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Improving Guided Wave-Based Signal Studies Using Automatic High-Bit-Rate Optical Communications with Quantum Cryptographic

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Abstract: **-**The information transfer through the fibers, which converts the electronic signals into light and employs the light emitting and the light source which enables the information transfer, is known as optical communications. Noise reduction is needed for information transfer. More noise is transferred in the optical fiber, which is the main problem with the information transfer. Then, the communication multiplies the bandwidth, and the optical communication can be enabled. The high modulation method and quantum cryptographic system manage the modulation method to reduce noise from information transmission. The guided waves for many communication purposes, multi-rate communication, and non-moderate communication can be used in this research. The application of the quantum cryptographic system and the modulation for analog signal processing keep the noise reduction, bandwidth, and optical communication can be improved by up to 97% of noise can be released in the fiber optic for the mortification of the communication system. The noise reduction can be made with optical communication. Up to 80% of noise can be removed in the modulation and the quantum cryptographic. Automatic improvement of the high bit rate communication using the quantum cryptographic and the system to reduce the multiplication and bandwidth using the quantum cryptographic system.

Keywords*: Bit-Rate Communication, Digital Modulation, Mono-Mode Communication, Multi-mode Communication, Optical Communications, Quantum Cryptography.*

1. Introduction

The method of transmitting information from one place to the other through optical fiber and electromagnetic waves by using the internet, sending telephone and the signals which help in the transmission can be enabled. This will be useful in revolutionizing a significant role in electrical information and the communication network. Here, the communication allows for the cable television and the signal's reach. Fibre communication is applied for distorted, revolutionized critical communication. This essential communication enables the communication systems to work faster [5]. The technique of a quantum cryptographic system is used for encryption and the decryption method for transmitting the data, which is preserving from hacking. The

significant technological limitations and the signal processing of the data demonstrate the fiber optic and fiber cable enabled in the quantum cryptographic system for improving the security concern. However, existing methods cannot be secure until the condition depends on the assumption and the situation which allows the cryptography, which makes the premises condignly confident in the successful turning point in quantum cryptography. Also, here, the high bit rate communication manages the quantum communication, and the technologies that enable the growth of the incentives in the high-growing integration of the quantum communication can be helped. It describes the transfer of the location and another transmission of the bit-rates and the kilobits to make the megabits per second. This high bit rate can be mentioned as the sample and depth of the high bit rate. This enables the CD bitrate and the quality of the general scene to produce the baud rate. The more transparent and detailed sound modification and depth, which allows better quality and increased bit rate, can be enabled for audio and video processing. The transmission of the fibers and the electronic signals manages the light pulses, and the remittance of the diode and the light source is controlled [10]. Also, optical communication can be contained in the electronic requirements, and the optical signals balances in the telecommunications to provide in the communication systems to maintain the terrestrial for the basic introduction. The main contribution of this paper is as follows.

a. Using quantum cryptography improves the communication between wireless and fiber optic communication.
b. We are maintaining the high bit rate communication for improving the optical transmission in the information transfer.
c. Helps in the reduction of the optical communication for the quantum cryptographic configurations.

The sectional divisions are as follows: The author wrote the researchers in the process, Section 1 as the introduction, section2 as the related works, section 3 as the methodology, section 4 as the results, and Section 5 as the conclusion.

2. Literature review

[1] In this article, the post-quantum cryptography, which is made in the instruction for the set of extensions and the break in the mathematical cryptographic and the evolution of the security and the theoretical transforms, manages the lack of the number theoretic transforms. The acceleration of the non-linear operation can be done—the method of Elliptic curve cryptographic EEC. The post-quantum cryptographic algorithm is used securely against the seven finalists and the high performance, which enables the lattice-based cryptography to perform high optical communication. In the future, this may be stabilized. Then, the randomness, the post-quantum, and the structured management enable high performance, and the categories for enabling quantum security can be enabled. [2] Here in this manuscript, post-quantum cryptography has been evaluated in powerful platforms. Here, secure communication enables the vehicle-to-everything and the product, which enables the empowerment, and the device, which enables the robust, efficient, and security solution, which enables the challenging solution to maintain the post-quantum cryptography to enable the standardization process. Here, the automotive environment enables encryption, and the three bears can be implemented in the POC. Here is the error correction capability. So, in the future, the microcontroller and the security that improves the security level can be managed. The capability of error correction can be enabled for the cryptosystem, and the information transfer is done in this paper. [3] Here the distortion and the modulation technique over the fiber system and the security level, which maintains the zero modulation code for enabling the restoration technique to improve the power of the efficiency based on the switching, is proposed. Here, the receiver enhancement and the frequency of the RF signal can be enabled in this paper. Here, the Gaussian rectangle shape enables linearity improvement, and the shape can be evaluated. In the future, this can be used to maintain the shapes and the signal gain in power, which is enhanced in the signal and their frequencies to produce the electrical power after the performance of the parameter in the amplifier and the transmitter can be enabled. Here, the efficiency and the technique of RF voltage can be enabled. [4] the communication underwater maintains the optical communication, and then the development of the optical communication can be managed in wireless communication with the help of the UOWC method. Here, the physical configuration, which enables electromagnetic and aquatic communication, can be enabled for the physical process. Here, the most prominent

technique is the modulation rate technique to manage the fast transfer in the technique and the modulation under the configuration and the frequency in the communication. Also, in the future, wireless optic communication can be done under the sea's water. [5] here in this paper, the critical industrial based on the underwater examination of the industry and the management level for the experimental research can be made for the practical means and the hydrosphere. This information enables the acquisition system based on the IoT. This enables the multi-mode information and the presentation of the communication technology and the electricity to manage the practice application to proceed. It is in the communication and the information to proceed in the future. [6] Here, the optoelectronic device for managing the communication transfer with the high-speed data transfer in the optic fiber based on the measurements and the paper, which focuses on the optical modulation and the high precision to make the high-speed modulation and the optoelectronic and the single operation can be managed in the rapid modulation can be enabled. Here, the optical frequency and the response manage the modulation and the domain analysis. [7] Here, the FSO and the short range of applications manage the optimum bit error and the wavelength for the single attention and the better performance of the previous data, which is done during the transmitter in the better performance of the single power optimizations. The study enables 21.7% of the efficiency to improve the transmitter. Then, maintaining the enhancement and the transmitter can be operating management. This is done based on the previous model, and the transmitter and the proposed model for the previous method and the transmitter of the data can be classified. [8] Here, the performance of the wavelength of the optical communication has been noted, and then the investigation of the three primary conditions and the MPL, which is caused by the performance and the investigation that has been done during the communication and the power, which is comparative and the condition for the degradation for the maximum. Here, the MPL and the PCS manage the proposed system for the hazy weather.

3. Guided Wave-Based Signal Studies in Optical Communication

Guided wave-based signal studies in optical communication work are based on exchanging information from one person to another that passes through any medium, such as any mobile communication medium. In this criteria, we use the fiber optic cable as the mobile communication medium for fulfilling the mobile communication, data communication, and Cable Television Signal transmission are transferred using fiber optic cable. This study focuses on Optical communication, sharing information through the fibre optic cable using infrared light. This optical data communication consists of a transmitter that encodes a message into an optical signal, an optical fiber passing medium, and a receiver reproducing a letter for sharing information that needs point-to-pint or mesh networks [16]. A building block of this communication is a transmitter or receiver, a modulator or demodulator, and a lighting signal. In such a case, the Optical fibers carry the information as a signal. Information that must be conveyed is often provided as an electrical signal, which can be analogue or digital: Mono-mode and multi-mode optical fibers correct inconvenience in optical fiber communication. Mono-mode is used for long-distance communication, but it is more expensive. The advantage is more efficient than a multi-mode. A preamble is necessary to check to apply the single-mode/mono-mode and multi-mode in the Communication process [10].

For this purpose, communication is transferring a message/signal or anything from one end to another where it can pass through a medium to transmit a signal called light, an optical signal called Optical communication. Light is the most powerful medium to communicate the signal speed with the other sources. It can be the tremendous change in the recent technology trends where it can be used to efficiently transform video and audio signals to the receiver and transmitting end. Light needs some medium to travel to its frequency, which can be a thin film lighter than wire, so it can be used with fiber optic cables worldwide [9]. The fiber optic cable is the only element that travels the internet to different sections of the world connected through the landmass and underwater oceans.

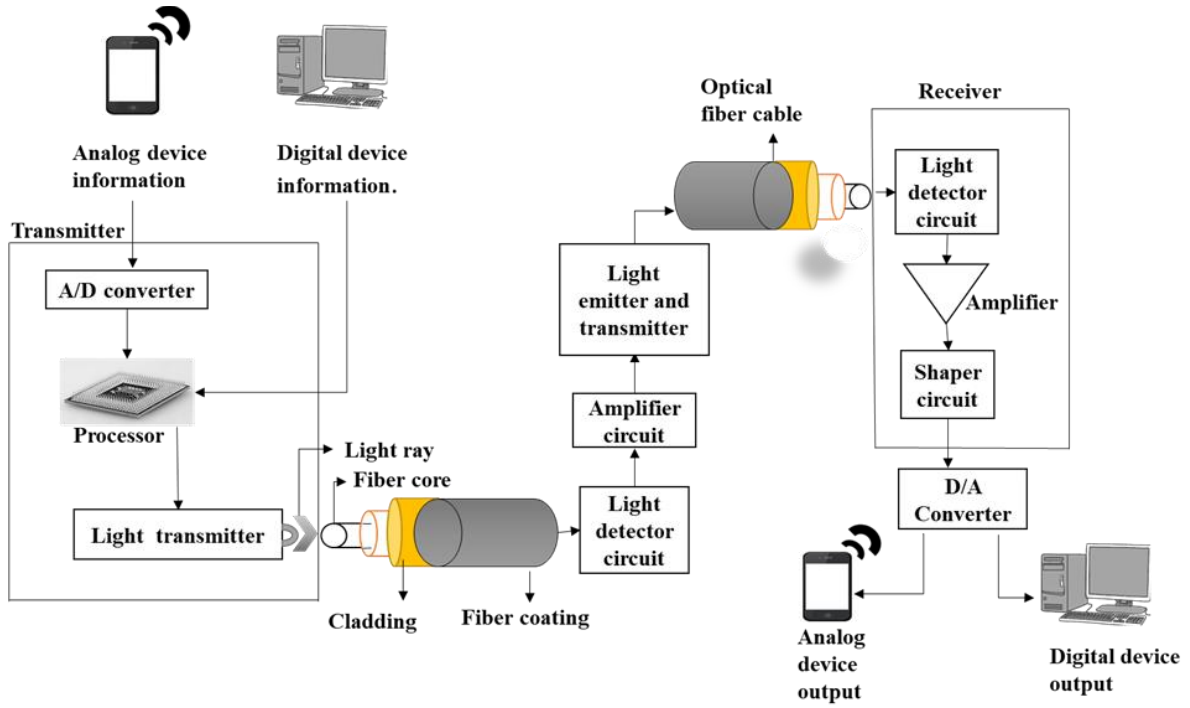

Figure 1. Preamble, optical fiber communication, work concerning the single-mode/Mono- mode and multi-mode in the Communication process

Figure 1 shows how optical communication works concerning the single-mode/Mono- mode and multi-mode in the Communication process. Cables installed underneath and beneath the ocean have made it feasible to communicate optically. Optical fiber connections transport the majority of the data. Thousands of fiber strands make up an optical fiber cable. The word from the digital or analog device will first be translated into a binary code equivalent to a series of zeros and ones. Following conversion, these zeroes and ones are sent by mobile phones as electromagnetic waves. A high-frequency wave is sent when one, and a low-frequency wave when zero. A nearby mobile tower then picks up these electromagnetic waves. The structure produces a light pulse if the electromagnetic waves are high frequency [18]. If not, no pulse is produced. Now, optical fiber cables can readily transfer these light pulses. The information-carrying light pulses must pass through a wire to reach their destination. The glass used to make the cylindrical object has a high refractive index. Let's say the laser hits the interface at a position different from the critical angle. The light will then go to the opposite end due to 100% internal reflection. Over a long distance, light may be contained in an optical fiber.

From these constraints, the optical fiber communication system has various sources, such as semiconductor-based light sources, namely, Light Emitting Diodes (LEDs) and laser diodes. This light source was chosen because it has a single wavelength that can produce light pulses by dispersing much light in a limited space. When light travels through a medium, its speed varies, and the refractive index describes this change in speed—the variations and rates of reasonable cause another phenomenon [15]. An appropriate driving circuit modulates them following the signal. LED directly converts electrical signals into light, delivering efficient golden generation with little-wasted electricity. The advantages of LED in optical communication are lower initial cost, simple design, and ease of manufacture. Laser light is used because of its single wavelengths of light.

Optical fibers have 120 μm diameter highly pure glass fibers to cover a maximum 100km radius with a data rate of 10Gbps. In visual communication, optical power is represented in units of dBm. Hence the optical fiber measurements, a Numerical Aperture (NA) is calculated as

$$NumericalAperture\ (NA) = \frac{sin\,(\theta_A - \theta_B)^{r0}}{2_{r0}} \quad (1)$$

Here, the mode field diameter of a single mode fiber is related to the spot size of the fundamental mode. Here, the r_0 is the field radius.

3.1. High bit-rate communication in optical fiber communication

In optical communication number of bits, 1s or 0s processed per second is called bit-rate. It measures how much data will transfer in a particular time concerning the frequency and bandwidth of signals. The high bit rate varies and is controlled by increasing and decreasing frequency. This frequency is directly proposal to the bit rate [20]. The bit rate might be high whenever the system increases the frequency. A high bit rate means video quality should be high; even the file will be much longer.

Conversely, modulation techniques are an essential process of encoding information from a message in a particular way in data transmission. It is helpful for the demodulation technique to recover the information using the channel bandpass filter. This bandpass filter controls the lowest and highest frequency components for control and sends a low-frequency signal to the destination channel [22]. Hence the modulation techniques are used here to send the data to the bandpass filter range because every channel gets its frequency range to send multiple signals to a single channel.

i. *Single-mode fiber optical communication:* Two modes occur in optical communication, i.e.,single-mode/mono-mode and multi-mode in the Communication process (figure 2).

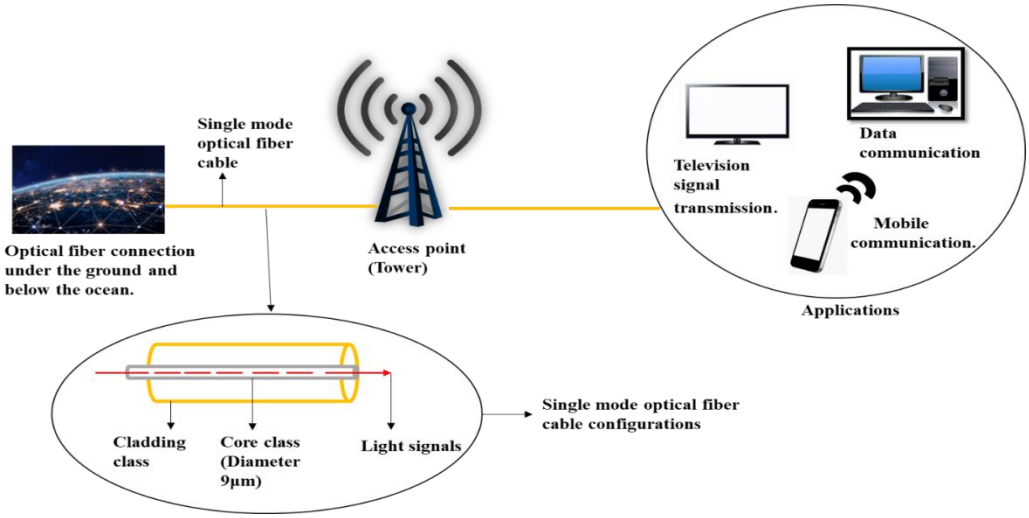

Figure 2. Single-mode fiber optical communication

Light waves are intended to go from one end of a single-mode optical cable to the other. We see a single light beam because the wave moves in the same direction or pattern. Because of its high-rate transmission and ability to serve as the internet's backbone, it is employed for long-distance communication. Here the many types of light energy can transmit the signal from one end to another via fiber optic cable, and data should pass over the wires [11]. It can be determined by the bit rate where the bit rate is used in a particular frequency to the channels that may be called a bit, bytes, etc.

In contrast, the internet speed can be determined by the speed at its transmits data via cables. A Bit rate with high frequency to the channel can increase the connectivity of time to the internet with bandwidth, where it can be avoided by certain losses like bending loss and scattering losses of the cables; there is signal formation in the fiber optic cable whether it can connect with the analog signal or digital signals or multi-level signaling frequency [15]. Analog can connect the signals continuously with the waveform method concerning the current and voltage and digital communication that travels the waveform in the sequence of discrete form. Inside the line, two types of wire connecting formation are mono-mode rate and Multi-mode transmission.

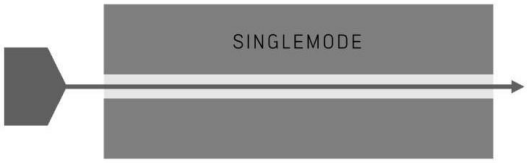

Figure 3. Source of light travels through the core and cladding layer

Figure 4. Medium of a multi-line signal source

Monomode Rate Communication: This is the type where the light source can travel by a single medium of cables inside the insulating layer of the line. Figure 3: The above picture shows the source of light travel through the core and cladding layer of the fiber cable. Monomodefibers are very dense with small internal core diameters [4]. Generally, each optical fiber cable is composed of a very pure, thin optical strand of silica glass material covered by a lower refractive index of cladding, as the fundamental mode has no cut-off.

The general algorithm for mono-mode rate communication

process(sender)
for each mono-mode fiber, **do**
transmit data: based on the reconstruction method
get normalized frequency
if (LP_{01} mode can exist) **then**
for LP_{01} mode, **do**
operation depends on a lower limit of guided propagation
end for
process(receiver)
occur normalized cut-off frequency
V_c= 2.405
for low power and normalized frequency, **do**
for$0 \leq V < 2.405$**do**
single-mode operation: $2.405\sqrt{\frac{g+2}{2}}$
end for
end for
end for

The phrase mono-mode refers to the propagation of light with a specific polarisation, and it should be emphasized that there are two modes with orthogonal polarisation throughout this range. Additionally, the normalized frequency can be altered to fall within the range by reducing the core radius and perhaps the relative refractive index difference, typically less than 1% for single-mode fibers [8].

ii. *Multi-mode fiber optical communication:* It is a type of cable with a multi-line of fiber optical cable connected with the core and cladding layer of the fiber optic cable. Figure 4 shows the medium of a multi-line signal source can transmit in one line in between core and cladding layers

Algorithm for multi-mode rate communication

input:M_n= no.of modes (multi-mode fiber)
$t_{d,m}$= delay (guided mode) m is count
for multi-mode fiber communication systems, **do**
for M in range(2,4,8,16,32, 64...)
calculate frequency
$F_{fiber}= \sum_{m=1}^{M_n} e^{-2j\pi . f . t_{d.m}}$
locate subcarriers on fiber
for multi-carrier modulation, do
calculate error rate
$P_{ratio} = \left\{Q[\sqrt{2r_s}sin(\frac{\pi}{N})]\right\}$
calculate BER
$P_{ratio}(k)= \left\{Q[\sqrt{2r_s(k)}sin(\frac{\pi}{M_k})]\right\}$
calculate SNR
$P_{ratio}(k)= \left\{Q[\sqrt{\frac{A^2F_k^2}{M_0\,(k)}}sin(\frac{\pi}{2^{Rk}})]\right\}$
if (A and M_0= same) then
$P_{ratio}(k)= \left\{Q[\sqrt{\frac{A^2F_k^2}{N_0\,(k)}}sin(\frac{\pi}{2^{Rk}})]\right\}$
else

the highest error rate would dominate
end if end for end for end for

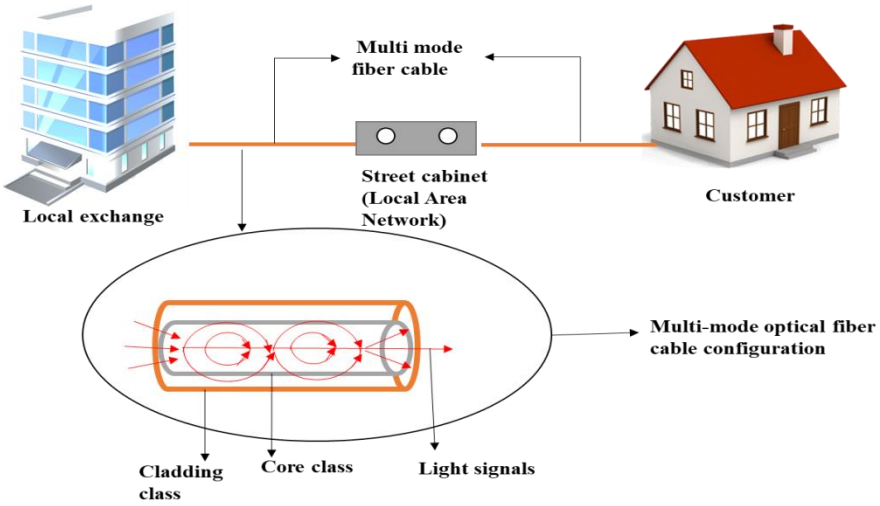

Figure 5. Multi-mode fiber optical communication

From Figure 5, Multi-mode fiber is primarily used in short-distance communication, like within a building or a campus. Light waves travel multiple paths and take communication data rates up to 100Gbps. These high bit-rate communications and Modulation methods improve optical communication [19].

The optical communication system has enormous bandwidth capacity. It ensures data security and privacy using digital, multi-level, and analog modulation techniques and quantum cryptography [12]. The modulation techniques (digital, multi-level, and analog) appropriate for high-bit-rate communication are examined in this paper. The high bit rate exceeds the 50Mbps that specific instruments have by default. Due to the comparatively small channel allotments in popular frequency bands, the communication link becomes bandwidth-limited at more excellent data rates. Therefore, we need modulation methods that are both bandwidth- and power-efficient. This power- and bandwidth-efficient mono-mode and multi-mode rate communication system offers a solution to the issue of high bit rates [17].

Pseudocode for high-bit-rate communication

input: digital data *#Encoding signal at the transmitter*
for each data communication, **do**
generate optical carrier
encode signal using modulation schemes
transmit data with carrier plus data
inject data to a receiver *#Decoding signal at a receiver*
generate output a carrier
subtract carrier with encoded data
get digital data
end for

The general high-bit-rate communication process is clearly explained in the above pseudocode. In the communication system, the optical oscillators generate the carrier for encoding the input using digital, multi-level, and analog modulation methods. The data is transmitted over the single or multi-mode fiber to reach the receiver end. At the receiver end, another optical oscillator is used for the transmitter. The encoded data is injected into the receiver, generating carrier output without the original input data [12]. Therefore, the initially transmitted data is revealed by subtracting the carriers from the incoming encoded signals. Each data sequence is securely encrypted into optical carriers before being transported via a 100-kilometre single-mode fiber, where it is successfully decrypted at the receiver end [14].

3.2. Automatic improvement in Optical Communication

The technology can reduce the noise by increasing the quality of the bit rate transmission speed of the transmitter and receiver response time. It can be close and continuous attention to the Noise pulse modulation, and also by certain losses and attenuation of power voltage can be reduced in the process. The separate channels can avoid multiplication for multi-level modulation by lowering the signal complication and increasing the bandwidth [16].

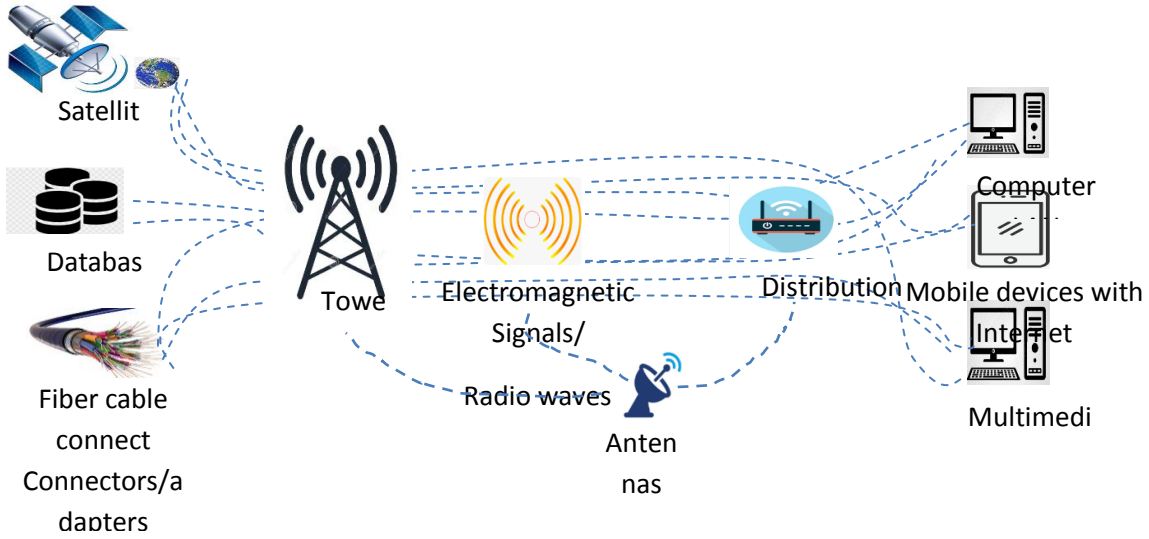

Figure 6.Automatic improvement in Optical Communication stages and respective components

From the automatic improvement in optical communication, the latest technology of the 5G advancement also be implemented through the optical fiber method. In this era, the bandwidth increase and the signal strength with the high data speed to the access point noise can be reduced by the high quality of multi-level transmission fiber signals. By increasing fiber optic cable bandwidth, we can improve the downloading efficiency at a high bit rate. It can be implemented by Orthogonal frequency-division multiplexing (OFDM). It can be used in a comprehensive high-band frequency with a single information stream [14]. It can be split into high bit rates with the independent channel and reduce the multiplication of signal conjoint in the same direction, reducing the noise by the movement to noise ratio cancellation. Suppose the password can be measured by decibels (dB). In that case, it can be determined by the loss of length of the signal travel to the noise created in its frequency operation. This processing schemais defined in the following Figure 6 [15].

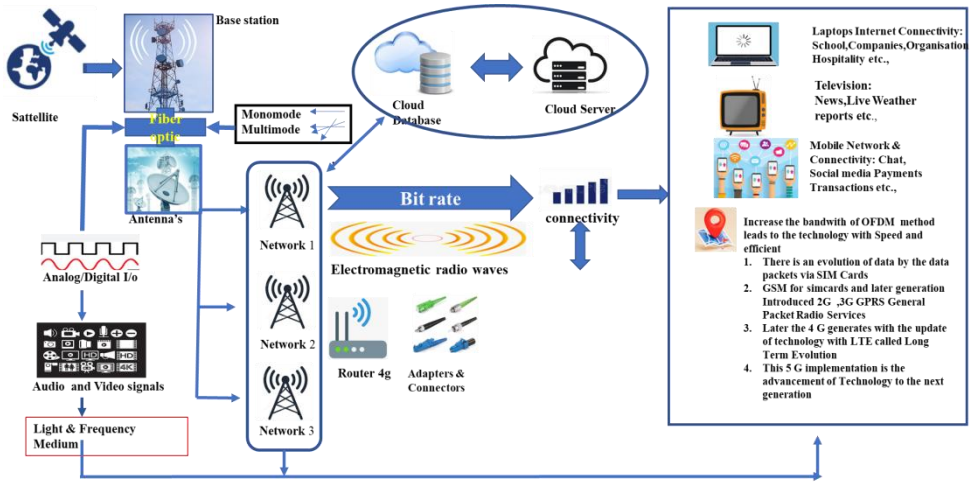

Figure 7. Process of Automatic Improvement Optical Communication

From Figure 7, the light can transmit the data by taking binary ones and 0s in the transmitter response and receiver time availability. The light-medium can travel in fiber optic cable where LASER or LED can transmit data to the path, leading to the signal transmission. The total internal reflection and deviation angle maintained through fiber cables and greater network availability can increase technological advancement. The data security to the user and receiver by the increasing bit rate to the fiber cables attenuates. The signal transmission speed is the automatic improvement in optical communication [20]. Also, reducing the noise, multiplication, and bandwidth leads to proper technological growth to empower advancement.

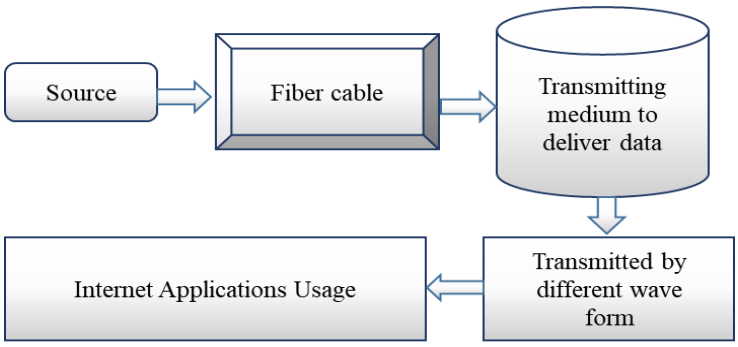

Figure 8. The Flowchart of the fiber cable path to data travel

Figure 8 explainsa simple diagrammatic chart of the process flow diagram of light sources that can travel to the medium of fiber optic cable, where it transmits the data with a high bit rate of data of the file to the cable with a maximum signal strength of the channels it travels to the different usage and applications of the medium where the networks links.

3.3. Proposed automatic high-bit-rate optical communications with quantum cryptographic

The quantum cryptographic system is the primary technique used to improve the fiber optic communication cable network. The better way to enhance the technology that travels its data to the user is by the Security features that include only a Quantum cryptographic method. The data passes through that can be encrypted and may open [21]. Conversely, a data quantum cryptographic decryption forms a secure data transfer from one end user to the data's destination. To understand this quantum cryptographic form of fast data transfer, the following security for the encryption of data and decryption by third parties are used to clarify the Quantum cryptographic encryption and decryption antidiscrimination [22].

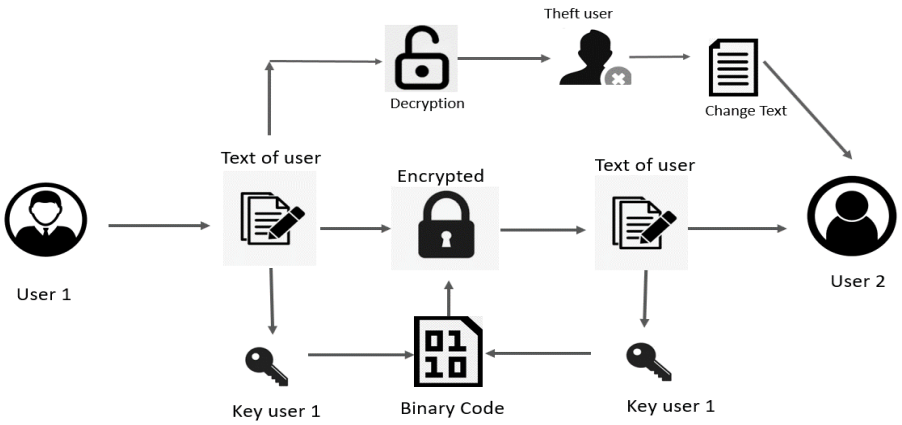

Figure 9. Users-friendly security for the encryption of data and decryption by third parties

Optical communication can be implemented through fiber cables, and it can transfer data securely with efficient user friendly that the data should not be theft by third-party access. Figure 9 shows security for the encryption of data and decryption by third parties. The Quantum cryptographic system can enforce it so the data not only be for security purposes but also be transmitted by analog and digital conversions for the various form that the audio-video type of the light/optical transmission can be separated. It can be used with a digital analog input for

the audio signal that can be continuous. Data output can be projected as digital with the help of discrete signal transmission through an optical fiber cable. It can be projected through both mediums of quantum Cryptographic multi-level Modulation rate of access Communication. The satellite can access the towers. It can be implemented with fiber data to transmit and distribute the different areas using different techniques [6]. The sub-distribution buildings are connected with local server antennas that transmit the receiver signal through radio and Electromagnetic wave generation. This Electromagnetic wave generation can convert the digital and audio outputs of the signal transmission to the user end. This will be the complete package of production provided by the fiber optic cable internet service provider. It will concern the high bit rate that can increase the quality of analog, Digital, and Multi-level modulation to the user experience; increasing the ability of a High bit rate can avail the many benefits to the technology and advancement towards the future [13].

3.4.1. Quantum Cryptographic React with Quantum Data

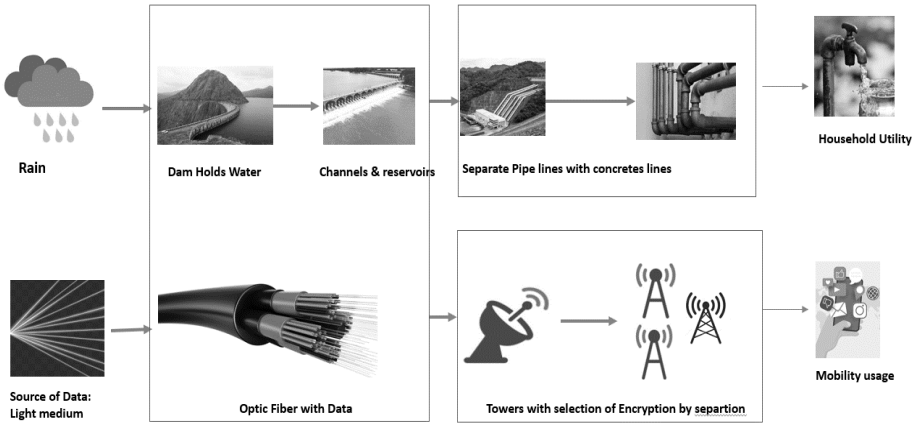

Figure 10. The process of Quantum Cryptography concluded with the Construction of the Dam Technique

Figure 10, shows that the process of Quantum Cryptography concluded with the Construction of the Dam Technique. It helps to understand how Optical Communications with Quantum Cryptographic React with Quantum Data with real-time examples. Figure 10 completed how the construction dam techniques can be implemented over the quantum cryptographic system technique can be processed. The method of Construction dam the rain is considered as data stored in the dam constructed by cement concrete and shielding. Hence the optical fiber cable flow via data can be transmitted through different channels like the channels and reservoirs in the dam so that the solid concrete stream of layers can separate. This substantial stream that divides the water channels through the pipeline can be encrypted by the safety of underground connection and to the sub tunnels of pipes and all relationships divided by the flow of water [18]. In the dam, it can be controlled by the controller of the dam reservoirs and motors to the sub pipelines as the same method can be included in the fiber optic cable, passing the data with a flow of high bit rate. This increased bit rate can be controlled by bandwidth and muscular signal strength. The user can encrypt it to the user end—perhaps the cable connection for different usability and availability is finally sent to the utility end of the pipelines. Usability and availability level can reach the user end with concerned usage, and the data can be used with an optic fiber cable connected with the user end as mobility. Hence the signal can be used with the cycle rate of time it reaches the destination time [3].
Quantum cryptography is an encryption method that uses quantum mechanics to transmit and secure data that can be preserved with the entire secure concern. To implement this example criteria for Quantum Cryptography to our secure communication technique, Cryptography is considered a primary secure communication technique in Quantum data handling. In this method, the sender and receiver only show the data. The quantum state is measured here without disturbing any other system; hence the photons are used for their ability to carry the information through optical fiber cables [9].
Digital modulation has greater demand for its capacity to convey a more significant amount of data than analog modulation. The data optically transmitted over the fibers is called an optical communication network. This process uses light sources that can convert electronic signals into light pulses, sent at one end of the optic fiber and received at the other end of the cable using photodiodes that convert the light source into electronic signals

[15]. This technique provides data security and capacity and system availability with quality communication. In the modern era, digital communication has more noise than other communication. This study overviews modulation schemes employed in optical communication, quantum cryptographic systems, and bit error rate concepts.

Pseudocode for quantum cryptographic framework and digital modulation methods

Input: data bit

While transmission **do**

for each piece of information, **do**

Generate: carriers for carrying bits

Measure: noise and ISI

Compute: BER

$$BER = \sqrt{\frac{2E_{avg}}{N_o}}$$

For each bit in P_b **do**

Calculate Average energy

$$E_{avg} = S_r P_b$$

End For

Assume $\frac{E_{avg}}{N_o} \leftarrow -10\log\left(\frac{1}{datarate \times 10^3 kbps}\right)$

End For

End While

To clarify these constraints, the example is one person sending data to another. As we know, the data is a form of a photon. Binary bits represent the photon so that the data will transfer 0s or 1s in a single direction. However, the data photon will vibrate or oscillate in the transfer process. So before sending the photon, it passed through the polarizer. A polarizer is a filter that allows specific photons to split with the same vibration while allowing other photons to produce a different beat. The photon will do so as it moves toward the receiver through the optical fiber line. Here, a beam splitter is required to read each photon's polarisation. The photon data doesn't know the proper photon polarisation when the receiver receives it [19]. Hence, a polarisation was selected at random. Which receiver was used to polarise the data is compared by the sender. The recipient now knows which polarizer was utilized to convey each photon. The receiver then verifies the suitable polarizer. The remaining sequence is treated as data once the photons read with the incorrect splitter are eliminated.

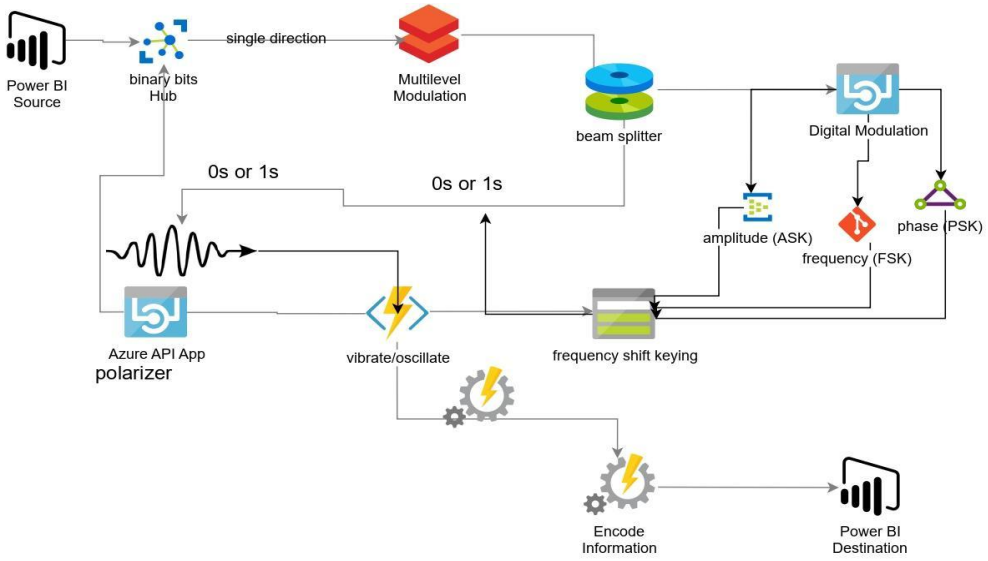

Figure 11. Signal handling with amplitude, frequency, and phase in the Quantum Cryptography process

Figure 11. also use the modulation method to control the information or encode a piece of information. There is a lot of modulation method used here. The first digital modulation method is one of the best methods compared

to the other methods. Because it can transfer a more significant amount of data. The digital modulation method provides high data security and quicker system availability with great-quality communication. In this method, radio frequency is transmitted only when 1s arrive and stops when 0s arrive [21]. If the information signal alters, the frequency parameter is called frequency shift keying. It is the simplest form of shift keying and uses two frequencies: one is for transmitting 1s and another for 0s. The second analog method in this method analog is converted into digital. It is portable and low-cost. Analog signals consume only less bandwidth.

Multi-level modulation methods are the primary constraints for improving bandwidth efficiency. Transmitting more data from one point to another per symbol improves bandwidth efficiency. Even though the multi-level modulation allows more data transmission through the communication channel, that is most sensitive to noise and non-linearities compared to the other schemes [21].

The result closed with quantum cryptographic systems and multi-level modulation

input: data-d, symbol-R
while channel communication **do**
set: SNR gain =3 dB
for each symbol, **do**
perform adaptive DC bias : R_{min}=0 && P (TR) ∝R
for each symbol's bias
d←$d_{min}$and d_{min}←$\sqrt{2}$
SNR←1.5dB
Compute: overall SNR improvement
$\frac{SNR_{AB-QAM}}{SNR_{PAM}}$=$\sqrt{2}.\frac{\sqrt{2E}}{E+1}$→sdB-$10log_{10}(\frac{E+1}{E})$
Compute: BER
$$BER_{AB-QAM} \approx \frac{6E^2-8E+14}{2E^2 log_2 E}.\ Q\left(\frac{2E}{E^2-1}\sqrt{\frac{log_2 E}{\rho_m^2 S_b}}\right)$$
return, higher bandwidth, and non-negative output
end for **end for**
end while

According to the probability of transmitted data symbols, the average of symbols changes. As in PA, this fluctuating symbol average enhances the character's permitted swing [8]. The in-phase and quadrature symbols can be extracted using matched filtering to 1 and 2, although there is some signal-space diversity when the correlated data from 3 dimensions is used. From geometrical reasoning, it can be demonstrated that by making use of this variety, the constellation's dmin is improved by a $\sqrt{2}$, or equivalently, the SNR is improved by 1.5 dB. Combining the abovementioned effects yields the formula below, representing the overall SNR improvement of AB-QAM over QAM.

$$\frac{SNR_{AB-QAM}}{SNR_{PAM}}=\sqrt{2}.\frac{\sqrt{2E}}{E+1}\rightarrow \text{sdB-}10log_{10}(\frac{E+1}{E}) \quad (2)$$

The result is shown in terms of BER expression for -AB-QAM as below,

$$BER_{AB-QAM} \approx \frac{6E^2-8E+14}{2E^2 log_2 E}.\ Q\left(\frac{2E}{E^2-1}\sqrt{\frac{log_2 E}{\rho_m^2 S_b}}\right) \quad (3)$$

In the multi-level modulation technique, the channel shares among multiple users. Three methods can be used in frequency, time, and Code division access. It shares both time and bandwidth among various media. Its transmission occurs through digital signals. It supports a high data rate and is more flexible. A secured communication method is quantum cryptographic, which implies protocol for involving the components with the mechanism [16]. It provides the key for encrypting and decrypting the data while transmitting it from the sender and receiver side and also can detect the third party trying to theft the key.

Pseudocode for Working principles for quantum cryptographic

set:sender-S, Receiver-R, TP-third party

input= qubit ()
while using quantum communication, do
If (S sends qubit→ R) then
Tpchanges the state of qubit
R not receive the qubit state
end if
If (S prepares a qubit in the state |+⟩ (X-basis)), then
Bob measure 1
else if(TP measure this qubit (Z-basis)) then
change states|+⟩|+⟩ to either |0⟩|0⟩ or |1⟩|1⟩
R no longer certain to measure 0
if (input (state of qubit) = output (state of qubit) =50%) then
secured quantum channel
else if(input (state of qubit) = output (state of qubit) <50%) then
interruption of the third party
change channel for communication
end if
end if
end while

Generally, the classical channel could be a telephone line. We send electric signals through the cable representing our message (or bits). The quantum key distribution protocol involves repeating this process enough that a third party cannot escape this interception.

The result closed with quantum cryptographic systems and analog modulation

input; M-orthogonal element signal-$O_i(T)$
fori=0-M-1 do
for $0 \leq T < T_{sl}$ do
$O_i(T) \leftarrow e^{2k\pi (F_0 + i/T_{sl})T}$
else
$O_i(t) \leftarrow 0$
end for
OFDM transmitted signal
$x(T) = R\left(\sum_{k=-\infty}^{+\infty} \sum_{i=0}^{M-1} c_{j,i} O_i(T - jT_{sl})\right)$
end for
end process

Changing the carrier signal while utilizing a modulating signal—frequently containing the data that must be sent or conveyed—is the modulation process. When the carriers' signals are modulated, we may transmit a signal over the bypass frequency band. We may broadcast several signals concurrently via a single channel if each signal has its frequency. Smaller antennas can capture modulated signals [14]. Therefore, this serves as one of the defenses for modifying carrier signals. Becauseinput signals allow power amplifiers to run at saturation and utilize all available power, and they are primarily employed in satellite and optical communications. Frequency-modulated signals may be delivered and received cheaply since their reception antennas are smaller. As a result, frequency modulation is the analog modulation method that optical communication systems use the most frequently.

4. Results

The study focuses on the Automatic improvement of Optical communications by improving the guided waves using high-bit-rate communication for reducing noise, multiplication, and bandwidth. To enhance optical communication, the experiment environment aims to analyze the improving mono-mode and multi-mode high-rate waveguides' contributions to optical communication [7]. When the light signal is transmitted via a single-mode cable with a bandwidth, there will also be some light reflection that optimizes transmission speed and

reduce attenuation, which is more suitable for long-distance signal transmission when a signal transmits over the multi-mode cable, which brings high review, higher bandwidth, transmission speed, and increased attenuation measures. It is more suitable for short-distance signal transmission. Table 1 shows a specification measure of integrated optical waveguides.

Table1.Specification measures of waveguides

Specifications		**Monomode cable**	**Multi-mode cable**
Dimension		**8.3 to10 microns**	**50-100 microns**
Light Reflection		**small**	**higher**
Attenuation	**850nm (Low speed)**	NA	3.5dB/km
	1300nm (High speed)	>0.5dB/km	1.0dB/km
Bandwidth	**850nm (Low speed)**	NA	160MHz.km
	1300nm (High speed)	>1GHz	500MHz.km
Type of Connector		Blue shroud	Beige Shroud

The dimension mentions the core and cladding diameter of the single and multi-mode cables. In optical communication, the input is transmitted light from one end to the other. In other words, the loss of signal power in optical cable connections is known as attenuation [12].

Table 2. Carrier Frequency and normalized amplitude of Mono-mode fiber and Multi-mode Fiber optic communication

Carrier Frequency $\times 10^4$(MHz)	**Normalized Amplitude**	
	Mono-mode Fiber	**Multi-mode Fiber**
3.0	0.045	0.221
3.1	0.132	0.154
3.2	1.435	0.051
3.3	0.073	1.231
3.4	0.215	1.021
3.5	0.042	1.130
3.6	1.135	0.910
3.7	0.073	1.121
3.8	0.046	1.153
3.9	0.021	0.245
4.0	0.094	1.123

Three processes, reflection, refraction, and absorption, lead to attenuation. Bandwidth is the range of frequencies from 0 Hz (DC) to 3 dB, where the light signal has been attenuated by 3 dB or to half the transmitter power. The mono-mode and multi-mode fiber comparison is clearly illustrated based on the abovementioned factors in Table 1. Then the frequency response analysis of both fiber cables based on carrier frequency is observed and discovered in Table 2.

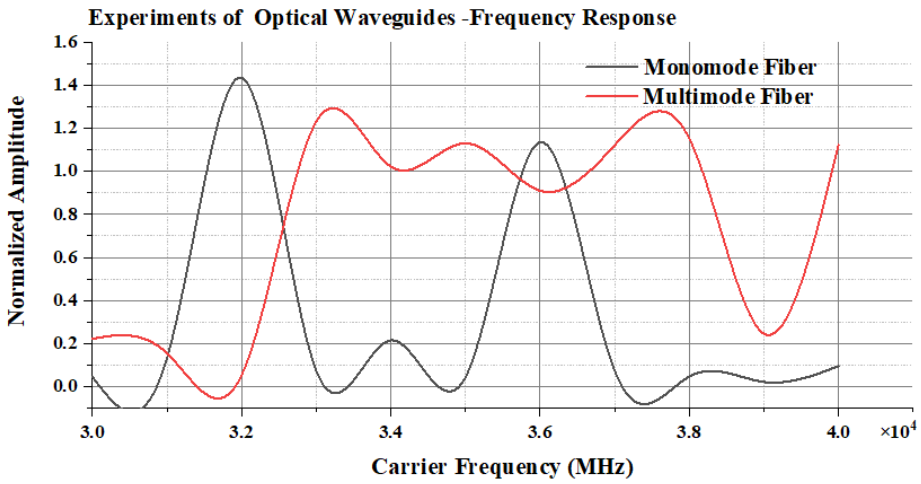

Figure12. Frequency response of waveguides

Figure 12 depicts loading bits results based on the mono-fiber and multi-fiber frequency response. The horizontal axis refers to the carrier frequency, and the vertical axis refers to the normalized amplitude. The frequency response of single-mode and multi-mode fiber from 30 GHz to 40 GHz and the subcarrier position is allocated here. These variations are based on the amount of subcarrier in the fiber cable. Initially, the single-mode fiber carrier frequency is higher than the multi-mode fiber. Suddenly the multi-mode thread reaches a higher carrier frequency than the singular multi-mode fiber. As a result, the multi-mode has a higher carrier frequency than the single-mode fiber. This study overviews modulation schemes employed in optical communication and quantum cryptographic systems, along with bit error rate and bandwidth efficiency concepts. We need to analyze the high-bit-rate communication of various modulation methods such as Digital modulation, multi-level, and analog modulation methods. Modern communication systems are primarily digital, offering superior noise immunity than analog ones. Additionally, the signal is transmitted using digital modulation.

Table 3. Performance measures of Digital modulation methods

$\frac{E_{avg}}{N_o}$ (dB)	Bit Error rate (Error/bit)				Bandwidth Efficiency			
	4-PSK	**8-PSK**	**16-PSK**	**BPSK**	**4-PSK**	**8-PSK**	**16-PSK**	**BPSK**
-5	0.233	0.262	0.364	0.163	0.43	1.12	1.03	1.23
0	0.203	0.243	0.313	0.127	0.93	1.64	1.25	2.43
5	0.174	0.164	0.193	0.156	1.24	2.31	1.42	4.63
10	0.0825	0.0731	0.0658	0.0214	1.63	2.52	1.63	5.27
15	0.0024	0.0012	0.0075	0.00088	1.84	2.93	1.83	6.31
20	0.00093	0.0006	0.00081	0.00094	2.83	3.28	2.09	7.83

The performance standards for digital modulation are expressed in bit error rate (BER). It relies on the level of inter-symbol interference and the amount of noise present. They are using Pb as the bit period in the case of polar NRZ waveform transmission. Table 3 illustrates the various digital modulation methods' bit error rates and bandwidth efficiency.

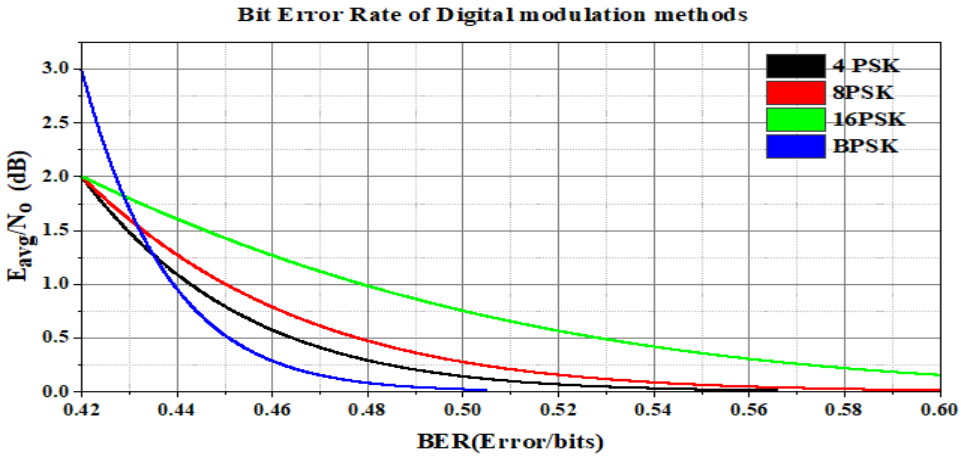

Figure 13. The bit error rate of the digital modulation method

Figure 13 compares the bit error rate of the various methods in the digital modulation methods. The 4PSK is more secondary than the 8PSK and 16PSK but higher than the BPSK. The result shows that the bit error rate of BPSK is lesser, meaning the bit rate loss during the transmission is comparatively lesser than the other methods.

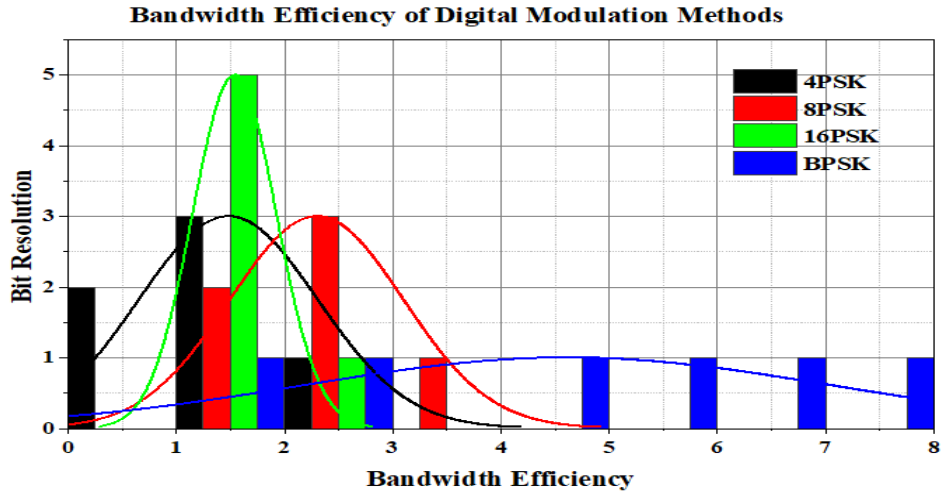

Figure 14. Bandwidth efficiency analysis

Figure 14 shows the bandwidth efficiency of various digital modulation methods. The bandwidth is measured as the maximum amount of data bits transmitted over the network to the specified receiver per second while maintaining the service quality. For BPSK, a bit resolution of 50% causes a bandwidth efficiency increase of 63% (from 1.035 to 7.98 bits/sec), compared to 44% (from 0.296 to 1.88 bits/sec/Hz),35% (from 1.126 to 2.576 bits/sec/Hz) and 26% (from 1.026 to 2.088 bits/sec/Hz)for4-PSK, 8-PSK, and 16-PSK, respectively. Comparing the four methods, the BPSK has higher bandwidth efficiency than others because, for each bit resolution, the BPSK has increasing value stability in bandwidth measure. The other 4PSK, 8PSK, and 16PSK methods have lesser bandwidth efficiency than the BPSK method.

Table 4. Statistical measures of multi-level modulation methods

Bandwidth Efficiency	**Multi-level modulation methods Bit error rate**		
	QAM	**PAM**	**AB-QAM**
0.5	0.00233	0.00364	0.0000063

1	0.0032	0.0045	0.0054
1.5	0.00403	0.00313	0.0063
2	0.00614	0.0093	0.0084
2.5	0.085	0.068	0.018
3	0.094	0.085	0.035

We need to estimate the proposed AB-QAM methods bandwidth efficiency, which is slightly higher than the other methods regarding bit error rate. The measures are approximately calculated and shown in Table 4. To analyze the Multi-level modulation methods, Each symbol's DC bias is neglected.

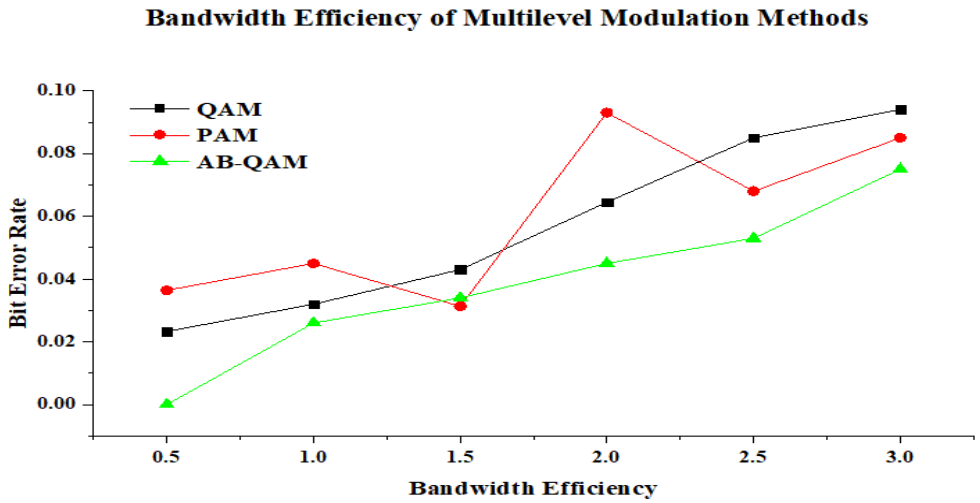

Figure 15. The BER against the bandwidth efficiency

The bandwidth efficiency of the proposed AB-QAM with the other two existing methods is shown in Figure 15. MATLAB's optical communication channel model was used to simulate the results for AB-QAM and QAM. According to Figure 15, all three approaches have the same bandwidth efficiency. Still, the proposed AB-QAM method has a lower bit error rate (BER) than the other two ways.

Table 5. The carrier frequency and Analog modulation methods Spectral efficiency

Carrier frequency	Analog Modulation Methods Spectral Efficiency		
	OFDMA	MC-CDMA	COFDM
0	0.091	0.096	0.085
0.2	0.079	0.084	0.075
0.4	0.065	0.073	0.063
0.6	0.050	0.056	0.046
0.8	0.036	0.045	0.030
1.0	0.02	0.03	0.01

Noise interruptions are extremely rarely tolerated by frequency modulation. The COFDM can be transmitted light signal data and spread over many carriers rather than modulating it onto a single-mode fiber. This performance is analyzed by comparing it with existing methods.

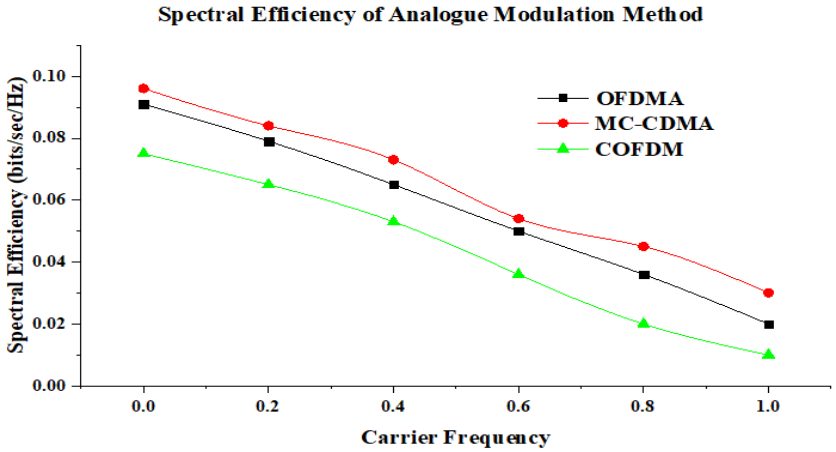

Figure 16. Spectral efficiency versus the number of users for OFDMA, MC-CDMA, and COFDM systems

Figure 16. shows the spectral efficiency versus the number of OFDMA, MC-CDMA, and COFDM systems users. At the partial loading condition, the OFDMA, MC-CDMA, and COFDM systems' spectral efficiency is degraded due to carrier frequency offset(CFO). The MC-CDMA outperforms the other two approaches in terms of CFO resilience. For COFDM, a CFO of 25% causes a spectral efficiency loss of 23% (from 0.085 to 0.068 bits/sec/Hz), compared to only 8% (from 0.096 to 0.088 bits/sec/Hz) and 5% (from 0.086 to 0.076 bits/sec/Hz) for MC-CDMA and OFDMA, respectively. And this is because MC-CDMA and OFDMA offer diversity gain, whereas COFDM does not. Since subcarriers begin to overlap when the normalized CFO reaches one, as expected, the spectral efficiency for OFDMA, MC-CDMA, and COFDM declines to zeros. In, COFDM The amount of subcarriers (Nc) that can be transmitted in each symbol period Ps. is called as entire symbol rate as expressed as follows,

$$T = \frac{N_c}{P_s} \tag{4}$$

From the results, the proposed method is evaluated based on bandwidth efficiency and bit error rate measures. An Automatic improvement of Optical communications by improving guided waves using high-bit-rate contact using three modulation methods are better in reducing noise, and multiplication of carriers and providing better bandwidth efficiency.

5. Conclusion

The proposed model implemented in this paper for managing the fast transmission of data through optical fiber communications can be elaborated using the quantum cryptographic system. Here the dispersions and the impairment of the data and the highest value of the channel developed for reducing the noise, bandwidth, and multiplication of the high bit rate can be elaborated using the system configuration for enabling the high bit rates communication. Here the mono mode and the multi-mode rate communication help the quantum cryptography from the high bit range to make the communication very effective. Also, this study reduces the noise and bandwidth based on optical communications. Here the bit rate communication enables the results with quantum cryptography. The mono mode and the multi-mode transmission can be proposed by busing this integrated waveguide. In the future, optical waves can be transferred faster than the current transferring speed due to some of the advanced models making the data transfer by removing the noise and the other unwanted details in the data.

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Ethics Approval: My manuscript does not report on or involve using any animal or human data or tissue. Hence Not applicable to this article.

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