Asian Journal of Convergence in Technology Volume1, Issue 4
Issn No.:2350-1146, I.F-2.71

DATA TRANSMISSION THROUGH FREE SPACE OPTICAL LASER

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***ABSTRACT*- Free space optics (FSO) is a very advanced form of communication usually named as line-of-sight communication technology that is recently providing optical transmission up to 3 Gbps of text, speech(sound), images and video graphic communications through the air as medium, allowing exchange of data without any use of conventional fiber optic cables or securing frequency spectrum licenses. FSO system could carry full duplex (bi-directional) data at giga bits per second rates over Metropolitan distances of a few city blocks, buildings or area of few kms. FSO, also known as wireless optics, which overcomes this last-mile access blockage by sending high – bit rate signals through the air using laser transmission.**

***Index Terms* — Optical communication, PIN diode, Modulation Schemes**

I. INTRODUCTION

Since its inception in 1958, NASA relied exclusively on radio frequency (RF) based communication as the only viable medium for exchanging data between a mission and a spacecraft.

From Apollo to more modern feats such as the Luna Reconnaissance Orbiter (LRO), the principles and method of communication have evolved and advanced.

Todays, with mission demanding communication with higher data rates then even before, NASA is taking steps to embark on a new era of communication technology. The laser communication relay Demonstration (LCRD) project will help pave the way, pioneering technologies that will enable the exchange of data through beams of light.

Transforming the way NASA communicates mission-critical information, LCRD will use laser to encode and transmit data. Laser communication will allow communication rates to 10 to 100 times faster RF based communication. [8]

FSO is communication process that uses light containing information to travel in free space to exchange data between two or more points.[9] The technology is of use , where the physical transfer by the means of fiber optic cable are difficult due to high cost or any other considerations . Free space optics (FSO) communications, also called free space photonics (FSP). Like fiber, free space optics (FSO) uses laser for the exchange of data, but as an alternative of enclosing the data stream in a glass fiber, it is transmitted through the air as a medium.

FSO, is not a very new idea but, it is very interesting one. It has extraction that 90 back over 30 years-to the era before fiber optic cable became one of the preferred transmission medium for high speed communication. [8] FSO technology has been revitalized to recommended high bandwidth last mile connectivity for todays converged network requirements. As long as there is a clear line of sight between the source and the destination and adequate transmitter power. FSO communication is probable virtually at the speed of light. Because light travels faster through air than it does through glass, so it is reasonable to categorize FSO as optical communications at the speed of light. FSO works on the same basic principle as IR based TV remote control, wireless keyboards and wire palm devices works. In current scenario we are faced an escalating demand for very high bandwidth and differentiated

data services. Network traffic doubles every year compelling the bandwidth or data storing capacity to rise and keep pace with the increase. The appropriate solution for the imperative demand is the unexploited bandwidth potential of optical communications.

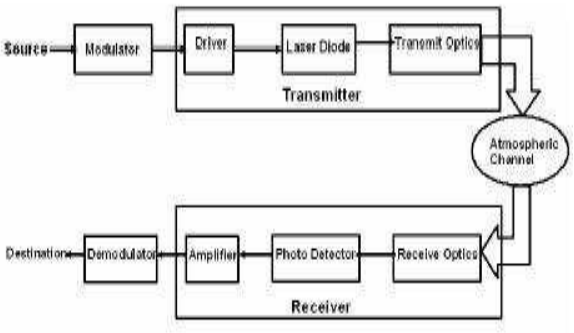

fig 1. Block diagram of FSO system

II. ORIGIN OF FSO

IT is said that this mode of communication was first used in the 8th century by the Greeks. They use fire as a light source, atmosphere as the transmission medium and human eye as receiver.

FSO or optical wireless communication by Alexander graham bell in the late 19th century even before his invention of telephone, Bell's FSO experiment transformed voice sounds to telephone signals and transmitted them between receivers through free space along a beam of light for a distance some 800ft, this was later called photo-phone. Although Bell's photo-phone not at all became a business reality, then also it verified the basic principle of optical communication.

Essentially all of the engineering developed till date of FSO or free space optical communication systems was done under the previous 30 years or so mainly for defense applications .

FSO, FIBER OPTICS AND RF WIRELESS: A COMPARISON.

FSO vs RF

RF communications provides mobility into large coverage areas. In this scenario the data transfer rates to individual users are supposed to be limited. At lower data rates RF is good for giving treatment, Owing to the scattering and the diffraction of the radio frequency waves, and the compassion of the receiver that can be made. Channels are healthy to being blocked by obstacles and coverage can be obtained between rooms.

Higher data rates require higher spectral components at these frequencies the radio signal propagation shift to line of sight communication and problems becomes similar to that using light. Components operating at these high frequencies are very expensive, and the advantages of RF (coverage, receiver sensitivity) become less in use.

	WIRELESS OPTICAL LASERLINK	FIBER OPTIC LINK	WIRELESS RADIO LINK
MAX. TRANSFER RATE	10-600Mbps	Upto several Gbps	10 – 100 Mbps
COST	Moderate low cost	Very expensive	Low cost`
SETUP TIME	Very low	High	Low
LICENSE	Not required	Permisssion required	License required
INTERCEPTING	Almost impossible	Difficult but possible	Easily possible

III. FSO vs Fiber Optic Cable

In planning communications networks, much amount capital can be saved by constructing the network gradually, adding to it as defensible by consumer demand. Free space optical networks lend themselves to such a measurable model far better than fiber – based networks can do. With fiber, the expenditure of excavating a signal is so high that it makes sense to setup as much fiber as possible while the channel is open. With FSO, only the equipment completely

needed at any time needs to be arranged. As new customers are signing up the apparatus needed to support them is mounted. This demand –based method lowers the capital outflow required to grow the customers based and permits the service provided to instantly begin recuperating costs linked with the network equipment capital expenditure. In this scenario, not only the service provider but also the consumer wins, because he/she can be immediately online and initiate to gain from the higher bandwidth network connection.[8]

IV. TECHNOLOGY OF FSO

The concept behind FSO is easy. FSO utilizes highly directed beams of light radiation between two end points to transfer information/massage (data, sound or video). This is parallel to OFC (optical fiber cable) networks, apart from that light pulses are send through free air as a substitute of OFC cores .An FSO unit comprises of an optical transceiver with a laser transmitter and a receiver to have bidirectional capability. [8] E ach FSO unit uses a high power , narrow beam width optical source (laser) in addition with a lens that transmits light through the air to another receiving lens . The receiving lens connects to a high compassion receiver via optical; fiber. Two FSO units can obtain the optical connectivity to a maximum of 6kms.

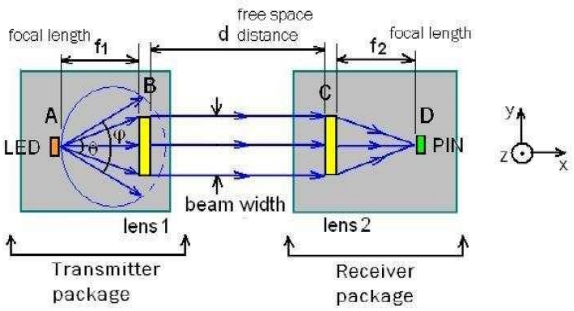

Fig 2 : optical link geometry

Optical system operates in the IR or near IR section of light and the simplest way to envisage how the work is , envisage to points interconnected with fiber optic cable and then remove the cable. The IR carrier utilized for transmitting the signal is engendered either by a high power LED or a LASER diode. Two analogous or parallel beams are used, one for transmission work and one for reception work, taking a standard data, voice or video signal, altering it to a digital format and transmitting it via free space.

Today's recent laser system offers network connectivity at a speed of approximately 600 Mbps and beyond with total trustworthiness. The beams are kept very narrow to make sure that it does not hinder with other FSO beams. The receiving detectors are PIN diodes or avalanche photo diodes. The FSO transmits imperceptible, eye safe, light beams from transmitter to the receiver with low power IR lasers in the tera hertz spectrum.

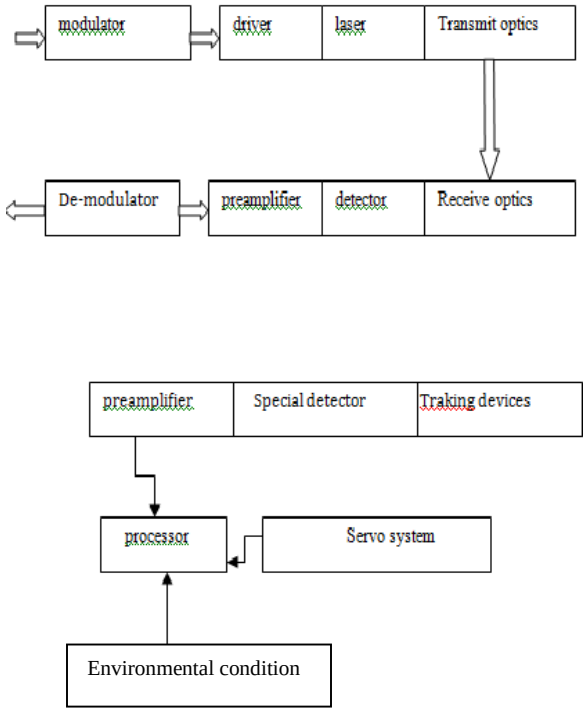

Fig 3 Subsystem of FSO system

In the transmitting section, the data is sent to the modulator for modulating the signal and the driver is for initiating the laser. In the receiver section the optical signal is received and it is transformed to electrical signal, preamplifier is used to amplify the input signal and then send to demodulator for reproducing original signal .

V. MODULATION TECHNIQUE USED IN FSO

On and off keying (ook), OOK is simplest and very useful digital form of modulation that considers digital data as the simplest binary logic 1 or 0 of a carrier wave. In its simplest form the presence of existence of a carrier for a time duration represent a binary 1, while its absence of non-existence for the same time duration represents a binary "0" [10].

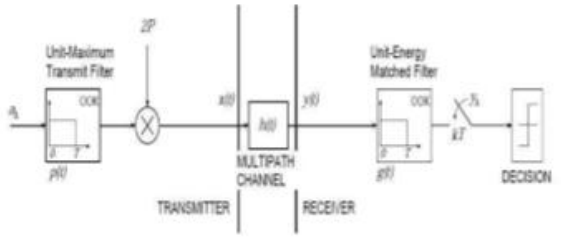

Fig 4:Block diagram of ON and OFF keying

PULSE POSITION MODULATION:

PPM is a useful type of signal modulation in which "N" information bits are encoded by transmitting only a single pulse in one of possible time shift. This is repeated after every "T' sec, the transmitted bit rate is carried out to be "N/T" bit per second. It is applied for that optical communication system, where there tends to be little multipath interference. [11]

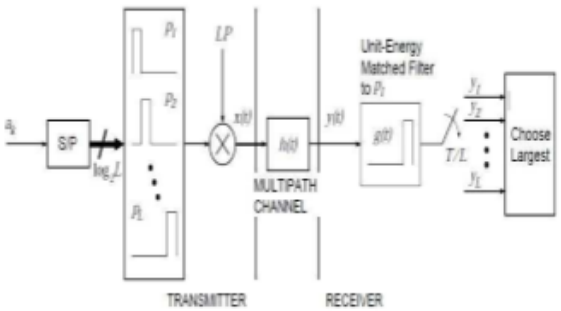

Fig 5: block diagram PPM.

VI. APPLICATION OF FSO

Optical communication systems are becoming more and more popular as the interest and requirement in high capacity and long distance space communication grow. FSO overcomes the last mile access bottleneck by sending high bit rate signals through the air using laser transmission.

Application of FSO system is many and varied but a few are listed:

- Metro area network (MAN): FSO network can decrease the brake between the last mile customer, thereby enabling access to new customers to a high speed MAN's.
- Last mile access end users can be linked to high speed links with FSO. It can also be taken to bypass local loop system to offer business with high speed connections.
- Enterprise connectivity: as FSO links can be mounted with no difficulty, they offer a natural method of interconnecting LAN segments that are housed in buildibgs stranged by public streets or other right of – way property.
- BACKHAUL: FSO can be used to carry cellular telephone traffic from antenna towers back to wire into the public switched telephone network.
- FIBER BACKUP : FSO can also be arranged in surplus links to backup fiber in lieu of a second fiber link

Fig 6: view of metro area network

VII. CONCLUSION

This paper discussed in detail how FSO technology can be rapidly deployed to provide immediate service to the customers at a low initial investment, without any licensing hurdle making high speed high bandwidth communication possible. Though not very popular in India at the moment , FSO has a tremendous scope for development companies like CISCO, LIGHT POIN few other have made huge investment to promote this technology in the market.it is only a matter of time before the customer realized , the benefits of FSO and the technology deployed in large scale.

ACKNOWLEDGEMENT

The authors sincerely thank the Director, HOD, of DYPIET pimpri and Head of department of electronics under university of pune for their encouragement to carry out this work. Special thanks to the Prof. Madhavi Repe (electronics dpt.), for their help and necessary support.

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