BER AND SIMULATION OF OFDM MODULATOR AND DEMODULATOR FOR WIRELESS BROADBAND APPLICATIONS

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ABSTRACT: **With the rapid growth of digital wireless communication in recent years, the need for high speed mobile data transmission has increased. New modulation techniques are being implemented to keep up with the desired more communication capacity. Processing power has increased to a point where OFDM has become feasible and economical. Some examples of current applications using OFDM include DVB (Digital video broadcasting), DAB (Digital audio broadcasting), and HDTV (high - definition television).OFDM as a transmission technique has been known having a lot of strengths compared to any other transmission technique, such as its high spectral efficiency, its robustness to the channel fading. Orthogonal. frequency division multiplexing (OFDM) has become very popular, allowing high speed wireless communications. Orthogonal frequency division multiplexing (OFDM) has become very popular, allowing high speed wireless communications. A basic OFDM system consists of a QAM or QPSK modulator, a serial to parallel data, and an IFFT and FFT module, Guard interval inserter, in phase and quadrature phase signal generator, and parallel to serial data. In this thesis I have implemented the OFDM modulator and demodulator by using different types of digital modulation techniques such as BPSK, QPSK, 8-QAM. BER for OFDM by using 8-QAM,16-QAM, 64-QAM . MATLAB environment was used for simulation of proposed algorithm.**

*Keywords***: OFDM, Multipath delay, FADING, ISI, BER.**

I . INTRODUCTION

One of the proposed 3rd generation telecom systems is Universal Mobile Telecommunication System (UMTS), which aims to provide a more flexible data rate, a higher capacity and more tightly integrated services than the second generation mobile. Most 3rd generation mobile phone system are using CDMA or extended TDMA by improving flexibility of service available but CDMA was found to perform poorly in single cellular system and high Inter-user interference. Several techniques, with aim of improving cell capacity, providing multipath immunity, flexibility, high tolerance to peak power clipping and channel noise and also providing a high spectral efficiency includes Orthogonal Frequency Division Multiplexing. OFDM allows many users to transmit in an allocated band by subdividing the available B.W into many carriers called tones.They arepacked much closer together than standard FDM. This leads to OFDM providing high spectral efficiency.It is robust against ISI and FADING.

II OFDM- FOR MOBILE COMMUNICATION

OFDM represents a different system-design approach. It can be thought of as a combination of modulation and multiple-access schemes that segments a communications channel in such a way that many users can share it. Whereas TDMA segments are according to time and CDMA segments are according to spreading codes, OFDM segments are according to frequency. It is a technique that divides the spectrum into a number of equally spaced tones and carries a portion of a user's information on each tone. A tone can be

thought of as a frequency, much in the same way that each key on a piano represents a unique frequency. OFDM can be viewed as a form of frequency division multiplexing (FDM), however, OFDM has an important special property that each tone is orthogonal with every other tone. FDM typically requires there to be frequency guard bands between the frequencies so that they do not interfere with each other. OFDM allows the spectrum of each tone to overlap, and because they are orthogonal, they do not interfere with each other. By allowing the tones to overlap, the overall amount of spectrum required is reduced.

OFDM is a modulation technique in that it enables user data to be modulated onto the tones by adjusting the tone's phase, amplitude or both. In the most basic form, a tone may be present or disable to indicate a 1or0 bit of information; however either PSK &QAM is typically employed. An OFDM system takes a data stream & splits it into N parallel data streams, each at rate 1/N of the original rate. Each stream is then mapped to a tone at a unique frequency combined together using the IFFT (Inverse Fast Fourier Transform) to yield the time-domain waveforms to be transmitted. Note that the peak of each tone corresponds to a zero level or null for every other tone.
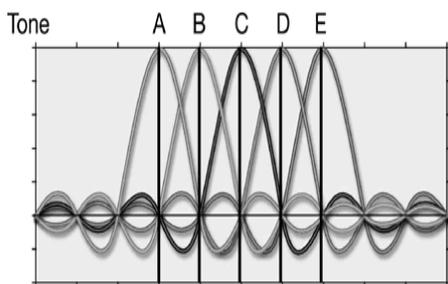

Figure 1 Tones for OFDM

Thus each user can be assigned a predetermined number of tones when they information to send, or alternatively a user can be assigned a variable number of tones based on the amount of information that they have to send. The assignments are controlled by the media access control [MAC] layer, which schedules the resource assignments based on user demand.
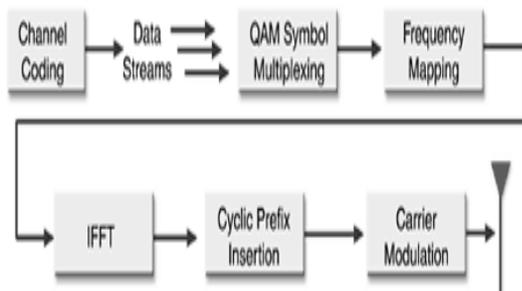

Figure 2 OFDM transmitter chain

By adding guard time, called a cyclic prefix. The channel can be made to behave as if the transmitted waveforms ensure orthogonality, which essentially prevents one subcarrier from interfering with another. The cyclic prefix is actually a copy of the last portion of data symbol appended to the front of the symbol during the guard interval as in Fig.3.
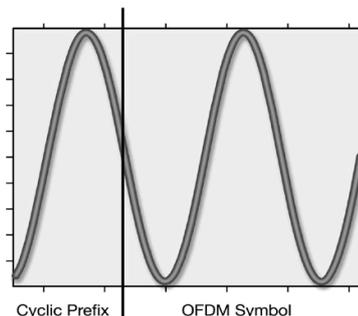

Figure 3 Cyclic Extension of Sinusoid

Multipath causes tones and delayed replicas of tones to arrive at the receiver with some delay spread. This leads to misalignment between sinusoidal which need to be aligned be orthogonal. The cyclic prefix allows the tones to be realigned at the receiver, thus regaining orthogonality.

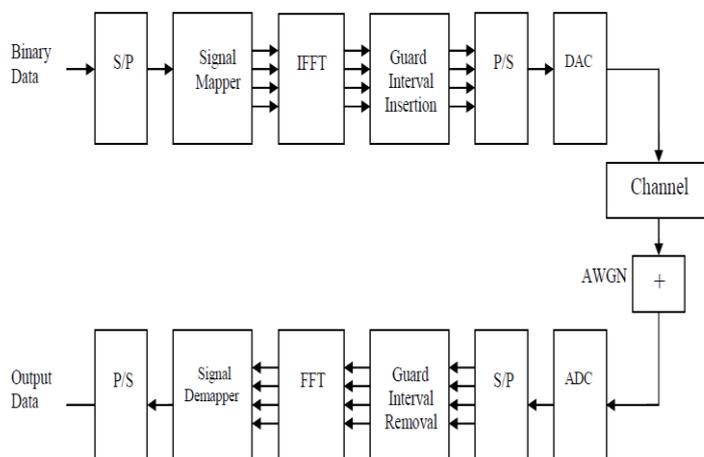## III OFDM TRANSMITTER AND RECEIVER BLOCK DIAGRAM

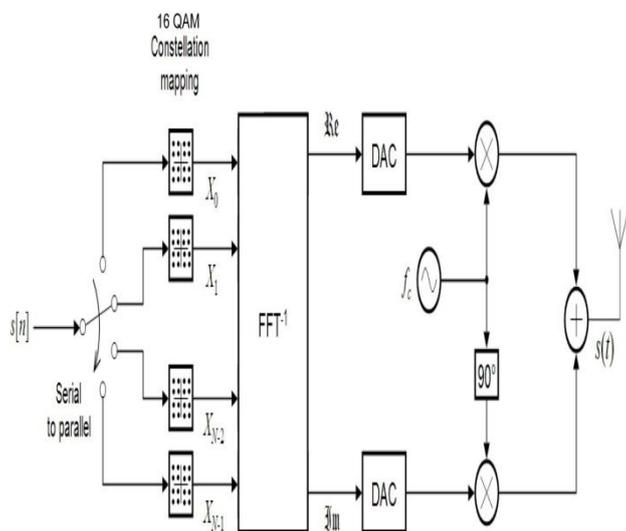*Figure 4: OFDM Tx and Rx block diagram*
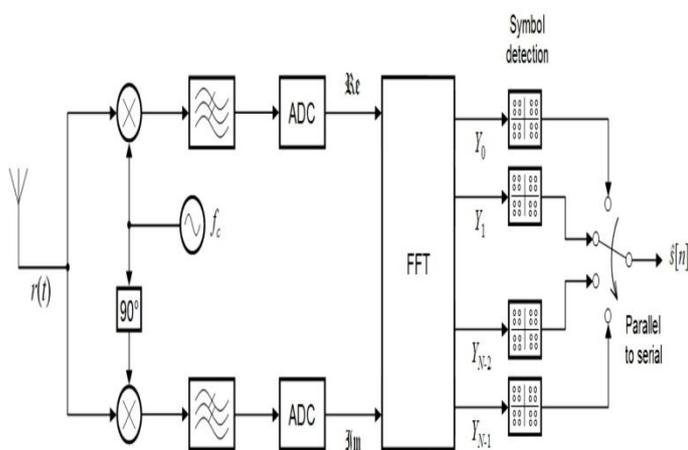
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Figure: 5(a) OFDM Transmitter

Figure: 5(b) OFDM Receiver

Figure 4 shows the block diagram of a typical OFDM transceiver. The transmitter section converts digital data to be transmitted, into a mapping of sub carrier amplitude and phase. It then transforms this spectral representation of the data into the time domain using an Inverse Discrete Fourier Transform (IDFT). The Inverse Fast Fourier Transform (IFFT) performs the same operations as an IDFT, except that it is much more computationally efficiency, and so is used in all practical systems.

In order to transmit the OFDM [4] signal the calculated time domain signal is then mixed up to the required frequency. The receiver performs the reverse operation of the transmitter, mixing the RF signal to base band for processing, then using a Fast Fourier Transform (FFT) to analyze the signal in the frequency domain. The amplitude and phase of the sub carriers is then picked out and converted back to digital data. The IFFT and the FFT are complementary function and the most appropriate term depends on whether the signal is being received or generated. In cases where the signal is independent of this distinction then the term FFT and IFFT is used interchangeably respectively.

IV OFDM Transmitter and Receiver:

4(a) Serial to Parallel Conversion Data: The input serial data stream is formatted into the word size required for transmission, e.g. 2bit/word for QPSK and 4bit/word for 16-QAM shifted into a parallel format. The data is then transmitted in parallel by assigning each data word to one carrier in the transmission as shown in above figure3.7 (a).

4(b) Modulation of Data: The data to be transmitted on each carrier is then differential encoded with previous symbols, then mapped into a phase shift-keying format. Since differential encoding requires an initial phase reference an extra symbol is added at the start for this purpose. The data on each symbol is then mapped to a phase angle based on the modulation method. For example QPSK the phase angles used are 0, 90, 180, and 270 degrees. The use of phase shift keying produces a constant amplitude signal and was chosen for its simplicity and to reduce problems with amplitude fluctuations due to fading.

4(c) Inverse Fourier Transform : After the required spectrum is worked out, an inverse Fourier transform is used to find the corresponding time waveform. The guard period is then added to the start of each symbol

4(d) Guard Period : The guard period used was made up of two sections. Half of the guard period time is a zero amplitude transmission. The other half of the guard period is a cyclic extension of the symbol to be transmitted. This was to allow for symbol timing to be easily recovered by envelope detection. However it was found that it was not required in any of the simulations as the timing could be accurately determined position of the samples. After the guard has been added, the symbols are then converted back to a serial time waveform. This is then the base band signal for the OFDM transmission.

4(e) Channel : A channel model is then applied to the transmitted signal. The model allows for the signal to noise ratio, multipath, and peak power clipping to be controlled. The signal to noise ratio is set by adding a known amount of white noise to the transmitted signal. Multipath delay spread then added by simulating the delay spread using an FIR filter. The length of the FIR filter represents the maximum delay spread,

while the coefficient amplitude represents the reflected signal magnitude.

4(f) Receiver : The receiver basically does the reverse operation to the transmitter. The guard period is removed. The FFT of each symbol is then taken to find the original transmitted spectrum. The phase angle of each transmission carrier is then evaluated and converted back to the data word by demodulating the received phase. The data words are then combined back to the same word size as the original data.

V .PERFORMANCE OF OFDM

The performance of OFDM technique can be compared using OFDM simulated results given below.

PARAMETER	VALUE
SUB CARRIERS	16
FFT SIZE	64 FFT
GUARD PERIOD	800 ns
MULTIPLE ACCESS	BPSK, QPSK, 8-QAM, 16-QAM, 64-QAM
BIT RATES	6,12,18,24,36,48,54 Mbs
CHANNEL SPACING	20MHZ

Table1.1 OFDM system parameters used for the simulation

VI : OFDM SIMULATION RESULTS

QPSK Modulation: (tx data = 64)
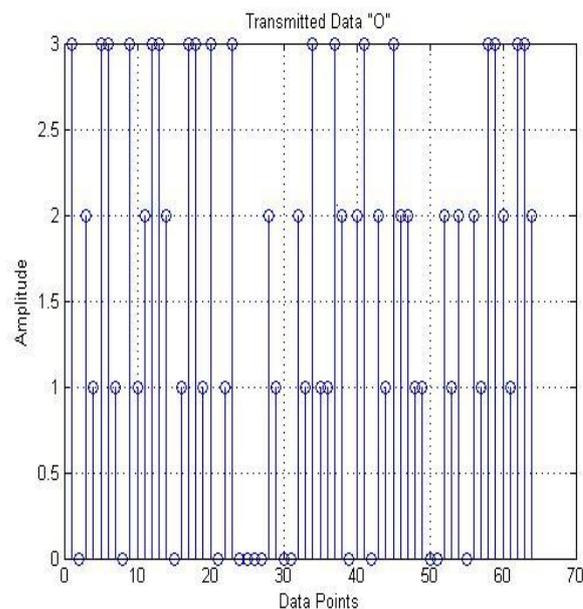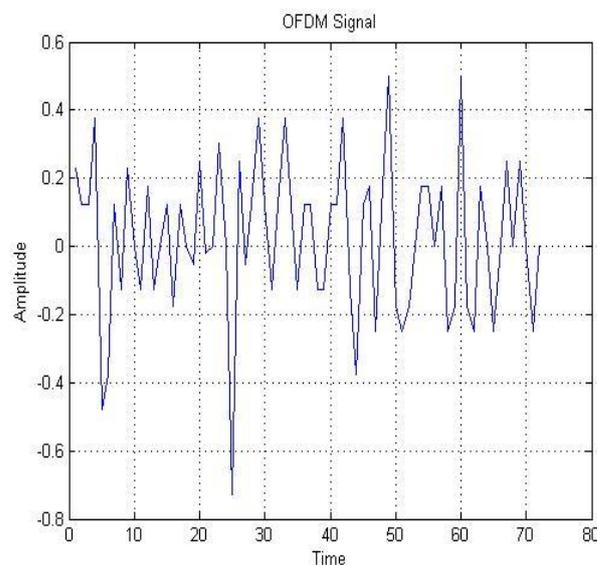

Figure 6.1(a): Transmitted signals

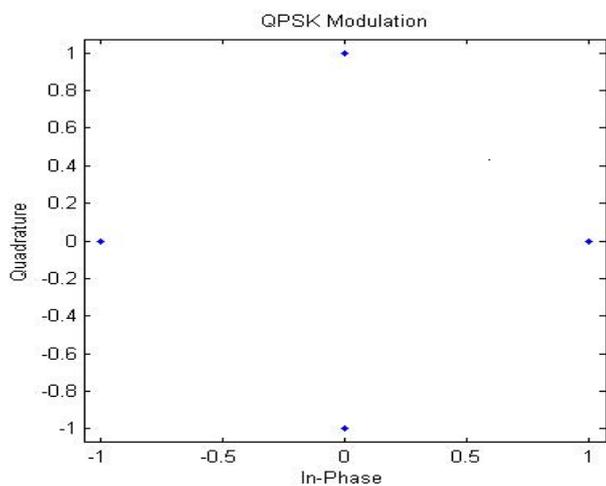*Figure 6.1(c): OFDM signal*

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Figure 6.1(b): Signal constellation diagram
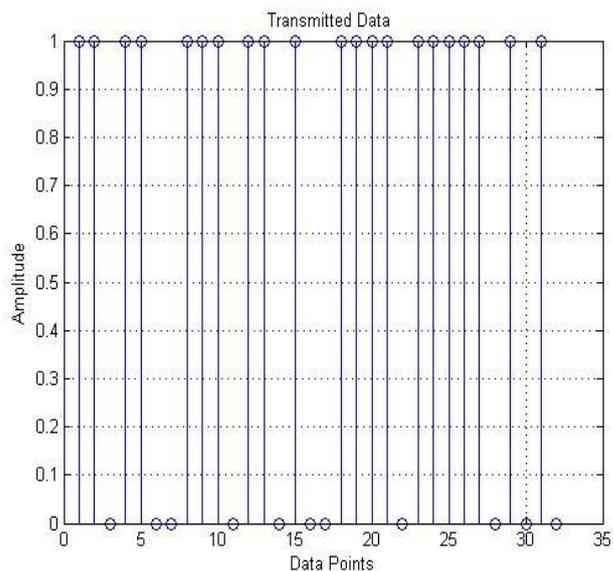
Figure 6.2(a): Transmitted signals
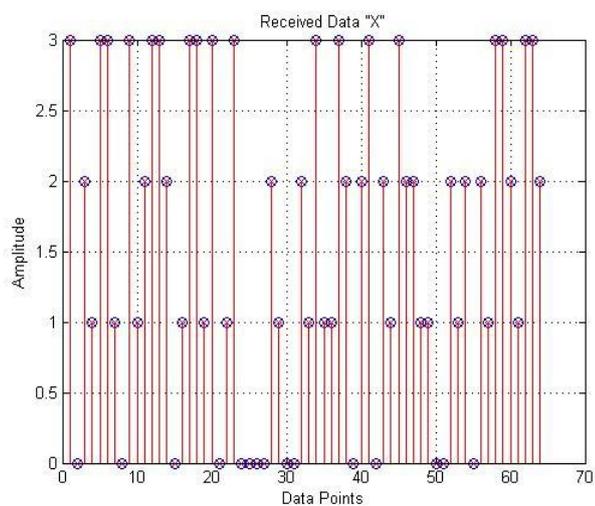
Figure 6.1(d): Received signals

BPSK Modulation*: (tx data = 32)
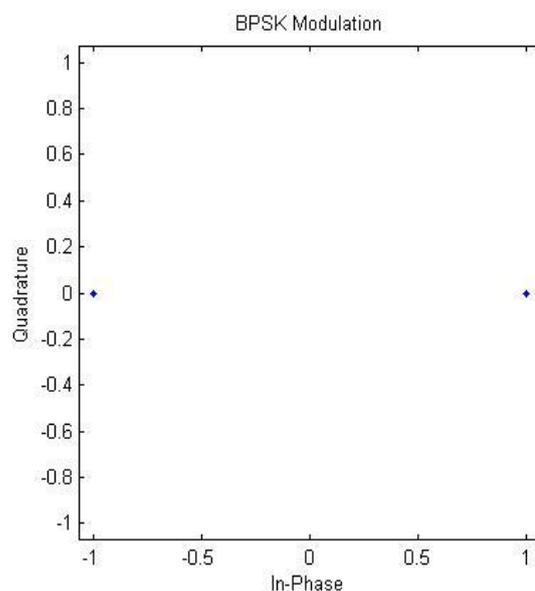
Figure 6.2(b): Signal constellation diagram
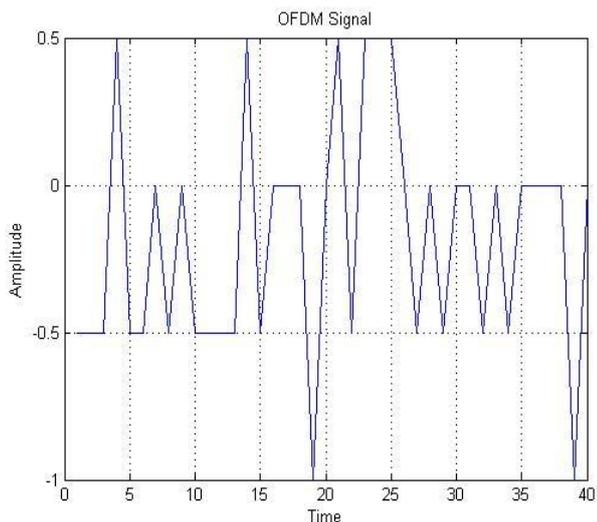
8-QAM Modulation: *(tx data = 128)*

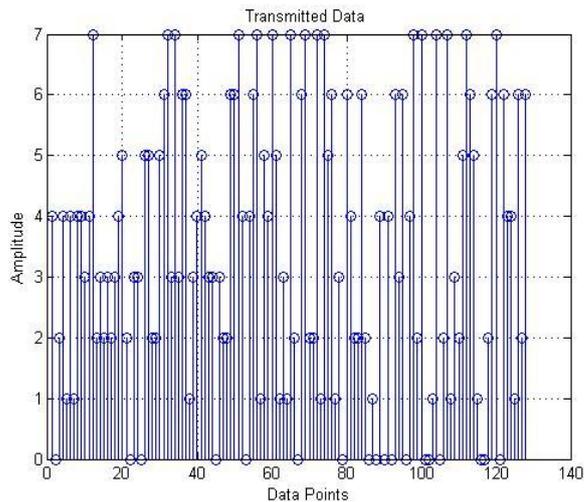*Figure 6.2(c): OFDM signal*

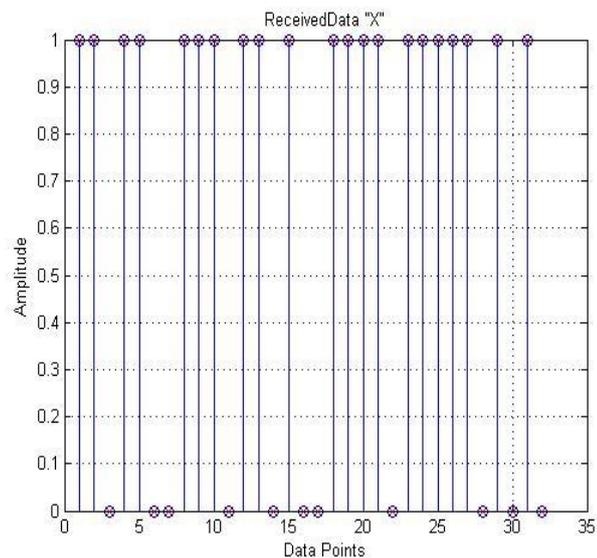*Figure 6.3(a): Transmitted signals*

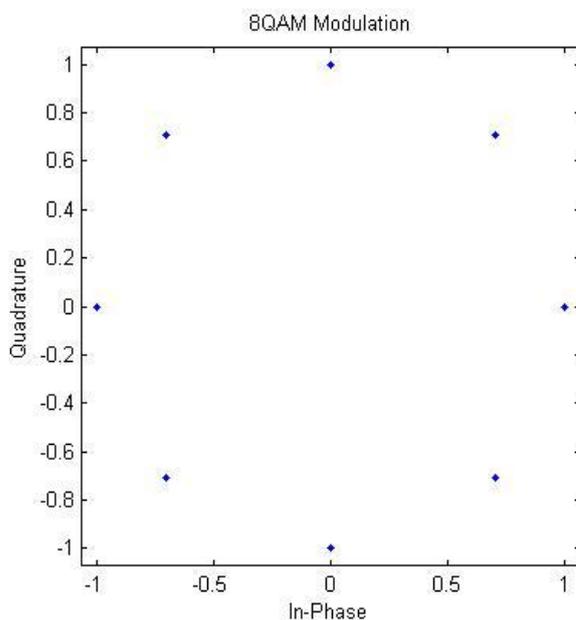*Figure 6.2(d): Received signals*

Figure 6.3(b): Signal constellation diagram

VII: COMPARISION OF BER

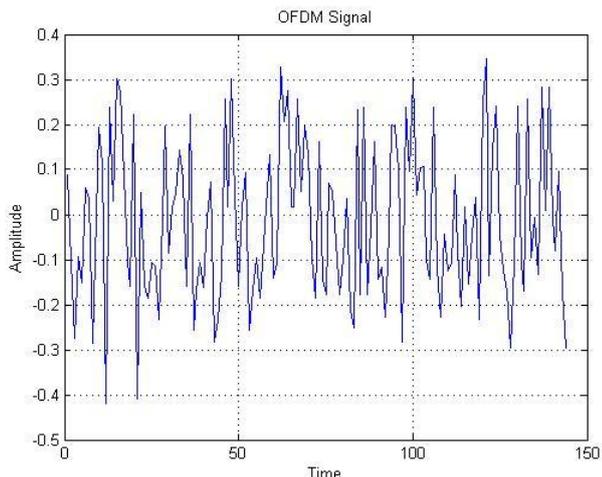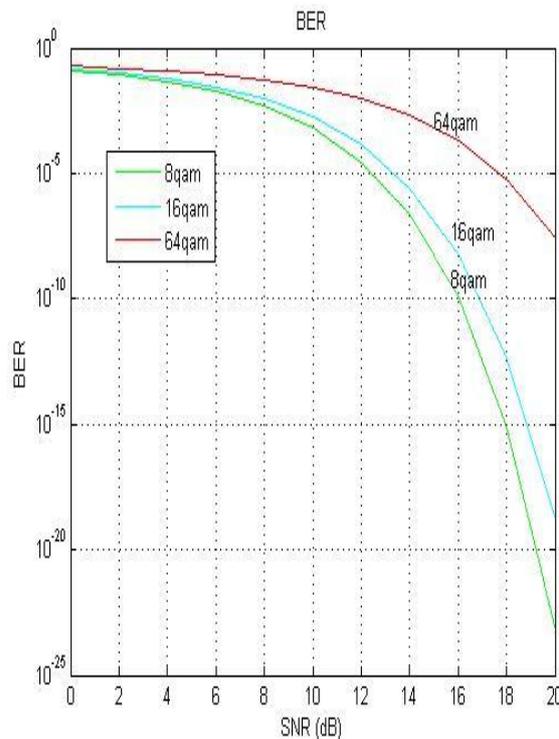*Figure 6.3(c): OFDM signal*
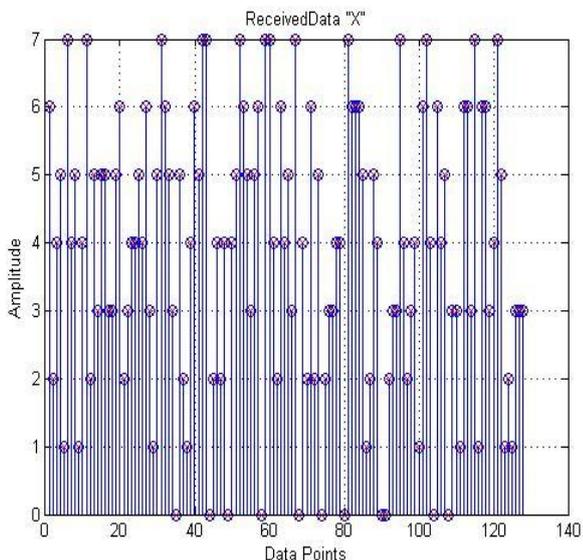

Figure 8: BER vs SNR for 8-QAM,16-QAM,64QAM

VII: CONCLUSION

This paper highlights the unique design challenges faced by mobile data systems that result from the vagaries of the harsh wireless channel. OFDM has been shown to address these challenges and to be a key enabler of a system design that can provide high performance mobile data communication. Also OFDM is well positioned to meet the unique demands of mobile packet data traffic. OFDM is supports 3g technology and also 4g.such as MIMO-OFDM,WIMAX technology.

Figure 6.3(d): Received signals

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