AN EFFICIENT ANALYSIS OF DATA TRANSMISSION IN FREE SPACE OPTICAL COMMUNICATION AND ITS CHALLENGES

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Abstract - Free-space optical communication (FSO) is an optical communication technology that uses light propagating in free space to wirelessly transmit data for telecommunications. Atmospheric turbulence has shown an major impact on the quality of laser beam traveling through the atmosphere over a larger distances. In this paper we are applying 150 m channel spacing with 40GHZ bandwidth and 150nm laser source. FSO channel work like Afocal scheme, it can diminish the span of the laser bar, and expected longer free-space transmission in FSO correspondence, recipient side equivalent gain joining strategy in the presence of strong atmospheric turbulence. FSO is a communication system where free space goes about as medium among transceivers and they ought to be in LOS for effective transmission of optical flag. Medium can be air, space, or vacuum. This system can be utilized for correspondence reason in hours and in lesser economy. There are numerous points of interest of FSO like high transfer speed and no range permit. The transmission in FSO is reliant on the medium in light of the fact that the nearness of outside components like rain, haze, and dimness, physical deterrent, scrambling, and climatic disturbance are a portion of these variables.

Keywords: *Free space optics, NRZ, RZ, PIN, APD, FSO Channel, Dense- Wavelength-Division Multiplexing*

I. INTRODUCTION

Free space optical communication transmit fast information rate, an amazing sign with laser light proliferation in free space interface. FSO correspondence is high directivity, unlicensed data transfer capacity, simple setup, and adaptability through a free space connect, disconnection from different impedances and utilizing by numerous applications with FSO interface [1-2]. It has a few favorable circumstances over the conventional radio recurrence (RF) based remote correspondence. In this, a 150m-160Gbps FSO correspondence with FSO channel like afocal conspire and thick wavelength-division-multiplexing (DWDM) is utilizing and wavelength is 1550nm CW laser source. Free space transmission remove is incredibly expanded by the afocal conspire transmission rate is fundamentally expanded by DWDM innovation. By afocal conspire which is decrease the measure of the laser pillar, it gives long free space transmission remove in FSO correspondence [2]. DWDM FSO correspondence diverse optical wavelength to exchange information is to be valuable for giving higher transmission rate. The reenactment of FSO correspondence by utilizing 16 channel of CW laser source with 193.1 THz recurrence with 20 dBm control source and each channel did of variety of 0.1 THz, with 150-m free space interface with aggregate transmission 160Gbps with the assistance low clamor speaker (LNA) and clock/information recuperation at the less than desirable end, and we see the great piece mistake rate and eye graph. Be that as it may, issue looked by air disturbance like as (rain, fog, haze, dust and so forth), and preferred standpoint of optical remote correspondence high transmission rate rapid light based Wi-Fi and (Li-Fi) application [4] also.

II. ATMOSPHERE TURBULENCE AND PROBLEM STATEMENT

In free space optics, simulation setup configuration of 150-m DWDM FSO communication, Continuous laser source (CW) efficiently split into 16 channels setup with 193.1 THz frequency with 20 dbm power on each channel, 1x16 arrayed wave guided grafting (AWG) de-multiplexer (DMUX) with channel spacing 50 GHz Sixteen wavelength of λ1 to λ16 and bandwidth is 0.32 nm or 40 GHz output of AWG multiplexer (MUX) is 16x1 transmitted into a mesh Zehnder modulator (MZM) with extinction ratio of 40 db with Pseudorandom binary sequence (PRBS) bit sequence with (0001011011101011) generated by PRBS generator or input data sequence ,transmitted over 16 channels ,after this data will go through the erbium doped fiber amplifier (EDFA) it is amplified the signal pump with forward and backward laser is 1550 nm then, the second stage is a variable optical attenuator (VOA) start the optical power launch into FSO channel with attenuation 0.55 db, optimized to the best transmission performance in 1550 region with DWDM FSO communication wavelength. In the FSO channel we are configured with free space length is 150-m and attenuation is 2.77db/km in this region of FSO channel transmitter aperture diameter is 10 mm and beam divergence is 0.00137 mrad, with 1db additional transmission loss. Transform the divergent beam into the parallel beam, the function of afocal scheme is reduce the size of the laser beam and the second stage of lens focuses the reduced parallel beam into a point. Over 150-m space link receiver diameter is 8mm. Data received with optical receiver, with PIN Photodiode component is used to convert an optical signal into an electrical current based on the device‘s responsively of 1 mA/mW (at 1550 nm) with gain is 3 db bandwidth of 0.32 nm and ionization ratio is 0.9, in this little noise as possible, LNA amplification data stream is recovered or regenerate by bit error rate analyser.But in this situation, we can face challenges like atmospherics turbulence (rain, haze, fog, dust etc).because of this natural disaster we are not able to receive the data we found the error.

2.1 The Received photo-detector current at the presence of Atmospheric Turbulences

The received optical signal level is highly dependable on the FSO channel parameters.

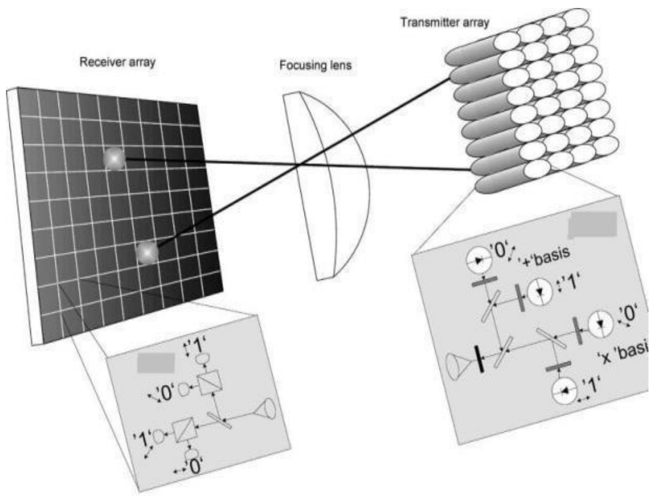

Fig 1 Photo detector

For a PIN diode, a photo-detector current Ip will be generated based on

$$I_P = \Re P_{rx} = \Re P_{tx} L_{tx} G_{tx} L_P L_R G_{rx} L_{rx}$$

Where *R* is responsivity of PIN diode, *Prx* is received power, *Ptx* is transmitted power, *Ltx* is transmitted optics efficiency, *Gtx* is transmitted gain, *Lp* is pointing loss, *LR* is range loss, *Grx* is receiving gain and *Lrx* is receiving optics efficiency. Assuming accurate beam pointing, values of these parameters are fixed except the range loss, which depends on the distance

Generally the decrease in the quality of the flag as it spreads through the medium as in here is the air. It is figured through the proportion of the transmitted capacity to the gotten control. The experimental recipe for the estimation of the lessening coefficient is as beneath: Where V is the perceivability, λ is the recurrence utilized what's more, q is the molecule estimate dissemination coefficient. Here perceivability is characterized as the separation at which a bare human eye can recognize white limits and the dark limits. For the figuring of constriction by haze and rain there are distinctive models. For mist weakening there are two models KRUZE'S demonstrate and KIM'S show. These models utilizes distinctive conditions for the figuring of lessening which are as demonstrated as follows

(1). KRUZE'S model: This model is generally utilized to compute the FSO gear connect spending plan. This display compares tobest results on the recurrence 1550 nm as opposed to different frequencies recommended to be utilized in the FSO correspondence. The condition utilized in this model has the shape demonstrated as follows:

The particle size distribution for this model has the

form:

$$q = \begin{cases} 1.6 \text{ if V } > \ 50\ km \\ 1.3 \text{ if 6km } < \ V \ < \ 50\ km \\ 0.585 \text{ V1/3 if V } < \ 6\ km \end{cases}$$

(2). KIM’S model : The evaluation of the parameter q was not collected in dense fog for the

visibility lower than 6 km. So for the visibility lower than 1 km the significance of the KRUZE model was in doubt. Then the recent studies proposed another expression for the particle size distribution coefficient (q). this model was the KIM’S model, whose expression has the form

shown below :

$$\begin{aligned} q = \ & 1.6 \text{ if V} > 50 \text{ km} \\ & 1.3 \text{ if 6 km} < \text{V} < 50 \text{ km} \\ & 0.5 \text{ if 1 km} < \text{V} < 6 \text{ km} \\ & 0.1 \text{ if 0.5 km} < \text{V} < 1 \text{ km} \\ & 0 \text{ if V} < 0.5 \text{ km} \end{aligned}$$

III. CHALLENGES

Optical remote systems dependent on free space optical correspondence must be intended to battle the atmospheric challenges which can influence the framework execution definitely. There are a few difficulties confronting the channel performance. Initially, free space way misfortune marvel . Besides, explore the impact of various Weather conditions that shows up in the examinations managing scrambling , disturbance and sparkle . FSO interface collector strongly affects the conduct of the connection. Sorts of finders, different wellsprings of commotion and mistake remedy procedures For maintaining wanted piece blunder rates acknowledged levels are the best factors that ought to be considered in the structure of down to earth FSO recipients . For FSO interface transmitters, numerous adjustment procedures are utilized, for example, NRZ, RZ , PPM, BPSK and DQPSK. Distinctive kinds of light sources are utilized in FSO like LED, VSCEL lasers, QCL. Different wavelengths are assessed such, 785 nm, 830 nm, 850 nm, 950 nm, 1550 nm and 10,000 nm.

IV. SIMULATION RESULTS

In the free space optics, we are applying the 16 channel of CLW laser source and given the source in terahertz recurrence like 193.1 THz. With each channel variety of various Different laser control source. All power experience the exhibit wave grinding (AWG) with 16 channel work like as demux and power source and second is work like as mux and all power is going on and examine yield ports. In PRBS when we give the information like twofold grouping of 14 digit bit/s, paired succession is applying non-come back to zero NRZ, at that point balanced the power source EDFA length 1 m, and forward and in reverse laser source is 1550nm, all power is move in factor optical constriction (VOA), weakening component is 0.55 db. We are applying the FSO divert in free space interface length is 150-m, extra misfortunes 1 db in channel transmission opening, we are utilizing the optical recipient in this 3 db misfortunes of contrast NRZ modulator factor and the arrangement of fallowing at 1550 nm area. In this applying 5 cycle in a framework at giving great piece mistake rate and clear EYE diagram.

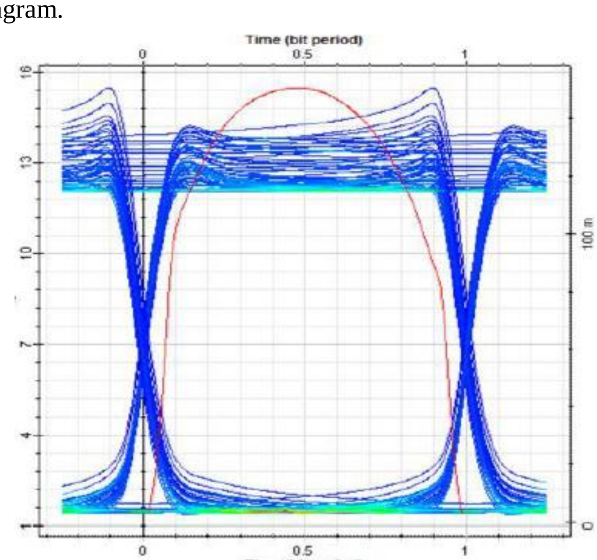

Fig 2 : BER Analyzer

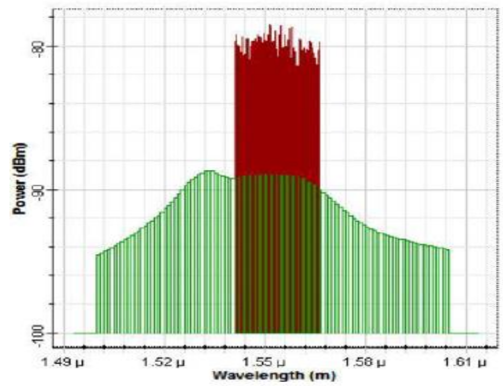

Fig 3 : Optical Spectrum Analyzer

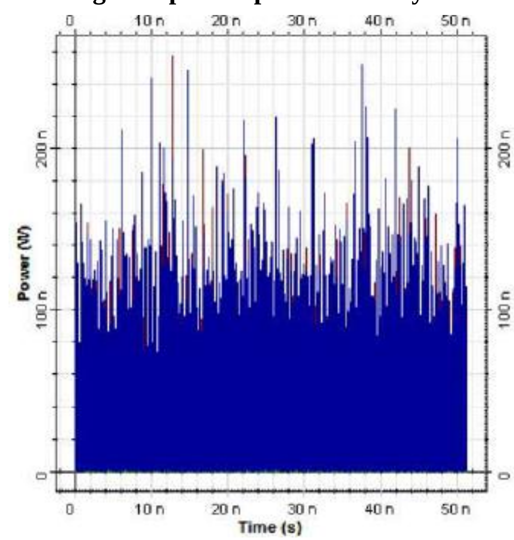

Fig 4 : Optical time Domain Visualizer

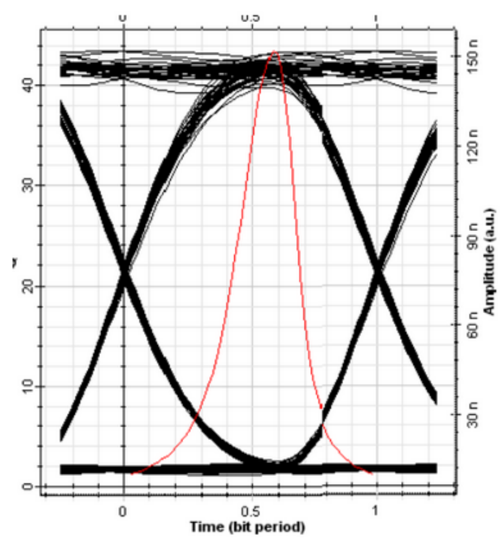

Fig 5 : EYE diagram NRZ modulated using APD photo diode at 1310nm.

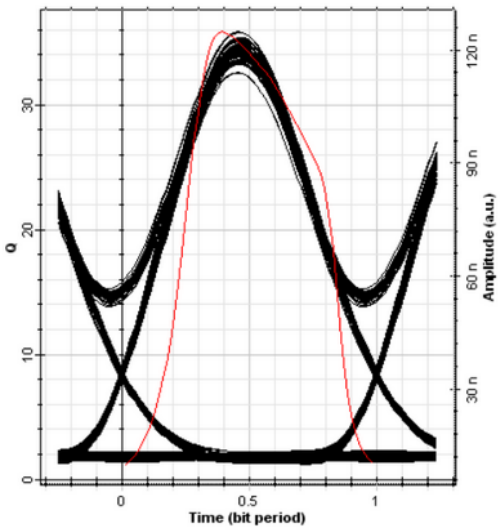

Fig 6 : EYE diagram RZ modulated using APD photo diode at 1310nm

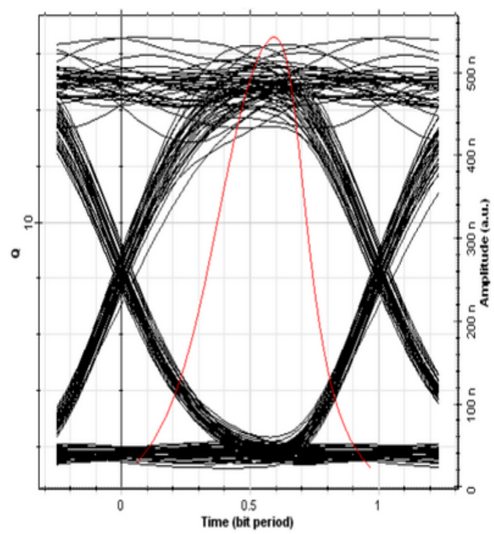

Fig 7 : EYE diagram NRZ modulated using PIN photo diode at 1310nm

V. CONCLUSION

As proposed the basics FSO communication but for better performance, we used maximum ratio combination technique. We try to analysis to find out the expression of the signal & photo-detector currents in presence of strong atmospheric turbulence for the MIMO FSO system as far as possible considering all the parameters which are efficiently practical to the system. The signal to noise ratio (SNR) and the unconditional BER was evaluated numerically for different system parameters. The degradation in system performance because of the direct impact and enhancement in collector affectability were resolved numerically. And after that we endeavor to plot in the diagram and decide the execution for various choppiness condition. Ideal framework parameters were resolved for a given framework BER, and we accept BER 10-7. The proposed DWDM FSO correspondences are reenactment exhibited with low Bit Error Rate (BER) activity and clear eye graph. The discoveries exhibited that such a DWDM FSO correspondence can give the upsides of optical remote connections for long transmission separation and high transmission rate. In any case, in this, we discovered a few information misfortunes and Errors like Atmospherics Turbulence Such as (Haze, Thunderstorm, Rain, haze, and Dust).

VI. REFERENCES

[1] W.S.Tsai [et al. (2016)] "A 50-m/320-Gb/s DWDM FSO Communication with A focal Scheme" IEEE Photon. J. vol. 8, no.3 June 2016, Art no7904007.

[2] W. S. Tsai [et al. (2016)], "A 50-m/40Gbps 680-nm VCSEL-based FSO communication," IEEE Photon. J., vol. 8, no. 2, 2016, Art. no. 7903008.

[3] W. S. Tsai [etal.(2015)],"A 20-m/40-Gb/s 1550-nm DFB LD-based FSO link," IEEE Photon. J.vol.7, no.6, Dec. 2015, Art. no. 7905907.

[4] H. H. Lu [et al.(2015)] "10 m/25 Gbps LiFi transmission system based on a two-stage injection-locked 680 nm VCSEL transmitter," Opt. Lett., vol. 40, no. 19, pp. 4563–4566, Oct. 2015.

[5] I. S. Ansari, M. S. Alouini, and J. Cheng, "Ergodic capacity analysis of free-space optical links with nonzero bore- sight pointing errors," IEEE Trans. Wireless Communication., vol. 14, no. 8, pp. 4248–4264, Aug. 2015.

[6] C. L. Ying, "20-Gbps optical LiFi transport system," Opt. Lett., vol. 40, no. 14, pp. 3276–3279, Jul. 2015.

[7] M. A. Khalighi and M. Uysal, "Survey on free space optical communication: A communication theory perspective,"IEEE Commun. Surveys Tuts., vol. 16, no. 4, pp. 2231–2258, 2014.

[8] W. Y. Lin [et al.(2012)], "10-m/500 Mbps WDM visible light communication systems," Opt. Exp., vol. 20, no. 9, pp.9919– 9924, Apr. 2012.

[9] R. Antil "An overview of DWDM Technology & Network", I J OF Scientific Vol-1, Issue-11, Dec-2012.

[10] K.Wang, A. Nirmalathas, C. Lin, and E. Skafidas, "High-speed optical wireless communication system for indoor applications," IEEE Photon. Technol. Lett., vol. 23, no. 8, pp. 519–521, Apr. 2011.

[11] Gerd Keiser "5th edition of optical fiber communication.

[12] H. Kaur, G. Soni, "Performance Analysis of Free Space Optical Communication Link Using Different Modulation and Wavelength"Journal of Scientific Research & Reports 6(3): 201-209, 2015; Article no.JSRR.2015.145 ISSN: 2320-0227

[13] S Bloom, E. Korevaar, J Schuster and H.willbrand , "Understanding the performance of free space optics," J Opt. Networking., Vol. 2,no.6,pp. 178-200, June 2003.

[14] W.zhang,S. Hranilovic and C. Shi, "Soft switching Hybrid FSO/RF links using short length Rapter codes :Design and implementation, "IEEE J. Sel. Area comm., Vol. 27, no.9, pp. 1-11, December 2009.

[15] S.Arnon, "Optical wireless communication," In Encyclopaedia of optical engineering, pp. 1866- 1886, New York, USA, 2000.

[16] H. Manor and S. Arnon, "Performance of an Optical Wireless Communication System as a Function of Wavelength," Appl. Opt., vol. 42, no. 21, pp. 4285-4294, July. 2003.

[17] M. S. Awan, Marzuki, E. Leitgeb, F. Nadeem, M. S. Khan and C. Capsoni, "Fog attenuation dependence onatmospheric visibility at two wavelengths for fso link planning," Lough borough Antennas & PropagationConference, UK, pp. 193- 196 , November. 2010.

[18] I. I. Kim, B. McArthur and E. Korevaar, "Comparison of Laser Beam Propagation at 785 nm and 1550 nm in Fogand Haze for Optical Wireless Communications," In: Proc. SPIE 4214,

February. 2001, pp. 26-37.

[19] W. O. Popoola and Z. Ghassemlooy, "BPSK subcarrier intensity modulated free space optical

communications in atmospheric turbulence," J. Lightwave. Technol., vol. 27, no. 8, pp. 967–973,

April. 2009.

[20]M. S. Awan, Marzuki, E. Leitgeb, F. Nadeem, M. S. Khan and C. Capsoni, "Weather effects impact on the optical pulse propagation in free space," In: Proc. 69th Vehicular Technology Conference (VTC), Barcelona, April. 2009.pp. 1-5.

[21] W. O. Popoola and Z. Ghassemlooy, "BPSK subcarrier intensity modulated free space optical

Communications in atmospheric turbulence," J. Light wave. Technol., vol. 27, no. 8, pp. 967–973,

April. 2009.

[22] F. Xu, M. Ali Khalighi and S. Bourennane, "Impact of Different Noise Sources on the Performance of PIN- and APD-based FSO Receivers," 11th International Conference on Telecommunications, ConTEL, Graz, Austria, pp.