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Performance of OFDM in time selective Multipath fading channel in 4G Systems

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ABSTRACT:

With the growing demand for higher data rate networks, OFDM has emerged as a key technology for 4G standards like 3GPP LTE, IEEE 802.16m WiMAX and IEEE 802.11n WLAN. With its robustness to frequency selective fading, high spectral efficiency and ease of implementation by means of Discrete Fourier Transform (DFT), OFDM is a cutting edge technology for Broadband mobile wireless. Along with its compatibility with MIMO, OFDM is an attractive air interface solution to meet the demands of 4G networks. In mobile environment, channel is subject to both time and frequency selective fading. Although OFDM is resistant to ISI resulting from frequency selective fades, but it is quite sensitive to time selective multipath fading. This time selective fading causes ICI thus degrading system performance. For a satisfactory performance of OFDM, it is imperative that the sub-carriers remain orthogonal to each other. The orthogonal behavior of sub-carriers can be jeopardized due to two effects namely Carrier frequency offset, and Doppler spread. Doppler is nothing but the frequency shift caused by the movement of transmitter or receiver In the case of high Doppler spread owing to high mobility, maintaining orthogonality between sub-carriers is a challenging task. In the case of Carrier frequency offset, which is caused by the use of Local Oscillators, there is a frequency shift of the received signal spectrum. This frequency shift of the received signal spectrum compromises the orthogonality between the sub-carriers. This project reviews the methods to mitigate the deleterious effect of time selective fading and compares the simulation result of high Doppler spread with that of small Doppler spread. In this project we are going to analyze the Doppler Effect on OFDM system. PSK modulation is considered in this project. In this project we are demonstrates the effect of Doppler spread on Bit Error Rate(BER) with and without compensation. It is evident that without Doppler estimation and compensation, there is significant degradation in the performance of OFDM.

Keywords: ICI, ISI, LTE, MIMO, OFDM

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I INTRODUCTION

Orthogonal Frequency Division Multiplexing is a special form of multicarrier modulation which is particularly suited for transmission over a dispersive channel. Orthogonal Frequency Division Multiplexing (OFDM) is a wideband modulation scheme that is designed to cope with the problems of the multipath reception. Essentially, the wideband frequency selective fading channel is divided into many narrow-band sub channels. If the number of sub channels is high enough, each sub channel could be considered as flat. This is because we transmit many narrowband overlapping digital signals in parallel, inside one wide band. Increasing the number of parallel transmission channels reduces the data rate that each individual carrier must convey, and that lengthens the symbol period. The development of OFDM systems can be divided into three parts. They are Frequency Division Multiplexing, Multicarrier Communication and Orthogonal Frequency Division Multiplexing. Multicarrier Communication involves splitting of the signal to give a number of signals over that frequency range. Each of these signals are individually modulated and transmitted over the channel. At the receiver end, these signals are fed to a de- multiplexer where it is demodulated and recombined to obtain the original signal. Orthogonal frequency division multiplexing (OFDM) was discovered by Chang in his pioneering paper in 1966. The basic idea is that dispersive transmission media can be rendered non-dispersive, if the transmission channel is subdivided in a high number of parallel, low-rate, non-dispersive channels [3,4]. Given the propagation environment-whether it is a wire line, stationary, or mobile wireless scenario-the increased dispersion associated with increased transmission rates can always be avoided by increasing the number of sub channels. This is equivalent to increasing the memory of the channel equalizer in conventional equalized serial modems [3]. Since its discovery, this technique has fascinated researchers; but due to its implementation complexity, its applications have been scarce until quite recently. Recently, however, it been adopted as the new European digital audio broadcasting (DAB) standard [6, 7], and it has also been adopted for digital terrestrial television broadcast (DVB) in Europe. There are many qualifiers where fading channels are involved. Fading channels may be described as either frequency non-selective (flat) or frequency-selective and as either fast or slowly fading. In order to make sense of these characteristics it is necessary to first define a few terms. When the transmission channel exhibits constant gain and linear phase over a bandwidth much smaller than that of the signal, the channel is said to be frequency selective. If the opposite is true, it is frequency non-selective, or flat.

II.LITERATURE SURVEY

The future fourth generation (4G) mobile communication systems is underway worldwide in major companies and academic institutions, forward-thinking professionals are striving to gain a thorough understanding of the cutting-edge technologies and design techniques that will make these systems work. This book helps readers do just that by: providing a comprehensive introduction to multicarrier techniques for 4G mobile communications with a special focus on the analytical aspects; explaining radio channel characteristics and phenomena and discussing the advantages and disadvantages of the OFDM scheme; featuring new multicarrier-related techniques, MC-CDMA, research on several 4G systems, and a look at several problems to be overcome with these systems; examining the concept and detail of the ODFM scheme and how to carry out theoretical analysis on the performance of transmission systems in radio channels; showing how ODFM has been successfully adopted as a

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modulation scheme in communications systems and broadcasting systems such as ADSL, wireless LANs, and DVB-T [3]. Hence, the advent of Orthogonal Frequency Division Multiplexing (OFDM) technology along with its practical implementation marked the migration of Third Generation (3G) standards towards Fourth Generation (4G). It is a critical technology for 4G where multicarrier modulation (MCM) provides two distinct advantages [1]. There are four principal media for transmission of high-speed data to and from a customer premises:

1. DSL: Digital Subscriber Loop. It mainly uses Discrete Multi-tone (DMT) technique that is widely applied to xDSL.

2. Coaxial cable: originally installed for unidirectional (“downstream”) transmission of television, but increasingly being used for bi-directional data transmission.

3. Optical fiber: it is originally used for very high-speed trunk transmission, but now being implemented in FTTH (Fiber To The Home), FTTE (Fiber To The Exchange) and FTTN (Fiber To The Neighborhood).

4. Wireless: use of multicarrier modulation becomes an attractive solution in wireless, high data speed transmission system. The DMT technique is a version of MCM in the baseband, and OFDM (orthogonal frequency division multiplexing) technique is a special case of MCM in the passband.

III. PROBLEM OUTLINE

Interference caused by multipath propagation

Multipath propagation can give rise to interference that can reduce the signal to noise ratio and reduce bit error rates for digital signals. One cause of a degradation of the signal quality is the multipath fading already described. However there are other ways in which multipath propagation can degrade the signal and affect its integrity.

One of the ways which is particularly obvious when driving in a car and listening to an FM radio. At certain points the signal will become distorted and appear to break up. This arises from the fact that the signal is frequency modulated and at any given time, the frequency of the received signal provides the instantaneous voltage for the audio output. If multipath propagation occurs, then two or more signals will appear at the receiver. One is the direct or line of sight signal, and another is a reflected signal. As these will arrive at different times because of the different path lengths, they will have different frequencies, caused by the fact that the two signals have been transmitted by the transmitter at slightly different times. Accordingly when the two signals are received together, distortion can arise if they have similar signal strength levels.

Another form of multipath propagation interference that arises when digital transmissions are used is known as Inter Symbol Interference, ISI. This arises when the delay caused by the extended path length of the reflected signal. If the delay is significant proportion of a symbol, then the receiver may receive the direct signal which indicates one part of the symbol or one state, and another signal which is indicating another logical state. If this occurs, then the data can be corrupted.

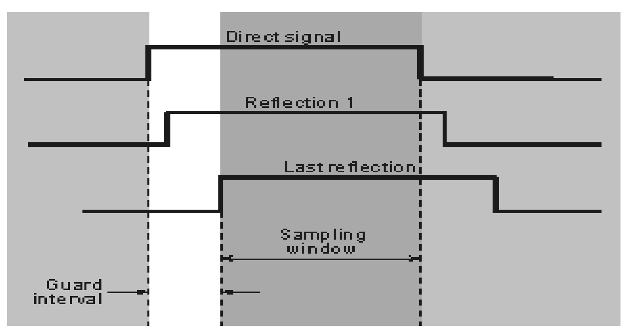

Fig 1: How inter symbol interference can be avoided

One way of overcoming this is to transmit the data at a rate the signal is sampled, only when all the reflections have arrived and the data is stable. This naturally limits the rate at which data can be transmitted, but ensures that data is not corrupted and the bit error rate is minimized. To calculate this the delay time needs to be calculated using estimates of the maximum delays that are likely to be encountered from reflections.

Using the latest signal processing techniques, a variety of methods can be used to overcome the problems with multipath propagation and the possibilities of interference.

EXISTING SYSTEM

In the existing system, we are analyzing the performance of the OFDM system with Doppler Effect. We are considering the PSK for modulation and Rayleigh channel. In this project we are demonstrates the effect of Doppler spread on Bit Error Rate (BER) with and without compensation. It is evident that without Doppler estimation and compensation, there is significant degradation in the performance of OFDM.

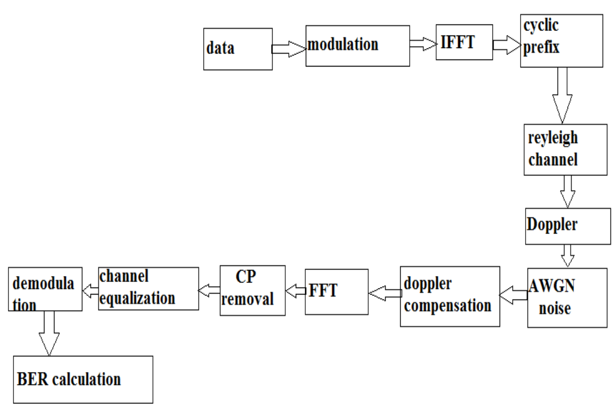

Fig:2. Performance of the OFDM system with Doppler Effect.

In the simulation we are considering two cases, one with Doppler compensation and another without Doppler compensation and we are comparing those two. From the above comparison, we can conclude that the BER was diminishing with increased SNR.

PROPOSED SYSTEM

In the proposed system, besides Doppler compensation, we are analyzing the performance for fixed PSK modulation with different Doppler shifts corresponding to speed 0, 20, 40, 60, 80, 100Kmph. From the above analysis we can conclude that as the Doppler shift increases there is corresponding increase in the BER.

And we are also analyzing the performance for fixed Doppler, different modulations 2-PSK,4-PSK,8-PSK,16-PSK,32PSK. From the above analysis we can conclude that for higher modulation schemes, there is more BER.

IV. METHODOLOGY

In this section, we focus on describing the design of OFDM system transmitter and receiver using frequency selective fading is introduced.

The development of OFDM systems can be divided into three parts. They are

Frequency Division Multiplexing

Multi carrier Communication and

Orthogonal Frequency Division Multiplexing

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Block diagram of proposed system

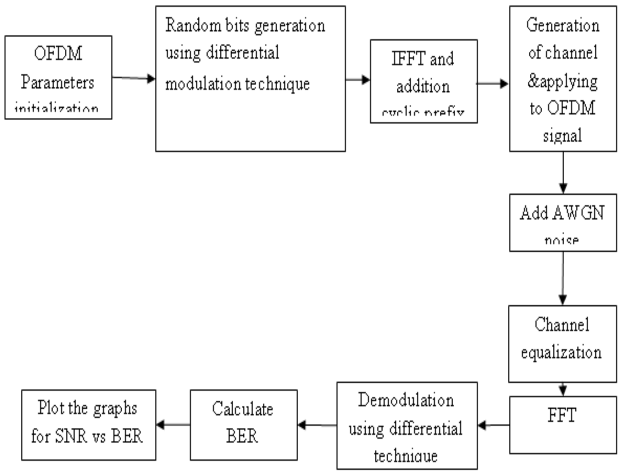

Fig 3: Block diagram of proposed system

Main blocks information is given in below sections.

M-ARY PSK

M-ary signalling is the higher version of basic digital modulation techniques where two or more bits of message signal are grouped together to make symbol and one of the M possible signals are transmitted during one symbol duration (Ts). The number of possible signals is M=2N where N is the number of bits in one symbol [6].

In M-ary PSK, the carrier phase takes on one of M possible values, namely

$$\theta_i = 2(i-1)\pi/M, \text{ where } i = 1,2,\ldots M. \qquad \text{eq. (1)}$$

The modulated waveform can be expressed as

$$S_i(t) = \sqrt{\frac{2E_s}{T_s}}\cos\left(2\pi f_c t + \frac{2\pi}{M}(i-1)\right) \quad \text{where } 0 \le t \le T_s \text{ and } i = 1,2,..,M \qquad \text{eq. (2)}$$

Where Es= (log2 M)Ebis the energy per symbol and Ts=(log2 M)Tb is the symbol period [6].

Power spectral density of M-ary PSK is

$$S_B(f) = 2P_s T_s\left[\frac{\sin(\pi f N T_s)}{\pi f N T_s}\right]^2 \qquad \text{eq. (3)}$$

The above equation gives the power spectral density of baseband M-ary PSK 'Tb' is the duration of one bit. Fig1 shows the plot of SB(f) for M-ary PSK.

V.RESULTS

Fig. 4 demonstrates the effect of Doppler spread on Bit Error Rate(BER) with and without compensation. It is evident that without Doppler estimation and compensation, there is significant degradation in the performance of OFDM. A correlation between transmit range and frequency is also drawn, demonstrating an inverse relation between the two for a given transmit power. Fig. 5 depicts a scenario for performance of OFDM with and without Doppler frequency. It is clearly evident that performance degrades with high Doppler component. The simulation is done with the following parameters.

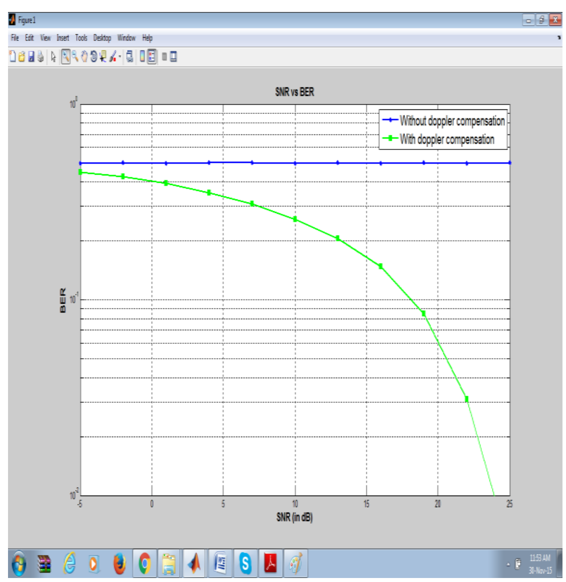

Fig 4: simulation 1

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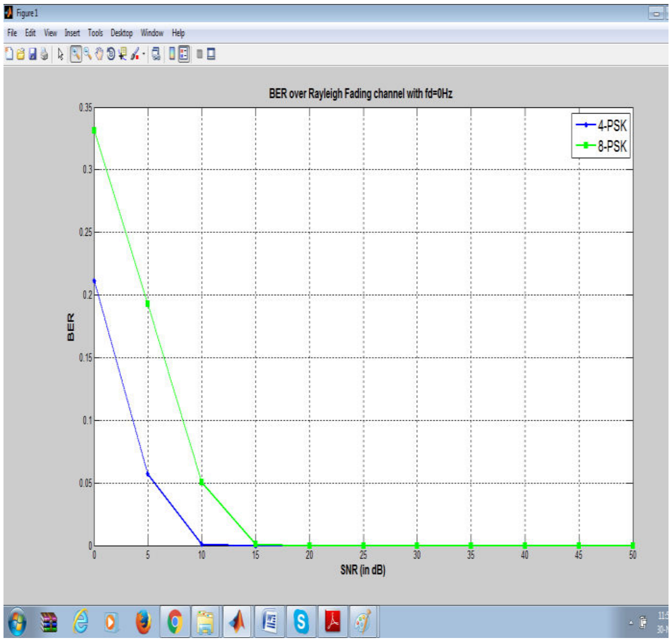

Fig 5: Simulation 2

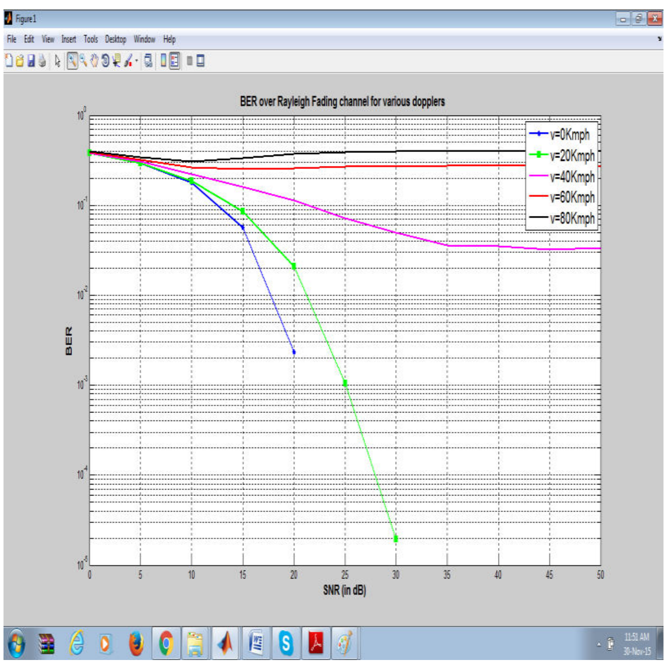

Fig 6 : Extension 1

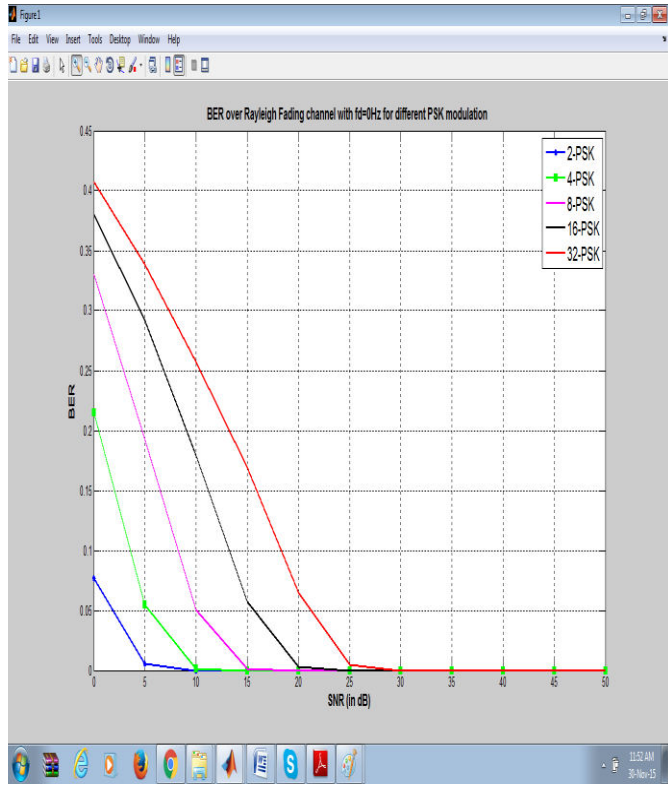

Fig 7: Extension 2

VI.CONCLUSION

Thus ICI results due to time selective fading when the channel is time varying. An OFDM system is robust to frequency selective fading but it is sensitive towards time selective fading, which can compromise the orthogonality of sub-carriers. In order to maintain orthogonality the ICI must be compensated by making frequency correction, estimating the frequency offset as well as ensuring that OFDM symbol duration is considerably less than Coherence Time.

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