Performance Analysis of IsOWC System Using Advanced Modulation Formats and Schemes over Wavelength Spectrum

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***Abstract* - In this article, analysis of IsOWC using advanced modulation formats NRZ,RZ, CSRZ, DRZ, DPSK and modulation schemes NRZ –DPSK, CSRZ-DPSK have been investigated over wavelength spectrum. It has been observed that all the modulation formats perform best and give maximum quality factor at 650 nm .As we move towards longer wavelength the Q factor keeps on decreasing.Amplitude modulation gives best results in terms of Q Factor and phase modulation is least acceptable. Although the eye opening reported in AM is greater than MZM but It is recommended to use MZM over AM due to greater values of extinction ratio. EAM and PM are reported to perform appalling.The power reception decrease with increase in wavelength magnitude.**

***Keywords* - IsOWC (Inter-Satellite Optical Wireless Communication), DPSK (Differential Phase Shift Keying), QFactor,NRZ(Non Return to zero),CSRZ(Carrier suppressed return to zero).**

I.INTRODUCTION

Inter-satellite Optical wireless communication (IsOWC) is a proficient way out for extremely high data rate point to point communication. With the growth of high definition television and applications, requirements of high speed wired and wireless is constantly rising in indoor and outdoor environments [1]. The microwave and RF frequencies are used to transmit the information but they undergo drawbacks like radiations make a way into walls and less data rate transmit due to losses [2].Optical wireless communication is a easy way out to support such applications and overcome the drawbacks of which cause less speed transfer. IsOWC technology has a lot of reimbursements than the disadvantages. Its high data rate capability, license free operation, unregulated bandwidth, low power, high efficiency, lesser antenna sizes and low cost. All these features made the IsOWC technology came into survival [3]. The shortcoming includes the tracking problem and misalignment of spreader and recipient apertures and the changes due to atmospheric circumstances. The tracking difficulty causes a variety of noise sources such as laser relative noise intensity, Johnson noise, dark current noise. Major degradation is caused by vibration noise. Susceptibility towards pointing errors is more due to the vibration noises. . The major center is to decrease the power dissipation and to decrease the BER. This results in high transmitter power and lesser receiver noise to get preferred signal [4].Long range transmission provide solution to bottleneck problems which rises due to long distance communication. Basic architecture is to transmit the electrical modulated data on wireless channel in the form of optical signal due to maximum speed of light in vacuum as well in atmosphere. This benefit gain popularity rather than using conventional RF systems in order to improve distance covered and improved performance. [5]. the system is commendable until the atmospheric turmoil is not there and effect of atmospheric turbulences is unlike for dissimilar modulation formats [6]. The data rate can be diverse from 10Gbps to 40Gbps with a bearable quality factor. System performance limits even if there is small deviation of pointing [4].Use of advanced modulation formats due to their great capability to make system bandwidth efficient and mitigate problems such as ISI(inter symbol interference) motivates us to find the way for better system in terms of capacity and speed.

In this work, performance analysis of OWC using different modulation formats such as CSRZ, DRZ, NRZ and RZ. Further system performance analyzed over different frequency spectrum in order to find best suited wavelength for OWC transmission. Power penalty at each format and over different wavelengths has been investigated for the selection of optimum modulation format and frequency spectrum for transmission. Overall system evaluation carried out by analyzing Q-factor, Received power and BER.

II. SYSTEM DESCRIPTION

IsOWC system has been modeled and performance depiction by OptiSystem7. The architecture for simulation is prepared. The system used for evaluation is a 16 channel system transmitting 40 Gbps at each channel. The system utilizes various modulation formats for evaluation under wavelength spectrum. Modulation formats used are RZ, NRZ, CSRZ, DRZ.The system is evaluated at 640 Gbps total bit rate.

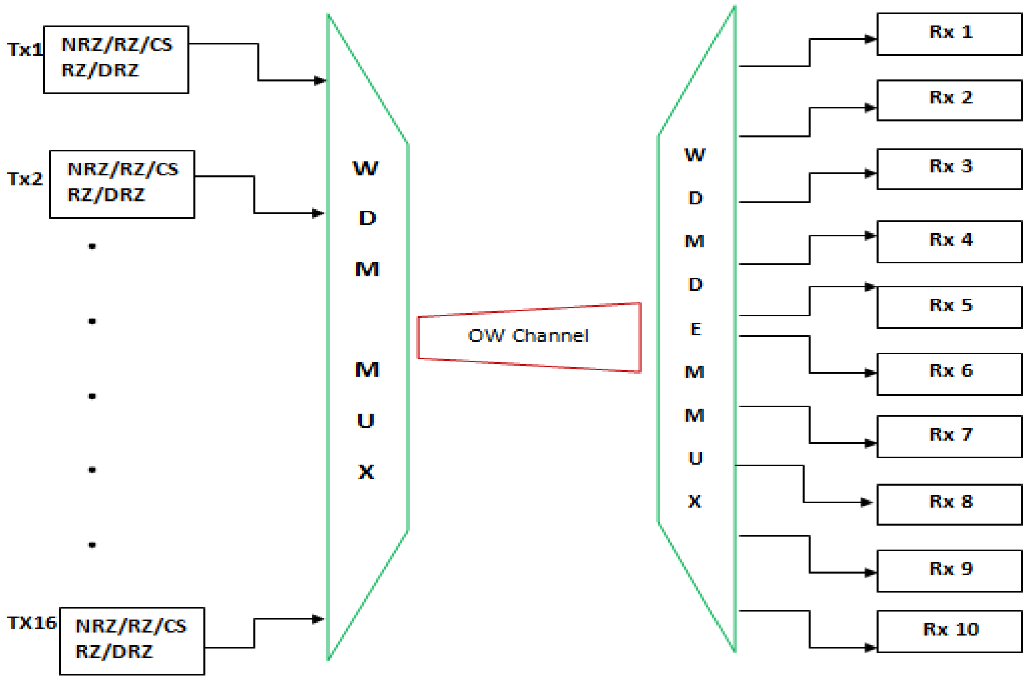


Figure.1: System setup of IsOWC System

16 such transmitting sections are used at 40 Gbps each. All the 16 signals transmit at frequency spaced at 200 GHz apart. Multiplexer combines signals and feeds it to telescope for optical wireless transmission. In simulation, the optical wireless communication channel is located amid an optical transmitter and optical receiver with optical antennae at both end. The optical wireless channel characterized by following mathematical equation. The optical power at reception is given by

$$P_R = P_T \, \eta_T \, \eta_R \left(\frac{\lambda}{4\pi \cdot Z} \right) G_T \, G_R \, L_T \, L_R$$

Where P_T is optical power transmitted by transmitter; η_R and η_T are the optics efficiency of the receiver and transmitter respectively; λ is the transmitted wavelength; Z is the distance of optical wireless link; G_T is the telescope gain of transmitter; G_R is the receiver telescope gain; and L_T, L_R are the pointing loss factor of transmitter and the receiver, respectively.

III. RESULTS AND DISCUSSION

In the system different modulation formats and modulation schemes have been evaluated on a 16 channel IsOWC link over wavelength spectrum. System architecture of 16 channels at 40 Gbps each is simulated for RZ, NRZ, CSRZ and DRZ modulation formats over different wavelengths. The modulation formats perform best and give maximum quality factor at 650 nm. As we move towards longer wavelength the Q factor keeps on decreasing. Performance is limited at wavelengths lower than 650 nm and remains decrementing as we budge towards L band. Although RZ and NRZ show slender fluctuations in quality as compared to DRZ and CSRZ but CSRZ gives highest Q factor at shorter wavelengths but for larger wavelength equipments it is suggested to use NRZ.

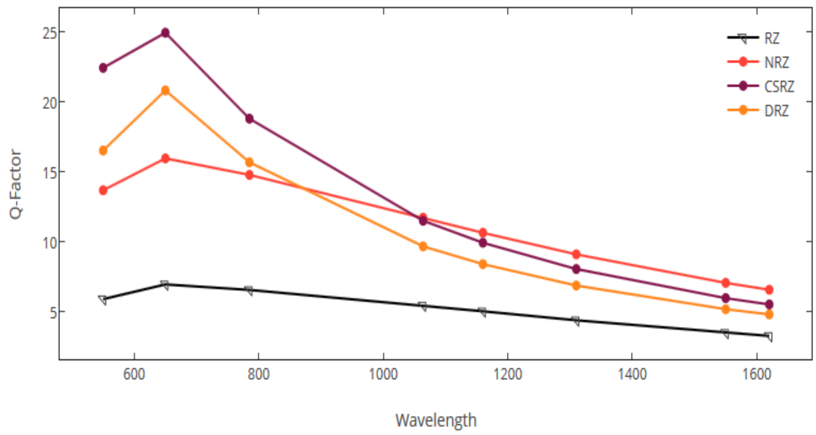
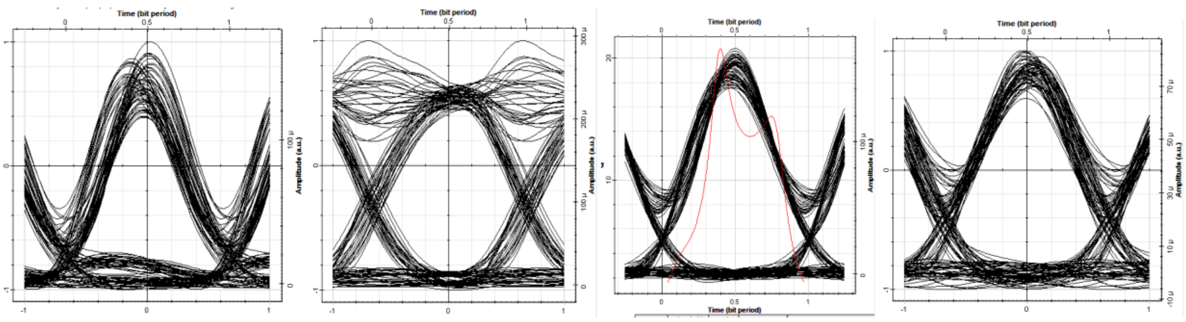


Figure 2- Q-Factor vs Wavelength for various modulation formats

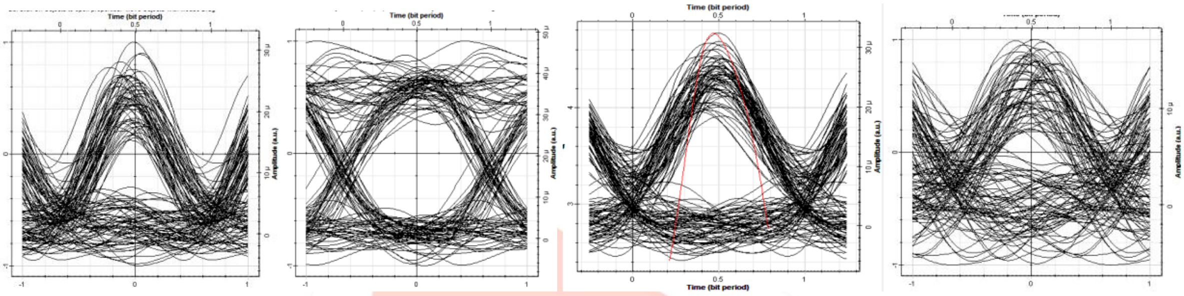
Figure.3. shows eye diagram for RZ, NRZ, CSRZ and DRZ at 650 nm .It has been observed that CSRZ performs best among the all modulation formats at 650nm.Aslo results carried out at 1550nm for same formats and evaluation revealed that system performance is better at lower wavelengths such as 650nm as compared to longer wavelengths as 1550nm.More eye opening has been seen in case of CSRZ and DRZ as and worst in case of RZ as depicted in Fig.3 and Fig.4.



(a) (b) (c) (d)

Figure 3-Evaluation of Eye diagrams at 650nm for (a) RZ (b)NRZ (c) CSRZ (d) DRZ

Figure 5 shows that CS-RZ is recommended over other techniques of line coding as while deciding power budget. The penalty by CSRZ is 7.46 dB while NRZ offers 7.54dB succeeded by RZ in some fluctuations over distance from 7.54 to 7.55 dB. While DRZ should be avoided where system is required to work in flexible user and power fluctuation limits because it gives a penalty of 7.69 dB.



(a) (b) (c) (d)

Figure 4-Evaluation of Eye diagrams at 1550nm for (a) RZ (b)NRZ (c) CSRZ (d) DRZ

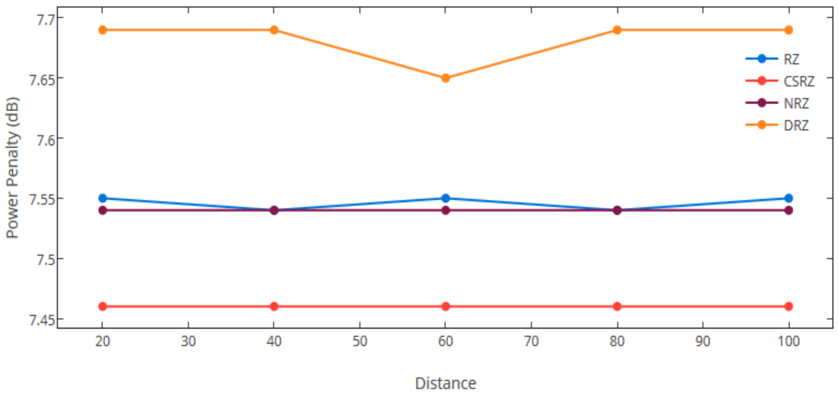
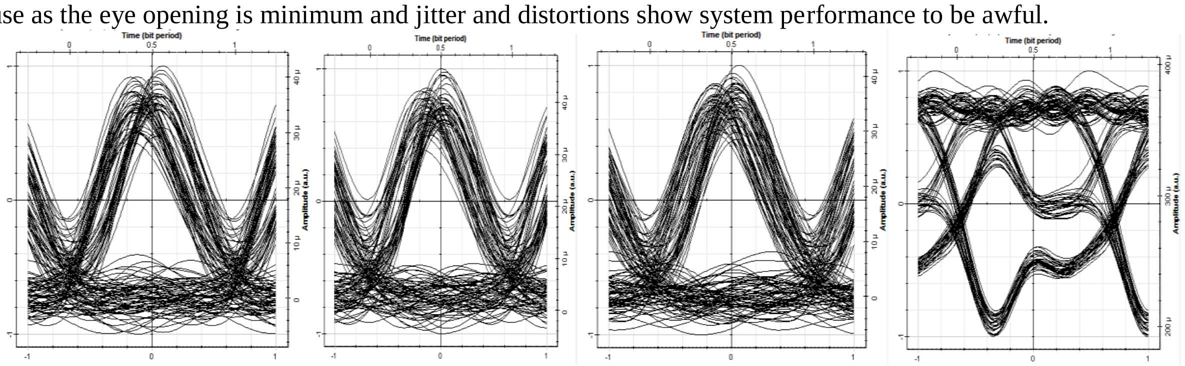


Figure 5- Distance vs Power penalty of various modulation formats

Further the results of use of different modulators has been investigated. The discussion is made on use of MZM, EAM, AM and PM. Figure.6. shows the eye diagrams of MZM, EAM, AM and PM for RZ line coding. From eye diagrams evaluation can be made on basis of eye opening, distortion and timing jitter. The received diagrams suggest that MZM prove to be best modulator offering maximum eye opening and minimum jitter. AM offers better results than EAM but PM cannot be considered as a good view for use as the eye opening is minimum and jitter and distortions show system performance to be awful.



(a) **(b)** **(c)** **(d)**

Figure.6- Eye Diagrams for (a) MZM (b) EAM (c) AM and (d) PM for RZ

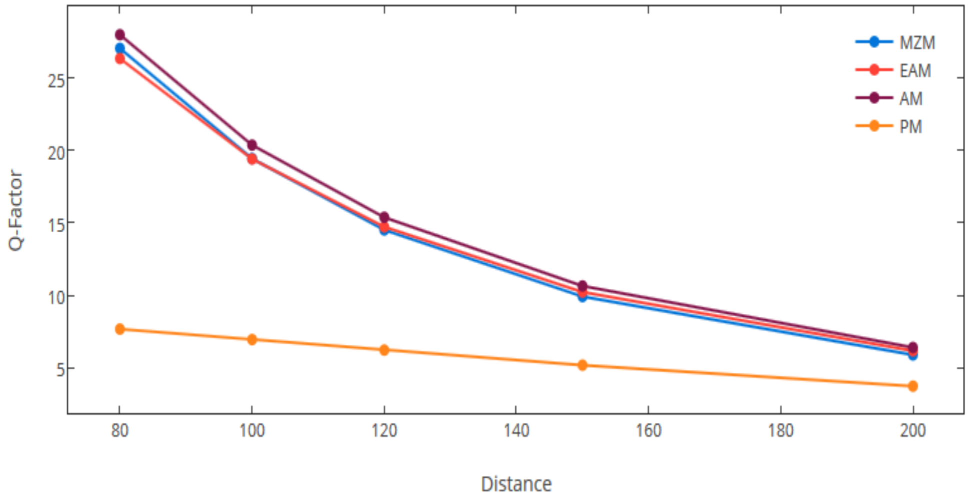


Figure.7- Performance of different modulators for NRZ

IV. CONCLUSION

The different modulation schemes of CSRZ, RZ, DRZ and NRZ are compared at 40Gbps system over different wavelengths. Out of these CSRZ has given better results at 650 nm as compared to 1550 nm. . It is verified from evaluation that optical wireless systems perform better at lower wavelength of 650 nm. For modulators such as MZM,EAM,PM and AM,best performance has been observed in case of amplitude modulator(AM). The plots validate that CSRZ offers minimum power penalty whereas maximum power is lost due to wavelength switching in case of DRZ. Amplitude modulation gives best results in terms of Q Factor and phase modulation is least acceptable. Although the eye opening reported in AM is greater than MZM but It is recommended to use MZM over AM due to greater values of extinction ratio. EAM and PM are reported to perform appalling.

REFERENCES

[1] E. Ciaramella, et.al "*1.28Terabit/s (32x40Gbit/s) WDM Transmission for free space optical communication*" IEEE, Journalof selected areas in communications, volume 27, no. 9, December (2009).

[2] Ke Wang, A .Nirmalathas, *et.al, "4 × 12.5Gbp/s WDM Optical Wireless Communication System for Indoor Applications*" IEEE, Journal of lightwave technology, vol. 29, no. 13, July 1,2011.

[3] A. H. Hashim, "*Modeling and performance study of inter-satellite optical wireless communication system"* International Conference on Photonics (ICP), IEEE, pp.1–4, (2010).

[4] B.Patnaik, P.K. sahu, "Inter-satellite optical wireless communication system design and simulation", IET, 2012.

[5] Borah, Deva K "*Pointing error effects on free-space optical communication links in the presence of atmospheric turbulence"*, Journal of Lightwave Technology, IEEE, Vol.27, No. 18, September 2009.

[6] Ciaramella, E. "*1.28 Terabit/s (32x40 Gbit/s) WDM Transmission for free space optical communication"*, Journal of Selected Areas in Communications, IEEE, vol. 27, No.9, December 2009.

[7] David W. Younga, Joseph.E.Saluja, et.al, *"Demonstration of high data rate wavelength division multiplexed transmission over a 150 km free space optical link*", IEEE.