BER PERFORMANCE IN PHYSICAL LAYER OF FSO COMMUNICATION SYSTEM

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ABSTRACT

FSO is a line-of-sight technology that uses a pair of FSO units consisting of an optical transceiver with a laser (transmitter) and a photo-detector (receiver) to provide full-duplex (bi-directional) capability between two points without the fiber. This paper presents the analysis of Bit Error Ratio under different weather conditions. The experiment was done with Light Pointe Airlite 100 to analyze the variation of BER values with days.

Keywords: FSO , Line Of Sight , BER , SNR , Light Pointe Airlite 100 , LAN Analyzer.

I. INTRODUCTION

FSO is a high-bandwidth cost-effective solution to the last-mile problem. It is a wireless, point-to-point, fiber less, laser-driven and line-of-sight optical communication technology that uses invisible light propagating in free space to transmit information. FSO can transmit data, voice and video simultaneously through the air at speeds capable of reaching 2Gbps at a distance of 2 miles (3 km) in full-duplex mode, enabling fiber-optic connectivity without requiring a physical fiber-optic cable.

II. THEORETICAL ANALYSIS

Random variations in the air's refractive index profile commonly referred as optical turbulences, responsible for the change in different properties of the transmission and reception of optical signals. The cause of these Optical Turbulences in the atmosphere is due a combination of moisture and temperature gradients caused from the Sun's heating of the Earth's surface.

The effectiveness of a FSO system can be determined by its bit-error-ratio (BER) performance, which is based on the signal-to-noise ratio (SNR) and the modulation scheme involved in the FSO system [5].

Now, in presence of turbulence effect, the SNR becomes a variable term and considering its average value the $\langle SNR \rangle$ is given as :

$$\langle SNR \rangle = \frac{SNR_0}{\sqrt{\left(\frac{P_{S0}}{\langle P_S \rangle} + \sigma_i^2(D) SNR_0^2\right)}} \quad \ldots\ldots (1)$$

WhereP_{S0} is the optical power in absence of atmospheric effects, $\langle P_S \rangle$is the mean optical power and $\sigma_i^2(D)$is the average Scintillation effect of the atmospheric turbulences.

The experiment conducted with Light Pointe [7] equipment uses the on-off keying (OOK) modulation scheme in transferring the data. The BER calculation is done based on the OOK modulation scheme. In OOK scheme, "1" is represented by presence of light pulse where "0" is represented by an absence of light pulse. The error occurs when the receiver detects a "0" when "1" is sent or detects a "1" when "0" is sent, both under the noisy conditions of the atmosphere.

The transmission of "0"s and "1"s with equal probability is equated to ½, and the probability of bit error is given as:

$P_E = \frac{1}{2}P(1|0) + \frac{1}{2}P(0|1)$…… (2)

Now, the bit-error-ratio with respect to the signal-to-noise ratio in absence of atmospheric turbulence is given as:

$BER_0 = \frac{1}{2}\left(\frac{SNR_0}{2\sqrt{2}}\right)$……. (3)And in presence of turbulence is given as:

$BER = \frac{1}{2}\int_0^\infty p_I(s)\ erfc\left(\frac{(SNR)s}{2\sqrt{2}(i_s)}\right)\ ds$ …(4)

Table 1 gives some BER values corresponding to SNR (dB) levels [3]:

Table 1: BER values with respect to SNR (dB)

BER	SNR (dB)
10^{-10}	19.4
10^{-9}	18.6
10^{-8}	18
10^{-7}	17.3
10^{-6}	16.4
10^{-5}	15.3

III. EXPERIMENTAL SET UP

The equipment set-up used in this experiment is shown in the figure

Figure 2: Equipment Set-Up Overview

IV. EXPERIMENTAL OBSERVATIONS

The experiment was done with Light Pointe Airlite 100 [7], in collaboration with the LAN Analyzer [9] during the month of January-February, 2015 in Kolkata(India). The temperature data was taken [10] along with the BER data during the experimental days. The equipment runs for 20 hours continuously to measure the BER. The layer of operation in this experiment was the Physical layer [9], having a frame structure shown below:

PRE (Preamble)	SFD (Start of Frame Delimiter)	DATA	IFG (Inter Frame Gap)

Figure 3: Physical Layer Frame Format

Table 2 shows the maximum-minimum temperatures along with the BER values for that day.

Days of Exp	Maximum Temperature in °C	Minimum Temperature in °C	Measured Bit-Error-Ratio
1	24	13	7.77e-9
2	26	13	5.6425e-9
3	24	14	1.23e-8
4	26	12	1.1333e-8
5	27	16	6.711e-8
6	27	16	5.6688e-8
7	29	12	1.6813e-8
8	31	14	2.6051e-8
9	28	16	3.0659e-8
10	25	16	1.7899e-8
11	28	17	1.9234e-8
12	27	17	2.0527e-8
13	28	15	3.0847e-8
14	28	16	3.0084e-8

Table 2: BER values with maximum-minimum temperatures

V. EXPERIMENTAL RESULT

Graph shows the BER variation with days.

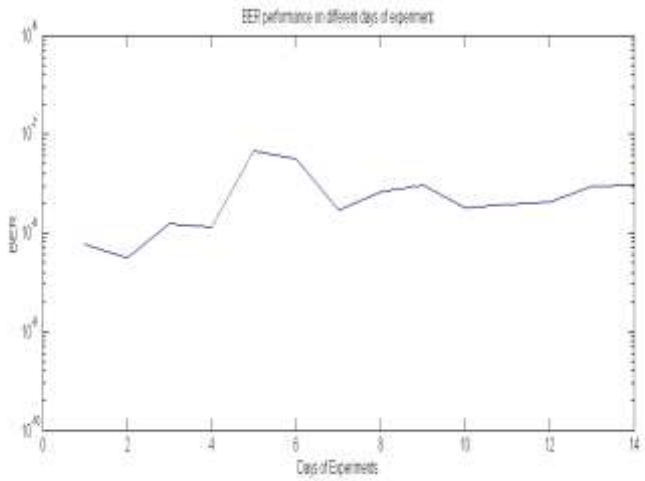

Figure 2: BER performance on different days

VI. CONCLUSION

In this experiment, we try to study the effects of temperature on BER performance in the FSO systems. During the experiment, it is found that the increase in temperature also increases the BER. Also it was investigated that most of the errors occurred during the dawn time of the day. The research could let to new investigations in the BER measurement parameters.

VII. ACKNOWLEDGEMENT

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