Analyzing the Parameter for 5G Communication for the FSO System along the EDFA Amplifier

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Abstract: ***The 5G network has a huge data rate, high - speed communication, more cell sites per square kilometer, demands a high level of precision from network operators, and has high operating costs which also consider environmental factors or effects on optical networks. Additionally, a wide band of RF spectrum is used by mobile network operators. The operating power is very high. Low power requirements are needed for 5G - FSO. The range can be expanded if the detector's sensitivity is raised. This research present depth understanding of the 5G technology and FSO network and FSO networkin the 5G network. Along with the implementation of a 5G link at different climatic conditions and different distances and EDFA at 5m.***

Keywords: 5G, FSO, BER, Q - Factor, EDFA

1. Introduction

One of the primary kinds of communication that has developed a wide array of eye - catching solutions to challenging communication problems, such as high data rates and low connection interferences for brief and far - off communications, is optical wireless communication. The supplied signal quality, the information rate, and the transceiver technologies have all tremendously improved compared to conventional optical wireless technologies. TV remote controls are just one example of an application where free space optical (FSO) communication lines have already been incorporated [1].

It has a transmitter, a channel, and a receiver. The modulated laser beam emitted through empty space by the transmitter is received, demodulated, and detected by the receiver. Since FSO uses a Line - Of - Sight connection, neither the transmitter nor the receiver should be obstructed by anything. [2]

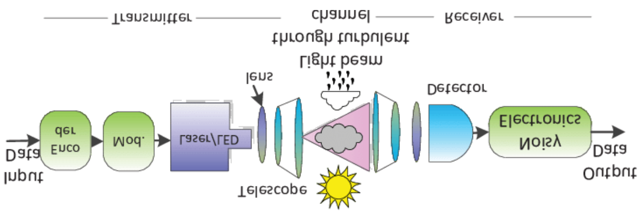

Figure 1: Block diagram of FSO Communication

Transmitter uses a modulation technique, which varies light intensity according to the modulating signal. The laser's power can be current by adjusting the laser currently in the driver circuit, the intensity - modulated light signal is transmitted with high directivity using the transmitting telescope. [3] Depending on its characteristics and wavelength, the light source is determined. And then the channel of the modulated light signal gets degraded. Free space, or air, is the medium exploited in FSO. The transmitted signal is scattered, absorbed, and faded by atmospheric fluctuation including fog, rain, and snow, which gradually reduces the FSO system's performance. And then at the receiver, the receiving telescope captures the modulated light signal, and the photodetector transforms the light signal into a suitable electrical signal. The sent information is then recovered by demodulating and processing the detected electrical signal. [4]

Era of Communication

A future era of communication networks has indeed been released roughly every two decades since the very first analogue communication system was established mostly in 1980s. The update through one generational to another helps in the improvement of service metrics while also introducing new features and functionalities. The goal of B5G and 6G is to improve performance by a factor of 10–100 above previous mobile generation advances. Cellular data throughput has expanded rapidly over the last 15 years, owing towards the clear popularity of smartphones or other smart appliances and contraption connections. In comparison to earlier years, global smartphone load - bearing capacity seems anticipated to widen 690 times by 2040 [5]. And according to International Telecommunication Union (ITU), mobile internet volume would take more than 10 ZB each capita by 2040 [6]. Smartphone memberships would exceed 17.1 trillion by 20205, up from 15.32 billion during 2010.

Furthermore, the utilization of M2M interconnection will grow at an accelerating rate. The increase in traffic at each smartphone will likewise expand. In 2010, a cellular device's monthly volume of traffic was 5.3 GB. Nevertheless, by 2030, this proportion will have increased by 50 times. In comparison to 2010, the amount of M2M memberships will expand 33 times in 2020 and 455 times in 2030. [7] The focus of recent research has switched to data - driven intuitive and user - friendly approaches. The 5G wireless communication will lay the groundwork for intelligent networks that can do Intelligent tasks. The throughput of 5G is expected to hit its capacity by 2030, according to estimates. Eventually, only 6G networks would be able to provide completely intelligent network adaptations and administration for sophisticated offerings. [8]

User needs have outgrown what the 5G network can provide, prompting the development of 6G wireless transmission. Experts from all across the globe have already been researching what 6G services will be like in 2030, as well as the potential motivations for effective 6G wireless technology. [9] The following are some of the major motivational factors driving the advancement of 6G communications networks: high data rate, highly reliable, reduced latency, high energy density, improved spectral effectiveness, fresh wavelengths, green communication, smart communications, availability requirements, telecommunications converge, positioning, computation, are all examples of new spectroscopy [10]. As a result, 6G will usher in a new era of entirely digital connectivity.

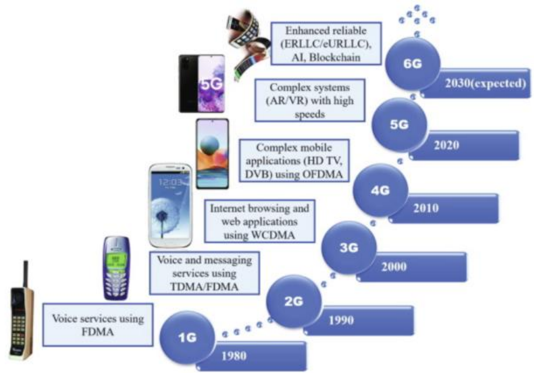

Figure 2: Era of Communication

Analysis of 5G wireless link

Although 5G networks have extremely high data rates and fast communication, there are more cell sites per square kilometer, network operators need to be extremely precise, and operating costs are ridiculously expensive. Similarly, RF spectrum in a wide band is used by mobile network operators. Extremely high operating power. Extremely little power, in the dBm range, is needed for 5G - FSO. The sensitivity can be expanded by raising the range of detectors. [11]

With the presented FSO concept, data rates up to 10Gbps and error - free signals up to different distances can be produced with the help of different amplifiers.

Design of the System

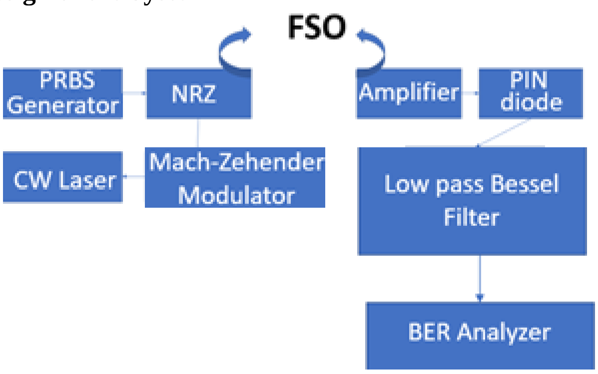

Figure 3: System block diagram

A representation of terrestrial communication is shown in the block diagram. The transmitter, channel, and receiver make up this system. At the transmitter end, there are pseudo - random bit sequence generators, NRZ pulse generators, Mach - Zehnder (MZ) modulators, and CW lasers. On the receiver side, there are amplifiers, PIN photodiodes, and low - pass Bessel filters. The system performance is evaluated by the use of a BER analyzer. [11]

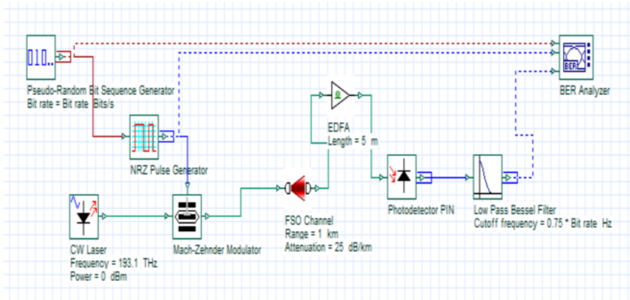

Figure 4: Layout of the FSO system

Due to atmospheric and geometric attenuation, the received signal is impacted in real applications. Clear sky, haze, rain, and moderate fog are the environmental conditions that are considered into account in this simulation. These have respective attenuation values of 0.1 dB/km, 4.2 dB/km, 8.68 dB/km, and 25.5 dB/km.

2. Results

Digital signals are analyzed using an eye diagram. It facilitates BER and Q - factor measurement. On the basis of BER, Q Factor, and eye diagrams, the simulations of various turbulence situations are compared.

The link is explored for three distance link ranges for BER AND Q Factor while the transmitter power and EDFA are maintained at 35 dBm and 5 m.

a) Clear Sky

Distance	Q - Factor	BER
0.5	2345.29	0
1	1584.97	0
1.5	1227.58	0

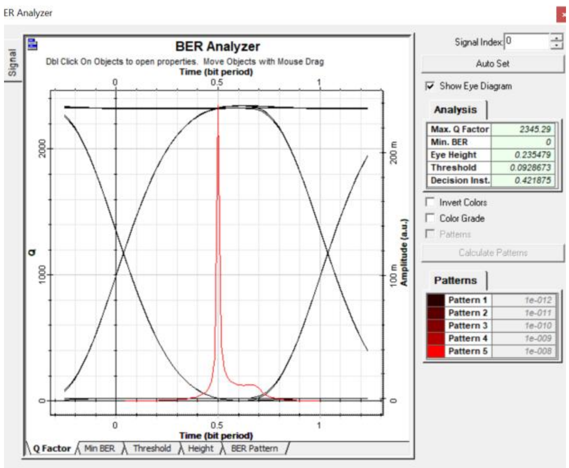

Figure 5: Clear sky at 0.5km

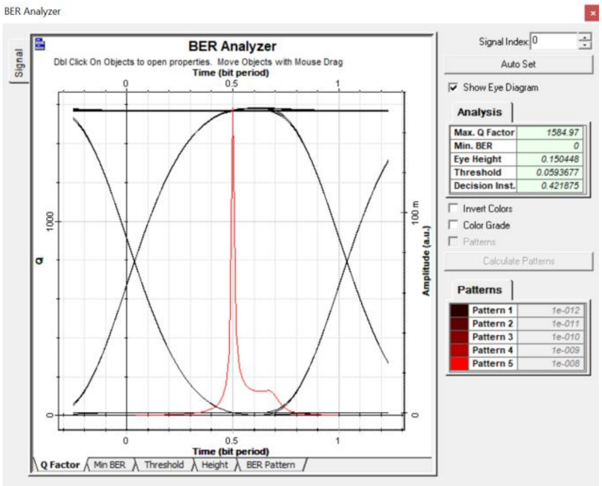

Figure 6: Clear sky at 1km

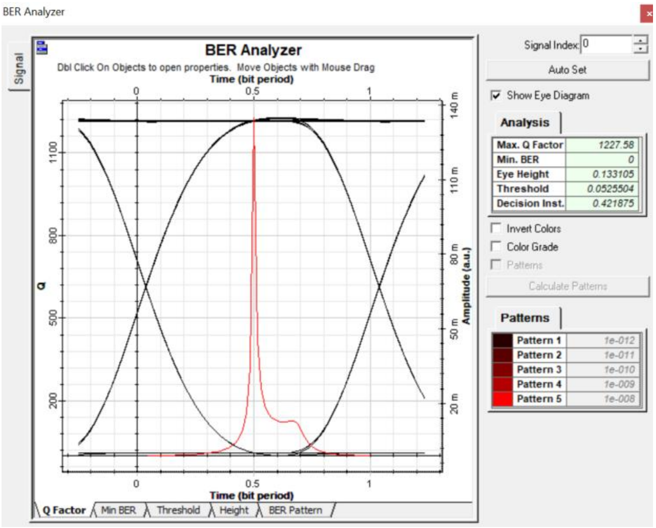

Figure 7: Clear sky at 1.5km

b) Haze

Distance	Q - Factor	BER
0.5	2041.14	0
1	1170.26	0
1.5	705.846	0

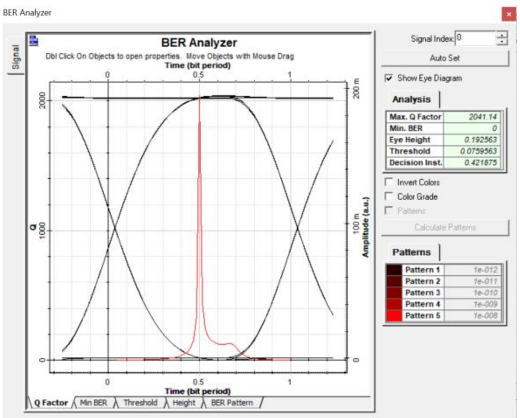

Figure 8: Haze at 0.5km

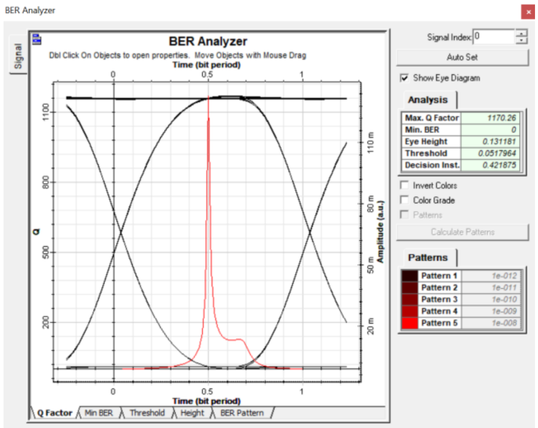

Figure 9: Haze at 1km

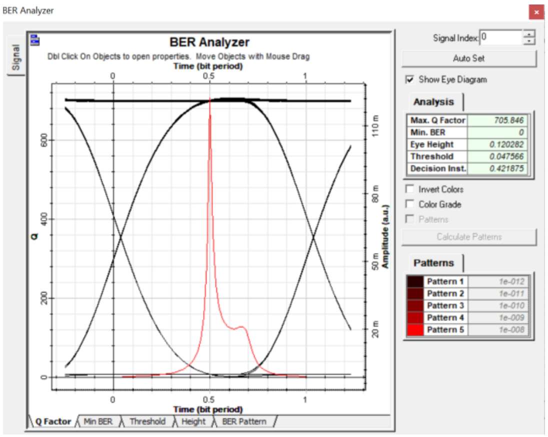

Figure 10: Haze at 1km

c) Rain

Distance	Q - Factor	BER
0.5	1761.02	0
1	784.551	0
1.5	342.585	0

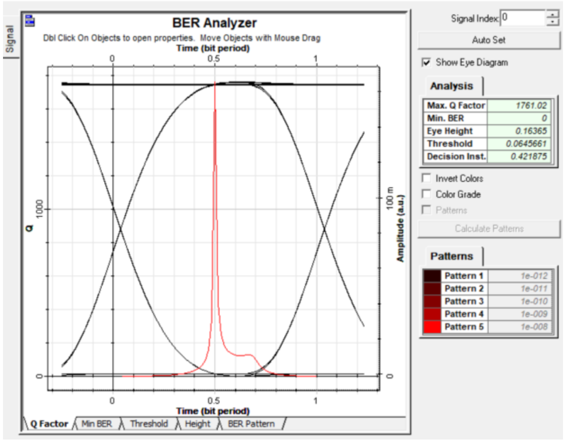

Figure 11: Rain at 0.5km

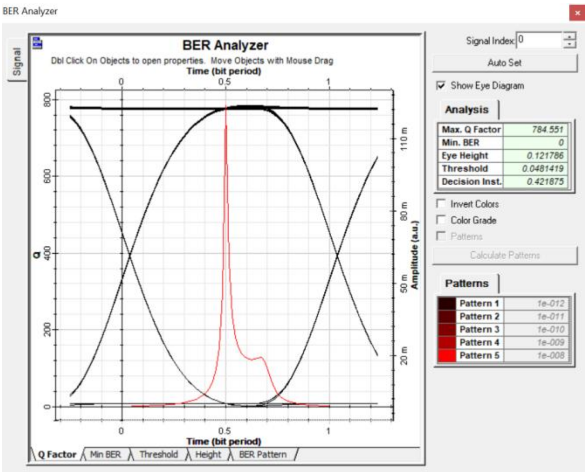

Figure 12: Rain at 1km

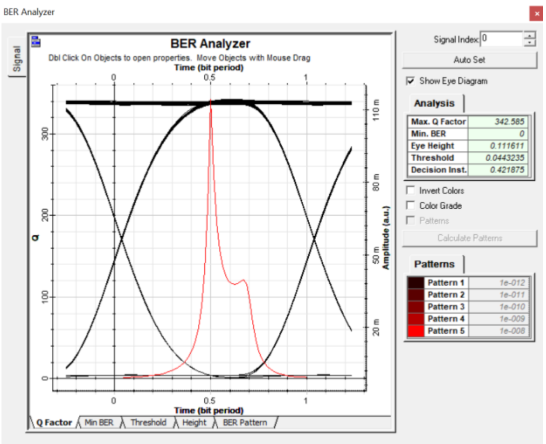

Figure 13: Rain at 1.5 km

d) Moderate fog

Distance	Q - Factor	BER
0.5	924.421	0
1	117.756	0
1.5	16.2576	8.23447e - 060

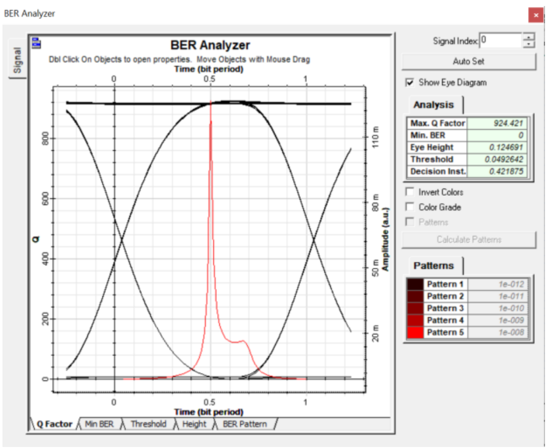

Figure 14: Moderate fog at 0.5 km

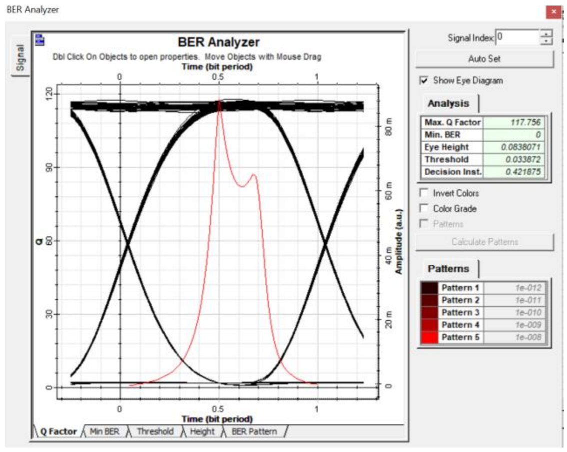

Figure 15: Moderate fog at 1km

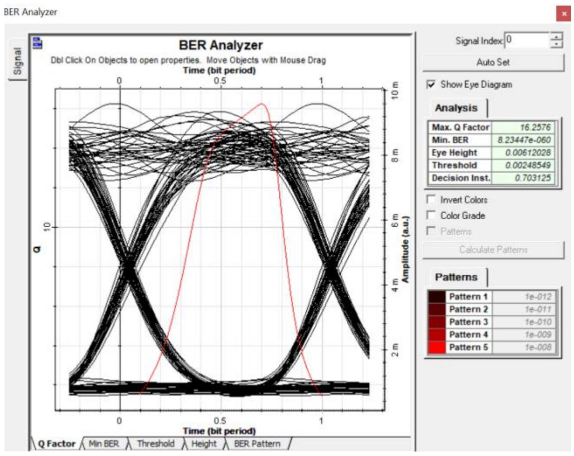

Figure 16: Moderate fog at 1.5km

3. Conclusion

The suggested FSO network is appropriate for 5G areas of application. With a Q - factor, this network supports 10 Gbps data transfer at a 1.5 - kilometer distance network supports 10 Gbps data transfer at a 1.5 - kilometer distance and EDFA of 5m with a Q - factor.35dBm of laser power is transmitted from this network.

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