Design of multi user free space optical communication system for Three Dimensional SPPDD for OCDMA

Amanpreet Kaur*1, Neetika Soni*2

*Student & Communication Systems & Guru Nanak Dev University Regional Campus, Jalandhar
Punjab, India

Abstract— 3-D W/T/P encoded signal transmitted over free space optical link under the effects of atmospheric turbulences i.e. haze, fog and clear weather. System performance is best when clear weather attenuation is considered (0.1dB/Km) and results degrades in case of Haze (4dB/Km) and worst in Fog (20dB/Km).This system analyzed at varied distance for all the three turbulences, also effect of amplifiers observed to mitigate the effects of attenuation. In all the systems discussed earlier SPPDD coding used (Single Pulse Per Plane with Direct Detection).

Keywords— OCDMA, 3-D codes, Wavelength, Time, Polarization, W/T/P, SPPDD, FSO

I. INTRODUCTION

Optical CDMA over Free Space Optics (FSO) communication is very efficient to provide high data rate for transmission having low BER and Multiple Access Interference (MAI). From previous papers it is cleared that W T P (Wavelength Time Polarization) provides better results than W T S (Wavelength Time Space) for Q-factor. In this we use W T P for FSO at W=T=4 keeping P=2. FSO is advancement over optical fiber because in this communication which is limited to the distance and require more resource management.

Firstly we discuss about W T P. Author found that extremely short pulses in 1-D (time domain) OCDMA have limited ability to support large number of users. To overcome the limitations of 1-D, 2-D OCDMA networks (utilizing both time and wavelength) are used. 2-D OCDMA reducing the collisions while simultaneously increasing the number of supported users in the system but these 2-D code sets does not support enough number of users in LAN for large scale. To increase the number of users 3-D code sets are used for short distances optical LANs, polarization states remains stable [1].

3-D time/wavelength/polarization encoding and decoding OCDMA system. In this number of potential users increased, by a factor 2k over a conventional 2-D code given the same code constraints, “k” is number of collisions the code set will allow. By varying the data rates we find the effects of BER using 3-D OCDMA codes having dimensions in time, wavelength and polarization [2]. Q-factor decreases, BER increases with increased data rate. At lower data rates have good Q-factor. Simulations done till 4gbps system gives good BER and these codes suitable for LAN to transmit data for single user [2].

ODCMA are used for transmitting high definition audio and video content, exploring sensor technology in medical to military and hospital environment. Increase in data in form of voice, video and text at each user end there is need to send data within high capacity channel catering more number of users. For that OCDMA as multiple access technology is explored. In this author presented a technique that, when employed doubles the number of active users. The transmission of 10 active users with data rate up to 5gb/s per user at variable received power with acceptable BER is presented using newly developed 3-D codes [3] A 3-D wavelength/time/space Multiple Pulses per Row (MPR) using zero transmission length of the system provides acceptable BER less than 10e-9. 3-D W/T/S MPR OCDMA system suitable for LAN [4]. To increase the number of users 3-D W/T/P MPR codes into an OCDMA system. This system supported eight simultaneously users with acceptable BER at 18 gbps with attenuation of -15 db for 100 km optical fiber length [5]. W/T/S has many limitations that its Q-factor in not so good for the increased fiber length so here we find that W/T/P has good Q-factor. Author proposed a wireless optical mesh network based on the OCDMA coded free space optical links. This network under the intermediate and strong turbulence channel conditions is investigated for the synchronous and asynchronous OCDMA [6]. An advanced wireless technology cable of providing higher data rates than current RF technologies is preferred to support efficient and reliable transmission. FSO communication that deploys optical links in the atmosphere without the use of optical fibers. For Line Of Sight (LOS) communication link, laser based FSO communication has many advantages over RF technologies. Author found security problem in subcarrier intensity modulated air to ground FSO communication system over the atmospheric turbulence using the reciprocity property of the FSO channel, by introducing the secret sharing and key agreement approach [7]. In this author found that Optical CDMA over the FSO communication systems at data rate 2.5 Gbps for 8000m distance. NRZ technique provides better performance as compared to RZ in optical CDMA over FSO communication and gives that transmission range decreases with increase in transmitter power. Efficiency of OCDMA over FSO communication system is decreased by increasing the users [8].

FSO communication has been used through the transmission of information which is loaded with optical radiations from a transmitter to receiver, separated by the atmosphere. Author gives description of transmitting high data rate over FSO link by
employing two OCDMA coding techniques i.e NRZ and RZ and finds that the performance of NRZ is better than other techniques [9].

II. SIMULATION SETUP

In FSO simulation has been done in three different environment in clear weather (0.1db/km), in haze (4db/km) and fog (20db/km). In this simulation setup W=T=4 at P=2 (W T P FSO) as shown in fig.1 for clear weather. W T P FSO consists of a transmitter, encoder at transmitter side, decoder at receiver side and FSO for transmission of data. Same as above at transmitter side two polarization channel. At P=2 there are total eight wavelengths and these wavelengths are range from polarization channel wavelength range from 1549 to 1551.4 nm. Each wavelength differs from a frequency spacing 0.8 nm. The input data bit sequence is at rate of 1Gbps after that coded light signal modulates the input data. The modulator is driver by modulator driver which decides the input data format and modulator uses in both setups is Mach-Zehnder modulator. The input data is NRZ. The modulated data is encoded in the encoder first four channels and other channels at polarization 0˚ and 90˚ respectively. Output of all encoder combine and sent to FSO at length (0.1km, 0.5km, 1km, 4km and 8km respectively). After that decoder is placed which decodes the data, it is just inverse of encoder and then receiver is placed.

III. RESULTS AND DISCUSSION

W T P for FSO, FSO is advancement over optical fiber because in this communication which is limited to the distance and require more resource management. In FSO simulation has been done in three different environment i.e. are clear weather (0.1db/km), in haze (4db/km) and fog (20db/km). We find that in clear weather Q-factor is better than in haze and fog. Fig. 2 shows that as the distance varied Q-factor is also varied and the Q-factor decreases in haze and fog as the distance increases. By varying the distance at in three different environments in clear weather (0.1db/km), in haze (4db/km) and fog (20db/km) with attenuation for W T P FSO, correspondingly Q-factor is measured and compares this varied distance versus Q-factor for all the wavelengths and find out that at which wavelength and time provides better results in which environment. By observing this graph we find out that in clear weather W T P FSO gives better Q-factor.
b) W=T=4, S=2 (W T P FSO) for fiber length fiber length 8km

Fig. 3 Eye Diagrams at S=2 for W=T=4 (W T P FSO under clean weather attenuation 0.1db/km) at fiber lengths 0.1km and 8km respectively.

a) W=T=4, S=2 (W T P FSO) for fiber length fiber length 0.1km

b) W=T=4, S=2 (W T P FSO) for fiber length fiber length 8km

Fig. 4 Eye Diagrams at S=2 for W=T=4 (W T P FSO under haze attenuation 4db/km) at fiber lengths 0.1km and 8km respectively.

a) W=T=4, S=2 (W T P FSO) for fiber length fiber length 0.1km

b) W=T=4, S=2 (W T P FSO) for fiber length fiber length 8km

Fig. 5 Eye Diagrams at S=2 for W=T=4 (W T P FSO under fog attenuation 20db/km) at fiber lengths 0.1km and 8km respectively.
TABLE I
EVALUATION W/T/P FSO AT DIFFERENT DISTANCE (KM) IN TERMS OF Q-FACTOR

<table>
<thead>
<tr>
<th>Distance</th>
<th>under clean weather attenuation</th>
<th>under haze attenuation 4db/km</th>
<th>under fog attenuation 20db/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1km</td>
<td>35.5984</td>
<td>35.6785</td>
<td>88.6817</td>
</tr>
<tr>
<td>0.5km</td>
<td>34.864</td>
<td>33.9379</td>
<td>25.8209</td>
</tr>
<tr>
<td>1km</td>
<td>33.2688</td>
<td>28.1524</td>
<td>0</td>
</tr>
<tr>
<td>4km</td>
<td>17.0776</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5km</td>
<td>5.7621</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig.6 to 8 shows the input signal at transmitter side, after that the data send to W T P FSO and received signal at receiver side.

Fig.6 Input and output signal for W T P FSO under clear weather at 0.1km

Fig.7 Input and output signal for W T P FSO under haze at 0.1km

Fig.8 Input and output signal for W T P FSO under fog at 0.1km
b) Output signal at Receiver

Fig. 8 Input and output signal for W T P FSO under haze at 0.1km

Conclusions

3-D W/T/P encoded signal transmitted over free space optical link under the effects of atmospheric turbulences i.e. haze, fog and clear weather. System performance is best when clear weather attenuation is considered (0.1dB/Km) and results degrades in case of Haze (4dB/Km) and worst in Fog (20dB/Km). This system analyzed at varied distance for all the three turbulences, also effect of amplifiers observed to mitigate the effects of attenuation. In all the systems discussed earlier SPPDD coding used (Single Pulse Per Plane with Direct Detection).

REFERENCES


