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Performance of OFDM system for AWGN, Rayleigh and Rician Channel

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ABSTRACT: In recently Orthogonal frequency division multiplexing is utilized for high data transmission in wireless standard such as DVB, DAB, LTE, wireless LAN etc. OFDM system utilized the spectrum with its Orthogonality and in order to reduce interference. OFDM has ability to providing much higher spectral efficiency because multiple subcarrier are orthogonal one another. The drawback of OFDM system that is sensitive to the carrier frequency offset or time variation due to Doppler shift and introduced inter carrier interference. In this paper simulation of OFDM system by using quadrature amplitude modulation (QAM) technique in term of BER over AWGN, Rayleigh channel and Rician channel with Doppler shift

KEYWORDS: OFDM, AWGN channel, Rician channel, Rayleigh channel, QAM.

I. INTRODUCTION

In wireless communication multicarrier transmission has become an attractive technique that utilized for high data rate transmission. OFDM one of them used for high rate transmission. OFDM system also utilized for modulation and multiplexing. It has ability to mitigate the problem by converting frequency selective channel into several number of flat fading channel when signal is splitting by high rate serial stream to the several lower rate parallel stream and that are send over a multiple subcarrier. OFDM system offer several advantages such as high spectral efficiency, immunity to ISI. However the disadvantages of OFDM is that it is sensitive to the carrier frequency offset or due to Doppler shift which orthogonality between subcarrier is destroyed and occur inter carrier interference which is degrades the system performance [1]. In OFDM system subcarrier are allow to overlapped and it has achieve high spectral efficiency as shown in fig1 since all carrier are orthogonal one another and reducing ICI. orthogonality introduced when integral of product of the two signal is zero in given time interval [2].

$$\int_0^T \cos(2\pi m f_0 t)\cos(2\pi n f_0 t)dt = 0, \qquad (1)$$

This paper organized following section such as II. General block diagram of OFDM system. Section III include different types of channel. Section IV present Doppler shift. Section V present conclusion

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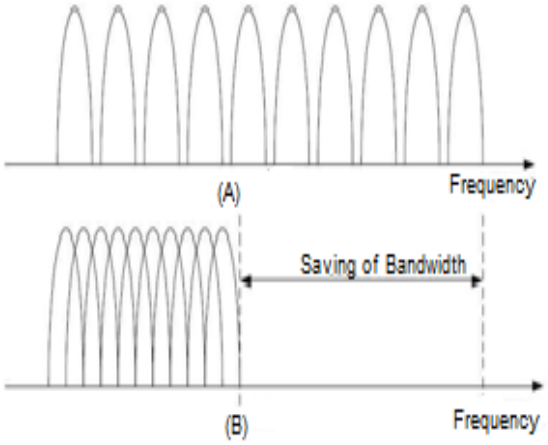

Fig1. Multiplexing techniques (A) Frequency division multiplexing technique (FDM) (B) Orthogonal Frequency Division multiplexing Technique (OFDM).

II. PROPOSED SYSTEM

Fig. 2 represented block diagram of an OFDM system. The bit sequence is enter in modulation block and this sequence is mapped by using QAM modulator and output of this block is complex symbol. This symbol in parallel form by using serial to parallel block. Then pilot inserted is used in order to reduced interference and BER [6]. After pilot insertion IFFT block used for symbol mapping. IFFT block convert frequency domain into time domain signal [3]. Output of IFFT is

$$x(n) = \frac{1}{N}\sum_{m=0}^{N-1} X_m \, e^{2j\pi mn/N}, \quad 0 < n < N-1 \qquad (2)$$

Then cyclic prefix used as guard interval in order to eliminate inter symbol interference by copying last samples of in front of it [2]. Parallel symbol in serial form by using parallel to serial block and then transmitted on channel.

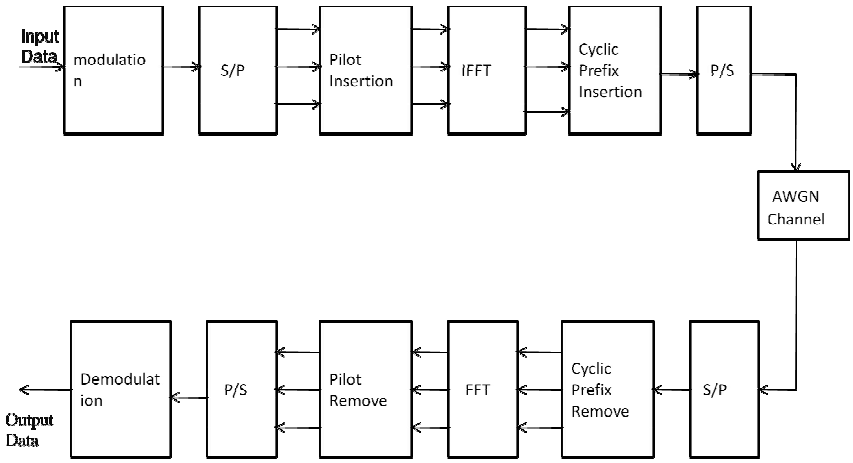

Fig2. Block diagram of OFDM system

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In receiver side opposite operation are performed. The data back to parallel form and the cyclic prefix is removed. The FFT block use performed opposite operation of IFFT. After FFT block pilot symbol is removed and parallel data back to serial form and then demodulated to obtained original form.

III. TYPES OF CHANNELS

OFDM system performs under different type of channel such as AWGN, Rayleigh channel and Rician channel [4].

a. AWGN Channel

AWGN is an adaptive white Gaussian noise (AWGN) channel it is a ratio of signal power to the noise power and energy per bit to per symbol, Capacity of this channel is given as

$$C = \frac{1}{2}\log\left(1 + \frac{p}{n}\right) \qquad (3)$$

Where C is a channel capacity

In AWGN channel signal passed through the channel its added white Gaussian noise. AWGN channel cannot operate either multipath fading or any system parameter [4]. Received signal expressed as

$$R(t) = S(t) + N(t) \qquad (4)$$

Where, S(t) denoted as transmitted signal and
N(t) denoted as background noise.

b. Rayleigh Fading

It is a statistical model that include multiple objects in the environment are scatter the transmit radio signal before its arriving at receiver. In Rayleigh channel in which signal arrived at receiver by using main and reflected signal. This signal in environment get reflected from different object include building, tree, vehicle etc and create problem when added envelope of separate signal [5]. In Rayleigh fading channel there is no LOS propagation path between transmitter and receiver. It is a suitable model for troposphere and ionosphere.

c. Rician Fading

Rician fading channel is a non deterministic channel. In Rician fading channel include dominant component. This dominant component also called as stationary signal. Rician fading channel transmitted signal arrive at receiver include one of the line of sight propagation path. This signal arrived at receiver side by using different path and one of the paths is changes.

IV. DOPPLER SHIFT

Doppler shift introduced when difference between frequency of transmitted signal and received signal, that is frequency of transmitter and receiver signal are changes called as Doppler shift[5]. Frequency increases distance between an observer and source decreases and Frequency decreases distance between an observer and source increases it is also called as Doppler shift. If positive Doppler shift occur then source move toward the direction of wave and Doppler shift is a negative then source move away from direction of wave. Doppler shift occur when orthogonality between subcarrier is destroyed. Frequency of Doppler shift can be represent as

$$fd = \frac{2\pi}{V}\|v\|\cos(\theta(t)) \qquad (5)$$

V is a constant velocity.

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V. SIMULATION RESULTS

OFDM system parameter are used for simulation in table1. Simulation is carried out signal to noise ratio for each value of bit error rate is calculated for AWGN, Rayleigh fading channel and Rician Fading channel. Simulation of OFDM system by using 16-QAM is carried out in term of BER .

Table 1. Simulation Parameters of OFDM system

Parameter	Value
total number of subcarriers	52
FFT size	64
Doppler shift	10, 40Hz
Type of channels	AWGN, Rician and Rayleigh channel

From Fig3. we can observed that the AWGN channel is provide better BER performance than Rayleigh fading channel and Rician fading channel . BER is higher in Rayleigh fading channel.

Fig4. represent BER Vs Eb/No for Rayleigh channel with Doppler shift 10 and 40 Hz . Increase in Doppler shift BER with increases. BER is higher for Rayleigh channel when Doppler shift 40 Hz

From Fig5. We can observed that performance of Rician channel with Doppler shift 10 and 40 Hz . BER is higher for Doppler shift 40Hz than Doppler shift 10Hz in Rician fading channel.

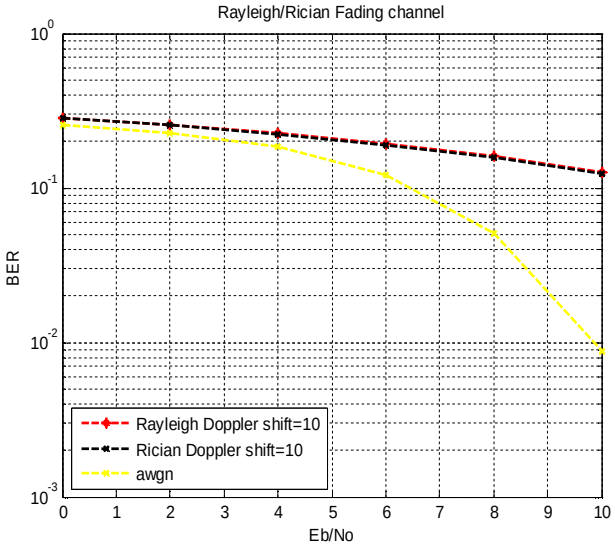

Fig3. BER Vs Eb/No for different channel.

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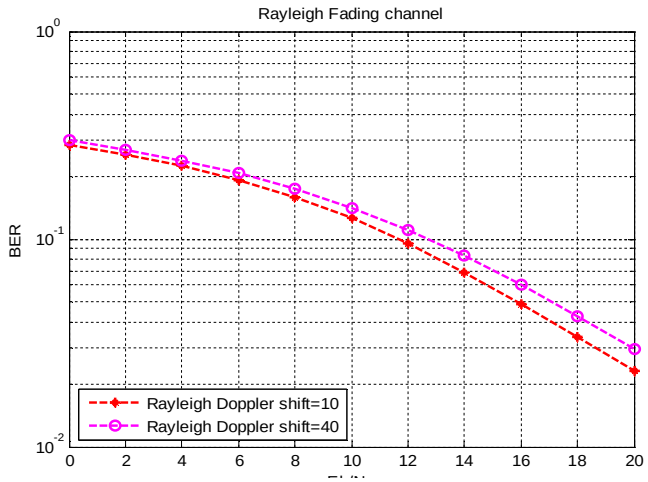

Fig4. BER Vs Eb/No for Rayleigh channel

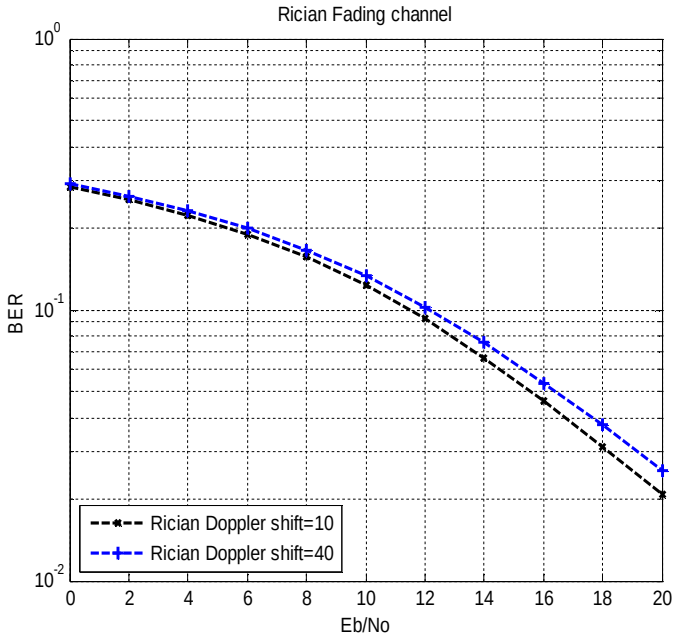

Fig5. BER Vs Eb/No for Rician channel

VI. CONCLUSION

In this paper, simulation of OFDM system under different channel in term of BER. From result we conclude that the BER performance is better in AWGN channel as compare to Rayleigh fading and Rician fading channel. From result we can also observed BER performance is better in Rayleigh and Rician fading channel when Doppler shift is 10Hz.

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BIOGRAPHY

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