Transmission Performance of Random Diagonal Codes

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Abstract— **This paper presents the performance enhancement of SAC-OCDMA system employing Random Diagonal Code at 10 Gbps. By analyzing the results taken from commercial optical systems simulator "Optisystem 7.0" it was made clear that the transmission distance is limited by Dispersion at higher data rates .The SAC-OCDMA network operating at 1550 nm, the maximum allowable distance is 10 km which is increased to 50 km and 61km with use of optical amplifier alone and optical amplifier combined with Ideal dispersion fiber Bragg grating respectively.**

Keywords: **Random Diagonal code, optical amplifier, Ideal dispersion compensation FBG, Attenuation**

I. Introduction

Optical Code Division multiple Access has received popularity in the field of communication due to its characteristics of asynchronous access, enhanced security. The underlying principle for the working of OCDMA is data extraction in the presence of multiple users [1]. In a SAC-OCDMA system, the effect of MAI can be decreased by the application of codes which are orthogonal, unipolar and with constant weight [2]. There are various codes [3–5] to mitigate the MAI effect.. In OCDMA system, As MAI leads to overlapping spectra from different users which arises PIIN [6]. When incoherent light field vectors are mixed and incident upon a receiver (like PIN,APD) the phase noise of the field vector causes an intensity noise term in the receiver output, called PIIN [7]. PIIN arises due to mixing of two incoherent light field vector that has same polarization. The widening of spectrum beyond the maximum allowable electrical bandwidth limits the noise intensity seen at the receiver side is called PIIN [8]. So the remedies to overcome MAI and PIIN are Random Diagonal Code. The code designs with zero cross correlation, constant weight is required in OCDMA systems which will remove the effect of MAI and nullify the effect of PIIN.The perfect example of such code is Random Diagonal Code in which the whole spectrum is divided into chips, each chip phase is altered according to phase code.In [9] it has been assumed that the value of cross-correlation is always equal to zero, because of the data signal is carried on the data segment only. But the performance of the optical Network employing these codes gets hindered due to Dispersion, attenuation and losses. Dispersion leads to widening of the spectra and it becomes difficult to identify one's and zero's at the receiver side.

In this manuscript an attempt is made to enhance the performance of proposed system by the application of optical amplifier and Ideal dispersion fiber Bragg grating. The transmission distance increased by 4.3 times due to optical amplifier which boosted up the strength of received signal but it introduced noise that worsen the effect of dispersion and nonlinearity since signal degradation keeps on adding over multiple amplification stages. So in order to reduce this effect dispersion mitigating device Ideal Dispersion Fiber Bragg Grating is employed along with optical amplifier which increased the transmission distance by 6.1 times.

The rest of the manuscript is organized as follows, description of proposed system is described in section 2.The results are discussed in section 3.finally conclusion is discussed in section 4.

II. System Description

Figure.1 shows the block diagram of the RD Segment in which wavelength of laser is modified for each user. Laser is used to generate Data segment and LED is used to generate Code Segment. Data is modulated using Mach Zhender modulator with extinction ratio of 30 dB. The tests were carried out at a rate of 10 Gb/s for 10 km distance with the ITU-T G.652 standard single-mode optical fiber (SMF).All the attenuation α (i.e., 0.25 dB/km), dispersion (i.e., 18 ps/nm/ km), and nonlinear effects were added. After the splitter, we used a fiber Bragg grating (FBG) spectral amplitude decoder operates as filter and photodiode decodes the data at data sub-matrix, LPF (Low Pass Filter) rejects all unwanted frequencies and a BER analyzer to visualize the eye diagram [10] as shown in Figure.2. The parameters values used during simulation are presented below in Table.1

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Table1. List of Parameters used during Simulation

Parameters	Value
Operating wavelength region	1550nm
Signal data	128-bit PN sequence
Signal Bit Rate	10Gb/s
Fiber length	10 km
Fiber group velocity dispersion	18 ps/nm/km
Fiber Loss	0.25 dB/km
Receiver fiber bandwidth	0.75*bit rate

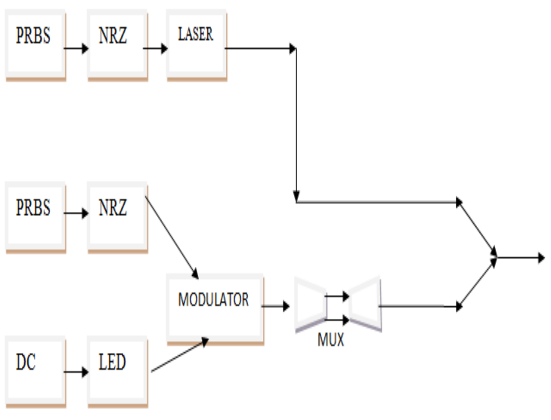

Figure.1 RD segment [11]

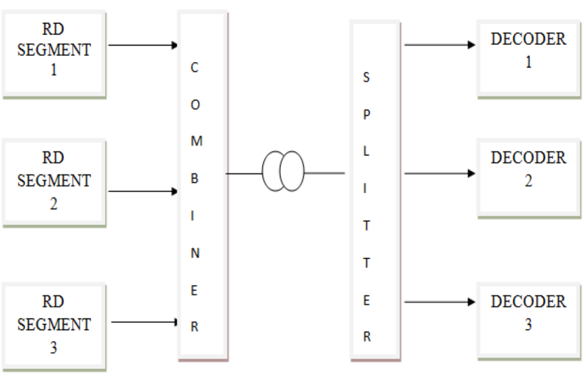

Figure.2 Simulation setup of SAC-OCDMA System operating at 10Gbps

III. RESULTS AND DISCUSSIONS

A. With Optical Amplifier

Fiber losses can also be compensated by using optical amplifiers, which amplify the optical bit stream directly without requiring conversion of the signal from optical to the electric domain [12].Optical Amplifier having gain of 20 dB and Noise Figure of 4dB is attached with optical fibre and it has increased the transmission distance to 50 Km at the data rate of 10 Gbps with dispersion of 18ps/nm/km and attenuation of 0.25 dB/km. Figure.3 presents the Eye diagram of one of RD channel with the application of optical amplifier at 50 km with minimum allowable ber and eye height of 5.09773exp(-005) Figure.4 indicates how much increase in transmission length occurred due to use of optical amplifier.

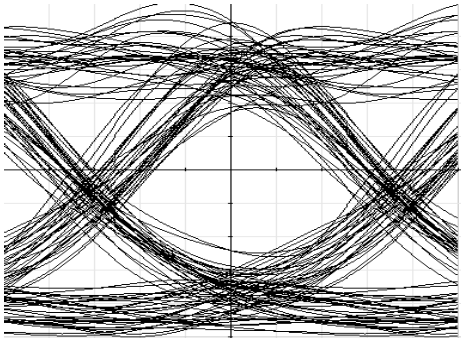

Figure. 3 Eye Diagram of one of RD channel operating at 10Gbps with optical amplifier at distance of 50 km.

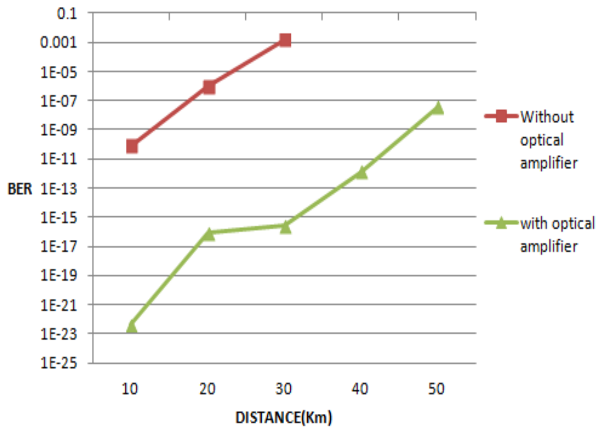

Figure.4 BER of compared system with different transmission length with optical amplifier only

B. Optical amplifier and Ideal dispersion Compensation Fibre Bragg Grating

Optical amplifiers solve the loss problem but they add noise and multiply the negative effect of fiber dispersion and nonlinearity due to this signal degradation keeps on adding over multiple amplification stages. So proposed optical network are often limited by fiber dispersion but can be overcome with the help of dispersion-compensation techniques [13].For this reason Ideal Dispersion Compensation fiber Bragg grating is used in conjunction with optical amplifier having 20dB gain. The maximum allowable BER was found at 61 km. Figure.5 shows the eye diagram of

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proposed system with the help of optical amplifier and ideal dispersion compensation fibre bragg grating which has an eye height of 7.63 exp (-005) and ber of the order of ~ exp(-23) at 50 km.A comparison shown in Figure.6 clearly depicts the benefit of implementing Ideal Dispersion Fiber Bragg Grating with optical amplifier. Figure.7 shows how much increment has been encountered in the value of Quality factor with the employment of dispersion compensation technique .

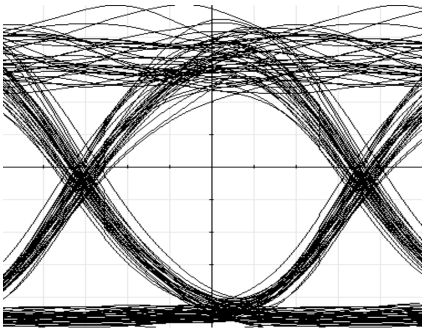

Figure.5: Eye Diagram of one of RD channel operating at 10Gbps with optical amplifier and Ideal Dispersion fiber Bragg grating at distance of 50 km.

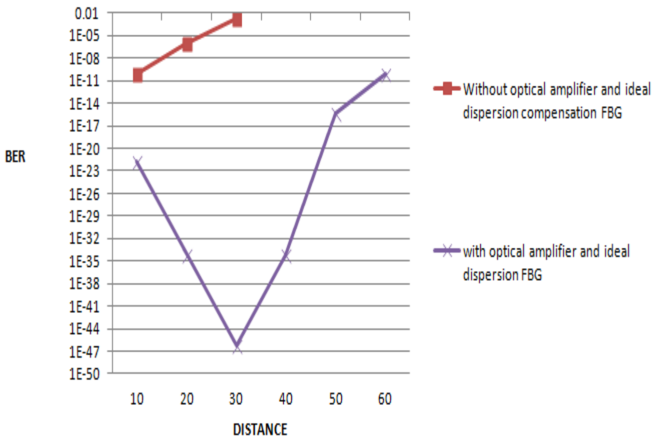

Figure.6 BER of compared system with different transmission length with the application of optical amplifier and ideal dispersion FBG

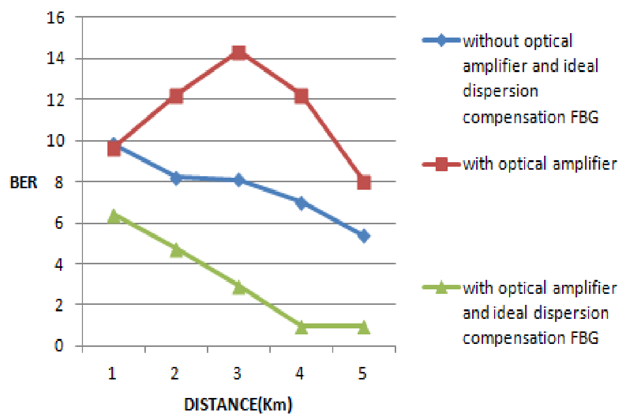

Figure.7 Quality Factor of compared system with different transmission length

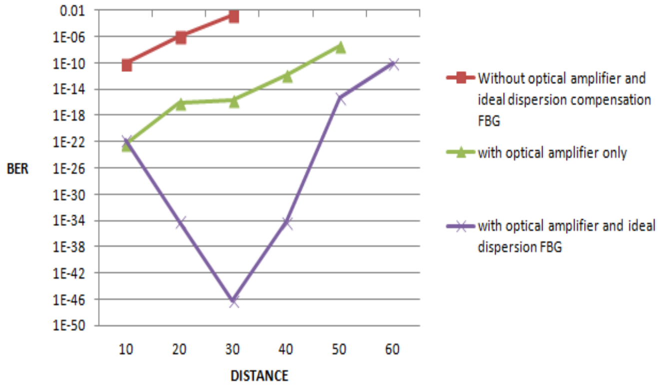

Figure .8 BER of compared system with different transmission length

IV. CONCLUSION

The performance of SAC-OCDMA network operating with 10 Gbps has been investigated to address the effect of transmission through a single mode fiber. As the transmission length increases by 5 times using optical amplifier and 6.1 times using optical amplifier with Ideal dispersion compensation FBG.With the application of dispersion compensation along with optical amplifier achieves BER 3.76834exp(-023) whereas optical amplifier alone achieves BER 5.26 exp(-10). The eye diagram along with graphic analysis indicate that the performance of fiber optic-based SAC-OCDMA RD network enhances not only by employing optical amplifier alone but along with Dispersion compensation technique (Ideal Dispersion Compensation Fiber Bragg Grating) as they add noise to the system as shown in Figure.8.

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