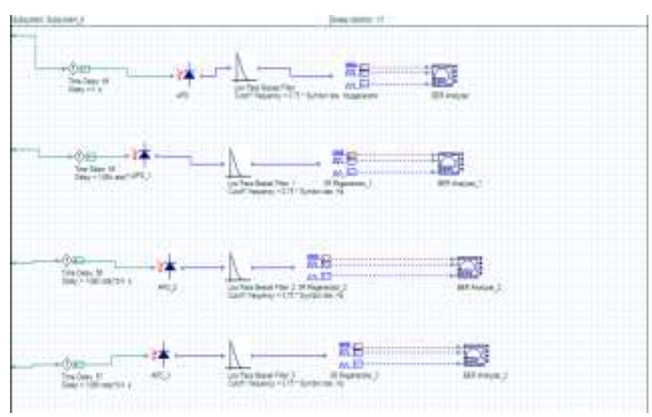

Figure 5. One receiver sub system

III. EVALUATION OF TOPOLOGY

A. Analysis at 50KM fiber length at 1Gbps data rate

The power spectrum at WDM MUX is shown below;

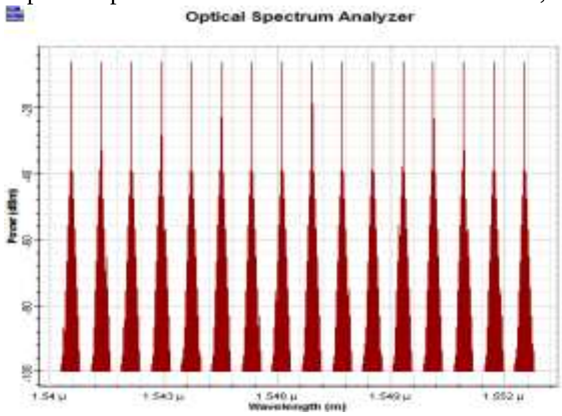

Figure 6. Output power spectrum

The diagram at ONU (for worst –case) is shown below;

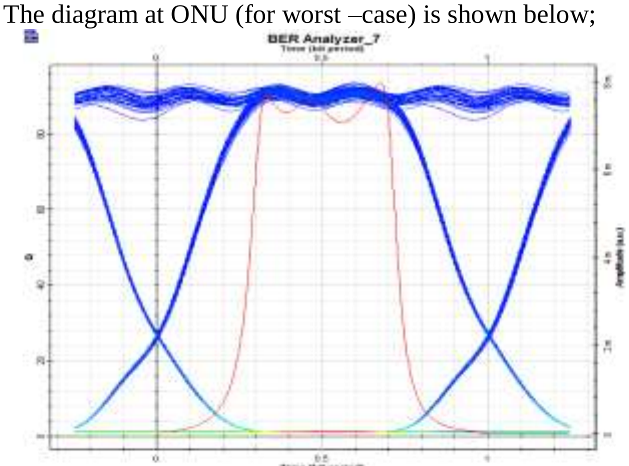

Figure 7. Eye diagram at 50km(1Gbps)

Table II. BER analysis at 50km(1Gbps)(for worst ONU)

parameter	value
Max. Q factor	94.2759
Min. BER	0
Eye height	0.00749305
threshold	0.000126436

B. Analysis at100km

At 1Gbps the output power spectrum is shows same power level of each channel, however power spectrum at 2Gbps and 3Gbps is shown below;

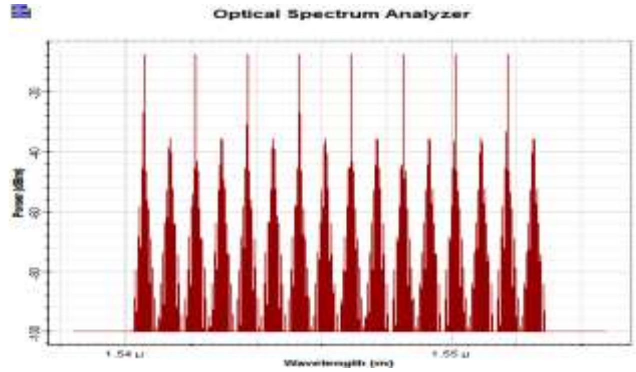

Figure 8. Power spectrum at 2Gbps

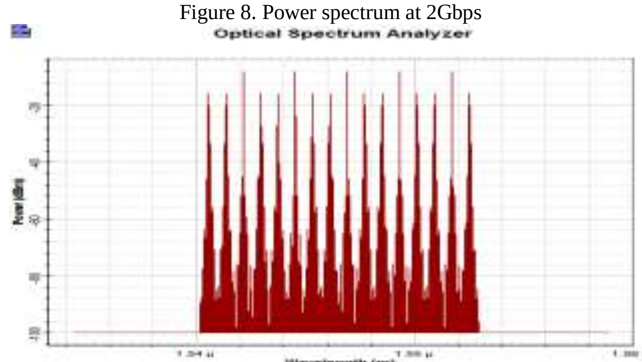

Figure 9. Power spectrum at 3bps

Eye diagram at ONU (for worst) are shown below;

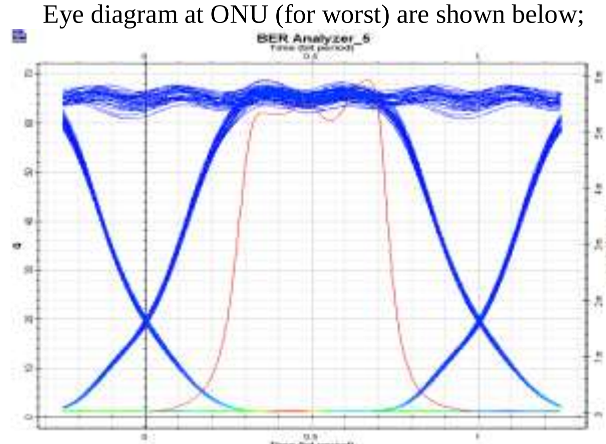

Figure 10. Eye diagram at 1Gbps

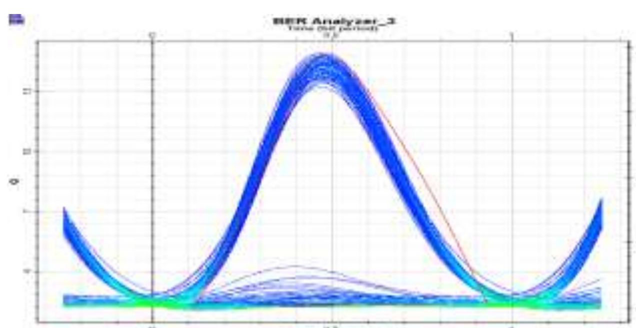

Figure 11. Eye diagram at 2Gbps

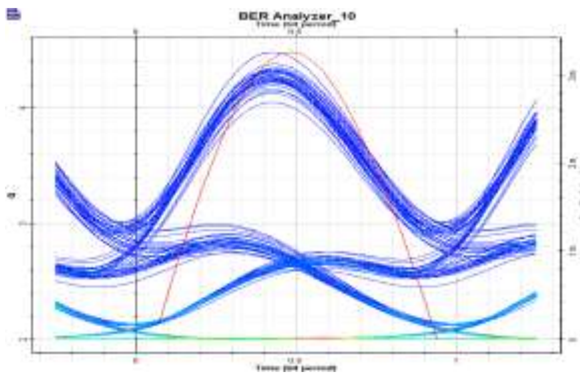

Figure 12: Eye diagram at 3 Gbps

Table III. BER analysis at 100km(1Gbps) (for worst ONUs)

Parameter	At 1Gbps	At 2Gbps	At Gbps
MAX. Q factor	68.7564	14.18955	4.57947
Min BER	0	1.76e-50	3.7e-6

Figure 13 and 14 shows the Eye diagram with quality factor at the transmitter without and with a low pass Bessel filter, respectively.

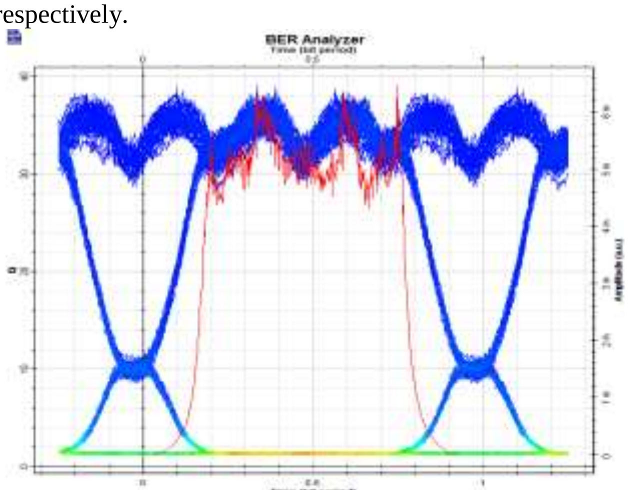

Figure 13. Receiver without low pass filter.

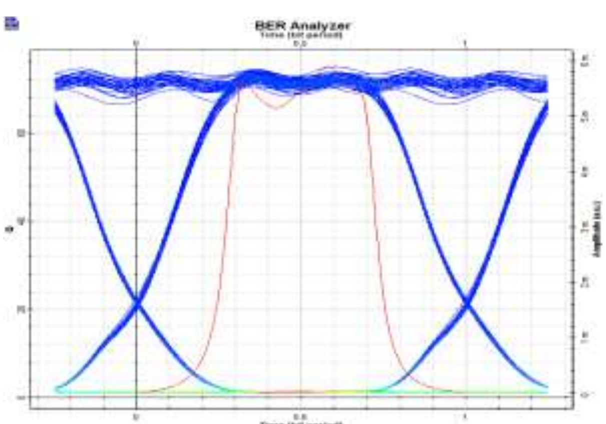

Figure 14. Receiver with low pass filter

Table IV BER analysis at 100km(1Gbps)with and with out filter(for an ONU).

parameter	With out filter	With filter
MAX. Q factor	39.0641	74.9915
Min BER	0	0
Eye height	0.005413	0.00543

C. Comparison of APD and PIN Diode

The APD diode provides better performance in terms of BER and Q factor values. Therefore, APD diodes were used for simulation. The figure 15 and 16 shows the Eye diagram with quality factor at the transmitter using PIN and APD diodes. The measurement was taken at the data rate of 1Gbps on the 100km long fiber link. Both the detector (PIN and APD) parameters were set almost the same, with $1A\cdot W^{-1}$ as responsivity and 10 nA of dark current for both diodes. However, two additional parameters gain of 3 and ionization ratio of 0.9 were also set for the APD .

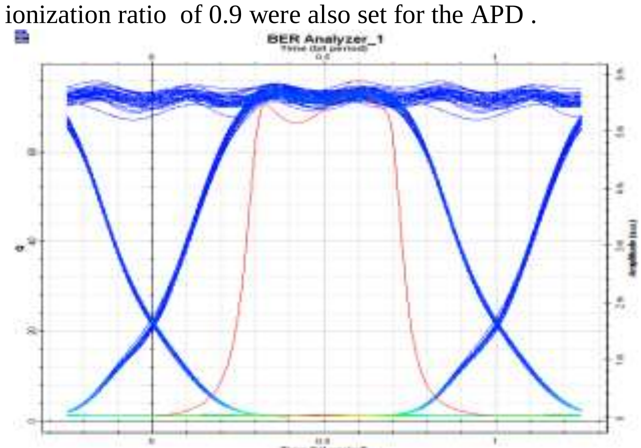

Figure 15. Eye diagram using APD diode.

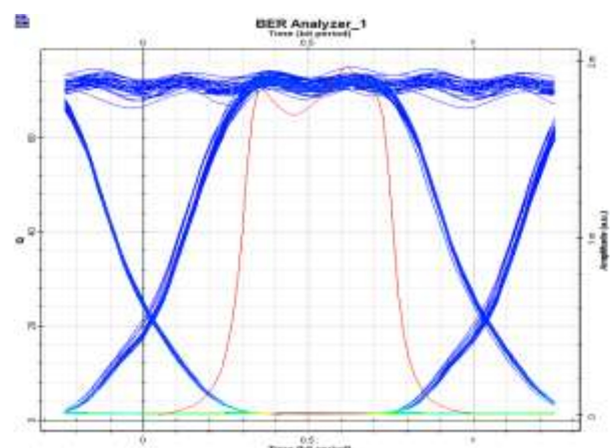

Figure 16. Eye diagram using PIN diode.

Table V. BER analysis at 100km(1Gbps)with APD and PIN(for an ONU)

parameter	For APD	For PIN
Max. Q factor	75.7336	74.9996
Min. BER	0	0
Eye height	0.00543	0.00181

IV. CONCLUSION

Optical fiber networks with it high bandwidth are considered as the most important candidate of next generation access (NGA) technologies. An analysis of Hybrid WDM/TDM PON for different bit rates at different fiber lengths is done. It is simulated using OptiSystem software and the results were analyzed. The network can support upto 48Gbps at error of $10^{-6}$to 10^{-7}. Hybrid WDM/TDM PON offers a great potential and a very feasible solution for the high speed and bandwidth hungry future next generation access networks.

REFERENCES

[1] KIMURA, S. WDM/TDM-PON Technologies for Future Flexible Optical Access Networks, In: *OptoeElectronics and Communications Conference (OECC)*, IEEE, 2010. pp. 14 – 15, ISBN 978-1-4244-6785-3

[2] AHSAN, Shamim; LEE, Seop, Man. Migration to the Next Generation Optical Access Networks Using Hybrid WDM/TDMPON, Vol. 6, No. 1, pp. 18-25, , *Journal of Networks*, 2011.

[3] LEE, S.; KIM, E.; LEE, Y.; LEE, S.; JUNG, D.; HWANG, S.; OH, Y.; PARK, J. A design of WDM/TDM-PON provisioning for future optical access network upgrade. *IEICE TRANSACTIONS on Communications*, Vol. E90-B, No. 9, pp. 2456-2463,2007.

[4] Mozhgan Mahloo, Jiajia Chen, and Lena Wosinska, Abhishek Dixit, Bart Lannoo, and Didier Colle, "Toward Reliable Hybrid WDM/TDM Passive Optical Networks", IEEE Communications Magazine, February 2014.

[5] Optiwave . Available at WWW: <http://optiwave.com/>.

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