

Performance Analysis Of Intersatellite Optical Wireless Link Using Multiple TX/RX And CO-OFDM Techniques

Sona G Dev, Sunu Ann Thomas

Abstract- FSO Communication is the three dimension global communication system with high bandwidth access. Intersatellite communication can be considered as one of the major robust technology of FSO communication. Investigation of various parameters related to intersatellite OWC can be virtually done by using optisystem software. The performance of the system can also be studied. This paper analyzed the performance of multiple transmitter/receiver OWC system and CO-OFDM OWC system.

Index Terms-CO-OFDM, Intersatellite link, optisystem 12.0, OWC, Q factor

1 INTRODUCTION

Optical wireless communication is one of the new technologies in optical field which makes it enable to get wireless communication of high data rate. This provides an important method for the communication between satellites orbiting around the earth. The man made satellites have been developed for the research and communication purpose which provide much benefits to the mankind. The satellites are revolving around the earth in different orbits such as, low earth orbit (LEO), medium earth orbit (MEO), highly elliptical orbit (HEO), and geosynchronous orbit (GEO). A communication link that connects two separate satellites directly is termed as an intersatellite link. There may be multiple links generating from the same satellite. Intersatellite link is essential for the communication between different satellites into same orbit or even in different orbits.

In this paper, the communication between two LEO satellites are considered as it suffers more propagation delay and propagation loss. The LEO satellites are orbiting at a height of 600 -1600 KM. In certain satellites mission more than one satellite are required; for example global tracking system satellites and iridium satellites.

- Sona G Dev is currently pursuing masters degree program in communication engineering in MG university, India, -mail: sonagdev@gmail.com
- Sunu Ann Thomas is currently working as assistant professor in MG university, India, E-mail: sunu.thomas@mangalam.in

The fastest and efficient method to connect two satellites for such purposes is by optical link. Recent needs required high speed and thus optical wireless communication becomes more popular. Optical wireless

communication is a large capacity and high speed technique which use lasers as the carrier signal. Using lasers instead of RF provides narrower beam width. So many other advantages such as reducing the size of antenna, reducing the weight of the satellites, minimizing the power are obtained. This work utilizes the advantages of multiple TX/RX, i.e., using multiple laser beams instead of one. Various parameters are measured and compared to obtain a beneficial result. CO-OFDM have provided high data rate and high capacity in the optical communication. The intersatellite CO-OFDM system is also analyzed for better performance result.

2 MIMO AND CO-OFDM TECHNIQUES

2.1 MIMO System: Spatial Diversity

Diversity technique using multiple antennas at the transmitter and receiver is termed as spatial diversity. It is schematically represented in the figure 1. With every pair of antennas added to the system, the throughput will be linearly increased. The spatial dimension of the wireless channel is utilized by multiple antennas. To provide reliability by simultaneously transmitting the same signal through the new degrees of freedom provided by spatial dimension. Multiple beams from the transmitters are sent through different paths and received by the receivers.

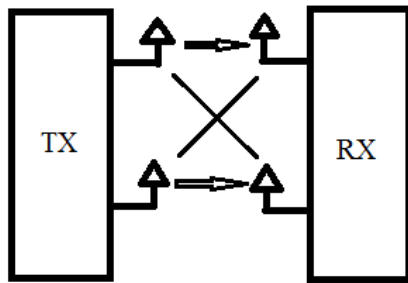


Fig.1 Spatial Diversity

2.2 CO-OFDM

In CO-OFDM, OFDM data is modulated to light frequency and then detection is done in coherent manner. Even though OFDM is standardized for a long time, the CO-OFDM is relatively a new concept which is proposed around 2008. CO-OFDM combines two powerful techniques; coherent detection and OFDM, which delivers high electrical and optical spectral efficiency, receiver sensitivity and optical dispersion resilience. The schematic representation of CO-OFDM is shown in fig. 2.

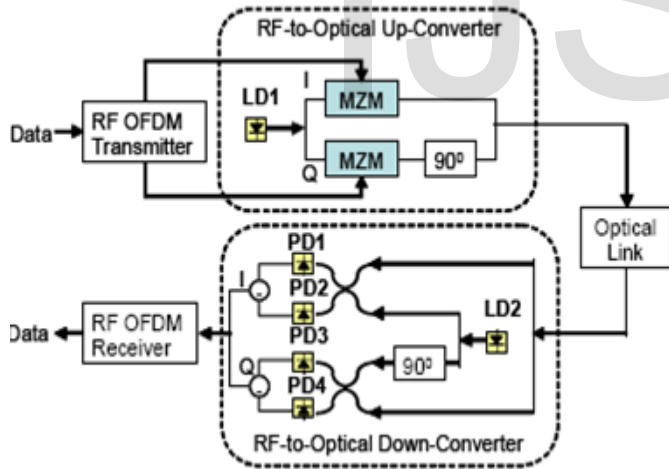


Fig.2. CO-OFDM system

3 DESIGN AND SIMULATION

3.1 Communication Link System Design

Design of intersatellite circuit is done using optisystem 12.0 software which has three major parts; transmitter, receiver and communication channel. Fig.3 shows the optisystem simulation setup. The starting component at the transmitting side is a pseudo-random bit sequence generator which provides information that is to

be transmitted. A corresponding non return to zero coded signal is generated using a NRZ pulse generator. At transmitter, the electrical signal is converted to optical form. Mach-zehnder modulators are used for this purpose.

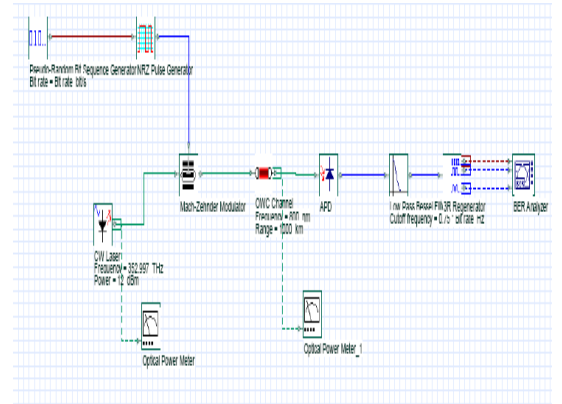


Fig.3. Simple Intersatellite link

A photodiode detect the receiving light beam at the receiver side and converts it into electrical form. Avalanche photodiode is used for this purpose in larger distance application. Bessel filter is used for limiting the bandwidth. 3R generator is used for obtaining regenerative electrical output from original bit sequence. The input for eye diagram is fed from 3R generator.

3.2 Simulation Of 8 Tx/Rx Intersatellite Owc Model

Figure 4 shows the combination of multiple TX/RX which is used in intersatellite OWC model.

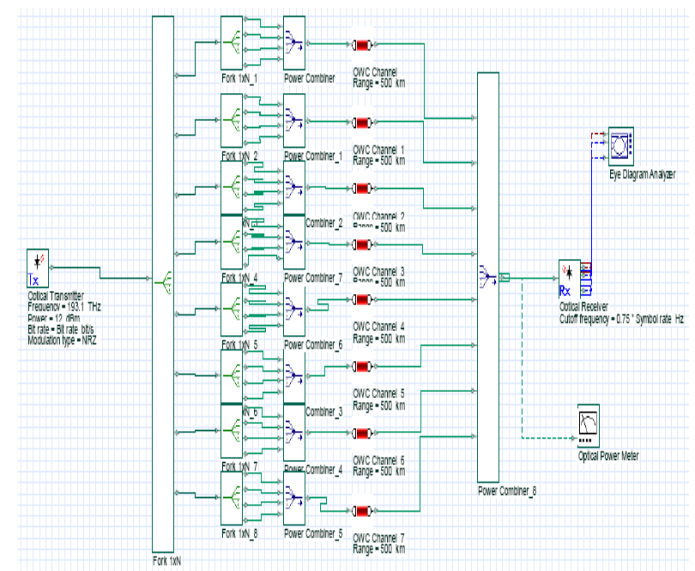


Fig.4 Simulation Layout of 8 TX/8 RX Intersatellite OWC system

The eye diagram analyzer gives the value of maximum Q-factor, minimum BER, eye high threshold.

3.3 SIMULATION OF CO-OFDM OWC SYSTEM

There are two major section in the transmitter side. The first section generates OFDM signal in RF Form and the second section converts the RF signal to optical signal using mach-zehnder modulator. At the receiver the signal received is demodulated using OFDM demodulator and the resulting signal is passed through a 4-QAM sequence decoder to get the original bits. Figure 5 shows the CO-OFDM layout in optisystem.

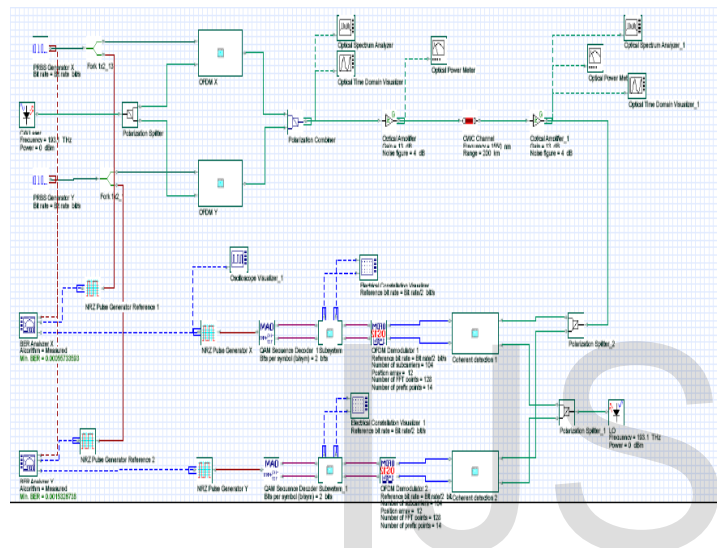


Fig.5. Simulation Layout of CO-OFDM intersatellite OWC system

4 SIMULATION RESULTS AND DISCUSSIONS

4.1 MIMO System

In this work the effect of various parameters such as distance, wavelength, bit rate and transmitted power are analyzed. Also the effect of increasing number of transmitters and receivers are also analyzed. Fig. 6 shows the eye diagram of 8 MIMO systems.

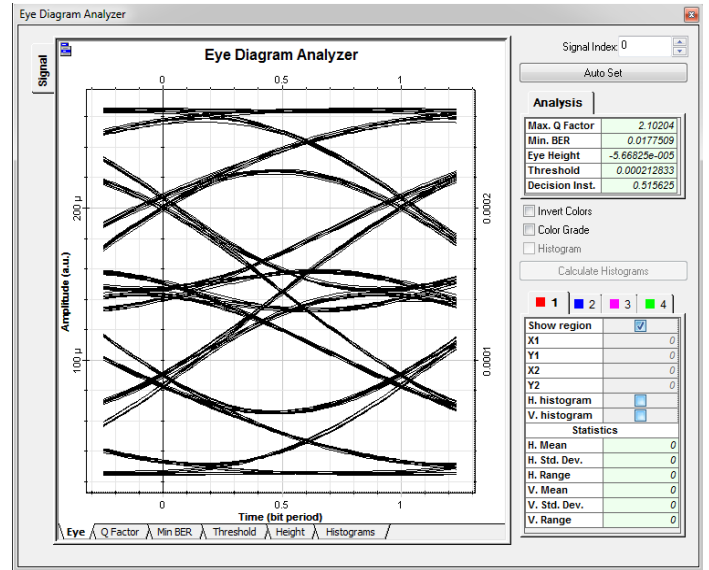


Fig.6 Eye diagram of 8RX/8TX intersatellite OWC link

Fig. 7 and fig. 8 shows the impact of wavelength on Q factor and Received power.

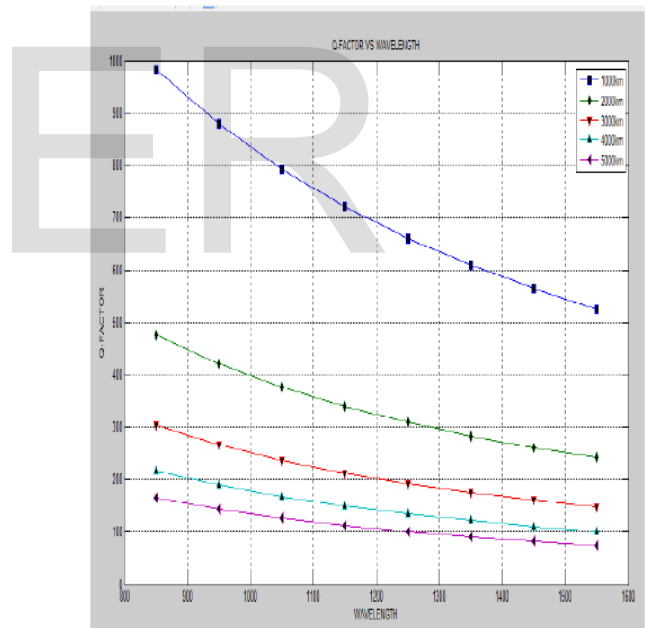


Fig.7. Q factor vs wavelength at different distances

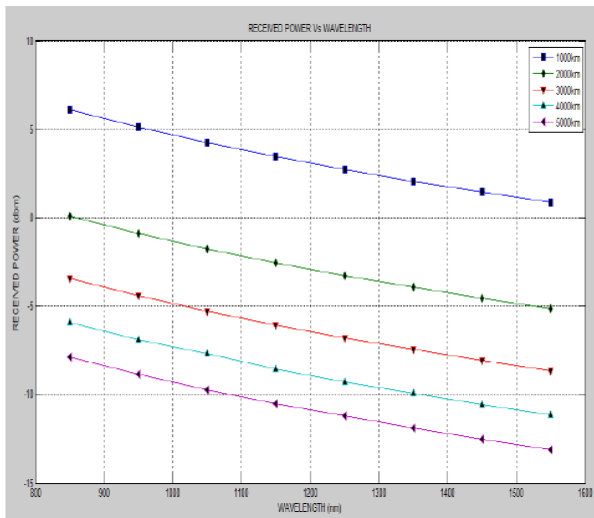


Fig.8. Received power vs wavelength at different distances

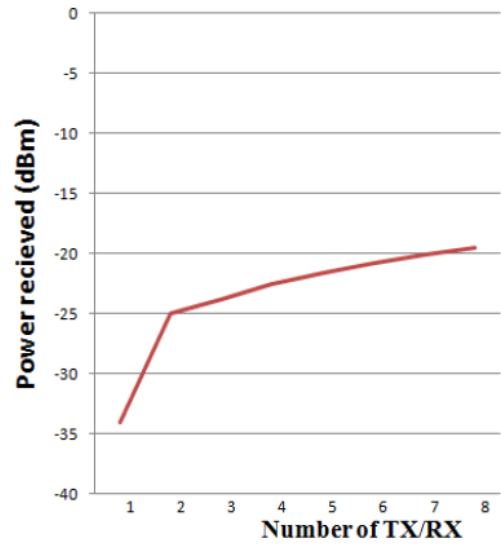


Fig.10. power received vs number of TX/RX

Fig. 9 shows the impact of distance on Q factor

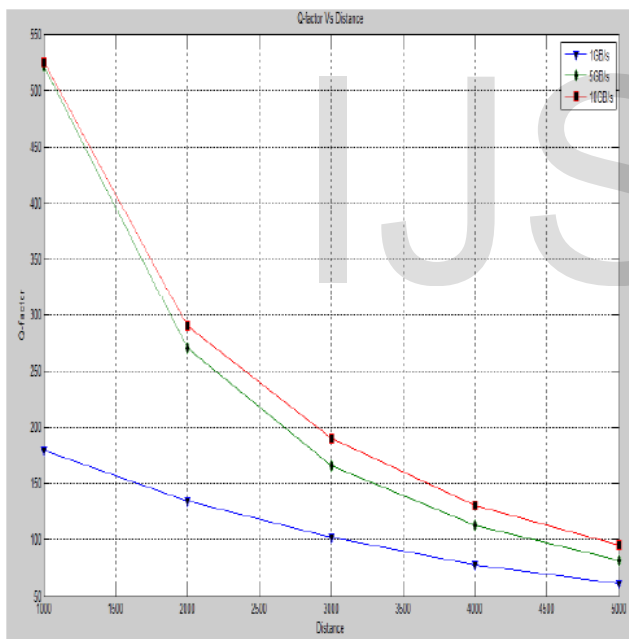


Fig.9. Q factor vs distance at different data rate.

Q factor increases as bit rate increases. Figure 10 shows the effect of increasing transmitters and receivers on received power

4.2 CO-OFDM System

Fig.11 shows the eye diagram of CO-OFDM intersatellite OWC link.

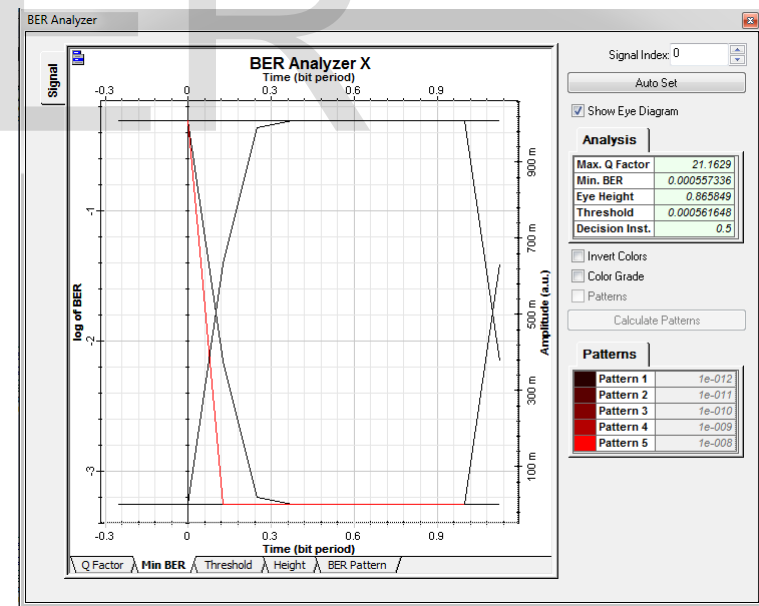


Fig.11. Eye Diagram of CO-OFDM OWC link

Fig.12 shows the of transmission distance on BER

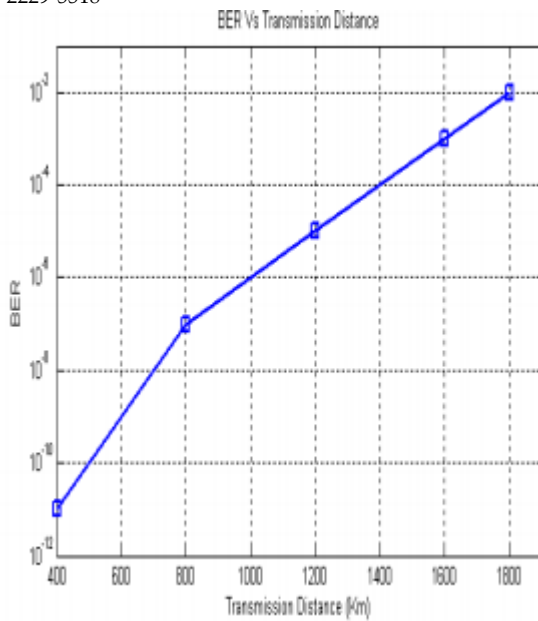


Fig.12.BER vs Distance

CONCLUSION

Satellites are used for so many purpose and its applications increases day by day. Here some modifications are providing by using multiple TX/RX system and CO-OFDM system. The main conclusions are that the performance of intersatellite communication for lower bit rate is better for particular optimum distance range. The sensitivity of the receiver can be increased by using the different optimum data rates. Also the requirements of power for multiple channels are lower so that the effect of laser power can be reduced.

REFERENCE

- [1].Jamalipour, A. *Low Earth Orbital Satellites for Personal Communication Networks*. UK: Artech House Publisher. 1999.
- [2].Sodnik, Z., Furch, B. and Lutz, H. Free-Space Laser Communication Activities in Europe: SILEX and beyond. *19th Annual Meeting of the IEEE*, 2006.
- [3] Shlomi Arnon, "Optimization of Urban Optical Wireless Communication systems", *ieee transactions on wireless communications*, vol. 2, no. 4, july 2003.
- [4] L. Kaplan, "Optimization of Satellite Laser Communication Subject to Log-Square-Hoyt Fading", *ieee transactions on aerospace and electronic systems* vol. 47, no. 4 october 2011
- [5] s.arnon, s. rotman, n.s. kopeika, "Optimum Transmitter Optics Aperturefor Satellite Optical Communication", *ieee transactions on aerospace and electronic systems* vol. 34, no. 2 april 1998.

[6] A.W. Naji, Wajdi Al-Khateeb, "Performance Analysis Of a Free Space Optical Link With Multiple Transmitter/Receiver" 2012 Ieee International conference on Space Science and Communication (IconSpace) 2012, Penang, Malaysia.

[7]Inter-Satellite Communication Considerations And Requirement For Distributed Spacecraft And Formation Flying Systems Carl F. Kwadrat", William D. Horne", Bernard L. Edwards**