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Performance Evaluation of Satellite Optical Wireless Communication System

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ABSTRACT

Inter-satellite Optical wireless communication (IsOWC) is a good alternative for very high data rate point to point communication. In this paper we have presented the brief introduction to intersatellite communication system and its application. We have also presented a brief survey related with intersatellite communication system. This article also shows the effects on Maximum Q-factor for varying distances and varying data rates.

Keywords: - IsOWC (Inter-Satellite Optical Wireless Communication).

I. INTRODUCTION

Inter-satellite Optical wireless communication (IsOWC) can be used for very high data rate point to point communication. As the demand of high definition television and video conferencing is increasing, the demand for both high speed wired and wireless access is also increasing simultaneously in indoor and outdoor environments [1]. Earlier we used to transfer Information using microwave and RF frequencies but they suffer from serious drawbacks like radiations make a way into walls and less data rate transfer due to losses [2]. That is why the microwave and RF links are replaced by optical wireless technology. The IsOWC technology has high data rate capability, license free operation, unregulated bandwidth, low power, high efficiency, lesser antenna sizes and low cost. All these features made the IsOWC technology came into survival [3].

Our goal is to reduce the power dissipation as well as the BER. This result in high transmitter power and lesser receiver noise to obtain desired signal [4]. Problems regarding connectivity and long range data transmission has been eliminated by using IsOWC. The system include a laser beam modulated with data and is transmitted through free space with less attenuation in comparison of microwave and RF links as light travels faster in vacuum and can travel a long distance in thousands of kilometers with minimum bit error rate [5]. The data rate can be varied from 5Gbps to20Gbps with a tolerance factor of quality. The system requires more power when operated at large distances.

OPTICAL INTERSATELLITE SYSTEM

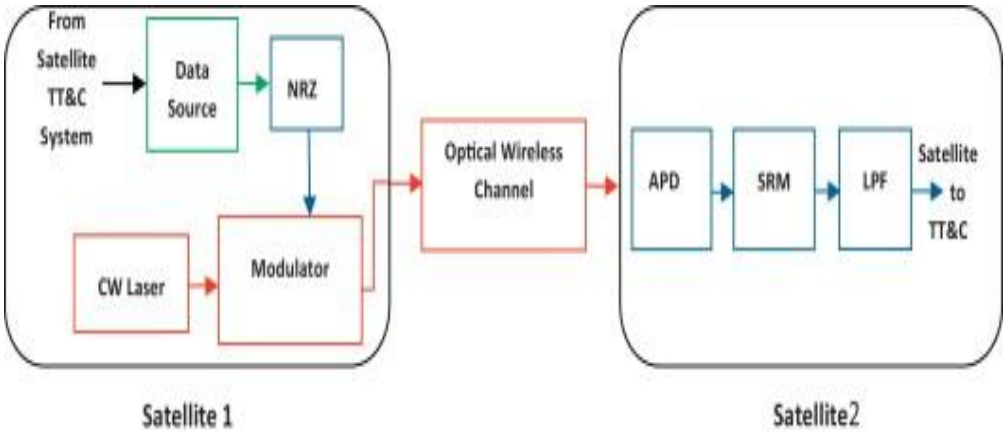

Fig. 1 Basic Block diagram for IsOWC

The basic block diagram of IsOWC link is shown in fig 1. The Intersatellite Optical Wireless Communication (IsOWC) system has various points of interest. Started with, no licensing is required in terrestrial communication to

invulnerability to the radio signal interference. The point-to-point laser signal is too hard to capture. It is difficult to tap the IsOWC link. Contamination of the earth and its atmosphere with electromagnetic radiations is not an issue in this case since the wavelength of IsOWC is ranging just from 850 nm to 1500 nm. The performance investigation will be as far as measured received power, eye pattern and BER.

III. PROPOSED BLOCK DIAGRAM

In proposed system, the first subsystem is the PRBS generator which is a part of transmitter. The data which is to be transmitted i.e. data source generates by it. The second subsystem represents the different modulation formats which get its input from the previous block. This subsystem encodes the data from PRBS output by using modulation techniques. The third subsystem is MZ Modulayor which operates on wavelength of 1552 nm because of low attenuation characteristics. The free space between transmitter and receiver is considered as OWC channel which is the propagating medium for the transmitted optical signal. The optical receiver comprises of a photo detector followed by a low pass Bessel filter. This system is converted the optical signal back into electrical signal.APD (avalanche photo-diode) is used because of its high gain property. The last subsystem is BER tester which gives the Quality factor and BER measurement.

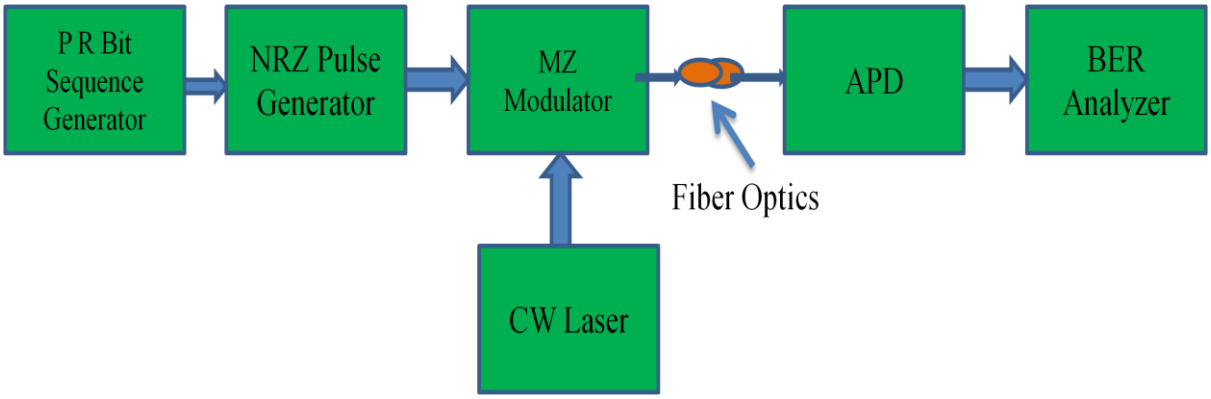

Fig. 2 Proposed Block diagram for IsOWC

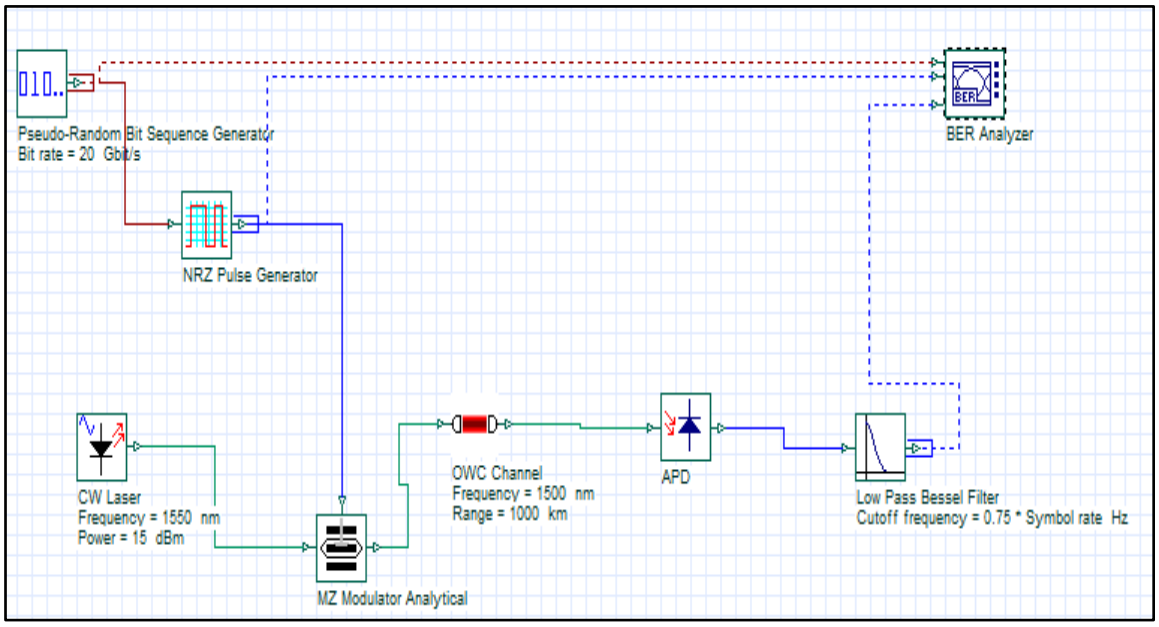

Fig. 3 Inter-Satellite optical wireless communication link simulation setup

IsOWC system designed was modeled and simulated for performance characterization. Several parameters of the system were varied to obtain optimum system performance. The main parameter that was considered is the light propagation distance of the specific OWC channel, other OWC link performance characteristics were also in considered which includes the system bit rate, the frequency of light carrier signal of CW laser and the optical receiver sensitivity. From the simulation, observation was done which is the relationship of the Q-factor and distance at varying the bit rates. IsOWC system has been modelled and performance depiction by OptiSystem14.

RESULT AND DISCUSSION

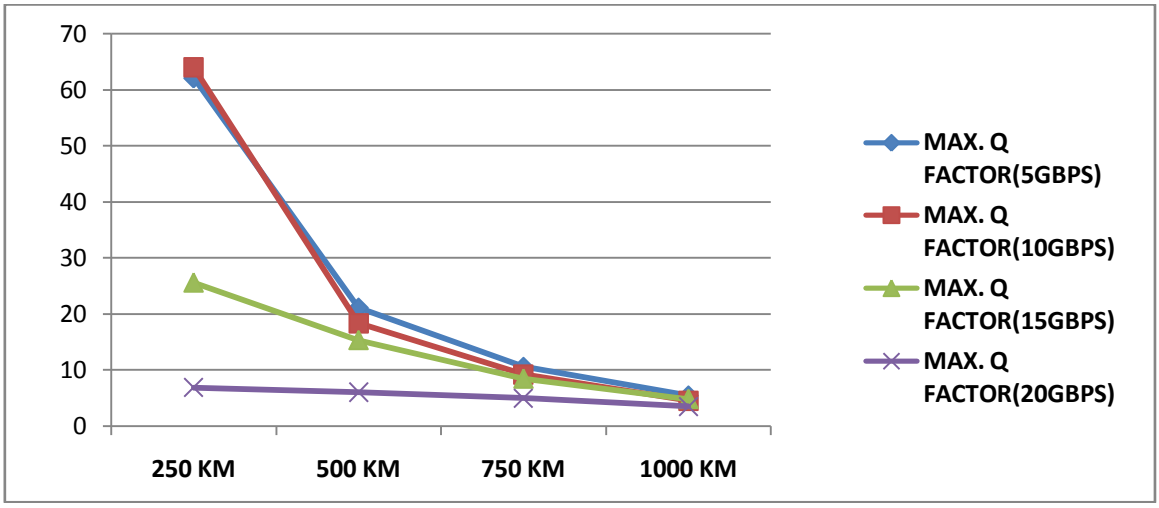

Fig. 4 Maximum achievable Q-factor for variable distances at 1500nm IsOWC link for bitrates 5Gbps to 20Gbps

Table I: Variation of Q factor and BER with distance at 5Gbps data rate

DISTANCE(KM)	MAX. Q FACTOR	MIN. BER
250	62.112	0
500	21.1599	1.11487e-099
750	10.5972	1.53439e-026
1000	5.49263	1.96985e-008

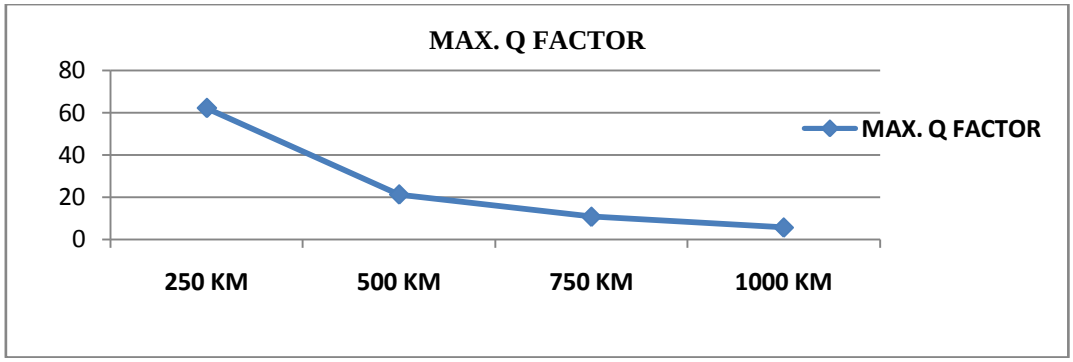

Fig. 5 MAX. Q factor vs distance at data rate 5GBPS

Eye Diagrams Analyzer: The Analyzer of OPTISYSTEM shows multiple paths of a modulated signal to produce an Eye diagram. The performance of the system was also analyzed using BER analyzer.

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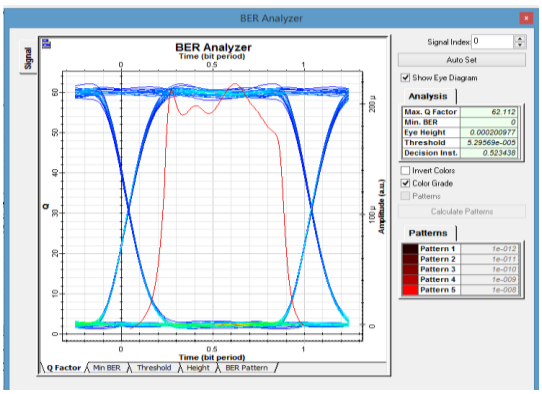

Fig. 6 Eye Diagram for 5 Gbps data rate at 250km

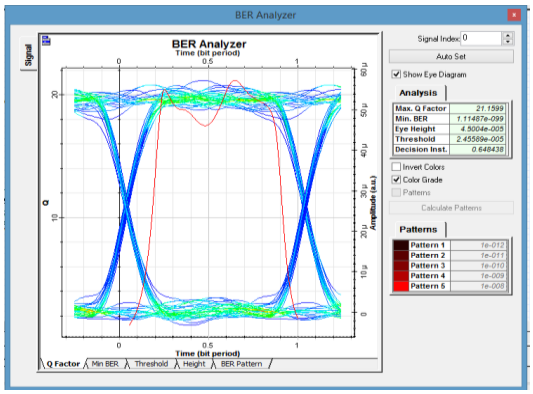

Fig.7 Eye Diagram for 5 Gbps data rate at 500km

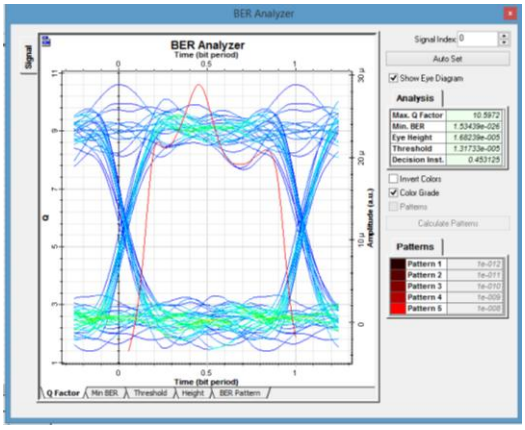

Fig.8 Eye Diagram for 5 Gbps data rate at 750km

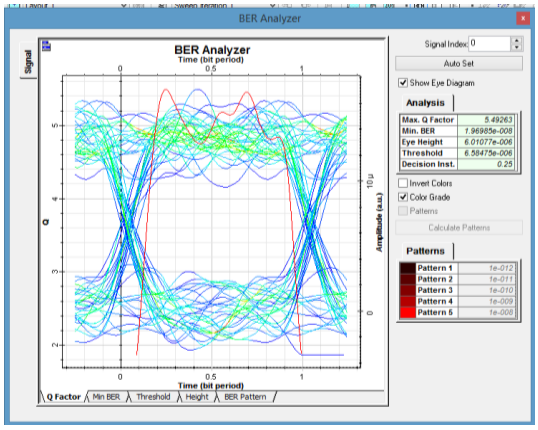

Fig.9 Eye Diagram for 5 Gbps data rate at 1000km

Table II Variation of Q factor and BER with distance at 10Gbps data rate

DISTANCE(KM)	MAX. Q FACTOR	MIN. BER
250	63.9634	0
500	18.3587	1.36125e-075
750	9.18732	2.00767e-020
1000	4.55449	2.58367e-006

Variation of Q factor and BER with distance at 10Gbps data rate

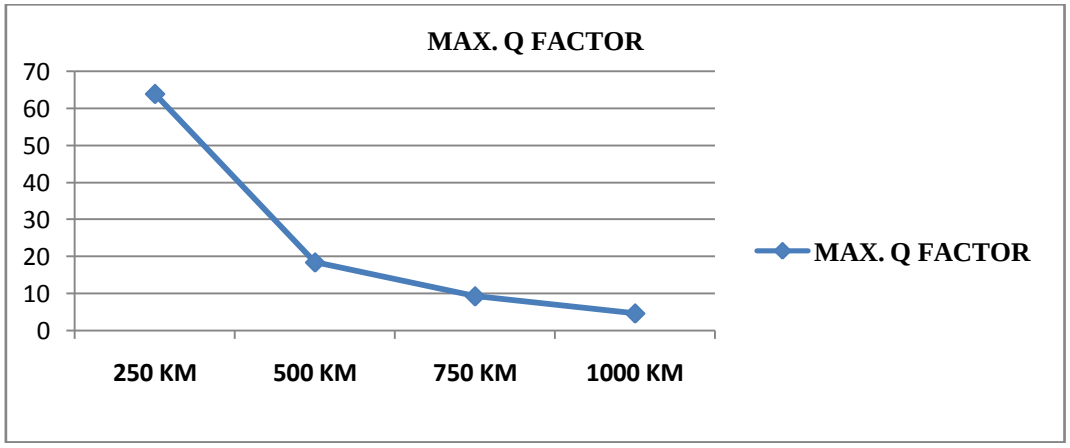

Fig. 10 Max. Q factor Vs distance at data rate 10Gbps

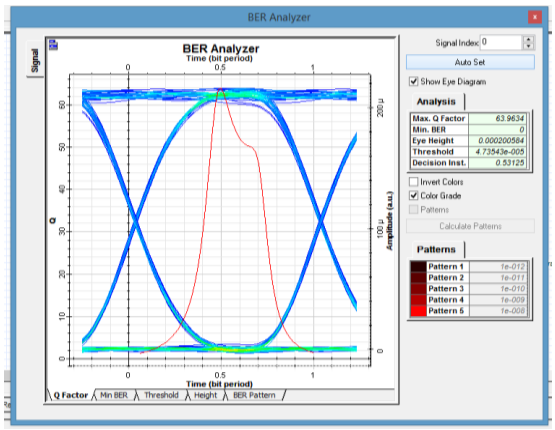

Fig.11 Eye diagram for 10Gbps data rate at 250km

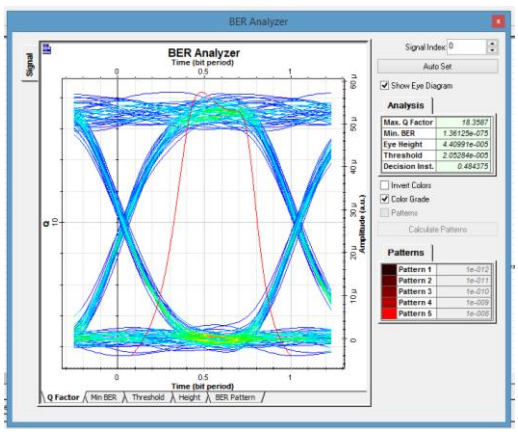

Fig. 12 Eye diagram for 10Gbps data rate at 500km

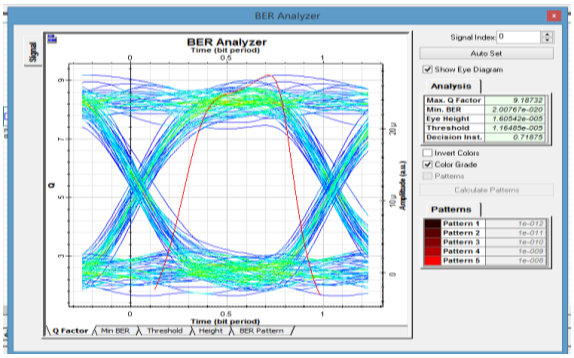

Fig. 13 Eye diagram for 10Bbps data rate at 750km

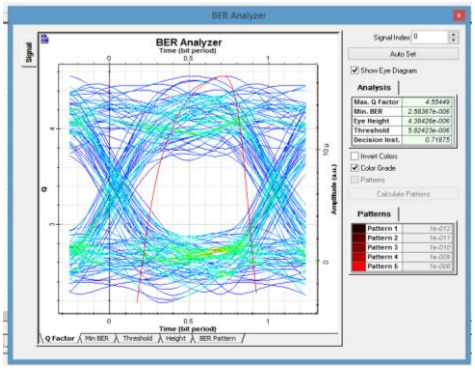

Fig. 14 Eye diagram for 10Gbps data rate at 1000km

DISTANCE(KM)	MAX. Q FACTOR	MIN. BER
250	25.6517	2.02174e-145
500	15.3794	1.10487e-005
750	8.48671	1.05185e-17
1000	4.8507	6.14863e-007

VARIATION OF Q FACTOR AND BER WITH DISTANCE AT 15GBPS DATA RATE

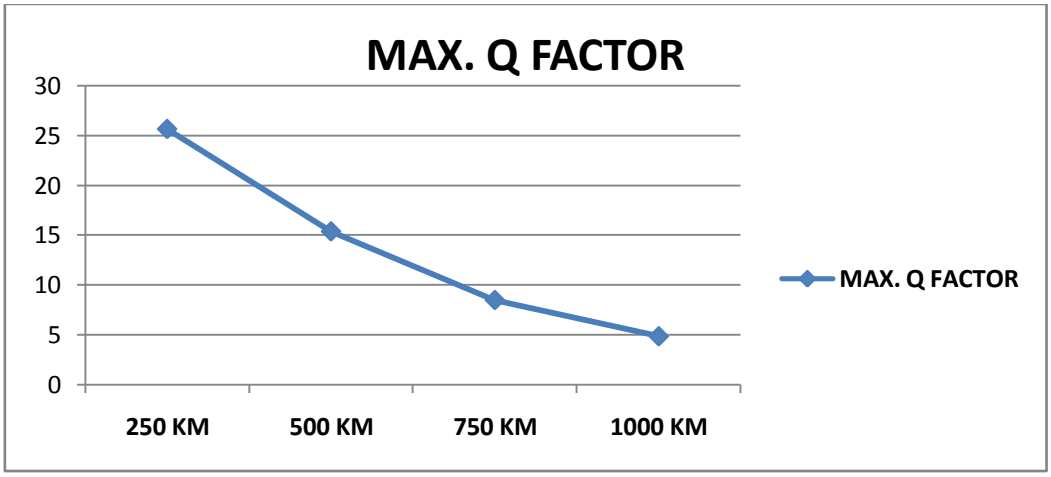

Fig. 15 max. Q factor vs distance at data rate 15Gbps

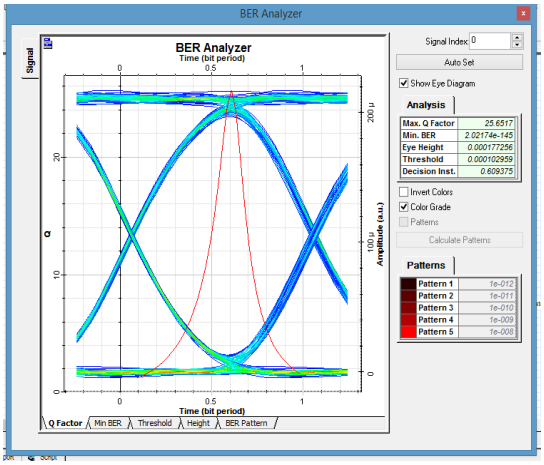

Fig 16 Eye diagram for 15Gbps data rate at 250km

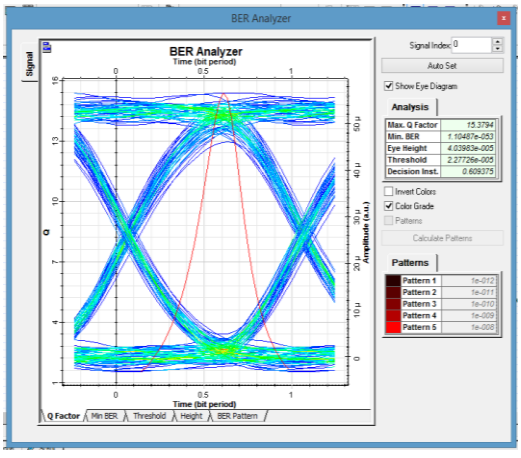

Fig. 17 Eye diagram for 15Gbps data rate at 500k

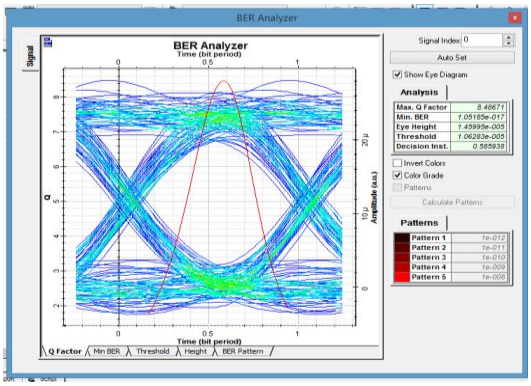

Fig. 18 Eye diagram for 15Gbps data rate 750km

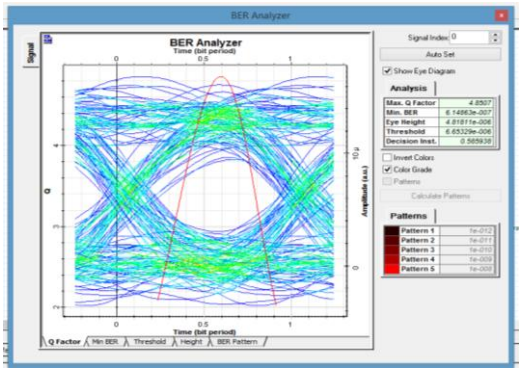

Fig. 19 Eye diagram for 15Gbps data rate at 1000km

DISTANCE(KM)	MAX. Q FACTOR	MIN. BER
250	6.90211	2.56127e-012
500	6.1018	5.24194e-010
750	5.02693	2.48637e-007
1000	3.5617	0.000184029

Variation of Q factor and BER with distance at 20Gbps data rate

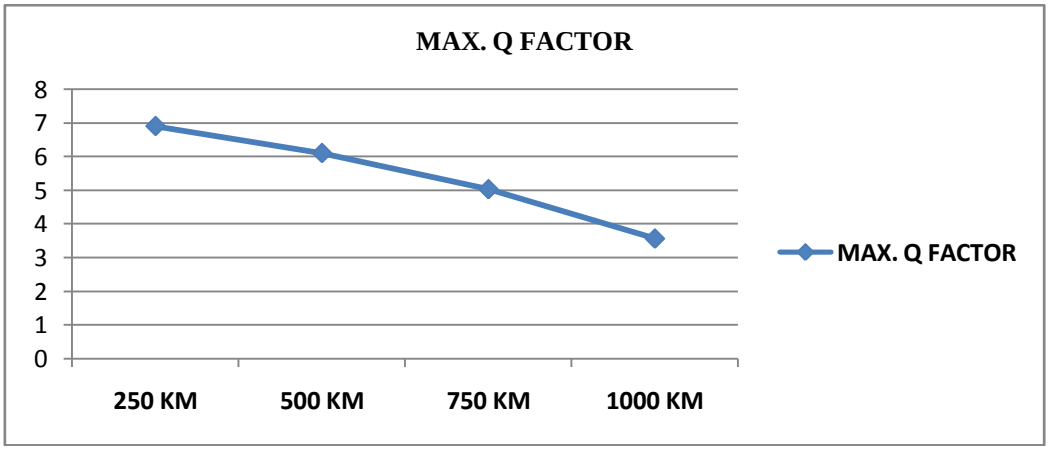

Fig. 20 max. Q factor Vs distance at data rate 20Gbps

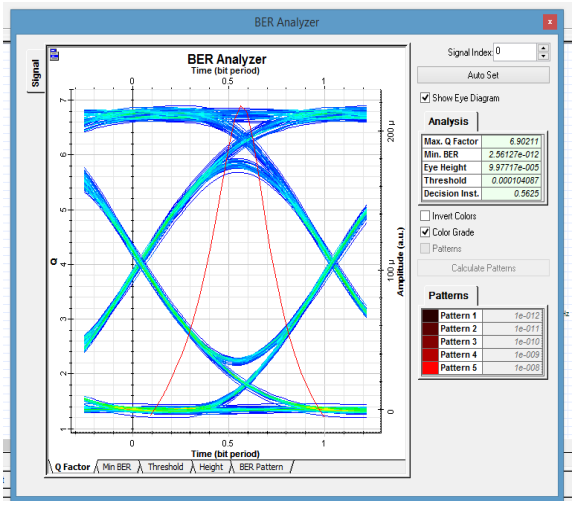

Fig.21 Eye diagram for 20Gbps data rate at 250km

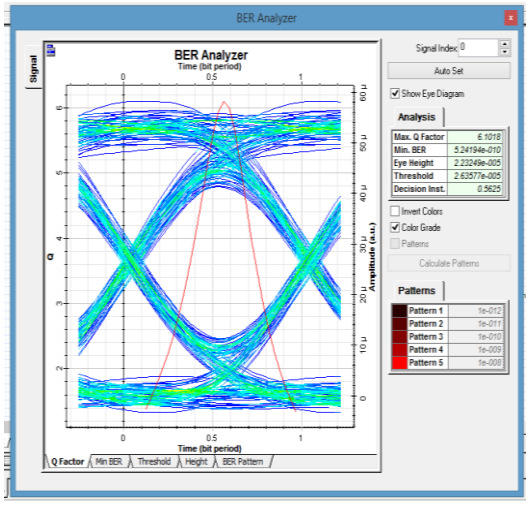

Fig. 22 Eye diagram for 20Gbps data rate at 500km

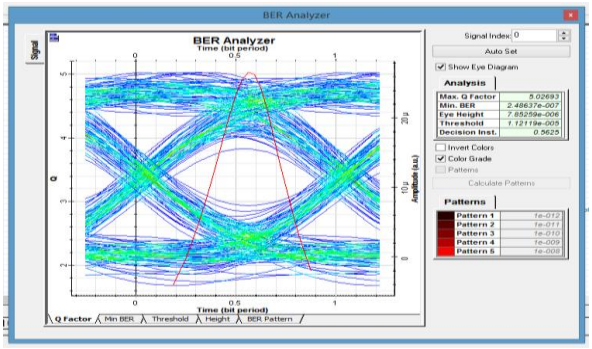

Fig. 23 Eye diagram for 20Gbps data rate at 750km

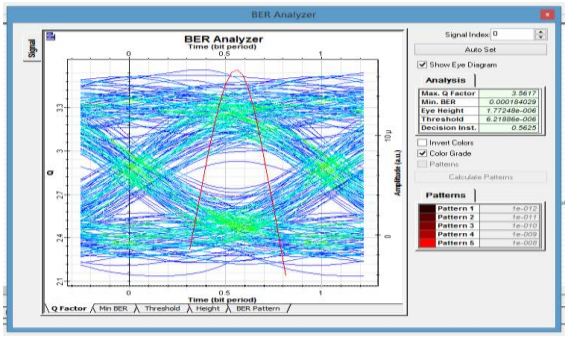

Fig. 24 Eye diagram for 20Gbps data rate at 1000km

CONCLUSION

This project is done to analyze a method to connect and network these satellites by using optical link. It has been discussed that IsOWC can provide intersatellite communication at higher speed and much further distance compared to RF links. First conclusion is the received error increases as the distance between satellites increase. Second conclusion is Optical signal with lower bit rate can be used for further distance between satellites since the system performance is better at lower bit rates. Last conclusion is longer signal wavelength produces more errors but transmission at 1500nm is used to reduce the effect of scattering and for its compatibility with existing devices.

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