To Compare the Signal in Time and Frequency Domain using DCF with Pre and Post Compensation

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Abstract— *In this paper; dispersion compensating fibers are used to compensate for the positive dispersion accumulated over the length of fiber. Post and Pre dispersion compensation scheme is employed for dispersion compensation. TRAINGULAR modulation format is employed. The performance of this scheme is analyzed and then the optimization of this scheme is done at wavelength of C band. The investigation is done on detailed simulative analysis using optisystem.*

Keywords— Dispersion compensating fiber, Dispersion, Analyzer, Bit Error Rate, Single mode fiber

I. INTRODUCTION

The Optical fiber communications have changed our lives in many ways over the last four decades there is no doubt that low-loss optical transmission fibers have been critical to the enormous success of optical communications technology. There is no doubt that low loss optical transmission fibers have been critical to the enormous success of optical communications technology. In the telecommunication sector, the so-called passive optical network was proposed for the already envisioned fiber-to-the-home (FTTH) network. This network relied heavily on the use of passive optical splitters. These splitters were fabricated from standard single-mode fibers (SMFs). Although FTTH, at a large scale, did not occur until decades later, research into the use of components for telecommunications applications continued. The commercial introduction of the fiber optic amplifier in the early 1990s revolutionized optical fiber transmissions. With amplification, optical signals could travel hundreds of kilometers without regeneration [1].The performance of any communication system is ultimately limited by the signal-to-noise ratio (SNR) of the received signal and available bandwidth. This limitation cans be stated more formally by using the concept of *channel capacity* introduced within the framework of information theory [2].

II. THE EFFECT of FIBER-OPTIC DISPERSION ON OPTICAL TRANSMISSION

Loss and dispersion are the major factor that affect fiber-optical communication being the high-capacity develops. The EDFA is the gigantic change happened in the fiber-optical communication system; the loss is no longer the major factor to restrict the fiber-optical transmission. Since EDFA works in 1550 nm wave band, the average Single Mode Fiber (SMF) dispersion value in that wave band is very big, about 15-20ps / (nm. km-1). It is easy to see that the dispersion become the major factors that restrict long distance fiber-optical transfers [3]. Dispersion is defined as because of the different frequency or mode of light pulse in fiber transmits at different rates, so that these frequency components or models receive the fiber terminals at different time. It can cause intolerable amounts of distortions that ultimately lead to errors.

In single-mode fiber performance is primarily limited by chromatic dispersion which occurs because the index of the glass varies slightly depending on the wavelength of the light,and light from real optical transmitters necessarily has non zero spectral width (due to modulation)[4,5].

III. DCF DISPERSION COMPENSATION TECHNOLOGY

In order to improve overall system performance and reduced as much as possible the transmission performance influenced by the dispersion, several dispersion compensation technologies were proposed [6]. Amongst the various techniques proposed in the literature, the ones that appear to hold immediate promise for dispersion compensation and management could be broadly classified as: dispersion compensating fibers (DCF), chirped fiber Bragg gratings (FBG), and high-order mode (HOM) fiber [7]. The idea of using dispersion compensation fiber for dispersion compensation was proposed as early as in 1980 but, until after the invention of optical amplifiers, DCF began to be widespread attention and study. As products of DCF are more mature, stable, not easily affected by temperature, wide bandwidth, DCF has become a most useful method of dispersion compensation.[8]

IV. DISPRSION COMPNSATION SCHEME EMPLOYED

The use of dispersion compensating fiber is an efficient way to upgrade installed links made of standard single mode fiber Conventional dispersion compensating fibers have a high negative dispersion -70 to -90 ps/nm.km and can be used to compensate the positive dispersion of transmission fiber in C band. Of particular interests are the pre-, post- and symmetrical compensation techniques where each link is made of spans where the DCF is located before, after the SMF or symmetrically across the SMF. A DCF module should have low insertion loss, low polarization mode dispersion and low optical nonlinearity. [9]

By placing one DCF with negative dispersion after a SMF with positive dispersion, the net dispersion will be zero

$$D_{SMF} \times L_{SMF} = - D_{DCF} \times L_{DCF}$$

Where D and L are the dispersion and length of each fiber segment respectively.

Fiber based Compensation is done by two methods:

i) Pre-Compensation

ii) Post Compensation

Pre-Compensation: The optical communication system is pre compensated by the dispersion compensating fiber of negative dispersion against the standard fiber.

Post-Compensation: The optical communication system is post compensated by the dispersion compensating fiber of negative dispersion against the standard fiber. [10]

Among these two methods, post compensation model can transmit low power signal at a much higher bit rate, to a longer distance maintain a higher quality of the signal than post compensation.[11].

V. SYSTEM SET UP AND SIMULATION DETAILS

The transmitter section consists of data source, modulator driver (TRAINGULAR driver), laser source (CW laser) and amplitude modulator. Data source produces a pseudo-random sequence of bits at a rate of 30 Gbit/s. The output of data source is given to modulator driver which produces TRAINGULAR format pulse with duty cycle of 0.5. The output of laser source is CW type. The line-width was set to 10 MHz full width half maximum. The modulator is of Mach-zehnder modulators have the Excitation ratio 30db.The loop control system has only one loop. Each span consists of 100 km of transmission fiber (SMF) and 21 km DCF in order to fully compensate for the dispersion slope and accumulated dispersion in the transmission fiber. The parameters for DCF are attenuation 0.3db/km and dispersion -80ps/nm/km. The SMF have the reference wavelength of 1550nm with attenuation 0.3dB/km and Dispersion 17ps/nm/km. The input powers of transmission fiber and DCF are varied independently from each other to find the maximum reach limit. Two EDFAs in front of transmission fiber and DCF with 6.6 dB gain and 4 dB noise figures each are used to adjust input power levels. At the receiver side, the optical signal is transformed in to an electrical signal by a PIN photodiode The PIN photo detector have the Responsbitiy 1A/W and Dark current 10nA. The electrical signal is filtered by a low pass Bessel filter with Sweep value of Cut frequency “0.7*Bit rate “Hz. The simulation set up for post compensation scheme is as shown in Figs.1.

The length of dispersion compensated fiber is taken as 21 km and that of single mode fiber is taken as 100 km and EDFAs with 4 dB noise figure are used and these are modeled by wavelength independent gain and noise addition.. The simulation is done with optsim software which is an advanced optical communication system simulation package designed for professional engineering and cutting-edge study of WDM, DWDM, TDM, CATV, optical LAN, parallel optical bus, and other emerging optical systems in telecom, data communication, and other applications.

VI. RESULTS AND ANALYSIS

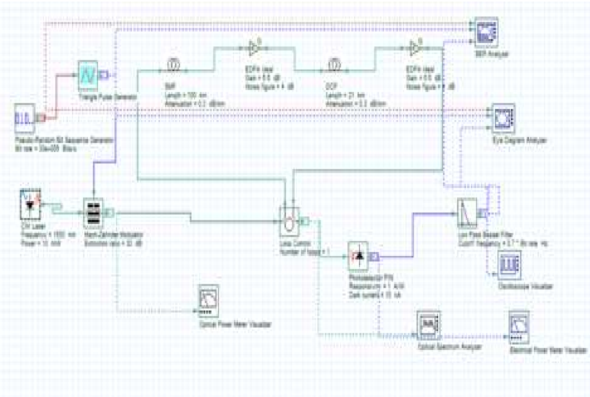

Fig. 1 Schematic for Post Compensation Scheme

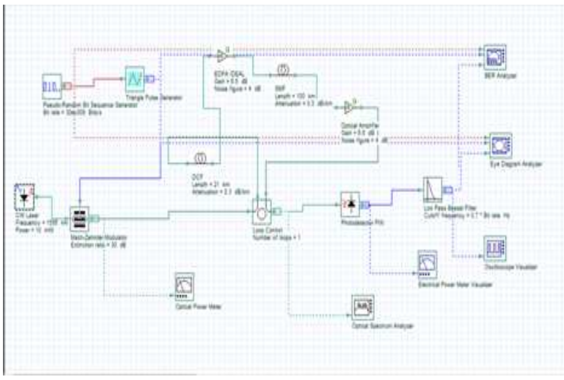

Fig. 2 Schematic for Pre Compensation Scheme

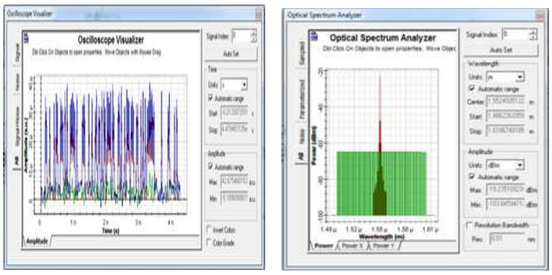

Fig. 3 Visualization of Optical Signal with Traingular format at 1550nm with Pre compnsation scheme

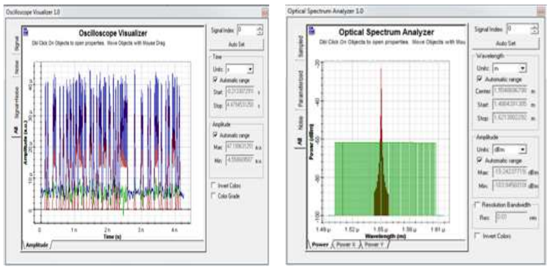

Fig. 4 Visualization of Optical Signal with Traingular format at 1550nm with Post compnsation scheme

VII. CONCLUSION

In this paper, the modulation format TRAINGULAR is investigated in a repeated 30 Gbit/s dispersion managed system based on 121 km fiber spans. Dispersion Compensation scheme employed were pre and post dispersion compensation schemes. Input power levels of SMF are DCF are optimized. Existence of transmission optimum is clearly observed from contour plots. After optimizing dispersion compensation schemes, Post compensation is better and Q factor obtained is about 11.

REFERENCE

[1] Ming-Jun Li, Xin Chen, Daniel A. Nolan, Ji Wang, James A.West, and Karl W. Koch, ―Specialty fibers for optical communication systems‖ Optical Fiber Telecommunications V A:Components and Subsystems, 2008, Elsevier.

[2] C. E. Shannon, ―A mathematical theory of communication,‖ Bell Syst. Tech. J., vol. 27, pp. 379–423, 623–656, 1948.

[3] WuQiang,Yu Chong Xiu, "Analysis on dispersion compensation with DCF", semiconductor optoelectronics,Vol.24 No.3 pp.186-196.June 2003

[4] Zhaohuaigang, "study on dispersion compensation in optical transmission system", study pn optical communications,Vol.3 ,No.141, 2007

[5] Wangchen,Raomin, "the performance of the DCFTransmissionn system", Journal of applied sciences,Vol.21, No.2,pp.177-181,June 2003

[6] Djafar K. Mynbaev Lowell and L. Scheiner, "Fiber-optic communications technology"Beijing, Science publishing company, 2002

[7] Jianjun Yu, Bojun Yang,"Dispersion-allacated soliton technology with long amplifier spacing and long

distance," IEEEphoton technol lett, vol 9, pp. 952-954,No.7, 1997:

[8] ZhouZhiQiang, TangYuLiang, "Optimmum schemes of dispersion compensation transmission systems using dispersion compensation fibers",laser technology, VoI.24,No.5,pp.265-269 Oct.2000

[9] Kikuchi, N. Sasaki, S.and Sekine, K. “10 Gbit/s dispersion compen- sated transmission over 2245 km conventional fibers in recirculating loop”IET Electronics Letters, vol. 31(5), pp. 375-377, 1995

[10] Rothnie, D.M. and Midwinter J.E. , “Improved standard fiber performance by positioning the dispersion compensating fiber” IET Electronics Letters, vol. 32(20), pp. 1907-1908,1996

[11] Mir Zayed Shames, “Signal Quality of Dispersion managed Quasi –linear high bit rate optical transmission system,” in IJECET, vol.4, pp. 108-114, june 2013