Role of Wavelength Division Multiplexing Scheme in Free Space Optical Communication Systems

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ABSTRACT
Swift demand of data rate supporting advanced number of end consumers at high speed has steered researchers to harvest Free Space Optics (FSO). This work is focused on engaging 2 × 10 Gbps return-zero (RZ) encoded wavelength-division (WDM) multiplexed Free Space Optics Communication system. The signal received is analyzed using BER analyzer and Eye diagrams

Keywords
RZ, WDM, BER, Eye Diagram

1. INTRODUCTION
We ask that authors follow some simple guidelines. In essence, we ask you to make your paper look exactly like this document. The easiest way to do this is simply to download the template, and replace the content with your own material. Traditional radio systems are fronting encumbrance in designing due to demand of data for diversity of new services. Researchers have developed a contemporary communication system that reveals the properties of prevailing wireless and optical fiber communication technologies, named as Free Space Optical Communication (FSO) [1]. Contemporary FSO system has been mostly explored to take advantages of existing wired optical communication [2]. FSO concentrate on strengthening of communication by assimilating point to point laser signals. FSO provides huge bandwidth, unregulated spectrum, cost effective implementation and low input power as compared to traditional wired fibers [3-4]. FSO also provides alternate to the locations where the deployment of wired network is hard to reach. Despite all these advantages, FSO system is affected by rain, fog, refractive index variation etc. [5-7]. Many researchers have provided different solution to deal with such issues over the years [8-11]. Another issue that is to be addressed is system capacity. Many researchers have employed different multiplexing schemes and even advanced novel one. One such scheme which is widely used in optical communication is known as wavelength division multiplexing (WDM) [12-48]. In this work, we emphasize on the high speed long reach FSO system. To replicate that we employ return-zero modulation format in two different channels each with data rate of 10 Gbps and wavelengths 1550 nm and 1551 nm. The signal is multiplexed using WDM and the channel used is free space of the range 20 Km. The receiver consist of photo diode followed by low pass filter and bit error rate analyser. The rest of the paper is organized as, Section II consists of system description, result and discussion is presented in Section III and Section IV concludes the paper.

2. SYSTEM DESCRIPTION
The proposed system is modelled using OptiSystem™ software as shown in Fig. 1. The system contains two transmitter channels each consists of pseudo-random bit sequence (PRBS) generator. PRBS provides 10 Gbps of data rates which is subjected to return-zero (RZ) encoder. For carrier we have use continuous-wave (CW) laser as source. The RZ encoded information signal and carrier signal is modulated in mach-zander modulator (MZM). This modulated signal from each transmitter is then fed to WDM multiplexer and output obtained 2 × 10 Gbps data is sent over the free space channel of the length 20 Km. At the receiver the signal is de-multiplexed and sent to the respective section corresponding to the wavelength. The section contains photo detector, we have used PIN diode as photo detector. Then a low pass filter section is used to omit any unwanted component and final the signal is tested and analysed using BER analyser. The parameters of the components used in system for simulation are shown in table 1.

Table 1: Component Parameter

Sr. No.	Parameter	Value/Type
1.	Operating Wavelength (nm)	1550 for Channel 1 1551 for Channel 2
2	Input Power (dBm)	0
3	Link Distance (Km)	1600 – 2200
4	Amplifier Gain (dB)	14
5	Noise Figure (dB)	4
6	Data Rates (Gbps)	10 per Channel
7	Tx and RX Aperture Diameter (cm)	20
8	Photodiode	PIN
9	Responsibility (A/W)	1
10	Dark Current (nA)	10

3. RESULTS AND DISCUSSION
The proposed FSO link is varied from 16 km to 20 Km for analysing the system response. Figure 2 signifies system performance in terms of minimum bit error rate and maximum Q factor with respect to free space optics range. Fig. 2 a) indicates minimum BER obtained for channel 1 as 1.57×10^{-32} , 9.00×10^{-19} and 5.91×10^{-12} over the free space optics range of 16 Km, 18 Km and 20 Km respectively. The minimum BER obtained for channel 1 as 2.82×10^{-35} , 9.91×10^{-20} and 8.60×10^{-13} over the free space optics range of 16

Km, 18 Km and 20 Km respectively.

Similarly, Fig 2 b) indicates maximum Q factor obtained for channel 1 as 11.80 dB, 8.76 dB and 6.78 db over the free space optics range of 16 Km, 18 Km and 20 Km respectively. The maximum Q factor obtained for channel 2 as 11.80 dB, 8.76 dB and 6.78 db over the free space optics range of 16 Km, 18 Km and 20 Km respectively.

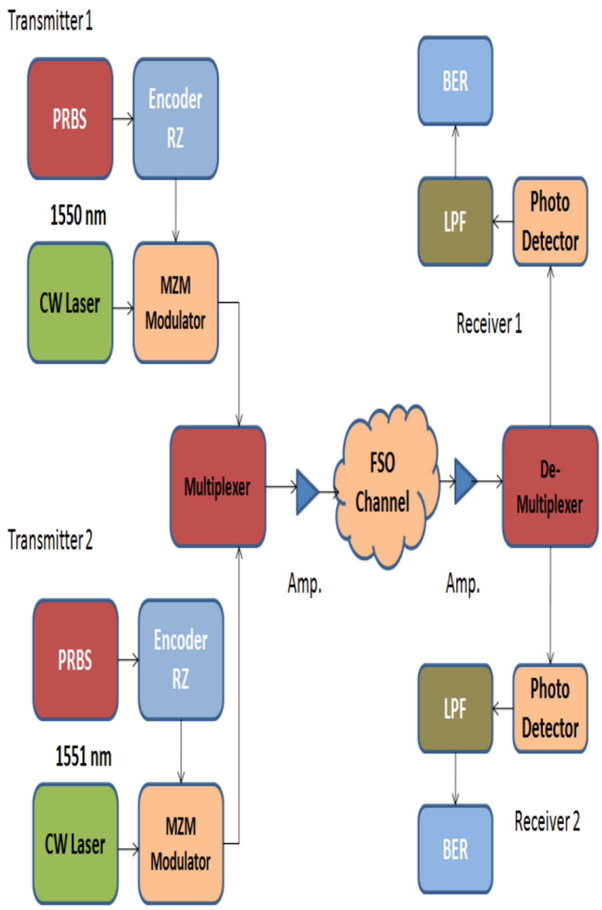
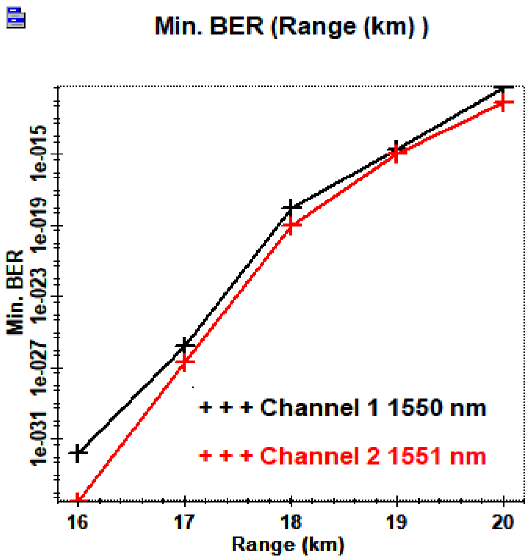
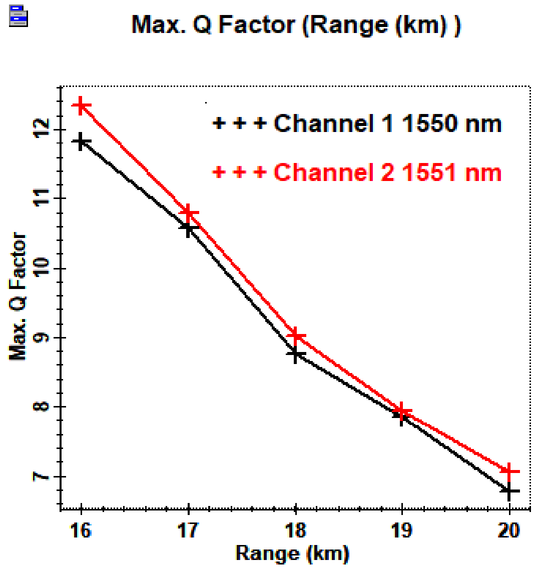


Fig.1 Proposed 2 × 10 Gbps FSO system

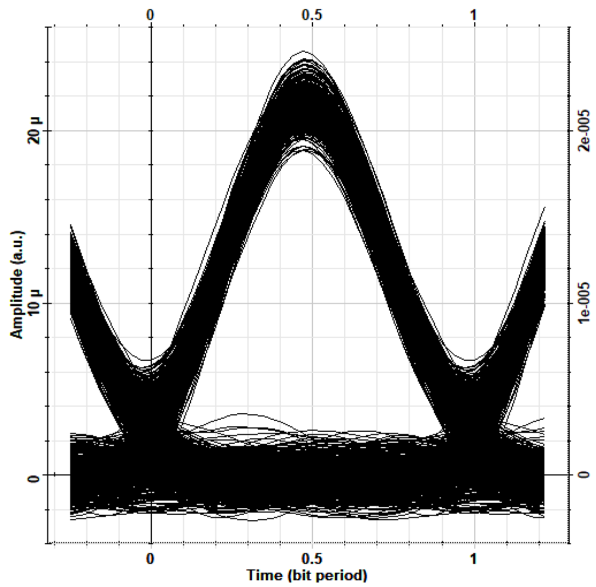


(a)

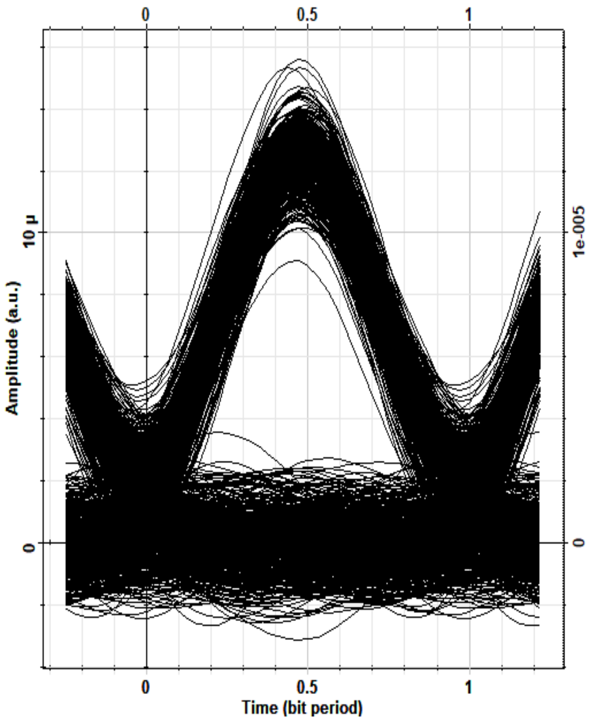


(b)

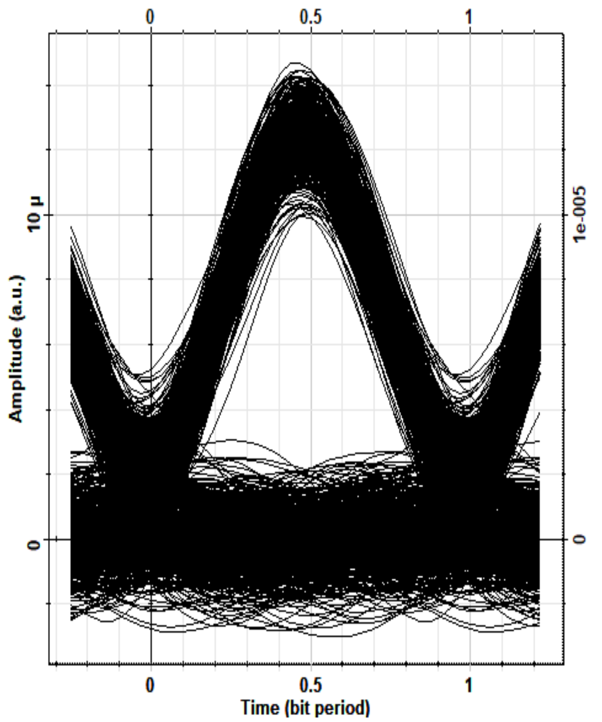
Fig. 2 a) Min. BER Vs Range for Channel 1 and Channel 2 and b) Max. Q factor Vs Range for Channel 1 and Channel 2



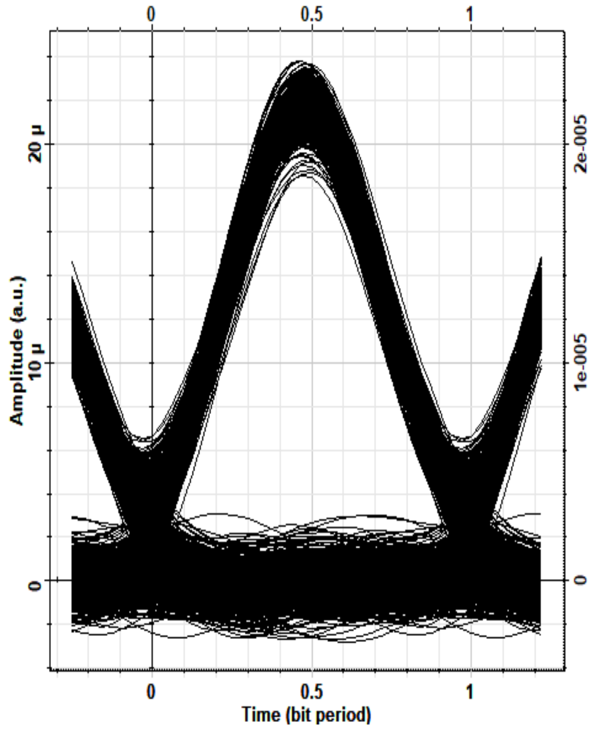
(a)



(b)



(d)



(c)

Fig 3 Eye Diagram: a) and b) represents eye diagram for channel 1 at 16 Km and 20 Km and b) represents eye diagram for channel 2 at 16 Km and 20 Km and

Fig. 3 indicates the eye diagram for channel 1 and 2 at the receiver end at 16 Km and 20 Km respectively. Clear opening of the eye indicates reception of the signal at the receiver terminal with acceptable Q factor and BER.

4. CONCLUSION

Utilization of WDM with FSO system has been proved to be more effective in augmenting data rates. In this paper 2 × 10 Gbps RZ encoded WDM Free Space Optics has been investigated. Two channel each carrying 10 Gbps data with RZ encoding has been sent over 20 Km long FSO channel. The received results have been tested in terms of minimum BER, maximum Q factor and Eye patterns. The reported results indicate successful transmission of the information in both the channels.

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