Comparison of MDRZ, CSRZ and DRZ schemes using different Communiation Channels

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ABSTRACT
With the advancement in the technology, the needs of the users are also growing. The demand for higher bandwidth is one of these requirements. In order to fulfill this, Fiber Optic communication is developed. It transfers the data in the form of light waves and also achieves higher data transmission rate by facilitating the wider bandwidth for transmission. This mode of communication uses various encoding schemes such as NRZ and various communication channels to improve the quality of communication.

The implementation is done by using optisystem. The various encoding schemes are implemented with three different communication channels. It is observed that MDRZ outnumber rest of the encoding scheme with respect to the value of BER and Q. Factor.

Keywords
Fiber Optic Communication, FSO, OWC, MDRZ, CSRZ, DRZ

1. INTRODUCTION
Wireless communication is media to perform communication by using internet without following any physical structure or topology [1]. Wireless communication is possible by communication channels that transfers the data from one place to another i.e. source to destination. In wireless communication data travels in electric form [2].

After wireless communication, the technology shifted towards optical communication [3]. It is a form of wireless communication in which optical channels are used to accomplish the communication [4]. The fiber optic communication suffers from various issues like gigging, delays, and it is also considered as the most expensive due to high maintenance cost [5].

After fiber optic communication the concept of radio over fiber comes to the existence{6]. It is an advanced technology that can accomplish the process of communication over a long distance efficiently and reliably. It also suffers from issue of higher implementation cost[7].

Figure 1 depicts the structure of fiber optical communication. It is comprised of base stations, a fiber feeder network, and centralized office for service providers and micro cells[8].

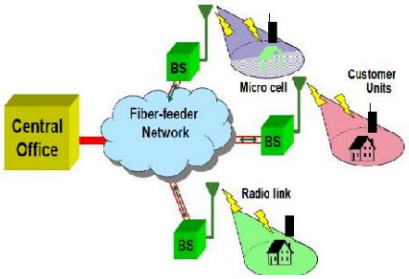

Figure 1 Architecture of RoF[2]

2. COMMUNICATION CHANNEL
This section describes the various communication channels used for fiber optic.

2.1 Single Mode Fiber (SMF)
SMF stands for single mode fiber communication channel. It also have the capability to propagate the optical signals which have the single mode and poses the core diameter of less than 50µm and the value of diameter corresponding to cladding is 70µm [9]. SMF is used channel for signal transmission but it is a communication channel which also suffers from high cost issues, therefore this problem makes its use less frequently [10]. This supports large spectral bandwidth of the carrier signals i.e. it can transfer large quantity of information in the single mode [11] carrier whereas the bandwidth of multi-mode fiber is lesser as compare to SMFs. It has the following features:

- In SMF, the voltage level is low.
- It is used for long haul communications.
- The cost of manufacturing SMF is higher compare to other mediums [12].
- Signals can be transferred by using single path.
- The width of central core is small.
- Supports higher bandwidth (1000MHz).

2.2 Optical Wireless Communication (OWC)
OWC uses near infrared frequency light for communication [13]. The OWC system still contains three central communication fragments which are the transmitter, the propagation channel and the receiver [14]. Figure 2 shows the basic illustration of the OWC system. OWC systems are not significantly diverse from free space optics and fiber optic communications, but the variance depends on the propagation medium[15]. The OWC channel is reflected to be a vacuum, which is estimated to be free of atmospheric attenuation factors [9]. Because of the moderate bandwidth [16], it provides high security, low price, less power consumption, and high rate. A wireless optical channel element, which is also a free-space optical element, can be applied for huge distances where atmospheric reduction is not the main penalty source, but directivity angle. For example, satellite communication [17] [18].

2.3 Free Space Optics (FSO)
Transmitting a visible or infrared beam modulated via the atmosphere to realize optical communication is called Free Space Optics communication [19]. The FSO shown in Figure 2 shows a typical free-space optical link, not via conductors such as wires and fibers, or some type of waveguide. Another important feature of the FSO is that it is meaningless by electromagnetic interference and radio frequency interference and plagues the wireless communication system severely [20]. The FSO system is used for disaster recovery applications and

temporary connection, and the cable network is in place. Free space optical communication is simply affected by atmospheric distortion. FSO is the most protected and becomes a high speed medium for data transmission [21] [22].

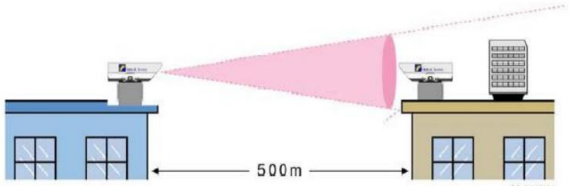

Figure 2 FSO Communication Links [1]

FSO is the most protected and becomes a high speed medium for data transmission [23]. Following are some advantages of FSO:

- FSO is based on bi-directional mode as well as full duplex mode of communication.
- It can carry data at Gb (gigabit) per second rate over a large distance.
- In this data is traveled in the form of infrared light spectrum. In some lower frequency section of electromagnetic spectrum is restricted to less than 300 GH. This limitation is assigned in standard IEC60825-1 by International Electro technical Commission [24].
- There is no need to deploy wired connection because the data travels in air.
- It is quite cost effective. Due to which it has persuasive economic advantages.
- It takes less time for deploying free space optics as compare to others. It may take few days and even faster if the gear could be located in building behind windows instead of rooftops.
- The advantage of FSO is that it is mandatory in case of FSO to take permission from municipal in order to settle the network at a place [24].

Following section depicts the limitations of FSO communication:

- Since FSO follows air as a medium of data transmission therefore the performance of the network fully relies on environment at the given period. In case if the environmental conditions are not good then this can lead degradation in data rate. Therefore it is mandatory to consider the environment of the particular place in mind while developing a model of FSO.
- The concept of line of sight is important in FSO. Therefore if any obstacle occurs between sender and receiver then in such cases it is impossible to employ the setup. Hence to shun these kind of obstacles it is preferred to employ the setup on the top of the large buildings [25].
- The range covered by is small as compare to optical fibers. Therefore it is most suitable for LAN or MAN. It should be avoided to use FSO in case of overseas situations.
- Because the human eye can attract the light energy therefore it can also get infected by the lasers or lights in which the data travels in FSO. This can be harmful for retina of human eye. Specifically 850nm is required to deploy cautiously which can only achieved by mounting laser beams on walls [25].

Following is the list of applications of FSO:

- It is applied for 'last-mile' Network solutions.
- Temporary network provision also utilizes FSO.
- It is wifdely used in various fields where CCTV appliations.
- It is also used to create a communication link between more than one building s which are located in same area such as in a university there are different blocks which are located at a far distance and are reached by roads.
- It is also used for wireless mobile networks.
- It is also used to fulfill the security purpose of miliatry [26].

In this study FSO, SMF and OWC communications channels are implemented to analyze the performance of optical communication system. The conventional optical communication system preferred to use NRZ encoding schemes whereas in this study NRZ is replaced by MDRZ, CSRZ and DRZ in order to achieve higher data transmission rate [27].

3. PROBLEM FORMULATION

Strong atmospheric instability (because of rain, fog, haze etc.) is a major problem in optical communication system. Transmitter consists of a Pseudo Random Bit Sequence (PRBS) generator at bit rate of 20Gbps to modulate the data with NRZ format in conventional techniques. But NRZ format used in these systems for modulation do not generate results accordingly. Moreover, NRZ systems are more susceptible to inter-channel nonlinear effects. Due to which, it is found that the signal can transmitted with better Q factor, least BER and high received power with proposing enhanced techniques in OWC system.

4. PROPOSED WORK

After studying the previous work that has been done in the field of optical communication it is discovered that the traditional research work had been done by implementing the analysis of various communication channel along with the implementation of NRZ coding. NRZ is a modulation technique which is an enhancement of RZ modulation coding scheme. NRZ modulation does not benefit from the introduction of a transmission optical filter. In order to provide high data rate with high speed, number of techniques have been proposed, but still no technique can perform accordingly. In propose work various optical channels like SMF, OWC and FSO will be considered for the analysis purpose in order to achieve high data transmission rate. Consequently, different modulation schemes like MDRZ, CSRZ and DRZ will be analyzed in order to replace traditional modulation technique NRZ etc. The motivation behind the proposed work is to get the efficient and capable results which offers better Q factor and low BER. Optical communication systems using different channels will also be examined to acquire the best channel which will be able to perform competently in terms of atmospheric turbulence.

5. RESUTS AND DISCUSSIONS

This section represents the results that are obtained after implementing the proposed work by using optisuystem10.the proposed work implements various communication channels such as fiber optic channel, FSO and OWC by using MDRZ, CSRZ and DRZ encoding schemes.

The image below depicts the Simulink model for CSRZ encoding scheme.

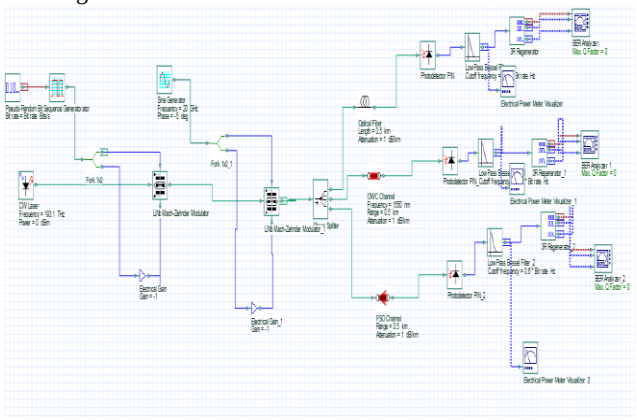

Figure 3 Simulink model for CSRZ

It is depicted in the figure above that the simulink model for CSRZ comprised of 0 dBm of input power, three communication channels i.e. fiber optic, FSO and OWC. Similarly the figures below depict the simulink model corresponding to DRZ and MDRZ encoding schemes.

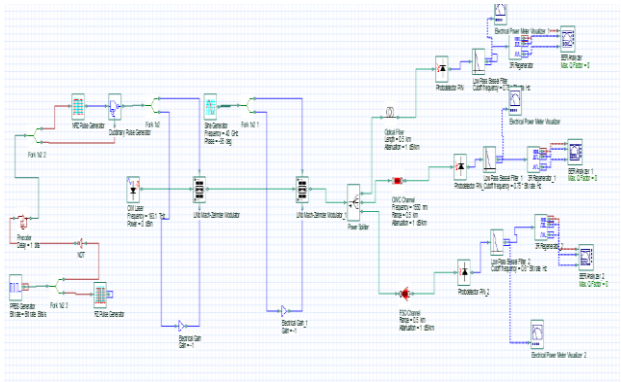

Figure4 Simulink Model for DRZ encoding scheme

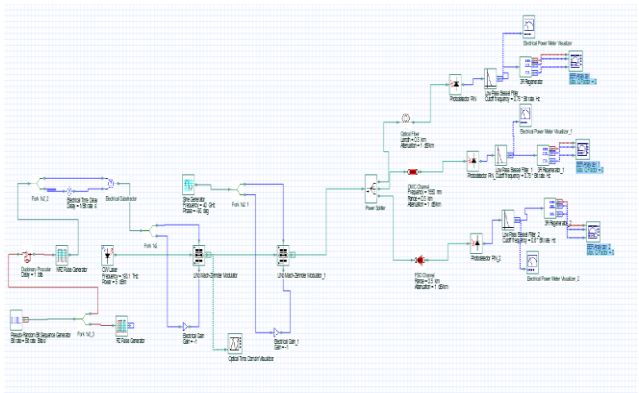

Figure5 Simulink Model for MDRZ encoding scheme

The table 1, 2 and 3 below depicts the values of output signal, Quality Factor and BER in case of CSRZ encoding scheme corresponding to Fiber optic communication channel, OWC communication channel and FSO communication channel.

Table 1: Parameters of CSRZ by using Fiber Optic, OWC and FSO

Communication Channel	Input Power(dBm)	Output Power (dBm)	Q. Factor	BER
Fiber Optic	0	-47.182	48.53	0
OWC	0	-48.794	37.61	5.425
FSO	0	-50.173	41.12	0

Table 2: Parameters of DRZ by using Fiber Optic, OWC and FSO

Communication Channel	Input Power(dBm)	Output Power (dBm)	Q. Factor	BER
Fiber Optic	0	-49.093	42.555	0
OWC	0	-50.638	38.75	0
FSO	0	-52.186	27.44	4.120

Table 3: Parameters of MDRZ by using Fiber Optic, OWC and FSO

Communication Channel	Input Power(dBm)	Output Power (dBm)	Q. Factor	BER
Fiber Optic	0	-43.469	56.597	0
OWC	0	-44.875	51.970	0
FSO	0	-46.142	51.541	0

The figure6 below depicts the eye diagram of MDRZ in case of fiber optic communication channel. The eye diagram is corresponding to BER depicts that the value of BER in this case is 0. The maximum Q Factor is observed to 56.5978 and eye height is 0.000312.

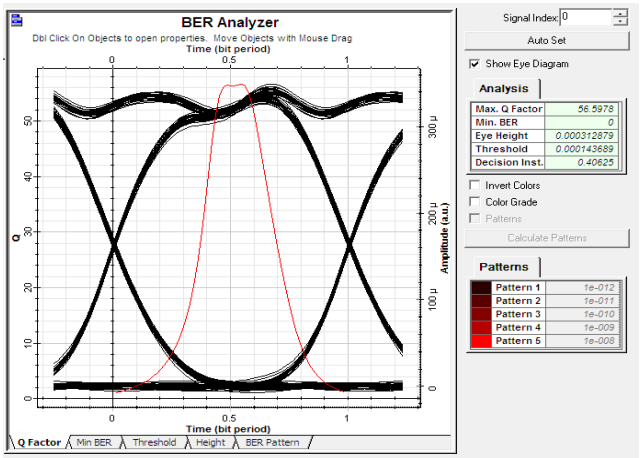

Figure 6 Eye Diagram for MDRZ using Fiber Optic Communication Channel

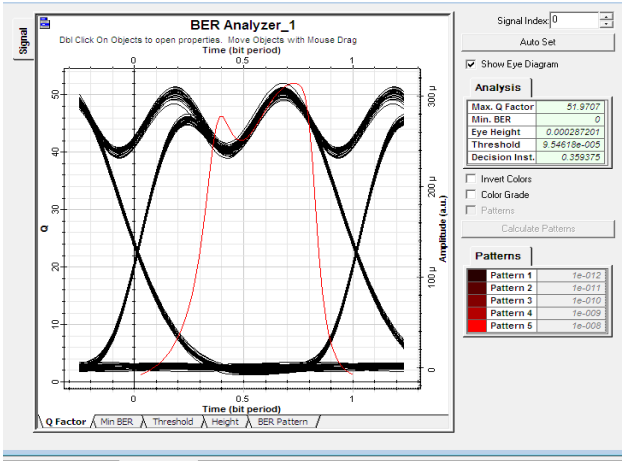

Figure 7 Eye Diagram for MDRZ using OWC Communication Channel

The figure 7 above depicts the eye diagram of MDRZ in case of OWC channel. The eye diagram plots the values of BER that is evaluated to 0. The maximum Q Factor is 51.970 and eye height is 0.000287.

The eye diagram in figure 8 shows the value of BER in case of MDRZ corresponding to FSO communication channel. The value of BR is 0, Quality Factor is 51.541 and eye height is measured to 0.000237.

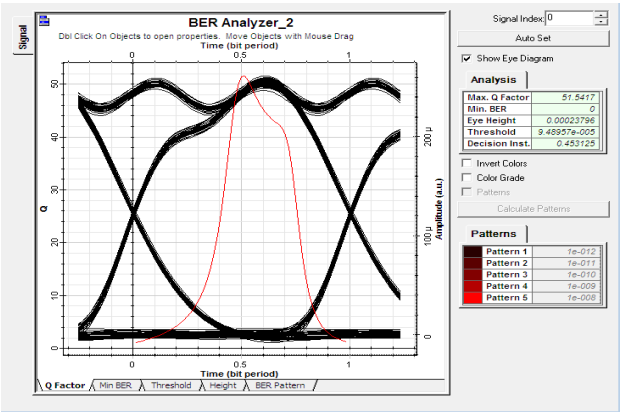

Figure 8 Eye Diagram for MDRZ using FSO Communication Channel

On the basis of above results it is concluded that the MDRZ has best results as compare to DRZ and CSRZ encoding methods. Since the value of BER in this case is 0 and it also poses the high value of quality factor in case of all communication channels.

6. CONCLUSION

Fiber optic communication is widely used medium of communication. It has various advantages over other mediums like it supports higher data transmission at wider range of bandwidth. This study is conducted to analyze the performance of various encoding schemes with fiber optic communication channel, FSO communication channel and OWC communication channel. On the basis of results that are driven in the form of Q. Factor and BER it is concluded that the MDRZ is outperformed CSRZ and DRZ in case of all above defined communication channels.

In future further enhancements can be done to increase the efficiency of communication system by using advanced encoding schemes.

7. REFERENCES

[1] Usha et al, "A Review Paper on Robust Model Design for FSO Communication System for Analysing Of Different Parameters", International journal of advance research ,ideas and innovations in technology, vol 3, issue 2, Pp 868-872, 2017

[2] Malti et al., "Comparison of CSRZ, DRZ and MDRZ Modulation Formats for High Bit Rate WDM-PON System using AWG", International Journal of Emerging Technology and Advanced Engineering, vol. 2, no.6, June 2012.

[3] Jyoti Choudhary et al., "Comparative analysis of DWDM system using different modulation and dispersion compensation techniques at different bit rates", International Journal of Advanced Research in Computer and Communication Engineering, vol. 3, no. 5, May 2014.

[4] Heena Goyal et al., "Performance Analysis of Optical Communication System using Different Channels", International Journal of Advanced Research in Computer and Communication Engineering, vol. 4, no. 9, September 2015.

[5] Ali Hussein Radhi, "Performance Analysis of Radio over Fiber System with Ook Based Dwdm for Fiber to Home Network", IEEE, Volume 8, Issue 5, PP 26-29,2013

[6] Anisha A.P(2015), "Full Duplex Transmission in RoF System using WDM and OADM Technology" IJERT, vol 4(1),Pp 1-5

[7] A. J. Cooper, "Fiber/Radio for the provision of cordless/mobile telephony services in the access," Electronic Letter, vol. 26, pp. 2054–2056, Nov 1990

[8] Osama A(2013), "High Transmission Capacity Performance of Radio Over Fiber System for Short and Long Distances " , IJSETR Vol 2(12) , Pp 2099- 2106

[9] Shuvodip Das(2014), " Modeling and Performance Analysis of RoF System for Home Area Network with Different Line Coding Schemes Using Optisystem", IJMSE, vol. 5(6) ,Pp 1-8

[10] Virendrakumar, (2014), "Design and Performance Analysis of Optical Transmission System", IOSRJEN, Vol. 04(5) ,PP 22-26,

[11] Abd El–Naser A. Mohame(2011), " Transmission Characteristics of Radio over Fiber (ROF) Millimeter Wave Systems in Local Area Optical Communication Networks", Int. J. Advanced Networking and Applications, Volume: 02, Issue: 06, Pp 876-886

[12] M. Baskaran et al, "A novel approach for simulataneou7s millimeter wave generation and high bit rate data transmission for radio over fiber system", ELSEVIER, vol 125, Issue 21, Pp 6347, 6351, 2016

[13] Sreenesh Shashidharan (2015), "Design and Simulation of Radio Over Fiber System and its Performance Analysis using RZ coding" ICEE, (EESCO) Communication and Optimization

[14] R. Holzlohner et al. (2002), "Accurate calculation of eye diagrams and bit error rates in optical transmission systems using linearization" Journal of Lightwave Technology(JET) vol. 20(3), Pp 389-400.

[15] Tao yang et al, "A novel radio-over-fiber system with dual millimeter wave signals generated simultaneously", ELSEVIER, vol 127, Issue 16, Pp 6532-6540, 2016

[16] F.R.Gfeller et al. (2005), "Wireless in-house data communication via diffuse infrared radiation" IEEE, Vol. 67, No. 11, Pp. 1474-1486.

[17] A. Lowery et al. (2002), "Multiple signal representation simulation of photonic devices, systems and networks", IEEE Vol.6, No. 2, Pp 282-296.

[18] Tae-Sik Cho et al. (2006), "Effect of Third-Order Intermodulation on Radio-Over-Fiber Systems by a Dual-Electrode Mach-Zehnder Modulator With ODSB and OSSB Signals", journal of lightwave technology Vol. 24, No. 5, Pp. 2052.

[19] S. Appathurai et al. (2005)"Nonlinearity and in-line residual dispersion tolerance of π-AP-RZ and CS-RZ modulation formats in 40-Gb/s transmission over standard single-mode fiber" IEEE photonics technology letters Vol. 17, No. 11, Pp. 2457-2459.

[20] Vikas kumar Pandey et al. (2014),"Radio-Over-Fiber (ROF) Technology With WDM PON System" IJISR Vol. 7, No. 2, Pp. 78-84.

[21] Thu A. Pham et al (2017), "High Capacity Mixed fiber wireless backhaul network using MMW radio over MCF and MIMO", ELSEVIER, Optics Communication, vol 400, Pp 43-49

[22] Nikos Pierson et al (2009), "A 60 GHz Radio-Over-Fiber Network Architecture for Seamless Communication With High Mobility", IEEE, vol 27, Issue 12, Pp 1957-1967

[23] David Wake et al. (2010), "Radio Over Fiber Link Design for Next Generation Wireless Systems", Journal of lightwave technology Vol. 28, No. 16, Pp. 2456-2464.

[24] T. Niiho et al. (2006), "Transmission performance of multichannel wireless LAN system based on radio-over-fiber techniques", IEEE Transactions on Microwave Theory and Techniques Vol. 54, No. 2, Pp. 980-989.

[25] Michael Sauer et al. (2007), "Radio Over Fiber for Picocellular Network Architectures", journal of lightwave technology Vol. 25, No. 11, Pp. 3301-3320.

[26] Harpreet kaur(2013), "Comparison of NRZ and RZ data modulation formats in SAC-OCDMA system under introduced clock timing jitter of laser diode", IJARCE, Vol. 2(8), Pp 2942 – 2949

[27] Vaishali Kulkarni (2011), "A Multilevel NRZ line coding Technique", ICTSM, Pp 1-6.

[28] Sushank Chaudhary, Priyanka Chauhan, Abhishek Sharma, "High Speed 4× 2.5 Gbps-5 GHz AMI-WDM-RoF Transmission System for WLANs", Journal of Optical Communications, Published Online: 2017-07-18 | DOI: https://doi.org/10.1515/joc-2017-0082

[29] Sushank Chaudhary, Deepika Thakur, Abhishek Sharma, "10 Gbps-60 GHz RoF Transmission System for 5 G Applications", Journal of Optical Communications, Published Online: 2017-07-22 | DOI: https://doi.org/10.1515/joc-2017-0079

[30] Rudrakshi Kapoor, Abhishek Sharma, Sushank Chaudhary, "Empirical Evaluation of 4 QAM and 4 PSK in OFDM-based Inter-Satellite Communication System", Journal of Optical Communications, Published Online: 2017-06-29 | DOI: https://doi.org/10.1515/joc-2017-0059

[31] Abhishek Sharma, Neha Chaudhary, Sushank Chaudhary, "6 × 20 Gbps Hybrid WDM–PI Inter-satellite System under the Influence of Transmitting Pointing Errors", Journal of Optical Communications, Published Online: 2016-05-27 | DOI: https://doi.org/10.1515/joc-2015-0099

[32] Abhishek Sharma, Neetu, "ANALYSIS AND MITIGATION OF RECEIVER POINTING ERROR ANGLE ON INTER-SATELLITE COMMUNICATION" International Journal of Innovative Technology and Research, Volume 3, Issue 6, Pages 2540-2544, Nov 2015

[33] Sushank Chaudhary, Abhishek Sharma, Neetu, "6 x 20Gbps Long Reach WDM-PI based High Altitude Platform Inter-Satellite Communication System" International Journal of Computer Applications, Volume 122, Issue 22, Pages 41-45, July 2015

[34] Savita Rana Abhishek Sharma, "Comprehensive study of Radio over Fiber with different Modulation Techniques – A Review", International Journal of Computer Applications, Volume 170, Issue 4, Pages 22-25, Aug 2017

[35] Abhishek Sharma, Deepika Thakur, "A Review on WLANs with Radio-Over-Fiber Technology", International Journal of Electronics and Communication Engineering (IJECE), Volume 6, Issue 5, Pages 1-6, Aug 2017.