Performance of Inter satellite Optical Communication Using Discrete Modulation Formats

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ABSTRACT

Optical networks are efficient in bandwidth which are very useful for wide area communication which is used to provide an efficient data transfer. In order to provide high speed data transmission between different satellites inter satellite optical wireless communication (ISOWC) is used. In this paper we performed in depth analysis of free space optical networks and evaluated the performance of ISOWC to provide high speed data transmission using different modulation formats.

Keywords:— *ISOWC, Free Space Optical communication, RZ, NRZ, CSRZ, DRZ, MDRZ, Q factor*

I. INTRODUCTION

Optical communication is playing an important role in backbone networks for long haul communication. As the multimedia applications are increasing day by day that require high speed data transfer from sender to receiver. This ever increasing traffic demand is being accommodated using several advancements in optical network technologies. The dwdm system [1][2], the improved ROF optical communication networks [3][4][5]and the evolving field of EONS [6][7] are being used to accommodate huge heterogeneous

traffic in existing networks. The ISOWC is used for point to point communication at a high data rate. With the increasing demand of real time digital multimedia services, the demand for efficient and economical communication networks that provides high speed wired and wireless access in indoor and outdoor environments [8]. The ISOWC supports high data rate capability, unregulated bandwidth, low power, high efficiency, lesser antenna sizes and low cost but it also have several disadvantages includes the tracking problem and misalignment of transmitter and receiver apertures and the changes due to atmospheric conditions. The tracking problem causes various noise sources such as laser relative noise intensity, Johnson noise, dark current noise.

Vibration noise is the most degrading factor in ISOWC communication system. These noises cause errors in the system and made it more susceptible towards the pointing errors. the main aim is to reduce the power dissipation and to reduce the ber. this result in high transmitter power and lesser receiver noise to obtain desired signal. Optical Wireless Communications (OWC) is a form of optical communication in which unguided visible, Infrared (IR), or Ultraviolet (UV) light is used to carry a signal. OWC systems operating in the

visible band (390–750 nm) are commonly referred to as visible light communication (VLC). VLC systems take advantage of light emitting diodes (LEDS) which can be pulsed at very high speeds without noticeable effect on the lighting output and human eye.

VLC can be possibly used in a wide range of applications including wireless local area networks, wireless personal area networks and vehicular networks among others.[1] on the other hand, terrestrial point-to-point OWC systems, also known as the free space optical (FSO) systems,[2] operate at the near IR frequencies (750–1600 nm). These systems typically use laser transmitters and offer a cost-effective protocol-transparent link with high data rates, i.e., 10 gbit/s per wavelength, and provide a potential solution for the backhaul bottleneck. There has also been a growing interest on ultraviolet communication (UVC) as a result of recent progress in solid state optical sources/detectors operating within solar-blind UV spectrum (200–280 nm). in this so-called deep UV band, solar radiation is negligible at the ground level and this makes possible the design of photon-counting detectors with wide field-of-view receivers that increase the received energy with little additional background noise. Such designs are particularly useful for outdoor non-line-of-sight configurations to support low power short-range UVC such as in wireless sensor and ad-hoc networks.

The system include a laser beam modulated with data and is transmitted through free space with less attenuation in comparison of microwave and RF links as light travels faster in vacuum and can travel a long distance in thousands of kilometers with minimum bit error rate the system is creditable until the atmospheric disturbances are not present and effect of atmospheric turbulences is heterogeneous for different modulation formats the data

rate can be varied from 5gbps to20gbps with a tolerable quality factor. Transmission properties affected due to other parameters include transmission aperture diameter, receiver aperture diameter and power of the operating laser source. the system requires more power when operated at large distances. To avoid the tracking problems the satellites should be in line-of-sight links so that transmitter and receiver pointing angles must be precisely confirmed. signal reception can be intricate or impossible with a small deviation in beam angles.

II. ANALYSIS OF INTERSATELLITE OPTICAL COMMUNICATION

Free space optical communication provides a unique method for the satellites orbiting around the earth to communication with each other. inter-satellite optical wireless communication systems (ISOWC), one of the important applications of free space optical communication technology, will be deployed in space in the near future as such systems provide a high bandwidth, small size, light weight, low power and low cost alternative to present microwave satellite systems. in this paper, optical inter-satellite link (ISL) is modeled using optical system and then investigation is carried out to study the effect of varying the wavelength between two satellites estranged by a distance of 1300 km at data rate 3 gbps.

In our proposed system, the first subsystem is the transmitter part which consists of PRBS generator. It generates the data which is to be transmitted i.e. data source. The second subsystem represents the different modulation formats which get its output from the previous block. This subsystem encodes the data from PRBS output by (CSRZ, DRZ and DPSK) techniques. the third subsystem is DML i.e. directly modulate laser which operates on wavelength of 1552 nm because of low attenuation characteristics in optical

communication in this wavelength region. The free space between transmitter and receiver is considered as OWC channel which is the propagating medium for the transmitted optical signal. The optical receiver comprises of a photo detector followed by a low pass bessel filter. In this section of system, the optical signal is converted back into electrical signal.apd (avalanche photo-diode) is used because of its high gain property. The last subsystem is BER tester which gives the quality factor and BER measurement.
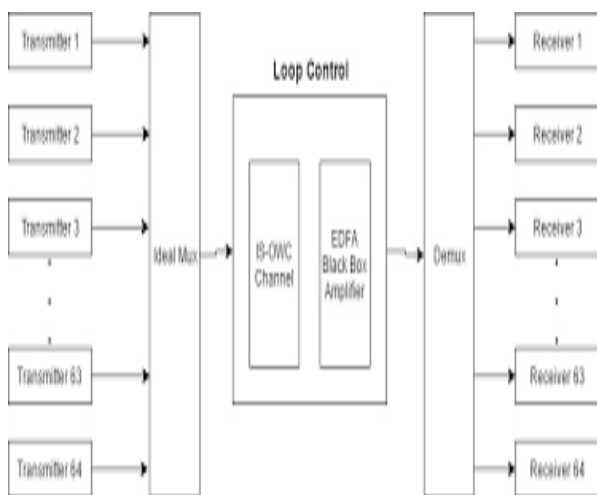

Figure 1 : Analysis of ISOWC

In order to analyze the performance of the inter-satellite link, BER and the quality factor are used as a key metric. This research presented the enhancement of the system performance with the help of advanced modulation techniques and several antennas. The author analyzed the optical link performance between the satellites by varying the parameters which affect the performance of the system. The results indicated that the proposed system could support the 10gbps of data rate and can employ the 4 x 4 transceiver system over the distance of 6000km. in this research, 40 gbps of higher data rate is accomplished in an inter-satellite optical wireless communication system with the help of QPSK modulation.

III. MODULATION FORMATS

The first step in the design of an optical communication systems is to decide how the electrical signal should be converted into an bit stream. There are two typical choices for the modulation format of the signal:

1. Return to Zero(RZ)

2. Non-return to Zero(NRZ)

Examples of modulation formats are shown in Figure 2:
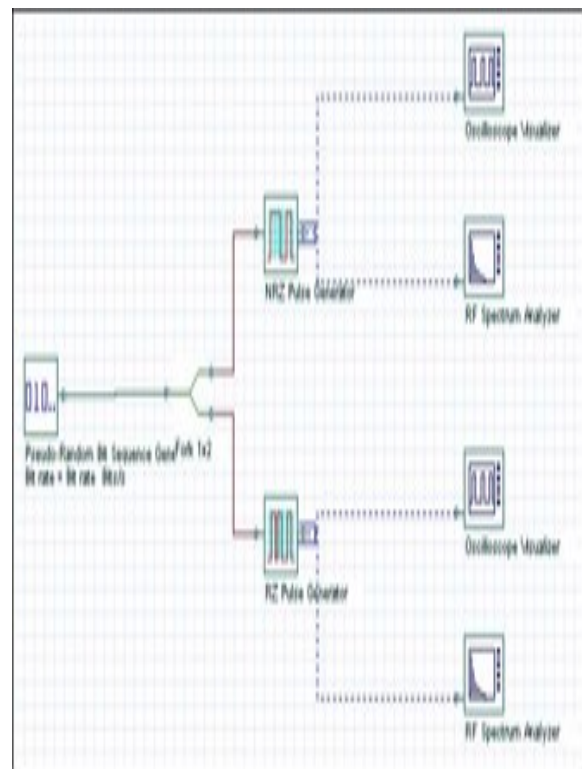

Figure 2 : Modulation formats

In the RZ formats, each pulse representing bit 1 is shorter than the bit slot, and its amplitude returns to zero before the bit duration is over (see figure 3). in the NRZ format, the pulse remains on throughout the bit slot and its amplitude does not drop to zero between two or more successive 1 bits (see figure 3). as a result, pulse width varies depending on the bit pattern, whereas it remains the same in the case of RZ format.
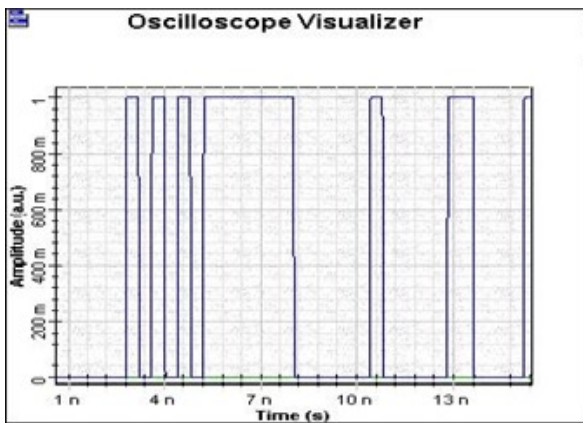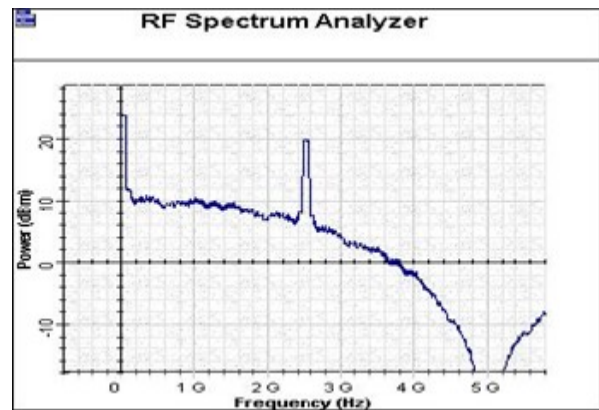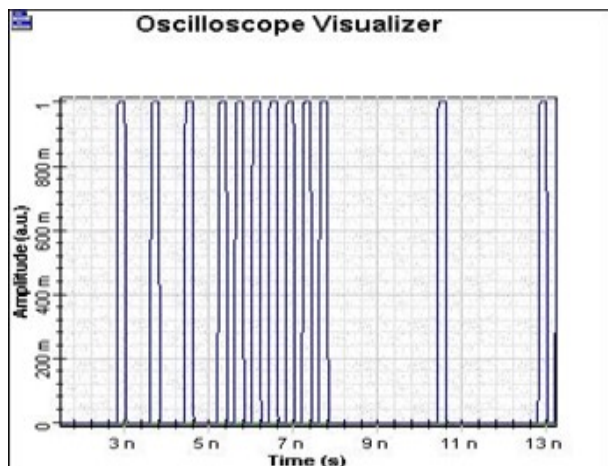
Figure 3: NRZ – time

Figure 4: RZ – time

An advantage of the NRZ format is that the bandwidth associated with the bit stream is smaller than that of the RZ format by about a factor of 2, because on-off transitions occur fewer times (see figure 5 and figure 6).
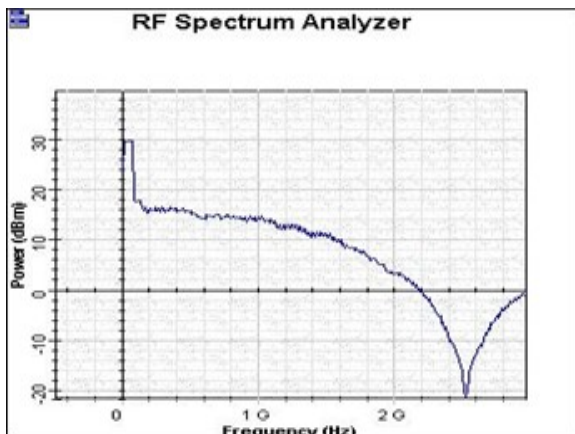

Figure 5 : NRZ – frequency

Figure 6 : RZ – frequency

IV. CONCLUSION

In this paper we have analyzed ISOWC for inter satellite communication which can provide communication at higher speed and up to a larger distance compared to ordinary RF links. The performance of Inter-satellite optical communications is efficiently measured and analyzed. We also measured the high speed data transmission in ISOWC using different modulation formats.

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