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REVIEW ARTICLE

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Review of WDM based Free Space Optics Communication System

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***Abstract*— Free space optic communication provide high speed, large bandwidth, low power, smaller size and efficient communication. FSO is license free and widely used for long range of distance operating under different atmospheric conditions. One of the critical problems facing with long range FSO communication is atmospheric turbulence which result degradation in signal. Free space optics (FSO) technology has various advantages over different communication systems such as higher data rates/speed, bandwidth and capacity despite of these advantages, it has attenuation problem which can degrade the system performance. By using Wavelength Division Multiplexing (WDM) over FSO link, the system capacity can be increased. This literature survey deal with the FSO communication system, features of FSO system and atmospheric turbulence on WDM-FSO communication link in the existing method.**

Keywords—Atmospheric effect, WDM-FSO, Bit error rate (BER), Q-factor, attenuation.

I. INTRODUCTION

Free Space Optic (FSO) communication is solving the bottleneck broadband connectivity problem. FSO provide the higher data rate up to 10Gbps. Data rate provide by FSO links continue to increase in both long and short range applications. FSO technology depends on the propagation of optical beam through various media such as outer space, air, vacuum or something similar to wireless transmission.[1] FSO is capable of up to 10Gbps of data rate, operating between 780- 1600 nm wavelengths. FSO allow optical connectivity without requiring Fiber-optic cables. While the FSO communication also called outdoor optical wireless communication. Free Space Optic require light which can focus using Light Emitting Diodes (LEDs) and Lasers. The use of laser is similar concept as optical transmission using fiber-optic cable but the difference is medium of transmission. [2]

The subsystem in an FSO system is illustrated in "fig.1." Source information is provided to modulator.The modulation of source data generally take place in diggerent ways; Amplitude modulation (AM), Frequency modulation (FM), Phase modulation (PM). For optical wave often used modutation technique is Intensity modulation (IM).
The data is transmitted by external modulator, such as Mach-
Zehnder modulator to Laser diode. FSO generally used VCSELs, Fabry-Perot and DSF Lasers. Other laser are not suitable for high performance FSO system. In the receiver side inverse operation is realizes, where photo-detector convert the optical signal back into electrical form. In other word receiver at the other end collects the light using lenses and mirrors. The atmospheric attenuation is one of the most factor effect the FSO channel.[3]

The rest of the paper is organized as follow: section II discussed the features of FSO system, in section III the wavelength division multiplexing (WDM) is described. Literature survey is discussed in section IV and then conclusion is given in section VI.

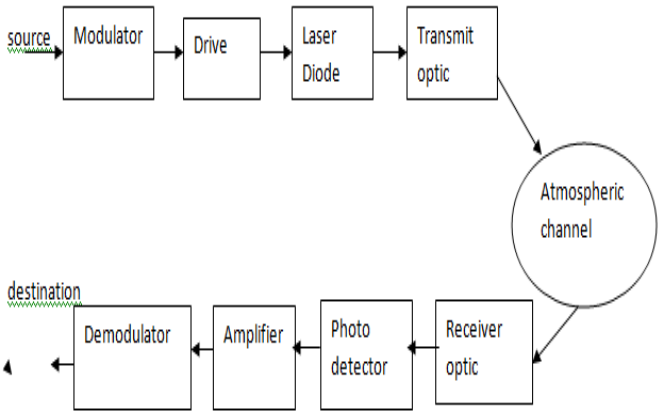

Fig.1. Block diagram of Free Space Optic

II. FEATURES OF FSO SYSTEM

High Data Rate- FSO system provide high data rate at low Bit Error Rate (BER) and bit rate is upto 10Gbps.

Less interference, low power consumption- FSO

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system consume low power and providing less interference. Fresnel zone is not necessity in it. It can provide full duplex operation.

Higher security, cheap- Higher security feacture is provided by Free Space Optic communication. Cost of FSO system is lower as compared to Fiber-Optic system due to no need of wire in FSO system so FSO system is cheaper than Fiber-optic system.

Long range operation- FSO communication link used for long range operation due to its higher data rate

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Narrow beam size- Transmitted power is concentrated with in a very narrow area because laser beam has divergence betweem 0.01- 0.1 mard.[4]

III. WAVELENGTH DIVISION MULTIPLEXING (WDM)

WDM systems are mainly popular with telecommunication companies. The first WDM systems were capable for combined only two signal. But modern WDM systems can handle160 signal and 320 channel system is also present. WDM system are divided into three sections; normal (WDM), coarse (WDM), and dense (WDM).Where normal WDM system uses 1310 nm and 1550 nm wavelengths. Dense WDM uses C-band (1530 nm-1565 nm). Coarse WDM provide 16 channel across multiple transmission.

A WDM system uses multiplexer and de-multiplexer. Multiplexer is used at transmitter side to combine the signal of different wavelengths. Where the de-multiplexer is uses at receiver side to apart the signals. Basic wavelength division multiplexing system is as shown in “fig.2.”

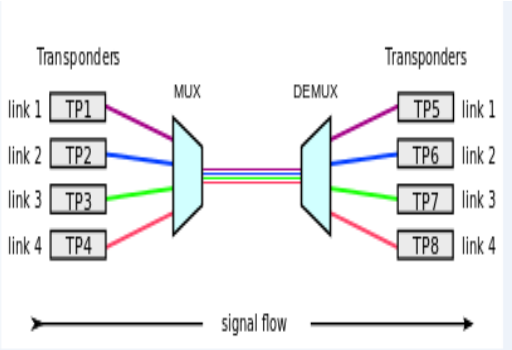

Fig.2. Basic WDM system

WDM system is achieved high data rate and higher capacity. WDM system overcome the signal degradation in FSO system due to its higher capacity.

IV. LITERATURE REVIEW

An extended literature has been reviewed related to Free space optic (FSO) communication system under different weather condition. Some of the research work has been discussed as:

A. MULTIPLE TRANSMITTERS AND RECEIVERS FSO SYSTEM WITH VARIOUS AMPLIFIERS

Harneet kaur, Himali sarangal,[5] has investigate FSO system using 4X4 Transmitter Receiver combination integrated with various type of amplifier under different weather conditions. By using the feasible system parameters for 4X4multiple transceiver FSO system integrated with pre-amplification, maximum range of 425 km can be achieved for acceptable received power under clear weather condition. With the use of multiple transceiver and optical pre-amplification along with APD receiver, FSO system work up to 425 km with acceptable received power and BER under clear weather condition. On the other hand foe EDFA and TWT this range is 200 km and 194 km respectively. With increase of atmospheric attenuation as the weather condition gets worsen, the maximum achieved distance can extended up to 3.25 km and 2.27 km for optical pre-amplification and TWT pre-amplification respectively with acceptable received power and BER.

B. WDM-FSO LINK UNDER AHMEDABAD WEATHER CONDITIONS

Simulation of Wavelength Division Multiplexing (WDM) based Free Space Optic (FSO) link for different weather conditions in Ahmedabad are purposed by Daval Shah, Dilip Kumar kothari [6] the performance of WDM based FSO system is analyzed by using parametric optimization. The minimum value of BER achieved is greater or equal to 10^{-9} for optimized link range at data rate 2.5Gbps. the optimized link range for light rain, medium rain and heavy rain is achieved as 15.6 km, 6.1 km and 3 km.

C. TERRESTRIAL WDM-FSO LINK UNDER DIFFERENT WEATHER CHANNEL

The performance of WDM-FSO communication system is simulation analyzed by Mazin Ali, A. Ali,[7] using NRZ modulation technique over different weather conditions. Based on this technique the received signal

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power , signal to noise ratio, Q-factor and BER are analyzed. Simulation results indicate that the performance of WDM-FSO is more suited for strong attenuation. On the other hand, the suitability of distance link under this technique is suited, where WDM has more advantage when used in optical communication system.

D. POWER EFFICIENT, LONG REACH WDM-FSO SYSTEM

The concept of laser power is analyzed by changing the power level and the performance is compared with that of system with constant power. FSO requires free space as the medium of communication. Attenuation caused by the medium can degrade a system performance. To overcome the effect of these losses due to attenuation, either the data rate is decreased or the laser power is increased. Aditi, Preeti,[8] has been found that for higher attenuation, there is no significant decrease in link distance where as the power is reduced from 40 dBm to 10 dBm.

E. WDM-FSO LINK UNDER TURBULENCE CHANNEL

The performance analysis of FSO communication link in various atmospheric turbulence has been analysis for different bit rate using NRZ and RZ technique. The effect of turbulence on link performance has been investigate by varying bit rate, turbulence strength and modulation format. Simulation results show that RZ format is best for strong turbulence. Where NRZ technique is used for low and medium turbulence. Mazin Ali A. Ali,[9] has observed that RZ modulation gave us better performance in comparison to NRZ modulation under strong turbulence because RZ format has a strong carrier component to NRZ format. When the atmospheric turbulence is increased and reached to strong turbulence, then the maximum link is reduced with acceptable BER.

F. FSO SYSTEM WITH SPATIAL DIVERSITY

Reeba Roy, Jain Sara Baba [10] investigates Multiple TX/RX Free Space Optic system under clear, haze and fog conditions using Q-factor, Bit Error Rate (BER). Use of multiple TX/RX in the Free Space Optic system increases the performance of FSO system under different atmospheric disturbances. Spatial diversity in the FSO system increased the efficiency of systems under different disturbance. Even though Q factor of FSO system decreases on increasing attenuation , the 4 TX/4 RX shows higher Q-factor so better performance.

V. CONCLUSION

In this paper, the features and several design parameters in FSO communication are discussed. This literature survey has been reviewed related to Free Space Optic (FSO) communication system with main focus on study of different atmospheric condition. The Work done by different researches in field of FSO system using so many techniques and methods is discussed in literature survey. Finally it has been concluded that the WDM based FSO system give best performance under different atmospheric channels.

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