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Performance analysis of BER and Throughput of different MIMO systems using different modulations

Harsha Karande[1], Manasi Dixit[2]

[1]M.E student, Dept. of Electronics Engineering, KIT's College of Engineering, Maharastra, India
[2]Professor Dept. of Electronics Engineering, KIT's College of Engineering, Maharastra, India

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Abstract - *The main aim of 4g LTE mobile communication system is to integrate with large Varity of communication services as high speed data transfer, video call as well as audio and internet access services without buffering. Now a days mobile communication is playing very important role in telecommunication industry through wide area radio access technique. The flexibility of WiMAX and LTE network is able to combine the mobile and fixed broadband network. The OFDM technique is wildly used for data transfer in many wireless and wired multicarrier communication systems. The IEEE802.16 standard is related to air interface to gather the requirement of ITU for 4G mobile network. Long term evolution (LTE) uses OFDM techniques along with MIMO for better communication. It is capable of data transfer in high speed without losing performance and efficiency. OFDM overcomes the challenge of providing high speed access with security. this paper represents the performance analysis of OFDM system in MIMO downlink system and achieve high data rate, getting low bit error rate (BER) with respect to the SNR (signal to noise ratio). The modulation technique QPSK, 16QAM, 64QAM is used. The SNR and guard interval in OFDM signal improves the system performance for transmission.*

Key Words: **Binary Phase Shift Keying (BPSK), multiple-input multiple-output (MIMO), orthogonal frequency division multiplexing (OFDM), Bit error rate (BER), Additive White Gaussian Noise (AWGN)**

1. INTRODUCTION

In the wireless communication with multiple transmit and multiple receive antenna system can provide high capacity of transition at low probability of bit error with extremely low power, even in highly densed populated urban areas. In recent few years, orthogonal frequency division multiplexing (OFDM) has been started to use widely in communications systems to operate in frequency division channels. Combination of MIMO-OFDM communication system has significantly improved capacity and reliability by using the robustness of OFDM to fading. Orthogonal frequency division multiplexing (OFDM) is the most promising multi-carrier modulation (MCM) technique used in next generation wireless communication networks due to its high performance comparative to narrow-band interference and simplicity of transceivers. It has been proved in recent years that the use of MIMO system can potentially increase the use of spectral efficiency for wireless communication in the multipath fading environment. MIMO technique is the one which uses multiple antennas at both the transmitter and receiver to improve communication performance between users because it increases data throughput and link range with limited bandwidth or transmitter power. Antenna diversity is the function that is effective enough to reduce the effects of multipath fading. The use of multiple antennas at the transmission and reception end is expected to results in improvement quality of the broadband communication services. This technique is well known as Multiple Input Multiple Output (MIMO) founded by Alamouti who previously discovered a scheme by using two antennas at sender end with one receiving antenna. This is also capable to provide the same diversity with a single antenna transmitter and two receiving antennas. This MIMO technique can be integrate with the multicarrier modulation OFDM. MIMO take also important fundamental role in LTE development by 3G and 4G n/w. In the OFDM technique breaks the high rate data flow into the form of low data rate flow which can be easily transmitted at same time over the number of sub-carrier channels.

1.1 OFDM

OFDM technique uses multi carrier transmission in which data is transmitted on a set of orthogonal independent sub carriers of frequency spectrum. by the elimination of guard bands in OFDM systems leads to minimize the wastage of bandwidth along with measure improvement in performance in multi path environment. Multiplexing with OFDM is a promising mechanism to perform multicarrier data modulation with maximum utilization of available bandwidth and high performance characteristics profile against fading in multipath communication. It can be defined as MIMO (Multiple Input and Multiple Output) in combination with other modulation schemes which can increase capacity, reliability of internet services and multimedia application. Combination of MIMO and OFDM technique reduces the equalization complexities by the transition of different data on different frequency levels to achieve spectral efficiency and error recovery features, which will leads to offer high spatial rate by transmitting data on multiple antennas and transmission in Non-Line-of sight (NLOS). Thus the MIMO-OFDM technique is widely used to achieve diversity. It will utilize the three fundamental parameters that is frequency multiplexing

(OFDM), time and spatial MIMO (Multiple Input Multiple Output). The MIMO-OFDM is the regenerative and most famous services for Wireless broad band communication. OFDM is very key technology for next-generation cellular data communications as (3GPPLTE, Mobile WiMAX, IMT-Advanced) and as well as wireless LAN (IEEE 802.11a, IEEE 802.11n), wireless PAN (MBOFDM), and broadcasting (DAB DVB, and DMB)

1.2 MIMO System

MIMO is wireless technology which uses multiple transmitters and receivers to transfer more data at the same time for accuracy. All wireless schemes with 802.11n supports MIMO, which is the part of technology that permits 802.11n to get much higher speed than products without 802.11n. When MIMO technique was suggested in the mid-to-late 1990s by Gerard Foschini and others, they introduce bandwidth efficiency of such techniques seemed to be in violation of the Shannon limit. But, there was no such violation because the diversity and signal processing delivered with MIMO, transforms a point-to-point single channel into multiple parallel channels or matrix channels, hence in effect with multiplying the capacity. MIMO offers spectral efficiency with high data rates. MIMO is also an important part of the 802.11n standards used by your wireless router as well as 802.16 for Mobile WiMAX used by your cell phone. MIMO has several different diversity modes are available, and that are Time diversity, Frequency diversity, Space diversity.

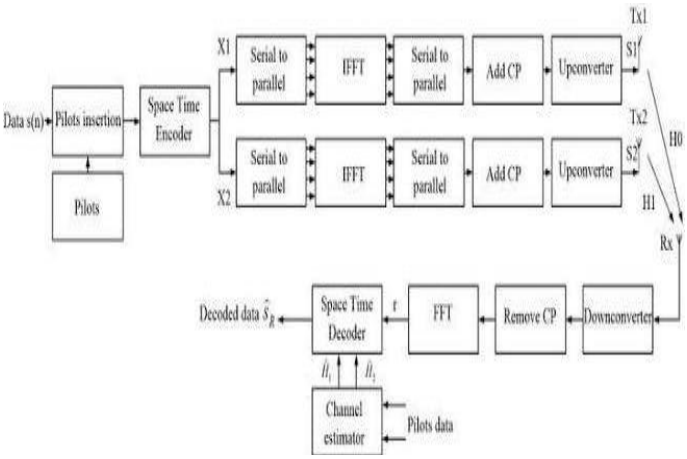


Fig. (1): OFDM-MIMO block diagram

2. Modulation Techniques

2.1 Binary-phase-shift-keying (BPSK)

BPSK is the first and simplest form of phase shift keying mechanism. It uses two phases which are differ by 180° and so it can also be treated as 2-PSK. It does not actually matters the position allocation of the constellation points are, and in the figure (1) they are pointed on the real axis, at 0° and 180°. The data is often encoded and differentiated to modulation. Functionally BPSK is very equivalent to 2-QAM modulation. The principle equation of BPSK is eq. (1):

$$\text{BPSK output} = [\sin(2\pi f_a t)] \times \sin(2\pi f_c t)] \quad \text{..... (1)}$$

Where f_a = fundamental frequency of input (hertz)

f_c =reference carrier frequency

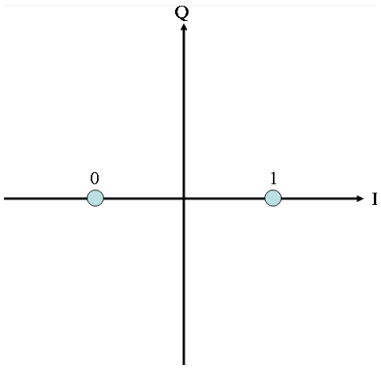


Fig.(2): constellation diagram of BPSK

2.2 Quadrature-phase-shift-keying (QPSK)

At sometimes QPSK is known as quadric-phase PSK, 4-PSK, or 4-QAM. QPSK can encode the two bits per symbol with four phases and with Gray coding which minimize the bit error rate (BER) sometimes misperceived as the twice BER of BPSK. QPSK either can be used to double the data rate transfer compared with a BPSK system with maintaining the same bandwidth of the signal. The advantage of QPSK modulation over BPSK is, QPSK transmits the double data rate in a given bandwidth compared to BPSK modulation at the same BER. The principle equation (2) is:

$$s(t) = \begin{cases} A\cos(2\pi fct + \pi/4) & \text{for binary 11} \\ A\cos(2\pi fct + 3\pi/4) & \text{for binary 01} \\ A\cos(2\pi fct - 3\pi/4) & \text{for binary 00} \\ A\cos(2\pi fct - \pi/4) & \text{for binary 10} \end{cases} \quad \text{..... (2)}$$

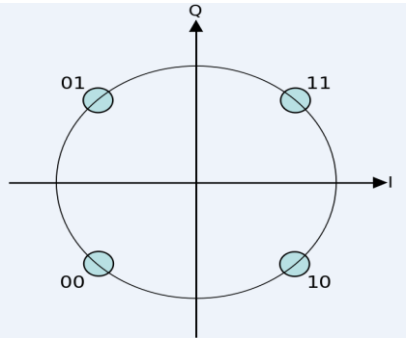


Fig.(3): constellation diagram of QPSK mod.

2.3 Quadrature amplitude modulation (QAM)

QAM technique is both an analog and a digital modulation scheme. It transfers the two analog message signals, or two digital bit streams, by changing or encoding the amplitudes of two carrier waves by using the amplitude-shift keying (ASK) digital modulation technique or amplitude modulation (AM) that is analog modulation scheme. The two sinusoidal carrier waves which are out of the phase with each other by 90° and thats why called Quadrature carriers or Quadrature components hence QAM is the name of the scheme. The modulated waves are added together, and the resulting waveform is the combination of both phase shift keying (PSK) and amplitude-shift keying (ASK), or (for the analog case) of phase modulation and amplitude modulation. In the case of digital QAM, at least two phases with finite numbers and at least two amplitudes are used. PSK modulators are designed by using the QAM principle, but they are not considered as QAM because the amplitude of the modulated carrier signal is constant. The principle equation (3)

$$s(t) = d1(t)\cos 2\pi fct + d2(t)\sin 2\pi fct \quad \text{..... (3)}$$

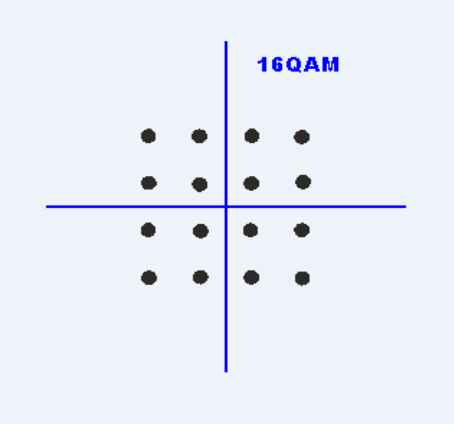
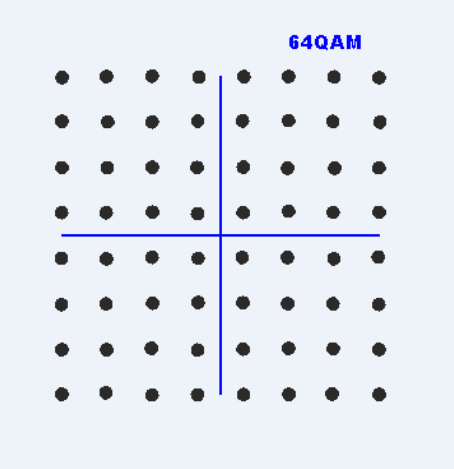


Fig.(4): Constellation dia. of 16-QAM mod.



Fig,(5): Constellation of 64-QAM mod.

3. SIMULATION RESULT

The model was implemented in MATLAB-R2014a simulation according to the above described systems for convolution coding techniques. Performance analysis of BER Vs SNR curve, throughput Vs SNR curve of transmit diversity and spatial multiplexing, of 2*2 MIMO is done for communication channel like AWGN with Rayleigh channel using QPSK, 16-QAM, 64-QAM, modulation techniques. Here we have transmit our data with the help of OFDM technique in which large numbers of closely-spaced orthogonal sub-carriers are used and they carry data and performance is plotted by bit error rate verses signal to noise ratio.

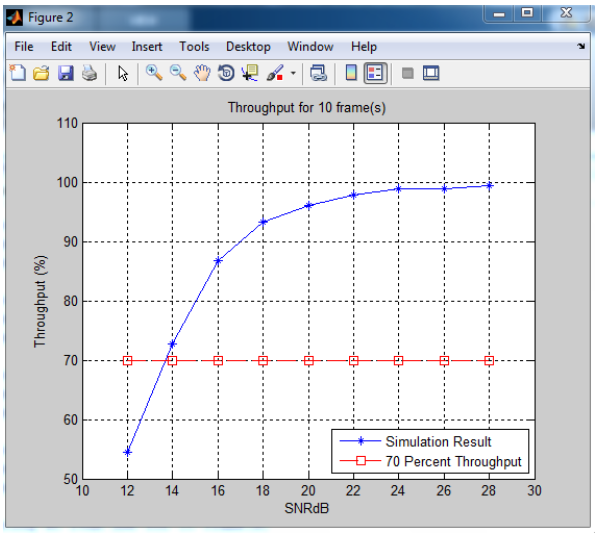


Fig.(6): throughput Vs SNR of spatial multiplexing

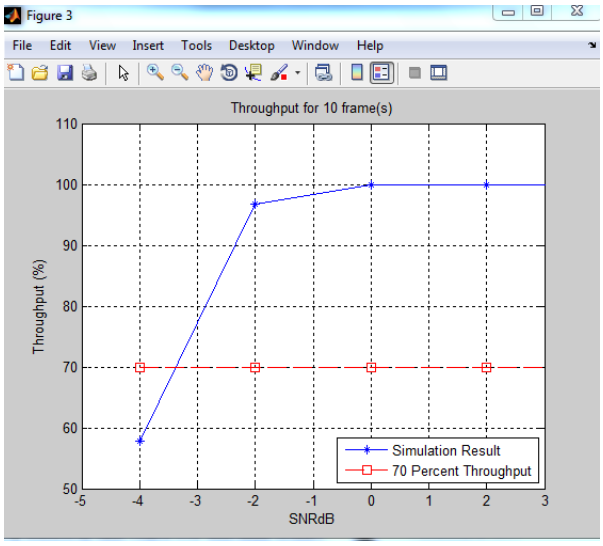


Fig.(7): Throughput Vs SNR of Transmit Diversity

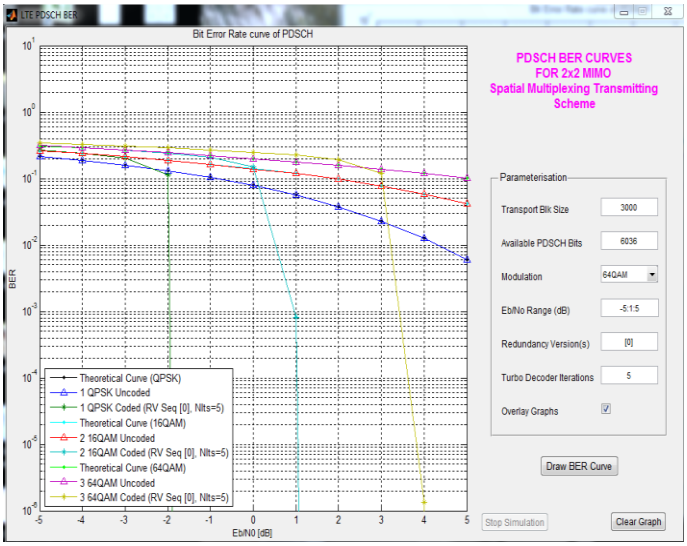


Fig.(8): BER Vs SNR curve of spatial multiplexing

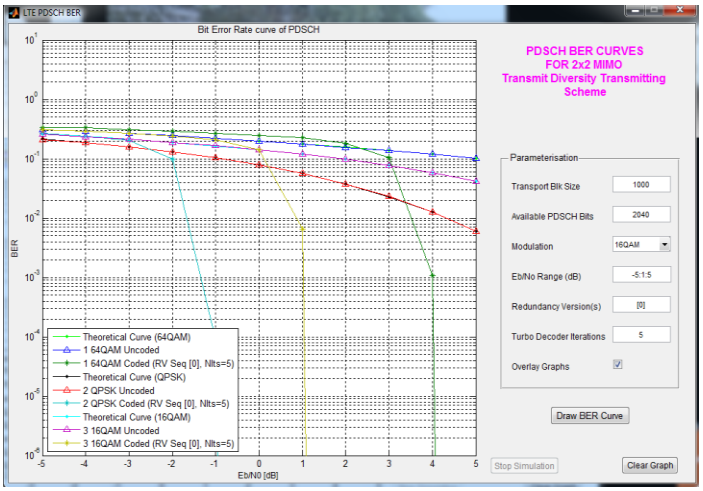


Fig.(9): BER Vs SNR curve of transmit diversity

4. CONCLUSIONS

From the above discussion and simulation result it is suggested that Spatial multiplexing is ideal to achieve very high peak rates, while the transmit diversity is a valuable scheme to minimize the bit error rate of occurrence and thereby can used to improve signal quality. Therefore suggestion is that transmit diversity can be utilized where channel conditions determines for Low SNR Range and multiplexing for High SNR Range.

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