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Extended Abstract

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Advancements in free space optical communication

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The technology of optical communication has gained importance due to high bandwidth and data rate requirements. The thrust areas of research under Optical Communications include Optical Wireless links, WDM, wavelength interleaving, newer modulation formats, etc. In recent, different scenarios of optical communication techniques like WDM, RoFSO, and bidirectional link and under water optical transmission are benefitted to utilizing optical bandwidth in the field of Free Space Optical communication (FSO). Free Space Optical (FSO) communication is capable of providing cable free communication at very high data rates up to Gbps. It is a growing area of research these days due to its low power, bandwidth scalability, unregulated spectrum, mass requirement, rapid speed of deployment and cost-effectiveness. Recent growth of FSO is evidenced by vast improvement in communication technology, resulting in investigations of many exciting simulative and experimental implementations. However, the system is influenced by unpredictable atmospheric and weather conditions, therefore it degrades the optical link performance. Current works are focusing on research trend and recent advancements in FSO communication. Solutions to make FSO an efficient technology, architecture for future mobile communication system are portrayed. The reliability of the FSO link can be improved by constructing atmospheric chamber as prototype to study free space channel and its characterization can be done under a controlled environment without the need for longer waiting times as would be in the case of outdoor FSO links. To mimic the outdoor environmental conditions, an indoor chamber equipped with fans and heating coil is made up, which gives manual control of the temperature and wind velocity within the chamber. We have tried to characterize the combined effect of the wind and the temperature induced scintillation on the FSO system. The effect of perpendicular wind flow on a rain interrupted FSO link is also experimentally investigated using a laboratory tested. Performance analysis of various modulation formats in terms of their communication metrics has been evaluated. In brief, the experimental analysis of Free Space Optical Link under controlled atmospheric turbulence created within an indoor chamber, which replicates the outdoor environment. The free space needs to be characterized and optimized to maintain a particular strength of turbulence. The performance of the link is evaluated by calculating the parameters like BER, SNR, min. received power etc. To increase the model's credibility to an acceptable level, simulation work is done for verifying the model correctly and validating an accurate representation of the real system.

Free space optical (FSO) communication is the wireless transmission of data via a modulated optical beam directed through free space, without fiber optics or other optical systems guiding the light. The fundamental idea goes back to ancient times, as light (or smoke) signals were used to transmit information. From a more modern point of view, Graham Bell's patent on the photophone may mark the onset of modern FSO techniques, as it transmitted audio signals (i.e., voice) via the modulation of sunlight. A renaissance of FSO systems started with the availability of lasers, light sources with high output power and high coherence, which allowed the accurate direction of the light beams over long distances. During the 1970s and 1980s the main proposed application of FSO systems was for secure and long distance (50–1000 km) communication, mainly targeted for ground–satellite or satellite–satellite communication. This focus changed drastically over the last decade as a new market for FSO grew in the establishment of high bandwidth data link and their integration over a locally restricted area.

The main competitors in this market are the fiber-based optical network, the RF communication system, as well as the low bandwidth copper cable-based system. In comparison to the closely related wireless radio frequency transmission, the higher frequency of the optical carrier (∼1014–1015 Hz) thereby allows for much higher transmission rates, comparable to those of typical fiber optic networks. On the other hand, the use of an optical carrier also results in much more directed beam propagation, which requires an undisturbed line-of-sight between emitter and detector. This restricts the application of most FSO systems to a range between a few hundred meters up to several kilometers, which are still favorable for distribution of high bandwidth networks over a locally restricted area. This makes FSO a highly attractive candidate for the 'last-mile' distribution of high-bandwidth Ethernet to the individual homes.

The simplicity of setup of FSO links, as well as their modularity, is thereby their biggest advantage, compared to fiber-based networks. It makes them not only highly cost efficient, but it eases the maintenance or allows for fast and easy upgrades, as it does not require any extensive and time-consuming installation – in contrast to the installation of fiber optic cables. This advantage makes FSO highly attractive for temporary installations (emergency or short-time high broadcast situations, such as the Olympic Games), as well as to overcome geometrical restraints (river, seas, etc.). As most detector and emitter systems are typically based on the same electro-optical components used for fiber optic networks, they seamlessly integrate and expand an existing network without complications in data handling.

Bottom Note: *This work is partly presented at New Frontiers in Optics, Photonics, Lasers and Communication Systems, May 13, 2019, Tokyo, Japan*