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BIT ERROR RATE ANALYSIS IN SIMULATION OF MODULATION TECHNIQUES USING OFDM

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Abstract— Orthogonal Frequency Division Multiplexing (OFDM) based communication systems have been identified as one of the key transmission techniques for next generation wireless communication systems. The main objective is to transmit the OFDM signal with low bit error rate in the noisy environment. A cyclic prefix acts as a buffer region where delayed information from the previous symbols can get stored. Different modulation technique with respect to bit-error rate and SNR ratio is analyzed using MATLAB software. Here the performance of OFDM signal is analyzed by comparing the BER results of coding technique such as convolution. As well various modulation methods are also used. Various types of modulation methods are used with normal OFDM to analyze the system performances which are Binary Phase Shift Keying (BPSK), and Quadrature Phase Shift Keying (QPSK). The goal of our project is to improve system performance by the mean of low bit error rate. Finally bit error rate of these methods are analyzed by comparing BER versus SNR plots. Soft decoding method in convolution with high code rate results better BER performance.

Key words—Orthogonal Frequency Division Multiplexing (OFDM),Bit Error Rate (BER), Signal to Noise Ratio (SNR), Various Modulation Techniques.

I. INTRODUCTION

OFDM have been in existence for several decades. However, in recent years these techniques came into practice in modern communications system. In 4G wireless communication systems, bandwidth is a precious commodity, and service providers are continuously met with the challenge of accommodating more users with in a limited allocated bandwidth[1]. In a basic communication system, the data are modulated onto a single carrier frequency. The available bandwidth is then totally occupied by each symbol. This kind of system can lead to inter-symbol-interference (ISI) in case of frequency selective channel. The growth in use of the information networks lead to the need for new communication technique with higher data rate. There is several modulation techniques are available but among the variety of modulation technique, OFDM modulation technique is the best. It is a powerful modulation technique used for high data rate, and is able to eliminate ISI.

The basic idea of OFDM is to divide the available spectrum into several orthogonal sub-channels so that each narrowband sub-channel experiences almost flat fading. Orthogonal frequency division multiplexing (OFDM) is becoming the chosen modulation technique for wireless communications. OFDM can provide large data rates with sufficient robustness to radio channel impairments. With OFDM, it is possible to have overlapping sub channels in the frequency domain, thus increasing the transmission rate. The attraction of OFDM is mainly because of its way of handling the multipath interference at the receiver. Multipath phenomenon generates two effects (a) Frequency selective fading and (b) Inter-symbol interference (ISI). The "flatness" perceived by a narrowband channel overcomes the frequency selective fading. On the other hand, modulating symbols at a very low rate makes the symbols much longer than channel impulse response and hence reduces the ISI. Use of suitable error correcting codes provides more robustness against frequency selective fading The use of FFT technique to implement modulation and demodulation functions makes it computationally more efficient. OFDM systems have gained an increased interest during the last years.

II.OFDM

A. BASICS

Orthogonal Frequency Division Multiplexing or OFDM is a modulation format that is being used for many of the latest wireless and telecommunications standards. OFDM is a combination of modulation and multiplexing. Multiplexing generally refers to independent signals, those produced by different sources.

Modulation is a mapping of the information on changes in the carrier phase, frequency or amplitude or combination.
Multiplexing is the method of sharing a bandwidth with other independent data channels.

OFDM is also Multicarrier Transmission technique which divides out there spectrum into several carrier and being modulated by a single data rate stream. In OFDM, the signal is first split into independent channels, modulated by data and then re-multiplexed to create the OFDM carrier. Orthogonality gives the carriers a valid reason to be closely spaced with overlapping without ICI. Let $x(t)$ is a function and its orthogonal function will be $x^*(t)$ so the condition of Orthogonality is given by equation (1) and represented in Fig 1[3].

$$\int x(t)\, x^*(t) = 0 \qquad (1)$$

If a sine wave of frequency m multiplied by a sinusoid (sine or cosine) of a frequency n,

$$f(t) = \sin mwt \times \sin nwt$$

where both m and n are integers, since these two components are each a sinusoid, the integral is equal to zero over one period[4]. The integral or area under this product is given by

$$= \int_0^{2\pi} \frac{1}{2} \cos(m-n)\, wt - \int_0^{2\pi} \frac{1}{2} \cos(m+n)\, wt$$

$$= 0 - 0$$

Here all the subcarriers are sine waves. The area under one period of a sine or cosine wave, or any other sinusoidal with some phase angle, is zero. This can be shown diagrammatically by Fig 1.

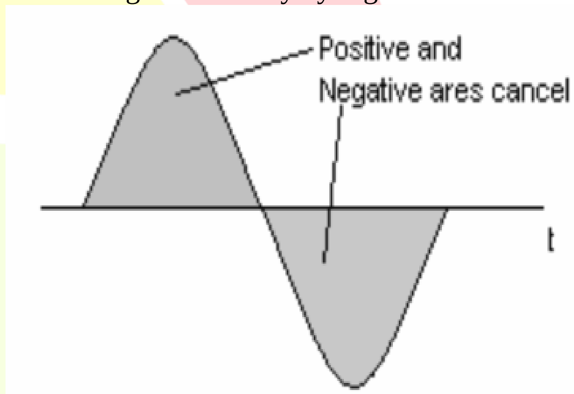

Figure 1 Orthogonality of two subcarriers

The orthogonality allows simultaneous transmission on a lot of sub-carriers in a tight frequency space without interference from each other. In essence this is similar to CDMA, where codes are used to make data sequences independent (also orthogonal) which allows many independent users to transmit in same space successfully[4].

B. WORKING MODEL

The BERT generation generates the data system. the transmitter section converts digital data to be transmitted, into a mapping of subcarrier amplitude and phase by using modulation techniques. Then transforms this spectral representation of the data in to the time domain using an inverse fast Fourier transform (IFFT) as it is much more computationally efficient, and so is used in all practical systems [5,6]. The addition of a cyclic

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prefix to each symbol solves both ISI and ICI. Digital data is then transmitted over the channel. After the time-domain signal passes through the channel, it is broken back into the parallel symbols and the prefix is simply discarded. The receiver performs the reverse operation of the transmitter. The amplitude and phase of the subcarriers are then picked out and converted back to digital data. The block diagram of OFDM is shown in the figure 2.

To eliminate Inter-Symbol Interference (ISI) almost completely, a guard time is introduced for each OFDM symbol. The guard interval is chosen larger than the expected delay spread, such that multipath components from one symbol cannot interfere with the next symbol. Every block of *N* samples as obtained by IFFT is quasi periodically extended by a length *Ng* simply repeating *Ng* samples of the useful information block [11].

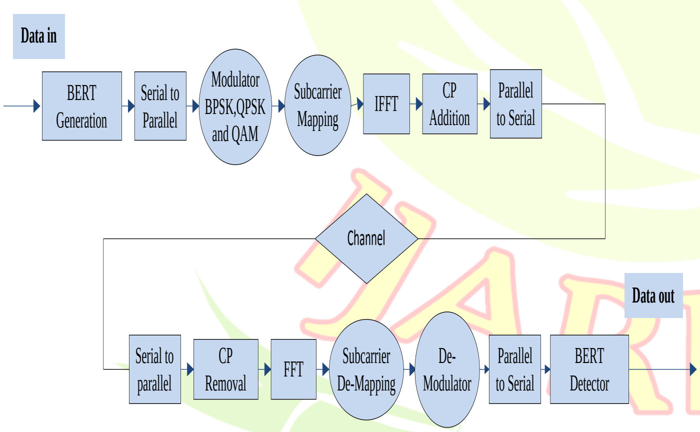

Figure 2 OFDM model used for simulation

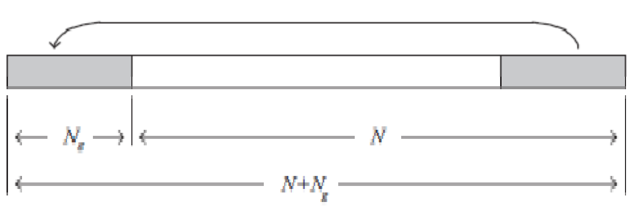

Figure 3 Guard intervals by cyclic extension [11].

The total sequence length becomes *N* + *Ng* samples, corresponding to duration of *Ts* + *Tg*. Trailing and leading samples of this extended block are corrupted by the channel transient response, hence the receiver should demodulate only the central *N* number of samples, essentially unaffected by the channel's transient response.

Thus the efficiency in terms of bit rate capacity can be expressed as shown in equation(2)

$$n_g = \frac{N}{N+N_g} \qquad (2)$$

The OFDM has several advantages over single carrier modulation systems and these make it a viable alternative for CDMA in future wireless networks [9]. The advantages of OFDM are Multi path delay spread tolerance, Immunity to frequency selective fading channels, efficient modulation and demodulation, High transmission bitrates, Easy equalization, High spectral efficiency and Flexibility[10].

An OFDM system is defined by IFFT/FFT length – N, the underlying modulation technique (BPSK/QPSK/QAM), supported data rate, etc.[8]. The FFT/IFFT length N defines the number of total subcarriers present in the OFDM system. For example, an OFDM system with N=64 provides 64 subcarriers.

III. MEASUREMENTS IN OFDM

A. BIT ERROR RATE (BER)

The bit error rate (BER) is the number of bit errors per unit time. The bit error ratio (also BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval.

The BER mathematically can be defined by (3)

$$\text{BER}=\frac{\text{Number of errors}}{\text{Total No of bits transmitted}} \qquad (3)$$

There are some factors that affect on BER. If the transmission speed and transmission medium are good in a particular time but Signal-to-Noise (SNR) is high then BER will be very low[7].

B. SIGNAL-TO-NOISE (SNR)

Signal-to-noise ratio is defined as the ratio of the power of a signal (meaningful information) and the power of background noise (unwanted signal).

The SNR mathematically can be defined by (4)

$$\mathrm{SNR} = 10\log_{10}\frac{\text{Signal Power}}{\text{Noise Power}}\,db \qquad (4)$$

SNR is an indicator commonly used to evaluate the quality of a communication link. Higher value of SNR means better quality of the communication link[9].

IV. MODULATION TECHNIQUES

The technique of superimposing the message signal on the carrier is known as modulation. Modulation is performed at the transmitter and the reverse operation of demodulation or detection is performed at the receiving end. Different classes of digital modulation techniques used for transmission of digitally represented data.

(a)Amplitude Shift Keying (ASK)
(b)Frequency Shift Keying (FSK)
(c)Phase Shift Keying (PSK)

All of these techniques vary a parameter of a sinusoid to represent the information which we send. A general carrier wave may be written as

$$C(t) = A\sin(2\pi ft + \emptyset) \qquad (5)$$

A sinusoid has three different parameters than can be varied. These are its amplitude, phase and frequency[4].

(a) Amplitude Shift Keying (ASK) is the change in amplitude with respect to each symbol, frequency constant and low bandwidth requirements.
(b) Frequency Shift Keying (FSK) is the change in frequency with respect to each symbol and needs larger bandwidth.
(c) Phase Shift Keying (PSK) is the change in phase with respect to each symbol and robust against interference.

Here we are using Phase Shift Keying (PSK) techniques are Binary Phase Shift Keying (BPSK) and Quadrature Phase-shift Keying (QPSK).

(i)Binary Phase Shift Keying (BPSK)

BPSK (also sometimes called PRK, phase reversal keying, or 2PSK) is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK.

The general form for BPSK equation(6) is written as

$$S_n(t) = \sqrt{\frac{2E_b}{T_b}}\cos\big(2\pi f_c t + \pi(1-n)\big), n = 0,1. \quad (6)$$

This yields two phases, 0 and π.

(ii)Quadrature Phase-shift Keying (QPSK)

QPSK is also known as *quadriphase PSK*, 4-PSK, or 4-QAM.QPSK uses four points on the constellation diagram, equispaced around a circle(00,01,10,11).The implementation of QPSK is more general than that of BPSK and also indicates the implementation of higher-order PSK[8].

The general form for QPSK equation(7) is written as

$$S_n(t) = \sqrt{\frac{2E_b}{T_b}}\cos\left(2\pi f_c t + (2n-1)\frac{\pi}{4}\right), n = 0,1,2,3. \quad (7)$$

This yields the four phases are π/4, 3π/4, 5π/4 and 7π/4 as needed.

VI. SIMULATION RESULTS

The simulation results of BER performance of BPSK and QPSK digital modulation with OFDM technique over Additive White Gaussian Noise (AWGN) channel as shown in figure 2. The Additive White Gaussian

Noise (AWGN) is a basic noise model used in information theory to mimic the effect of many random processes that occur in nature. The performance of BER of BPSK and QPSK modulation has been investigated by means of a computer simulation using MATLAB.

A.BPSK Technique

The BER performance of an OFDM system with BPSK modulation over AWGN channel and N = 64 is shown in the Figure 4.

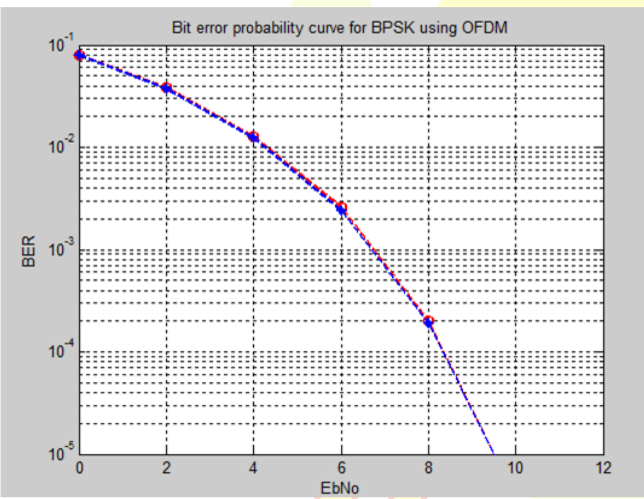

Figure 4 BER versus SNR curve for BPSK

From the simulation result we can observe that the theoretical and simulated results of BPSK modulation over AWGN channel are the same. Hence this result is correct.

B.QPSK Technique

The BER performance of an OFDM system with QPSK modulation over AWGN channel and N = 64 is shown in the figure 5.

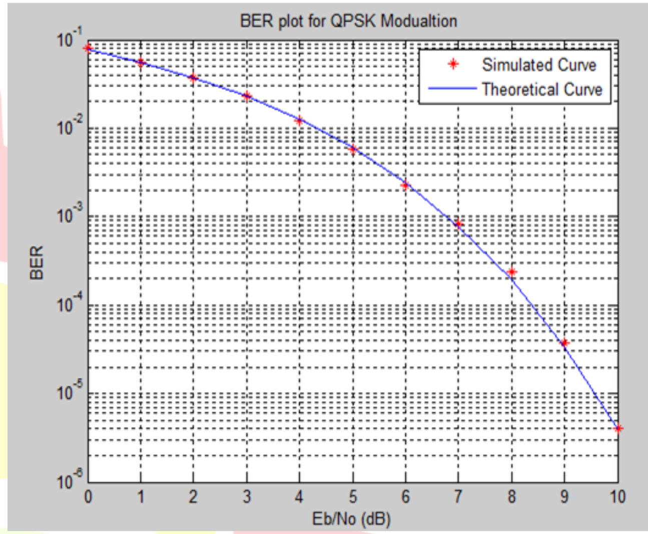

Figure 5 BER versus SNR curve for QPSK

SNR values in dB are adjusted every time by adding noise in the AWGN channel. For particular SNR value system is simulated and corresponding probability of error (Bit Error Rate, BER) is calculated.

C. Comparison of OFDM Systems with BPSK and QPSK

The comparison of the BER versus SNR curves obtained in the OFDM systems with BPSK and QPSK modulation schemes as shown in the figure 6. The orthogonality of sub channels in OFDM can be maintained and individual sub channels can be completely separated by the FFT at the receiver when there are no inter symbol interference (ISI) and inter carrier interference (ICI) introduced by transmission channel distortion.

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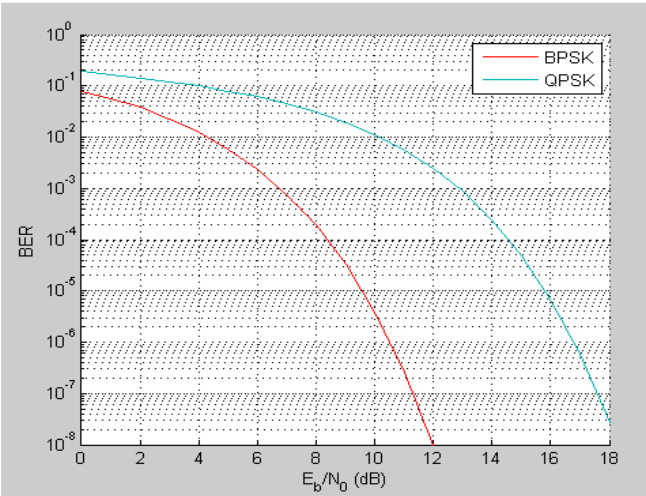

Figure 6 Comparison of BER versus SNR of Two Modulation Schemes

D.BER versus DATA RATE

The data rate is another important parameter in practical system. The figure 7 shows the BER versus data rate with different phase deviations of the system. Generally speaking, with data rate increasing, all the BER performance of different phase deviations caused by the OFDM system see the increase.

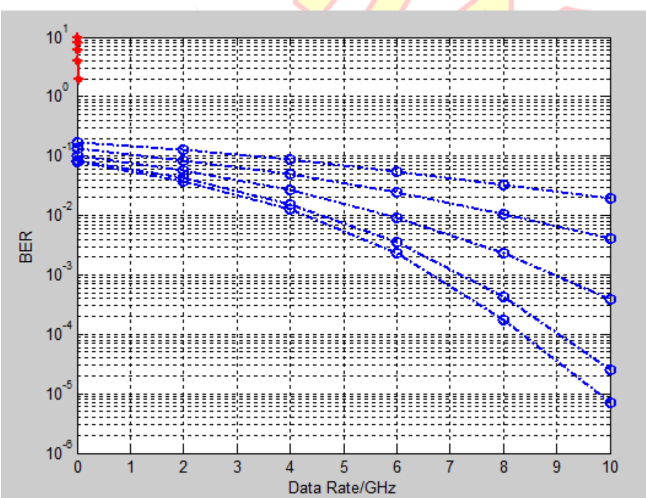

Figure 7 BER versus Data Rate

However, it produces about 16 dB, 9 dB, and 2 dB for BER performance with data rate when the phase deviations of the system are over π/16 like π/4,3π/16,π/8. These analyses mentioned above are very helpful for the design of high data rate communication in future.

E. BPSK modulation with various angles:

The BER measurement with various angles are π/4,3π/16,π/8 using BPSK modulation as shown in the figure 8.

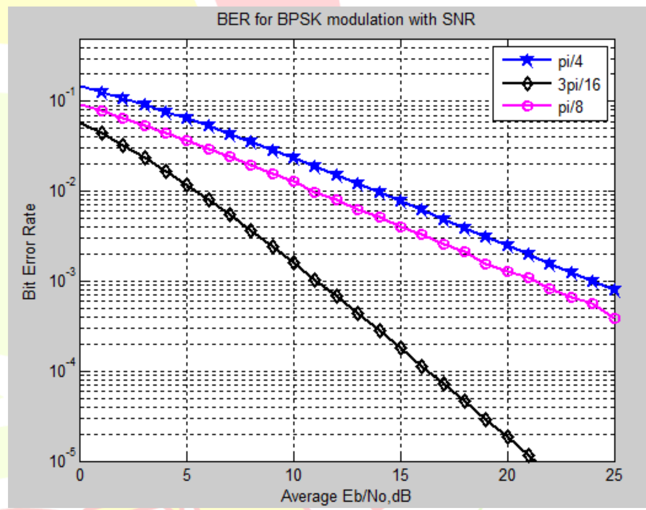

Figure 8 BER versus SNR with various angles

In the OFDM system implementation Fast Fourier Transform (FFT) and its inverse (IFFT) were used to perform the modulation and demodulation operations. BPSK is used as digital modulation technique with various angles for BER measurement versus SNR. As we go on increasing the SNR value, bit error rate reduces.

VII. CONCLUSION

OFDM is digital transmission technique developed into a popular scheme for wideband digital communication systems. It is well suited for wideband, high data rate transmissions. The main advantage is that less equalization is necessary. It has been successfully simulated using MATLAB software, the performance of OFDM system was tested for two digital modulation techniques namely BPSK and QPSK. From the simulation results, it is observed that the BPSK allows the BER to be improved in a noisy channel at the cost of maximum data transmission capacity. Use of QPSK allows higher transmission capacity, but at the cost of slight increase in the probability of error. This is because of the fact that QPSK uses two bits per symbol. Hence QPSK is easily affected by the noise. Therefore OFDM with QPSK requires larger transmit power. From the results, use of OFDM with QPSK is beneficial for short distance transmission link, whereas for long distance transmission link OFDM with BPSK will be preferable.

REFERENCES

[1] ”FPGA Implementation of OFDM Transceiver using FFT Algorithm” shaminder Kaur1, Rajesh Mehra2,ECE Department, NITTTR, Chandigarh, India-160019.International Journal of Engineering Science and Technology (IJEST)

[2] International Journal of Emerging Technology and Advanced Engineering “OFDM Simulator Using MATLAB” Volume 3, Issue 9, September 2013) Deepak Sharma1, Praveen Srivastava2

[3] An initiative Guide of OFDM, 2004.

[4] Simulation of Wireless Communication System Using OFDM Principle

[5] L. Hanzo, W. Webb, and T. Keller, “Single and Multi-carrier Quadrature Amplitude Modulation”, New York, USA: *IEEE Press-John Wiley*, April 2000.

[6] S. B. Weinstein and P. M. Ebert, “Data transmission by frequency division multiplexing using the discrete Fourier transform,” *IEEE Transactions on Communication Technology*, vol. COM–19, pp. 628–634, October 1971.

[7] Ashok Kamboj Geeta Kaushik, “Study & Simulation of OFDM System”, IJMER, Vol.2, Issue.1, Jan-Feb 2012.

[8] Wikipedia.org

[9]M.A.Mohamed, A.S.Samarah and M.I.Fath Allah”Implementation of Adaptive OFDM System using FPGA”. International Journal of Computer Science Issues,Vol.9, Issue 3, No 3,May 2012.

[10] Shaminder Kaur, Rajesh Mehra, “FPGA Implementation of OFDM Transceiver using FFT Algorithm”

[11] Mullett, G. J., *Wireless Telecommunication System & Networks*, Thoms Delmar Learning, 2006.

[12] Rappaport, T. S., *Wireless Communications Principles and Practice*, Prentice Hall, 2001.

[13] Oltean M.,‖*An Introduction to Orthogonal Frequency Division Multiplexing*, Thesis: Universitatea Politehnica Timişoara,2004.