INTRODUCTION

Communication, as it has always been relied and simply depended upon speed. The faster the means ! the more popular, the more effective the communication is !

Presently in the twenty-first centaury wireless networking is gaining because of speed and ease of deployment and relatively high network robustness. Modern era of optical communication originated with the invention of LASER in 1958 and fabrication of low-loss optical fiber in 1970.

When we hear of optical communications we all think of optical fibers, what I have for u today is AN OPTICAL COMMUNICATION SYSTEM WITHOUT FIBERS or in other words WIRE FREE OPTICS.

Free space optics or FSO –Although it only recently and rather suddenly sprang in to public awareness, free space optics is not a new idea. It has roots that 90 back over 30 years-to the era before fiber optic cable became the preferred transport medium for high speed communication. FSO technology has been revived to offer high band width last mile connectivity for today's converged network requirements.

FSO ! FREE SPACE OPTICS

Free space optics or FSO, free space photonics or optical wireless, refers to the transmission of modulated visible or infrared beams through the atmosphere to obtain optical communication. FSO systems can function over distances of several kilometers.

FSO is a line-of-sight technology, which enables optical transmission up to 2.5 Gbps of data, voice and video communications, allowing optical connectivity without deploying fiber optic cable or securing spectrum licenses. Free space optics require light, which can be focused by using either light emitting diodes (LED) or LASERS(light amplification by stimulated emission of radiation). The use of lasers is a simple concept similar to optical transmissions using fiber-optic cables, the only difference being the medium.

As long as there is a clear line of sight between the source and the destination and enough transmitter power, communication is possible virtually at the speed of light. Because light travels through air faster than it does through glass, so it is fair to classify FSO as optical communications at the speed of light. FSO works on the same basic principle as infrared television remote controls, wireless keyboards or wireless palm devices.

FSO TRANSMITTER

FSO RECEIVER

RELEVANCE OF FSO IN PRESENT DAY COMMUNICATION

Presently we are faced with a burgeoning demand for high bandwidth and differentiated data services. Network traffic doubles every 9-12 months forcing the bandwidth or data storing capacity to grow and keep pare with this increase. The right solution for the pressing demand is the untapped bandwidth potential of optical communications.

Optical communications are in the process of evolving Giga bits/sec to terabits/sec and eventually to pentabits/sec. The explosion of internet and internet based applications has fuelled the bandwidth requirements. Business applications have grown out of the physical boundaries of the enterprise and gone wide area linking remote vendors, suppliers, and customers in a new web of business applications. Hence companies are looking for high bandwidth last mile options. The high initial cost and vast time required for installation in case of OFC speaks for a wireless technology for high bandwidth last mile connectivity there FSO finds its place.

ORIGIN OF FSO

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

FSO or optical wireless communication by Alexander Graham Bell in the late 19th centaury even before his telephone ! Bells FSO experiment converted voice sounds to telephone signals and transmitted them between receivers through free air space along a beam of light for a distance of some 600 feet, - this was later called PHOTOPHONE. Although Bells photo phone never became a commercial reality , it demonstrated the basic principle of optical communications.

Essentially all of the engineering of today's FSO or free space optical communication systems was done over the past 40 years or so mostly for defense applications.

THE TECHNOLOGY OF FSO

The concept behind FSO is simple. FSO uses a directed beam of light radiation between two end points to transfer information (data, voice or even video). This is similar to OFC (optical fiber cable) networks, except that light pulses are sent through free air instead of OFC cores.

An FSO unit consists of an optical transceiver with a laser transmitter and a receiver to provide full duplex (bi-directional) capability. Each FSO unit uses a high power optical source (laser) plus a lens that transmits light through the atmosphere to another lens receiving information. The receiving lens connects to a high sensitivity receiver via optical fiber. Two FSO units can take the optical connectivity to a maximum of 4kms.

WORKING OF FSO SYSTEM

Optical systems work in the infrared or near infrared region of light and the easiest way to visualize how the work is imagine, two points interconnected with fiber optic cable and then remove the cable. The infrared carrier used for transmitting the signal is generated either by a high power LED or a laser diode. Two parallel beams are used, one for transmission and one for reception, taking a standard data, voice or video signal, converting it to a digital format and transmitting it through free space .

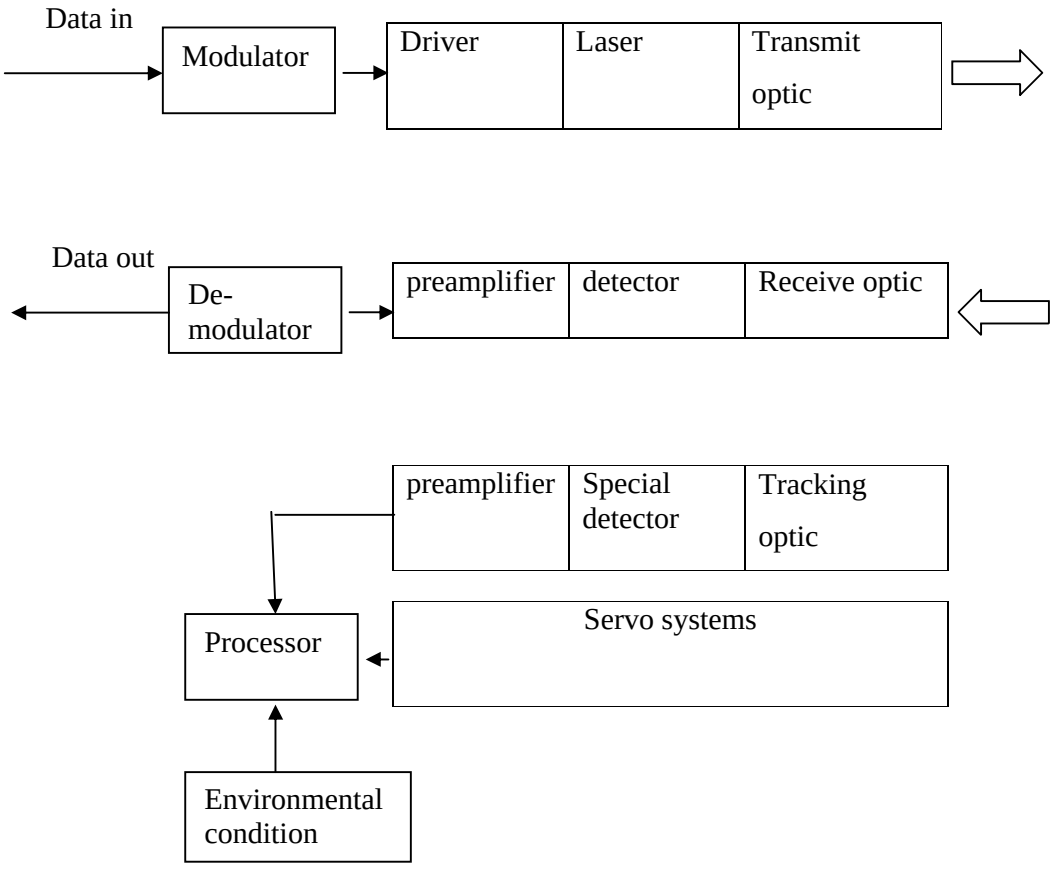
Today's modern laser system provide network connectivity at speed of 622 Mega bits/sec and beyond with total reliability. The beams are kept very narrow to ensure that it does not interfere with other FSO beams. The receive detectors are either PIN diodes or avalanche photodiodes.

The FSO transmits invisible eye safe light beams from transmitter to the receiver using low power infrared lasers in the tera hertz spectrum. FSO can function over kilometers.

WAVELENGTH

Currently available FSO hardware are of two types based on the operating wavelength – 800 nm and 1550 nm. 1550 FSO systems are selected because of more eye safety, reduced solar background radiation and compatibility with existing technology infrastructure.

SUBSYSTEM



In the transmitting section, the data is given to the modulator for modulating signal and the driver is for activating the laser. In the receiver section the optical signal is detected and it is converted to electrical signal, preamplifier is used to amplify the signal and then given to demodulator for getting original signal. Tracking system which determines the path of the beam and there is special detector (CCD, CMOS) for detecting the signal and given to pre amplifier. The servo system is used for controlling system, the signal coming from the path to the processor and compares with the

environmental condition, if there is any change in the signal then the servo system is used to correct the signal.

APPLICATIONS OF FSO

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

Applications of FSO system is many and varied but a few can be listed.

1. **Metro Area Network (MAN):** FSO network can close the gap between the last mile customers, there by providing access to new customers to high speed MAN's resulting to Metro Network extension.
2. **Last Mile Access :** End users can be connected to high speed links using FSO. It can also be used to bypass local loop systems to provide business with high speed connections.
3. **Enterprise connectivity :** As FSO links can be installed with ease, they provide a natural method of interconnecting LAN segments that are housed in buildings separated by public streets or other right-of-way property.
4. **Fiber backup :** FSO can also be deployed in redundant links to backup fiber in place of a second fiber link.
5. **Backhaul :** FSO can be used to carry cellular telephone traffic from antenna towers back to facilities wired into the public switched telephone network.
6. **Service acceleration :** instant services to the customers before fiber being layed

MARKET

Telecommunication has seen massive expansion over the last few years. First came the tremendous growth of the optical fiber. Long-haul Wide Area Network (WAN) followed by more recent emphasis on Metropolitan Area Networks (MAN). Meanwhile LAN giga bit Ethernet ports are being deployed with a comparable growth rate. Even then there is pressing demand for speed and high bandwidth.

The ‘connectivity bottleneck’ which refer the imbalance between the increasing demand for high bandwidth by end users and inability to reach them is still an unsolved puzzle. Of the several modes employed to combat this ‘last mile bottleneck’, the huge investment is trenching, and the non- redeployability of the fiber has made it uneconomical and non-satisfying.

Other alternatives like LMDS, a RF technology has its own limitations like higher initial investment, need for roof rights, frequencies, rainfall fading, complex set and high deployment time.

In the United States the telecommunication industries 5 percent of buildings are connected to OFC. Yet 75 percent are with in one mile of fiber. Thus FSO offers to the service providers, a compelling alternative for optical connectivity and a complement to fiber optics.

MERITS OF FSO

1. Free space optics offers a flexible networking solution that delivers on the promise of broadband.
2. Straight forward deployment-as it requires no licenses.
3. Rapid time of deployment.
4. Low initial investment.
5. Ease of installation even indoors in less than 30 minutes.
6. Security and freedom from irksome regulations like roof top rights and spectral licenses.

7. Re-deployability

Unlike radio and microwave systems FSO is an optical technology and no spectrum licensing or frequency co-ordination with other users is required. Interference from or to other system or equipment is not a concern and the point to point laser signal is extremely difficult to intercept and therefore secure. Data rate comparable to OFC can be obtained with very low error rate and the extremely narrow laser beam which enables unlimited number of separate FSO links to be installed in a given location.

LIMITATIONS OF FSO

The advantages of free space optics come without some cost. As the medium is air and the light pass through it, some environmental challenges are inevitable.

1. FOG AND FSO

Fog substantially attenuates visible radiation, and it has a similar affect on the near-infrared wavelengths that are employed in FSO systems. Rain and snow have little affect on FSO. Fog being microns in diameter, it hinder the passage of light by absorption, scattering and reflection . Dealing with fog – which is known as Mie scattering, is largely a matter of boosting the transmitted power. In areas of heavy fogs 1550nm lasers can be of more are. Fog can be countered by a network design with short FSO link distances. FSO installation in foggy cities like san Francisco have successfully achieved carrier-class reliability.

2. PHYSICAL OBSTRUCTIONS

Flying birds can temporarily block a single beam, but this tends to cause only short interruptions and transmissions are easily and automatically re-assumed. Multi-beam systems are used for better performance.

3. SCINTILLATION

Scintillation refers the variations in light intensity caused by atmospheric turbulence. Such turbulence may be caused by wind and temperature gradients which results in air pockets of varying diversity act as prisms or lenses with time varying properties.

This scintillation affects on FSO can be tackled by multi beam approach exploiting multiple regions of space- this approach is called spatial diversity.

4. SOLAR INTERFERENCE

This can be combated in two ways.

- The first is a long pass optical filter window used to block all wavelengths below 850nm from entering the system.

- The second is an optical narrow band filter proceeding the receive detector used to filter all but the wavelength actually used for intersystem communications.

5. SCATTERING

Scattering is caused when the wavelength collides with the scatterer. The physical size of the scatterer determines the type of scattering.

- When the scatterer is smaller than the wavelength-Rayleigh scattering.
- When the scatterer is of comparable size to the wavelength -Mie scattering.

- When the scatterer is much larger than the wavelength -Non-selective scattering

In scattering there is no loss of energy, only a directional re-distribution of energy which may cause reduction in beam intensity for longer distance.

6. ABSORPTION

Absorption occurs when suspended water molecules in the terrestrial atmosphere extinguish photons. This causes a decrease in the power density of the FSO beam and directly affects the availability of a system. Absorption occurs more readily at some wavelengths than others.

However, the use of appropriate power, based on atmospheric conditions, and use of spatial diversity helps to maintain the required level of network availability.

7. BUILDING SWAY / SEISMIC ACTIVITY

One of the most common difficulties that arises when deploying FSO links on tall buildings or towers is sway due to wind or seismic activity Both storms and earthquakes can cause buildings to move enough to affect beam aiming. The problem can be dealt with in two complementary ways: through beam divergence, and active tracking

a. With beam divergence, the transmitted beam spread, forming optical cones which can take many perturbations.

b. Active tracking is based on movable mirrors that controls the direction in which beams are launched.

FSO ! AS A FUTURE TECHNOLOGY

Infrared technology is as secure or cable applications and can be more reliable than wired technology as it obviates wear and tear on the connector hardware. In the future it is forecast that this technology will be implemented in copiers, fax machines, overhead projectors, bank ATMs, credit cards, game consoles and head sets. All these have local applications and it is really here where this technology is best suited, owing to the inherent difficulties in its technological process for interconnecting over distances.

Outdoors two its use is bound to grow as communications companies , broadcasters and end users discovers how crowded the radio spectrum has become. Once infrared's image issue has been overcome and its profile raised, the medium will truly have a bright, if invisible, future !

CONCLUSION

We have 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 deployment 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 customers realized, the benefits of FSO and the technology deployed in large scale.

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ABSTRACT

Free space optics (FSO) is a line-of-sight technology that currently enables optical transmission up to 2.5 Gbps of data, voice, and video communications through the air , allowing optical connectivity without deploying fiber optic cables or securing spectrum licenses. FSO system can carry full duplex data at giga bits per second rates over Metropolitan distances of a few city blocks of few kms. FSO, also known as optical wireless, overcomes this last-mile access bottleneck by sending high –bitrate signals through the air using laser transmission .

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