Dense Wavelength Division Multiplexing using Dispersion Fibre with Erbium Doped Fiber Amplifier

T.Kavitha and Reshma Pavani

Abstract: Dense wavelength division multiplexing is used in various broadband communications. It combines information from distinct sources on an optical fiber, each signal being transmitted simultaneously on its own distinct light wavelength. Radio over fibre is a hybrid system that has both fibre optic link and free space radio path. This paper aims to evaluate the performance of the system using Erbium Doped Fibre Amplifier, Single Mode Fibre and Dispersion compensating Fibre. Single beam of light is passed by the SMF and is used for long distance signal transmission. DCF is used to reduce the dispersion in the optical signal. EDFA reduces the degradation of the signal by cancelling the effect of attenuation. It is an optical repeater used to raise the intensity of the optical signal. Mach – Zehnder modulator is used for the modulation. The simulation is carried out by using optisystem software version 15.0. Various parameters like Q-factor, BER pattern, threshold, minimum BER are compared and estimated.

Keywords: Dense wavelength division multiplexing, Dispersion compensated fibre, Erbium doped fibre amplifier, Optisystem, Single mode fibre

I. INTRODUCTION

Wavelength division multiplexing (WDM) in fiber optic communication is a technology that multiplexes various light carrier signals on a particular optical fiber using distinct laser light wavelength to perform distinct signals. WDM is frequently applied to an optical carrier called wavelength. This is simply conventional because wavelength and frequency convey the same data [1][2]. A WDM scheme utilizes a transmitter multiplexer to join together the various signals and a receiver demultiplexer to divide them apart. With the correct fiber type, a device can be installed concurrently and can operate as an optical add drop multiplexer [3]. Erbium doped fiber amplifier (EDFA) are widely used in WDM – DWDM technology that improves optical network ability with optical amplification and works efficiently at high speed without affecting any cost. The signal is enhanced by EDFA's doping ion interaction [4][5] The primary feature is that its working wavelength is 1550nm, showing the smallest attenuation compared to other optical transmission windows. EDFA's technical features include efficient pumping, high gain, low noise, high output power, minimum inter channel interference and low distortion.[6]

In WDM transmitted channels the power level is unbalance therefore equalization of gain in electronic equipment is done. So error free signal is transmitted through the optical fiber. There are many ways to achieve optical flat spectral gain such as controlling the power of the pump, correctly selecting fiber length, varying input power and properly selecting the characteristic of the optical notch filter. In radio over fiber (ROF) the radio frequency signal is modulated by the light carrier signal. It is an attractive technology with low loss and high bandwidth. The installation and maintenance cost is reduced by properly designing the antenna system.[8-10]

The primary objective of communication system is to improve transmission distance. In high capacity optical communication system, dispersion and loss are the primary factors causing signal degradation [11][12]. Dispersion leads an optical pulse's time slot and profile to alter during propagation, causing intersymbol interference and thus causing bit error. Dispersion is typically evaluated as time spread per distance travelled. The efficiency of single mode fibers is mainly restricted by chromatic dispersion, which happens because the glass index differs slightly based on the light wavelength, and light from real optical transmitters generally has non – zero spectral width (owing to modulation). To address the degradation Impacts, the EDFA amplifiers can be used to decrease or cancel the attenuation impact. The dispersion compensation methods can be used to mitigate the distortion caused by dispersion[13][14] This paper examines the dispersion compensation scheme in the WDM taking into account the different kinds of nonlinear effects and the effect of EDFA on the optical transmission equation.

II. PROPOSED SYSTEM:

The advanced optical component WDM multiplexer is commonly used in optical connections. By interconnecting distinct channels, it can improve connectivity and bandwidth of processing system. One of the three techniques is used in most WDM multiplexers: arrayed wave guide grating (AWG), filter and dispersive component, diffraction grating. Some filter based multiplexers

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show elevated insertion losses for devices with multiple channels, making them unsuitable for multimode and bi-directional transmission applications.

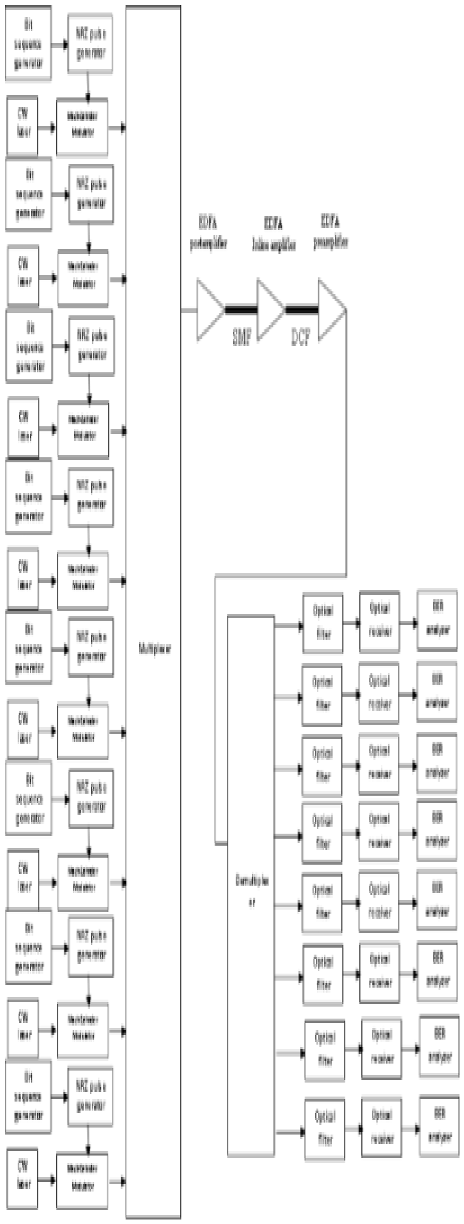

Figure 1: DWDM System using SMF, DCF and EDFA

In the DWDM scheme, the transmitter uses the post amplifier to increase the signal while the preamplifier is used to increase the receiver side signals. Before signal is totally degraded, EDFA is used as an in – line amplifier. This degraded data is amplified using EDFA before transmission via an optical fiber. This amplifier is primarily used to improve the signal in the spectrum region between 1530nm and also no need to convert the signal in electrical domain. The laser source used is 980nm or 1480nm wavelength and 30dB amplification is achieved. Single mode fiber is a single stand for the transmission of a light ray and it has only one mode of propagation. Compare to multi mode fiber, it can carry higher bandwidths, but needs a light source with a tiny spectral width. The WDM receiver consists of the PIN photo detector, the fourth order low pass bessel electrical filter and the BER analyzer with default settings. BER analyzer is used to predict the rate of bit error based on a Gaussian algorithm with a short sequence of bits being transmitted. It shows the diagram of the eye, the curve of the Q factor, the threshold, the height and the pattern of the BER.

III. RESULTS AND DISCUSSIONS

The simulation outputs were presented from the system design. As described and explained before in the previous section, compare the performance of three design namely, SMF and DCF, SMF AND DCF combined with EDFA, DWDM for 8 channels is simulated in optiwave (optisystem) design software. The 8 channel DWDM system using SMF, DCF and EDFA are designed and analyzed for data rate of 1Gb/s, 2.5Gb/s, 10Gb/s. The Mach-Zehnder modulator (MZM) optical range is symmetrical and focused around 193.1 THz. The optical spectrum is distributed across a broad frequency range.

A Graph is drawn between Q-factor and distance to assess the DWDM system efficiency. The eye diagram is also obtained to investigate the performance. The carrier signal is sent through the CW – Laser and the message signal is sent through the pseudo-Random Generator at Gb/s. the final output at the BER Analyzer. It consists of Min BER, Q-factor, Eye height, Threshold and BER Pattern.

A. Simulation Results for SMF

The performance of SMF is shown in the graphs below. The Eye diagram of the SMF is shown in the figure 2 and the Q-factor vs Distance graph is shown in the figure 3.

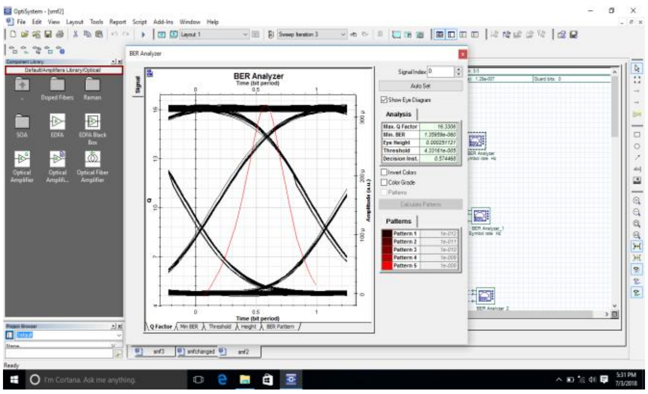

Figure 2 Eye Diagram of SMF

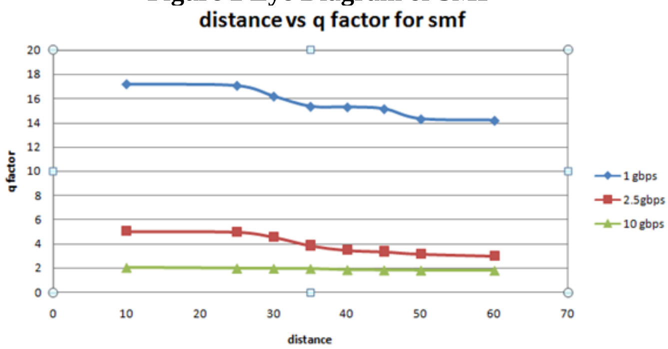

Figure 3 Distance vs Q-factor graph for SMF

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B. Simulation Results for SMF and DCF

Simulation results for SMF and DCF are shown in the graphs below. The Dispersion compensation filter is used to decrease the dispersion in the optical signal. The Eye diagram of SMF and DCF will be better than only SMF. The Eye diagram is shown in the figure 4 and the distance versus Q-factor graph is shown in the figure 5.

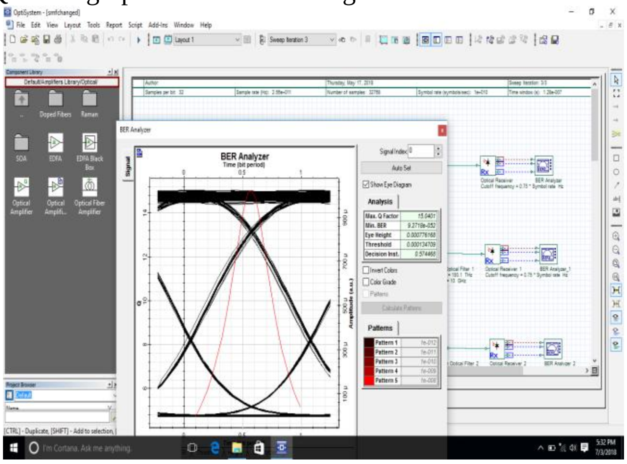

Figure 4 Eye Diagrams of SMF and DCF

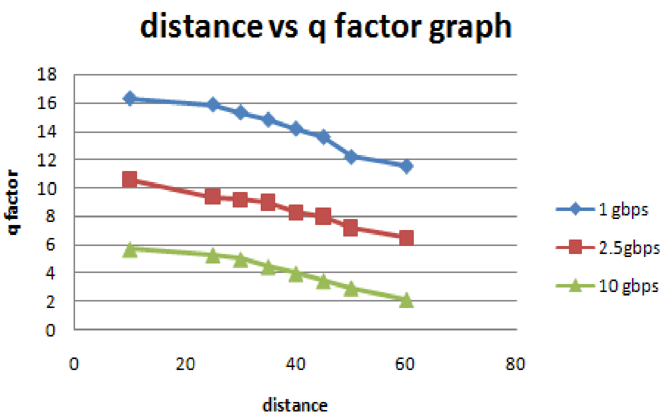

Figure 5 Distance vs Q-factor graph for SMF and EDFA

C. Simulation Results of SMF, DCF and EDFA

Simulation results of SMF, DCF and EDFA are shown in the graphs below. As explained earlier, EDFA is used as a regenerator which is used to boost the optical signal. The performance of the system with EDFA will be higher when compared to the other two systems without EDFA. The Dispersion compensation filter also used to reduce the dispersion in the signal. So, the performance of the system with EDFA will be higher. The Eye diagram of SMF, DCF and EDFA are shown in the figure 6 and the distance vs Q-factor graph is shown in the figure 7.

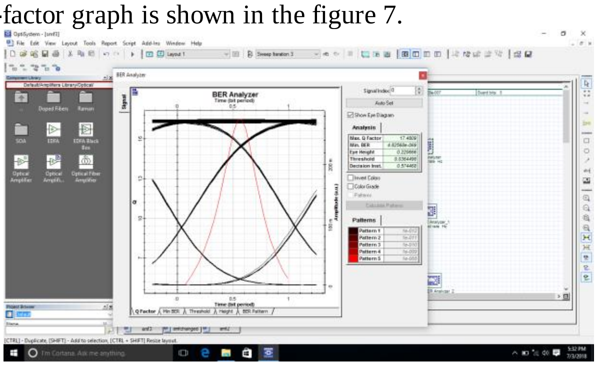

Figure 6 Eye Diagrams of SMF, DCF and EDFA

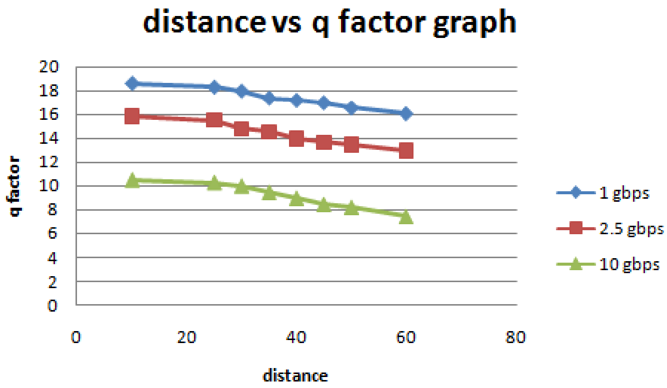

Figure 7 Distance vs Q-factor graph for SMF, DCF and EDFA

D. Optical Spectrum Analyzer

The Optical Spectrum Analyzer gives the energy distribution in the frequency domain in relative units. It is used in the system design. The graph shown in the figure 8 shows the frequency distribution.

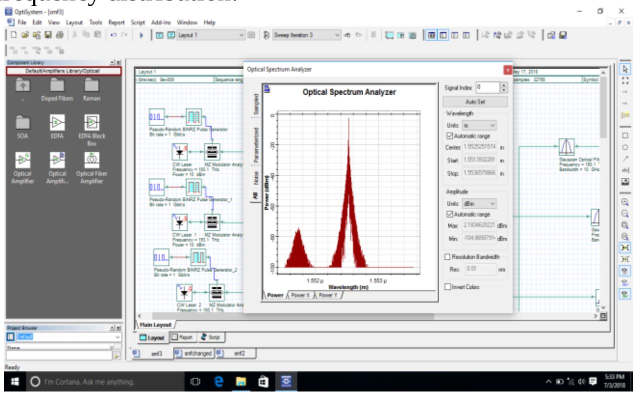

Figure 8 Optical Spectrum Analyzer graph

IV. CONCLUSION:

SMF span is greatly affected by the effect of degradation factors. The efficiency of the DWDM scheme improves with the use of dispersion compensation fiber and EDFA. The graph for Q-factor is compared for different frequency levels. By comparing the eye diagrams and Q-factor system with EDFA has high performance. EDFA greatly increases the performance of the fiber optic system.

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