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BER Performance of OFDM System over AWGN channel with Different Modulation Schemes

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Abstract— **In this paper, we investigate the bit error rate (BER) performance of Orthogonal frequency division multiplexing (OFDM)-Binary phase shift keying (BPSK) OFDM-Quadrature phase shift keying (QPSK), OFDM-Quadrature amplitude shift keying (QAM) over AWGN channel. The performance of transmission modes are evaluated by calculating the BER versus signal to noise ratio (SNR) under the Additive white Gaussian noise(AWGN), channel.**

Index Terms— **BER,BPSK,OFDM,AWGN,QAM.**

I. INTRODUCTION

It is important to evaluate the performance of wireless devices by considering the transmission characteristics, wireless channel parameters and device structure. The performance of data transmission over wireless channels is well captured by observing their BER, which is a function of SNR at the receiver. In wireless channels, several models have been proposed and investigated to calculate SNR. All the models are a function of the distance between the sender and the receiver, the path loss exponent and the channel gain. Several probability distributed functions are available to model a time-variant parameter i.e. channel gain. We describe the three important and frequently used distributions. Those are AWGN, Rayleigh, Rician, models. It is increasingly believed that OFDM results in an improved downlink multimedia services requires high data rates communications, but this condition is significantly limited by inter-symbol interference (ISI) due to the existence of the multiple paths. Multicarrier modulation techniques, including OFDM modulation are considered as the most promising technique to combat this problem .OFDM technique is a multi-carrier transmission technique which is being recognized as an excellent method for high speed bi-directional wireless data communication.

II. OFDM SYSTEM

Orthogonal frequency division multiplexing (OFDM) is a communications technique that divides a communications channel into a number of equally spaced frequency bands. A subcarrier carrying a portion of the user information is transmitted in each band. Each subcarrier is orthogonal (independent of each other) with every other subcarrier; differentiating OFDM from the commonly used frequency division multiplexing (FDM).FDM is a technology that transmits multiple signals simultaneously over a single transmission path, Such as a cable or wireless system. Each signal travels within its own unique frequency range (carrier), which is modulated by the data (text, voice, video, etc.).Orthogonal FDM's (OFDM) spread spectrum technique distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the orthogonallity in this technique which prevents the demodulators from seeing frequencies other than their own

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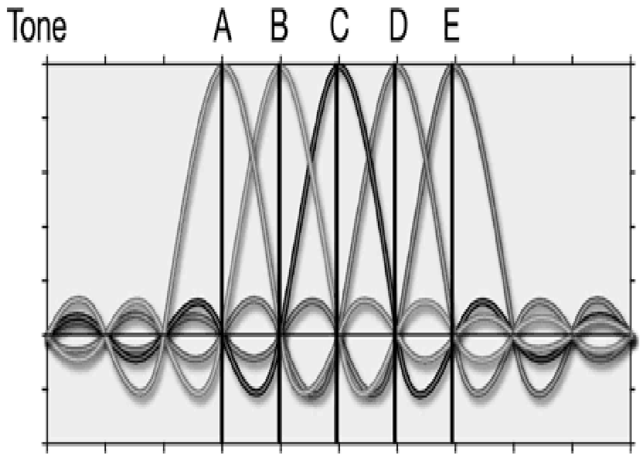

Fig 1 OFDM Tones shows Orthogonility

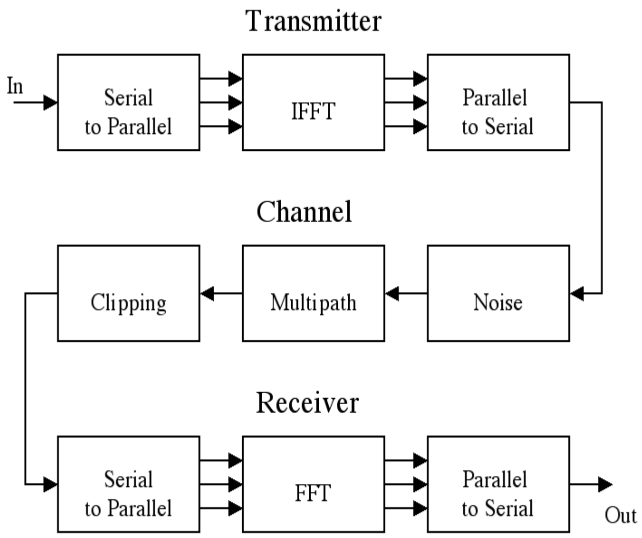

Fig 2 OFDM Transmitter and Receiver

III. AWGN CHANNEL

High data rate communication over additive white Gaussian noise channel (AWGN) is limited by noise .The received signal in the interval $0 \leq t \leq T$ may be expressed as

$$r(t) = s_m(t) + n(t)$$

Where n(t) denotes the sample function of additive white Gaussian noise (AWGN) process with power- spectral density

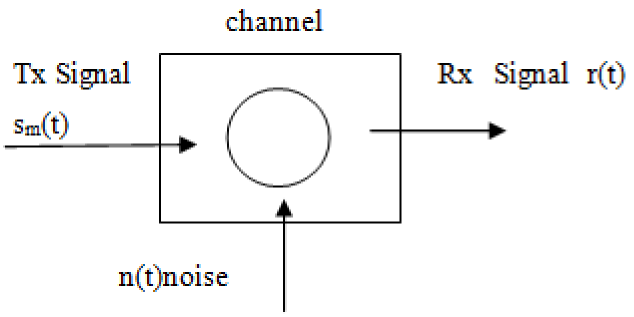

Fig 3 Model for received signal passed through AWGN channel

IV. DIGITAL MODULATION

A. *Binary Phase Shift Keying (BPSK)*

PSK uses a finite number of phases; each assigned a unique pattern of binary digits. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase. BPSK is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK. It does not particularly matter exactly where the constellation points are positioned, and in this figure they are shown on the real axis, at 0° and 180°.

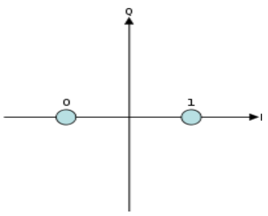

Fig 4 Constellations for BPSK

B. *Quadrature Phase Shift Keying (QPSK)*

QPSK uses four points on the constellation diagram, equispaced around a circle. With four phases, QPSK can encode two bits per symbol, shown in the diagram with gray coding to minimize the bit error rate (BER) — sometimes misperceived as twice the BER of BPSK. The mathematical analysis shows that QPSK can be used either to double the data rate compared with a BPSK system while maintaining the *same* bandwidth of the signal, or to *maintain the data-rate of BPSK* but halving the bandwidth needed. In this latter case, the BER of QPSK is *exactly the same* as the BER of BPSK - and deciding differently is a common confusion when considering or describing QPSK.

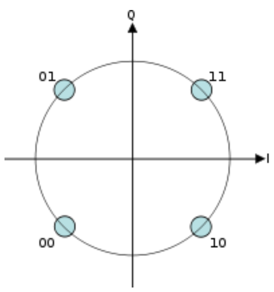

Fig 5 Constellations for QPSK

C. *Quadrature amplitude modulation(QAM)*

QAM is the encoding of the information into a carrier wave by variation of the amplitude of both the carrier wave and a —quadrature carrier that is 90^0 out of phase with the main carrier in accordance with two input signals. That is, the amplitude and the phase of the carrier wave are simultaneously changed according to the information you want to transmit. In 16-in 16-state Quadrature Amplitude Modulation (16-QAM), there are four I values and four Q values.The symbol rate is one fourth of the bit rate. So this modulation format produces a more spectrally efficient transmission. It is more efficient than BPSK, QPSK.

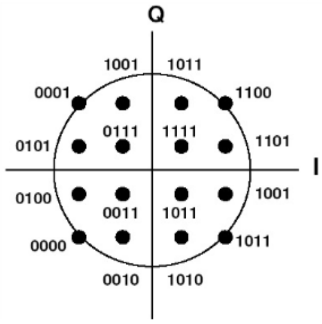

Fig 6 Constellations for QAM

5. BER and SNR

a) *Bit error rate (BER)*

The BER, or quality of the digital link, is calculated from the number of bits received in error divided by the number of bits transmitted.

BER= (Bits in Error) / (Total bits received).

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. The BER is the number of bit errors divided by the total number of transferred bits during a particular time interval. BER is a unit less performance measure, often expressed as a percentage. IEEE 802.11 standard has ability to sense the bit error rate (BER) of its link and implemented modulation to data rate and exchange to Forward Error Correction (FEC), which is used to set the BER as low error rate for data applications. Noise affects the BER performance. Quantization errors also reduce BER performance, through incorrect or ambiguous reconstruction of the digital waveform. The accuracy of the analog modulation process and the effects of the filtering on Signal and noise bandwidth also effect quantization errors.

b) *Signal to Noise Ratio*

SNR is the ratio of the received signal strength over the noise strength in the frequency range of the operation. Noise strength, in general, can include the noise in the environment and other unwanted signals (interference). BER is inversely related to SNR, that is high BER causes low SNR. High BER causes increases packet loss, increase in delay and decreases throughput. The exact relation between the SNR and the BER is not easy to determine in the multi-channel environment. Signal to noise ratio (SNR) is an indicator commonly used to evaluate the quality of a communication link.

SNR = 10 log10 (Signal Power / Noise Power) dB

V. Results and Analysis

We have to develop the structure for Simulating OFDM system. The performance evaluation has been carried out with the modulation technique of BPSK, QPSK over AWGN channel.

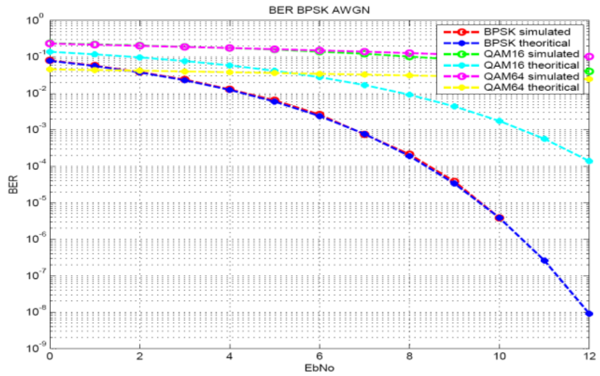

Fig 7 BER Comparison of OFDM system under AWGN channel

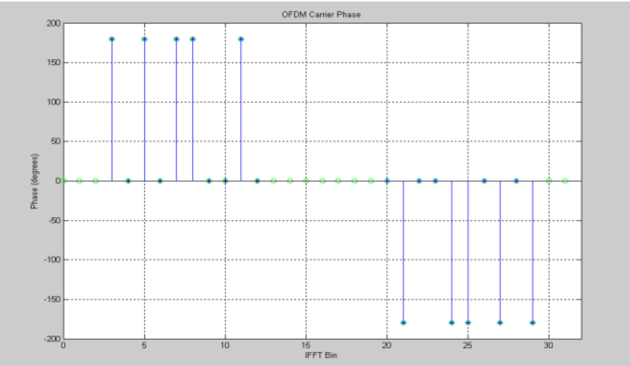

Fig 8 OFDM Carrier Phase for BPSK

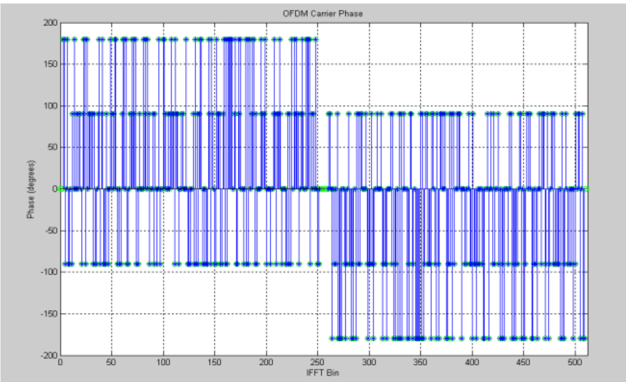

Fig 9 OFDM Carrier Phase for QPSK

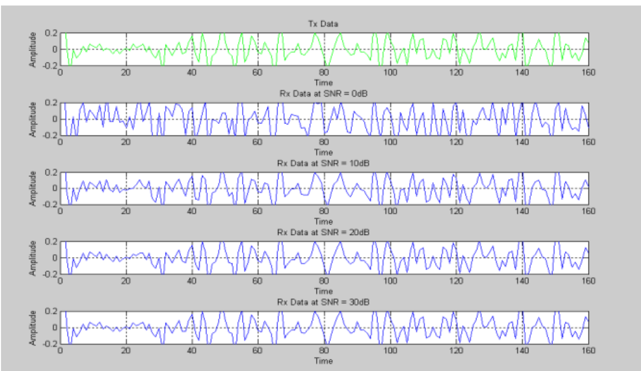

Fig 10 Transmitted and Received data at different SNR for BPSK

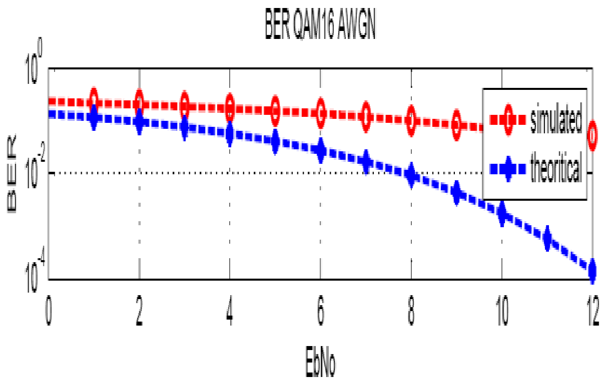

Fig 11 BER vs SNR for OFDM-16 QAM System

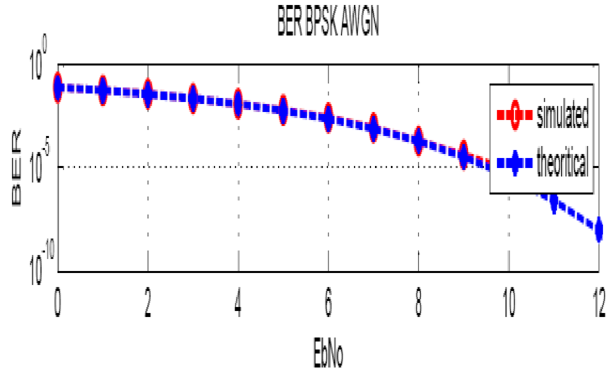

Fig 12 BER vs SNR for OFDM-BPSK System

VI. Conclusion

The presence of multipath in wireless OFDM transmission does not allow AWGN channel assumption due to fading. In this paper the performance of OFDM in AWGN wireless channel models is evaluated.. The SNR for each modulation takes into account the number of bits per symbol, and so the signal power corresponds to the energy per bit times the number of bits per symbol.

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