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Designing four-Channel High Rate TDM Passive Optical Network with NRZ Scheme for Wired Environment

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Abstract

It is advantageous to think about the innovations accessible for presenting time division multiplexing (TDM) in PONs, This strategy is utilized to get the coveted points of interest of PON. Examination is made between past innovations to choose which gives better execution under certain given criteria like power, data transmission, no of clients, cost, adaptability and unwavering quality. The capability of PONs to convey high data transmissions to clients in get to systems and their favourable circumstances over current access innovations have been generally perceived. PONs have gained solid ground as far as institutionalization and sending in the course of recent years. This paper basically covers fundamental design of TDM-PON network with multiple inputs or channels. Chanel can use different coding scheme at input side. Data can be transferred using wired environment which used nonlinear fiber.

Keywords: Optical network, WDM, TDM, PON, Nonlinear fiber.

INTRODUCTION

In the TDM PON, the CO devotes schedule opening to the numerous endorser (ONU) associated with the PON. Each ONU would then be able to utilize the full upstream data transfer capacity of the optical connection for the span of it's doled out schedule vacancy. Since the TDM PON can commonly benefit N = at least 32 supporters, the normal devoted transfer speed to each ONU is typically just a couple of percent of the channel limit. To interface the different ONUs to a solitary feeder fiber. This couples N:1 of the power from every endorser into the feeder fiber for transmission back to the OLT at the CO.

There are three institutionalized forms of the TDM-PON: Ethernet PON (EPON), broadband PON (BPON), and Gigabit PON (GPON). They all utilization one wavelength for downstream transmission and another wavelength for upstream transmission as represented in figure 1. One essential qualification between the three sorts of TDM-PON is operational speed. BPON is moderately low speed with 155 Mbps upstream/622 Mbps downstream operation. The EPON bolsters 1.0 Gbps symmetrical operation. The GPON guarantees 2.5/1.25 Gbps topsy-turvy operation. Two Types of Time Division Multiplexing Techniques are utilized (a) Fixed Time Division Multiplexing (b) Statistical Time Division Multiplexing. In Fixed time division multiplexing technique a settled measure of time moving or delay is presented between two OLTs while in Statistical time division multiplexing the moving time is chosen by activity at input side and measure of information to be sent from OLTs.

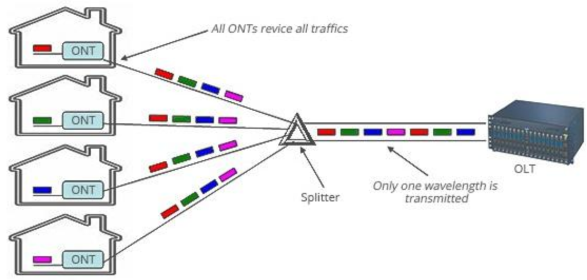

Figure 1: TDM-PON Diagram

The OLT is situated in a local office and controls the bidirectional stream of data over the Optical Distribution Network (ODN). In the down connection bearing the limit of an OLT is to take in voice, data, and video gushing activity from a long separation or metro system and communicate it to all the ONT framework segment on the ODN. A product is to be presented at splitter stage. ONT is found specifically at the client's premises. There its motivation is to give an optical association with the PON on the upstream side and to interface electrically to the client gear on the opposite side [21]. A more assortment of ONT helpful plans and frame outlines are open to suit the necessities of various bases of prerequisite. The traverse of an ONT can extend from an essential parts that may be associated with the outside of a house to a genuinely modern unit mounted in a standard home application hardware rack for use in huge applications, for instance, edifices or office structures. An ONU customarily is housed in an outside the home hardware protect. These foundations incorporate safe houses situated at a check or in a united place inside an office stop. The association from the ONU to the customer's premises can be a wound combine copper link, a coaxial connection, a free space optical fiber interface, or a remote association.

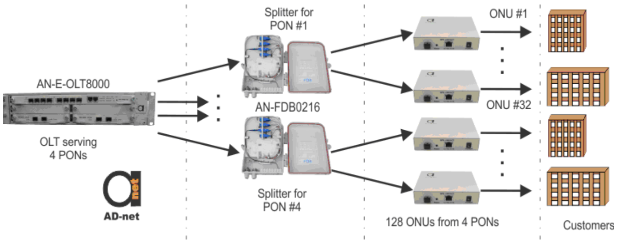

Figure 2: Optical Line Terminal connection in PON

LITERATURE REVIEW

Sensational increment in the limit of business optical systems, which has prompted a significantly more emotional insurgency in arrange administrations. This system limit increment was made conceivable by proceeding with increments in the limit of fiber optic transmission frameworks and by comparative increments in the limit of exchanging frameworks. Since 1983, transmission framework limit has developed by more than four requests of extent, while exchanging framework limit has developed by a still respectable three requests of greatness. All the more as of late, we have seen the business sending of optical system components that can set up and reconfigure wavelengths under programming control [1].

TDM-PON SYSTEM BLOCKS

TDM system block diagram is divided in four major parts Data transmission, Control signal generation, and Interferometer and Data reception. Data transmission blocks for four users is shown in figure 3. It includes various sub blocks like NRZ transmitter which includes PRBS generator, Electrical signal generator, CW Laser. It also includes Time shifter block also. Time shifter block basically provide time shifting between input channels or users to allocate specific time of transmission. This time shifted signal are multiplexed together as shown in Figure 3. This multiplexed signals are transmitted through optical channel with nonlinear effect. Power normalizer is used to get the desired power level where output can be checked.

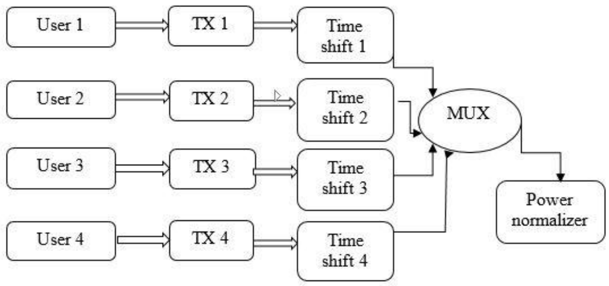

Figure 3: Optical Data Transmission block

In control signal generation there two control signals are created which are time moved. The two signs are having high power, Control signal power is no less than 10 times greeter contrast with information Signals. Interferometer piece incorporates two directional coupler multiplexers, two multiplexers, two exchanging component. Demonstrating of demultiplexer will require bi-directional flag spread in a circle. It was demonstrated that the same interferometry impact could be accomplished utilizing elective design of Terahertz optical a symmetric gadget. In light of symmetric Mach-Zehnder (SMZ) interferometer (bring down setup) with SOA in each arm of SMZ. In this arrangement the information and control signals co-proliferate and can be demonstrated in OptSim. Time delay between two control beats is equivalent to the exchanging window span, i.e. width of TDM direct in DEMUX applications.

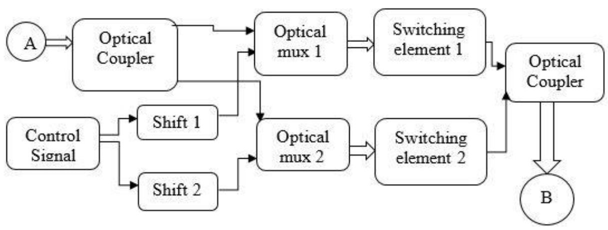

Figure 4: Control and Interferometer block

In information reception block two polarization piece which can utilized. A polarization or wavelength channel is utilized at the yield to dismiss the control flag and pass the exchanged information signals. The polarization piece depends on coefficient framework. As indicated by estimation of coefficient we can expel control flag and get de-multiplex information flag as it were. Beneficiary piece gets information flag which incorporates photo detector, preamplifier and channel. B is the information taken from optical coupler utilized as a part of interferometer. Different analyzer can be utilized at different phases of every piece to influence investigation of Eye Diagram, signal scope and range analysers to ceaselessly screen the flag age, preparing and flag gathering.

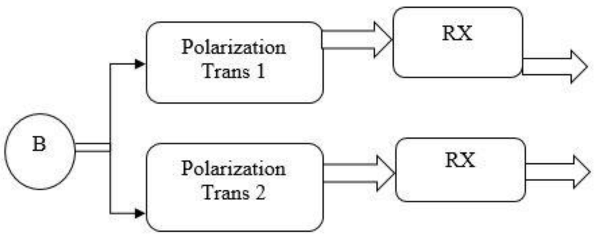

Figure 5: Optical Network Unit block

RESULTS AND DISCUSSION

Data transmission, Transmitter, interferometer, OLT, ONU are simulated using OPTSIM software. Various parameters selected for simulations are as mentioned in the table 1 and table 2. Important parameters are total no of channels, bitrate, type of coding method power level of signal, time shift between two signals and normalized power rating. Various blocks are simulated using OPTSIM software by passing above mentioned parameters.

Table 1: OLT Parameters

Data signal	Parameter	Value
1.	No. of users	4
2.	Bit rate	10 Gbps
3.	Pattern length	7 bits
4.	Wave length	1550 nm
5.	Peak power	0.1 watt
6.	Code	NRZ
7.	Modulation type	Intensity
8.	Time shift	25 ps
9.	Normalized power	-12 dbm
10.	Pattern type	Alternate (101010101…)

Table 2: Control Parameters

Control signal	Parameter	Value
1.	Laser type	Mode-lock laser
2.	Wave length	1550 nm
3.	Laser power	1 watt
4.	No of couplers used	2
5	Control Signal Time Shift	$5x10^{-12}$

To realize TDM OLT components required are PRBS generator: (Pseudo Random bit sequence generator), Electrical signal generator, LASER, Modulator, Time shifter, Optical Multiplexer and Optical Normalizer as shown in figure 6.

Control signal can be generated using LASER, optical normalizer (used to generate desired high power) two control signals are used using optical splitter which are shifted by pulse width (Time shift=Pulse width).These two control signal are further given to interferometer block for demultiplexing data signal which also includes SOA as nonlinear switch as shown in figure 7. In absence of control signal Data signal will pass from it otherwise it works as reflector.

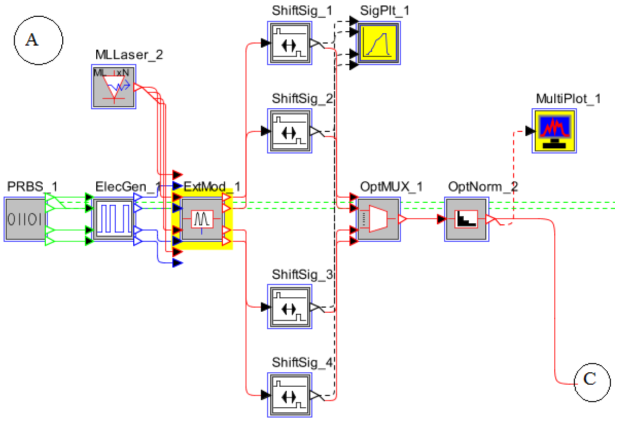

Figure 6: Optical Data Transmission block

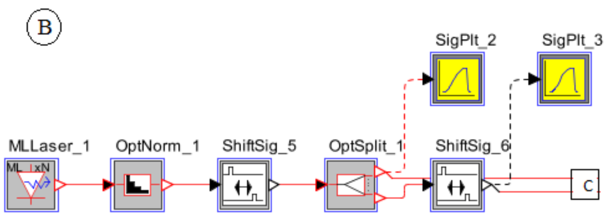

Figure 7: Optical Data Transmission block

Optical coupler will split the OLT data in two directions as shown in figure 8. Which is mixed with control signals. SOA acts as a nonlinear switch. At the output side another optical coupler is used which combines the output from two nonlinear switches and pass it to ONT. Signal analyzer blocks are used which display power level and time position of the TDM signal.

Output from optical coupler is fed to ONT via polarization transformer block as shown in figure 9. In coefficient matrix of Polarization transformer select the value of C11=1 and other parameters C12=C21=C22=0. Polarization transformer block will reject the control signal and only pass the data signal

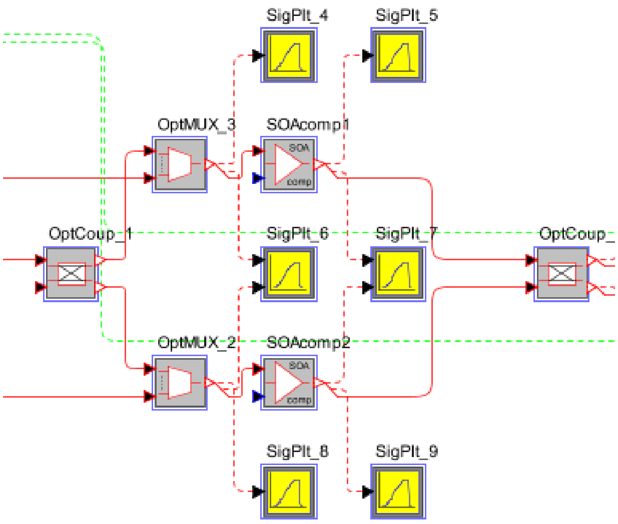

Figure 8: Optical Data Transmission block

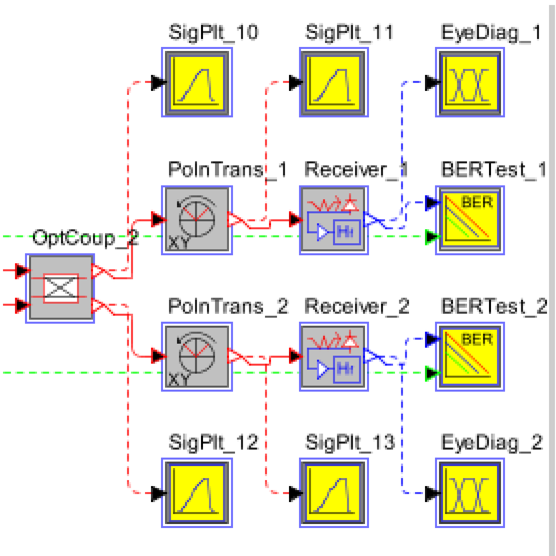

Figure 9: Optical Data Transmission block

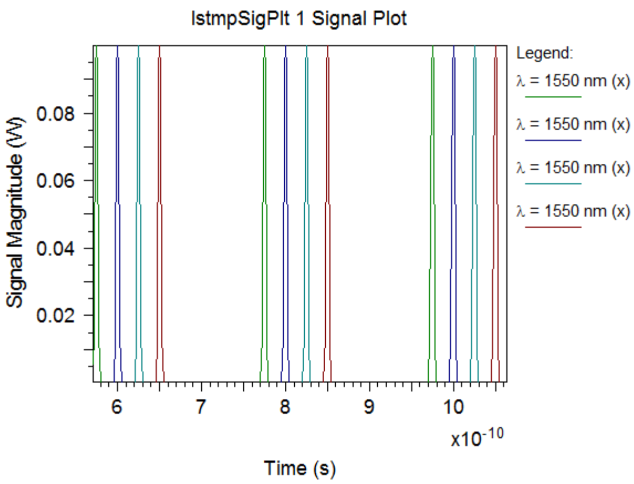

Figure 10: TDM Signal

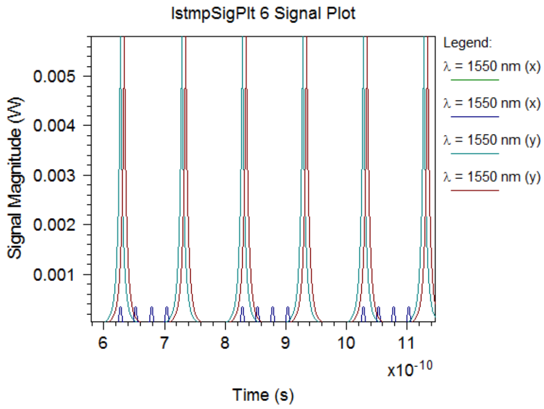

Figure 11: Data mixed with control signal

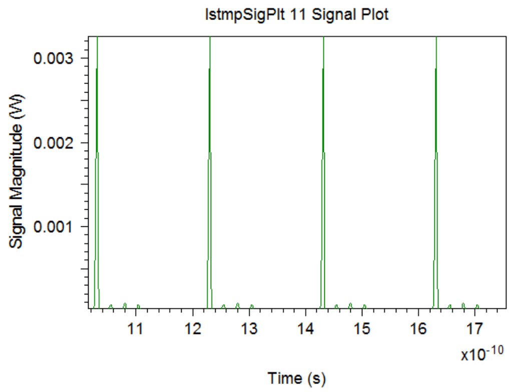

Figure 12: First user ONU output

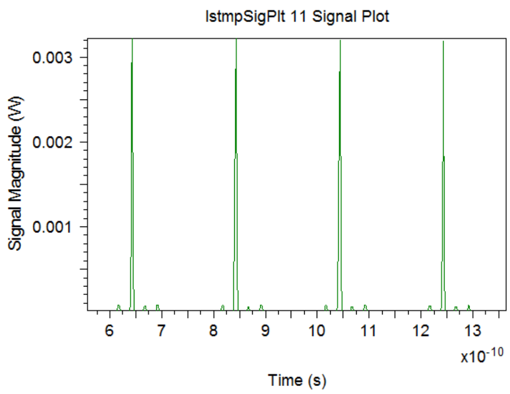

Figure 13: Second user ONU output

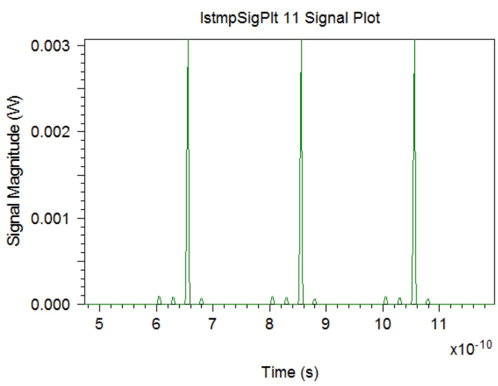

Figure 14: Third user ONU output

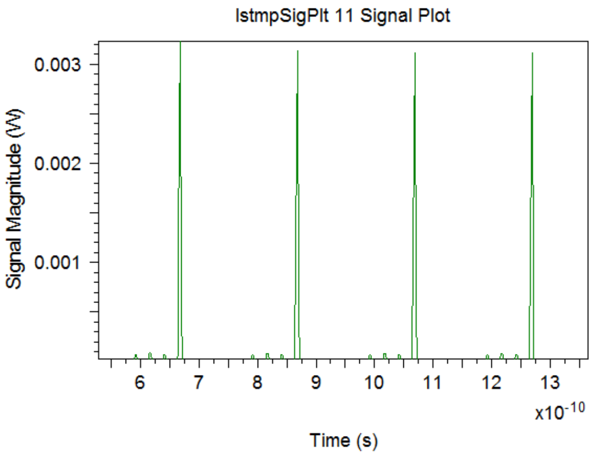

Figure 15: Fourth user ONU output

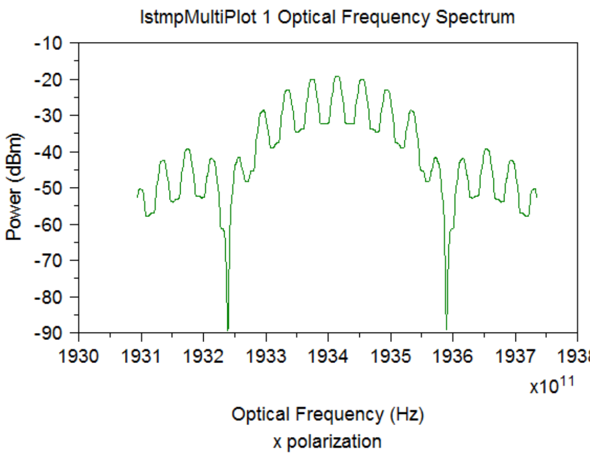

Figure 16: TDM Spectrum Signal

Figure 10 indicates how four signals from OLTs are multiplexed together. It uses signal analyzer block to represent Power of signal vs time relationship obtained after multiplexing. Figure 11 shows how the multiplexed signal is combined with control signal. It will represent the signal at interferometer side. Where two signals are mixed together. One signal is data signal, other signal is control signal. The amplitude of control signal is very much higher than the amplitude of data signal. Because it is use in interferometer for switching between the two signals. The higher amplitude is control signal, and the lower signal amplitude is data signal. Signal demultiplexing at ONU side is shown in Figure 12-15. The spectrum of TDM signal is shown in figure 16. These results are base of the TDM-PON and one can obtained desired results by adding more no of OLTs. These results can be compared with WDM-PON.

Abbreviations and acronyms

PON:	Passive Optical network
ONT:	Optical Network Terminal
OLT:	Optical Line Terminal
OADM:	Optical Add-Drop Multiplexer
EPON:	Ethernet Passive Optical Network
GEPON:	Gigabit Ethernet Passive Optical Network
AON:	Active Optical Network
ODN:	Optical Distribution Network
NGPON:	Next Generation Passive Optical Network

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