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Performance Analysis of RZ Modulation for Long Haul Single Mode Fibre

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Abstract: -- **In this paper, performance of RZ (Return to Zero On-Off Keying) modulation was investigated in WDM (Wavelength Division Multiplexing) based Single Mode Fibre (SMF). The simulation was done by the Industrial Software OptSIM for 40GBit/s. Three different length of Single Mode Fibre (90 km, 180 km, 270 km) were chosen for 4 and 16 channel WDM and the length of Dispersion Compensated Fibre was fixed accordingly. For each number of channel, fibre span was varied in accordance with the lengths mentioned above. The BER (Bit Error Rate) was estimated for the best as well as the for the worst channel scenario. Analysing '4 Channel WDM' simulation, rapid increase of BER was observed for "RZ-OOK" as it increased from 10-9 to 10-8. "RZ-OOK" continued to show poor result as its BER was ranged from 10-6 to 10-4 for 16 channel. Therefore, it was concluded that for long haul transmission in SMF, RZ showed moderate performance both in 8 and 16 Channel WDM.**

Keywords — RZ, WDM, SMF, BER.

I. INTRODUCTION

Return-to-zero (RZ) is one of the most commonly used modulations in the current fiber-optical communication system [1] [2]. WDM has capacity to support high bandwidth data transmission [3]. This research puts both the traditional RZ modulation format in long haul optical fibre transmission for the next generation high data rate of 40GB/s for WDM.

II. LITERATURE REVIEW

IM or intensity modulation is a special form of 'Amplitude Shift Keying' (ASK) in which there is no carrier wavelength to be present when transmitting a '0'. It can simply be applied by switching the optical source off and on which is direct modulation. In terms of duty cycle, there are two kinds of intensity modulation which are Non Return to Zero (NRZ) OOK and Return to Zero (RZ) OOK. When the source is turned on for the full period of its 'On Time' meaning 100% duty cycle, it refers to RZ and on the contrary when it is on for the fraction of the period for example 1/2 or 1/3 of its period causing duty cycle to be 50% or 30% respectively, it is referred to RZ.

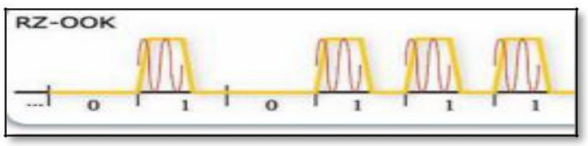

Figure 1- NRZ-OOK and RZ-OOK Modulation Technique [4]

III. SIMULATION CONFIGURATION

Following table 1 one indicates the parameter configuration for the simulation.

Table 1: Parameter Configuration

Design Parameter	Performance parameter
• Optical Link (Standard Single Mode Fibre)	• BER (Beat Error Rate)
• Optical Source (Laser of 1550 nm & 1310 nm)	• Eye Diagram
• Bit Rate (40 B/S)	

IV. SIMULATION OPERATION

The designs, modelling were constructed and simulated in the industrial level software "OptSim", version 5. The total length of SMF was divided into three stages-90km, 180km and 270km. The fibre was selected to be the minimum which was 0.2 decibel (db) per kilometre. In accordance with minimum loss, high dispersion was introduced to 'SMF' which was fixed at '17 ps/nm/km'. Fibre non-linear coefficient was selected to be ~1.36811 1/w/k. '-100ps/nm/km' of dispersion was introduced to DCF. "Flat Gain" EDFA was used throughout the entire period with a gain of 30db. "The Flat Noise Figure" was kept as 5db. Figure 2 and 3 indicate the RZ modulation format built in Optsim.

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Figure 2. RZ Modulation format

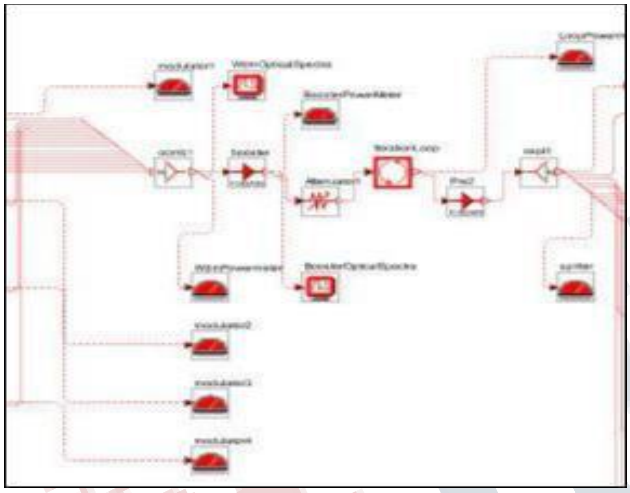

Figure 3. 16 Channel WDM Schematic Diagram of SMF transmission link with receiver built in Optsim (RZ)

V. RESULTS

Three SMF spans were used in order to measure the BER, those were 90km, 180km and 270km. Simulation had been completed for 2 different channels (4 and 16). BER fell down drastically with the increase of fibre length (Table 2 and 3). With the increase of number of channel, BER became even worse. To analyse the reason behind it, it was figured out that due to the wide optical spectra of RZ, while transmitting through WDM, the signal got affected severely by the other channels and cross talk and non-linearity took place.

4-Channel RZ:

Fibre Length (km)	Worst channel (BER)	Best Channel (BER)
90	10^{-4}	10^{-9}
180	10^{-4}	10^{-9}
270	10^{-4}	10^{-8}

Table 2- BER values for 4 Channel WDM RZ-OOK (Bit Rate~ 40 Gb/s)

16-Channel RZ:

Fibre Length (km)	Worst channel (BER)	Best Channel (BER)
90	10^{-3}	10^{-6}
180	10^{-3}	10^{-5}
270	10^{-2}	10^{-4}

Figure 3- BER values for 16 Channel WDM RZ-OOK (Bit Rate~ 40 Gb/s)

Considering '4 Channel WDM' RZ showed poor performance in terms of fibre length for all the 3 spans than NRZ as the BER increased from 10-9 to 10-8. Lastly, while investigating '16 Channel WDM', BER increased for both the modulation formats. "RZ-OOK" showed the worst as the BER ranged from 10-6 to 10-4

VI. CONCLUSION

To conclude, the objectives of this research were successfully accomplished. RZ-OOK performed poor in terms of all categories making it unworthy for long haul transmission specially for increased number of WDM channel whereas for small number of WDM channel, the result showed moderate performance. One of the most widely used techniques were compared in WDM system for next generation data rate in long haul transmission. Lastly, it greatly enhanced the knowledge and understanding of transmitting information of high data rate in WDM system which will further benefit the

researchers to go forward and take necessary step.

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