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The RoF based FSO link for next generation Communication

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Abstract- The shifting surfaces from past to present has evolved many changes and brought many challenges as well and the field of communications is the one which has witnessed this changing dynamics the most. Since the influence of the emerging technologies in yielding better performance than the existing , hence it calls for the newer infrastructure , installation to be made for its establishment and henceforth for its working. Such incorporation of the change in the entire layout is not always possible, especially in case at the network level. Thus in order to optimize the performance of the operating communication systems comprising of the enhanced features of the newer technologies , we need to go with the option of modification of the existing ones as well as from the latest ones so that they will be complementing and supplementing each other. The optical communication due to the advancement of the photonics and terahertz based schemes is providing excellent ground for the nourishment of the next generation communication systems .Now-a-days the optical fiber has proved out to be the most efficient means of communication channel medium, but it does have some limitations. The paper has focussed on getting the solution for these - last mile problems and overcoming the difficulty of getting a reliable link for the communication purpose in areas where installing the fibers is not easy and thereby the incorporation of FSO link.

Index Terms- Radio over fiber, Wavelength division multiplexing, Free space optical system, Erbium doped fiber amplifier.

I. INTRODUCTION

The optical fiber based communication channels has some performance declining factors which limits its efficiency . These are some last mile problem also that is the fiber laying in the places where authorities have issues regarding the frequent digging of the trenches for laying the fiber.As a rescue to these problems ,the concept of the working of the RoF along with the FSO is introduced . Till now optical fiber based communication system is found to be the most superior in class than the other means of the communication , the various types of the data services, high data rates as well as rendering the seamless communication needs to optimize its performance over wide range of application. In order to provide high capacity RoF amends the Central station and various Base stations configuration wherein the base station is given with the simple functionalities and hence is less expensive . But the central station has to perform the complex work like that of the modulation amplification etc. The RoF configuration of network typically lays an emphasis on its operation with the micro/ pico cellular sites because , the small yet effective antenna size located at the base station facilitates with the efficient coverage of the respective area of its concern which further on implies to the frequency reuse to be possible in its domain of working. Also in order to increase the capacity of the system RoF technique, have the provision of the WDM which is capable of providing large no. of channels working simultaneously.

Never the less the demand for high speed and high bandwidth communications channel is increasing in the new era of information age. FSO is being presented as a solution for next generation high-speed wireless communication technology, as it is free to implement, easy to install, secure and has very high bandwidth.

The FSO has emerged to be as the strong contender for providing the high speed transmission links when it comes to the issue of the last mile solution. bearing the similar characteristic as that of the RoF the FSO yields better performance features in comparision to the RoF , because it has the high bandwidth , and thereby provide high data rates , further the no. of the received signal level increases ,which gives the implication that now large no. of users can be accommodated in the network , incorporating large no. of base stations facilitating frequency reuse becomes feasible.

Earlier studies have revealed that the mesh topology is well suited for the FSO based configuration , wherein there is an opportunity of having either the relay assisted short multihops or the diversity technique which can be made functional .The WDM technique when implemented with the FSO is able to provide the customer with the large array of the communication service ,all because the system capacity is increased by it.

II. RESEARCH STATUS OF FSO

The last mile solution is the significant topic of extensive research among the telecommunication Engineers .As in most of the places the fiber cable installation has already been done to get better communication link performance over the co-axial cables or the satellite links , therefore replacing the same with the FSO to attain relatively upgraded results is not practically possible everywhere.Also the high speed communication links in remote locations by FSO communication link is still considered as a relatively new technology though fiber-optic communication has been widely used in worldwide telecommunication industry.The FSO technology facilitates large bandwidth transmission capabilities where it uses optical transmitters and receivers and even enables WDM-like technologies to operate through free space. This fuels the reason for seeking the compliance between the two technologies, that is the integration of RoF and FSO instead of substituting one for another. The FSO links can provide fiber-like data rates over short distances with low probability of interference Besides, it also present the last mile solutions with static communication system that is by substituting wired or microwave system at base station level where the RoF will be working as the network backbone is not that much effective as its combination with the FSO is. FSO is an unexpectedly simple technology. The system is based on the connectivity between FSO-based optical wireless units where each of them consists of an optical transceiver to provide a full-duplex (bi-directional) ability.Optical source with a lens that transmit light through the atmosphere to another lens receiving information are used in each of the optical wireless unit. The receiving lens is connected to a high-sensitivity receiver through optical fiber at that specific point. There are a number of advantages using FSO technology approach where it required no RF spectrum licensing and also they are easily upgradable.Also it can be put to use in the areas of difficult physical channel access.With the FSO lies the great scope of performing the diversity techniques , be it the aperture diversity or the path diversity to recover the transmitted signal level at the receiver end.

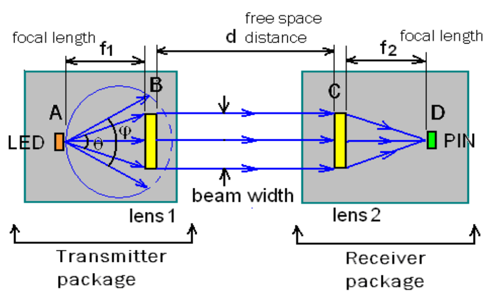

Fig. no. 1 FSO signal transmission and reception

The wavelength of 1550 nm is typically well suited for free-space transmission, and high quality transmitter and detector components are readily available. The combination of low attenuation and high component availability in this wavelength makes the development of wavelength-division multiplexing (WDM) FSO systems feasible. However, components are generally more expensive, and detectors are typically less sensitive and have a smaller receive surface area.The modulated light source, which is typically a laser or light-emitting diode (LED), provides the transmitted optical signal and determines all the transmitter capabilities of the system. Only the detector sensitivity plays an equally important role in total system . The small footprint and low power consumption (important for overall system design and maintenance), and ability to operate over a wide temperature range without major performance degradation (important for outdoor systems) are the strong points of merit for the FSO. There are numerous advantages of free space optics application with RoF, FSO provides a wireless solution to last mile connection or connection between two buildings. There is no hassle with digging and burying fiber cable. Also free space optics requires no RF license. Therefore FSO system could be deployed easily,(a FSO system quickly). It is easily upgradable, and its open interfaces support equipment from a variety of vendors, which helps enterprises and service providers protect their investment in embedded telecommunications infrastructures. It can be deployed behind windows, eliminating the need for costly rooftop rights. It is immune to radio frequency interference or saturation.It also provides up to 2.5 Gbps of data throughput. This provides ample bandwidth to transfer files between two sites. With the growing size of files, free space optics provides the necessary bandwidth to transfer these files efficiently.FSO is a very secure wireless solution. The laser beam cannot be detected with a spectrum analyzer or RF meter. The beam is invisible which makes it hard to find. The laser beam that is used to transmit and receive data is very narrow. This means that it is almost impossible to intercept the data being transmitted. One would have to be in the line of sight between receiver and transmitter to be able to accomplish this feat. Of course if that happens it would cause an alert due to the receiving site has lost connection. There are no security upgrades that are required for FSO .The above discussed points will be working as a complementary points for the RoF system.Whereas there are a number of weaknesses with FSO **.**The distance of FSO is very limited. Operating distance is usually within 2 km. Therefore although this is a powerful system with great throughput, the limitation of its distance is a big deterrent. Line of sight must be maintained at all times during transmission. Any obstacle, be it environmental or animals, can hinder the transmission. FSO technology must be designed to combat changes in the atmosphere, which can affect FSO system performance capacity. Among the issues to be considered when deploying FSO-based optical wireless systems.

III. LINK DESIGN

The designing of the link is the one intended to be implemented at the receiver section ,wherein the solution for the two problem is sought-
1. Last mile
2.Places where fiber installation for the communication channel is not possible.
The Central station of the RoF based FSO link model will be transmitting the signals considering it to be two in number , they upon being amplified is then sent for the wavelength division multiplexing at the transmitter end , the output of the WDM multiplexer is the single wave incorporating within itself two signals which is being carried at different frequencies, upon being launched into the the channel it is preamplified by the EDFA from where it goes to the SMF , and after that before reaching the receiver station , the signal when is given out of the SMF undergoes the post amplification ,after this the signal got demultiplexed and now from here they are sent to their respective base stations the corresponding signals are carried in two different manner , for the first section the array of the FSO antennas exhibiting the aperture diversity is used to recover the signal, whereas the second base station the signal is transmitted to its destination by a SMF assisted FSO link where the SMF will be providing the backup link to the FSO so that in case of any atmospheric fluctuations to which the FSO is less immune to ,

and hence will not be able to take up the signal, then immediately the SMF of the same range as that of the FSO will become operative.The second scheme is typically a solution to the last mile , whereas the first one is the solution for the last mile as well as for the places where fiber installation is difficult to be achieved. In both the cases , the possibility of signal to be lost or subjected to fading even if occurs then the system proves out to be the robust one to withstand all such performance degrading factors since because it has these mitigation schemes operational within it.

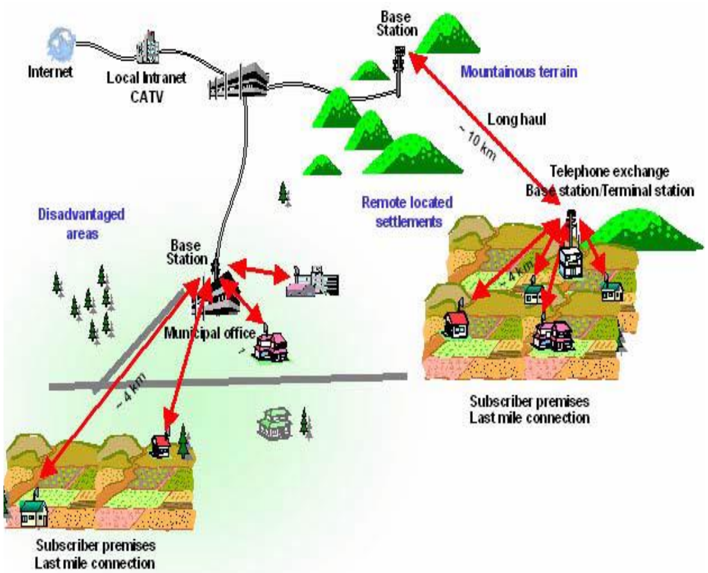

Fig.no.2 Places where FSO can be implemented

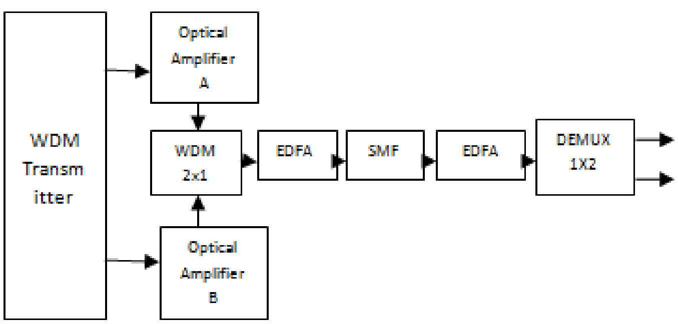

Fig.no.3 Transmitter section of the RoF based FSO link

The transmitter section is common for both the receiving station.

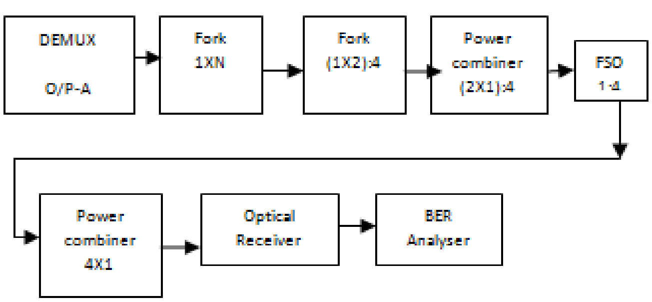

Fig.no.4 Receiver Section-A (Array of FSO exhibiting aperture diversity)

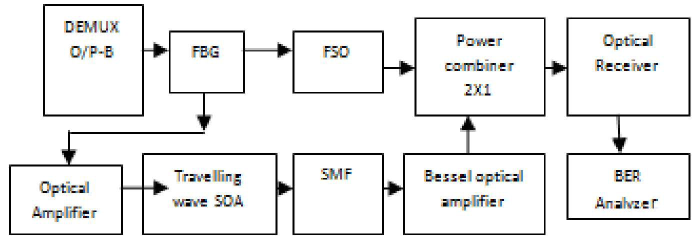

Fig.no.5 Receiver Section-B (FSO having SMF as backup link)

The simulation of the system has been carried out at different length of the SMF from 10 km to 65 km and the values from the BER analyzer has been noted down .The following graphs depicts the result for the length of SMF and Q factors obtained corresponding to it .The first

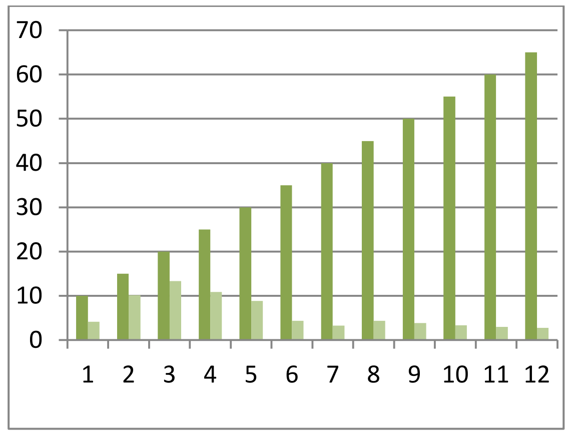

Fig. no. 6 Graph for receiver section-1
SMF length/Qfactor

Xaxis-Samples
Yaxis –SMF length in kms (dark green bars) and Q factor(light green bars)
graph is for the first receiver section where FSO with aperture diversity is operational , whereas the second receiver section shows the FSO with the SMF link backup.

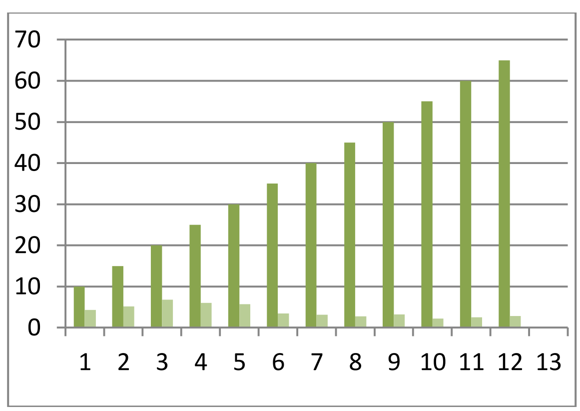

Fig. no. 7 Graph for receiver section-2

SMF length/Q factor

Yaxis –SMF length in kms (dark green bars) and Q factor(light green bars)

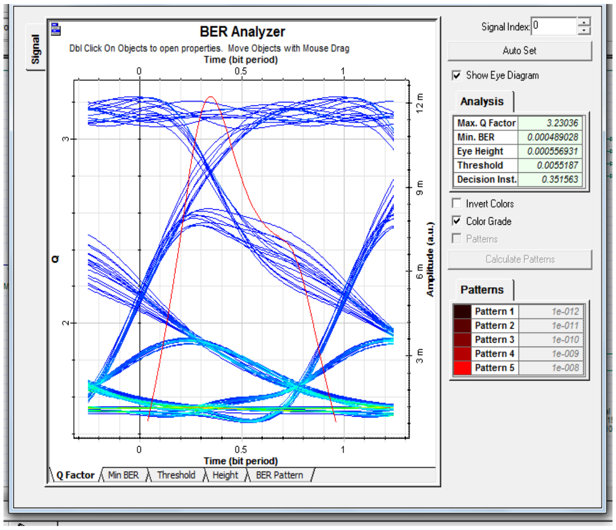

Fig.no.8 Eye diagram for 1st receiver section at SMF 40 Kms

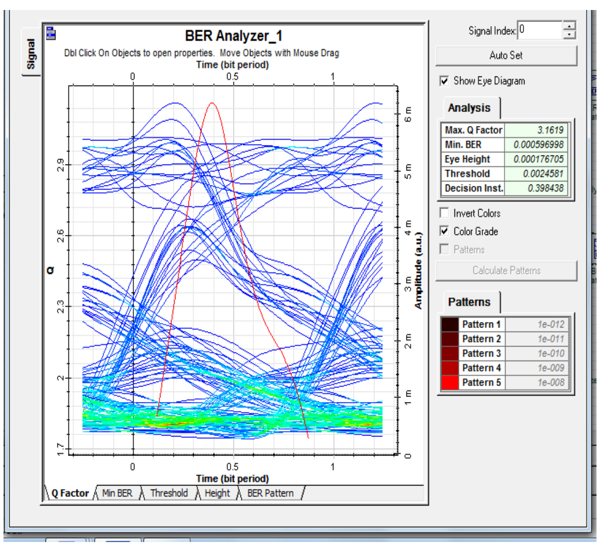

Fig.no.9 Eye diagram for 2nd receiver section at SMF 40Kms

IV. RESULT AND DISCUSSION

After carrying simulation in optisystem software the best Max. Q factor is achieved at the SMF length of 20km , with the Min BER and Eye opening height at their desired value , whereas at 60 km and above for section 1 , the results of all these parameters declines , likewise for the section 2 .It is also seen that the optimum value for working is also yielded by the system at SMF of 40 km length , therefore if we wish for better Q factor values while operating at shorter distances , 20km of SMF length will give out good results whereas if long distance communication is required then the SMF length between 40-50 km is also good to be used.

V. CONCLUSION

The implementation of the RoF with the FSO be it either in form of FSO aperture diversity or FSO with SMF backup , both yield improved result over the conventional RoF architecture of working.

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