International Journal of Engineering Trends and Technology (IJETT) – Volume 12 Number 10 - Jun 2014

Modification in Parameter of Intersatellite Communication using Multiple Transmitter and Receiver

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***Abstract*— Free Space Optical Communication (FSO) is the three dimension high BW access global communication system. FSO communication is one of the major robust technology in 'Intersatellite Communication'. By using optisystem software, investigation of different parameters regarding intersatellite communication is done through virtual circuit and also studying the performance of intersatellite communication. Through this paper analysis of the received power and quality factor (Q-factor) at different distance between LEO-LEO communication is observed in the form of eye diagram. In this paper modification is done by using multiple transmitter and receiver for LEO-LEO communication over 5000km distance with maximum 10gbps data rate [1,2].**

***Index Terms*—FSO, Intersatellite Communication, LEO-LEO, Q-Factor.**

I. INTRODUCTION

At present high data rate communication is the huge demand in the world. FSO is the best paradigm of this demand i.e FSO is a most advanced topic for high data rate communication. FSO provide wider BW channel that supports larger number of user as compared to RF [3].

FSO mention its main benefits as: 1) there is no licensing necessity or tariffs for link accessing; 2) non appearance of radio frequency and short out the problem of radiation hazards ; 3) wide bandwidth which provide high data rates; 4) low power consumption[3].By using these optimum characteristics of FSO we can implement a virtual circuit by optisystem software for point to point communication between intersatellite link and analysis different parameter for improvement of intersatellite link performance.

Out of LEO (low Earth Orbit), MEO (medium Earth orbit), GEO (geosynchronous orbit), HEO (highly elliptical orbit) the satellites may be located in one of these orbit. For communication between these satellites a link is require. This type of communication link is known as intersatellite link in which satellite can be communicate directly through this link which is based on FSO communication concept [2].

II COMMUNICATION LINK SYSTEM DESIGN

By using optisystem 7.0 software design of intersatellite circuit is made which has three major parts transmitter, receiver and communication channel. At transmitting side pseudo-random bit sequence generator is a starting component that provide information which want to be transmitted in fig.1. A NRZ pulse genera tor generates a non return to zero coded signals. The basic function optical transmitter is to change the electrical signal into optical form. Mach-Zehnder modulator using a laser light signal as a carrier for input signal whose power set on 10dbm[4].

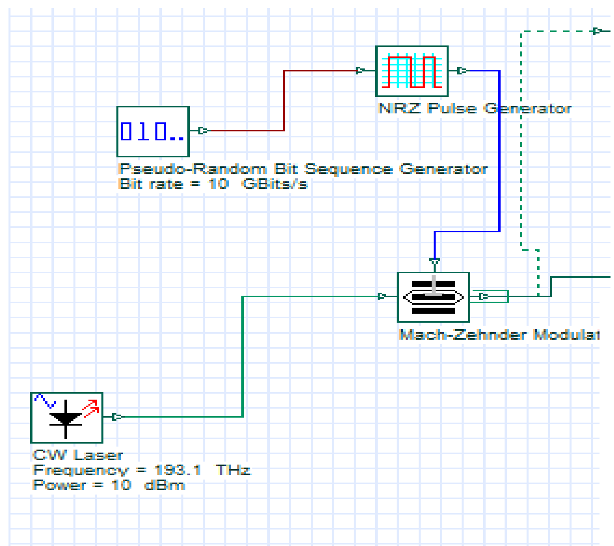


Fig 1 Intersatellite link transmitter

OWC channel or medium between an optical transmitter and optical receiver

The concept of wireless optical channel can be expressed in term of mathematically formula [5].

$$P_R = P_T \eta_T \eta_R \left(\frac{\lambda}{4\pi \cdot Z}\right) G_T G_R L_T L_R$$

P_R- Received optical power, P_T- Transmitted optical power η_R- optics efficiency of the receiver, η_T-optical efficiency of the transmitter, λ- wavelength, Z-distance between the transmitter and the receiver, GT-transmitter telescope gain, GR - receiver telescope gain, LT, LR -transmitter and the receiver pointing loss factor,

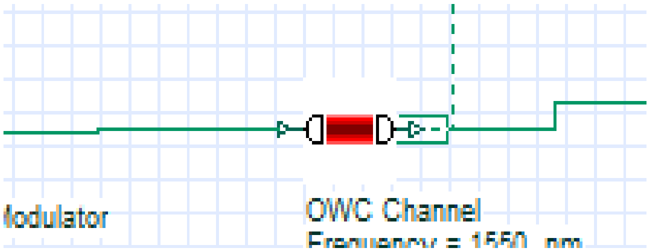


Fig 2 Intersatellite link channel

At receiving side A photodiode identify the receiving light signal which converts this signal into electrical form. For high amplification purpose Avalanche photodiode (APD) some time used in free space optical data transmission in larger distance application. Bessel filter which has cutoff frequency of 0.75*bit rate for limiting the BW. For getting regenerative electrically output from original bit sequence 3R generator is used. The output of 3R generator work as an input for eye diagram analyzer

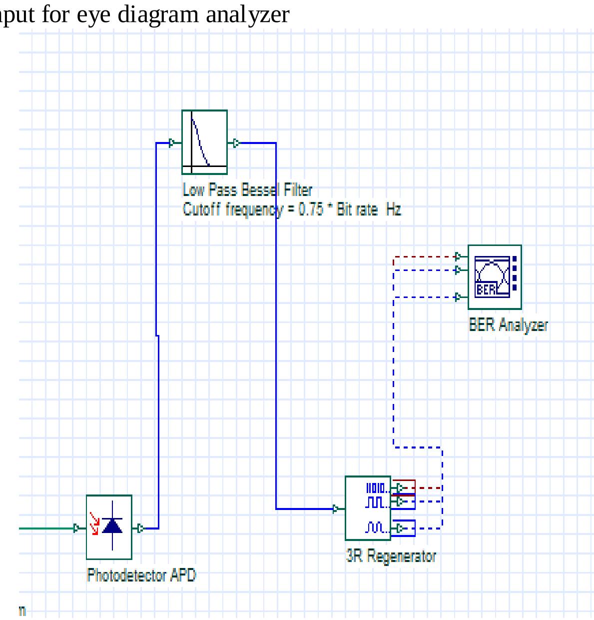


Fig. 3 Intersatellite link receiver

III SIMULATION OF 4 Tx/Rx INTERSATELLITE OFC MODEL

Fig.IV. show that the combination of multiple Tx/Rx which is use in intersatellite FSO model [6]. There are two subsystems at starting and ending points of this model exhibits the operating property of Intersatellite link transmitter and Intersatellite link receiver. Both of transmitter and receiver link implement by the optical component through virtual circuit by optisystem software 7.0. Pairs of power combiner and owc channel between these two subsystems appear as wireless medium. Power combiner use where requirement of high coupling efficiency for wide wavelength application.

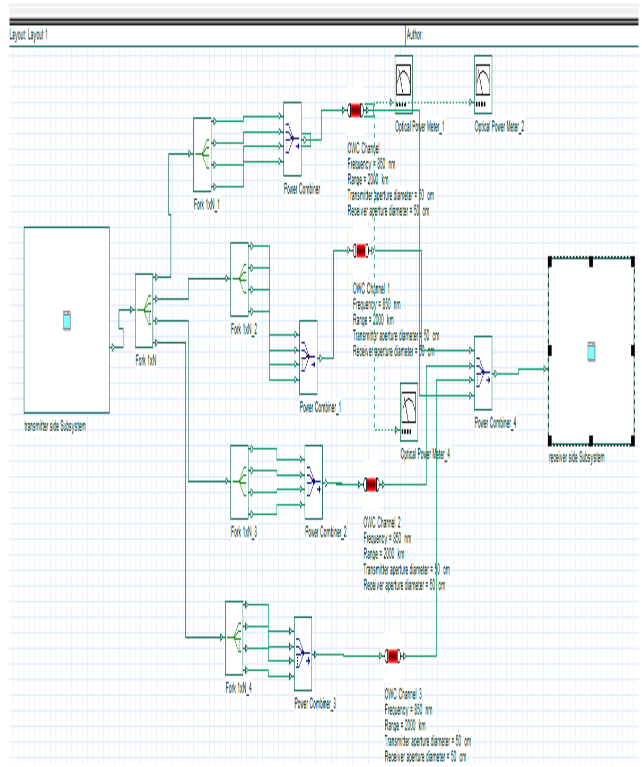


Fig. 4 Simulation of 4 Tx/Rx Intersatellite fso communication model

IV NUMERICAL ANALYSIS AND RESULT

In this simulation the impact of different parameter such as Distance, wavelength, Bit Rate and transmitted power on Q-factor and received power are analyzed. Graph is plotted between these parameter with the help of Matalab7.9 software

TABLE I
STANDARD PARAMETER TAKEN FOR SIMULATION

Parameter	Range
1.Distance	1000-5000km
2.Wavelength	850-1550 nm
3.power(cw- laser)	10 dbm
4.cut of frq(LPF)	0.75 bit rate hz

A. *Impact of wavelength on Q-factor & received power*

In the plot it is observed that as wavelength increases the Q-factor decreases rapidly. The major difference observed between 1000- 2000 km distance is that for wavelength

850nm the Q-factor is 900 nm at 1000km and for same wavelength at distance 2000 it is 500 nm.

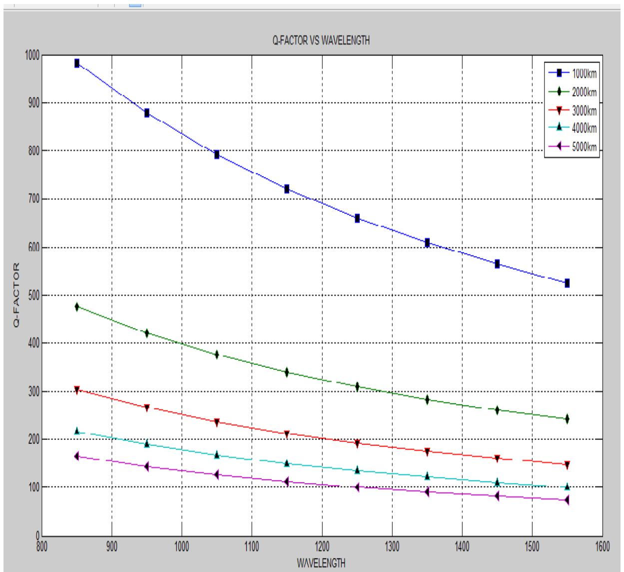


Fig 5 Q-factor vs wavelength at different distances

But change in Q-factor at remaining distances is less compare to starting 1000 and 2000 km distance. And secondly it is observed from fig. 6 as wavelength increases the received power will decrease. The result is possible for 850-1550nm wavelength for LEO-LEO communication between 1000-5000km distances in fig 5.

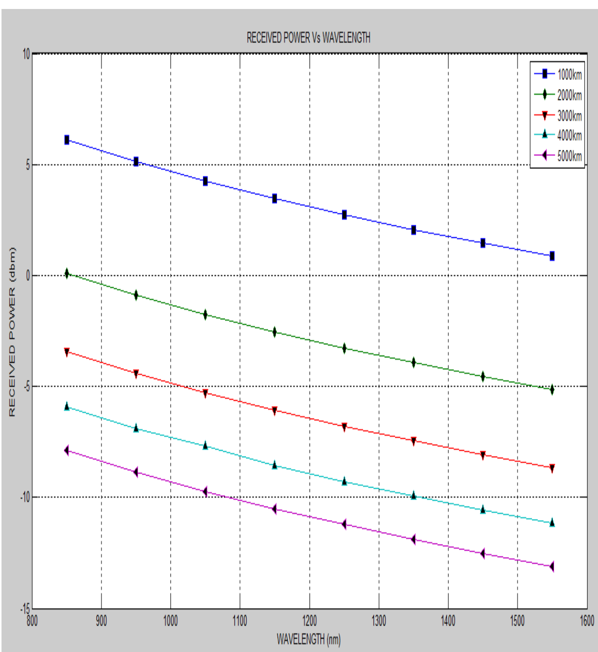


Fig 6 received power vs Wavelength at different Distances

In table no2 the value of max Q-factor and received power at different wavelength is calculated by taking standard parameters from table no 1

TABLE II
POSSIBLE MAX VALUE of Q-FACTOR and RECEIVED POWER

Wavelength(nm)	Max. Q-factor	Received power(dbm)
850	983.71	6.09
950	878.40	5.12
1150	720.83	3.46
1350	608.79	2.07
1550	525.17	0.87

B. *Impact of Distance on Q-factor*

Observation from fig.VII is that the Q-factor increases as Bit Rate increases. Differences in Q-factor for 5gb and 10gb data rate is less as compare to1gb and 5gb data rates for same distance for example the Q-factor for 10gb and 5gb data rates has small difference compare to 1gb and 5gb data rates for 2000km distance.

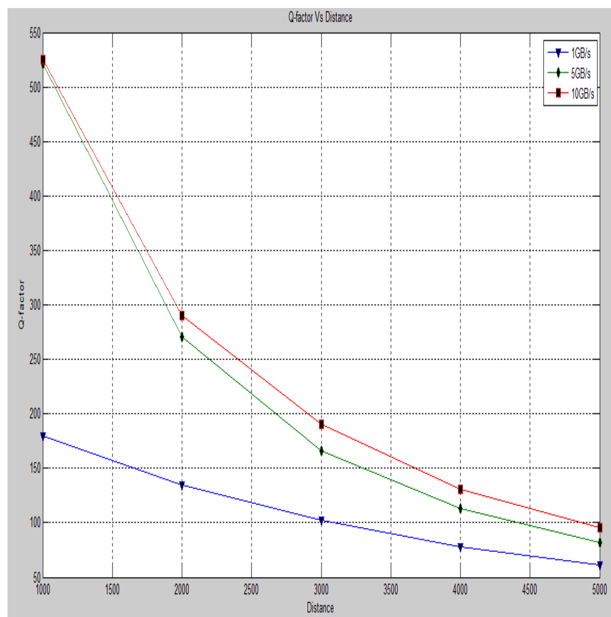
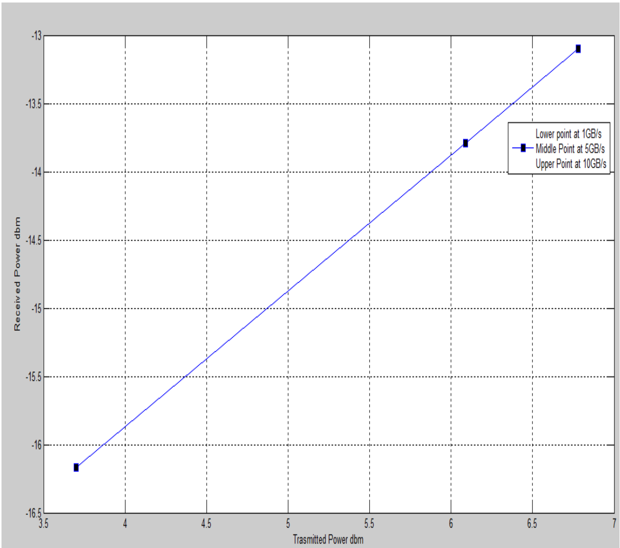


Fig. 7 Q-factor vs distance at different data rate

C. *Impact of Transmitted Power on Received Power*

Variation in received power is depending upon the change in bit rate of this intersatellite model. Fig.VIII has shown that variation in received power with variation in transmitted power at different data rate. In this plot it is observed that as data rate increase the amount of received power increase. Point to be noted here the transmitted power also depend upon the bit rate.



.Fig 8 Received power vs transmitted power

There are three point taken in this plot is that upper point, middle point and lower point regarding to following data rate 10gbps,5gbps and 1gbps. The received power increases linearly with these points.

V CONCLUSION

Satellite used in space to perform many application for human being. The advancement in satellite communication technology provide cellular services for people at many places. In this paper some modification in parameter have been perform in order to enhance the efficiency of intersatellite communication

The conclusions of this paper are as the followings:

I. The performance of intersatellite communication for lower bit rate is better for particular optimam distance range.

II. There are many effects of scattering and compatibility at longer signal wavelength but we can reduce such type of effects at 1550nm wavelength

III. The sensitivity of the receiver can be increase by using the different optimam data rates

IV. The requirement of power for multiple channel are lower so that we can reduce the effect of laser power

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