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A Comparative Study between Multipath Fading Channels

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***Abstract* - There are various kinds of channel used in wireless communication. This Paper shows a performance analysis on the basis of different fading channels. This is the comparative analysis with different kinds of modulation techniques. communication. The effects of noise on fading and property of the channel were tested. Here we have also measured the Bit Error Rate with respect to different modulation techniques and compare the rate in different channels. The results show that the BER performance is improved dramatically in low SNR than in high SNR. This is reasonable since at low SNR, white Gaussian noise dominate the BER which can be improved by enhancing SNR while in high SNR, phase estimation error dominate the BER error which cannot be improved by simply enhancing SNR. Next we have tested, analyzed and compared the performance of the channels. The more accurate model is Rayleigh model which can be considered for developing multipath fading channel model.**

***IndexTerms* - Fading channels, Rayleigh fading, AWGN Channel, Rician channel, BER, SNR.**

I. INTRODUCTION

The growing demands for voice and multimedia services on mobile wireless communication spur the advancement of the wireless communication field in the recent decade. One of the major underlying technologies is the digital modulation technique which allows digitized data to be carried or transmitted via the analog radio frequency (RF) channels. Digital modulation techniques contribute to the evolution of our mobile wireless communications by increasing the speed, capacity, performance as well as the quality of the wireless network. This paper concentrates on BPSK modulation technique. Digital modulation schemes have greater capacity to convey large amounts of information than analog modulation schemes. The modulation techniques here consider are Binary phase shift keying (BPSK)[7] due to its simplicity. Channel is the most important issue for any kind of communication system. There are various kinds of channel – Additive white gaussain noise channel, Rayleigh Fading channel, Rician Fading channel [5]. The term Rayleigh fading channel refers to a multiplicative distortion h(t) of the transmitted signal s(t), as in y(t) = h(t)·s(t)+ n(t), where y(t) is the received waveform and n(t) is the noise[1]. Zhifeng Chen has build up a wireless communication simulator including Gray coding modulation, different channel models (AWGN, flat fading and frequency selective fading channels), channel estimation, adaptive equalization, and demodulation [2]. He has tested the effect of different channel models to the data and image in receiver with constellation and BER (bit error rate) plots under QPSK modulation. Chengshan Xiao, Yahong Rosa Zheng, and Norman C. Beaulieu were analyzed the statistical properties of Clarke's fading model with a finite number of sinusoids and an improved reference model is proposed for the simulation of Rayleigh fading channels [3]. Yahong Rosa Zheng and Chengshan Xiao proposed new sum-of-sinusoids statistical simulation models are proposed for Rayleigh fading channels [4].

We have proposed multipath fading channel in which the effect of a propagation environment on a radio signal such as signal strength variations, phase shift variations in the signal and additive noise has been considered. Rayleigh is the well known statistical distribution for amplitude modeling of radio signal in fading environment. Any kind of received signal with Rayleigh distribution instantaneous power follows the exponential distribution property. The probability distribution function of power is given as

$$P(\lambda) = \left(\frac{1}{\lambda_0}\right)e^{(-\lambda/\lambda_0)}$$

Where,

$$\lambda_0 = E[\lambda]\int_0^{\lambda} \lambda\, P(\lambda)\, d\lambda = 2\sigma^2$$

Where E[λ] is the average value and $2\sigma^2$ is the mean square value.

AWGN is the simplest model of a channel. This kind of model is well suited for wired communication. Generally this model is used to take place with well-mannered mathematical models of communication system functionality without fading and distortions. The fading channel output received signal is given by,

$$r(t) = c(t)\, s(t) + n(t)$$

Where, n (t) is the AWGN with the power spectral density η in both real and imaginary Components. c (t) is the zero mean complex gain of the channel and s (t) is the transmitted signal [4]. c (t) can be formulated as,

$$c(t) = \exp(jw_0 t) m(t)$$

Where, m (t) is the complex Gaussian fading process with variance σm^2.We have tested, analyzed and compared the BER performance of Rayleigh channel model, AWGN Channel Model and Rician channel models and it has been observed that more accurate model is Rayleigh channel model because its BER curves have steepness and values more closely to theoretical analysis.

II. MODULATION TECHNIQUE

Binary Phase Shift Keying (BPSK)

BPSK is the simplest form of phase shift keying (PSK). In binary phase shift keying (BPSK) the transmitted signal is a sinusoid of fixed amplitude. It uses two phases which are separated by 180° and so can also be termed 2-PSK **[8].** Binary Phase Shift Keying (BPSK) modulation is the simplest and most robust of all techniques, the signal shifts the phase of the waveform to one of the two states, either zero or π. It is only able to transmit 1 bit/symbol in this case and so this is considered to be a disadvantage when using high data-rate systems with limited bandwidth.

For transmission of “1”:

$$S_1(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_0 t)$$

For Transmission of “0”:

$$S_2(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_0 t + \pi)$$

In another way, it can be understood as a binary level digital modulation scheme of phase variation that has two theoretical phase angles, +90° and -90°. It is immune to noise and interference therefore it improves BER performance. Each modulation symbol represents a single phase.

Quadrature Phase Shift Keying (QPSK)

QPSK is basically a digital modulation technique where the information or the modulating signal is in the form of a binary data stream and the phase o f an sinusoidal signal known as the carrier signal is modulated according to the incoming binary symbols ‘0’ and ‘1’. In QPSK two successive bits are combined reducing the bit rate or signaling rate and also bandwidth of the channel which is a main resource of communication system. Combination of two bits creates distinct symbols..The phase of the carrier signal is shifted by 45° (π/4 radians), when a symbol makes a change to the next symbol.

III. PERFORMANCE PARAMETERS OF CHANNEL

a) Bit Error Rate (BER):-

BER is the probability of bit error in information stream. To achieve a good BER to reduce the bit errors as much as possible, signal-to-noise ratio (SNR) should be high. BER can be reduced by increasing the Eb/No value, which can be achieved either by increasing the bandwidth or by decreasing the data rate. Probability that bit are received in error is bit error rate. The bit error rate or bit error ratio (BER) is the number of bit errors divided by the total number of transferred bits during a time interval.

b) Signal-to-Noise (SNR):

SNR is defined as the ratio between signal power to noise power and it is normally expressed in decibel (dB). The mathematical expression of SNR is given by

$$\mathrm{SNR} = 10\mathrm{LOG}\frac{\text{Signal power}}{\text{Noise Power}}\mathrm{dB}$$

c) Eb/No :-

To improve the reliability of data transmission, the designer will have to increase the signal power or to maximize the value of the ratio Eb/No. The mathematical expression of energy per bit is $E_b = P_s.T_b$, where

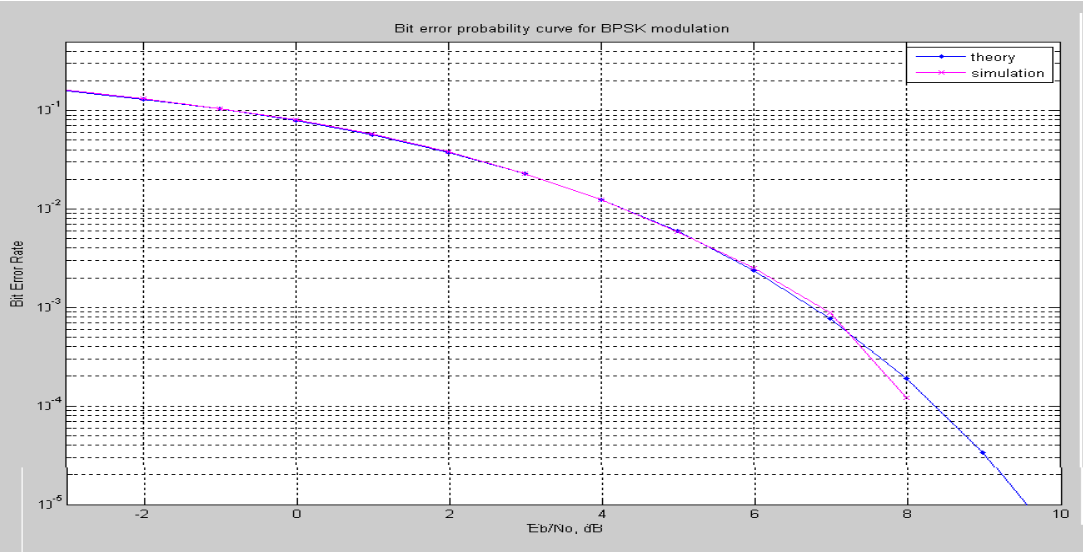
Ps = average signal power, T_b = bit duration.

IV. PERFORMANCE ANALYSIS

When multipath fading occurs, the BER will increase for a given channel SNR. The techniques such as diversity, equalization, data interleaving are used to combat multipath fading.

a)AWGN Channel

AWGN channel is very straightforward we have to just add a white Gaussian noise into signal to meet specified SNR. The analysis of the performance on the basis of BER and SNR is shown in “Fig.1” The AWGN channel is a good model for many satellite communication. It is not a good model for most terrestrial links because of multipath, terrain blocking, interference, etc. However, for terrestrial path modeling, AWGN is commonly used to simulate background noise of the channel under study, in addition to multipath, terrain blocking, interference, ground clutter and self interference that modern radio systems encounter in terrestrial operation.[9]



"Fig.1: BER FOR BPSK IN AWGN CHANNEL"

b)Rayleigh Fading

The Rayleigh fading channel refers to a multiplicative distortion h(t) of the transmitted signal s (t) and noise as y(t)=h(t){s(t)+n(t)},where y(t)is the received waveform and n (t) is the noise. Rayleigh fading is the specialized model for stochastic fading when there is no line-of-sight propagated signal and is sometimes considered as a special case of the more generalized concept of racian fading. In Rayleigh fading the amplitude gain is characterized by a distribution. The analysis of the performance on the basis of BER and SNR is shown in the "Fig.2"

c)Rician Fading

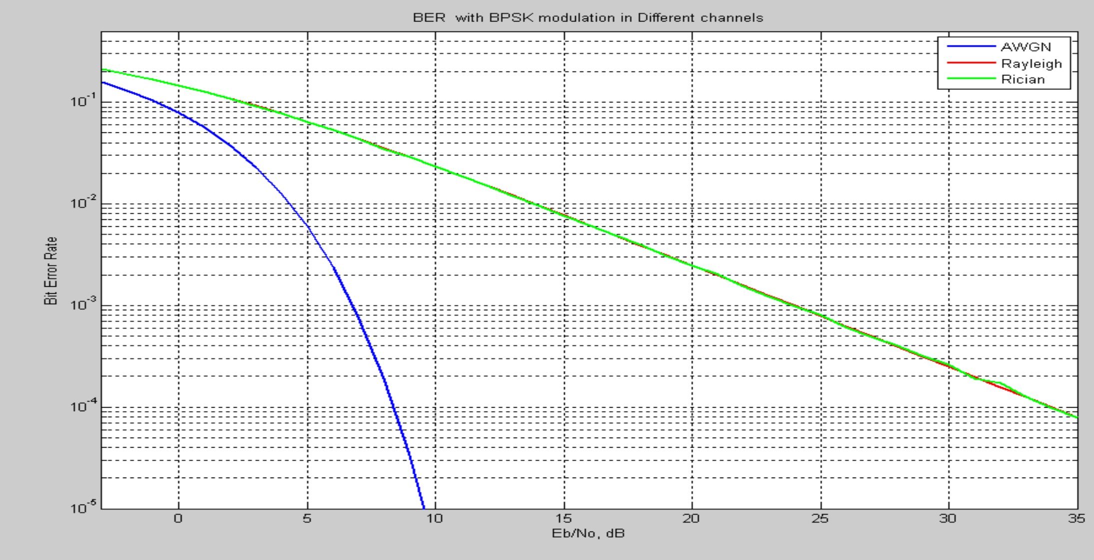
In environments where there is a dominant Line-of-Sight (LOS) path between the transmitter an d the receiver, the complex Gaussian distributed fading coefficient should be modeled with a non-zero mean, giving rise to the Rician fading. Or also say that, Rayleigh fading with strong line of sight (LOS) content is said to have a Rician distribution, or to be Rician fading [10] Rician fading is a stochastic model for radio propagation. It is considered that the signal arrives at the receiver through two different paths, and at least one of the paths is changing (lengthening or shortening). Rician fading occurs when one of the paths is a line-of-sight and signal is much stronger than the others. In Rician fading, the amplitude gain is characterized by a Rician distribution. We have considered the following discrete-time memoryless Rician fading channel model,

$$y_i = mx_i + a_i x_i + n_i$$

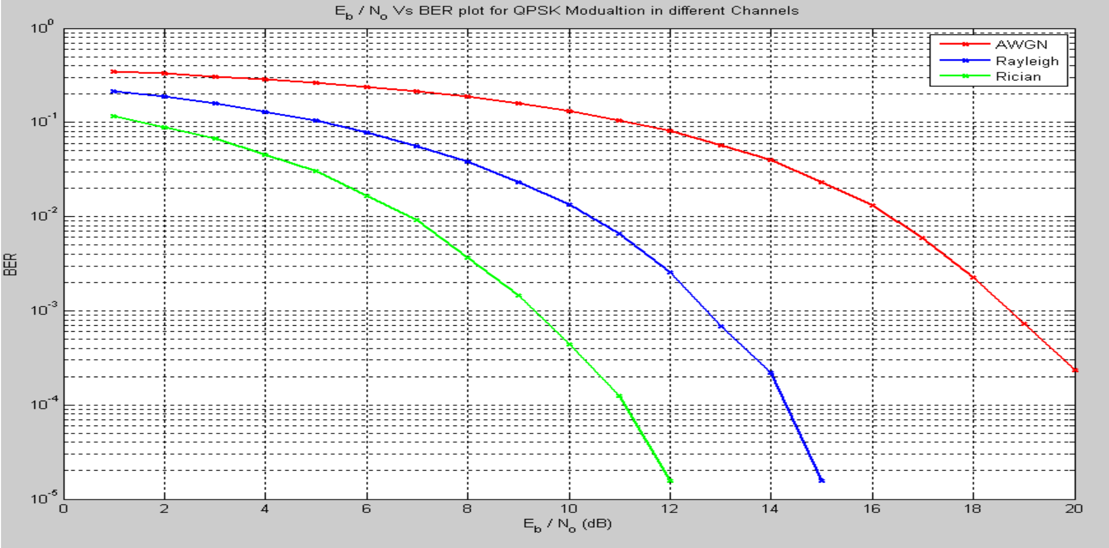
Where, a_i and n_i are circular zero mean complex Gaussian random variables, independent of each other. The rician fading channel model is particularly appropriate for direct propagating line of sight component in addition to the faded component arising from multipath propagation.

V.Simulation Results:

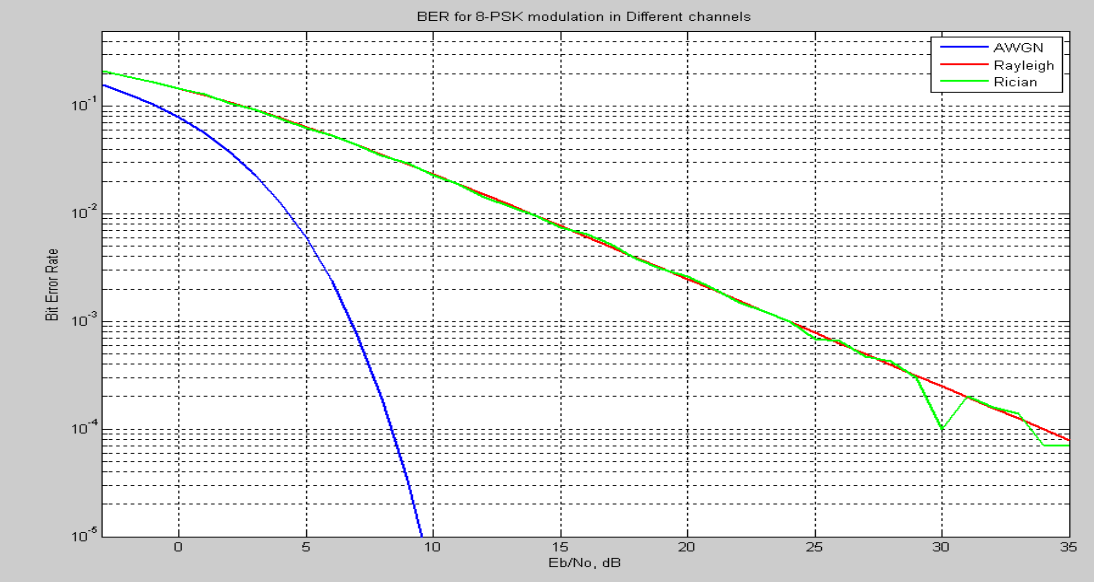
In this paper comparative study of bit error rate (BER) & SNR (signal to noise ratio) in different PSK techniques under AWGN, Rayleigh & Racian Fading channel has been presented. The BER performance with BPSK modulation in different channels is shown in figure 2. For constant BER the value of SNR for both Rayleigh & racian channel is approximately same but in AWGN channel it decreases. Similarly the performance evaluations of QPSK, 8-PSK, 16 –PSK & 64 –PSK are also given in figure 3, 4, 5& 6 respectively.



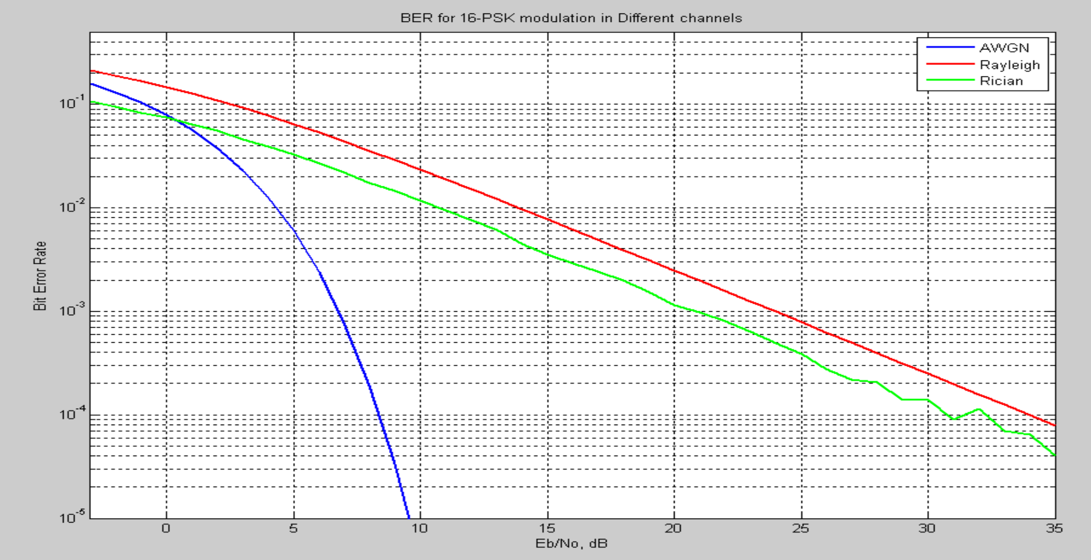
"Fig.2: BER WITH BPSK MODULATION IN DIFFERENT CHANNELS"



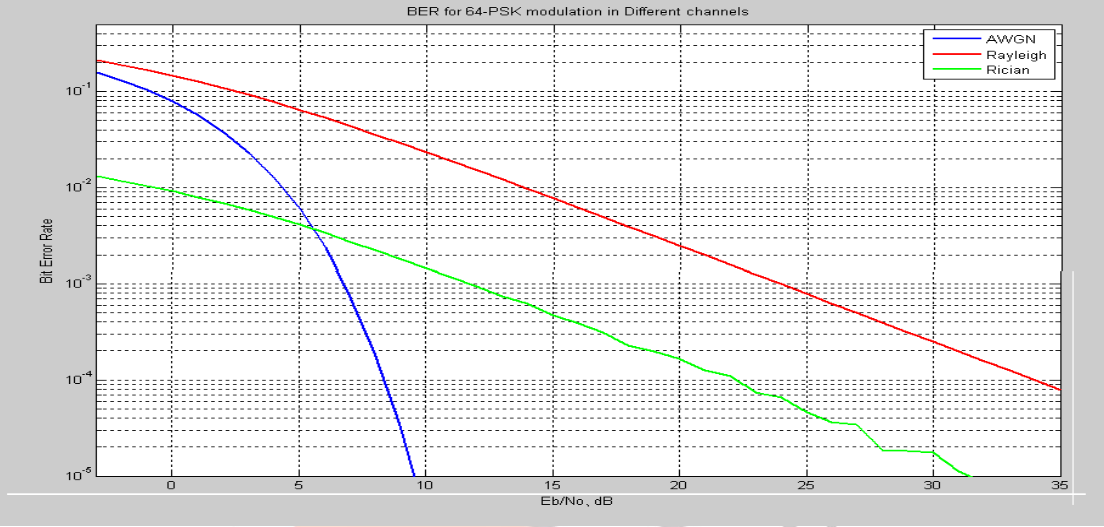
"Fig.3: BER WITH QPSK MODULATION IN DIFFERENT CHANNELS"



"Fig.4: BER WITH 8-PSK MODULATION IN DIFFERENT CHANNELS"



"Fig.5: BER WITH 16-PSK MODULATION IN DIFFERENT CHANNELS"



"Fig.6: BER WITH 64-PSK MODULATION IN DIFFERENT CHANNELS"

V. CONCLUSION

In this paper, multipath fading channel model has been simulated. In BER Vs SNR plot, we have used BPSK modulation to test the effect of different channels to the received signal. It is possible to more modulation techniques in our model, such as QAM with different modulation orders. We have also compared and analyzed the improvement of Rayleigh channel with AWGN channel and Rician channel considering effect of BER and SNR on their performance in fading. The conclusion is that more accurate model is Rayleigh channel model because its BER curves have steepness and values more closely to theoretical analysis. It will be of great interest for many workers to implement more functionality support for channel fading.

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