A High spectral Efficiency Transmission with iterative Polar modulation in optical Network.

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Abstract: **The significance and importance of a fiber-optic communication increases with a revolutionary advancements in optical transmitters, detectors, high purity optoelectronic material components, optical sources makes the fiber optic technology the fastest growing communication technology in the world. This revolution causes to produce improved bit error rate, low loss, reliable and secured communications. In multiple services, the UWB wired and wireless communications have been developed tremendously to meet the low complex, low cost, low power consumption, high data rates specifications. In the present work, an attempt is made to use with and without reuse modulation scheme based using MATLB /SIMULINK model. Observations are made at different SMF distance and noted the values of BER and SNR. In WDM PON system IPQAM gives better performance as compared to other format. We are interested to perform the error probability and signal to noise ratio analysis using MATLAB graphical user interface. By increasing signal to noise ratio the error probability decreases linearly from maximum to minimum with respect to that the channel capacity varies. In IPQAM the above said observations is much more linear, from this we conclude the IPQAM format gives the very high improved channel capacity in OFDM Communications system. IPQAM Technique is use full in OFDM and also coded OFDM optical communication networks. Comparatively IPQAM gives more channel capacity in optical networks than QAM. The above modulation techniques such as QAM and IPQAM modulations propagate the signal in different way in high speed optical transport network. Additionally the IPQAM allows a further understanding the issues of now a day's optical transmission system.**

Keywords: **QAM(Quadrature Amplitude Modulation), IPQAM(Iterative Polar Quadrature Amplitude Modulation), PON(Pasive Optical), UWB(Ultra Wide Band), WDM (wavelength Division- Multiplexing), BER(Bit Error Rate), SNR(Signal to Noise Ratio), SMF(Single Mode Fiber).**

I. INTRODUCTION

The invention and subsequent development of optical fibers have displaced copper wire for transmission of signals for most commercial applications in telecommunications systems and computer networks worldwide. Optical fibers are about the size of a human hair and can carry several orders of magnitude of information than copper wires. Optical fibers are small in diameter, stronger, lighter, and cheaper compared to copper wires. In addition, the signal-carrying capacity of the installed optical fiber cables can be readily increased as signal-processing technologies improve. The invention comes out of the interaction of physicists and electrical engineers extending the electromagnetic waveguide theory and applying to glass fibers with a minimum of defects and impurities that attenuate (i.e., scatter or absorb) the light signal.

In optical fiber communication system, the source provides information in the form of electrical signal to the transmitter. The electrical stage of the transmitter drives an optical source to produce modulated light wave carrier. Semiconductor LASERs (or) LEDs are usually used as optical source here. The information carrying light wave then passes through the transmission medium i.e. optical fiber cables in this communication system. Now it reaches to the receiver stage where the optical detector demodulates the optical carrier and gives an electrical output signal to the electrical stage. The common types of optical detectors used are photodiodes, p-i-n, avalanche, phototransistors, photoconductors etc. Finally the electrical stage gets the real information back and given it to the concerned destination.[28] The optical carrier may be modulated by either analog or digital information signal.

II. DISCRIPTION

In digital optical fiber communication system, the information is suitably encoded prior to the drive circuit stage of optical source [1]. Similarly at the receiver end a decoder is used after amplifier and equalizer stage.

Due to the enormous information carrying capability, immune to electromagnetic radiation and low weight make use of optical fibers in the field of military, aviation, alongside utility lines, power lines and railroad tracks. The fiber-optic communications produces secure communications.

The significance and importance of a fiber-optic communication increases with a revolutionary advancements in optical transmitters, detectors, high purity optoelectronic material components, optical sources makes the fiber optic technology the fastest growing communication technology in the world. This revolution causes to produce improved bit error rate, low loss, reliable and secured communications. In multiple services, the UWB,[32,37] wired and wireless communications have been developed tremendously to meet the low complex, low cost, low power consumption, high data rates specifications.[9-15]

In the present work, an attempt is made to use with and without reuse modulation scheme based using MATLB /SIMULINK model. Observations are made at different SMF distance and noted the values of BER and SNR. The graph is drawn between SNR and BER at different distances with and without reuse using concept of 512 M-arrray QAM &IPQAM modulation.

Quadrature modulation (QAM)Is both analog and digital modulation scheme. It conveys two analog message signals, or two digital bit streams, by changing (*modulating*) the amplitudes of two carrier waves, using the amplitude-shift keying (ASK) digital modulation scheme or amplitude modulation (AM) analog modulation scheme. The two carrier waves, usually sinusoids, are out of phase with each other by 90° and are thus called Quadrature carriers or Quadrature components — hence the name of the scheme. The modulated waves are summed, and the resulting waveform is a combination of both phase-shift keying (PSK) and amplitude-shift keying (ASK), or (in the analog case) of phase modulation (PM) and amplitude modulation. In the digital QAM case, a finite number of at least two phases and at least two amplitudes are used. PSK modulators are often designed using the QAM principle,[16,19] but are not considered as QAM since the amplitude of the modulated carrier signal is constant. QAM is used extensively as a modulation scheme for digital telecommunication systems. Arbitrarily high spectral efficiencies can be achieved with QAM by setting a suitable constellation size [21-27], limited only by the noise level and linearity of the communications channel.

QAM is being used in optical fiber systems as bit rates increase; QAM16 and QAM64 can be optically emulated with a 3-pathinterferometer. QAM, Quadrature amplitude modulation is widely used in many digital data radio communications and data communications applications. A variety of forms of QAM are available and some of the more common forms include 16 QAM, 32 QAM, 64 QAM, 128 QAM, and 256 QAM. Here the figures refer to the number of points on the constellation, i.e. the number of distinct states that can exist.

The various flavours of QAM may be used when data-rates beyond those offered by 8-PSK are required by a radio communications system. This is because QAM achieves a greater distance between adjacent points in the I-Q plane by distributing the points more evenly. And in this way the points on the constellation are more distinct and data errors are reduced. While it is possible to transmit more bits per symbol, if the energy of the constellation is to remain the same, the points on the constellation must be closer together and the transmission becomes more susceptible to noise. This results in a higher bit error rate than for the lower order QAM variants. In this way there is a balance between obtaining the higher data rates and maintaining an acceptable bit error rate for any radio communications system.

Constellation diagrams for QAM:

The constellation diagrams show the different positions for the states within different forms of QAM, quadrature amplitude modulation. As the order of the modulation increases, so does the number of points on the QAM constellation [17].

QAM MODULATOR:

Transmitter: In the ideal structure of a QAM transmitter, with a carrier frequency f_0 and the frequency response of the transmitter's filter H_t:

First the flow of bits to be transmitted is split into two equal parts: this process generates two independent signals to be transmitted. They are encoded separately just like they were in an amplitude-shift keying (ASK) modulator. Then one channel (the one "in phase") is multiplied by a cosine, while the other channel (in "quadrature") is multiplied by a sine. This way there is a phase of 90° between them. They are simply added one to the other and sent through the real channel.

The sent signal can be expressed in the form:

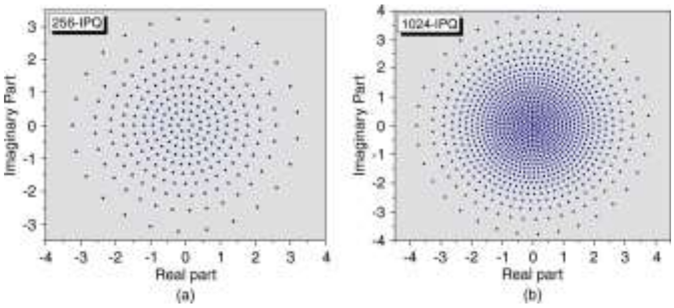
$$s(t) = \sum_{n=-\infty}^{\infty} \left[v_c[n] \cdot h_t(t - nT_s)\cos(2\pi f_0 t) - v_s[n] \cdot h_t(t - nT_s)\sin(2\pi f_0 t) \right]$$

Where $v_c[n]$ and $v_s[n]$ are the voltages applied in response to the n^{th} symbol to the cosine and sine waves respectively

IPQAM MODULATION:

Telelynx QM-8000 Ip series IP QAM trans modulator is an extremely powerful equipment that converts electrical Gigabit IP connection in to RF QAM signals. QM 8000-IP series receives the data streams and the multiple program transport streams of digital TV by Gigabit Ethernet Port. It can support o/p of up to 6 independent groups of four adjacent RF channels where each group has independent settings for QF frequency and QAM constellation.

If the highly integrated can be applied to either standard definition or high definition with the capability to linking a CATV broadcasting Network and a telecome network, this device can play an important role in multisite DVB-C Network (or) VOB on demand systems. The gigabit IP input can receive 8(model 8008),16(model 8026) (or) 24(model 8024) QAM carriers and each QAM can support constellation 256&512.



IPQAM -Based Modulation:

The proposed modulation format can be considered as an upgrade for the quadrature amplitude modulation (QAM) or as a generalization of the star QAM as the constellation points form concentric rings as in a star-QAM but with an irregular yet nonrandom distribution. This format is based on the minimum mean-square quantization error (QMSE) of information, and it takes into consideration the channel to be used and the noise probability density function. In this paper, we focus on one example to show the potential of the scheme: the ASE noise-dominated scenario. Let us now move to the design of the constellation for the modulation format and explain the theory behind it. As this paper is concerned with the performance of non-uniform signaling, the constellation of the modulation must be selected in accordance with the non-uniform probability distribution of the channel. We know that optimum source distribution for Gaussian channels, such as ASE noise-dominated channels, is Gaussian. The in-phase sI and Quadrature Q components of Gaussian random constellation s=(s1-sQ) follow a 2-D Gaussian distribution with zero mean.Corresponding polar coordinates of this signal constellation point are given by

$s=|s|e^{j\theta}$; $|S|= (s1^2+sq^{2)})^{½}$;$\theta=\tan^{-1} sq/s1$ **- (1)**

With distribution of envelope jsj being Rayleigh and signal Constellation is obtained by quantizing the source while minimizing the QMSE. This is achieved using restricted IPQ that consists of a non-uniform scalar quantization of the amplitude and a uniform scalar quantization of the phase. The number of points on each ring is selected iteratively for all the concentric rings, keeping the final number or points for the constellation in mind.[19,20]

Let Li denote the number of constellation points per ring of radius mi, Lr denote the number of rings in the constellation, and L denote the total number of signal constellation points ðL ¼

$Li=3\sqrt{(mi)^2}\ {}_{ri}\int^{ri+1} p(r)dr / \Sigma_i{}^{Lr}{}_{=2} 1/2a\ \sqrt{(mi)^2}{}_{ri}\int^{i+1} p(r)dr$ **- (2)**

for i=1,2,3…..Lr

Where p(r) is Rayleigh distribution function

$P(r)=r/\sigma^2\ e^{r2/2\sigma2}$ for r>=0 **- (3)**

From (2) and (3) represents the source power.

The radius of i^{th} ring is determined by

$mi=2\sin(\Delta\theta i/2)\ {}_{ri}\int^{ri+1} r\ p(r)dr\ /\Delta\ \theta i\ {}_{ri}\int^{ri+1} p(r)dr, \Delta\theta i=2\pi/Li$ **- (4)**

for i=1,2,………Lr

The limits of integration in (2) and (4) are determined by

$ri=\pi(mi^2-mi^2-1)/2(mi\ Li\ \sin(\Delta\theta i/2)-m_{i-1}l_{i-1}\sin(\Delta\theta i-1/2)$ **- (5)**

for i=1,2,……Lr

As the rather quick iteration process goes, the number of rings, the radius of each ring, and the number of point on each ring are found. As discussed earlier, the phase distribution is uniform, hence all the information needed for the design are summarized.

To further improve the performance of the proposed modulation format, structured LDPC codes are used to encode the data before modulation. Structured LDPC codes tend to reduce the encoding complexity in comparison with the random codes as encoding is done using linear shift register circuitry. Moreover, they have been proven to work very well without suffering from the error-floor phenomenon, even for BER lower than. As noticed from these figures, the distribution of the points is non-uniform, and it forms a 2-D Gaussian distribution with zero mean. Toward the edges of the constellation the density is minimal, and therefore, the distance between the constellation points is higher. As we go toward the center of the constellation, the density of constellation points keeps increasing till reaching its peak the innermost ring.

Channel capacity:

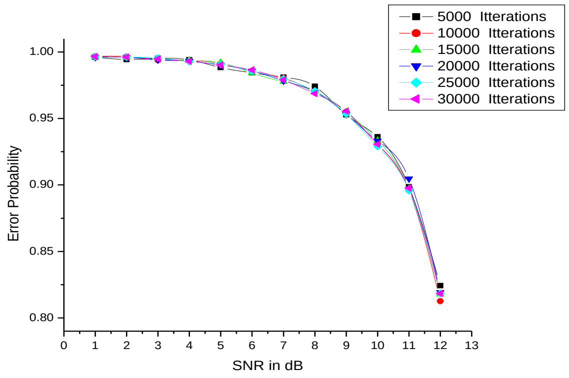
Channel capacity is defined as the maximum information rate that a communication channel can carry within a given bandwidth. Approaching channel capacity has been one of the major topics of interest for many researchers for decades. Forward error-correction (FEC) codes were introduced as a means to closely approach capacity as they improve the bit error ratio (BER) performance of the communication systems.

It is the tightest upper bound on the rate of information that can be reliably transmitted over a communications channel. By the noisy-channel coding theorem, the channel capacity of a given channel is the limiting information rate (in units of information per unit time) that can be achieved with arbitrarily small error probability.

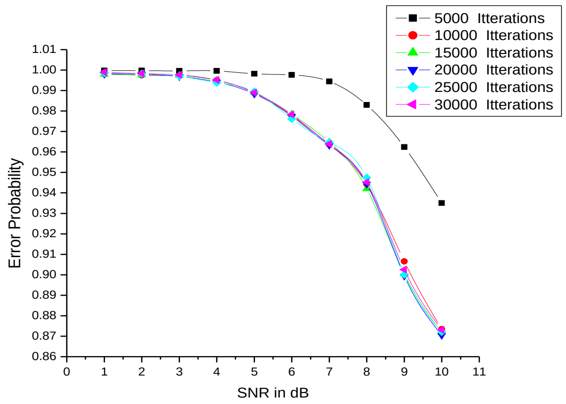
Information theory, developed by Claude E. Shannon during World War II, defines the notion of channel capacity and provides a mathematical model by which one can compute it. The key result states that the capacity of the channel, as defined above, is given by the maximum of the mutual information between the input and output of the channel, where the maximization is with respect to the input distribution.[21,27]

RESULTS

QAM:



IPQAM:



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From the above graphs I conclude the QAM is linear comparative .IPQAM is much more linearity than QAM. This linearity will improve the spectral efficiency. In QAM the number of iterations /samples increased in equal intervals with respect to signal to noise ratio increased due to error probability decreased. This phenomena is observed in samples varies from 2000 to 30000 but graphical plot shown in equal intervals for 5000 iterations. In IPQAM the number of iterations /samples increased in equal intervals with respect to signal to noise ratio increased due to error probability decreased. This phenomena is observed in samples varies from 2000 to 30000 but graphical plot shown in equal intervals for 5000 iterations.

CONCLUSIONS

The design of the QAM and IPQAM modulation system in MATLAB simulink is performed and the results are plotted. The simulink involve linear effect (QAM) and non-linear effect (IPQAM) we would like to extend the simulation for non-linear effect, these results will be closer to real system. In WDM PON system IPQAM gives better performance as compared to other format. We are interested to perform the error probability and signal to noise ratio analysis using MATLAB graphical user interface.

We present a non-uniform modulation format based on IPQAM to achieve channel capacity. By increasing number of samples we can observe more linearity in iterative polar quadrature amplitude modulation (IPQAM) than quadrature amplitude modulation (QAM).By increasing signal to noise ratio the error probability decreases linearly from maximum to minimum with respect to that the channel capacity varies. In IPQAM the above said observations is much more linear, from this we conclude the IPQAM format gives the very high improved channel capacity in OFDM Communications system. IPQAM Technique is use full in OFDM and also coded OFDM optical communication networks. Comparatively IPQAM gives more channel capacity in optical networks than QAM.

Iterative Polar modulations give the geometrical and mathematical analysis of optical fiber communication networks. We presents a modulated format based IPQAM to achieve channel capacity the proposed scheme in combination with polarization multiplexing achieving channel capacity. In fiber optic channels IPQAM achieves an increase in the propagation distance. The new IPQAM constellation in the next generation communication scheme can get better performance without adding complexity to the constellation as to the systems. The constellation style and system futures a new iterations scheme forward. The new iteration scheme makes the system performance. So this scheme can be used in the same level of hardware. Finally these modulation schemes are useful to improve channel capacity of OFDM and Coded-OFDM and in future designed Multiplexing optical networks.

The above modulation techniques such as QAM and IPQAM modulations propagate the signal in different way in high speed optical transport network. Additionally the IPQAM allows a further understanding the issues of now a day's optical transmission system.

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