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A Review of Inter Satellite Optical Wireless Communication System and Its Application

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ABSTRACT

Inter-satellite Optical wireless communication (IsOWC) is a good alternative for very high data rate point to point communication. In this paper we have presented the brief introduction to intersatellite communication system and its application. We have also presented a brief survey related with intersatellite communication system.

Keywords: IsOWC (Inter-Satellite Optical Wireless Communication).

I. INTRODUCTION

Inter-satellite Optical wireless communication (IsOWC) is a good alternative for very high data rate point to point communication. With the increasing demand of high definition television and video conferencing, the demand for both high speed wired and wireless access is increasing continuously in indoor and outdoor environments [1]. Information was used to transfer using microwave and RF frequencies but they suffer from serious drawbacks like radiations make a way into walls and less data rate transfer due to losses [2]. Due to this reason the microwave and RF links are replaced by optical wireless technology.

The IsOWC technology has a lot of plus points 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 disadvantage 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 causes 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 [4].

IsOWC has eliminated the problems regarding connectivity and long range data transmission. 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 [5]. The system is creditable until the atmospheric disturbances are not present and effect of atmospheric turbulences is heterogeneous for different modulation formats [6]. 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. OPTICAL INTERSATELLITE SYSTEM

IsOWC system has been modelled and performance depiction by OptiSystem14.The IsOWC basic diagram is shown in fig 1.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.

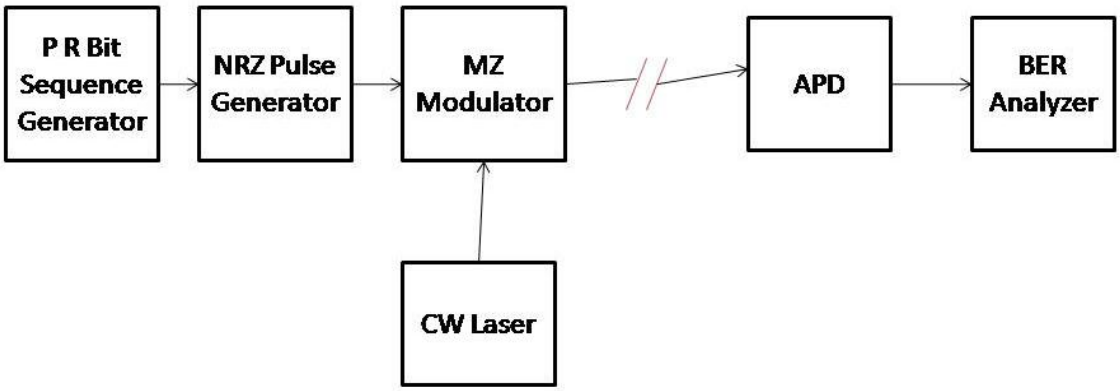

Figure 1 Basic Block diagram for IsOWC

The Intersatellite Optical Wireless Communication (IsOWC) system has various points of interest. To begin with, no licensing is required in terrestrial communication. Another point of interest is the invulnerability to the radio signal interference; on the other hand immersion has included the security highlights in this innovation. The point-to-point laser signal is too hard to capture. It is difficult to tap the IsOWC link. Ecological shrewd, FSO does not contaminate the earth with electromagnetic radiations since the wavelength of IsOWC is just from 850 nm to 1500 nm. The performance investigation will be as far as measured received power, eye pattern and BER.

III. FSO FOR INTER-SATELLITE COMMUNICATION

Despite of physical correspondence, FSO additionally has a huge part in space applications. In 1977, European Space Agency (ESA) began the project semiconductor laser Inter-satellite connection test (SILEX) to understand the analogy between satellites in space.[1] This program, which came to genuine operation since 2003, prompted result in making the ESA all around perceived in space bury satellite correspondence joins. The essential application of FSO as between satellite is appeared in the Fig. 1. SILEX is taking into account a blend of two optical correspondence payloads i.e. French Earth perception rocket. SPOT-4 furthermore, Advanced Relay and Technology Mission Satellite (ARTEMIS) which permits the information transmission of 50 Mbps by utilizing GaAlAs laser diodes [3]. The Intersatellite Optical Wireless Communication (IsOWC) system has various points of interest. To begin with, no licensing is required in terrestrial communication. Another point of interest is the invulnerability to the radio signal interference; on the other hand immersion has included the security highlights in this innovation. The point-to-point laser signal is too hard to capture. It is difficult to tap the IsOWC link. Ecological shrewd, FSO does not contaminate the earth with electromagnetic radiations since the wavelength of IsOWC is just from 850 nm to 1500 nm.

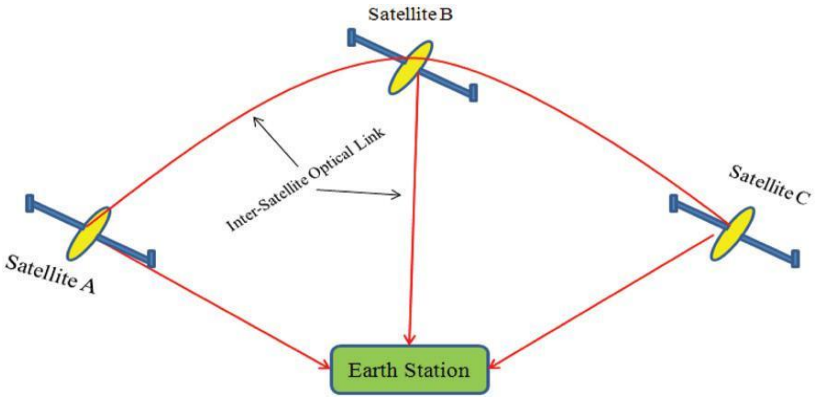

Figure 2: FSO as Inter-Satellite communication link

IV. LITERATURE REVIEW

Hamdy A. Sharshar, Eman Mohsen El-gammal- This paper has presented the complete analysis comparison study of optical intersatellite links for different both transmission bit rates and operating wavelengths. Quality factor and bit

error rates are the major interesting performance parameters in our comparison. It is observed that by decreasing wavelength, the quality factor increases and BER decreases at the same bit rate Quality factor is inversely proportional to BER and distance. When bit rate and distance increases, the quality factor decreases.

Heena Arora, Rakesh Goyal -In this paper, inter-satellite optical wireless communication (IsOWC) system is proposed, one of the imperative utilizations of free space optics/wireless space optics (FSO)/WSO innovation. IsOWC frameworks give a high bandwidth, small size, small weight, low power and minimal effort different option for present microwave satellite frameworks. Optical communications systems have evolved from lengthy fibers to powerful wireless system. This has hence resulted in the use of optical wireless communication system in space communications. As the quantity of satellites circling the Earth expands year by year, a system between the satellites gives a strategy to them to correspond with one another. This is vital for satellites to send data to each other furthermore to hand off the data starting with one satellite then onto the next satellite and after that to the ground stations. By utilizing laser satellite correspondence, the satellites can be joined with information rates up to a few Gbps. The system performance including bit rates, input power, wavelength and distance on an inter-satellite link was analyzed. Various issues such as bit rates, input power, wavelength and distance were presented in IsOWC.

Navjot Kaur, Gaurav Soni- Free space optical communication provides a very important method for the satellites orbiting around the earth to communicate with each other. Inter- satellite optical wireless communication systems (IsOWC) are one of the important applications of FSO/WSO technology that will be expand in space in the near future. These systems provide a high bandwidth, small size, light weight, low power and low cost to present microwave satellite systems. In this paper, optical intersatellite link (ISL) is modeled using optisystem software between two satellites separated by a distance of 1700 km at data rate 3 Gbps at varying modulation formats.

Prabhdeep Kaura, Amit Guptab, Mandeep Chaudhary-Integration of DWDM in Optical wireless communication has undoubtedly revolutionized the satellite communication systems for use in the coming future. Thus OWC systems have become popular due to their outstanding performance uniqueness. This paper looks into the performance of Inter Satellite Optical Wireless Communication system link using DWDM multiplexing technique for long distance transmission. The Inter satellite link has been modeled at a data rate of 10 Gbps for communication range of 5000 kilometers. Furthermore, it demonstrates a comparative analysis of RZ (Return to zero) and NRZ (Non-return to zero) modulation formats by varying the levels of input power

Prabhjot Kaur, Bhawna Utreja-In this article, different modulation formats CSRZ, DRZ, DPSK have been investigated in inter-satellite links on optical wireless communication system. It has been observed that DPSK performs better at long range than CSRZ, DRZ techniques while CSRZ and DRZ perform better for little range. Q-Factor has been used for the assessment of the techniques to give the simulation results. The results show that DPSK which has simple design and less cost performs best at a higher transmission range at the data rate of 40Gbps. DPSK system has been simulated at different power levels and Q-factor has been observed at these power levels. The increasing aperture diameters of both transmitters and receivers have shown significant improvement in the performance of DPSK system.

Asmaa Zaki M , Heba A. Fayed , Ahmed Abd El Aziz, Moustafa H. Aly -Space communication systems as employed in satellite to satellite links are traditionally performed using microwaves. Since, the future of satellite systems will permit more efficient and more reliable operation these (Inter Satellite Links) ISLs will be optical links. This paper proposes a link model between satellites in free space over Low Earth Orbit (LEO) in order to recognize maximum bit rate. The performance of such a link is affected by various parameters, as in depending on the propagating wavelength. Moreover, the maximum bit rate is calculated and analyzed employing Avalanche Photodiode (APD) and Non Return to Zero (NRZ) modulation at different wavelengths improving the quality of the system.

Roshni Joy, Ami Lavingia, Prof. Kruti Lavingia - The day to day development has advanced the optical communication system from long-lasting fibers to wireless system such as inter-satellite transmission system. This can be accomplished as the optical systems have resulted to be used in space communication as a medium between two satellites. The inter-satellite optical wireless communication link is designed and simulated for performance characterization. In this work we are using optical wireless channels (OWC) for inter-satellite communication and optimize the data exchange depending upon the performance parameters like Quality factor, Bit error rate and Received power. In IsOWC link parameters considered mainly are bit rates and input transmitted power.

ADVANTAGES OF INTER-SATELLITE OPTICAL WIRELESS COMMUNICATION LINK

Various advantages of the Intersatellite Optical Wireless Communication (IsOWC) are included licensing is not required in terrestrial communication, immunity to the radio signal interference, it is hard to capture point to point laser signal so IsOWC link is better option and electromagnetic radiations does not defile the earth atmosphere since the wavelength of IsOWC is just from 850 nm to 1500 nm.

APPLICATIONS INTER-SATELLITE OPTICAL WIRELESS COMMUNICATION LINK

There are many applications of IsOWC, applications of where satellites need to communicate with each other. One of the applications is data relay between inter orbit satellites and another is to connect satellites in constellations.

Data Relay for Inter Orbit Satellites Unlike GEO satellites, LEO and MEO satellites orbit are not stationary from Earth. This means that the satellite is not constantly in its Earth station's view. By using intersatellite link, data can be sent a LEO and MEO satellite at any time by using a GEO satellite as relay. Data can also be relayed from one LEO satellite to another if they have line of sight. Transmitting data from Earth to satellite has high time delay; therefore by using IsOWC, the time delay can be reduced.

Relaying data using intersatellite links also reduce the time it takes to send a data from one part of the world to another.

Connecting Constellations of Satellites Some missions and applications require more than one satellite such as the global tracking system (GPS) satellites and Iridium satellites. To connect these satellites, the fastest and most efficient way is by using optical intersatellite links. These satellites are to become the base stations for cellular mobile communication. Iridium satellites employ RF intersatellite links to connect with each other at Ka-band frequency. Due to the short distance between the satellites and low data rate, the intersatellite link is applicable. However, by using IsOWC, the data rate can be improved and more mobile user can be supported.

CONCLUSION

In this paper we have studied about the basic working of IsOWC link and its applications. This paper will also gives knowledge about advantages and disadvantages of IsOWC link. In this article we have also studied the FSO i.e. Free Space Optics as IsOWC link. This paper will act as base for the researcher to carryout their research in this field effectively and efficiently.

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