Simulative Investigation of WDM RoFSO Networks Including the Effect of Channel Spacing

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Abstract-*Radio over free space optics (RoFSO) is an emerging technology in the field of optical communication. Wavelength division multiplexing (WDM) technique can be used to increase the data rates and capacity of RoFSO networks. In this paper, WDM based RoFSO network is studied for a distance of 2 Km on various channel spacing like 25 GHz, 50 GHz and 75 GHz at a data rates of 4Gbps.It is reported that various channel spacing offers bit error rate (BER) in the range of 10-17 to 10-3 for a distance of 1Km to 2 Km. The FSO network with 75 GHz channel spacing produces output with approximately 4dBmhigher power compared to 25 GHz channel spacing. As the Beam divergence is decreased the RoFSO network performance advances and covers the larger distance. Eye diagrams are also analyzed which shows that higher is the channel spacing lesser is the BER.*

Keywords-RoFSO, WDM, BER.

I. INTRODUCTION

To overcome the bandwidth limitation problem and meet out the large bandwidth requirement of today's market, FSO came into picture that makes use of optical wireless technology to transfer data. RoFSO uses light beam to transfer data from one point to another at a very high speed [1]. Light beam can be generated by the LED and LASER. The advantages of free space optical networks are high data rates, lower costs as compared to fiber networks and simple installation.

To increase the capacity significantly WDM technique can be used along with RoFSO network. In WDM technique each communication channel is allocated a different wavelength and multiplexed for transmission. At the receiver end wavelengths are spatially separated to different sites. The spacing between the individual wavelengths transmitted serve as the basis for defining Dense WDM and Coarse WDM [2].

The error rate performance of free-space optical (FSO) links over strong turbulence fading channels together with misalignment effects [3]. The increment in range, angle and transmission aperture, the attenuation increases. Some other facts are also included in the increment of attenuation those were less vision, distance and frequency [4].

The receiver structure using saturated optical amplifiers causes a significant reduction in scintillation index and as a result, a reduction of BER up to three orders of magnitude is observed. Amplifiers discussed were EDFA and SOA [5].

In this paper, Coarse WDM technique is used to analyze the performance of FSO network on the ground of various channel spacing. The channel spacing used in this paper is 2 nm (25 GHz), 4 nm (50 GHz), 6 nm (75 GHz) to analyze the FSO network in terms of BER, eye diagram, and received power.

II. SIMULATION SETUP

This section provides details of simulative model designed for analyzing the performance of WDM based RoFSO network. OPT SIM is used to analyze the performance of FSO system. Figure.1 shows a simple block diagram of designed network.

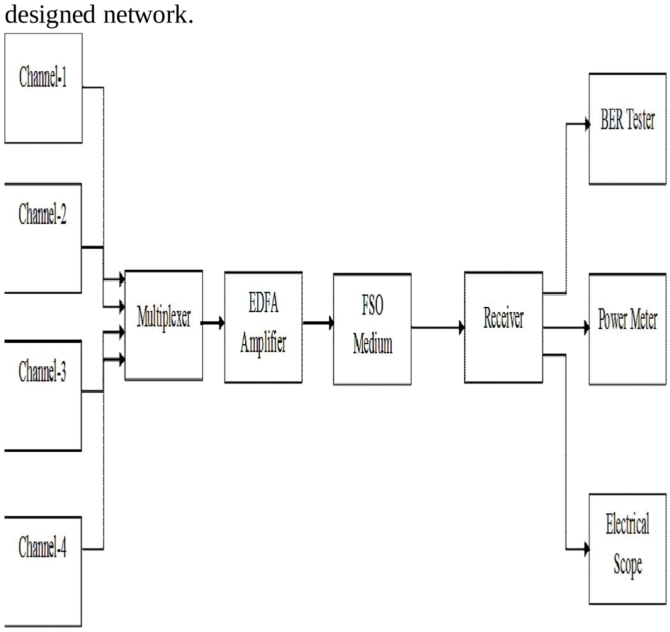


Figure 1: Block diagram of RoFSO network

A four channel network is simulated over the distance of 2 Km on various channel spacing. Bit rate for data transmission is 2 Gbps. Mach-Zehnder modulator is used to modulate the light beam. Beam divergence has been varied from .4 to .8 radian. Performance of FSO system on various channel spacing is compared in terms of BER, Q factor, received power and eye diagram etc. PIN photo detector is used to detect the beam. Various measurement tools like BER tester, power meter, electrical scope etc. are used to analyze the signal.

III. RESULTS & DISCUSSIONS

Figure 2 shows the variation of BER w.r.t. distance for channel spacing of 25GHz, 50 GHz, and 75GHz. It has been observed that as the distance increases from 1Km to 2Km BER increases. It has been noted that spacing of 25 GHz supports transmission up to 1 Km, 50 GHz spacing supports 1.2 Km and 75GHz spacing supports 1.6 Km of transmission at beam divergence of 0.4 radian.

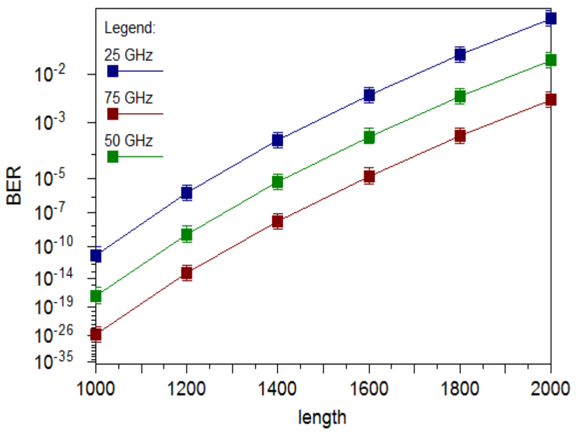


Figure 2: BER vs. Distance at various channel spacing

Figure 3 presents the variation of the average received power w.r.t. distance. It is seen that as the distance increases the received power is reduced.

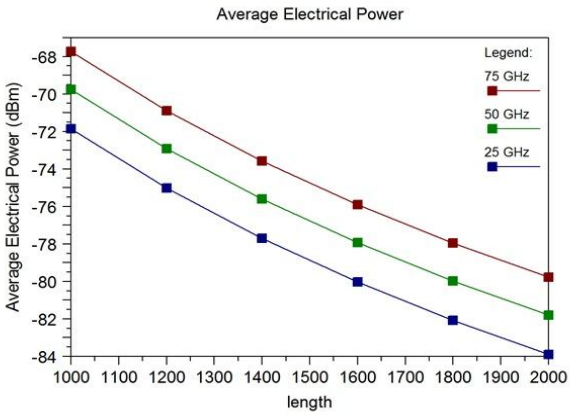


Figure 3: Length vs. Average electrical power

It is also found that as distance varied from 1 Km to 2 Km, received power decreases from -72 to -84 dBm, for 25 GHz spacing, -70 to 82 dBm, and for 50 GHz spacing and -68 to -80 dBm. Thus larger channel spacing provides higher output power.

Figure 4 shows variation of beam divergence w.r.t. BER at the distance of 1 Km on various channel spacing. As the beam divergence is varied from .4 to .1 BER values are varied from 10-12to 10-1 for 25 GHz spacing, 10-17to10-2 for 50 GHz spacing, and10-26 to 10-3 for 75 GHz spacing. It is concluded that as the beam divergence increases the performance of the link deteriorates.

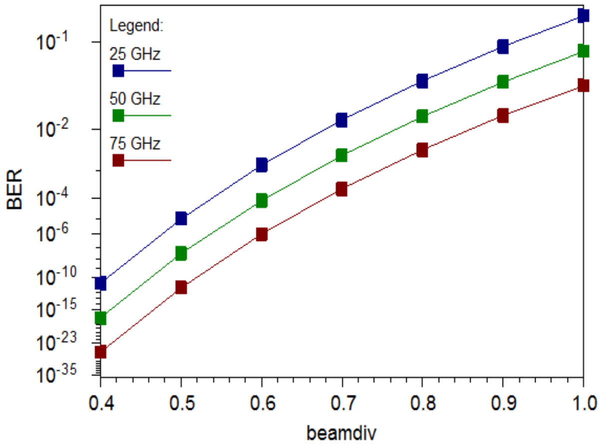


Figure 4: BER vs. Beam div at various channel spacing

Figure 5 illustrates the variation of average electrical power w.r.t. beam divergence. It is revealed from the plot that as beam divergence increases from 0.4 to 1 radian received power is decreases significantly from -68 to -88 dBm

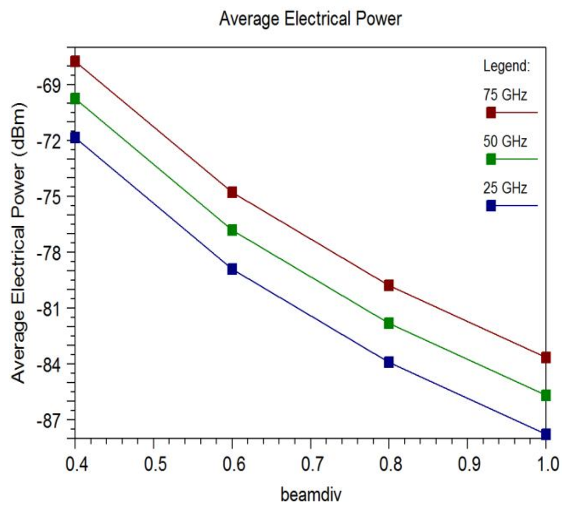


Figure 5: Average Electrical Power vs. Beam divergence

Figure 6 displays relation between BER and aperture area of receiver. As the aperture area increases from 40 to 100 sq. cm., BER decreases from 10-3 to 10-11 for 25 GHz, 10-4 to 10-17 for 50 GHz, and 10-6 to 10-26 for 75 GHz channel spacing. The network provides better transmission for aperture area of greater than 90 sq. cm. for 25 GHz, 75 sq. cm. for 50 GHz, and 50 sq. cm. for 75 GHz spacing.

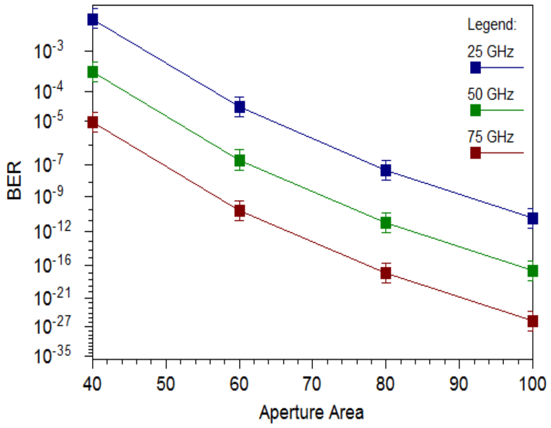


Figure 6: BER vs. Aperture area at various channel spacing

Figure 7shows the behavior of received electrical power w.r.t. aperture area for all channel spacing. It has been observed that as the area increases from 40 sq. cm. to 100 sq.cm. average electrical power increases from -80 dBm to -73 dBm for 25 GHz, -77.8 dBm to -70.6 dBm for 50 GHz, and -75.9 dBm to -68 dBm for 75 GHz channel spacing.

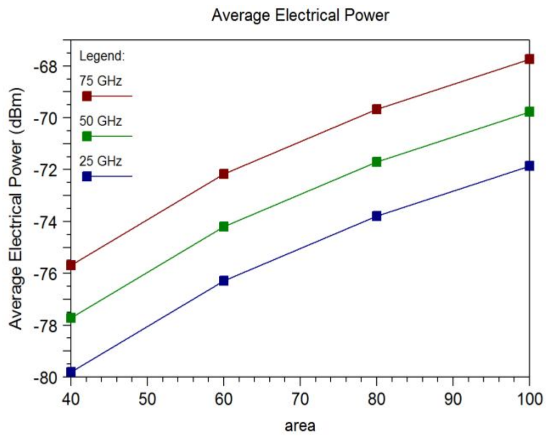
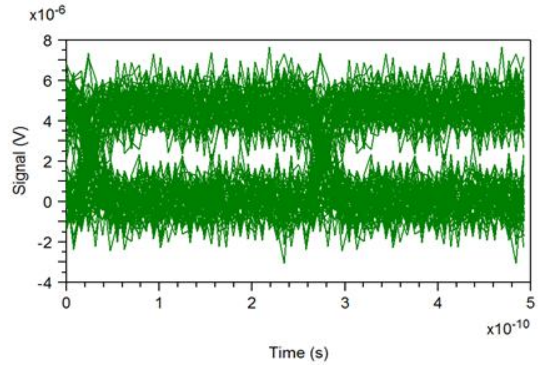
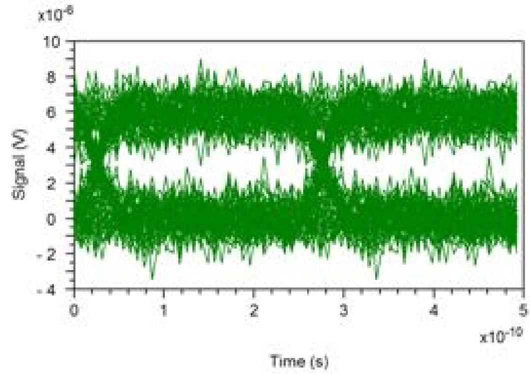


Figure 7: Average electrical power vs Aperture area

In figure 8 eye diagrams are observed for 1Km distance at the aperture area of 40 sq. cm. and beam divergence of 0.4 radian.



(a)

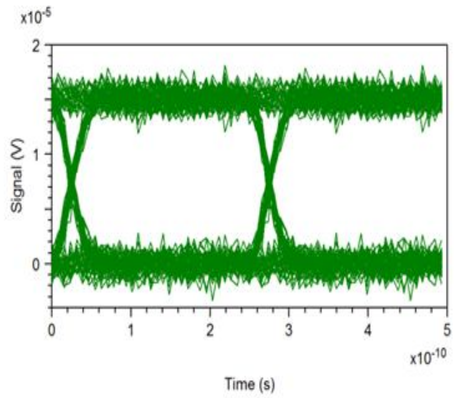


(b)

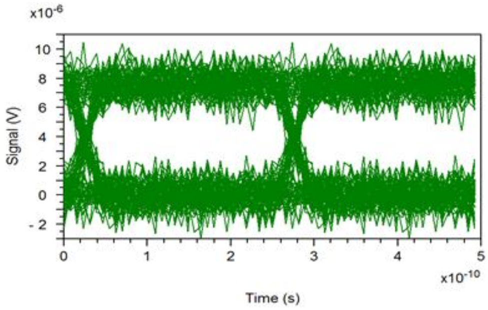
Figure 8: Eye diagrams for 40 sq. cm. aperture area at channel spacing of (a) 25 GHz (b) 50 GHz

From these eye diagram it is also analyzed that as the aperture area increases RoFSO performance improves.

The following eye diagram are observed for 50 GHz channel spacing for 1 Km and 1.6 Km distance at a beam divergence of 0.4 radian and aperture area of 100 sq.cm. in figure 9(a) and 9(b). From these plots it has been analyzed that as the distance increases link performance gets worse.



(a)



(b)

Figure 9: Eye diagrams for channel spacing of 50 GHz at distance of (a) 1 Km (b) 1.6 Km

IV. CONCLUSION

RoFSO has emerged as frontrunner technology to support ultra-high speed mobile and excises. The paper presents a simulative investigation of the effects of channel spacing in RoFSO based links. It is concluded as the channel spacing is increased from 25 to 75 GHz, BER drops significantly. A huge decrement of BER from 10-10 to 10-26 is observed when channel spacing is increased from 25 to 75 GHz at a distance of 1 Km. Besides it, it is also revealed that increasing the beam divergence degrades the performance as BER increases heavily. While increasing the receiver aperture area improves the performance of the system. Hence the system performance can be improved by carefully selecting channel spacing along with beam divergence and receiver aperture area.

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