Design & Performance Analysis of MIMO-FSO Communication System Based on Four channel Spectrum Slicing using AM Technique

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Abstract - *In this paper, the Spectrum slicing is proposed for multiple beam FSO. This technique is used to effective price & power efficient for MIMO-FSO to satisfy the growing worldwide demand for transmission capacity. The SS-WDM-MIMO-FSO communication system has been completed and investigated for four channel FSO with data rate up to 10 Gb/s using a CW laser and source power of 0 dBm to 4 dBm. The wavelength is 1550.11nm to 1552.52nm and frequency is 193.1 THz to 193.4 THz . The ASE source is realized using four EDFA amplifiers, in cascade mode. The attenuation offered by completely different weather condition can decrease the system performance by using optical amplifier. The system performance can be the effect of attenuation. It is incontestable that SS-WDN-MIMO-FSO system are able to offer information transmission for downstream traffic in 2.5 kilometer with <10-9 by using amplifier modulation technique. The result shows the benefits of SS-WDM are excited on the environmental conditions which increase performance of system. The susceptibility of FSO towards atmospherically attenuation has introduced the need MIMO system in FSO system because the finest solution. This technology can be an alternative backup to already establish MIMO-FSO link effectively. The response of MIMO-FSO using Amplitude Modulation technique in in terms maximum achievable BER.*

Key Words: *SS-WDM, FSO, BER, EDFA, AM*

1. INTRODUCTION

Now a days, Free Space Optical (FSO) communication has been broadly researched in order to take advantage of beneficial properties over wired communications such as optical fiber [3]. It is used as a communication channel/medium [1]. Free space communication has wide bandwidth, high data rate capacity, high security and easy link installation [2]. As long as there is a clear line of sight between the source and the destination FSO communication is possible [3]. Optical connection between source and destination has been provided by using Laser diode and Photo detector [1,2]. It can transmit data, voice or video at speed capable of reaching 2.5Gb/s to 10Gb/s .The range of FSO transceiver up t 500 m to 3000 m. It is a full duplex technique .Freedom from licensing and regulation [15-19].

Moreover all optical FSO has the advantage of allowing efficiency high speed implementation at Gb/s rates within

longer distance without the need for optical-electrical-optical process [3]. It is a communication technology which involves using these OWC link in outdoor terrestrial regions where there is a clear line of sight, favoring a point to point communication over distances upto several kilometers [10].
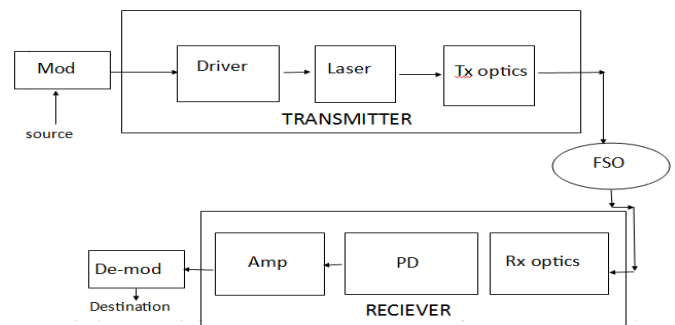

Fig - 1: Block diagram FSO communication

This is an emerging field which uses invisible beams of light to provide optical bandwidth connection with a data rate up to 10Gb/s, enabling voice, data and video communications simultaneously in air, without the need of any physical fiber optical cable. Each optical unit consist of an optical source, lens or telescope that transmit light though the atmosphere to another lens receiving the information [10].
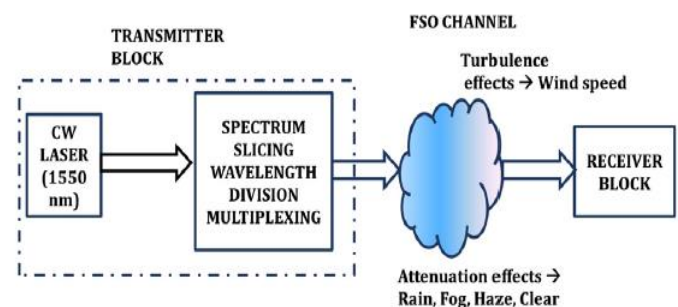

Fig - 2: Architecture of Spectrum slicing wavelength Division Multiplexing [1]

Although WDM access network use spectrum in the distribution link to support multiple user at high bit rate and FSO has the potential to achieve higher reliability and capability [3]. The advantage of WDM technique enables

bidirectional of communication system and multiplication of capability [3]. Above all, it is the adoptive and scalable network architecture, which can support high bandwidth and wide coverage area over the heavy rain weather in FSO space [2]. This method of spectrum slicing is a cost efferent, suitable and promising solution for transistor in optical line of Dense WDM free space optical [19-22]. Mainly high power ASE source with flat spectrum in more suitable for the use in homogenous WDM optical system because it is very important to obtain spectrally slicing channel with equivalent output power levels [19-22]. There are several modulation scheme that can be implemented in FSO channel like OOK, PPM, PAM, DPSK, BPSK, QPSK etc. which enhances the performance of the system [9,10].

FSO performance is adversely affected by the environment through which it propagates. The basic and the main cause of interference is the atmospheric turbulence and fog (10–100 dB/km). These particles modify the light characteristics and hinder the passage of light. This in turn decreases the power density of transmitted beam and decreasing the effective distance of the FSO link [10]. In order to overcome this issue certain techniques like SS-WDM were implemented. This serves the best by providing higher capacity and a wide coverage area which facilitates more number of users. It is a scalable network which marks its specialty in the optical networking communication [21-23].

This paper is centered towards increasing the number of channels to increase the performance using SS technique. The paper is organized as follows: section 2. discusses-investigation SS-WDM-MIMO-FSO

2. The principle of Spectrum Slicing Wavelength Division Multiplexing (SS-WDM)

SS-WDM are allows significantly slicing wide waveforms in lower speed slices and transmits each separate slice in parallel. Parallel transmission of slicing from a single broadband noise source has a highest potential for creating a multichannel system. SS has a higher potential for future fiber to home access network which can further be incorporate in any optical system where low power consumption is preferred & it is used to enable a single optical laser serve multiple end-points. Each customer is connected into the optical network via a free space optics [1].Wavelength division multiplexing access network use spectrum slicing in the distribution link to support multiple user at very high bit rate and FSO the potential to achieve highest reliability and capacity. SS-WDM is adoptive and scalable network architecture and it is also support high bandwidth & wide coverage area over rain weather in FSO. SS work is configured using DEMUX that is used to disperse power for the signal being transmitted [1,2].
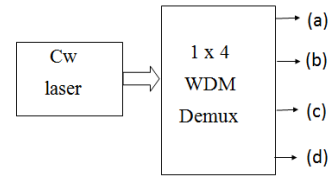

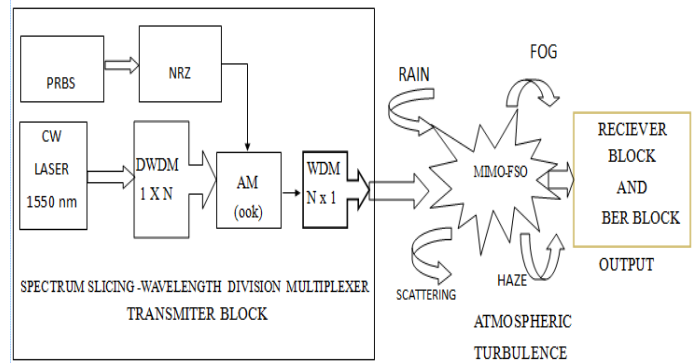
Fig - 3: Optical spectrums 1×4 WDM Demux

Fig - 4: Block diagram of SS-WDM- Free Space Optical Communication

A single CW laser is connected to 1×4 WDM Demux for dispersing the lighting source. The signal is divided into four channels as shown in Fig. 3, each having a different frequency with channel spacing. Each sliced channel is then transmitted to the Point-To-Multipoint (P2MP) in each optical line terminal as discussed.

3. Related work

Prabu k., et al. [2017] SS-WDM has subjected to numerous implementation from increasing the quantity of user to analyzed the performance by considering beam divergence as an element. The performance of SS-WDM-FSO and WDM-FSO system are analyzed to recording are compared and result tabulated. It is observed that the link distance is inverse associated with attenuation. if attenuation is increase attenuation increasing then visibility is decreased , if attenuation is decreased then visibility is increased. SS-WDM provides less BER compared to causing out the signal while not applying slicing. Rashidi F., et al.[2017] The SS-WDM FSO system has been complete and investigated for four DE-MUX channel with data rate upto 1.56Gb/s employing a CW optical laser supply with and while not SS technique. The simulation result shows that the SS-WDM technique data rate 1.56 Gb/s is achieved over a transmission distance 2.5 km, BER 9.86 and power of 10 dBm. Thakur A., et al [2017] The purpose of Super continuum spectrum slicing WDM FSO system is evaluated at 2.5 Gbps data rate up to 5 km. The analysis has been applied for various atmospherically instabilities like clear weather, haze, medium rain and fog. SC-SS-WDM-FSO system exhibits batter than WDM-FSO in term of Q factor and BER beneath totally different atmospherically turbulences. Das S., et al

.[2016] The proposed of implementation of FSO provide optical bandwidth connection providing a high data rate then different technology. FSO systems have provided to be very effective means that of communication in present situation in-spite of facing atmospherically disturbances and condition. The optisystem is implementation PPM modulation theme performs; in term of maximum Q-factor, and minimum BER higher than that exploitation ASK modulation technique. Q-factor of FSO for PPM for haze is the highest being 10.7286. ASK mistreatment PIN photodiode higher than PPM, wherever APD work higher for ASK. Chaudhari S., et al.[2014] This is investigation the performance of an FSO system with OFDM and QAM. The 4-level QAM may be transmitted 10Gb/s within the FSO system below completely different weather. Results indicate that the mixture of SOA prolongs the utmost potential distance with acceptable SNR to 185 metric quantity below clear weather conditions whereas below region fog, the utmost distance is extended to a mix of 2.5 km. Murphy E., et al [2014] The proposed of the DWDM-PON use in aircraft and considered a method of reducing power consumption of the network using pre amplification. Through the analysis of power consumptions, it has been shown that power savings around the order of 40% could be realized at the transmitters and associated cooling in realistic conditions. Beri B., et al.[2014] The Propose of the WDM-FSO is investigated and found with success institution of communication link. The simulation results indicate the trade-off between simulation parameters at a pair of.5Gbps below clear weather the BER value 3.41661e-012 is achieved for 180 kilometers whereas at 30 dB, optical maser power 30cm aperture the BER value of 1.81523e-021 is achieved 300 kilometers transmission distance.

4. Simulation Design & Results Discussion

In this paper, the simulation carried out optisystem 15.0 version. The SS-WDM is proposed for MIMO-FSO is a cost effective and power efficient for MIMO-FSO to satisfy the growing worldwide demand for transmission capacity. The simulation layout shown in fig-5. We have described 4 channel amplitude spontaneous emission source is simulated by amplification of broadband noise source using erbium doped fiber amplifier(EDFA). To reduce the negative impact of intensity noise as well as cross amplitude modulation the correct choice of filter shape & low pass bandwidth is very important. In fig. 8 are 4 SS-WDM-MIMO-FSO communication system channels frequency 193.1 to 193.4 which are flat signal. The system described above has been simulated using given parameter in the table-1 & table-2.
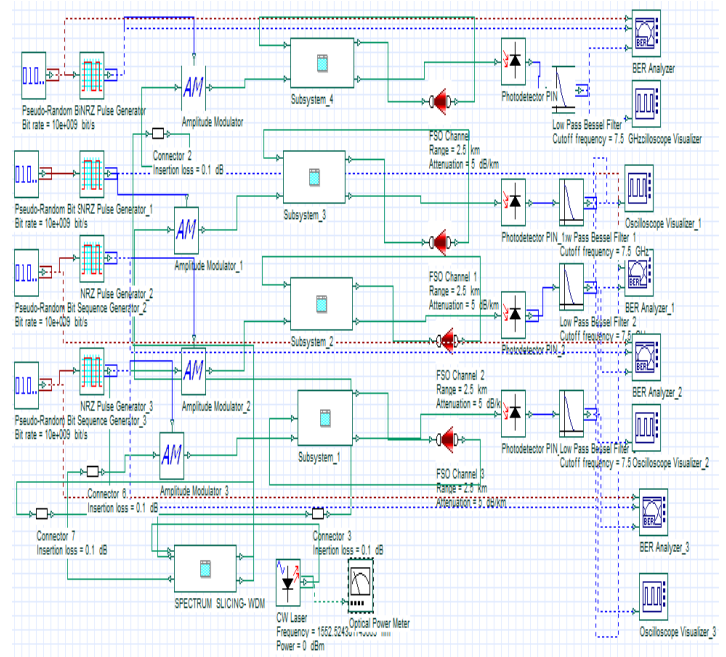

Fig -5: Simulation layout of SS-WDM-MIMO-FSO

The SS-WDM-MIMO-FSO system has been realized and investigated for four channel FSO with data rate upto 10 Gb/s using a CW laser using source power has 0 dBm to 4dBm and wavelength is 1552.52nm to 1554nm. The ASE source is realized using four EDFA amplifier in cascade mode.
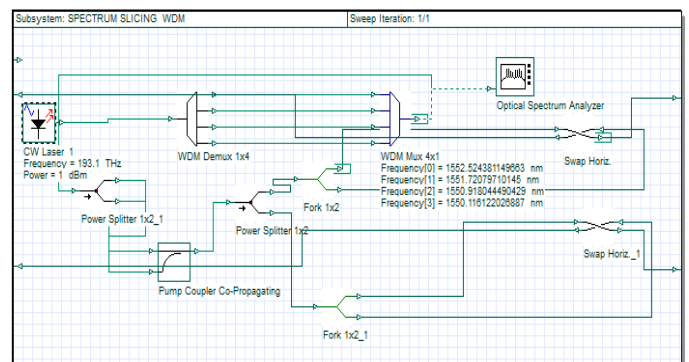

Fig-7: Subsystem of SS-WDM

Table -1: Design parameter specification

S. No	Devices	Parameters	Values
01	PRBS Generator	Bit Rate	10 Gb/s
02	WDM system	Wavelength	1550.11-1554
03	CW LASER	Frequency	193.1THz-193.4THz
		Power	0 – 4 dBm

		Line-Width	10MHz
04	EDFA Amplifier	Gain	35dB
		Noise Figure	30dB
05	Modulation Technique	Amplitude Modulation	Single Each User
06	Connector	Insertion Loss	0.1dB
07	Free Space Optics	FSO	4
		Range	2.5km
		Attenuation	5dB/km
		TX Aperture Diameter	5cm
		Rx Aperture Diameter	20cm
		Beam Divergence	2mrad
		Tx & Rx Loss	0.1 dB
08	Low Pass Bessel Filter	Cut off frequency	7.5 GHz
09	Photo Detector PIN	Dark current	10nA
		Responsibility	1A/w

The performance of the system is analyzed by using optical power meter, BER analyzer, optical spectrum analyzer. The system can work only upto 2.5km for data rate of 10Gbps.
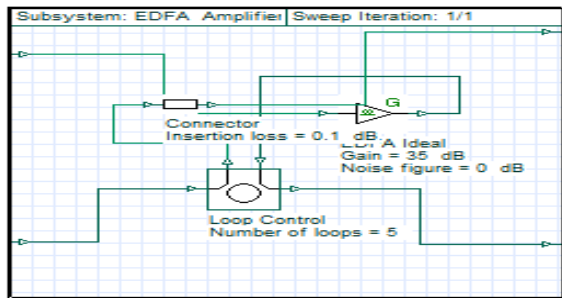

Fig- 6: Subsystem of EDFA amplifier

Table -2: Design parameter of BER

Power (dBm)	Bit Error Rate(dB)			
	Channel1	Channel2	Channel3	Channel4
0	-23.4	-22.5	-36.8	35.8
1	-47.1	-45.1	-36.8	-35.8
2	-38.4	-35.9	-47.7	-38.2
3	-75.7	-73.3	-59.0	-58.2
4	-64.1	-84.2	-48.7	-73.9

In this paper simulation modeling of a SS-WDM-MIMO-FSO communication system is successful establishment of different wavelength of frequency with 2.5 kilometer with each FSO channel data rate 10 Gb/s has been transmit through SS-WDM-MIMO-FSO. The ASE source is realized using four EDFA amplifiers, in cascade mode. The attenuation offered by completely different weather condition can decrease the system performance by using optical amplifier. The system performance can be the effect of attenuation. It is incontestable that SS-WDN-MIMO-FSO system are able to offer information transmission for downstream traffic in 2.5 kilometer with <10-9 by using amplifier modulation technique. The result shows the benefits of SS-WDM are excited on the environmental conditions which increase performance of system. The susceptibility of FSO towards atmospherically attenuation has introduced the need MIMO system in FSO system because the finest solution The simulation result indicate the tradeoff between simulation parameter, the BER value of -22.5 dB to -84.2 dB is archival for 2.5 km while 0 to 4 dBm laser power, EDFA optical amplifier has noise figure is 30 dB and Gain is 35 dB, the effect of filter used the received and environmental effect on FSO in which Attenuation is 5dB/km. the susceptibility of FSO towards atmospheric attenuation has introduced the need of MIMO technique in FSO system as the finest solution. This technology can be an alternative backup to already establish MIMO-FSO link effectively.
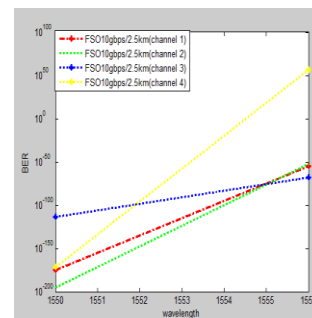

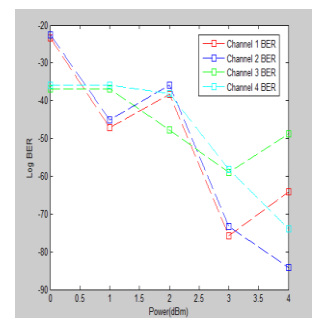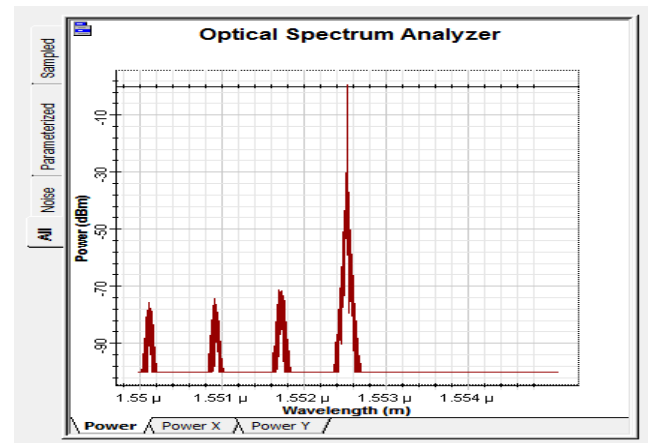**Chart -1**: BER vs Wavelength   **Chart -2**: BER vs Power

Fig-8: optical spectrum analyzer

The attenuation offered by different atmospheric condition can degrade the system performance. By using appropriate optical amplifier, the susceptibility of FSO towards atmospheric attenuation has introduced the need of MIMO technique in FSO system as the finest solution. This technology can be an alternative backup to already establish MIMO-FSO link effectively. The response of MIMO-FSO using Amplitude Modulation technique in terms maximum achievable BER

5. CONCLUSIONS

In this paper simulation modeling of a SS-WDM-MIMO-FSO communication system is successful establishment of different wavelength of frequency with 2.5 kilometer with each FSO channel data rate 10 Gb/s has been transmit through SS-WDM-MIMO-FSO. The simulation result indicate the tradeoff between simulation parameter, the BER value of -22.5 dB to -84.2 dB is archival for 2.5 km while 0 to 4 dBm laser power, EDFA optical amplifier has noise figure is 30 dB and Gain is 35 dB, the effect of filter used the received and environmental effect on FSO in which Attenuation is 5dB/km. the susceptibility of FSO towards atmospheric attenuation has introduced the need of MIMO technique in FSO system as the finest solution. This technology can be an alternative backup to already establish MIMO-FSO link effectively. The response of MIMO-FSO using Amplitude Modulation technique in terms maximum achievable BER.

6. ACKNOWLEDGEMENT

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