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Transmission Performance Analysis of Three Different Channels in Optical Communication Systems

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Abstract— In this paper will have done comparative performance study for three different optical channels system, all the channels operated at the same optical transmitted with non return-to-zero (NRZ). Performance study is done for variable ranges 1, 2, 3, 4, 5 km for the different channels. Single Mode Fiber, Free Space Optical (FSO) Channel and optical wireless communication Channel (OWC) is observed that at low bit rate (10Gb/s/ch) per channel multiplexed optical system shows the most performance signal power, maximum Q Factor, minimum BER and eye pattern degrades. Results reveal the ability of improving the optical communication characteristics by using these channel and the optimum effect concluded at (5km) length of optical rang by using the OWC channel i.e.the quality factor and signal power were increased to reach (1550.7) and (-1.08dBm) respectively and MIN. BER is zero.

Index Terms— **optic communication system, Free Space Optical, optical wireless communication**

1 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. Fiber optics is a medium for carrying information from one point to another in the form of light. Unlike the copper form of transmission, fiber optics is not electrical in nature. A basic fiber optic system consists of transmitting device that converts an electrical signal into a light signal, an optical fiber cable that carries the light, and a receiver that accepts the light signal and converts it back into an electrical signal.[1]. Optical communication systems can be classified into two types: guided and unguided all guided optical communication systems currently use optical fibers, the commonly used term for them is fiber-optic communication systems In the case of unguided optical communication systems, the optical beam emitted by the transmitter propagated through space, similar to Optical Wireless Communication (OWC) systems and free-space optical communication (FSO). Although free-space optical communication systems are needed for certain applications and have been studied extensively [2].

Free space optics (FSO) communications, also known as wireless optical communication (WOC), refer to the transmission of modulated near-infrared (NIR) beams through the atmosphere to obtain optical communications [3]. As optical fibers, FSO techniques uses lasers to transmit data, but instead of enclosing the data stream in a glass fiber, it is transmitted through the air. It can thus be fully considered as a wireless way of transmitting information like ordinary wireless systems [4]. The idea, over which FSO is based, is the transmission of collimated light beams from one location to another by using low power infrared lasers. The light from a FSO channel is intercepted by system of lenses, capable of focusing photons on a highly sensitive detector receivers. Furthermore a new conception of Optical Wireless involves the use of single-mode fibers (SMF) directly as light launchers and light-collectors. Since this technique by passes the conversion into the electrical domain, an all-optical treatment of the information can be realized so that high performances achieved by optical fibers can be exploited [5]. Optical wireless systems can work over distances of several kilometers [6],[7]. As long as there is a clear line of sight between the source and the destination, and enough transmitter power the communication is guaranteed. FSO data rates, comparable to optical fiber transmission, can be carried with very low error rates, while the extremely narrow laser beam widths .

2 Background theory

The optical communication channels are used to transport the optical signal from transmitter to receiver without distorting it. Most light wave communication systems use optical fibers as the communication channel because fibers can transmit light with a relatively small amount of power loss. Fiber loss is, of course, an important design issue, as it determines directly the repeater spacing of a long-haul light wave system. Another important design issue is fiber dispersion, which leads the individual pulses inside the fiber will be broadening [8].

2.1 Optical Wireless Communication

Optical Wireless Communication (OWC) uses light at near-infrared frequency to communicate. OWC system still consists of three main communication parts which are transmitter, propagation channel and receiver, Figure 1. show the basic block diagram of an OWC system. The OWC system is not much different from free space optics and fiber optic communication where the difference relies in the propagation medi-

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um. OWC channel is considered to be outer space where it is assumed to be vacuum and free from atmospheric attenuation factors [9]. They provide high security, low cost, low power, and high rates due to the unregulated bandwidth [10]. The wireless optical channel component, that is also free-space optics, can be used for large distances where the atmospheric attenuation is not the major source of penalties, but the pointing angle. For example in satellite communications. [11],[12].

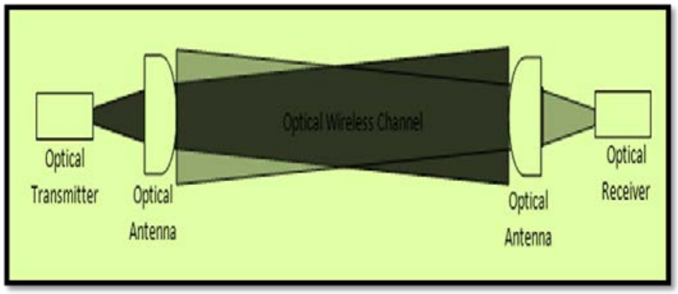

Fig1. An Overview of Optical Wireless Communication OWC System

2.2 Free Space Optics

Free Space Optics (FSO) communications meaning that the transmission of modulated visible or infrared beams through the atmosphere to obtain optical communications [13]. FSO. as shown in Figure 2. Demonstrates a typical free space optical link, rather than through a conductor such as a wire or fiber, or through a waveguide of some sort. Another important feature of FSO is that it is unaffected by electromagnetic interference and radio frequency interference, which increasingly plague radio based communication systems. FSO systems are used in disaster recovery applications and for temporary connectivity while cabled networks are being deployed. Free space optical communication is merely effected by atmospheric distortion. FSO will become most secure and high speed medium of data transmission [14].

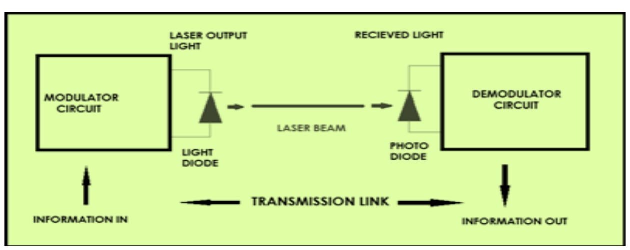

Fig. 2. An Overview of Free Space Optics FSO System

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3 System Model in OptiSystem

The OptiSystem software is developed by optiwave to perform complex optical communication simulation. It provides an easy user interface which is common to many other electrical engineering tools. The OptiSystem software is suitable to be used to model and simulate fiber optic system, free space optic system FSO and also OWC system. The design was then improved by expanding the optical transmitter and receiver with specific three channel single mode optical fiber , free space optic channel FSO and Optical Wireless Communication OWC channel. The proposed block diagram to simulate transmission system with SMF , FSO channel and OWC channel is shown in figure 3. Consist of optical transmitted to generate optical signals supplies input signal with 1550 nm wavelength and input power of 10 dBm which is externally modulated at 10 G bits/s. with a non-return-zero (NRZ) pseudorandom binary sequence, divider distributed power into the three channel, optical receiver has cutoff frequency is 0.75 Bit rate Hz and eye diagram analyzer is used to read output signal and figures will be processed as images. You need to embed the images in the paper itself. Please don't send the images as separate files. power, maximum Q. factor and minimum bite error rate, and Optical Spectrum Analyzer (OSA), for monitoring output signals after each component.

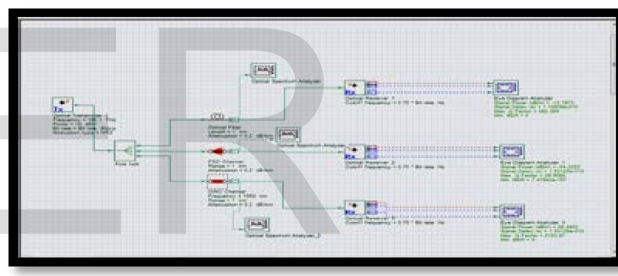

Fig3. An.The designed model of simulated system with Opti system software

4 .RESULTS AND DISCUSSIONS

The simulation and optimization of the design is done by OptiSystem simulation software. The eye diagrams and results of output signal power, bite error rate (BER) and maximum Q. factor at receiver are tabulated into Figure 4 until Figure 12 . by using three different channel with variable length of optical communication the related graphs are also plotted as shown in Figure 10 , 11 and 12**.**

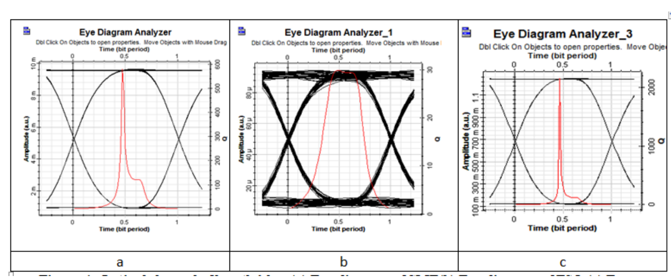

Fig. 4. Optical channel of length 1 km (a) Eye diagram of SMF(b) Eye diagram of FSO.(c) Eye diagram of OWC.

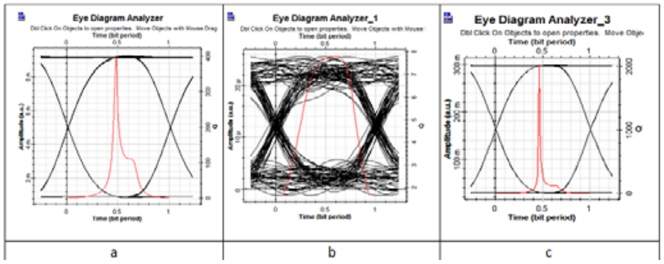

Fig.5. Optical channel of length 2 km (a) Eye diagram of SMF (b) Eye diagram of FSO.(c) Eye diagram of OWC.

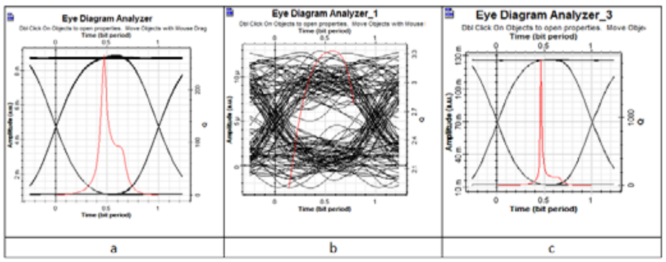

Fig.6.Optical channel of length 3 km (a) Eye diagram of SMF (b) Eye diagram of FSO.(c) Eye diagram of OWC.

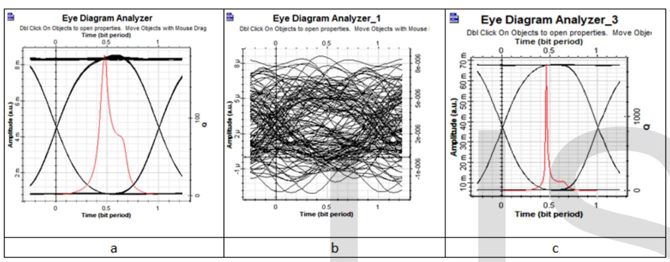

Fig.7.Optical channel of length 4 km (a) Eye diagram of SMF (b) Eye diagram of FSO.(c) Eye diagram of OWC.

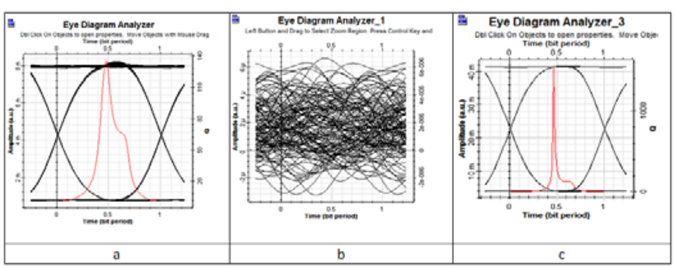

Fig.8.Optical channel of length 5 km (a) Eye diagram of SMF (b) Eye diagram of FSO.(c) Eye diagram of OWC.

In Figure 9 explain the reading of optical spectrum analyzer for three channels at 1km .

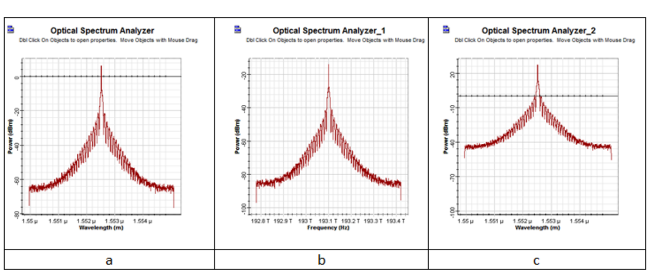

Fig 9. Optical channel of length 1 km (a) Optical Spectrum of SMF (b) Optical Optical Spectrum of FSO.(c) Optical Spectrum of OWC

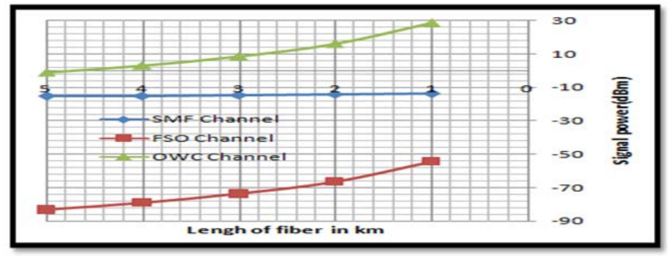

Fig.10. A graph showing length of optic channel vs signal power using three channel.

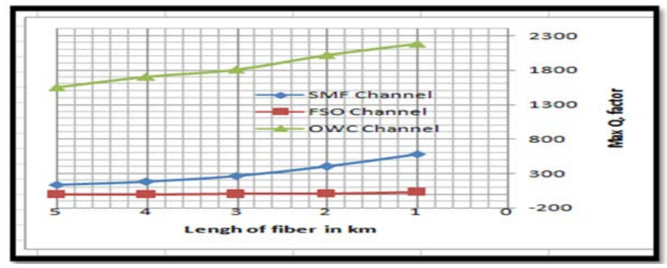

Fig11. A graph showing length of optic channel vs signal power using three channel

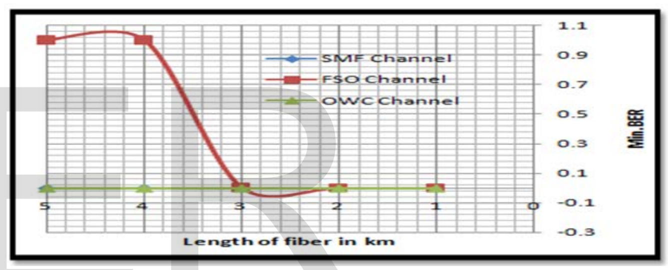

Fig12. A graph showing A graph showing length of optic channel vs min BER using three channel

The system performance can be evaluated in many ways such as by analyzing the BER and Q-factor. BER can be said to be the ratio of the number of bit errors detected in the receiver and the number of bits transmitted. Bit errors happen as the result of incorrect decisions being made in a receiver due to the presence of noise on a digital signal. Typically, as a quality factor, Q is a one of the important indicators to measure the optical performance by which to characterize the BER. From figure 4 until figure 8 explain output eye diagrams of three channels, for different transmission distances give a very good eye opening at SMF and OWC channels but can very narrow eye diagrams for FSO channel because increasing noise and interference by increase distances

As seen from figure 10 until figure 12, when compare the result for use three channels, show that all reading at 5km range through used three type of channels, then the signal power factor with OWC channel is -1.08dBm , max Q-factor 1550.7 and MIN. BER is zero. For SMF the signal power is -15.4 dBm, max Q-factor 134.67 and MIN. BER is zero . An the end FSO channel the signal power is -83.41dBm , max Q-factor zero and MIN. BER is one. Also, it can be obtained from result that increase in range length of the three channels leads to decrease expensioly in signal power and maximum Q. factor, then also degradation power in the case of the single mode fiber(SMF) and OWC channels with increased rang of channels give best result compare with FSO channel. Figure11 display the influence a variable change in long of the channels on the performance of transmission system, increase the rang of channel caused decreasing in Q. factor .In this figure the OWC channel will be gives the best result. In Figure 12 when the rang is change, making the system BER performance is increced for FSO channel approximation to one , will the two channel SMF and OWC stay constant on zeros .

5 CLUSIONCON

In this research study three optic communication channels was the conclusion of the results obtained through the use of program optisystem software and by reading obtained from the figure shapes The above found that the ability emerging each channel carrying up along the optical path and also proved by seen from above results, that the channel communications wireless and single mode fiber are give the best results i.e. reduced the value of minimum bit error rate the best channel and increased the values of signal output power and the quality factor when compared with other channels FSO channel, the value of bite error rate remained constant do not change with the variable length of optical path for both SMF and OWC channel, this gives indication that channel FSO is not working within the long rang of propagation and limited for a few hundred meters . a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions. Authors are strongly encouraged not to call out multiple figures or tables in the conclusion—these should be referenced in the body of the paper.

6 References

[1] Prachi Sharma1, Suraj Pardeshi2, Rohit Kumar Arora3, Mandeep Singh4 " A Review of the Development in the Field of Fiber Optic Communication Systems" International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com .Journal, Volume 3, Issue 5, May 2013.

[2] S. G. Lambert and W. L. Casey," Laser Communications in Space", Artec House, Norwood, MA, 1995.

[3] X. Zhu and J. M. Kahn, "Free-space optical communication through atmospheric turbulence channels," IEEE Trans. Commune., vol. 50, pp.1293–1300, 2002.

[4] A.K. Majumdar and J.C. Ricklin" Free-Space Laser Communications", Principles and Advantages. Springer Science Spring Street, New York, U.S.A., 2008.

[5] T. H. Carbonneau and D. R. Wisley, "Opportunities and challenges for optical wireless; the competitive advantage of free space telecommunications links in today's crowded market place", SPIE Conference on Optical Wireless Communications, Massachusetts, pp- 119-128, 1998.

[6] M. D'Amico, A. Leva, and B. Micheli, "Free-Space Optics Communication Systems: Italy", IEEE Microwave and wireless Components Letters, vol. 13, pp. 305-307, 2003.

[7] F. Nadeem, V. Kvicera, M.S. Awan, E. Leitgeb, S.S. Muhammad, and G. Kandus, "Weather Effects on Hybrid FSO/RF Communication Link", IEEE Journal on Selected Areas In Communications, vol. 27, pp.1687-1697, 2009.

[8] John Wiley & Sons, "Fiber-Optic Communications Systems", Third Edition. ISBNs: 0-471-21571-6 (Hardback); 0-471-22114-7 (Electronic) Optical Fibers Communication Channel,2002.

[9] aida hasfiza binti, "modeling intersatellite optical wireless communication system", a thesis submitted in fulfillment of the requirements for the award of the degree Bachelor of Electrical Engineering (Telecommunication) Faculty of Electrical Engineering Universiti Teknologi Malaysia MAY 2009.

[10]. D. J. Heatley, D. R. Wisely, I. Neild, and P. Cochrane, "Optical wireless: The story so far", IEEE Commune. Mag., vol. 36, no. 12, pp. 72–82, Dec. 1998.

[11] A. Polishuk, S. Argon, "Optimization of a laser satellite communication system with an optical preamplifier", J. Optical Society of America. Vol. 21, No. 7, pp 1307-1315, July 2004..

[12] S. Arnon, 'Performance of a laser satellite network with an optical preamplifier', J. Optical Society of America. Vol. 22, No. 4, pp 708-715, April 2005.

[13] X. Zhu and J. M. Kahn, "Free-space optical communication through atmospheric turbulence channels," IEEE Trans. Commune., vol. 50, pp.1293–1300, 2002.

[14] sameer asif1 & prashant kr. yadav2, " An overview to free space optics and its advantage over fiber optics simmer asif1" , E&C Eng. Department, M.I.T. Moradabad (U.P.), India, International Journal of Electronics and Communication Engineering (IJECE) Vol.1, Issue 1 Aug 2012 .

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