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Performance Comparison Of Optical Amplifiers And their Hybrid Configurations In 8x10 Gbps WDM Based Optical Network

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Abstract- Some conditions and requirements are not fulfilled by the individual amplifiers, so to accomplish various goals, hybrid configurations of amplifiers are designed. These hybrid amplifiers are composed with combination of (EDFA-SOA, RAMAN-EDFA, RAMAN-SOA) different amplifiers. In this paper we have investigated the performance of different amplifiers with 8 channel transmitter at data speed of 10 Gbits/s with constant attenuation value .2 dB/km. Performance is analyzed on the basis of Quality factor, eye opening, eye closure, jitter, bit error rate(BER).Different combinations provide better result that are suitable for efficient optical communication.

Keywords - Raman amplifier, semiconductor optical amplifier, erbium doper fiber, EDFA-SOA, RAMAN-SOA, RAMAN-EDFA, BER, WDM, hybrid amplifier optical fiber communication.

INTRODUCTION

Two major problems occur in the optical signal transmission are Attenuation and Dispersion. Power of signal is reduced during transmission is called attenuation. Pulse broadening and inter symbolic interference are major problems that causes dispersion. The growth of optical amplifiers permit a dramatic improvement in the efficiency of optical communication system [1]. Capacity increases is possible while reducing system cost, signal is degraded when transmitted over long distance. Earlier, it was accomplished with repeaters or we can say optoelectronic devices that convert optical signal into the electrical signal or vice versa. Evaluation of optical amplifiers eliminates the requirements of repeater or optoelectronic devices. Cost of system is also reduced by using optical amplifiers because there is no need of O-E OR E-O conversion. Optical amplifier is used in WDM system in which all the channel of transmitter are transmits simultaneously. Optical amplifiers are use plain after the transmitter and absolutely before the receiver for distortion free and efficient transmission of power.

Raman amplifiers are used to increase the capacity of fiber-optic networks, operates at the 1300 nm, 1400 nm for wavelength-division multiplexing or short-wavelength S-band[2]. As an example, using a cascade of -band lumped amplifiers, a 20-channel, OC-192 system is shown that propagates over 867 km of standard, single-mode fiber. Raman amplifiers provide a simple single platform for long-haul and ultralong-haul amplifier needs. Performance of augmented gain EDF amplifier systems by enhancing the stages of EDF amplifier & further by variation in pumping power on designed EDF amplifier system has been investigated [3] . It is investigated that signal to noise ratio and the noise figure can be find out by measuring the quality factor of amplified continuous wave signal modulated by external modulator [4].

Several technologies are used for the fabrication of Erbium-doped fiber [5].The semiconductor optical amplifier was able to transmit the signal from 69 to 112 kilometers. The main obstacle that limited the system performance was amplifier produced noise, that is very much greater than of the discrete Raman amplifier, which in turn has managed to extend transmission distance to 119 kilometers [6]. Performance of hybrid configuration has been analyzed with 16, 32 channel transmitter at data speed of 10Gbps [7]. SOA-EDFA showed good performance as it can travel max distance of 220,240,260 km at 16, 32 and 64 channels respectively. Also, RAMAN-EDFA showed a good performance as it has a high QUALITY FACTOR (24.27) and BER (1 X 10-40) at 16 channels [8].

The performance of optical amplifiers in DWDM system has been studied with different number channel of transmitter at channel spacing of 100 GHz [9-12]. We expend the investigation by comparing the performance of individual amplifier and their hybrid configuration. In this paper we have analyze the performance of RAMAN, EDFA, SOA, RAMAN-EDFA, RAMAN-SOA, EDFA-SOA various amplifiers with 8 channel of transmitter at data speed of 10Gbps and at attenuation 0.2dB/km.

SIMULATION SETUP

Simulation setup consist of total 10 blocks. In this, 8 channels are used to transmit with WDM in which all channel transmit the data simultaneously. Transmission speed used is 10 Gbps with channel spacing 50 GHz. Transmitter compound component made up of four components. (1) Data Source – Data source is used to generate the data in logical form with pseudo random sequence. (2) Modulator Drive – There are four types of modulator drivers in the simulation tool we have used. But in this investigation NRZ formatting is used. It is used to convert logical signal into the electrical signal. (3) CW Laser – CW Laser is used to generate laser beams equivalent to transmitter channels. In this case CW Laser generate 8 beams. (4) Amplitude Modulator – Amplitude modulator combine and modulates the signal coming from modulator drive and CW Laser and send it to transmission medium. Splitter is used to split the power to all output optical ports. Fiber is used with different lengths i.e. 10, 100, 200 km. The simulation set up is repeated for measuring the signal strength by utilizing various amplifiers i.e. EDFA, RAMAN, SOA, EDFA-SOA, RAMAN–EDFA, RAMAN-SOA using optical simulator. Performance of individual amplifiers and hybrid amplifiers are compares on the basis of Q factor, jitter, eye opening, eye closure, and BER.

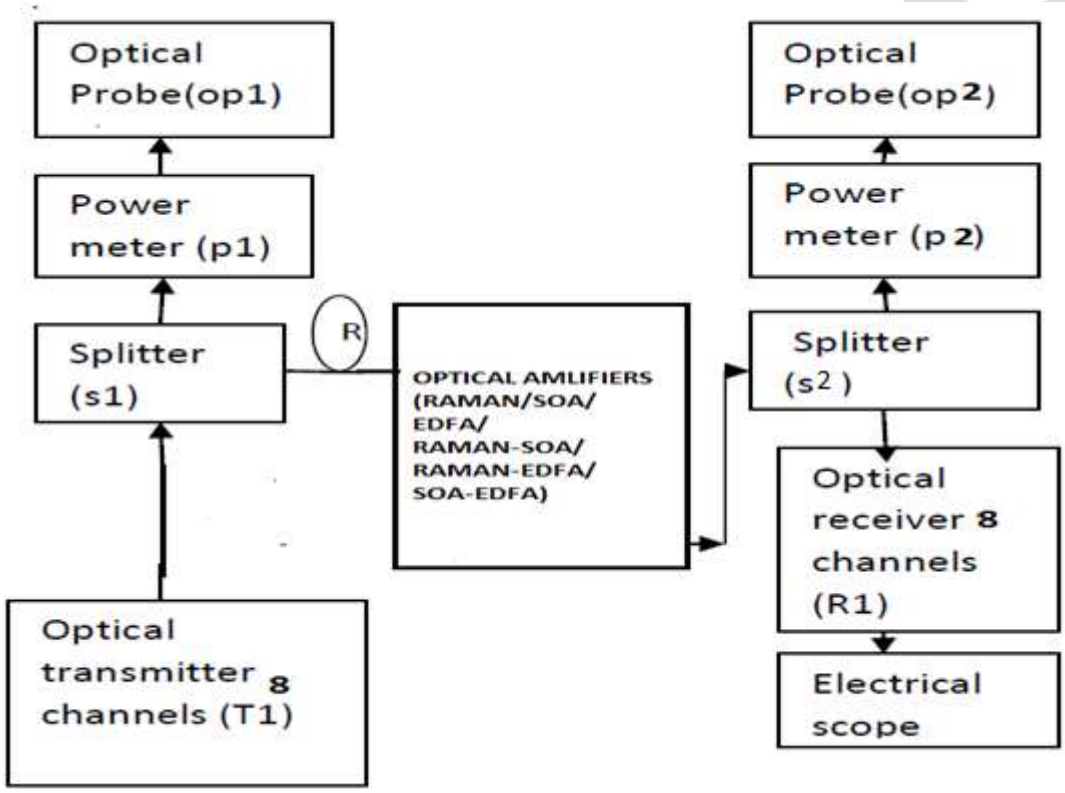

Fig. 1: Simulation Setup

RESULTS AND DICUSSION

WDM signal is transmitted at fixed attenuation and dispersion value of .2dB/km and 2 ps/nm/km respectively. Counter–propagating pump type is used for distributed Raman amplifier at operating temperature of 300 K with pump wavelength. EDFA is operates at wavelength range from 1250-1650 nm. EDFA having flat gain shape and fixed small signal gain of 25 dB. Various optical amplifiers has been compared for 8x10Gbps WDM system in term of received Q factor(dB), eye opening, eye closure(dB) and jitter(ns). In fig.2 variation in quality factor for different amplifier is 19.97 to 6.02(dB) for RAMAN, 15.24 to 6.02(dB) for EDFA, 14.73 to 6.02(dB) for SOA, 13.43 to 6.02(dB) for SOA-EDFA, 14.52 to 6.02(dB) for RAMAN-SOA, 19.92 to 6.02(dB) for RAMAN-EDFA. At 200km all amplifiers have almost same Q factor. The best Q factor is provided by RAMAN amplifier at 10 km of fiber length. At 100 km best Q factor is provided by RAMAN-EDFA.

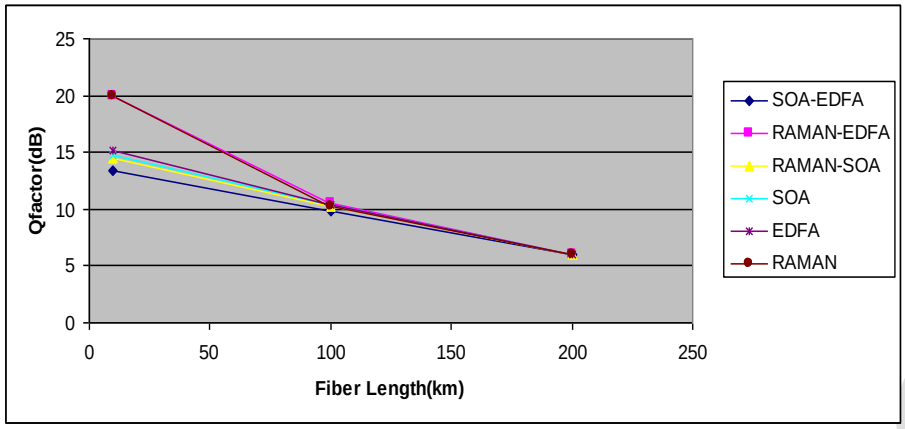

Fig 2: Q factor Vs fiber length

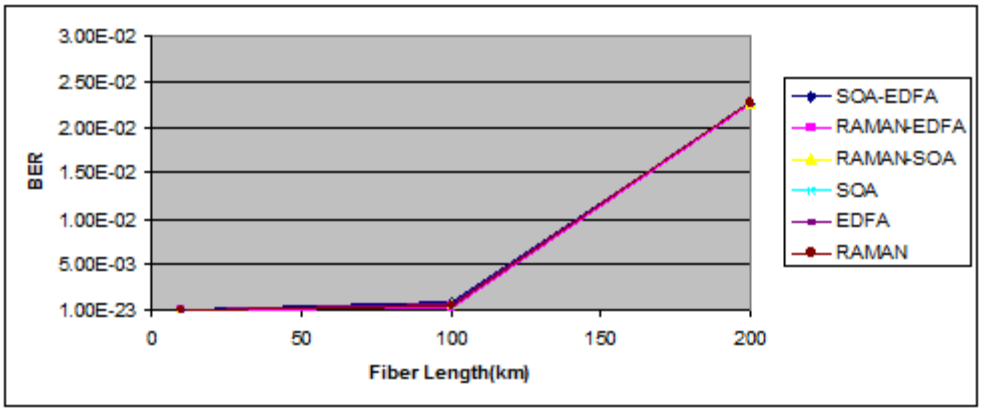

Fig 3: BER Vs fibre length

Figure 3 shows the graphical representation of BER Vs fiber length. Minimum BER is provided by RAMAN-EDFA so RAMAN-EDFA provide batter result. At 200km all the amplifiers have same BER i.e. .0227501 . SOA-EDFA provide highest BER as compare to all other amplifiers so it gives worst performance at all length.

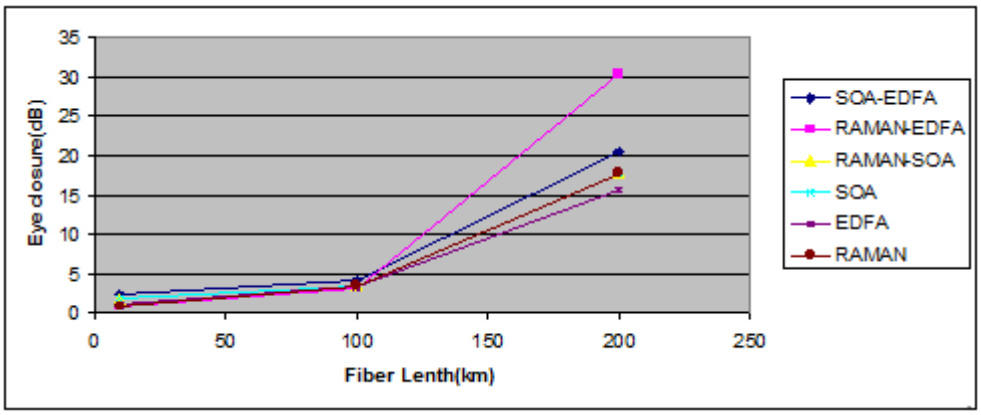

Fig 4: eye closure Vs fiber length.

The variation of eye closure in fig. 4 for various length of fiber is .84 to 17.77(dB) for RAMAN, .86 to 15.68 (dB) for EDFA, 1.75 to 17.73 (dB) for SOA, 1.81 to 17.74(dB) for RAMAN-SOA, .84 to 30.44(dB) for RAMAN-SOA, 2.31 to 20.47(dB) for SOA-EDFA. Eye closure increases with distance as shown in fig.4. Eye closure is maximum for RAMAN-EDFA and minimum for RAMAN-SOA.

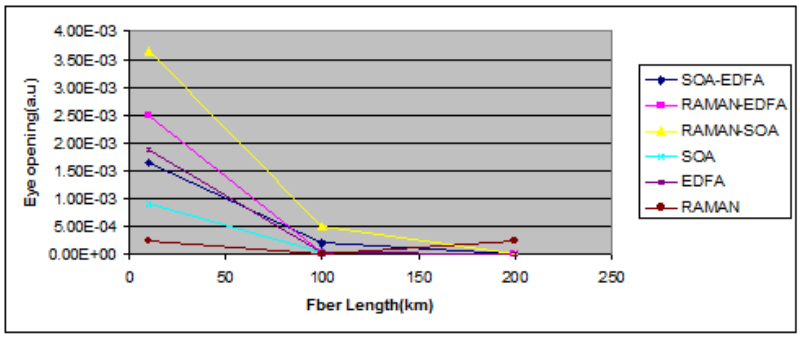

Fig 5: eye opening Vs fiber length

In figure 5. Eye opening vs. transmission distance is plotted. It is shown that eye opening decrease with distance. Larger eye opening means good quality of communication. Eye opening varies from 2.4 e-04 to 1.7e-009 for RAMAN, 1.88e-02 to 8.2e-009 for EDFA, 8.9 e-04 to 1.9e-008 for SOA, 3.6e-03 to 3.6e-007 for RAMAN-SOA, 2.5e-03 to 5.6e-010 for RAMAN-EDFA, 1.6e-03 to 1.00e-007 for SOA-EDFA. As shown in figure RAMAN-SOA provide highest eye opening as shown in figure 5 ,therefore it provide better result as compare to other amplifiers.

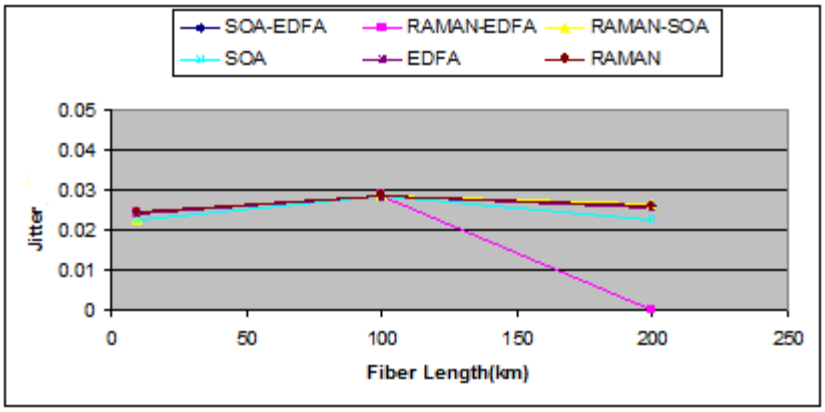

figure 6. Jitter vs. fiber length

In figure 6. Jitter vs. transmission distance is plotted. Jitter should be as small as possible. Lesser will be the jitter better will be the communication. Jitter is varies from .024 to .026 for RAMAN, .024 to .025 for EDFA, .0222 to .0227 for SOA, .0228 to .0227 for RAMAN-SOA, .024 to 5.6e-010 for RAMAN-SOA, .0237 to .0259 for SOA-EDFA. So as shown in graph value of jitter is minimum for RAMAN-EDFA . Therefore RAMAN-EDFA provide better performance as compare to other amplifiers in terms of jitter .

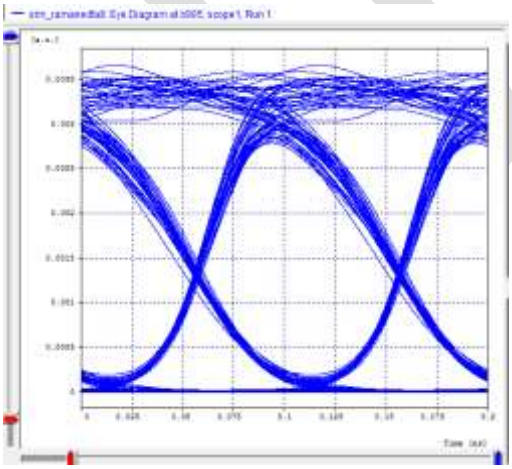

Fig 7: Eye diagram of RAMAN-EDFA at fiber length 10km.

CONCLUSION

We have designed and implemented hybrid optical amplifiers by using OptSim. We carried out simulation for different hybrid amplifier in the presence and absence of nonlinearities by varying the transmission distance and finding out most suitable among them. The performance of optical amplifiers was evaluated using the eye patterns, BER measurement, eye opening, eye closure ,jitter and Q factor. From this work it is concluded that RAMAN-EDFA gives best results than other amplifiers . RAMAN-EDFA gives highest Q factor 19.92(dB) ,smallest jitter (.0243) , minimum eye closure (.84694) but RAMAN-SOA provide largest eye opening (.00366) at 10 km.. From all these results we can say that RAMAN-EDFA provide best results among all these 6 amplifiers. So RAMAN-EDFA is promising alternative to RAMAN,EDFA,SOA,RAMAN-SOA and EDFA-SOA in optical fibre communication

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