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PERFORMANCE ANALYSIS OF ADAPTIVE MODULATION TECHNIQUES IN LTE

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Abstract - The fundamental criteria for best modulation scheme depends on Bit Error Rate (BER), Signal to Noise Ratio (SNR). The modulation technique used for LTE (4G) systems are M-PSK and QAM digital modulation schemes that are compared under AWGN channel to identify a suitable digital modulation scheme for MIMO-OFDM applications. Of all the digital modulation techniques the higher order QAM can transmit more data but are less reliable when compared to lower order QAM. This paper reports the study of the system under distinct adaptive modulation schemes, in-order to enhance the overall performance of the system.

Keywords: QAM, LTE, OFDM, AWGN.

I.INTRODUCTION

In telecommunication, Third Generation Partnership Project (3GPP) which is an industry trade group developed a wireless broadband technology called Long Term Evolution (LTE).The engineers in 3GPP named it as Long Term Evolution because it constitutes the successive pace in the progression of GSM, which is a progression of UMTS. Long-term evolution (LTE), also familiar as 4G, which is a rapidly growing common global technology that continuously progresses to render incomparable data rates, preferable capacity, and improved levels of user experience. Using a discrete radio interface together with core network refinements, aims at improving the capacity and speed. LTE has a vibrant ecosystem covering both the flavors: TDD and FDD. Both LTE FDD and TDD proffers very high data rates, low latency, and smooth interworking with 3G, moreover between FDD and TDD networks. This is a regular comprehensive standard for paired as well as unpaired spectrum allowing the operators to grasp all available spectrums. The LTE uses Evolved Packet System (EPS) which is completely based on IP. The LTE provides up to 1Gbps for stationary users and 100Mbps for highly mobile users.

II.ARCHITECTURE

The architecture of LTE consists of two major parts: Radio network and Core network. This is based on packet switching and not on circuit switching. For packet switched networks it needs its own radio network as well as core network. This leads to the evolution of new architecture called as the System Architecture Evolution (SAE). This architecture is not an up gradation of either 2G or 3G. The architecture is made simple with less number of nodes for high

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mobility. The radio network in the architecture is known as the E-UTRAN which is Evolved-Universal Terrestrial Radio Access Network. This is the one consisting of both the UE and the e-Nodeb. The core network in the architecture is called as the E-PC which is Evolved-Packet Core. This serves as an equivalent to the GPRS consisting of several subcomponents. The various entities in the E-PC are Mobile Management Entity (MME), Serving Gateway (SGW), PDN Gateway (PGW) and Home Subscriber Server (HSS) where PDN is the Packet Data Network. The handset in the LTE is called as the E-UE which is the Evolved User Equipment. The E-UE is connected to the e-nodeb in the E-UTRAN through the radio interface connection. And in turn the E-UTRAN is connected to the E-PC, which is fully packet switched with the help of various entities. The connection between the e-nodeb and the MME is the signaling connectivity and the connection between the e-nodeb and the SGW is data connectivity. [8] presented a short overview on widely used microwave and RF applications and the denomination of frequency bands. The chapter start outs with an illustrative case on wave propagation which will introduce fundamental aspects of high frequency technology.

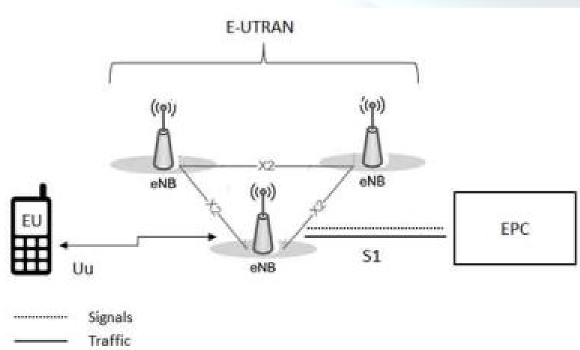

Fig1: Architecture of LTE
(Courtesy: www.tutorialspoint.com)

III.EXISTING SYSTEM

The amount of mobile web users has been greatly raised with the enhancement in mobile technology. 4G yields better and high speed internet access compared with the previous generations. It is the successor of 3G and predecessor of 5G. The prerequisite is that the peak data rate should be 100Mbps for high mobility users and 1Gbps for low mobility users.

A. Orthogonal Frequency Division Multiplexing

OFDM belongs to a group of transmission schemes called multicarrier modulation, where the frequency band is divided into narrow orthogonal part which is called as sub carriers. Here it divides a given high-bit-rate data stream into several parallel lower bit-rate streams. Several subcarriers are clustered to form a sub channel. Each subcarrier is modulated with any one of the modulation schemes such as Phase Shift Keying (PSK) or Quadrature Amplitude Modulation (QAM). There is overlapping of the subcarrier bandwidths without being affected by interference. OFDM has various features such as high flexibility, toughness to channel fading, easy equalization and high spectral efficiency. It is performed at the downlink channel of the LTE system.

B. Multiple Inputs Multiple Outputs

MIMO is abbreviated as Multiple Input and Multiple Output. They use several transmitters and receivers to transmit numerous datas at the same time in the downlink channel. Many antennas are used to deliver multiple analogous signals from a transmitter. These signals are casted back by trees and building on their way to the receiver and delivered to the receiver on a

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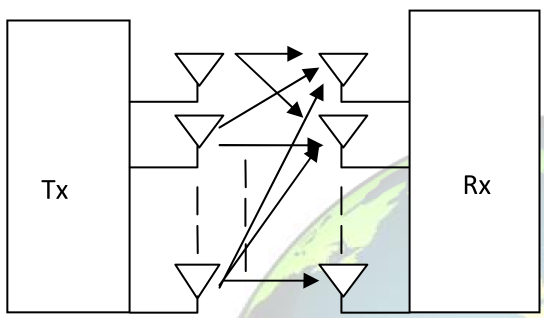
divergent way. The MIMO uses a self-contained sequence of actions in the receiver side to sort out the signals and generate a single signal which contains the actual transmitted data. This mainly reinforces high coverage, high data rate and better robustness, low bit error rate, enhanced spectral efficiency etc.



M antennas N antennas

Fig2: Multiple Input multiple output

C. Bit Error Rate (BER)

BER is the Bit Error Rate which is the number of error bits per unit time. It can also be defined as the ratio of the number of error bits to the total number of bits transmitted. It is expressed as follows,

$$\text{BER} = \frac{\text{No. of error bits}}{\text{Total no. of transmitted bits}}$$

BER is mainly influenced by channel noise, distortion, interference and multipath fading. The expectation value of the bit error ratio is the bit error probability p_e.

D. Signal to Noise Ratio (SNR)

SNR is the Signal to Noise Ratio which is the measure of the ratio of signal power to noise power. It is usually represented in decibel (dB) and expressed as,

$$\text{SNR} = \frac{P_{signal}}{P_{noise}}$$

It can also be defined as the ratio of bit energy (E_b) to noise power spectral density (N_0) as,

$$\text{SNR} = \frac{E_b}{N_0}$$

It acts as an indicator frequently used to assess the standard of the communication link. It also determines the nature of the transmission over a network channel. SNR and BER are inversely proportional. With the increase in SNR value the BER decreases and inverse is also true with a decrease in SNR, BER increases.

IV. PROPOSED SYSTEM

Here we calculate the BER and SNR in the MIMO-OFDM, which is a major air interface used for 4G and 5G wireless communication. This would be computed for the three major modulation techniques: QPSK, 16-QAM and 64-QAM.

A. Quadrature Phase Shift Keying (QPSK)

In the digital modulation technique, an adjunct of PSK which is a higher order of PSK, utilizes a four level phase state to broadcast 2bits/symbol in a concurrent manner, by choosing one of the four feasible evenly spaced carrier phase shift of 0, π/2, π and 3π/2, where every value of the carrier phase is equivalent to a definite pair of message bits of 00,01,10,11. This benefits the signal the accessibility of conveying double

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information using identical bandwidth. This shows that QPSK is more efficient than BPSK in terms of bandwidth. QPSK is mathematically represented as

$$S_{qpsk}(t) = \sqrt{\frac{2E_s}{T}} \cos\left(2\pi f_c t + \frac{(2n-1)\pi}{4}\right)$$

$$Where\ n = 1,2,3,4.$$

QPSK is used for various applications in the satellite transmission such as video conferencing, cellular phone systems, etc.

B. Quadrature Amplitude Modulation (QAM)

QAM (quadrature amplitude modulation) is the process of integrating a pair of amplitude-modulated (AM) signals into an individual channel, thereby maximizing the effective bandwidth. Two disparate signals are to be sent concurrently on a similar carrier frequency. QAM is a higher order modulation technique yielded from a combination of ASK and PSK. There are various forms of QAM here we consider the 16-QAM and 64-QAM. Higher order M-ary QAM provides space for additional points within the constellation. Hence the capacity of transmitting more bits per symbol would be attainable, and this essentially allows data to be transmitted considerably in a smaller bandwidth. M-ary QAM signals are generally represented as,

$$S_i(t)=\sqrt{\frac{2E_m}{T_s}}\, a_1\cos(2\pi f_c t)+\sqrt{\frac{2E_m}{T_s}}\, b_1\sin(2\pi f_c t)$$

$$0 \le t \le T, i = 1,2,3, \dots M$$

Where E_m is the energy of the signal with the lowest amplitude, a_1 and b_1 are the two self-sufficient integers selected corresponding to the position of the specific signal point. It is mainly exploited in digital telecommunication systems and areas of higher data delivery implementations such as cable modem networks.

Digital Modulation will remain to be pertinent in the domain of voice and data communication with elevated throughput because the main aim of a communication network designer is to pass on the data within a brief time bounded by the available bandwidth and at a reasonable cost with least amount of probability of error.

V.SIMULATION AND RESULTS

The desired waveforms of the system are obtained through the simulation with Matlab. Computations for the Bit Error Rate and Signal to Noise Ratio with the three modulation techniques in the MIMO-OFDM technologies are performed. As the value of SNR increases for a particular modulation technique the BER keeps decreasing.

Modulation	Bits per symbol	Symbol rate
QPSK	2	½ bit rate
16-QAM	4	¼ bit rate
64-QAM	6	1/6 bit rate

Table1: Bits per symbol and Symbol rate for different modulation schemes

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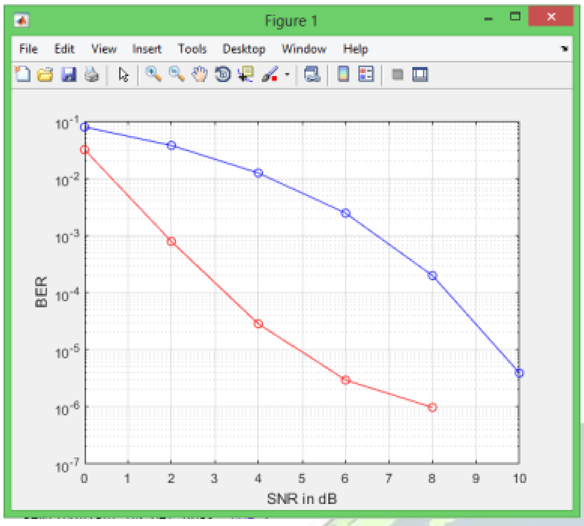

Fig3: BER Vs SNR for QPSK

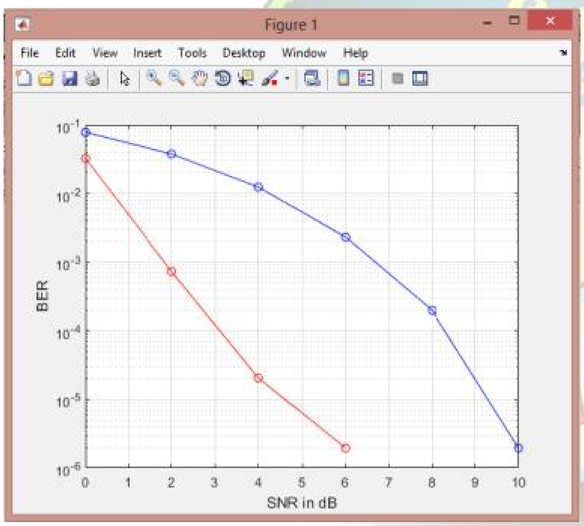

Fig4: BER Vs SNR for 16-QAM

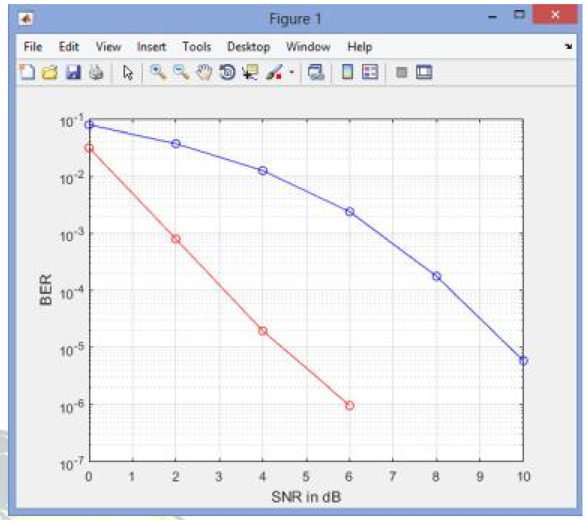

Fig5: BER Vs SNR for 64-QAM

VI.CONCLUSION

This paper presents a relative study with different modulation techniques for the LTE network. The Bit Error Rate and Signal to Noise Ratio are calculated in the MIMO-OFDM systems for QPSK, 16-QAM, 64-QAM. On the basis of the results procured in the present Matlab-based simulation we find that the 64-QAM provides better data rate compared to the other two modulation techniques.

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