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Survey on Free Space Optic

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Abstract: *Free space optic (FSO) is communication system that uses a light for carrying the information and to exchange data between to or more points. Free-Space Optics (FSO) is a line-of-sight technology that uses lasers to provide optical bandwidth connections. FSO is capable of data, voice and video communications through the air, allowing optical connectivity without requiring fiber-optic cable or securing spectrum licenses. The transmission of FSO is mainly dependent on the medium because the presence of forgein elements like rain, fog and have are the some of these factors. In this paper, the weather conditions & techniques employed to mitigate their effect are discussed in this paper.*

I. Introduction

Free Space Optic is relatively simple. FSO is current capable for transmission of data to 2.5 Gbps which can be increased upto to 10Gbps.Its based on the connectivity between FSO units consisting of the optical transceiver with a LASER transmitter and photo detector receiver to provide duplex capability. Each FSO unit uses a high power optical source(i.e LASER) plus a lens that transmits light through the atmosphere to another to another LENS receiving the information. The use of lasers is a simple concept similar to optical transmissions using fiber-optic cables; the only difference is the medium. 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. the ability to operate at high power levels for long distance. FSO technology requires no spectrum licensing. Successful experiments results determined the flexibility of FSO communication .Researchers at the German Aerospace Centre determined that the data transmission at 1.72 terabits per second across distance of 10.45km can be achieved. Optical beams are immune to electromagnetic interference. Optical components are less costly than Radio frequency components and also consume less power.

II. Characteristics

1. The FSO has relatively high bandwidth.
2. Transmission media of the FSO is air transmission media having speed of light.
3. The range of the potential application of FSO network is extensive, from home to satellite
4. Speed of deployment is fast.
5. FSO provide full-duplex bidirectional capability
6. Capacity is good than microwave &fiber.
7. As the FSO save, secure and undetectable system connect large area with minimum planning & deployment.
8. Efficient optical noise rejection and a high optical signal gain

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III. Application

Telecom network extensions: FSO can be deployed to extend an existing metro ring or to connect new networks. These links generally do not reach the ultimate end user, but are more an application for the core of the network.
Enterprise: The Flexibility of FSO allows it to be deployed in many enterprise applications such as LAN to LAN connectivity, Storage Area Networks, and intra-campus connections.
Fiber Complment: FSO may also be deployed as a redundant link to back up fiber. Most operators deploying fiber for business applications connect two fibers to secure a reliable service plus backup in the event of outage. Instead of deploying two fiber links, operators could opt to deploy an FSO system as the redundant link.
Access: FSO can also be deployed in access applications such as gigabit Ethernet access. Service providers can use FSO to provide high capacity links to businesses.
Backhaul: FSO can be used for backhaul such as LMDS or cellular backhaul as well as gigabit Ethernet "off-net" to transport network backhaul.

IV. Challenges

Fog: The major challenge to FSO communications is fog. Rain and snow have little effect on FSO, but fog is different. Fog is vapor composed of water droplets, which are only a few hundred microns in diameter but can modify light characteristics or completely hinder the passage of light through a combination of absorption, scattering and reflection. The primary way to counter fog when deploying FSO is through a network design that shortens FSO link distances and adds network redundancies. FSO installations in foggy cities such as San Francisco have successfully achieved carrier-class reliability

Absorption: Absorption occurs when suspended water molecules in the terrestrial atmosphere extinguish photons. This causes a decrease in the power density (attenuation) 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 (multiple beams within an FSO unit) helps maintain the required level of network availability.

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, this is known as Rayleigh scattering. When the scatterer is of comparable size to the wavelength, this is known as Mie scattering. When the scatterer is much larger than the wavelength, this is known as non-selective scattering. In scattering-unlike absorption-there is no loss of energy, only a directional redistribution of energy that may have significant reduction in beam intensity for longer distances.

Physical obstructions: Flying birds can temporarily block a single beam, but this tends to cause only short interruptions, and transmissions are easily and automatically resumed. LightPointe uses multi-beam systems (spatial diversity) to address this issue, as well as other atmospheric conditions, to provide for greater availability.

Building sway/seismic activity: The movement of buildings can upset receiver and transmitter alignment. LightPointe uses a divergent beam to maintain connectivity. LightPointe is developing a tracking device for use in ultra high-speed FSO systems mounted on freestanding towers.

Scintillation: Heated air rising from the earth or man-made devices such as heating ducts creates temperature variations among different air pockets. This can cause fluctuations in signal amplitude which leads to "image dancing" at the FSO receiver end. LightPointe's unique multi-beam system is designed to address the effects of scintillation. Refractive turbulence: Refractive turbulence causes two primary effects on optical beams.

- **Beam Wander:** Beam wander is caused by turbulent eddies that are larger than the beam.
- **Beam Spreading:** Beam spreading-long-term and short-term-is the spread of an optical beam as it propagates through the atmosphere.

Safety: To those unfamiliar with FSO, safety is often a concern because the technology uses lasers for transmission. This concern, however, is based on perception more than reality. The proper use and safety of lasers have been discussed since FSO devices first appeared in laboratories more than two decades ago. The two major concerns involve human exposure to laser beams (which present much more danger to the eyes than any other part of the human body) and high voltages within the laser systems and their power supplies. Standards have been set for laser safety and performance and our FSO systems comply with these standards.

V. Block Diagram

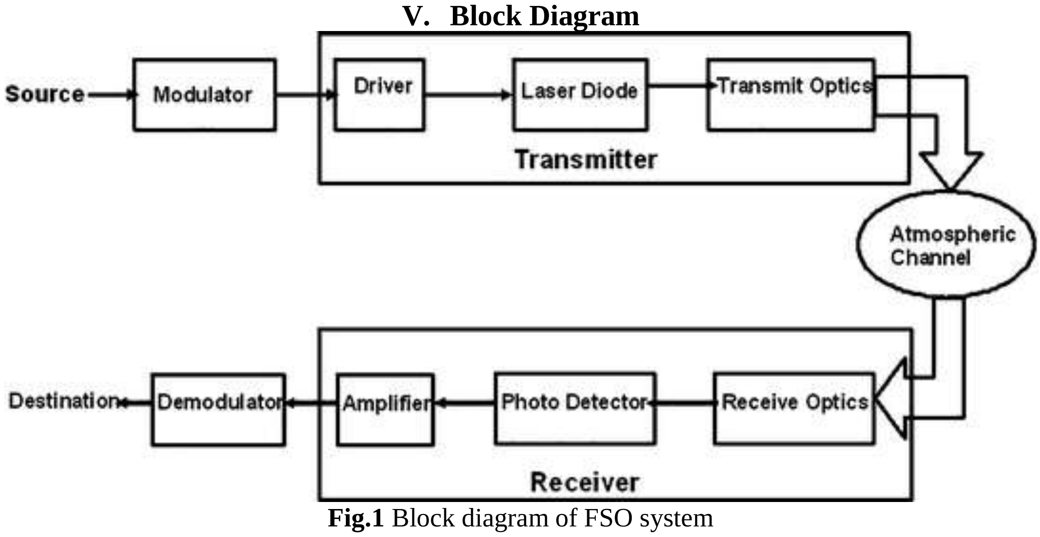

Fig.1 Block diagram of FSO system

Description of the block diagram
At Transmitter

A source producing data input is to be transmitted to a remote destination. This source has its output modulated onto an optical carrier; laser or LED, which is then transmitted as an optic al field through the atmospheric channel. The important aspects of the optical transmitter system are size, power, and beam quality, which determine laser intensity and minimum divergence obtainable from the system. At the receiver, the field is optically collected and detected, generally in the presence of noise interference, signal distortion, and background radiation. On the receiver side, important features are the aperture size and the f/-number, which determine the amount of the collected light and the detector field-of-view (FOV). The transmit optics consists of lens assembly (Plano convex lenses) and receiver Optics consist of telescope units to receive the incident light.

Modulation

Firstly, the incoming data stream is serial to parallel converted into "n" independent streams. These streams are encoded in parallel by an encoder. In the parallel encoder, a data block is composed by taking one bit out of each data sequence, each time the data blocks are encoded. The parity check bits are added and transmitted on "k" exclusive channels, which have same rate as the data sequence and are also generated by the encoder. Hence, this parallel encoder makes an (1 1 + k, n) code, where n + k is the codeword length. Secondly, these n + k codeword sequences are modulated into 00K or PPM codes on each channel. At the optical modulator, these code sequences modulate each diode with a different wavelength and are multiplexed. In the multiplexer, each optical signal from channels is focused on an optical fiber. The optical pulses from the fiber are spread on the optical channel

At Receiver

Compared with transmitters, receiver choices are much more limited. The two most common detector material systems used in the near-IR spectral range are based on Si or indium gallium arsenide (InGaAs) technology. Germanium is another material system that covers theoperating wavelength range of commercially available FSO systems. However, germanium technology is not used very often because of the high dark current values of this material. All these materials have a rather broad spectral response in wavelength, and, unlike lasers, they are not tuned toward a specific wavelength.

Demodulator

At the receiver, the transmitted pulses are received together with the ambient light noise. These multiplexed signals are separated in accordance with their carrier wavelength .The optical filter is used as the de-multiplexer. These optical band-pass filters are usually constructed of multiple thin dielectric layers, and can achieve narrow bandwidths. These separated signals passed to the photo diode array, demodulated by pulse demodulator, and then decoded in parallel by the parallel decoder. Finally, these parallel data blocks are parallel to serial converted to retrieve the original data.

LED vs Laser Diode as light source

The choice of LED vs. Laser Diode as a light source in a wireless optical transmission product depends on the target application, and the related performance, cost and reliability requirements of the overall solution being designed. Long range, very high speed (gigabit or more) point-to point FSO systems require laser diodes. Such products compete with high-speed RF point-to-point solutions often based on milimeter wave transmission in the 60, 70, 80 and 90 GHz bands. However, shorter range LED based systems can achieve high-speed optical system performance, while dramatically reducing the overall system size and cost.

VI. Review of FSO

FSO is a technique, in which we transmit information in the form of the light .In ancient times there many technique to transmit signal through light such fire etc. Today, this technique was developed using communication system.

IN 1880-1905

On February 19,1880 at Bell's Laboratory, the photophone was invented and its was communication device that allows transmission of speech on beam of light. On June 3, 1880 Bell's assistant transmitted a wireless voice telephone message between two buildings roof at distance 213 meters . For improving efficiency of the signal, transmission distance & also security. In late 18th century and early of 19th century a heliography device was invented .It is a wireless telegraph that signals by flashes of sunlight reflected by the mirror. The flashes are produced momentarily pivoting the mirror, or by interrupting the beam with shutter .The heliography was a simple but effective instrument for instantaneous communication over long distance. It main uses were military, survey and forest protection work. It was invemted by the German.

IN 1906-1960

Military was interest in photophones, so in 1935, the German Army developed a photophone where a tungsten filament lamp with an IR transmitting filter was used as a light source for improving security as well as distance. Modern OWC uses either lasers or Light emitting diodes (LEDs) as transmitters. In 1962, MIT Lincoln Labs built an experimental OWC link using a light emitting GaAs diode and was able to transmit TV signals over a distance of 30 miles. After the invention of the laser, OWC was envisioned to be the main deployment area for lasers and many trials were conducted using different types of lasers and modulation schemes. However, the results were in general disappointing due to large divergence of laser beams and the inability to cope with atmospheric effects. With the development of low-loss fiber optics in the 1970s, they became the obvious choice for long distance optical transmission and shifted the focus away from OWC systems.

IN 1960-2015

The invention of lasers in the 1960s, revolutionized free space optics. Military organizations were particularly interested and boosted their development. However the technology lost market momentum when the installation optical network networks for civilian uses was at its peak.Many simple and inexpensive consumer remote controls use low-speed communication using infrared (IR) light. This is known as consumer IR technologies

- In 2008, MRV Communications introduced a free-space optics (FSO)-based system with a data rate of 10 Gbit/s initially claiming a distance of 2 km at high availability. This equipment is no longer available; before end-of-life, the product's useful distance was changed down to 350 m.
- In 2013, the company MOSTCOM started to serially produce a new wireless communication system[8] that also had a data rate of 10 Gbit/s as well as an improved range of up to 2.5 km, but to get to 99.99% uptime the designers used an RF hybrid solution, meaning the data rate drops to extremely low levels during atmospheric disturbances (typically down to 10 Mbit/s). In April 2014, the company with Scientific and Technological Centre "Fiord" demonstrated the transmission speed 30 Gbit/s under "laboratory conditions".

VII. Conclusion

This paper gives us idea about the revolution of the free space optic. The many communication problems are solved by using this networking technique. Today there many challenges are faced by this technique such fog, rain, due bad weather signal transmission speed decreases. The major issue of this technique is that open outdoor communication in open atmosphere result in signal attenuation. To improve reliability, a number of new methods are being applied.

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