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Loss Calculation in Free Space Optical Communications

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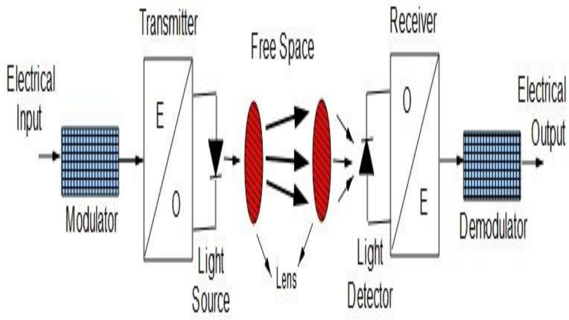
ABSTRACT: Free space optical (FSO) system is an alternative approach to replace the general optical communication in many applications .In this system signal is propagating through the air as a transmission medium. At present FSO system are capable of handling the data up to 2.5 Gbps. It supports audio, video and data through air as a transmission media. This will use optical carrier in the infrared and visible regions to establish the links. In this paper we calculated different losses in the system and specified various advanced methods for the future FSO. It also finds in many applications such as Military, Metro network extension, Telecommunication networking and Last-mile access.
Keywords: Scintillation, Geometric loss, divergence angle, attenuation loss, Tracking Mechanism

I. INTRODUCTION

Signal transmission through light wave becomes best method for broadband access networks. In this context Free Space Optical Communication is receiving considerable attention to provide broadband communications due to its remarkable advantages including flexibility, easy-to-install, and license-free. FSO systems can be categorized into two broad groups, i.e., conventional FSO based systems, and new generation FSO based-systems. Conventional FSO systems operate at 800 nm wavelength band, and need to use Optical to electrical and Electrical to optical conversions before emitting or coupling optical signals into an optical fiber. In this paper we discussed only about Conventional FSO systems.

FSO components are mainly classified into three stages as transmitter, receiver and free space transmission channel. The transmitter is used to send of optical radiation through the atmosphere, free space transmission is used to transmit signals through air as a transmission media. The Receiver is used to recover the signal from the transmission media.

II. FSO SYSTEM



The data connected to the system is in the form of electrical pulses and it is converted into light pulses by using electrical to optical converter and that is represented in the form by binary 1`s and 0`s. The transmitter mainly consists of two parts such as interface circuit and source driver circuit. The transmitter converts the input signal to an optical signal suitable for transmission. The drive circuit of the transmitter is used to transforms the electrical signal to an optical signal by varying the current follow through the light source. The light pulses are carefully projected by the Transmitter. This optical light source can divide in to two types as a light-emitting diode (LED) and laser diode (LD).

The message signal modulates the field generated by the optical source such as laser diode. The modulated optical field then propagates through a free-space path before arriving at the receiver. In the receiver side, photo detector converts the optical signal back into an electrical form. In other words, a receiver at the other end of the link collects the light using lenses and/or mirrors. Received signal converted back into fiber or cooper and connected to the network. Reverse direction data transported the same way (full duplex).The data rate of the system can be defined as Data Rate[bits/sec]=1/η P_r[photons/sec].

2.1. Atmospheric Effects: Thick fog is one of the most complex forms of interference in free space optical communication. This occurs because of the moisture in the fog that can reflect, absorb, and scatter the signal.

Absorption and scattering both occur when there is a lot of moisture in air. Absorption of the signal causes a reduction in signal strength. Scattering causes the signal to be dispersed in various directions. This is an issue particularly for long distances.

- Physical obstructions, such as trees and even building, can also be a problem.
- Scintillation, is heat rising from the earth or man-made, can also disrupt in the signal.
- Alignment, the main challenge with FSO systems is maintaining transceiver alignment.
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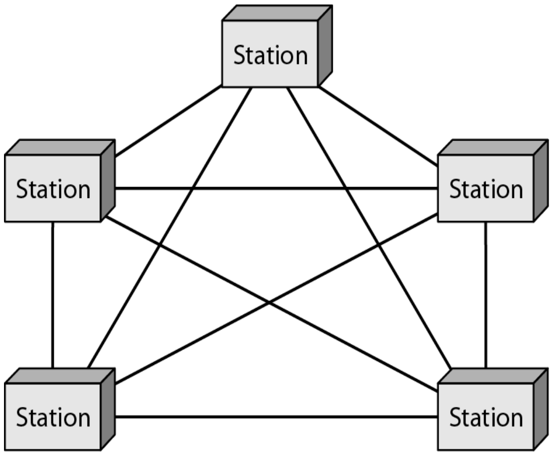
2.2. FSO Architecture: FSO architecture can be processed by using different network topologies as mesh, PMP, PTP, and ring. This gives metropolitan area service providers the freedom to rapidly build and extend networks that deliver fiber-optic speeds to today's customers.

III. MESH TOPLOGY



In a mesh connection every device has a dedicated point-to-point link to every other device. The term dedicated means that the link carries traffic only between the two devices it connects. A mesh offers several advantages over other network topologies. First, the use of dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems that can occur when links must be shared by multiple devices and mesh topology is robust.

Point-to-Multipoint connection: A single node serves as an originator and multiple links connected from that point. The effective method in FSO is to device should connect close to the building. Then the links are fiber coupled to the switch or router and placed at arbitrary locations either on the building rooftop or in an interior room or office therein. Attempts have been made to sectorize the optical beam to serve more than one customer at a time from a single node, as done in LMDS systems. The draw back with this connection is power limitations imposed by regulatory authorities.

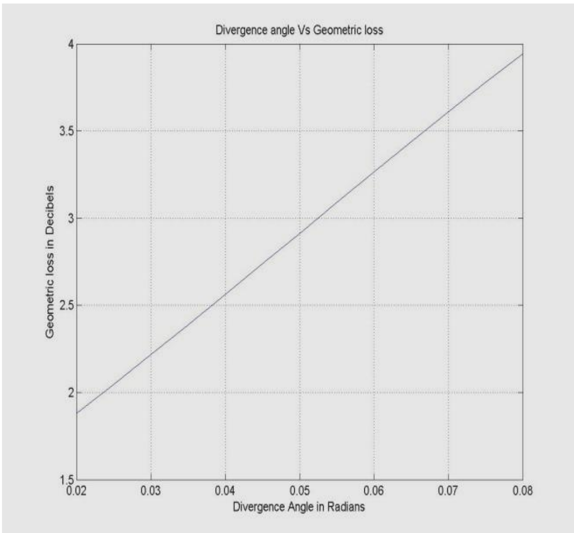
Multiple PTP connection: Multiple PTP connection is suitable, where it is desirable to create an extensive link path that exceeds the product range limit or the recommended weather constrained distance for an optical link. It is a dedicated connection which provides higher bandwidth.

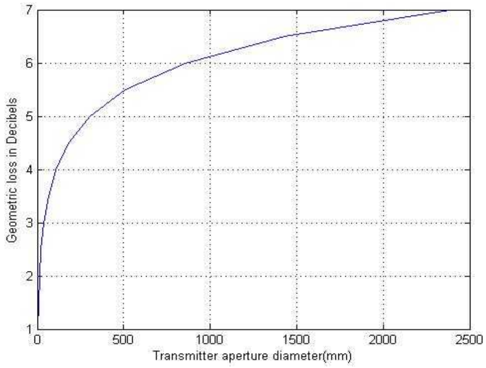
2.3. Noise in FSO system: When the signal is transmitting through air as a transmission medium different noise will include such as Background Radiation (e.g. sun light), Short noise, Thermal noise and scintillation noise. The scintillation is one of luminescence whereby light of a characteristic spectrum is emitted following the absorption of radiation. The emitted radiation from the source is usually less energetic than that absorbed light pulses at the receiving end.

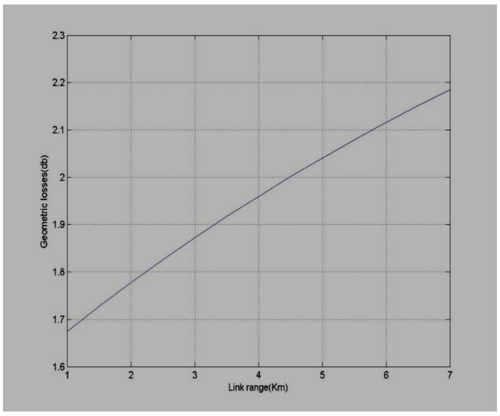
3. Related work and structure of the Paper: In this paper mainly we concentrated on different loss occurred while the signal is transmitting in the air as transmission medium. In addition to that while calculate the FSO link budget several parameters taken into account as geometric loss, link margin, received power and bit error rate. The received power should be grater less the transmitted power from the source and equal the transmitted power minus total loss. The signal power received PR x [W] depends on the transmit power PTx [W], transmit and receive antenna gains GTx,GRx and total loss.**Pr=Pt+ GTx+ GRx-Total loss**

IV. SIMULATION RESULTS

To further optimize the system design, we theoretically investigated the transmission performance of the FSO system.In the following figure by varying different parameters we plot the wave forms for Geometric loss, divergence angle and Link range.







V. FUTURE FSO SYSTEM

FSO systems have fading effect due to the turbulent atmosphere. In this method random changes in the atmosphere such as temperature gradient and pressure of atmosphere cause to the random variations of refractive index along the transmission path. These variations produce fluctuations in both intensity and phase of an signal propagating through air as a transmission medium. Such variations can lead to an increase in the link error probability, limiting the performance of the system. In new generation FSO systems the impact of phase variations is particularly severe due to the use of direct coupling the signal into a fiber cable at the receiver. Hence the system needs direct coupling techniques. Tracking subsystem is the most important key element in new generation FSO systems. However, under severe weather conditions such as heavy rain or strong atmospheric turbulence, the tracking capability was not enough due the limitation of the operation dynamic range. A system with improved tracking scheme and better system design would be necessary to provide better transmission availability for the network services. Recently, an advanced tracking algorithm in the acquisition/tracking controller consisting of a pointing predictor was proposed [5]. This adaptive tracking controller can help to maintain communication link even under some severe weather conditions.

VI. CONCLUSION

In this paper, we present an overview of FSO technology and analyze the system performance by varying different parameters. It is confirmed that this technology can be used to transmit high speed signal through air. We also review some of our recent activities and proposals on the optimization and improvement of the developed system. It is believed that the system is suitable for application as a universal plat form for providing high speed data rate and for free-space optical communication networks, extending broadband connectivity to underserved areas.

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