In this paper we compare review recent work on mostly all technique of optical receiver communication which is used in optical fiber communication. Telecommunication’s future technology is increasing day by day with need for more data rate with high speed of reliable data transmission. Optical networks play a vital role in meeting these demands. Network needs to be promising improved for high data rates and long reach capabilities by implementing optical fibre using optical receivers. The drawback of the methods is that a noisy received symbol phase is compared with a noisy reference, which leads to a higher required signal-to-noise ratio (SNR) and (BER) performance. We also represent in this paper the new proposed method for optical fiber communication in receiver side that is coding scheme by bit insertion code.

Keywords: Optical fiber, apd receiver, line coding ,NRZ Coding, RZ Coding, Manchester, AMI Coding, Differential Manchester Coding, Multi-state Coding, PFmB (m+1)B bit insertion code, BER,SNR

1. Introduction

Several years ago the optical fiber was introduced as an important new communication medium. It offers a lot of technical and economical advantages as compared with conventional metallic conductors like coaxial cables. For instance it weighs less. It is thinner, more flexible, and free of electromagnetic interferences, it has a larger bandwidth, and is composed of cheaper basic materials. Being an attractive solution to meet the growing need of information transmission capacity, it is the subject of many investigations and experiments. Optical communication systems have been widely used as a constituent of communication networks for the past several years. A basis communication system consists of transmitter, a receiver, and an information channel Arranged. at the transmitter, the message is generated and put into a form suitable for transfer over the information channel. Information channels can be divided into two categories:-unguided channel and guided channel. OPTICAL transmission networks based on wavelength division multiplexing (WDM) architecture is dominating the all-optical data transportation with bit rates exceeding several terabit-per-second rates to serve the ever increasing demand of Internet Protocol (IP) networks. Thus, full optical operation of these networks will be most important features in the near future. Some of the main TCP/IP networking functions such as routing, add-drop multiplexing and demultiplexing and wavelength conversion, need to be functional to encapsulate the IP packet requirements into the optical layer. The linear as well as the nonlinear characteristics of the optical fiber at higher bit rates, seriously limit the data transmission performance and it is therefore becoming necessary to develop approaches to improve regeneration of transmitted data. Experimental investigations have shown a considerable progress in this direction. These were based on compensation techniques, filtering, developing optimized line coding, and further processing of received signal. However, lot of research work needs to be carried out to improve the increasing effective data transmission through these systems. In this review we see that many coding scheme are used in several studies of optical communication. For fulfill all these future demands the requirements are done by passive optical networks using high bandwidth, increased reach, increasing more subscriber flexibility, required security, and greater density . The demands those being offered additionally gives symmetric bandwidths, in both downstream (the exchange to the user end ) & upstream(user end to the exchange ).

2. Coding Techniques Overview

Line coding
In the designing of an optical fiber link, an important consideration is the format of the transmitted optical signal. This is of importance because, in any practical digital optical fiber data link, the decision circuitry in the receiver must be able to extract precise timing information from the incoming optical signal. The three main purposes of timing are to allow the signal to be sampled by the receiver at the time the signal-to-noise ratio is maximum, to maintain the proper pulse spacing, and to indicate the start and end of each timing interval [6]. In addition, since errors resulting from channel noise and distortion mechanism can occur in the signal-detection process, may be desirable for the optical signal to have an inherent error detecting capability. These features can be incorporated into the data stream by restructuring (or encoding) the signal. This is generally done by introducing extra bits into the raw data stream at the transmitter on a regular and logical basis and, extracting them again at the receiver.

Signal encoding uses a set of rules for arranging the signal symbols in a particular pattern. This process is called channel or line coding. The purpose of this section is to examine the various types of line codes that are well suited for digital transmission on an optical fiber link. The discussion here is limited to binary codes, because they are the most widely used electrical codes and also because they are the most advantageous codes for optical systems(9,11).

2.1 NRZ Coding
Line coding defines the arrangement of symbols in a particular pattern for transmission that represent binary data. NRZ coding is a line code in which binary value ‘1’ is represented by positive voltage and ‘0’ is represented by negative voltage. The pulses have more energy than others. It requires only half the bandwidth than other coding. This is for Bipolar NRZ coding. There is also another type called unipolar NRZ coding, represented by ‘1’ is represented by positive voltage and ‘0’ is represented by DC line(9,3).

2.2 RZ Coding:
In RZ encoding, a binary 1 is represented by first half of the bit duration, during the second half the level returns to zero. Absence of a pulse represents a binary 0, during the entire bit duration. Twice the bandwidth is required for RZ coding, because for data transmission it takes only half a bit duration.

2.3 Manchester
Manchester code is another type of line coding technique used for data transmission, also called as Phase Encoding. In this type of encoding, each bit has minimum one transition and occupies the same time. Since the DC component carries no data, it is not present in this coding. Manchester code is widely used for all practical applications, since it consumes less bandwidth in order to achieve the original transmitted data rate. It ensures frequent line voltages, directly proportional to the clock rate. The below fig.1 shows various coding techniques.

2.4 AMI Coding
It is a synchronous clock encoding technique which uses bipolar pulses to represent logical 1 value. The alternating coding prevents the buildup of a D.C voltage level down the cable. This is considered an advantage since the cable may be used to carry a small D.C. current to power intermediate equipment such as line repeaters.

2.5 Differential Manchester Coding
It is a method of encoding data in which data and clock signals are combined to form a single self synchronizing data stream. It is a differential encoding, using the presence or absence of transitions to indicate logical value. This gives it several advantages over standard Manchester encoding(5,8).
2.6 Multi-state Coding

It is a method in the electronic systems where both signal amplitude and phase are used to create unique line states representing particular bit combinations.

The general idea for achieving error detection and correction is to add some redundancy to a message, which receivers can use to check consistency of the delivered message and to recover data determined erroneously. Error detection and correction schemes can be either systematic or non systematic. In a systematic scheme, the transmitter sends the original data, and attaches a fixed number of check bits (or parity data), which are derived from the data bits by some deterministic algorithm. If only error detection is required, a receiver can simply apply the same algorithm to the received data bits and compare its output with the received check bits; if the values do not match, an error has occurred at some point during the transmission. In a system that uses a non systematic code, the original message is transformed into an encoded message that has at least as many bits as the original message. If the channel capacity cannot be determined or is highly varying, an error detection scheme may be combined with a system for retransmissions of erroneous data. This is known as automatic repeat request (ARQ) and is most notably used in the Internet. An alternate approach for error control is hybrid automatic repeat request (HARQ) which is a combination of ARQ and error correction coding(5).

3. Apd receivers:

IN APD-BASED avalanche photodiodes (APDs) are arguably the photodetectors of choice in today’s ultrafast long-haul and metro-area lightwave systems. The popularity of APDs in high-speed receivers is attributed to their ability to provide high internal optoelectronic gain, which allows the photogenerated electrical signal to dominate the thermal (or Johnson) noise in the pre-amplifier stage of the receiver module without the need for optical pre-amplification of the received optical signal [1]. The optoelectronic gain results from the cascade, or avalanche, of electron and hole impact ionization that take place in the high-field intrinsic multiplication layer of the APD [2]. The avalanche multiplication process is inherently noisy, resulting in random fluctuations in the gain. Thus, the benefit of the gain is accompanied by a penalty: the shot noise present in the photo-generated electrical signal is accentuated according to the APD’s excess noise factor, which is a measure of uncertainty associated with the stochastic nature of the APD’s gain [2]. In addition, the APD’s avalanche buildup time, which is the time required for the cascade of impact ionizations to complete, also limits the receiver performance by inducing intersymbol interference (ISI) at high bit rates.

4. Draw backs in these line code techniques:

Some of the important literature we studied relevant to out topic and also helpful for completion of thesis are listed below with brief discussion of their work.

In this paper we proposed the bit error rate for both signal generators of RZ and NRZ with Mach-Zehnder modulation technique. Bit error rate found little bit smaller when applying 15 dB powers instead of 20 dB power with NRZ signal generator. For 8 bits input, all result of bit error rate is found except Electro Absorption modulation technique with RZ signal generator. Only the bit error rate is zero for RZ signal generator through Electro- Absorption modulation technique. Bit error rate is found while reducing power to 15 dB with the same condition(3).

But the problem not solving of high data rate on that base paper. Because the apd receiver is also have some drawback in BER & high data rate. This paper provides a rigorous characterization of the BER associated the general class of APD-based optical receivers used in ultra-fast direct-detection communication. The analysis takes into account ISI resulting from the non-instantaneous nature of the APD’s stochastic impulse response function, which is attributable to the so-called avalanche-buildup time, as well as the dead-space effect that is inherent in APDs with thin multiplication regions used in ultra-fast receivers. We have developed an exact expression for the MGF of the receiver’s output using the joint pdf of the APD’s gain and avalanche buildup time. The MGF of receiver’s output is then utilized to (a) calculate the BER exactly and (b) perform an asymptotic analysis of the BER yielding an upper bound for the BER based on the Gärtner-Ellis Theorem from large deviation theory. The results show that the Gaussian-approximation method is not suitable for ultra-fast transmission scenarios due to the presence of ISI, which tends to cause asymmetry and bi-modality in the shape of the probability density function of the receiver’s output. Notably, the large-deviation based asymptotic analysis yields a much improved approximation of the BER compared to the Gaussian approximation and also offers the correct decay rate in the BER as a function of the average photons per bit(4,6,7).

The NRZ and RZ have also some drawback at the rate of data & BER on this paper. A signal post processing approach has been suggested and tested on photo detected data signals that have been transmitted through single mode fiber transmission system. The approach was simulated on systems operating at 10Gbps with an NRZ modulation format. These transmission systems have been built using standard transmitters and receivers operating at central wavelengths of 1550 nm. Performance of improved system has been evaluated via the analysis of quality factor and bit error rate(2,6,8). These all required codeword or highly integrated coherent receiver with many more drawbacks but we used bit insertion technique does not required codeword & highly integrated equipments. Means in the proposed methods on previous papers, coding scheme used but the BER is not is not controlled & limited data rate in result. And these all code required code ward for coding.
4.1 BER (bit error rate)
The overall performance of any communications system, be it digital or analog is the probability of a bit error, or the bit error rate. What is the chance that if we send a 1, it is decoded a 0 on the other end. A typical BER for an optical system is $10^{-9}$ (one bit error in a trillion bits), and higher for wireless radio systems ($10^{-6}$). The BER, as one may suspect, is correlated to the receiver sensitivity. Receiver sensitivity is defined as the minimum number of photons per bit necessary to guarantee that the BER is smaller than the prescribed rate of $10^{-9}$. In [1], a proof is offered to show that this number $n_0 = 10$ photons per bit corresponds to a BER $10^{-9}$. This sensitivity corresponds to an optical energy $h_n n_0$ and an optical received power$(12,14)$

$$Pr = h_n n_0 B_0$$

4.2 SNR (Signal-to-Noise Ratio)
We said earlier that is similar to the Signal-to-Noise Ratio (SNR), but not quite the same. So, what exactly is the relationship? SNR is defined as the average signal power divided by the average noise power. The average signal power is calculated as $v_2 S - v_2 S$ which turns out to be $v_{pp} S/2$ for a DC-balanced NRZ signal. The noise power is calculated as $v_2 n$ which is $1/2: (v_2 n_0 + v_2 n_1)$ for an NRZ signal with an equal number of zeros and ones. The SNR follows as $(13,14)$:

$$SNR = \frac{(v_{pp}^2)}{2 \cdot (v_{n_0}^2 + v_{n_1}^2)}.$$  

5. Problem formulation proposed work
We formulated the method for our dissertation work that no explicit side information is needed and no error propagation is observed. We also apply the concept of line coding. we have done analysis of optical receiver by incorporating PFmB (m+1)B bit insertion code in the digital fiber optic link.

To analyze the performance an important consideration is the format of the transmitted optical signal. This is important because in any practical FO data link, the decision circuitry in the receiver must be able to extract precise timing information from the incoming optical signal. This is possible when the digital signal transmitted is free from timing jitter and dc baseline wander. line codes improve the transmission reliability over a channel by controlling the impairments like timing jitter base line wander and ISI. Several line codes available for fiber optic communication system, like CMI, DMI, mBnB block codes, mBIC, DmB!M. But PFmB(m+1)B bit insertion code. we have considered code which falls under the category of bit insertion codes. It is preferred to other codes because of its spectral characteristics. the spectrum of this code shows that the power spectral density rolls off to zero as the frequency approaches zero. as a result it overcomes the drawbacks of other line codes. this code is particularly suitable for high data rates and large values of m(number of bits in a word).

The objective of this paper is to do the analysis of the performance of the two types of receivers in which one uses pin photodiode as the photo detector and other uses APD. The performances are studied by plotting the graph between BER and SNR for the above mentioned pin photodiode and APD based receivers. Results are obtained by plotting the graph with and without using coding and decoding scheme of PFm (m+1) B. Finally these plots are analyzed and compared with the result achieved using MATLAB.

6. Conclusion:
It is clear that our culture has been accustomed to the instant gratification associated with the high bandwidth granted by optical communications. Fiber optic communications are able to deliver us to an age of unprecedented bandwidth, low signal attenuation, small space requirements, and ultimately low cost. When wired links are not possible due to either space, money, or political reasons the attractive possibility of BER exists. BER through turbulent channels is under active research and various methods have been developed to mitigate the channel’s impact on the bits, and adding more receivers in what is known as spatial diversity can also improve the BER and SNR by line coding(14). Fiber op-com digital coding will answer the world’s growing communications bandwidth needs, with ever decreasing cost and complexity of implementation. The comparison of results in PIN photodiode and APD case shows that considerably lower received power can be detected by the APD. The slope of the two curves is also found to be different, the curves for PIN photodiode case resemble closely with complementary error function curve as this receiver is thermal noise dominated. The steeper slope in case of APD can be regarded as a beneficial since for improving BER the received power or SNR has to be increased only by a small amount. As can be seen from MATLAB simulation. This paper has given a brief overview of the methods of implementation of bit insertion code and BER performance, illustrating some of the challenges faced by both systems.

References
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