ANALYZING IMPACT OF ATTENUATION OVER FIBER COMMUNICATION SYSTEM IN OPTICAL NETWORK

[1]Jaya Pruthi,[2]Parveen Rathi,[3]Deepak Kumar Goyal

MTech Scholar ,Vaish College of Engieering, Rohtak, Haryana

Assistant Professor, Vaish College of Engieering, Rohtak, Haryana

Professor, Vaish College of Engieering, Rohtak, Haryana

jayapruthi7@gmail.com

Abstract: The optical bottleneck in mobile front haul can now be addressed, rather than only backhaul, thanks to recent research efforts. Harmonic and intermediation distortions may be seen in RF signals produced by RoF networks. These issues arise because of the inherent, irreversible nature of nonlinear modulation in optical modulators. Due to their square-law features, photodiodes introduce distortion into the measured signal. There are limits put on RoF communication due to the nonlinearities of the wireless channel and the receiver. The difficulty of solving this issue is compounded by the fact that the fibre chromatic dispersion effect is more pronounced at higher RF carrier frequencies. In order to overcome these obstacles, several strategies have been developed. This proposal looks at Radio over Fibre communication as a means to lessen the present system's substantial nonlinearity and boost its performance. We'll make these adjustments to the system so that it runs more smoothly.

Keywords: Fiber Communication**,** Radio-over-Fiber, Opti-System, Matlab

1.Introduction

The acronym ROF, which stands for "Radio over Fibre," was initially proposed to the telecoms sector back in the 1980s as a hybrid technology. The advancement of RoF technology has allowed us to extend the range of the mm-wave wireless signal, allowing us to cover previously inaccessible locations with our network. The optical carrier in a RoF communication system modifies the RF signal before sending it down the optical fibre to the receiver.

In the 1980s, the telecommunications industry was introduced to the ROF hybrid technology. It went under a different moniker back then. RoF technological advancements have extended the reach of mm-wave wireless signals, enabling us to cover more ground and access previously inaccessible areas. RoF is a cutting-edge innovation that promises to merge the best features of wireless and optical networks into a single, superior solution. The fiber-based transmission used by RoF is not only portable and immune to attenuation, but also provides a tremendous bandwidth and is not affected by electrical interference. It is possible that optical fibres will play a role in the future generation of ultra-fast networks. Increases in storage space, throughput, and user capacity are probably to blame for RoF's meteoric rise in popularity [1]. The name means that in the RoF system, optical signals are sent wirelessly between a CS and a collection of BS. RoF technology may expand to include more protocols, such as 3G, 4G, and WiMAX.

The amount of light that is lost between the input and output of an optical fibre is referred to as attenuation. Attenuation is the term that's used to describe the general weakening of a signal. The amount of loss that occurs during optical transmission in a fibre is commonly measured in decibels per km.In order to calculate the attenuation, the appropriate formula was used. This calculation takes into account the overall length of the optical cable, the margin of error in the system, and the attenuation that occurs at a single splice.The attenuation of a signal is modelled as a function of its range in the following Matlab script.

OptiSystem is a tool that may be used to speed up and reduce the cost of the design process for optical systems, connections, and components. OptiSystem is an accurate network simulator designed for use with optical fibre communication networks. It is a very effective computer simulation application. With the assistance of the OptiSystem software development tool, it is possible to simulate and test any and all transmission layer optical links in a selection of different optical networks. Both the system and transmission layers of optical communication networks may be designed more effectively with the assistance of this software. Because it is modular in design, it can easily be integrated with a number of other software programmes. With the assistance of the graphical user interface, it is possible to handle not only the graphics but also the component designs, net lists, and component types. There is a substantial supply of components that are available with realistic, wavelength-dependent characteristics. You may investigate the effect that a typical component has on the overall performance of the system by using parameter sweeps.

2 Literature Review

Research conducted by V. Sarup and colleagues (2015) placed a key emphasis on rof systems' existing tendencies as well as possible future ones. This study investigates the history of radio over fibre technology, as well as its current state and prospects in the future. Techniques such as RoF-PON networks, OFDM, optical millimetre wave generation, and DWDM are some of the ones that are investigated in depth, and potential applications in the field of RoF communication systems are presented. This article provides a concise summary of the most recent research as well as creative approaches for RoF systems. Research into these approaches not only reveals the effects that parameters such as fibre length, MF, and other such elements have on more conventional methods such as DWDM and OFDM, but it also makes a compelling case for the use of cutting-edge technology. The primary objective of this research is to evaluate the work that has already been done on RoF connections in an effort to focus any future work towards the development of integrated networks that operate more effectively. [1]
According to the findings of research that was carried out by Mazin Al Noor et al. (2011), an increasing number of people are opting to make use of wireless networks in order to connect to the internet and other sources of information. Because of its dependability in delivering data to its intended destination, broadband communication networks greatly depended on it. This was true regardless of whether the receiver was located inside or outside the network. Even if you don't think it has a direct connection to the recent political upheavals, you cannot deny that there has been a large growth in the use of mobile phones and the internet. This surge has already surpassed the usage of fixed lines and has brought about significant changes in people's day-to-day lives. It is feasible to construct a network of communication devices that can only be used by individuals. This is made possible by the broad availability of wireless communication connections as well as properties of mobile devices that allow for mobility. A significant number of radio access points are necessary in order to maintain robust and mobile wireless connections within the context of a personal network, which assumes that a user will always have access to his or her

own communication environment. In order to go ahead with "all-around wireless," we need radio access points that are not only inexpensive but also simple to maintain, as well as signal processing that is streamlined and centralised radio network services. Researchers from all around the globe have been looking at "green communication" as a viable solution that is both environmentally benign and financially realistic. This is because the high RF energy consumption of mobile base stations is a fundamental concern in the wireless communication system. Simplifying antenna stations, increasing broadband communications capacity, and expanding the range over which wireless signals may be broadcast are all critical needs that must be met in order to enable the expansion of networks and mobility. This is necessary in order to centralise signal processing. [2]
Christina Lim et al. (2010) discussed the technologies for fiber-based wireless networks as well as the components that make up these networks. In order to provide mobile connections for ultrahigh capacity communications, researchers are actively looking on submillimeter-wave and millimeter-wave (mm-wave) fixed wireless access employing WDM technology in hybrid fiber-wireless networks. at spite of the fact that such radio networks depend mostly on centralised switching and routing operations, the architecture of these networks involves the installation of high-throughput antenna base-stations at strategically selected places in order to ensure optimum coverage. These sites might be picked at random. When transferring mm-wave wireless data inside of a hybrid network, there are a number of challenges that need to be conquered. A few examples of these challenges are LOECE, FCD, and degradation due to nonlinearities across the connection. Finding a technique to prevent wireless signals from being interrupted as they move through the network is one of the technical challenges that must be overcome while building up a hybrid network.In this study, we give both a detailed review of the methodologies that are presently in use for optically transmitting mm-wave wireless signals as well as an analysis of the problems that arise as a consequence of doing so. In addition to this, we investigate the various subsystem designs that may be used in order to incorporate fiber-wireless technologies into the optical networks that are now in use.[3]

An Economic and Technological Analysis of EPON and WiMAX in FiWi Networks was carried out by Navid Ghazisaidi and his colleagues. If the next generation of broadband access networks were hybrid fiber-wireless networks, there is a possibility that the environmental, cost, and capacity concerns might be alleviated. Both WiMAX and EPON have the potential to significantly improve the capabilities of fixed wireless local area networks (LANs). [4]
In 2005, Anthony Ng'oma and his colleagues were the first to showcase broadband wireless communication systems that were based on technologies including radio over fibre. Soon, all broadband communication networks will be required to provide wireless coverage to the end-user domain, which includes both inside and outside. If integrated broadband services are to be provided via these networks, then the data transmission capacity of such networks will need to be far larger than what is now needed of wireless networks. Because high operating frequencies suffer extremely significant losses while travelling through the walls of buildings, applications that take place within buildings need higher operating frequencies and smaller radio cells. Keeping the components of the radio antenna as simple as is practically possible may assist bring down the original investment as well as the continuing costs associated with such systems. One solution is to make use of technologies that allow for signal processing to be centralised in a single place, such as radio over fibre. This thesis studies high-frequency microwave communications across short distances, as well as ideas for long-range radio antennas and the feasibility of using single-mode and multimode fibres for this role. Researchers are investigating OFM as a potential replacement for the traditional radio-over-fiber systems already in use. In OFM, a sweeping optical signal is picked up by a photodetector located at the radio access node. Prior to this, the signal is first subjected to periodic filtering at the headend. The sweeping frequency is not very high, hovering about 3 GHz as an example. Components of the sweep signal are created at very high frequencies (more than 21 GHz) after

the photodetection that takes place at the RRAU. Through the use of bandpass filtering, the antenna is able to amplify and transmit just the microwave signal that is required. In order to create microwave carriers with the correct modulation, the frequency of the optical signal is swept, and its intensity is altered. Both of these processes take place simultaneously.[5]

In 2010, W. Chen and colleagues presented the first version of their theory to equalise pulse distortion. WDM approaches for high-throughput OC networks have ushered in a new age of dispersion correction solutions for the industry, which has resulted in the market seeing increased competition. Fiber-based dispersion correction offers a potential solution for updating WDM communication systems as a result of its excellent dispersion properties as well as its compatibility with transmission optical fibres. In recent years, there has been an explosion of interest in dispersion correction modules and fibres as a result of the bright future that they provide. In this line of study, the efficiency of dispersion correction fibre modules, also known as DCFMs, in 40 Gbps networks was optimised to its full potential. Initially, optical fibres were constructed that had dispersion properties that were carefully determined. A dispersion optical fibre with an improved refractive index profile might, in theory, achieve zero dispersion and a high figure of merit (FOM). The next step was for them to construct a high-performance dispersion optical fibre by using their top-secret plasma chemical vapour deposition (PCVD) process. Dispersion compensating fibres, also known as DCFs, and pigtail fibres, which are used to link DCFs to transmission fibres, are the two types of fibres that are used in the construction of modules that remedy signal dispersion. Some of the distinctive characteristics of DCFMs are a low IL, dispersion that is well suited for transmission fibres, and a considerable deal of stability in the face of changes in the environment. The wavelengths covered by the DCFMs extend from 1525 nm all the way up to 1625 nm, and they are flexible enough to be utilised for both dispersion tuning and slope correction. The compliance of the DCMs with GR-1221-CORE and GR-63 was experimentally investigated and found to be verified. [6]

H. B. Kim and colleagues (2005) investigated the framework of a radio-over-fiber wide area network that was developed especially for use in rural regions. Recently, there has been a lot of interest in "wireless last mile" as a cheaper option to conventional landline Internet connection. This is because it needs less infrastructure than xDSL and cable modem networks, which are the two most common types of Internet connections. In spite of the growing need for broadband connection in more sparsely populated rural areas, the majority of ongoing projects have concentrated their efforts on more densely populated regions. It is still necessary to have a big number of BS in order to cover broad areas, despite the fact that the population density is lower than in regions that are more densely inhabited. The findings of their investigation suggest that radio over fibre should be used while constructing wireless broadband networks in rural areas. Wavelength division multiplexing is used in order to provide the dynamic allocation of bandwidth to base stations based on the requirements of the users. The layout, the admittance rules, and the timetable were all subjected to a comprehensive review. In addition, a capacity analysis is carried out in order to more thoroughly analyse the benefits of the design.[7] Koonen et al. (2008) conducted research and analysis on radio transmissions using fibre optic cables. Broadband wireless services may be effectively delivered in access and in-building networks owing to the technology known as radio-over-fiber. Dispersion-resistant RoF transport techniques, such as optical frequency multiplication and flexible optical routing, are examples of some of these technologies.[8]

The usage of laser heterodyne was investigated by G.J. Simonis and colleagues in 1990, and the researchers discovered that it was beneficial for the generation, dispersion, and optical control of microwaves. Two outstanding optical signals emitted by Nd when stimulated by a diode laser:By using YAG ring lasers, it is possible to create microwave signals and transmit them optically with a high degree of tunability (from DC to 52 GHz) and a very narrow microwave line width. This is made possible by the use of ring lasers. It is feasible to electrically modify the amplitude by up to 20 dB and the phase by up to 5 pi by including a doped superlattice active area into a waveguide built of III-V semiconductors. This is accomplished by incorporating a doped superlattice active region. The simplicity with which integrated optics and fiberoptic communications can manage the various components of a phased-array antenna makes it possible to apply this technology without much difficulty. As a result, the technology is widely used. The millimeter-wave fiber-radio business is about to undergo a sea change as a result of a newly discovered class of small optical sources. [10]

D. Novak and colleagues (1995) conducted research on the use of semiconductor lasers as a signal generator for mm-wave wireless communications. In their study, the researchers gave a review. They have the potential to be used in the generation of optical signals in the millimetre wave band that have modulation depths that are close to 100%. Optical filtering is used in this method for the purpose of separating the co-existing optical modes in a high-speed photodiode from the spectrum of the pulsed laser. In this article, we demonstrate one possible use for mm-wave wireless communications using feeding microstrip patch antennas. It has the potential to be beneficial for optical fiber-based microcellular networks and wireless local area networks (LANs) found within buildings.[11]

D. Kim and colleagues (1995) detailed the process of producing ultra-stable mm-wave signals by the use of hybrid mode-locking of a single DBR laser. To our knowledge, this is the first time that it has been shown that a hybrid modelocked distributed Bragg reflector semiconductor laser is capable of producing exceptionally efficient and ultrastable millimeter-wave signals. The strategy of exposing the saturable absorber area of the laser to a weak RF signal (- 1 dBm) is considerably different from the technique that is often used in conventional hybrid modelocking systems. We get a signal of 34 GHz with a phase noise that is lower than -70 dBc/Hz when we offset it by 5 kHz from the output of the laser.Utilisation of an electro-absorption modulator as part of the process. [12]

The research done by L.D. Westbrook and colleagues in 1996 enables the transmission and reception of analogue signals in both directions via a single fibre optic connection. They show that it is possible to use a single electroabsorption device with a low insertion loss as a photodetector-receiver or a modulator-transmitter at either end of an analogue fiber-optic link. This was shown by the fact that they were able to do so. They invented a way of simultaneous, bi-directional analogue fiber-optic transmission utilising a single low-insertion-loss EA device. This technology has RF insertion loss of -42dB in both directions and negligible intermediation distortion, making it ideal for low-power, low-cost long-distance antenna applications. [13]

An electroabsorption waveguide device was presented by Stohr et al. in 1999. This device had the potential to be used in RF fiber-optic networks as a full-duplex transceiver that was both cost-effective and efficient. It was specified which experimental features of the spectrum modulation and detection of the dual-purpose transceiver should be determined. Both the extinction ratio and the sensitivity were measured at 12 dB and 0.8 A/W respectively. It was determined that there was an insertion loss of 7 dB. The modulation bandwidth and the detection bandwidth both exceeded 17 GHz individually. Using a dual-lightwave technique might perhaps allow for the achievement of the best possible outcomes in modulation and detection at the same time. optical RF subcarrier transmission across a distance of 10 kilometres that is not dispersive, including complete duplex and error-free operation multiplexing of signals.This depicts the building of a point-to-multipoint optical ring using shifted single-mode fibre.[14]

3 Problem Statement

The vast majority of problems with fibre optics are caused by damaged fibres. It has come to my attention that there is a significant deficit of signals. A weakened gearbox is the result of mechanical strain or excessive bending. It's possible that the length of the wire will prohibit a signal of sufficient strength from passing through. In addition to this, the signal strength may be rather poor if the connection has been compromised. In the event that the fibres sustain damage, it will be difficult to repair the system. Recent studies have been concentrating on reducing the amount of signal attenuation. In point of fact, the use of this cable for communication is nowhere like as widespread as the usage of other methods. It is possible to successfully transfer data using either single-mode or multi-mode fibre optics.

4 Proposed work

The current investigation took into consideration the attenuation that is brought on by fibre optics. Attenuation is a potential problem for many different communication systems, including optical fibre and optical fibre. The transmission of high-frequency light that is employed in fibre optics may be attenuated by using glass tubes in certain applications. The attenuation rate of fibre connections is very low, in contrast to that of RF and electrical noise. Light has to be modulated in such a manner that sufficient signal strength can be maintained at the receiver even after it has been de-modulated for an optical data link to be successful. During the process of transmission, the signal of the light becomes weaker. Connectors, cable splices, and cables are examples of passive media components that might be the cause of the issue. Higher-order mode loss happens when light is reflected back into the core of the fibre, where it was originally transmitted from. This indicates that the multimode signal will not go as far as the single mode signal would. When the maximum transmission distance is increased, there is a greater possibility that the signal may degrade and transmission will be inconsistent.

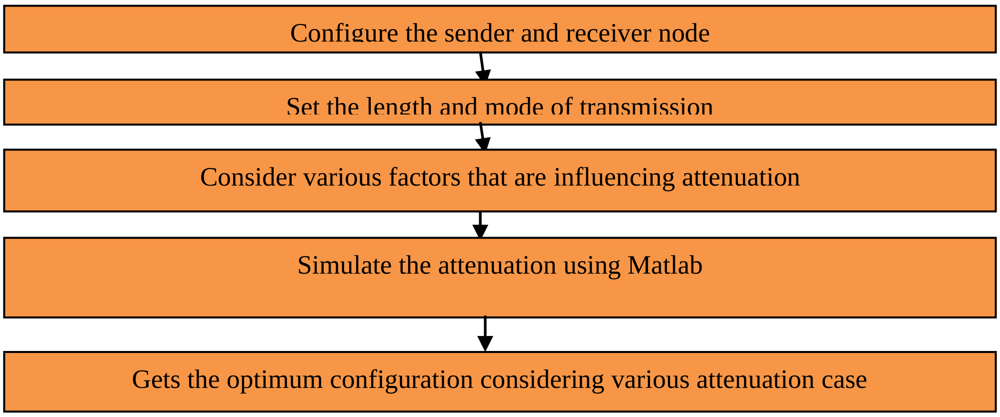


Fig 1 Process flow of proposed work

The suggested technique requires, first and foremost, that the relay and receiver nodes be setup. Modify the timing and method of the gearbox as soon as possible. After that, we go on to investigating the attenuation in a variety of environments. Matlab is used to create a model of this attenuation, in which elements such as distance, gearbox mode, and other variables are taken into consideration. After conducting an intensive search for other viable options, we were able to zero in on the most effective attenuation arrangement.

5 Result and Discussion

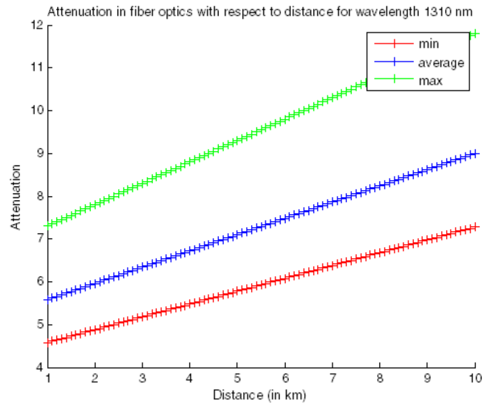
Attenuation is defined as a decrease in signal intensity or power that is sent via a fibre optic cable. Attenuation may occur in either a multimode or single-mode configuration. Decibels and decibels per km are two common units of measurement. There is a wide range of possible sizes for fibres, and each has a unique amount of optical loss measured in dB/km. The wavelength at which the device is running has a significant impact on the amount of loss that occurs in the fibre. At 1550 nm, the loss is at its lowest, while it is at its highest at 780 nm for all physical fibre sizes.

Table 1 For Wavelength 1310nm

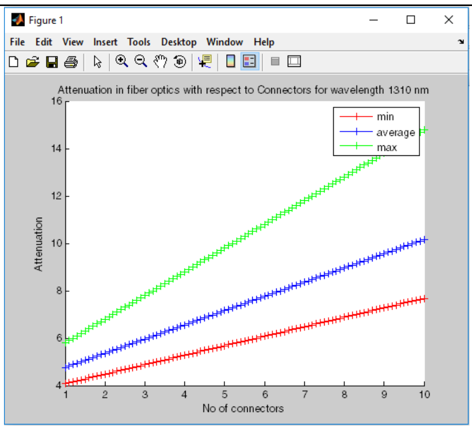
	Attenuation/ Km (dB/Km)	**Attenuation /optical connector (dB)**	**Attenuation / joint (dB)**	
Min	0.3	0.4	0.02	Best Conditions
Average	0.38	0.6	0.1	Normal
Max	0.5	1	0.2	Worst situation

Table 2 For Wavelength 1550nm

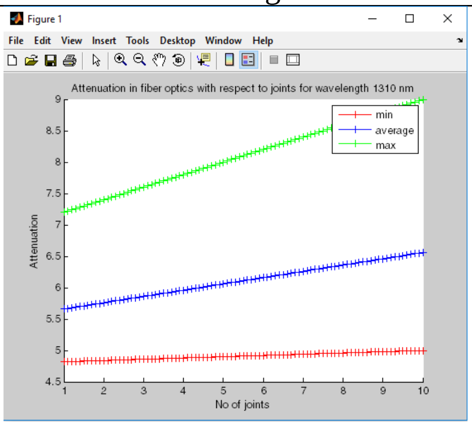
	Attenuation/ Km (dB/Km)	**Attenuation /optical connector (dB)**	**Attenuation/ joint (dB)**	
Min	0.17	0.2	0.01	Best Conditions
Average	0.22	0.35	0.05	Normal
Max	0.4	0.7	0.1	Worst situation



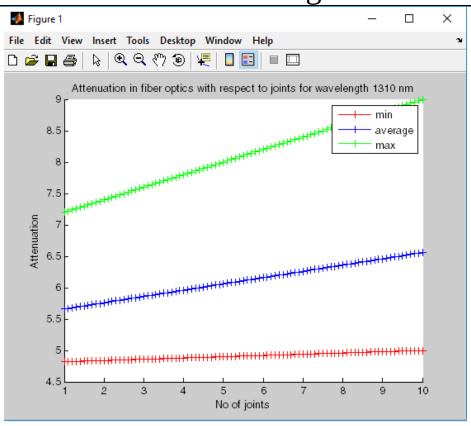
(a) Attenuation in fiber optics with respect to distance for wavelength 1310 nm



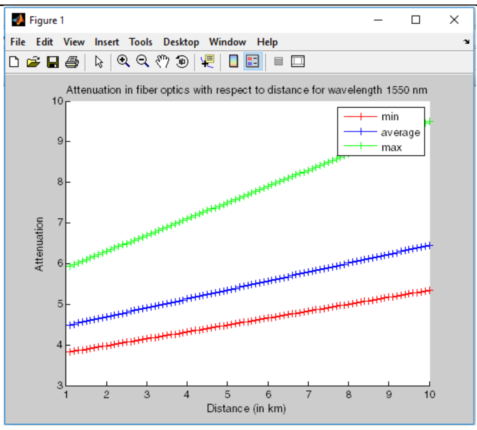
(b) Attenuation in fiber optics with respect to Connectors for wavelength 1310 nm



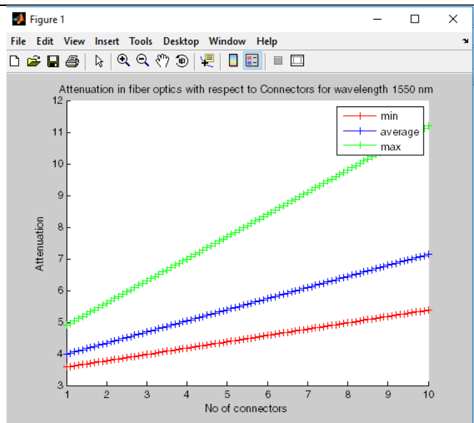
(c) Attenuation in fiber optics with respect to Connectors for wavelength 1310 nm



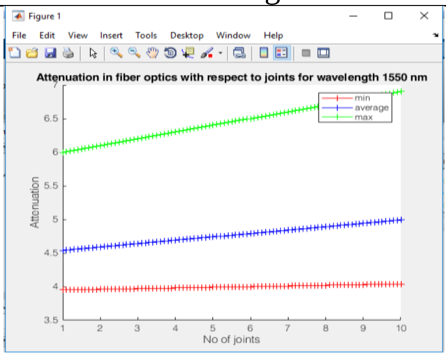
(d) Attenuation in fibre optics with respect to joints for wavelength 1310 nm



(e) Attenuation in fiber optics with respect to distance for wavelength 1550 nm



(f) Attenuation in fiber optics with respect to Connectors for wavelength 1550 nm



(g) Attenuation in fiber optics with respect to joints for wavelength 1550 nm

Fig 2 Attenuation in fiber optics for different wavelength

6 Conclusion

According to the findings of research, attenuation has an impact on the propagation of signals sent across fibre optic cables. This inquiry is looking at a number of different possible reasons for the attenuation of the signal. Within the framework of the simulation, both 1310 nm and 1550 nm wavelengths of fibre optics are taken into consideration. Matlab was used to model the effects of distance on signal distortion and attenuation caused by fibre optics. The modelling process takes into consideration the attenuation of optical signals in fibre optics that occurs at joints. It has been shown that the joint count, connection count, and distance all have a substantial impact on attenuation. There is a correlation between wavelength and attenuation. The findings of a model show that there is a correlation between distance and the amount of attenuation experienced. Because of simulation, distance, the number of joints, and the number of connections may all be taken into consideration throughout the design process of a network.

7 Future Scope

Research on the provision of backhaul is now underway, with the goal of developing strategies that reduce nonlinear distortion and dispersion in mobile front haul and improve the functionality of the RoF communication system. There is a possibility that RF transmissions in RoF networks will display harmonic distortions as well as intermediation distortions. These occurrences may be traced back to the optical modulators' nonlinear modulation capabilities as the root cause. The information that is obtained from photodiodes is distorted because of the square-law characteristics that they possess. Nonlinearities in the wireless channel and receiver have made it difficult for RoF to communicate effectively. The relevance of the effect that chromatic dispersion has on the RF signal that is sent via a fibre increases as the RF carrier frequency raises. There have been many different proposed solutions to these difficulties.

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