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BER COMPARISON IN OFDM SYSTEM WITH ADAPTIVE EQUALIZATION OVER RAYLEIGH FADING CHANNEL USING BPSK TECHNIQUE

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ABSTRACT

In this paper Bit Error Rate performance of OFDM - BPSK System over Rayleigh fading channel is analyzed. OFDM is an orthogonal frequency division multiplexing to reduce inter-symbol interference problem. Two of the most equalization algorithms are minimum mean square error (MMSE) equalizer and maximum likelihood sequence estimation (MLSE) equalizer. Finally simulations of OFDM signals are carried with Rayleigh faded signals to understand the effect of channel fading and to obtain optimum value of Bit Error Rate (BER) and Signal to noise ratio(SNR)

Keywords: ***OFDM, ISI, Rayleigh fading channel, minimum mean square error (MMSE) equalizer and maximum likelihood sequence estimation (MLSE)equalizer.***

INTRODUCTION

A general problem found in high speedcommunication is inter-symbol interference .ISI occurs when a transmission interferes with itself and thereceiver cannot decode the transmission correctly.[1]This paper will focus on Orthogonal Frequency Division Multiplexing (OFDM) Simulation and implementation and also compare the output result of BPSK modulation techniquewithOFDM.OFDM is especially suitable for high speed communication due to its resistance to ISI.As Communication systems increase their information transfer speed the time for each transmission. Primary objective of our study is reducing the ISI problem in the wireless communication. One solution can be Orthogonal Frequency Division Multiplexing (OFDM).The idea of OFDM [3] is to distribute the high rate data stream into many low rate data streams that are transmitted in a parallel way over many sub channels. Thus, in a sub channel, the symbol duration is low as compared to the maximum delay of the channel and hence, ISI can be handled.

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier transmission technique that has been recently recognized as an excellentmethodfor high speedbi-directional wireless data communication [2]. Economical integrated circuits that can perform the high speed digital operation necessary have become available .OFDM effectively squeezes multiple modulated carriers tightly together reducing the required bandwidth butkeeping the modulated signals orthogonal so they do not interfere with each other .Today, the technology y is used in such systems as asymmetric digital subscriber line(ADSL) as well as wireless systems such as IEEE 802.11 a\g (Wi- Fi*)and IEEE.16 (WiMAX*). It is also used for 802wireless digital audio and video broadcasting . It is based on Frequency Division Multiplexing (FDM), which is a technology y that uses multiple frequencies to simultaneously transmit multiple signals in parallel. Each signal has its own frequency range (subcarrier), which is then modulated by data. Each subcarrier is separated by aguardbandto ensure that they do not overlap. This sub-carrier is then demodulated at the receiver by using filtersto separate the bands.

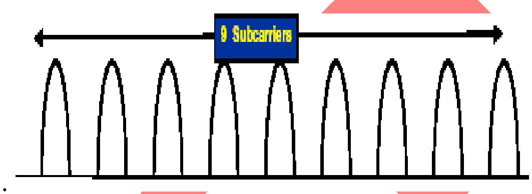

Fig: 1, FDM diagram

OFDM is similar to FDM but much more spectrally efficient by spacing the sub channel much more spectrally efficient b y spacing much closer together. This is done b y finding frequencies that are orthogonal, which means that are perpendicular in a mathematical sense, allowing the spectrum of each sub-channel to overlap another without Interfering with it. In the effect of this is seen as the required bandwidth is greatly reduced b y removing guard bands and allowing signals to overlap .In order to demodulate the signal ,a discrete Fourier transform (DFT) is needed .Fast Fourier transform (FFT) chips are commercially available making this is a relatively easyoperation

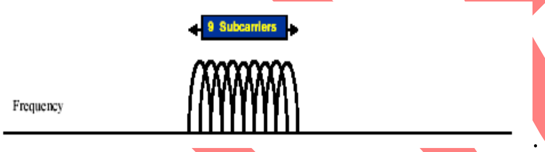

Fig 2: OFDM MODEL

SYSTEM MODEL

The base band time complex valued model of OFDM system [4] considered in the paper is depicted in figure 3.The model consists of three subsections namely transmitter channel and receiver.

Transmitter

This subsection consists of following blocks

Random Data Generator

Random data generator is used to generate a serial random binary data .This binary Data stream models the raw information that going to be transmitted. The serial binary data is then fed into OFDM transmitter.

S/P converter

The input serial binary data stream is grouped into word size required fortransmission in this each word. And word is converted into parallel streamcarrier.

Zero-padding and IFFT

The IFFT converts frequency domain data into the time domain signal. Prior to IFFT mapping zero- padding is performed to adjust the IFFT bit size of length. Zero padding is used because the number of subcarriers may be less then bitsize.
Let Xp(k)is the input Vector to IFFTblock and k varies from 0 to N-1 Where N=64.Out put of IFFT is given by the systemmodel.

Cyclic Prefix

It is a cyclic extension of an OFDM symbol to eliminate ISI effect on original OFDM symbol .The length of cyclic prefix is chosen ¼ of the length of symbol .The cyclic prefix adds time over head decreasing the overall spectral efficiency of the system .After the cyclic prefix has been added[5]

Channel model

Additive white Gaussian Noise (AWGN) is a channel model in which the only impairment to communication is a linear addition of wideband or white noise with a constant spectral density (expressed as watts par hertz of bandwidth) and a Gaussian distribution of amplitude. The model does not account for fading, frequency, selectivity, interference, nonlinearity or dispersion. Rayleigh fading is caused by multipath reception really fading is statistical model for the effect of propagation environment on a radio signal such as is used by wirelessdevices

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Receiver

The receiver does the reverse in contrast to the transmitter. Firstly the serial output channel is a converted into parallel stream and then cyclic prefix bits are removed from it .Then FFT of Each symbol is performed .To remove these channel effect MMSE and MLSE is performed equalized output is converted back to data words b y demodulator the data words are then multiplexed to get the originaldata

EQUALIZER

Equalizer [7] is a digital filter that provides an approximate inverse of channel frequency response. Equalization istomitigatetheeffectsofISIto decrease the probability oferror that occurs without suppression of ISI, but this reduction of ISI effects has tobe balanced with prevention of noise power enhancement.

Adaptive equalization

Adaptive equalizer is an equalizer that automatically adapts to time-varying properties of the communication channel. It is frequently used with coherent modulations such as phase shift keying, mitigating the effects of multipath propagation and Dopplerspreading.

Maximum-likelihood sequence Estimation (MLSE)

The receiver uses a maximum-likelihood sequence estimation (MLSE) implemented by means of the Viterbi algorithm to compensate for the heavy y selective distortions caused by multipath propagation. The performance of the receiver is evaluated through a channel simulator suitable for mobilecommunications. The results obtained show the good behavior characteristics for the receiver in different modes of operation. Easy implementation of the device using VLSI technology is expected for an optimized detector for digital signals the priority is not to reconstruct the transmitter signal, but it should do a best estimation of the transmitted data with the least possible number of errors Maximum likelihood sequence estimation is formally the application of maximum likelihood to this problem. That is, the estimate of $\{x(t)\}$ is defined to be sequence of values which maximize thefunctional

$$L(x) = p(r \mid x),$$

Where $p(r|x)$ denotes the conditional joint probability density function of the observed series $\{r(t)\}$ given that the underlying series has the values $\{x(t)\}$.

SIMULATION AND RESULTS

***Simulation parameters*:** Simulation parameters chosen for the model of OFDM transceiver re listed in Table 1. Simulation is carried out Rayleigh channel using BPSK modulation technique

Table1.Simulation parameters for OFDM transceiver

S.No	**Parameter**	**Value**
1	Carrier	BPSK
2	Number of data sub carriers	52
3	IFFT Size	64
4	Cyclic prefix	16
5	Bandwidth	20Mhz
6	Channel type	Rayleigh
7	Sub carrier frequency spacing	20 MHz/64=0.312
8	TFFT :IFFT	3.2 µsec
9	Symbol rate	Number of

Simulation Results

Simulation Results are plotted for bit error rate performance of OFDM System simulation is performed Rayleigh channel using BPSK, Modulation technique condition considering absence and presence of MMSE and MLSEEqualizer.

Rayleigh Channel

InthissectionbiterrorrateforBPSKusingOFDMinaRayleighchannel. OFDM technique along with cyclic prefix is used to reduce Inter symbol Interference (ISI) but still it cannot be eliminated completely in the case of MMSE and MLSE Equalizer. To reduce these effects equalization is performed on receiver side. Bit Error rate performance in Rayleigh channel using BPSK a modulation technique with and without equalizer it can be observed that bit error rate around 0.4 in B P S K , when no equalization is performed. Bit error rate decreasing when MLSE equalization is performed but later on it maintains a constant valueof 0.0015 in BPSK

Rayleigh *fading*

In Wireless communication, fading is deviation of the attenuation a carrier modulated telecommunicationsignalexperiencesovercertainpropagationmedia.Thefading mayvarywithtime,geographicalpositionandradiofrequencyandisoften modeled as a random process. A fading channel is a communication channels that experiences fading. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal, such as that used bywireless devices. Rayleighfadin g is viewed as a reasonable model for troposphere and ionosphere signal propagation as well as the effect of heavily built up urban environments on radiosignal

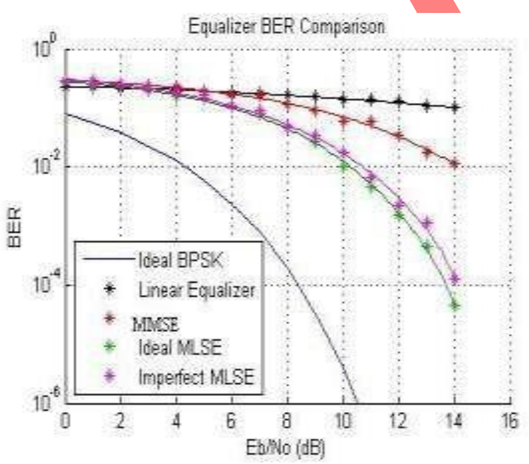

Fig.3: BER Comparison of MMSE and MLSE Equalizers in OFDM over Rayleigh fading channel

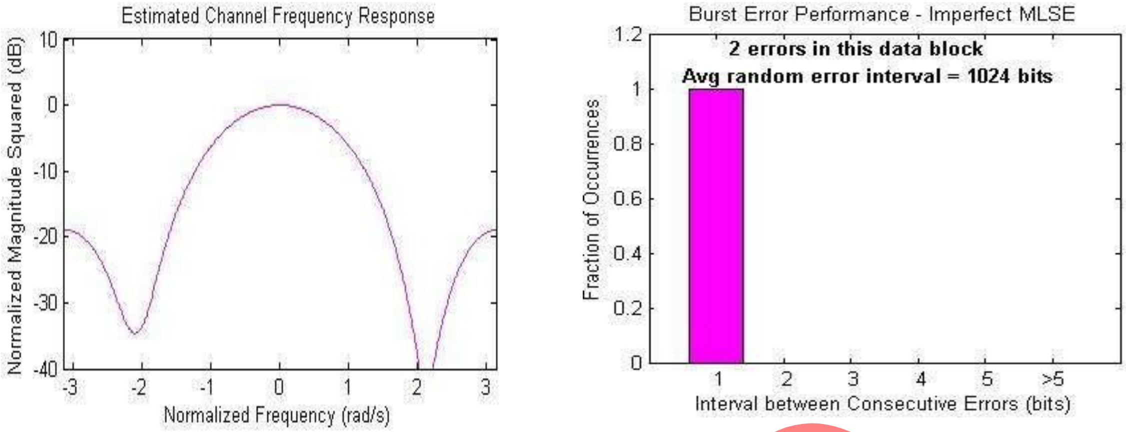

Fig.4&5: Frequency response in OFDM using Rayleigh fading channel and burst error performance in ofdm

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