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Performance Analysis of Optical Communication System using Different Channels

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Abstract: Strong atmospheric turbulence (disturbance due to rain, fog, haze etc.) is a major problem in optical communication system. In this paper, the performance analysis of an optical communication system with Free Space Optics (FSO), Optical Wireless Communication (OWC) and Single Mode Fiber (SMF) in weak atmospheric turbulence has been analysed. Data stream is transmitted at 20Gbps using different channels under attenuation 1dB/km, 2dB/km and 3dB/km. Comparison is made in terms of Q factor, BER and received optical power. It is found that the signal can be transmitted with better Q factor, least BER and high received power with OWC system.

Keywords: FSO, OWC, SMF, Quality Factor, Bit Error Rate.

I. INTRODUCTION

Now a day with the advancement of optical communication system there is a need of high data rate to send more data [1]. Optical communication system consists of transmitter, optical communication channel and receiver. Transmitter devices are used to convert an electrical signal into light signal and channel is used to carry these light signals into the receiver [2]. There are different types of communication system such as communication through different channels i.e. FSO, OWC and optical fiber. Recently there are many studies on FSO communication. It is a kind of new RF wireless communication technology. FSO can provide high speed point to point or point to multipoint communication which is difficult to communicate using Radio over Fiber (ROF) technology such as optical fiber [3]. It is implemented using a laser device which can be mounted inside buildings or offices and basically consists of an optical transceiver with a laser transmitter and receiver to provide full duplex capability [4].

Wavelength division multiplexing (WDM) has become the preferred transmission technology for long distances communication [5]. The performances of FSO systems using SC-QAM over log-normal and gamma–gamma turbulence channels have been investigated in some studies [6].The attractive features of RF technology include ease of deployment, license- free operation, high security and high data rates [7]. It provides good solution for broadband networks especially in geographical areas where optical fiber deployment is not feasible but there are some performance limitations.
The limiting factors are atmospheric turbulence such as fog, dust, snow and rain that weaken the transmission path and may terminate the network [8]. Unlicensed RF technology can be used but it is limited in capacity because of interference issues [9]. Atmospheric parameters must be considered in FSO but Optical Atmospheric Parameters. Wireless Communication (OWC) is free from these The OWC system is not much different from free space optics where the difference relies in the propagation medium [10]. In this there is a significant efforts research on finding significant and accurate system model to overcome the atmospheric turbulence. The atmospheric turbulence results in fluctuations at the received signal i.e. signal fading [11].In a recent work [2], the performance of three different channels in optical communication system was analyzed and its parameters such as Q factor, BER and maximum received power were evaluated with bit rate of 10Gbps. In this paper, we have extended the previous work to 20Gbps bit rate.
This paper is organized into following sections: Section I presents the introduction. Section II describes the simulation setup for optical communication system with different channels and Section III describes the result and discussion. Conclusion has been presented in section IV.

II. SIMULATION SETUP

An Optical Communication System consists of three sections i.e. transmitter, channel and receiver as shown in fig.1. The system has same transmitter with different channels for different receivers. Transmitter consists of a Pseudo Random Bit Sequence (PRBS) generator at bit rate of 20Gbps to modulate the data with NRZ format. A CW laser is used with line widthof 5MHz and frequency of 193.1THz. The incoming signals from NRZ pulse generator and CW laser are passed into the Mach- Zehnder Modulator. Then the signal is passed through the Power splitter which distributes the power into three different channels i.e. FSO, OWC and SMF. Then, the signal passes through the optical receiver connected with each different channel. Receiver consists of Avalanche Photo detector (APD) which is used to demodulate the optical signal and then passes to the low pass Bessel filter.

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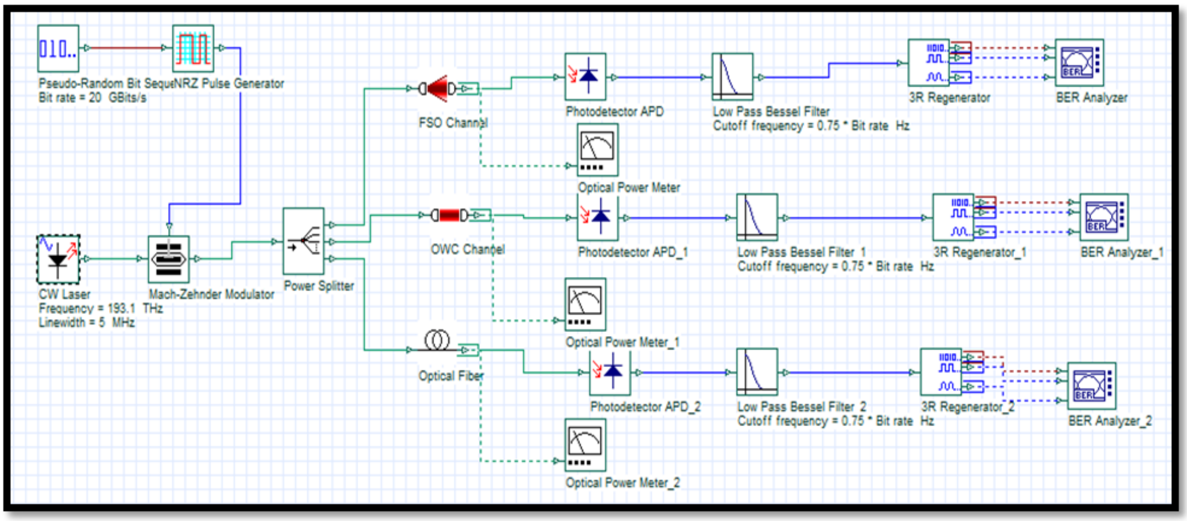

Figure 1: Optical Communication System

Low pass Bessel filter is used to remove the higher frequency components. The output of each LPF data signal is given to the 3R Regenerators. The original data is obtained and it is observed by using BER analyzer.

III. RESULTS AND DISCUSSION

The results are obtained to analyze the performance of FSO, OWC and SMF in optical communication system. The effects of attenuation in the atmosphere for different systems have been investigated in terms of Q factor, BER and optical received power for different transmission distances.

Figure 2 and Figure 3 describe the measurement of Q factor and BER for FSO system by considering attenuation 1dB/km, 2dB/km and 3dB/km.It can be seen from the results, that the Q factor and BER performance are achieved at distance up to 3.5km for 1dB/km attenuation. After that Q factor decreases means signal gets degraded and the BER increases with the increase in transmission distances. At 2dB/km and 3dB/km attenuation the Q factor andBER degrades after distance 2.5km and 2km.

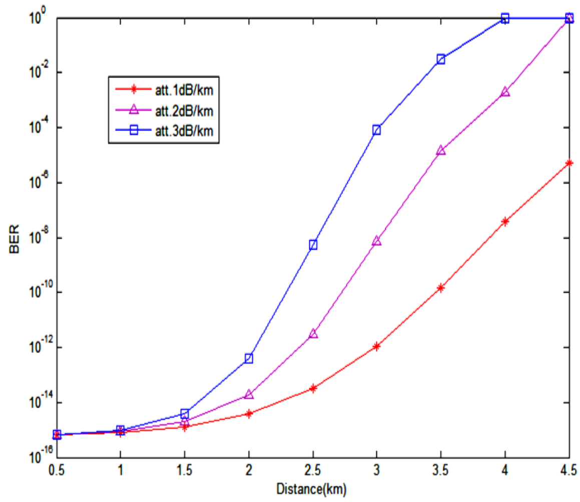

Figure 3: BER v/s transmission distance for FSO

Figure 4 and Figure 5 show the Q factor and BER v/s transmission distance respectively for OWC. It has also been observed that the system with OWC channel has very small affected with the attenuation factor. Under 1dB/km attenuation, it covers 22.5km distance.

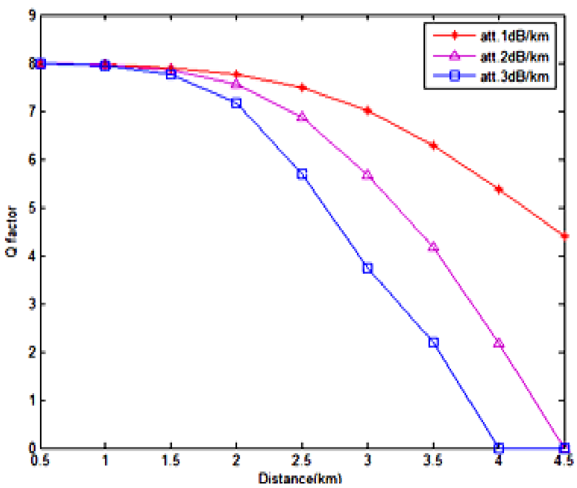

Figure 2: Q factor v/s transmission distance for FSO

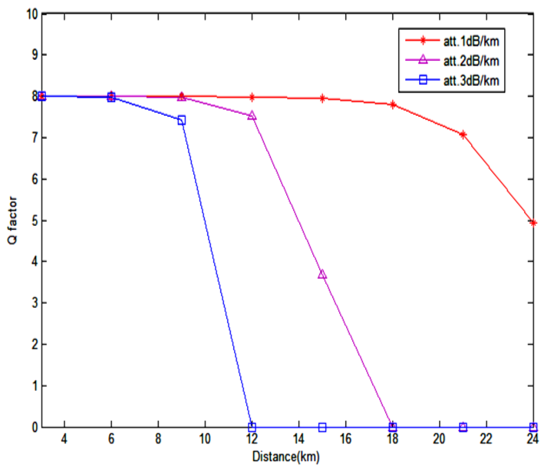

Fig.4: Q factor v/s transmission distance for OWC

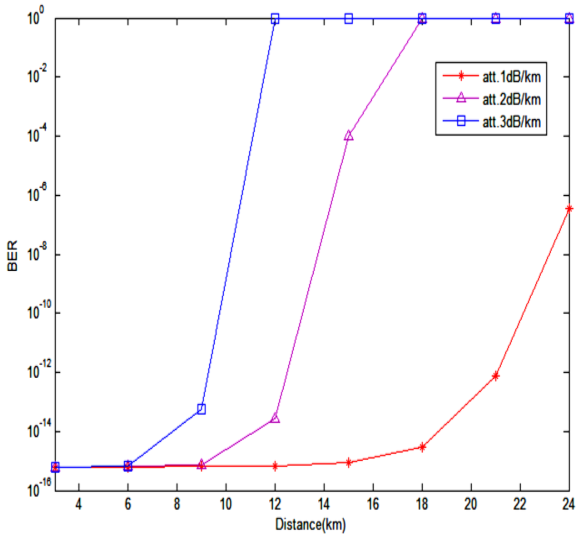

Figure5: BER v/s transmission distance for OWC

When the attenuation reaches to 2dB/km and 3dB/km then the acceptable Q factor and BER is achieved at a distance of 13.5km and 10.5km respectively.

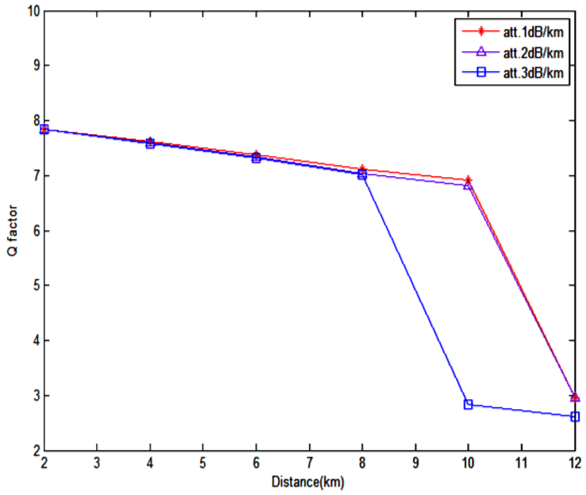

Figure 6: Q factor v/s transmission distance for SMF

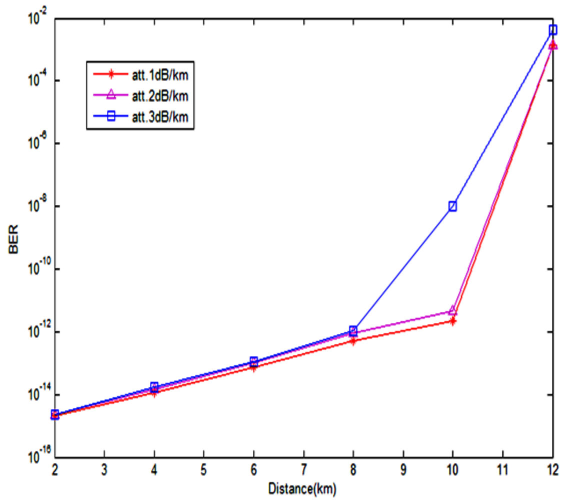

Figure7: BER v/s transmission distance for SMF

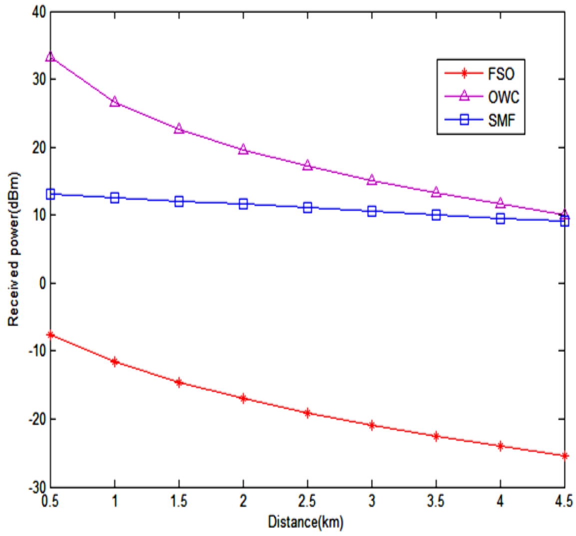

Figure8: Received power v/s transmission distance at 1dB/km

Figure 6 and Figure 7 describe the Q factor and BER with transmission distances for SMF. For the SMF system, the Q factor decreaseand BER increases with the increase in distance. The SMF system covers more distance than FSO but less than OWC. It covers 10km distance under 1dB/km and 2dB/km attenuation and with 3dB/km it covers 9km distancewith acceptable Q factor and BER.

Figure 8 to 10 show the received optical power versus transmission distance of different systems with different attenuation. It is evident from figures that with increase in attenuation received optical power decreases.

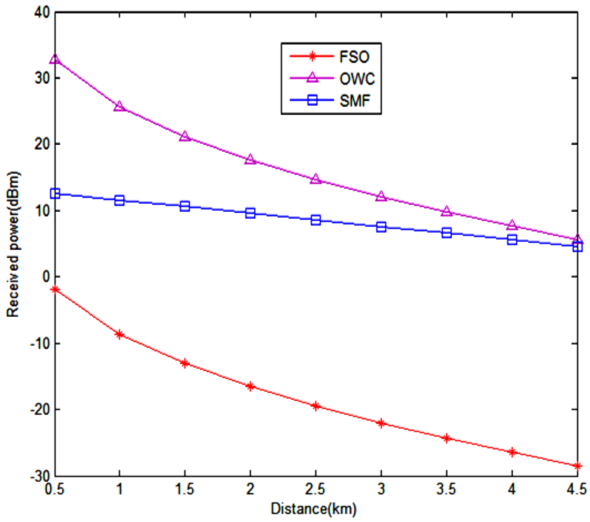

Figure9: Received power v/s transmission distances at 2dB/km

Results of this work are coincidence with [2] in which the performance of three different channels in optical communication system was analyzed and its parameters such as Q factor, BER and maximum received power were evaluated with bit rate of 10Gbps. In this paper, we have extended the previous work to 20Gbps bit rate.

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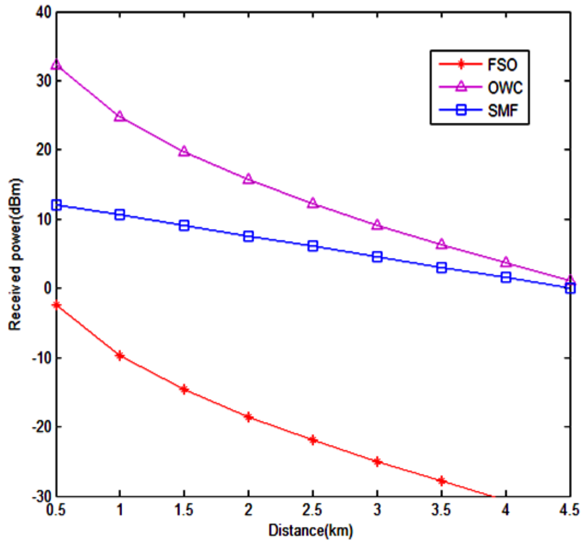

Figure10: Received power v/s transmission distances at 3dB/km

IV. CONCLUSION

In this investigation, the performance of optical communication system is compared for FSO, OWC and SMF channels in terms of Q factor, BER and optical received power at different attenuations. From the results, it is concluded that with the use of FSO, OWC and SMF the system will prolong up to 3.5km, 22.5km and 10km distance with Q factor of 6.29, 6.18 and 6.91 and BER of 1.53976e-010, 2.95755e-010 and 2.29519e-012. When the atmospheric attenuation is increased and it reaches to 3db/km, then the FSO, OWC and SMF channel provide the acceptable results at 2km, 9.5km and 9km transmission distance with Q factor of 7.16, 6.86 and 6.68 and BER of 3.98623e-013, 3.31519e-012 and 1.13991e-014 respectively. Hence, it is concluded that OWC do offer best performance as compared to FSO, SMF in the existence of atmospheric turbulence. The received optical power varies with the attenuation. As the attenuation increases the received optical power decreases.

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