Performance Analysis of 8-Channel WDM System using Symmetrical DCF and Optigrating

Neha and R.L Sharma

ABSTRACT: In order to increase the capacity of long haul wide area networks, wavelength division multiplexing is used and its deployment has also recently been considered in the metropolitan access networks. In order to remove dispersion in optical fiber, here we are using DCF techniques such as symmetrical DCF and Optigrating. At the transmitter Pseudo random bit sequence generator with NRZ Encoder and Continuous Wave LASER with Mach-Zehnder modulator used to get the appropriate input to the 8×1 multiplexer. Here 8×1 Multiplexer is used for all 8-Channels. At the receiver 1×8 demultiplexer used to receive the optical signals and PIN diode used as a photodector with low pass bessels filter. At last to simulate the operation Opti-system software is used.

Key words:* *Dispersion Compensation, Optical Communication, Dispersion Compensation Fiber (DCF) Model, Optigrating, BER, Eye diagram.

I. INTRODUCTION

There are many research works focusing on analyzing fiber performance by exploiting different aspects of fiber. We know that the optical fiber communication is known for high-speed transmission which offers enormous potential bandwidth in respect to other electrical cables and wire transmission. In general, most of the data transmission is greatly affected by these wires in small area network. As network is set up in university campuses, office buildings, industrial plants, so, we have to increase the speed of transmission specially latency and throughput between a transmitter and receiver. We have to minimize the dispersion between source and destination. We have considered the performance control analysis of single mode optical fiber. Due to less dispersion, single mode fiber is used. Work in this parer entitled ***"Performance Analysis of 8-Channel WDM system using Symmetrical DCF and Optigrating"*** first focuses on the NRZ modulation format used to create the optical pulses. We can compensate dispersion in optical fiber system by using following techniques.

i) Compensation by using Symmetrical DCF
ii) Compensation by using Optigrating

II. NON RETURN TO ZERO (NRZ) MODULATION FORMAT

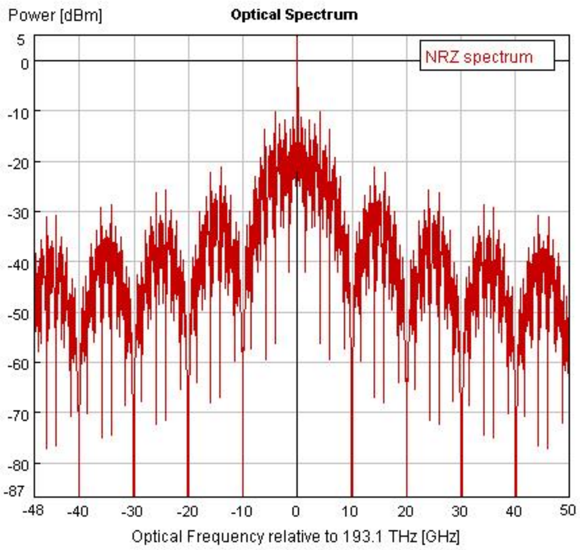

Figure 1: Non return to zero (NRZ) modulation format

The simplest modulation scheme is a non-return-to zero (NRZ) format, where the pulse is on for the entire bit period. Most commercial systems use the NRZ modulation format. The non-return-to-zero (NRZ) has been the most dominant modulation format in intensity modulated-direct detection fiber-optical communication systems for the last years. The reasons for using NRZ in the early days of fiber-optical communication as it is not sensitive to laser phase noise, requires a relatively low electrical bandwidth for transmitter and receivers compare with RZ and the simplest configuration of transmitterand receiver [1]. The NRZ pulses have a narrow optical spectrum as shown in Figure 1. The reduced spectrum width improves the dispersion tolerance but it has the effect of intersymbol interference between the pulses this modulation format is not suitable when high bit rates an distance are considered. The narrow spectrum of NRZ pulses yields a better realization of dense channel spacing in WDM systems.

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III. EFFECT OF DISPERSION ON OPTICAL TRANSMISSION

Dispersion is defined as because of the different frequency or mode of light pulses in fiber transmits at different rates, so that these frequency components or models receive the fiber terminals at different time. It can cause in tolerable amounts of distortions that ultimately lead to errors. Dispersion of the transmitted optical signal causes distortion for both digital and analog transmission along optical fiber.[2] When deliberating the major implementation of optical fiber transmission which involves digital modulation, then dispersion is the phenomenon within the fiber cause broadening of the transmitted light pulses as they travel along the medium. The phase velocity v = c / n of a wave is the velocity at which the phase of any one frequency component of the wave will propagate. For a homogeneous medium, the group velocity vg is related to the phase velocity by:

$$vg = c(n - \lambda \frac{dn}{d\lambda})^{-1}$$

The group velocity v_g is known as the velocity at which energy or information is conveyed along the wave. However, it is impossible in practice to produce perfectly monochromatic light waves, and light energy is generally composed of a sum of plane wave components of different frequencies. Often the situation exists where packet of waves formed by a group of waves which propagate at closely similar frequencies. It is observed that formation of such a wave packet resulting from the combination of waves move at a group velocity. In most cases this is true that the group velocity can be thought of as the signal velocity of the waveform.

The group velocity results in group velocity dispersion (GVD), which causes a short pulse of light to spread in time as a result of different frequency components of the pulse travelling at different velocities. GVD is frequently classified as the group delay dispersion parameter:

$$D = -\frac{\lambda}{c}\frac{d^2 n}{d\lambda^2}$$

A medium is said to have positive dispersion if D is less than zero. The medium is said to have negative dispersion if D is greater than zero. In a medium if higher frequency components travel slower than the lower frequency components it means light pulse is propagated through a normally dispersive medium. The pulse will be positively chirped, or up-chirped, increasing in frequency with time. Conversely, if high frequency components travel faster than the lower ones then medium is said to have an anomalously dispersive medium and the pulse becomes negatively chirped, or down-chirped, decreasing in frequency with time [2][3].

III. DISPERSION COMPENSATION TECHNIQUES

Below Figures (2-3) shows the simulation work by using compensation techniques such as Symmetrical DCF and Optigrating [5]. The circuit for simulation by using symmetrical DCF is shown in Figure 2. In our simulation, we have used DCF before and after of optical fiber to compensate the span loss. The main advantage of this technology is the fact that it provides a broadband operation with a smooth dispersion property and good optical characteristics. Very long lengths of dispersion compensating fibers are required to compensate for the dispersion of even modest lengths of transmission. So, it is proposed by using the symmetrical optimization for the optical fibers using Pre & Post compensation both [6].

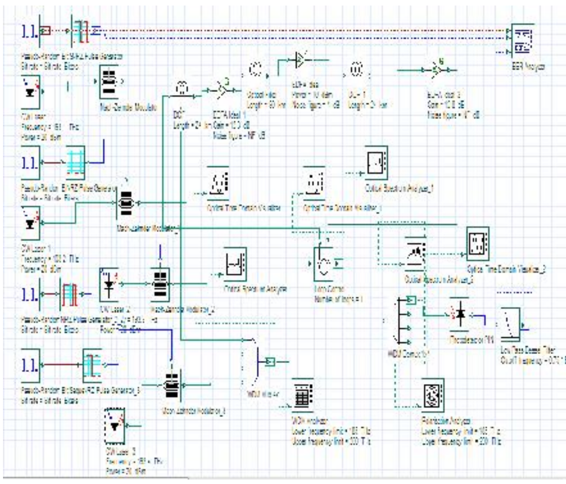

Figure 2: Dispersion compensation using Symmetrical DCF

The circuit for simulation by using optigrating shown in Figure 3. The physical idea behind this compensation is to create a linear chirped grating allows us to create a time delay between different spectral components of the signal [7].

For example if single mode fiber is operated at 1.55 µm, group velocity dispersion creates a negative chirp of the pulses, which means that the higher frequencies propagating faster are in the leading part of the pulse and the lower frequencies propagating slower are in the trailing one.

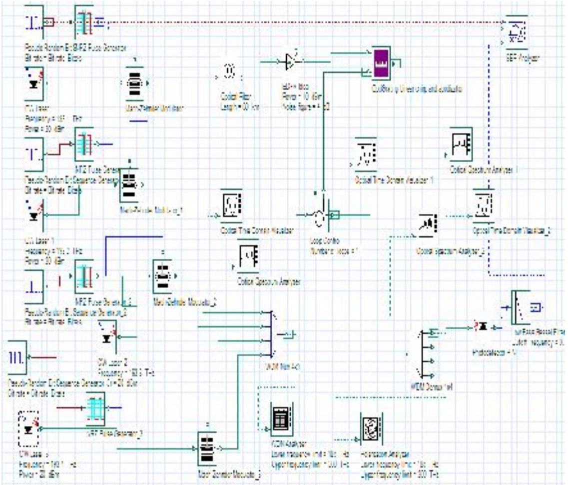

Figure 3: Dispersion compensation using Optigrating

As it is clear that different spectral components have different velocity of propagation this is the main cause of the spreading of pulse. So if we create a fiber Bragg grating with period linearly reducing along the grating, because of the fact that the higher frequencies will reflect after longer propagation in the grating, a time delay between lower and higher frequency components will appear [8]. As a result propagating and reflecting our pulse in this device will allow compensating the dispersion broadening of our pulse. If an apodized fiber Bragg grating is used in transmission, the device can be directly spliced into the transmission link. This will avoid the losses due to bulk optical devices such as the circulators [9] [10].

IV. RESULT AND ANALYSIS

In this simulation (by using Symmetrical DCF in Figure 4) we are observing that the Q factor, Min BER, Threshold and Eye Height are 12.0591, 6.28605e-034, 0.000467842 and 0.0024228 respectively. The Q Factor is comparatively high then Optigrating. Eye Height is comparatively high then Optigrating. In this technique we can see the dispersion at 193.1 THz dispersion is reduced from 2.16587e+008ps/ns to -1.37060e+008ps/ns and noise is also reducing. OSNR ratio is improved. The power of these signals is decreased this is only one drawback and it can be overcome by using optical amplifier at output side. At 193.2 THz, OSNR Improves while dispersion increases, power of signal is decrease. We can see this result is not in our favor on for this signal while other signals are received with fine parameters. At 193.3 THz, dispersion is reduced from 3.59741e+007ps/nm to -1.54523e+007ps/nm, noise is also reduced while OSNR improves. At 193.4 THz, dispersion is reduced from 6.33977e+007ps/nm to 5.79469e+006ps/nm, noise is reduced and OSNR improves.

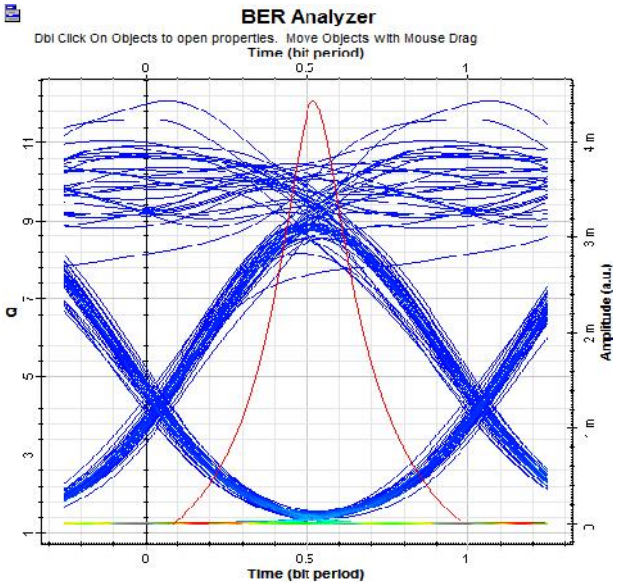

Figure 4: EYE diagram of signal for dispersion compensation using Symmetrical DCF

In this simulation (by using optigrating in Figure 5) we are observing that the Q factor, Min BER, Threshold and Eye Height are 8.36609, 2.23257e-017, 0.0000138807 and 0.000060105 respectively. The Q factor is comparatively low then other symmetrical DCF technique. Eye Height is also comparatively low. In this technique we can see the dispersion at 193.1 THz is reduced from 2.16587e+008ps/ns to 1.19494e+008ps/ns, noise is also reduce. OSNR ratio is improved. The power of these signals is decreased this is only one drawback and it can be overcome by using optical amplifier at output side. At 193.2 THz, OSNR Improves while dispersion increases and power of signal is decrease. We can see this result is not in our favor on for this signal while other signals are received with fine parameters. At 193.3 THz, dispersion is reduced from 3.59741e+007ps/nm to 1.84029e+008ps/nm, noise also reduces while OSNR improves. At 193.4 THz, dispersion is reduced from 6.33977e+007ps/nm to 1.09158e+006ps/nm, noise is also reduced and OSNR improves.

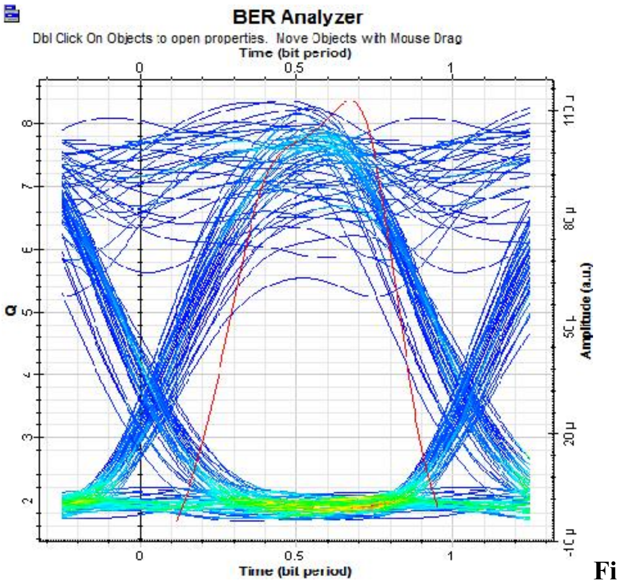

Figure 5: Eye Diagram of signal for dispersion compensation using Optigrating

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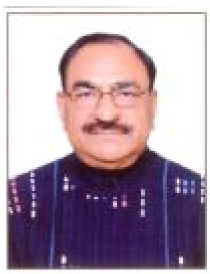
IV. CONCLUSION

Simulation is done by using OPTISYSTEM. It is an intuitive modeling and simulation environment supporting the design and the performance evaluation of the transmission level of optical communication systems which is influenced by the dispersion. For WDM network, graphs of optical spectrum (before and after transmission) show that performance parameter such as signal power, noise power , Bit error rate (BER), Quality factor and optical signal to noise ratio (OSNR) are poor with NRZ modulation format and it is almost constant or increasing with NRZ modulation format. For good communication OSNR should not decrease after transmission of signal through fiber so we use erbium doped fiber amplifier (EDFA) in WDM environment for single mode fiber.

Neha was born in UP on 7 Nov 1989. She received Bachelor of Engineering degree in Electronics and Communication Engineering from UP Technical University in 2010 and Pursuing M.Tech in ECE from Ajay Kumar Garg Engineering College, Ghaziabad (UP). She is working in Lord Krishna Engineering College as a Assistant Professor from last 2 years. Her area of interest is in optical fiber communication.



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