Advanced Research in Electrical and Electronic Engineering
p-ISSN: 2349-5804; e-ISSN: 2349-5812 Volume 6, Issue 1 January-March, 2019, pp. 1-5

http://www.krishisanskriti.org/Publication.html

A Review Paper on SAC OCDMA in FSO under different Weather Conditions

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Abstract— *The optical communication has the mostdramatic arena of research. The growth of extensive transmission capacity in networking fields defines that end user requirements for high bandwidth network services is at all-time demand. The upcoming need of telecommunication services is processing day to day not only for its faster capability purpose but also to accomplish high security in optical networks, which is an existence solution for an extensive transmission capacity. Therefore, SAC-OCDMA technique was introduced as the effect of Multiple access interference can be completely close out when the code sequences with fixed in-phase cross-correlation are used. In this study, the SAC-OCDMA with Multi diagonal code and diagonal double weight code with FSO is administered and anatomize under various weather conditions such as haze and rain. In this system Ten simultaneous users with 5Gbps data rate are valuated. The Effect of transmitted power and beam divergence are studied and tested in terms of Q- factor and BER.*

Keywords: *Optical Communication, Fiber Optical, Fiber Space Optic, BER, Attenuation.*

1. INTRODUCTION

In FSO, also called free- space photonics, refers to the transmission of modulated visible or infrared beams through the atmosphere to obtain broadband communication. FSO communication process is exposed to certain issues by distortions occurring in the atmosphere.FSO (Free Space Optics) is a wireless communication link that transmits the data in the form of visible infrared light beam. In FSO, the light beam is modulated through atmosphere to accomplish the communication. As name suggests "Free Space Optics", performs data transmission through free space such as air, outer space etc thus it did not require any physical media like fiber, wire to transmit the data. FSO is proved to be more powerful than wireless communication due to unaccountability of radio frequency inference.

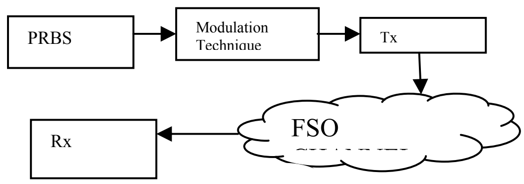

Figure 1: Block Diagram of FSO

The FSO design development should be done by considering the environmental conditions as a major factor. The environmental conditions like clouds, rain, and clear weather have highest impacts on FSO links. The conditions with high visibility level as well as low attenuation fall under the category of clear weather.

OCDMA is able to exploit the optical fibre bandwidth and is one of the most promising technologies that use CDMA. OCDMA uses optical components that are active or passive such as routing, switching, multiplexing the signal to encode and decode the signals. It is a type of internetworking and multiplexing technologies.

The OCDMA technique worked successfully in the wireless network and hence was adapted here also. If the destinations are different, the users can access the channel without waiting using the CDMA method[4]. Consequently, Hence, a detection technique known as Spectral Amplitude Direct Decoding Technique is proposed to suppress the effect of PIIN [5].

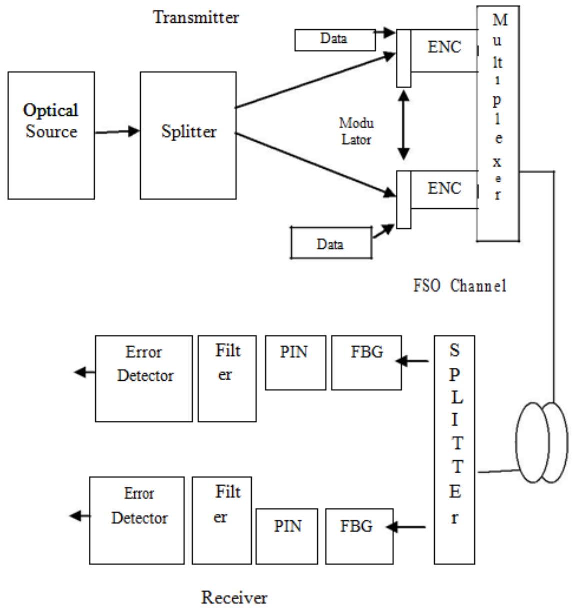

Figure 1: Block diagram of SAC-OCDMA

The SACOCDMA transmitter includes optical source, splitter, data generator, modulator and multiplexer. FBGs, PIN photodiodes, filters and error detectors are main components of SACOCDMA receiver. Encoder uses FBG which works in transmission and uses a broadband source and filters out everything except the frequencies present in the spectral code of the users. All the users in the same band share the same optical band width and content frequency elements in the system, they enter the channel asynchronously and without cooperation. The light field reflected from an FBG will be spectral encoded onto an address code.

All signals are combined using an N × 1 coupler onto one fiber to the Central Office (CO). The figure shows the balance detector used as receiver in SAC OCDMA. Balanced detection is used to eliminate MAI.

Many places use SAC-OCDMA FSO communication link for many services. Full description is given below:

- Outdoor wireless access: It can be used by wireless service providers for communication and requires no for using the SAC-OCDMA FSO as it is required in case of microwave bands.
- Storage Area Network (SAN): SAN is basically formed by SAC-OCDMA FSO links. This network provides access to consolidated, block level data storage.
- Last-mile access: To lay cables of users in the last mile is very costly for service providers as the cost of digging to lay fibre is so high and it would make sense to lay as much fibre as possible. The implementation of SAC-OCDMA FSO along with other networks can be used to solve such problem. It is also used for bypassing local-loop systems.
- Enterprise connectivity: Installation of SAC-OCDMA FSO system isvery easy. This feature makes it appropriate for connection of LAN segments to connect two buildings or other property.
- Fibre backup: A backup link can also be provided by SAC-OCDMA FSO if any failure transmission through fibre link occurs.

2. RELATED WORK

G. Kaur, et. al, (2017), have analyzed that Spectral amplitude coded Optical code division multiple access technique (SAC-OCDMA) has become a major area of research in optical communication. OCDMA allows multiple users to access a medium simultaneously without any contention. It has ability to operate asynchronously, provide privacy and security and reduce multiple user interference. In this paper performance of SAC-OCDMA with Diagonal double weight (DDW) code with FSO communication system is presented and compared under different conditions of rain and haze. 10 simultaneous users with 5Gbps data rate are evaluated in the system. Effect of transmitted power and beam divergence is also studied. Results have been formulated based upon eye diagrams and values of Q- factor and BER. Maximum distance covered is 10 Km with BER of 10−25 under clear weather. Simulation results show that DDW code is able to perform well at low power values also.

A. Priyadarshi, et.al, (2017), have depicted that Spectral Amplitude Coded-Optical Code Division Multiple Access (SAC-OCDMA) allows several users to transmit simultaneously over the same channel. Each of the users is assigned a code which is a part of orthogonal codes. The channel studied in this research paper is Free Space Optical (FSO) channel FSO has been an area of study in the field of communication because of the varied advantages it offers. FSO channel offers more realistic model in the communication domain. The FSO channel has a limitation that it provides different attenuation for different weather conditions which may include rain, clear, fog and haze weather condition. Hence it is sensitive to the weather condition prevalent in the region. This paper analyses the Bit Error Rate (BER) for different weather conditions. At the receiver side the detection scheme used is Single Photodiode Detection (SPD). Using a single photodiode reduces the shot noise and increases the optical to electrical conversion.

R. Li, (2017), have proposed a novel coherent optical code division multiple access (OCDMA) system for free space optical (FSO) communication for reducing the impairment from the turbulence-induced scintillation and improving the receiver sensitivity. Based on the scheme designed, the laser is modulated by phase shift keying and demodulated without the help of local laser. The error probability expression over atmospheric channels is derived. Simulation results show the effectiveness of the proposed scheme, and the performance of the novel proposed scheme is much better than that of the traditional coherent OCDMA system in overcoming the phase fluctuation. Therefore, the scheme is more suitable for multi-user access FSO communication in atmospheric turbulence channel.

W. A. Imtiaz, et.al, (2014), have analyzed that Optical code division multiple access (OCDMA) provides another dimension to multiple access systems in which each user is assigned a unique code. This allows each subscriber to simultaneously access the medium without any contention. However, simultaneous access of multiple users introduce multiple access interference (MAI) which primarily deteriorates the performance of OCDMA systems. This paper proposes a new code called diagonal double weight (DDW) code to elevate the performance and cardinality of spectral amplitude coding (SAC) OCDMA systems. Performance of our proposed code is evaluated using comprehensive analytical analysis followed by simulation analysis. Examination of bit error rate shows that DDW code along with single photodiode detection technique provides efficient performance, with added benefits of simplified design, large cardinality and ease of implementation.

R. K. Zakiah Sahbudin, et.al, (2012), In this paper, the performance of free space optical (FSO) communication system employing the spectral amplitude coding optical code division multiple access (SAC OCDMA) technique is presented. SAC OCDMA is one of the multiplexing schemes that have become a research area of interest in optical communication because of its flexibility in allocating channels, ability to operate asynchronously, enhanced privacy and increased network capacity. It utilizes Khazani–Syed (KS) code with spectral direct decoding (SDD) technique. The SAC OCDMA-FSO communication system was compared with the FSO system employing intensity modulation/direct detection (IM/DD) technique. The results of this study show that the performance of the proposed system is better than the system employing the IM/DD technique.

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, thereby 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

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-deploy ability

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 effect on the near-infrared wavelengths that are employed in FSO systems. Rain and snow have little effect 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 likes an 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 scattered. The physical size of the scattered determines the type of scattering.

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

1. 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 inwhich beams are launched.

IV. CONCLUSION

In the suggested work, 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. it was concluded that communication is affected by climatic factors in terms of its BER and Q-factor value. Weather conditions such as rain and haze deteriorate the quality of signal transmitted could be evaluated from the analysis. Communication can also be affected by the distance between the source and the destination. The communication system is evaluated for the affects and variations produced in system and signal deterioration under the atmospheric conditions.

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