

# A Literature Review on inter Satellite Optical Wireless Link and Impact of Encoding Schemes on Performance of 40Gbps System

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**Abstract**— In the modern world we require higher data rate and high speed of communication which connect the world. Satellite communication is the system which is used to interconnect the world. Conventional communication system depends on the RF link to connect intersatellite network. But RF has several limitations such as frequency allocation, size of transmitter and receiving antenna and heavy structure hence make it less suitable for intersatellite communication. Hence we move toward the optical technology .Optical link connect the several kilometers link between satellites with high speed advantage. In this paper we are studying the high speed optical link performance with various encoding schemes.

**Key words:** BER, IsOWC, EDFA, Return to Zero (RZ), Non Return to Zero (NRZ)

## I. INTRODUCTION

In radio over fiber system, we can utilize optical cable for transmission purpose incorporate with the radio signal. It combines the advantages of wireless radio system and optical communication system. In this technique light is modulated by radio signal and after modulation it is transmitted over a communication link generally an optical fiber link. The application of radio over fiber includes cable television, as shown in figure Different base station is connected with the central station with optical fiber. The base station converts the optical signal into electrical signal and electrical signals into optical signals. The transmitter and receiver are connected in the base station via antenna which transmit or receive the signal. The entire signal conditioning like modulation and demodulation is performed by control station. A satellite is an object that revolves around another object in space. For example we know that the Moon is a natural satellite of earth so as the Earth is a satellite to the Sun. With the advent of man-made satellites, are used for communication purpose to carry telephone channels and broadcast the television programs.

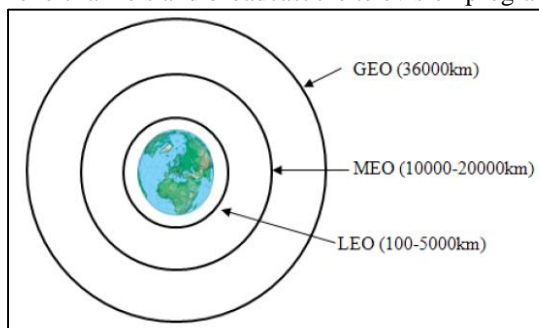


Fig. 1: Earth satellite communication orbit

The first communication satellite is SCORE after that many satellites were launched by the United States, Russia, United Kingdom and Canada. The motive of such satellite launching is for communication, scientific

research and global positioning. There are three types of satellites according to the orbit are Low Earth Orbit (LEO) (100km to 5,000km), The Medium Earth Orbit (MEO) (10,000km to 20,000km) and Geosynchronous Orbit (GEO) (around 36,000km ). For communication Geo is preferred because it seems synchronized with earth.

Radio over fiber technology is breakthrough in the field of optical communication. It is some time as known as intermediate frequency over fiber. If the frequency of input Radio frequency signal is greater than 10GHz than it is known as RF over fiber whereas when input frequency is less than 10GHz it is known as IF over fiber. In both systems high frequency radio signal is modulated with light signal generated by coherent laser sources. At the transmitter side, this modulated light is transmitted to the optical fiber. At the receiver side, the optical signal containing RF frequency is converted into electrical signal at different base station. Hence this architecture reduced the transmitter and receiver design cost as they don't require an up/down converters, network design, and uplink and downlink design and in satellite base station. This is so called radio over fiber when it is used for wireless communication. In the proposed work the Radio over fiber link is designed and the results are compared by analyze the impact of photo detectors on the BER and Quality factor. For simulation Optisystem 13 is used. The results are compared and analyzed with the help of eye pattern generated by the BER analyzer. BER is the ratio of number of bit received incorrectly to the total no. of received bit. For optical communication BER of  $10^{-9}$  or less is recommended.

$$BER = \frac{1}{2} \operatorname{erfc} \left( \frac{Q}{\sqrt{2}} \right) \approx \frac{1}{\sqrt{2\pi}Q} \exp \left( -\frac{Q^2}{2} \right)$$

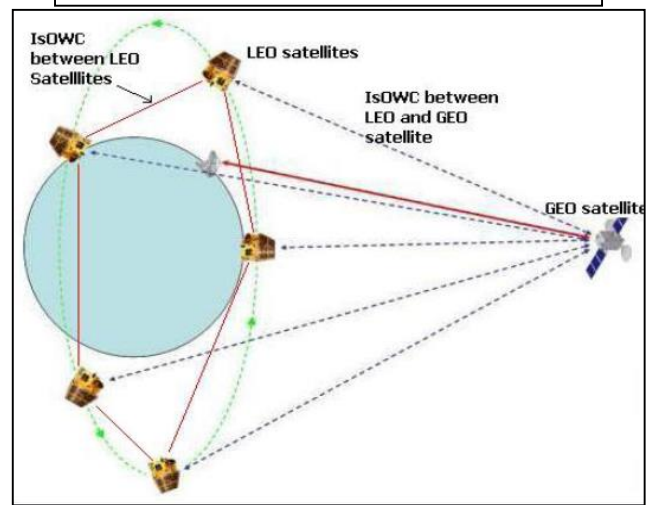


Fig. 2: Concept of data relay in intersatellite orbit

The devices used in intersatellite optical link are portable and quickly shift from one place to another very easily. Due to the composition of the atmosphere three

major effects are produced known as absorption, scattering and scintillation. This effect can be calculated using various models. In this thesis we utilize a post compensation technique in which DCF is connected before the SMF also fiber Bragg grating is used. In this thesis we utilize a post compensation technique in which DCF is connected before the SMF also fiber Bragg grating is used.

## II. INTERSATELLITE OPTICAL LINK

The optical wireless system consists of transmitter, propagation medium and receiver. Figure 3 shows the basic block diagram of an IsOWC system.

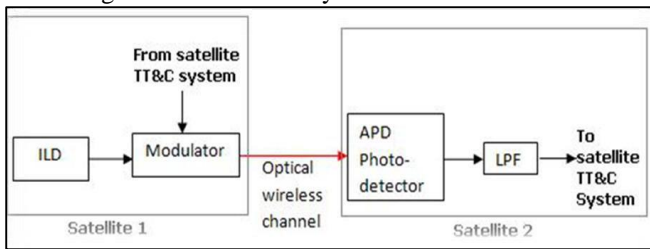


Fig. 3: IsOWC basic system block diagram for simplex communication

In the intersatellite system the transmitter is kept in the first satellite which transmits the data and the receiver is kept in the second satellite which receives the data. The medium between two satellites is the propagation medium generally called OWC channel through which light travel from one satellite to another. The satellite system is generally called Telemetry, Tracking and Communication (TT&C) system.

One of the biggest advantages of intersatellite optical link is by using optical link over radio frequency (RF) links one can send high speed data to a distance of thousands of kilometers while using a small size payload [2] also it is very low cost. In one conventional optical communication can need to install cables after digging the streets whereas in intersatellite optical link this is not required hence proven a good alternative.

Intersatellite optical link has high bandwidth availability so that provides broadband wireless connections from fiber backbones to end-users in the FTTH network. Intersatellite optical link systems support maximum 160 Gbps and these capacities are growing and also these rates will be reaching the Tbps range.

No need for license or frequency allocation in intersatellite optical link as Frequency allocation for microwave transmission is very difficult intersatellite optical link is suitable for financial, legal, military or other sensitive information transmission Invisible and eye safe, no health hazards so even a butterfly can fly unscathed through a beam Low bit error rates (BER). Some other advantages of intersatellite optical link includes absence of side lobes, portability of intersatellite optical link systems quickly and easily, there is no specific Fresnel zone required having low maintenance (Practical) and Lower costs as compared to conventional optical fiber networks.

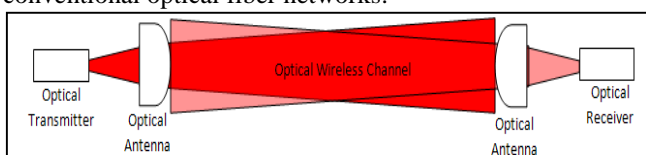


Fig. 3: Optical antenna increase the signal divergence

Generally Light-emitting diode (LED) and injected laser diode (ILD) are two types of optical light source commonly used in optical communication. Devices are made from semiconductor materials such as gallium arsenide, Ruby and Helium neon, the light is generated by the recombination of positively charge particle and negatively charge particle. The output light from Laser is monochromatic, coherent and high radiance hence used for long distance free space transmission. The light generated by the laser can travel to long distance rather than the light emitted by LED. Hence the Laser diode is used for Intersatellite optical system.

## III. INTRODUCTION OF MODULATION SCHEMES

A digital network is used to exchange of data from one station to another station in the network. We know that analog or digital data traverses through a communication media in the form of a signal from the source to the destination. The channel bridging the transmitter and the receiver may be a guided transmission medium such as a wire, a wave-guide, optical fiber or it can be an unguided atmospheric or space channel. But, irrespective of the medium, the signal traversing the channel becomes attenuated and gets distorted with increasing distance. Hence a process is adopted for matching the properties of the transmitted signal to the channel characteristics for efficient communication over the transmission media. There are two ways; the data can be either converted to digital or analog signal. Both the methods have pros and cons. Which one is used depends on the situation and the available bandwidth. Now, either form of data can be encoded into either form of signal. For the digital signaling, the data source can be either analog or digital, which is further encoded into digital signal, using different encoding technique. The basis of analog signaling is a constant frequency signal called a carrier signal, which is chosen to be compatible with the transmission media used, so that it can traverses a long distance with minimum attenuation and distortion. Data transmitted using these carrier signals by a process called modulation, where one or more fundamental parameters of the carrier signal, i.e. amplitude, frequency and phase are being modulated by the source data. The resulting signal is called modulated signal traverses the media, which is demodulated at the receiving end and we get the original signal.

The first approach converts the digital data to digital signal, known as line coding, as shown in Fig. 4. Important parameters of line coding techniques are mentioned below.

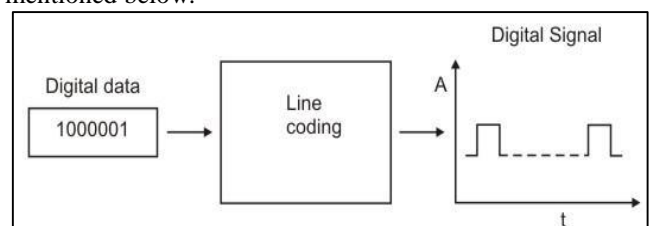


Fig. 4: Line coding to convert digital data to digital signal

- No of signal levels: This refers to the number values used in a signal, known as signal levels, to represent data

- Bit rate and Baud rate: The bit rate represents the number of bits sent per second, whereas the baud rate defines the number of signal elements per second in the signal. Depends on the encoding technique used, baud rate may be more than or less than the data rate.
- DC components: After line coding, the signal may have zero frequency component in the spectrum of the signal wave, which is known as the direct-current (DC) component. DC component in a signal wave is not desirable because the DC component does not pass through some components of a communication system such as a transformer. This leads to distortion in the signal and may create error at the output. The DC component also results in unwanted energy loss on the communication line.
- Signal Spectrum: Different encoding of data gives different spectrum of the signal. It is essential to use suitable encoding technique to match with the medium so that the signal may suffer minimum attenuation and distortion as it is transmitted through a medium.
- Synchronization: The bit interval of the receiver should be exactly same or within certain limit of that of the transmitter for correct interpretation of received signal. It may lead to wrong interpretation of the received signal, if any mismatch between the two. Generally, clock is generated and synchronized from the received signal with the help of a special hardware known as Phase Lock Loop (PLL). However, we can get it if the received signal is self-synchronizing having frequent transitions (preferably, a minimum of one transition per bit interval) in the signal.
- Cost of Implementation: It is desirable to keep the encoding technique simple enough such that it does not require high cost of implementation.
- Non Return to zero (NRZ): The most common and easiest way to transmit digital signal is to use two different voltage levels for the two binary digits. Generally a negative voltage is used to represent one binary value and a positive voltage to represent the other. The data is encoded as the presence or absence of a signal transition at the beginning of the bit time. As given in the figure below, in NRZ encoding, the signal level remains the same throughout the bit-period. There are two encoding schemes in NRZ: NRZ-L and NRZ-I. The advantages of NRZ coding are as follows. It is more reliable to detect a transition in the presence of noise than to compare a value to a threshold. NRZ coding is easy to engineer and it makes efficient use of bandwidth.
- Return to Zero (RZ): To ensure synchronization, there must be a signal transition in each bit as given in Figure 4.8. Key characteristics of the RZ coding are three levels, bit rate is double that of data rate, no DC components and good synchronization. The main limitation is an increase in bandwidth.

#### IV. CONCLUSION

There are tremendous advantages of optical inter-satellite systems over conventional microwave communication because of their outstanding performance with respect to speed and bandwidth. In this paper, the author investigates the

performance of Inter-Satellite Optical Wireless Communication system link using DWDM multiplexing technique for long distance transmission.

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