A review paper on Analysis of performance SOA, EDFA, Raman & Hybrid Optical Amplifiers in 8*10 Gbps WDM System

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***Abstract*-With modern development, communication have become an important part of human life and cannot be dispensed with, the communication process involves information generation, transmission, reception and interpretation.This paper gives an overview of analysis of performance of Semiconductor Optical Amplifier, ,Erbium Doped Fiber Amplifier,Raman & Hybrid Optical Amplifiers in 8*10 Gigabits per Second Wavelength Division Multiplexing(WDM) System. In this paper we will be discussing about use of Duobinary Return to Zero (DRZ) in place of Non Return to Zero (NRZ) Modulation scheme for better BER in different optical amplifiers.**

***Keywords*– BER(Bit Error Rate), DRZ,DWDM(Dense Wavelength Division Multiplexing),NB-HA(Narrow Band Hybrid-Amplifier), SWB-HA(Seamless and Wideband Hybrid Amplifier)**

I. INTRODUCTION

With the increase in the technology of networks and the internet, the need of the users also increases. The requirement of high bandwidth, high data transmission rate, etc increases. To fulfill this need the concept of WDM and fiber optic was developed. WDM is a wavelength division multiplexing. In which the multiple input signals are combined together and transfers as a single input. It uses the concept of multiplexing and de-multiplexing. In the existing work 8 signals with different wavelengths are transmitted at 10 Gbps with reduced channel spacing of 50 GHz. Each signal is modulated by NRZ format. The use of NRZ have some disadvantages like no error correction will be done using it, signal may drop due to presence of low frequency components, absence of clock, loss of synchronization is there in it. To remove this we will use another advance modulation scheme that will help in overcoming the drawback of using NRZ. This part is done at receiver side. At the receiver side, all the channels are demultiplex and pass to individual's receiver. PIN photodiode with low pass filter are used to convert modulated signal into original signal. Another issue that were faced in earlier developed systems was that it they have used only single filter. So, we can work on different filters and test the hybrid SOA and EDFA amplifier that will help in enhancing the Bit Error Rate (BER) of the overall system. Hence there is a requirement to develop such a system which will improve the overall BER of the system.

Fiber optic communication is a communication technology that uses light pulses to transfer information from one point to another through an optical fiber. The information transmitted is essentially digital information generated by telephone systems, cable television companies, and computer systems. An optical fiber is a dielectric cylindrical waveguide made from low-loss materials, usually silicon dioxide. Figure 1 gives a simplified description of a basic fiber optic communication system.

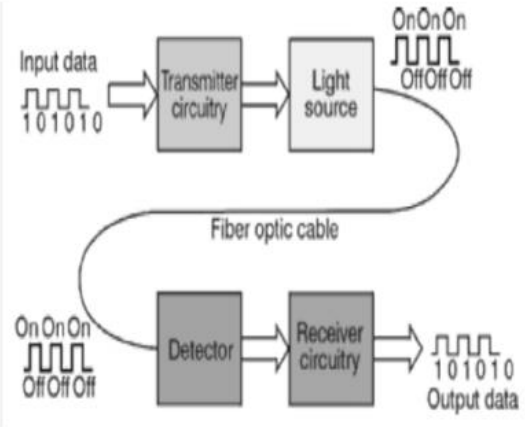

Figure 1

II. WDM TECHNOLOGY

WDM (Wavelength Division Multiplexed) is one of these solutions. The WDM network supports massive bandwidth range and also provides the better data transmission range. In WDM network, the data is multiplexed to the transmission lines. It provides the facility to transfer the multiple wavelength at a given period of time or simultaneously. The WDM uses the concept of Fiber optic network which supports the massive bandwidth and data transmission range. Hence there is need to fulfill the requirement regarding the better data transmission rate and vast bandwidth. To fulfill this need the concept of WDM along with fiber optic network is designed. The key feature of optical fiber network is that it provides large range of data transmission and gigantic bandwidth for data transferring.

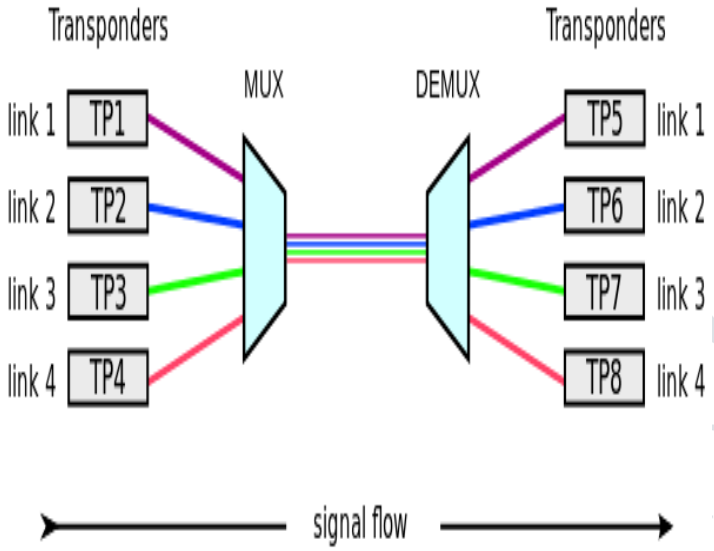

Figure 2. WDM(Wavelength Division Multiplexing)

WDM is the best solution for increasing number of channels and transmission capacity of the system. In WDM multiple signals at different frequencies are modulated and transmitted over the fiber. For the long distance transmission multimedia services require the high speed data transmission and large bandwidth to grow the networks without repeaters and that can be possible with optical amplifiers. Such networks are sensitive to fiber non linearity, dispersionand attenuations. Such large distance transmissions are required to maintain the performance of the system. Before optical amplifier regenerators were used that required the conversion of signals from one domain to another domain. These conversion required high speed electronics equipments. Optical amplifiers directly amplify optical signals without any conversionfrom optical to electrical. Optical amplifiers maintain the bandwidth and required level of the system by raising the strengthof the signal. Optical amplifiers are most efficient, most stable with minimum losses for long distance transmission. Initiallyconventional amplifiers Raman, EDFA and SOA were used in WDM networks. Each amplifier has their own drawbacks andbenefits. Amplification mechanism for Raman amplifier is Stimulated Raman Scattering. Raman amplifier can amplify sig-nal of any wavelength depending upon the proper choice of pump power and pump wavelength. Broad spectrum of Ramanamplifier is obtained by changing number of pumps and their wavelength. In Raman amplifier both the signal wavelengthand pump wavelength are different. Power is transferred from shorter wavelength to longer wavelength.[1]

SEMICONDUCTOR OPTICAL AMPLIFIER

A semiconductor laser amplifier is a modified semiconductor laser, which typically has different facet reflectivity and different device length . Semiconductor optical amplifier is very similar to a laser except it has no reflecting facets. A weak signal is sent through the active region of the semiconductor, which, via stimulated emission, results in a stronger signal emitted from the semiconductor.[2]

ERBIUM DOPED FIBER AMPLIFIER

The EDFA consists of three basic components: length of erbium doped fiber, pump laser and wavelength selective coupler to combine the signal and pump. The optimum fiber length used depends upon the pump power, input signal power, amount of erbium doping and pumping wavelength. Erbium doped fiber amplifiers (EDFAs) can be extensively used in optical fiber communication systems due to their compatibility with optical fiber.

EDFA amplifier gives amplification in 1550 nm optical window. EDFA transfer high pump power tosignal. EDFA have large dynamic range with low noise figure. EDFA is used for ultra long distance transmission. In order toupgrade the bandwidth and maximize the transmission length, hybrid optical amplifiers are designed [3,4]. Using Raman-EDFA hybrid amplifier gain flatness of 90.5 nm has been reached up to 50 km transmission distance [5]

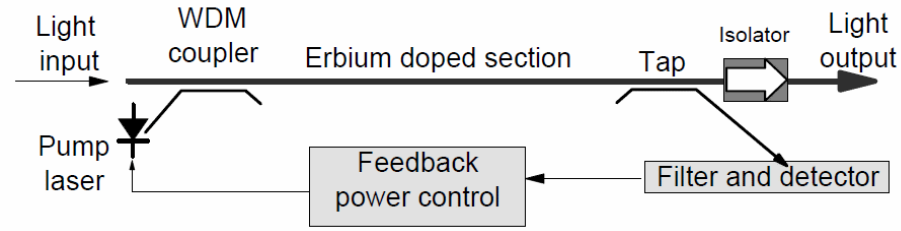

Figure 3. Erbium Doped Fiber Amplifier

RAMAN AMPLIFIER

Raman gain in optical fibers occurs from the transfer of power from one optical beam to another through the transfer of energy of a photon. A phonon arises when a beam of light couples with the vibration modes of the medium. In this instance the optical fiber is the amplifying medium making the gain provided by Raman amplifiers dependent on the optical fiber's composition. In silica fibers, the Raman gain bandwidth is over 260 nm, with the dominant peak occurring at 86 nm from the pump wavelength.

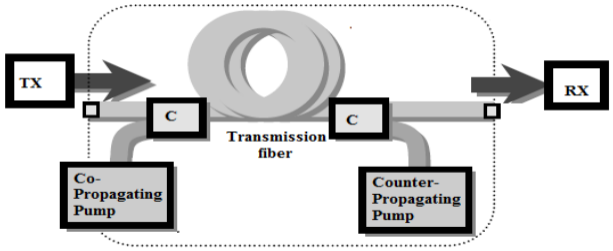

Figure 4. Raman Amplifier

HYBRID OPTICAL AMPLIFIER

The combination of more than one amplifier in a configuration is called hybrid optical amplifier. Mohammed N. Islam described that the total amplifier gain (GHybrid) is the sum of the two gains:

GHybrid=GEDFA+GRaman

Two kind of hybrid amplifier (HA) are: the narrowband HA (NB-HA) and the seamless and wideband HA (SWB-HA). The NB-HA employs distributed Raman amplification in the transmission fiber together with an EDFA and provides low noise transmission in the C- or Lband. The noise figure of the transmission line is lower than it would be if only an EDFA were used. The SWB-HA, on the other hand, employs distributed or discrete Raman amplification together with an EDFA and provides a low-noise and wideband transmission line or a low-noise and wideband discrete amplifier for the C- and L-bands. The typical gain bandwidth ($\triangle\lambda$) of the NB-HA is 30 to 40 nm, whereas that of the SWB-HA is 70 to 80 nm.[6]

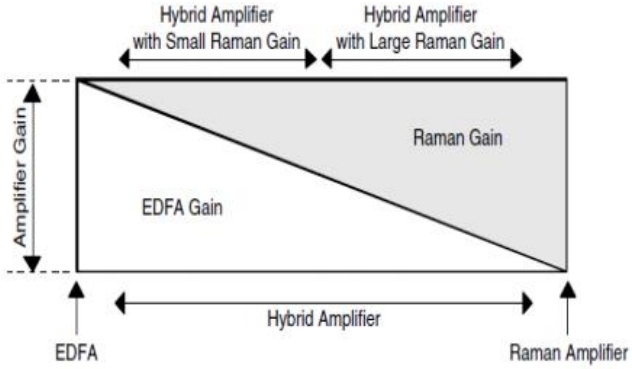

Figure 5. Gain partitioning in Hybrid Amplifier

III. PROBLEM FORMULATION

With the increase in the technology of networks and the internet, the need of the users also increases. The requirement of high bandwidth, high data transmission rate, etc increases. To fulfill this need the concept of WDM and fiber optic was developed. WDM is a wavelength division multiplexing. In which the multiple input signals are combined together and transfers as a single input. It uses the concept of multiplexing and de-multiplexing. In the existing work 8 signals with different wavelengths are transmitted at 10 Gbps with reduced channel spacing of 50 GHz. Each signal is modulated by NRZ format. The use of NRZ have some disadvantages like no error correction will be done using it, signal may drop due to presence of low frequency components, absence of clock, loss of synchronization is there in it. To remove this we will use another advance modulation scheme that will help in overcoming the drawback of using NRZ. This part is done at receiver side. At the receiver side, all the channels are demultiplex and pass to individual's receiver. PIN photodiode with low pass filter are used to convert modulated signal into original signal. Another issue that were faced in earlier developed systems was that it they have used only single filter. So, we can work on different filters and test the hybrid SOA and EDFA amplifier that will help in enhancing the Bit Error Rate (BER) of the overall system. Hence there is a requirement to develop such a system which will improve the overall BER of the system.

IV. PROPOSED WORK

Main objectives of the proposed work are: (a) To analyse 8*10 Gbps WDM System, (b) To replace the existing NRZ modulation scheme with improve DRZ scheme. (c) To enhance the criteria of BER by testing the existing system using different filters.

The previous section gives a brief revelation to the existing inventions that has been done in the field of optical networks or WDM to make it advantageous to the users. But after getting more engaged into the inventions various inabilities were bring up to the existence which were related to the Quality factor and BER reduction. Hence it is adjudicate to flourish such a mechanism which can overcome the previous limitations. The proposed work is decided to implement a hybridization of two amplifiers such as SOA-EDFA and replacing the existing NRZ modulation scheme with improved DRZ scheme. The BER of the system is improved by testing it using different filters. So, the existing system will be tested using different filters and compared it in terms of BER.

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REFERENCES

[1] Deepak Malik "Performance optimization of SOA, EDFA, Raman and hybrid optical amplifiers in WDM network with reduced channel spacing of 50 GHz" Elsevier, 2016.
[2] Prachi Sharma, "Fiber Optic Communication: An Overview", IJETAE, Vol 3, Issue 5, Pp 474-480, 2013.
[3] M. Azadeh, Fiber Optics Engineering. Springer, 2009, p. 379.
[4] P. C. Becker, N. A. Olsson, J. R. Simpson, Erbium-Doped FiberAmplifiers. Academic Press, 1999, p. 481.
[5] G. P. Agrawal, Fiber-Optic Communications Systems. John Wiley &Sons, 2002, p. 567.
[6] S. Olonkins et al, "Equalization of EDFA Gain Spectrum and Increase of OSNR through Introducing a Hybrid Raman-EDFA Solution", PIERS Proceedings, pp. 600-603, July 2015