BPSK BIT ERROR RATE OF OFDM USING MATLAB

SIDDHESH MARKAD [1], PRATIK MHATRE[2], AMIT JAMBHALE [3], NITIN BAGUL[4], PROF VIJAY GUPTA[5]

[1,2,3,4]STUDENT

[5]ASSISTANT TEACHER Shivajirao S. Jondhale college of Engg and Technology , Asangoan , Maharashtra ,India

Abstract:

The most widely used modulation technique for wireless communications is Orthogonal Frequency Division Multiplexing (OFDM). To provide high data rates OFDM uses parallel data transmission system is used. Digital modulation techniques contribute in our mobile wireless communications by increasing the capacity, speed as well as the quality of the wireless network.We find the a simple OFDM system , find the relation between Eb/No (Bit to Noise ratio) and Es/No (Signal to Noise ratio) and compute the bit error rate with BPSK.
.

Index Terms: OFDM, BPSK, BER, SNR

.

I. INTRODUCTION

In wireless communication technology the main objective is to provide high quality of data. Orthogonal Frequency Division Multiplexing (OFDM) has become a more popular technique for transmission of signals over wirelesschannels. In OFDM, signals are transmitted in sub-channel of different frequency in parallel fashion. The frequency of sub-channel are so selected that these frequencies are orthogonal to each other and therefore do not interfere with each other. This phenomenon makes it possible to transmit the data in overlapping frequency and hence reduces the bandwidth requirement considerably. OFDM is beneficial in many aspects such as high spectral efficiency, robustness, low computational complexity, frequency selective fading, and easy to implementation using IFFT/FFT [1]. In contrast to conventional Frequency Division Multiplexing, the spectral overlapping among sub-carriers are allowed in OFDM since orthogonality will ensure the subcarrier separation at the receiver, providing better spectral efficiency. OFDM transmission system offers possibilities for alleviating many of the problems encountered with single carrier systems. It has the advantage of spreading out a frequency selective fade over many symbols. This effectively randomizes errors caused by fading or impulse interference so that instead of several adjacent symbols being completely destroyed, many symbols are only slightly distorted. Because of dividing an entire signal bandwidth into many narrow sub-bands, the frequency response over individual sub-bands is relatively flat due to sub-band are smaller than coherence bandwidth of the channel. Thus, equalization is potentially simpler than in a single carrier system [2]. OFDM is a block modulation scheme where a block of N information symbols is transmitted in parallel on N subcarriers. The time duration of an OFDM symbol is N times larger than that of a single-carrier system. An

OFDM modulator can be implemented as an IDFT on a block of N information symbols followed by an ADC. To mitigate the effects of ISI caused by channel time spread, each block of IDFT coefficients is typically preceded by a Cyclic Prefix (CP) or a guard interval consisting of G samples, such that the length of the CP is at least equal to the channel length. Under this condition, a linear convolution of the transmitted sequence and the channel is converted to a circular convolution. As a result, the effects of the ISI are easily and completelyeliminated. Moreover, the approach enables the receiver to use fast signal processing transforms such as a fast FFT for OFDM implementation [3]. OFDM has many advantages compared with other transmission techniques. One of such advantages is high spectral efficiency (measured in bits/sec/Hz). The orthogonal in OFDM implies a precise mathematical relationship between the frequencies of the sub channels that use in the OFDM system. Each one of the frequencies is an integer multiple of a fundamental frequency. This ensures that a sub channel does not interfere with other sub channels even though the sub channels overlap. This results in high spectral efficiency. OFDM can be seen as either a modulation technique or a multiplexing technique. One of the main reasons to use OFDM is to increase the robustness against frequency selective fading or narrowband interference. In a single carrier system, a single fade or interferer can cause the entire link to fail, but in a multicarrier system, only a small percentage of the subcarriers will be affected
.

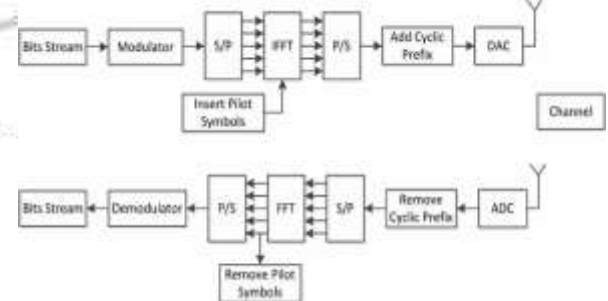## II. BLOCK DIAGRAM AND MODULES DESCRIPTION

Fig.1. Block Diagram

A. Modules and Description

Input:

We used a random bit generator to generate a random bit stream. The output is a 1 dimensional array of bits. We then perform a serial-to-parallel conversion sending the bits on parallel streams each representing a subcarrier

Series to Parallel: The series to parallel conversion is done to allot the bitstream generated in previous step to the various subcarriers. The number of subcarriers is taken to be 512. Thus the input bitstream is divided into 512 parallel bitstreams.

Modulator: Variousmodulation schemes have been used on all the subcarriers. The modulation schemes have been used and the results have been simulated. BPSK, QPSK, 16QAM, 64 QAM are the various modulation schemes which have been used.

Sub Carrier Mapping: The mapping of sub carriers is the next step to align the bit stream over the subcarriers.

IFFT: We then perform the IFFT of all the parallel data streams together ensuring orthogonally between the subcarriers and the conversion of symbols to time domain. By orthogonality, it is meant that all the subcarriers on which the data has been sent overlap each other in such a way that they don't interfere with one another and ensure minimum bandwidth usage. IFFT for a set of N complex data points from N orthogonal parallel streams is given by the formula.

Where, X(k) is a complex frequency domain data sent on subcarriers of frequency k/N, k=0,1,....,N k/N term is orthogonal to every other value of k/N

Cyclic prefix: Cyclic prefix addition is the next step of the procedure. The term cyclic prefix refers to the prefixing of a symbol with a repetition of the end. Although the receiver is typically configured to discard the cyclic prefix samples, the cyclic prefix serves two purposes: As a guard interval, it eliminates the inter symbol interference from the previous symbol.   As a repetition of the end of the symbol, it allows the linear convolution of a frequency-selective multipath channel to be modeled as circular convolution, which in turn may be transformed to the frequency domain using a discrete Fourier transform. This approach allows for simple frequency-domain processing, such as channel estimation and equalization.

Parallel to Serial: The cyclic prefixed bit stream is now converted back to serial bit stream to be transmitted over the channel. Channel: Rayleigh channel model has been used as the fading channel for this research work. The Rayleigh channel is implemented using the built-in function. Receiver Side Remove

CP: The cyclic prefix added at the time of transmission is removed in this step. This is the first step at the receiving end.

Serial to parallel: The serial bit stream is converted to parallel data and is mapped onto the respective subcarriers.
FFT: Fast Fourier Transform is used to convert the signal to Fourier domain to make the analysis easier. Built in functions is used to convert the data stream into Fourier domain.
Sub Carrier Mapping: The subcarrier mapping is used to map the subcarriers with the respective bit stream pattern on them.

Demodulator: The demodulator demodulates the bit stream, so as to retrieve the original or baseband signal. According to the type of modulation, used the corresponding demodulation method is applied.

Parallel to Serial: The parallel data is then converted back to serial bit pattern to retrieve the message which is the final output.
Cyclic Prefix

A cyclic prefix is often used in conjunction with modulation to retain sinusoids' properties in multipath channels. It is well known that sinusoidal signals are Eigen of linear, and time- invariant systems. Therefore, if the channel is assumed to be linear and time-invariant, then a sinusoid of infinite duration would be an Eigen. However, in practice, this cannot be achieved, as real signals are always time-limited. So, to mimic the infinite behavior, prefixing the end of the symbol to the beginning makes the linear convolution of the channel appear as though it were circular convolution, and thus, preserve this property in the part of the symbol after the cyclic prefix. OFDM uses cyclic prefixes to combat multipath by making channel estimation easy.

In the OFDM symbol transmission , ISI occurs at the receiver due to delay spread of the channel. ISI stands for Inter Symbol Interference. In order to avoid ISI, guard interval is inserted between two OFDM symbols. This guard internal is referred as **cyclic prefix (CP)**. This is kept greater than delay spread of the channel to avoid ISI.
Following are basics of cyclic prefix(CP):Zeros used in the guard time can alleviate interference between OFDM symbols. Orthogonality of carriers is lost when multipath channels are involved, which can be restored by cyclic prefix. It converts a linear convolution channel into a circular convolution channel.This restores the orthogonality at the receiver. The disadvantage is wastage of energy in the cyclic prefix samples.
The FFT start point would cause a problem even if the CP duration is made longer than the multipath channel delay. ISI would happen if the FFT starting point comes ahead of the earlier symbol end. However, if the opposite happens, where both ISI and ICI could occur, the problem would be worse

The frequent problem of ISI in high data rate communication is due to the fact that increase in data rate decreases the time duration. This gives rise of self interference due to multipath delay spread which is decoded incorrectly at the receiver end. The minimum requirement to avoid ISI is to keep time duration

greater than the maximum delay of the channel. This is one of the major drawbacks of multi-path single carrier transmission. To avoid this problem guard interval is provided before the data period so that ISI occurs in the guard interval which can be removed afterwards and the data can be retrieved. The high level of robustness against multipath delay spread of OFDM system is a result of the very long symbol period used compared to guard interval can be furtherincreased by the addition of a guard period between transmitted symbols. The guard period allows time for multi-path signals from the previous symbol to die away before the information from the current symbol is gathered. The most effective guard period to use is a cyclic extension of the symbol. If a mirror in time, the end of the symbol waveform is put at the start of the symbol as the guard period, it is the cyclic prefix shown in figure

2. Cyclic prefix will effectively extend the length of the symbol, while maintains the orthogonality of the waveform. With this cyclic extended symbol the samples required for performing the FFT (to decode the symbol), can be taken anywhere over the length of the symbol. This provides multi-path immunity as well as symbol time synchronization tolerance. Introduction of guard symbol during the guard period specifically if guard symbol is chosen to be a prefix extension to each block will reduce complexity at receiver as this convert the linear convolution of the signal and channel to a circular convolution and thereby causing the FFT of the circularly convolved signal and channel to simply be the product of their respective FFT's. The relative length of the cyclic prefix depends on the ratio of the channel delay spread to the OFDM symbol duration. The reasons to use a cyclic prefix for the guard interval are to maintain the receiver carrier synchronization and elimination of silent period of guard bands. Also the circular convolution can be applied between the OFDM signal and the channel response to model the transmission system. Cyclic prefix acts as a buffer region where delayed information from the previous symbols can get stored. The receiver has to exclude samples from the cyclic prefix which got corrupted by the previous symbol when choosing the samples for an OFDM symbol. Further, we learned that a sinusoidal added with a delayed version of the same

sinusoidal does not affect the frequency of the sinusoidal (it only affects the amplitude and phase). Given so, for demodulating the received symbol, the receiver can chose samples from a region which is not affected by the previous symbol. When the pertinent samples of an OFDM symbol is taken the orthogonality aspect in OFDM is not affected by the multipath channel i.e. even though the individual subcarriers undergo phase and amplitude change, as the frequency is not affected, there is no interference between the subcarriers. The flipside of adding cyclic prefix is the loss in data rate as we are conveying redundant information. To minimize this loss it is required to minimize cyclic prefix duration. Typically, cyclic prefix duration is determined by the expected duration of the multipath channel in the operating environment. For example, for the indoor wireless multipath channel, the typically expected multipath channel is of around 0.8μs duration.Consider a non-ideal channel $h(t) \neq \delta(t)$, that causes delay dispersion. Delay dispersion manifests itself as Inter Symbol Interference (ISI)on each subcarrier channel due to pulse overlapping. It will also cause ICC (Inter Carrier Interference) due to the non-orthogonality of the received signal. Adding cyclic prefix to each OFDM symbol mitigates the problems of ISI and ICC by removing them altogether. Lets say, without cyclic prefix we transmit the following N values (N=Nfft=length of FFT/IFFT) for a single OFDM symbol.

$X_0, X_1, X_2, ..., X_{N-1} X_0, X_1, X_2, ..., X_{N-1}$

Lets consider a cyclic prefix of length Ncp, (where Ncp<N), is formed by copying the last Ncp values from the above vector of X and adding those Ncp values to the front part of the same X vector.With a cyclic prefix length Ncp, (where Ncp<N), the following values constitute a single

OFDM symbol :If T is the duration of the an OFDM symbol in secs, due to the addition of cyclic prefix of length Ncp, the total duration of an OFDM symbol becomes T+Tcp, where Tcp=Ncp*T/N. Therefore, the number of samples allocated for cyclic prefix can be calculated as Ncp=Tcp*N/T, where N is the FFT/IFFT length, T is the IFFT/FFT period and Tcp is the duration of cyclic prefix.

OFDM Frame with cyclic extension for a single symbol time
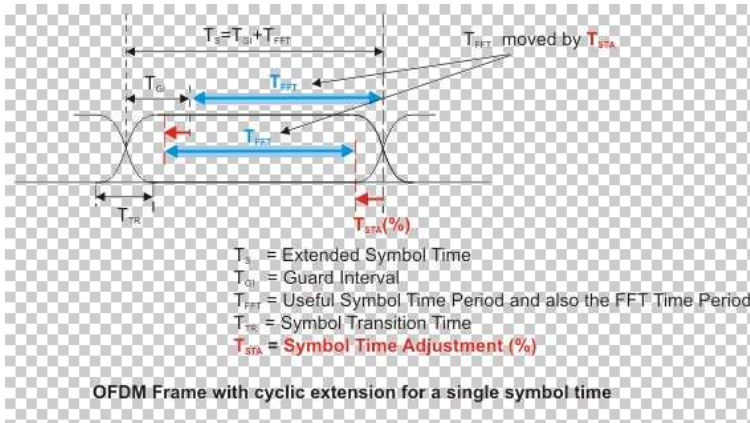
III.RESULT
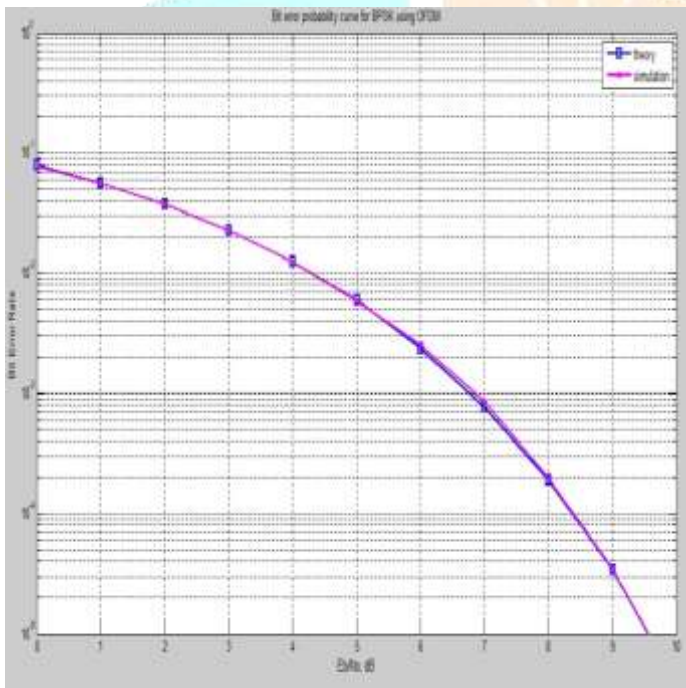
IV. CONCLUSION and FUTURES COPE CONCLUS ION:

☐ It can be conclude that From the performed simulations in the AWGN channel, it is found that OFDM- BPSK modulation has no advantage over a conventional BPSK modulation scheme. But it is found that both OFDM- BPSK and conventional BPSK having small bit error rate probability than that of the Rayleigh fading based BPSK system. The purpose of this paper is to implement and find the efficient modulation combination that performs better in the wireless

channels that are mostly multipath. The paper compares the performance of the OFDM system using binary phase shift keying whereas the future work may include the implementation of other modulation schemes and different channel scenarios for

VI. REFERENC ES

[1]. Mohammed S. Akhoirshida and Mustafa M. Matalgah--BER Performance Analysis of Interference-Limited BPSK Cooperative Communication Systems with Cochannel Interference in Nakagami-m Fading Channels, PAWR 2013,IEEE.

[2]. Jun Lu, ThiangTjhung,Fumiyuki Adachi and Cheng Li Huang, ―BER performance of OFDM-MDPSK system in Frequency – Selective RicianFading with Diversity Reception, IEEE Trans. On Vehicular Technology, vol. 49, no. 4, pp. 1216-

1225, July 2000.

[3]. Young Jae Ryu and Dong Seog Han, ―Timing phase
performance evaluation of any OFDM based system that better spectral efficiency obtained with the Binary Phase Shift Keying (BPSK) modulation technique. The comparative study of BER over different modulation techniques show that minimum BER can be achieved with the lower modulation technique. Coding rate also affects the BER performance. Less coding rate gives less bit error rate than high coding rate. We can observe that the simulated bit error rate is in good agreement with the theoretical bit error rate for BPSK modulation i.e

$$P_e = \frac{1}{2}\,\mathrm{erfc}\!\left(\frac{d_{ik}}{2\sqrt{N_0}}\right)$$

$$= \frac{1}{2}\,\mathrm{erfc}\!\left(\sqrt{\frac{E_b}{N_0}}\right)$$

We find the a simple OFDM system , find the relation between Eb/No (Bit to Noise ratio) and Es/No (Signal to Noise ratio) and compute the bit error rate with BPSK.

V. FUTURE S COPE:

☐ The closed form expression of BER can be derived for OFDM system with proposed PAPR reduction method.
☐ The windowing method of ICI reduction can be clubbed with ICI self cancellation scheme.

☐ The algorithm of timing offset estimation can be extended for channel estimation in OFDM system.

☐ The channel estimation is an area which required a lot of attention and improper channel estimation degrades the performance of system. In this work, it is assumed that channel is estimated perfectly. Hence one can evaluate the performance of proposed work with different channel estimation method.

estimator overcoming Rayleigh Fading For OFDM systems, IEEE Proc., pp. 66- 67

[4]. M. Nakagami, —The m-distribution—A general formula of

intensity distribution of rapid fading,‖ in Statistical Methods in Radio Wave Propagation, W. C. Hoffman, Ed. Elmsford, NY: Pergamon, 1960.

[5]. Zheingjiu Kang, Kung Yao, FlavioLorenzelli, —Nakagami-m Fading Modeling in the Frequency Domain for OFDM system analysis,‖ IEEE Communication letters, vol. 7, no.10, pp. 484-486, Oct.2003.

[6]. Zhengdu,Julian Cheng and Norman c. Beaulieu, —Asymptotic BER performance of OFDM in Frequency SelectiveNakagami-m Channels,‖ IEEE Conference on Vehicular

Technology , vol. 1, pp. 612-615,Sept. 2004.

[7]. Zhengdu,Julian Cheng and Norman c. Beaulieu, —Accurate Error Rate Performance Analysis of OFDM on Frequency SeelectiveNakagami-m Fadiing Channels,‖ IEEE Trans.oncommunications.vol. 54, no. 2, pp. 319-328, Feb. 2006.

[8]. Zhangyong Ma and Young-il- Kim, —A Novel OFDM receiver in Flat Fading Channel,‖ IEEE Conference on advanced communication technology, ICACT, Vol.. 2, pp. 1052-54, 2005.

[9]. SONG Lijun, TANG Youxi, LI Shaoqian and HUANG Shunji, —BER Performance of Frequency Domain Differential Demodulation OFDM in Flat Fading Channel,‖ Journal of Electronic Science and Technology of China, Vol. 1, no. 1, Dec. 2003.

Author's Profile:
Siddhesh Markad Student of Shivajirao S. Jondhale college of Engg and Technology, Asangoan, Maharashtra India

Pratik Mhatre Student of Shivajirao S. Jondhale college of Engg and Technology, Asangoan, Maharashtra India

Amit Jambhle Student of Shivajirao S. Jondhale college of Engg and Technology, Asangoan, Maharashtra India

Nitin Bagul Student of Shivajirao S. Jondhale college of Engg and Technology , Asangoan, Maharashtra India

Prof. Vijay Gupta Assistant professor in Shivajirao S.Jondhale college of Engg and technology, Asangoan, Maharashtra India