International Journal of Emerging Engineering Research and Technology
Volume 2, Issue 3, June 2014, PP 95-100
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

A Review on Performance Evaluation of Efficient Digital Modulation Technique

Er. Ankita Mittal

Assistant Professor, Electronics & Communication Engg.Dept.
Galaxy Global Educational Trust Group of Institutions,
Dinarpur,Ambala, India
ankita.mittal@galaxyglobaledu.com

Rohit Garg

Electronics & Communication Engg.Dept.
M.Tech Scholar Of Galaxy Global Educational Trust Group Of Institutions,
Dinarpur, Ambala, India
gargrohitengg@gmail.com

Abstract: *This paper presents a review of modulation techniques that target the best use of resources available in a communication system. These are referred to as efficient Modulation techniques. It proposes novelreceiver architecture for demodulating a DPSK/ASK orthogonally modulated signal. We can analysis the performance of these modulation techniques when the system is subjected to AWGN. These modulation schemes in the presence of amplifier nonlinearity and hostile transmission environments are analysed as a complete system using simulation to determine relative performance. We will use MATLAB for simulation and evaluation of BER and SNR.*

Keyword: *Modulation techniques, Communication system performance, optical signal processing, capacity.*

1. Introduction

The throughput of a dense wavelength-division-multiplexed (DWDM) transmission system can be increased by using a wider optical bandwidth, by increasing spectral efficiency, or by some combination of the two. Utilizing a wider bandwidth typically requires additional amplifiers and other optical components, so raising spectral efficiency is the more economical alternative.

When the number of signal and/or noise photons is small, the information-theoretic capacity of optical communication systems is also limited by the particle nature of photons. Coherent communication is equivalent to detecting the real and imaginary parts of the coherent states.

Digital modulation offers many advantages over analog modulation and greatly improves the performance of the communication systems. Many types of digital modulation schemes are possible, and choice of which one to use depends on spectral efficiency, power efficiency, and bit rate performance. A trade-off between power and spectral efficiency always exists in the design of a modulation scheme. Furthermore, better bit rate performance can be achieved by assigning more bandwidth and a larger amount of signal power [1].

Currently, the trend is to utilize bandwidth efficient techniques that exploit orthogonal frequency division multiplexing (OFDM) [1] or coherent detection of complex multilevel modulation formats (M-PSK, M-QAM). Although these techniques have significantly upgraded the performance of long-haul transmission systems, they are not appropriate for direct deployment at either the access or the metro part of the network due to their complexity, cost and energy footprint.

Targeting to the inherent capacity of the underlying channel, techniques which adapt and adjust (in realtime) transmission parameters based on the link quality have been proposed. These are referred to as “Adaptive Modulation and Coding” (AMC) and they provide as their output the values of transmission parameters to be employed in a following transmission period, based on feedback information and in accordance with particular cost functions related to the targeted Quality of Service

(QOS).At spectral efficiencies between 1 and 2 b/s/Hz, quaternary DPSK and PSK are perhaps most attractive techniques.

Techniques such as 8-PSK or 8- and 16-QAM are necessary to achieve spectral efficiencies above 2 b/s/Hz per polarization. Historically, the main advantages of coherent optical detection were considered to be high receiver sensitivity and the ability to perform channel de-multiplexing and chromatic dispersion compensation in the electrical domain [2].

Information technology continues to strongly benefit from laser technology which enabled the transition from comparably slow electronic telecommunication systems to all optical, spectrally broadband optical communication networks with high data transmission rates up to multiple Terabits per second. A key to high data transmission rates in optical fibers has been the development of efficient amplitude and/or phase modulators which are used to encode information in the carrier wave..In all proposed uses, reliable and versatile THz measurement systems require adequate optical components, i.e. modulators, for active adaptive control of the electromagnetic properties of the radiation.

Modulators can be categorized by the physical quantity they control, as e.g. amplitude, phase, pulse length and shape, spatial and temporal properties or by the technique or material system which is employed to modulate the wave. In most cases, modulators manipulate multiple properties of the THz wave at once, either on purpose or as a consequence of an undesired side effect.

The paper is organized as follows. In section II, we discuss related work with the modulation scheme. In Section III, It describes types of modulation techniques. In Section IV, it describes the system architecture and analyse the different parameters of Rayleigh scattering in impairing the upstream signal. Finally, conclusion is given in Section V.

2. RELATED WORK

In literature, it proposes and experimentally demonstrates novel receiver architecture based on injection locking for demodulating a DPSK/ASK orthogonally modulated signal. The receiver exploits the limiting amplification of an injection locked laser to discriminate the two data streams, enhance performance of DPSK, and increase ASK extinction ratio up to 10 dB, making this modulation setup suitable for the cost-efficient capacity upgrade of metro networks [3].

Communication via diffusion of molecules is an effective method for transporting information in Nano-networks. In this paper, new modulation techniques called Concentration Shift Keying (CSK) and Molecule Shift Keying (MOSK) are proposed for coding and decoding information of the so-called messenger molecule concentration waves in Nano-networks. The first technique, CSK, modulates the information via the variation in the concentration of the messenger molecules whereas MOSK utilizes different types of messenger molecules to represent the information. Using simulation, the performance of these modulation techniques is evaluated in terms of susceptibility to noise and transmission power requirements [4].

At bit rates of the order of 40 Gb/s, on-off keying (OOK) transmission becomes severely impaired by non-linear effects, particularly Intra-channel Four-Wave Mixing (IFWM). This paper analyses phase modulation techniques for the suppression of IFWM: in the Alternate-Phase Return-to-Zero (APRZ) and Pair wise APRZ (PAPRZ), the phase of the optical signal alternates between neighbouring bits or pairs of bits. APRZ and PAPRZ achieve increased non-linear tolerance by causing different IFWM contributions to interfere destructively, when appropriate phase-alternation amplitude is applied. In added technique, Asynchronous Phase Modulation (APM), phase of the optical signal is modulated by an independent clock signal, at a frequency lower than bit rate. APM achieves increased non-linear tolerance by a combination of destructive interference of IFWM contributions and suppression of the frequency-matching condition for the build-up of IFWM, when phase modulation with appropriate amplitude and frequency is applied.

Information-theoretic limits to spectral efficiency in dense wavelength-division-multiplexed (DWDM) transmission systems are reviewed, considering several modulation techniques(unconstrained, constant-intensity, binary), detection methods(coherent, direct), and propagation regimes (linear, nonlinear).Spontaneous emission from inline optical amplifiers is assumed to be the dominant noise source in all cases. Coherent detection permits use of two degrees of freedom per polarization, and its spectral efficiency limits are some b/s/Hz in typical terrestrial systems, even seeing nonlinear special effects. Using either constant-intensity modulation or straight detection, only one degree of freedom per polarization can be used, significantly reducing efficiency [5].

3. VARIOUS DIGITAL MODULATION TECHNIQUES

After the conversion of an analog signal to digital by sampling different type of digital modulation schemes can be achieved by the variation of different parameter of the carrier signal for example the Amplitude variation gives BASK, Frequency variation gives BFSK and the phase variation gives BPSK. Also sometimes a combinational variation of this parameter is done to generate the hybrid modulation technique viz. a combinational variation of Amplitude and Phase Shift Keying (APSK). Many more digital modulation techniques are available and can also be designed depending upon the type of signal and the application. These digital modulation techniques can be classified basically either on the basis of their detection characteristics or in terms of their bandwidth compaction characteristics.

3.1 Binary Amplitude Shift Keying [Bask]

The BASK is obtained by the alteration of the amplitude of the carrier wave [1, 11]. It is a coherent modulation technique hence the concept of the co -relation between the signal, number of basis functions, the I and Q components and the symbol shaping are not applicable here. It has very poor band width efficiency. The basic merit of this technique is its simple implementations but is highly prone to noise and the performance is well established only in the linear region which does not make it a viable digital modulation technique for wireless or mobile application in the present scenario. The combination with PSK [20] yields derivatives like QAM and M-ary ASK, which have important application with improved parameters [6].

3.2 Binary Frequency Shift Keying [BFSK]

When two different frequencies are used to represent two different symbols, then the modulation technique is termed as BFSK.BFSK can be a wideband or a narrow band digital modulation technique depending upon the separation between the two carrier frequencies, though cost effective and provides simple implementations but is not a bandwidth efficient technique and is normally ruled out because of the receiver design complexities.

3.3 Binary Phase Shift Keying [BPSK]

When the phase of the carrier wave is altered with reference of the modulating signal then the resultant modulation scheme is termed as Phase Shift Keying. The digital modulation technique can be said to be the simplest form of phase modulation and is known as binary because the carrier phase represents only two phase states [13]. It is normally used for high speed data transfer application, provides a 3dB power advantage over the BASK modulation technique and is robust and simple in implementation but proves to be an inefficient user of the provided bandwidth and is normally termed as a non –linear modulation scheme. It provides small error rates than any other systems.

3.4 Differential Phase Shift Keying [DPSK]

For the perfect detection of a phase modulated signal, it become evident that the receiver needs a coherent reference signal but if differential encoding and phase shift keying are incorporated together at the transmitter then the digital modulation technique evolved is termed as Differential Phase Shift Keying [1, 14]. For the transmission of a symbol 1, phase is unchanged whereas for transmission of symbol 0 , the phase of the signal is advanced by . The track of the phase change information which becomes essential in determining the relative phase change between symbols transmitted. The whole process is based on the assumption that the change of phase is very slow to an extent that it can be considered to be almost constant over two bit intervals [7].

3.5 Quadrature Phase Shift Keying (QPSK)

Another extension of the PSK digital modulation technique is the division of the phase of the carrier signal designed by allotting four equally spaced values for the phase angle. QPSK has four message points in the constellation diagram and so it becomes a highly bandwidth efficient digital modulation technique. But the exact phase retrieval becomes a very important factor for the receiver design considerations, failing which can give rise to erroneous detection of the signal. This factor increases the receiver design complexities. To compensate for these problems, normally the idea of pulse shaping the carrier modulated signal is employed with the Root Raised Cosine Pulse shaping for achieving better performances which in turn provides a demerits that the constant envelope property of the signal is lost.

3.6 Minimum Shift Keying [MSK]

Minimum Shift Keying (MSK) is a modified form of continuous phase FSK. Here, in this case, the spacing between the two carrier frequencies is equal to half of the bit rate which is the minimum spacing that allows the two frequencies states to be orthogonal. An MSK signal can e said to be derived from either an Offset Quadrature Phase Shift Keying (OQPSK) signal by replacing a square pulse by ½ co-sinusoidal pulse or alternatively from an FSK signal. The information capacity of an MSK signal is equal to that of QPSK signal but due to the ½ cosine pulse shaping the bandwidth requirement is lesser than that required by QPSK. It achieved smooth phase transitions thus providing a constant envelope. It has lower out of band power and can be said to be more spectrally efficient than the QPSK modulation technique [8].

3.7 Orthogonal Frequency Division Multiplexing (OFDM)

The OFDM is a modulation scheme having multicarrier transmission techniques here the available spectrum is divided into many carriers each one being modulated at a low rate data stream. The spacing between the carriers is closer and the carriers are orthogonal to one another preventing interferences between the closely spaced carriers hence OFDM can be thought of as a combination of modulation and multiplexing techniques, each carrier in a OFDM signal has very narrow bandwidth so the resulting symbol rate is low which means that the signal has high tolerance to multipath delay spread reducing the possibility of inter symbol interferences (ISI) which is the requirement for the higher is the transmission rate, the large will be the bandwidth of the signal as compared with the coherence bandwidth of the propagation channel, at this stage the different spectral components present in the signal will experience different fading characteristics, this frequency selective fading has to be characterized using appropriate techniques in order to achieve acceptable error rate at the detection or output in order to achieve characterization in frequency selective fading the basic approach is to partition the signal into frequency bands, each one of which is narrow as compared to the coherence bandwidth of the channel and subsequently each of this signal component is then modulated onto a different sub carrier and the signal components are sent parallel over the channel. Hence, each signal component will now experience non- frequency-selective fading because now the high rate serial data sequence is converted into a number of lower rate parallel sequences and then each of them is modulated onto a sub carrier, the effective method to achieve this is orthogonal frequency division multiplexing (OFDM).

3.8 Comparison of All Techniques

The BASK technique is simpler and economic in implementation and is less prone to errors but provides less bandwidth efficiency and operates efficiency in the linear region only, which does not make it an efficient technique for the wireless communication systems. On the other hand, he BFSK technique is still less prone to errors and the bandwidth requirement is the same as that of BASK but is not a bandwidth efficient technique. The BPSK modulation technique is still better than the above mentioned two modulation techniques. It is a coherent modulation technique and can be used for high speed data transfer application and has a basic advantage of double information capacity over BASK and BFSK. Simple implementation and robustness makes it a useful technique for satellite communication but on the other hand it has proved an inefficient use of the bandwidth and is categorized under a class of non -linear modulation techniques. The error performance is better and is optimized to achieve minimum possible error rate. The detection of phase shift makes the receiver design complex, so the technique is not of interest for the wireless or mobile communication applications. The DPSK technique provides information capacity similar to BPSK and is considered to be more viable technique than BPSK and is a non-coherent orthogonal modulation. But the receiver complexities are more than BPSK because memory is required in the system to keep the track of relative phase difference [9].

In detection of a QPSK signal, the detection of exact phase shit becomes an important criterion which on the other hand increases receiver design complexities as well The improvement further in this modulation technique can be achieved by pulse shaping the modulated carrier. The pulse shaping by ½ co-sinusoidal pulse shaping provides a better performance modulation technique, the Minimum Shift Keying (MSK), which can also be viewed as comprising of two CPFSK signals. This has a major advantage that the out of band power is significantly lower than QPSK.

4. Performance Measures

A fair comparison between various types of modulation schemes must include the power and bandwidth constraints of a real system. Neither energy nor bandwidth consumption alone is a sufficient measure of a modulation scheme. When a large amount of power is available, it is easy to reduce the bandwidth of a modulation scheme; similarly high power is not needed to achieve a low BER if a wide bandwidth can be tapped [10].

4.1 Spectral Efficiency

There are several different spectral measurements used for modulation schemes. We define the spectral efficiency as eq. (1):

$$\eta = \frac{Bits\ per\ sec}{Bandwidth\ of\ channel} \quad (1)$$

4.2 Energy Efficiency

The conventional measure E_b/N_o only takes into account the received power and provides no information on how much DC power consumption is required for the transmission of one information bit. Alternative energy efficiency is given by eq. (2):

$$SNR = \frac{Et}{No} \quad (2)$$

5. Conclusion

An analysis of the digital modulation technique carried out in this paper reveals that the selection of a digital modulation technique is solely dependent on the type of application. This is because of the fact that some of the technique provide lesser complexities in the design of the modulation and demodulation system and prove economic like the BASK, BFSK, BPSK and DPSK techniques and can be visualized for the systems which really does not require high amount of precisions or when economy is the major aspect and the BER performances can be tolerated.

References

[1] Armstrong, “OFDM for optical communications,”J. Lightw. Technol., vol. 27, no. 3, pp. 189–204, Feb. 1, 2009.

[2] M. Nakazawa, “Optical quadrature amplitude modulation (QAM)with coherent detection up to 128 states,” in Proc. OFC/NFOEC,Mar. 2009, pp. 1–3.

[3] C. W. Chow, C. S. Wong, and H. K. Tsang, “All-optical ASK/DPSK label-swapping and buffering using Fabry–Perot laser diodes,” IEEE Sel. Topics Quantum Electron., vol. 10, no. 2, pp. 363–370, Apr.2004.

[4] Y. Zhang, N. Deng, C. K. Chan, and L. K. Chen, “A multicast WDM-PON architecture using DPSK/NRZ orthogonal modulation,” IEEE Photon. Technol. Lett., vol. 20, no. 17, pp. 1479–1481,Sep. 1, 2008.

[5] L. Cai, S. Xiao, Z. Liu, R. Li, M. Zhu, and W. Hu, “Cost effective WDM-PON for simultaneously transmitting unicast and broadcast/multicast data by superimposing IRZ signal onto NRZ signal,” in Proc. 34th ECOC, Sep. 2008, pp. 1–2.

[6] M. H. Eiselt and B. T. Teipen, “DPSK-3ASK transmission optimization by adapting modulation levels,”Proc. SPIE, vol. 7136, no. 2, pp. 1–7,2008.

[7] A. Fragkos, A. Bogris, D. Syvridis, and R. Phelan, “Amplitude noiselimiting amplifier for phase encoded signals using injection locking in semiconductor lasers,” J. Lightw. Technol., vol. 30, no. 5,pp. 764–771, Mar. 1, 2012.

[8] R. Lang and K. Kobayashi, “External optical feedback effects on semiconductor injection laser properties,” IEEE J. Quantum Electron., vol. 16, no. 3, pp. 347–355, Mar. 1980.

[9] G.P.Aggrawal, Nonlinear fiber optics, 3rded.NewYork, USA: Springer Verlag, 2001.

[10] M. Forzati, et al., "IFWM Suppression by Asynchronous Phase Modulation," in European Conference on Optical Communications (ECOC), Th3.2.2, Cannes, France, 2006.

AUTHOR'S BIOGRAPHY

Rohit Garg student M.Tech. I have passed B.Tech(ECE) from Technology Education & Research Integrated Institutions,Kurukshetra,India in 2011 and presently a student of M.Tech ECE final year at Galaxy Global Educational Trust Group of Institutions,Dinarpur,Ambala,India