Performance Analysis of Guided & Unguided Channels in Optical Communication Systems in C-Band

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Abstract : Comparative performance analysis of single mode fiber (SMF) channel and wireless optical communication (WOC) channel is simulated in this paper. The link is operated for the same distance considering two channel schemes. The performance is measured in terms of bit error rate, quality factor and considering eye pattern. Simulation work is done using optisystem software.

IndexTerms **– Single Mode Fiber, Wireless Optical Communication, Guided, Unguided, RZ**

I. INTRODUCTION

The optical fiber communications have changed our lives in many ways. Fiber optics is a medium for conveying data starting with one point then onto the next as light. Not at all like the copper type of transmission, fiber optics is not electrical in nature. An essential fiber optic framework comprises of transmitting device that change over an electrical sign into a light signal, an optical fiber link that conveys the light, and a collector that acknowledges the light signal and converts it again into an electrical sign.

Optical communication systems can be classified into two types: guided and unguided. All guided optical communication systems currently use optical fibers. In the case of unguided optical systems, the optical beam is emitted by the transmitter which propagates through space, and which can be termed as wireless optical communication (WOC).

Wireless optical communication (WOC) communications, also known as Free space optics (FSO), refer to the transmission of modulated near-infrared (NIR) beams through the atmosphere to obtain optical communications [3]. Similar to fiber optics, FSO techniques uses lasers to transmit data, but instead of enclosing the data stream in a glass fiber, it is transmitted through the space. Thus it can be considered as a wireless way of transmitting information. Optical wireless systems can work over distances of several kilometers [6]. As long as there is a clear line of sight (LOS) between the source and the destination, and sufficient transmitter power the communication is definite. WOC data rates, comparable to optical fiber transmission, can be carried with very low error rates.

II. BACKGROUND THEORY

The optical communication system can be divided into three parts: transmitter, channel/medium & receiver side. Optical communication channels are used to carry the light signal from transmitter to receiver without distorting it. Most of optical signal communication system 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 and fiber nonlinearities, which lead the individual pulses inside the fiber, to broaden. [3]

2.1 Guided Channel:

In guided channel communication, optical fiber is used to transmit the light signal from transmitter to receiver. In this, the transmission of modulated signal is through glass fibers. Figure 1 shows optical communication system with guided channel. Single Mode fiber is use for the transmission.

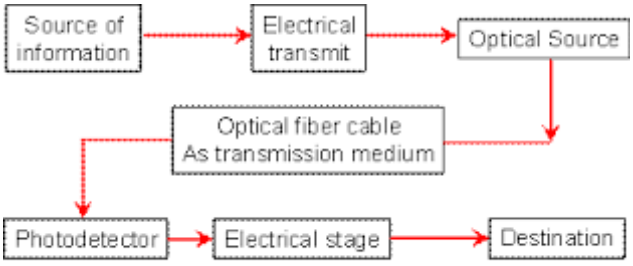


Figure 1

2.2 Unguided Channel:

Unguided channel communication means, that the transmission of modulated light signal through the atmosphere or vaccum to obtain optical communications. It can be termed as wireless optical communication (WOC). Figure 2, demonstrates a typical free space optical system.

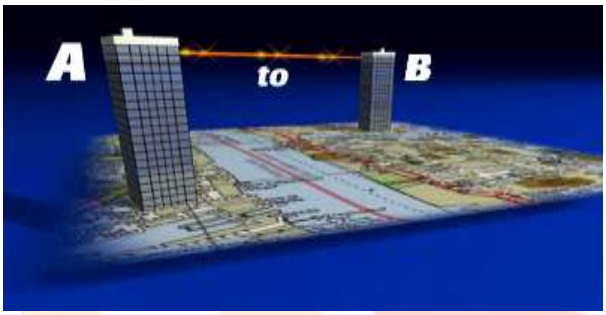


Figure 2

Important feature of WOC is that it is unaffected by electromagnetic interference and radio frequency interference, which increasingly plague radio based communication systems. Another advantage of WOC based communication is that it is free from fiber non-linearity and distortions. WOC systems are used in inter-satellite communication system where deploying for fiber cables are difficult. Wireless optical communication is merely effected by atmospheric distortion. WOC will become most secure and high speed medium of data transmission.

III. SIMULATION SETUP

The simulation is done using OptiSystem Simulation Software. OptiSystem is a thorough programming outline suite that empowers to arrange, test, and rebuild optical connections in cutting edge optical systems. Propose algorithm comprises of a transmitter with RZ signals, SMF and OWC channels, and optical receiver consisting of PIN photodetector, Bessel filter and BER analyzer to analyze the yield result. At the input side CW laser is used to provide the light source to the link, along with that pseudo random bit sequence generator and mach zehnder modulator is taken as in.

The simulation model for guided channel using RZ modulation format is shown in figure 3. The modulated signal from the transmitter side is fed to the single mode fiber (SMF) guided channel.

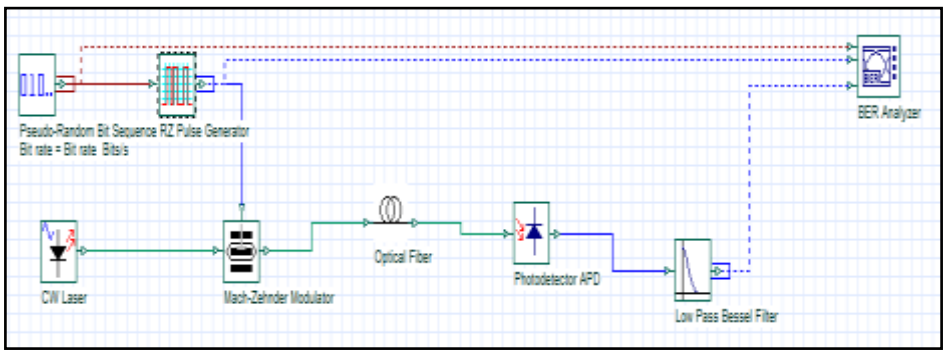


Figure 3

The simulation model for unguided channel using RZ modulation format is shown in figure 4. The modulated signal from the transmitter side is fed to the Wireless Optical Channel (WOC) unguided channel.

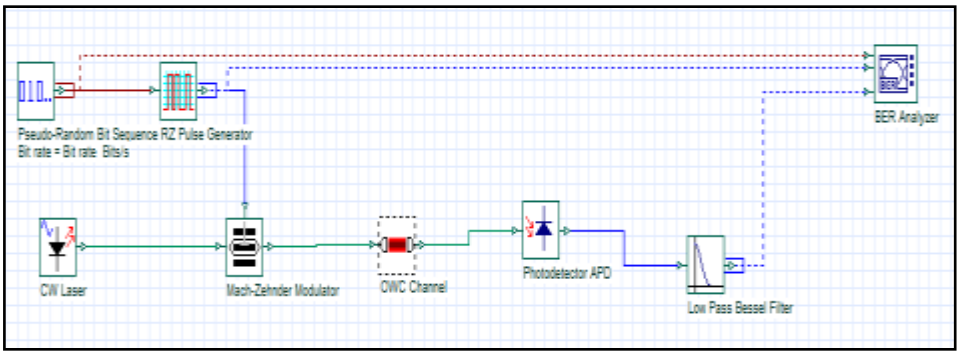


Figure 4

The bit rate of 10Gbps is kept and its effect on the output signal is analysed in terms of quality factor and eye diagram. The transmission distance is varied from 10km, 50km and 100km and the observation is taken for each transmission distance. The input power level is kept constant of about 0dbm. The simulation is carried out on a single channel system.

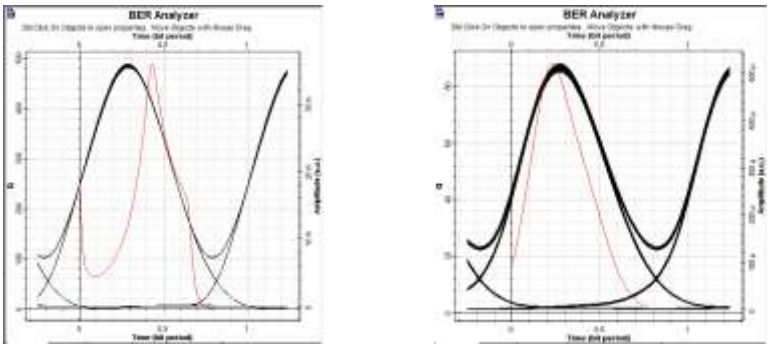
Table -1: Simulation Parameters

Parameters	Values
Bit Rate	10 Gbps
Modulation	RZ
Distance (km)	10 , 50, 100 km
Transmission Channel	SMF & WOC
Power	0dbm
Wavelength	1550 nm

The simulation is carried out under 1550nm wavelength at 0 dbm power. The efficiency of transmitter and receiver is taken as 1. The link is operated at bit rate of 10Gbps for varied transmission distance.

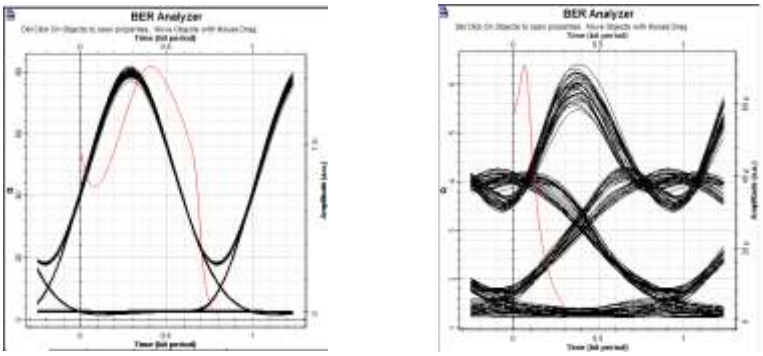
IV. SIMULATION RESULT & ANALYSIS

We have simulated the optical link working at varied bitrates for guided and unguided channels using RZ modulation scheme. The transmission distance effects are analyzed in terms of Q Factor, BER with the use of Eye Diagrams for both the channels schemes.



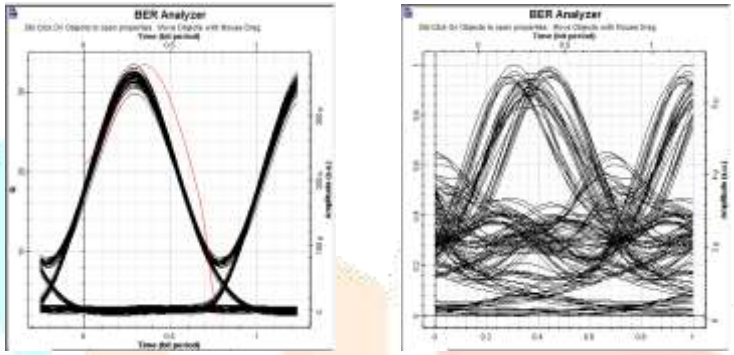
(a) (b)

Figure 3: Eye Diagram @ 10km (a) WOC Channel (b) SMF Channel



(a) (b)

Figure 4: Eye Diagram @ 50km (a) WOC Channel (b) SMF Channel



(a) (b)

Figure 5: Eye Diagram @ 100km (a) WOC Channel (b) SMF Channel

Table 2: Q-factor vs. Distance

Distance	SMF	WOC
10 km	88.07	535.93
50 km	6.40	75.05
100km	0	26.83

IV. CONCLUSION

In this paper, the effect of transmission channel i.e., guided and unguided for varied transmission distance is taken into consideration. The simulation is carried out for varied transmission distance at 10gbps bitrates. From the results it can accomplish that unguided link gives better performance compares to guided link. It can be concluded that for longer distance at higher bit rate the eye diagram has smaller eye opening. Here, the system is simulated at 10 Gbps, and the system gets 88.07 Q-factor using RZ signal at 10 km of transmission distance for SMF and 535.93 Q-factor for WOC link, whereas at 100 km of longer transmission distance we are getting 0 Q-factor for SMF and 26.83 for WOC. From the result it is seen that as the transmission distance increases it impacts the overall system performance, also Q factor decreases. The performance of guided link can be improved by using optical amplifiers in the transmission link.

REFERENCES

[1] Murat Uysal and Hatef Nouri " Optical Wireless Communications – An Emerging Technology" 978-1-4799-5601-2/14/$31.00 ©2014 IEEE.

[2] 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.

[3]Sushank Chaudhary, Angela Amphawan "The Role and Challenges of Free-space Optical" JOURNAL OF OPTICAL COMMUNICATIONS, AUGUST 2014, DOI 10.1515/joc-2014-0004.

[4] Govind Agrawal, " Nonlinear Fiber Optics" , Elsevier, 2013.

[5] Gerd Keiser, Optical Fiber Communications, The McGraw-Hill, 2011.