Analysis of Massive MIMO System for 5G

DISSERTATION-II

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By

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CERTIFICATE

This is to certify that Gurpreet Kaur bearing Registration no. 11616628 have completed objective formulation/Base Paper implementation of the thesis titled, **"Analysis of Massive MIMO system for 5G"** under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of thesis has ever been submitted for any other degree at any university.

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DECLARATION

I, Gurpreet Kaur, student of M. Tech under Department of Electronics and Communication of Lovely Professional University, Punjab, hereby declare that all the information furnished in this Dissertation-II report is based on my own intensive research and is genuine.

This report does not, to the best of our knowledge, contain part of my work which has been submitted for the award of my degree either of this University or any other University without proper citation.

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ABSTRACT

Massive MIMO methods are utilized nowadays for advancements in the different areas such as Wi-Fi and LTE, and new strategies are under review for future benchmarks like LTE Advanced. Massive MIMO is a technique to obtain QOS such as throughputs, reliability and more capacity

In wireless communication, there is no physical connection through cables such as twisted-pair cables, coaxial cables and optical fiber cables between transmitter and receiver. The performance of wireless systems can be improved through the use of multiple antennas, usually called multiple-input/multiple-output (MIMO). The research work has been carried out for MIMO systems having antenna configurations 2X2 (Alamouti), 3X3 (OSTBC3) and 4X4 (OSTBC4, QOSTBC4) and the work may be extended for higher antenna configurations. The performance of MIMO system is analyzed using zero-forcing receiver over non-linear fading channels such as AWGN channel, Rayleigh channel and Rician channel with increasing number of receiving antennas in all these configurations. This configuration is done using different values of modulations that is M-PSK.

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LIST OF ABBREVIATIONS

AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
CSI	Channel State Information
IEEE	Institute of Electrical and Electronics Engineers
ISI	Inter Symbol Interference
LOS	Line of Sight
MIMO	Multiple input-multiple output
ML	Maximum Likelihood
MMSE	Minimum Mean Square Error
M-PSK	M ary Phase Shift Keying
M-QAM	M ary Quadrature Amplitude Modulation
MU-MIMO	Multi User MIMO
OSTBC	Orthogonal Space Time Block Code
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift keying
QOSTBC	Quasi Orthogonal Space Time Block Code
RF	Radio Frequency
RX	Receiver
SD	Spatial Diversity
SDM	Spatial Division Multiplexing
SISO	Single Input Single Output
SM	Spatial Multiplexing
SNR	Signal to Noise Ratio
ST	Space-time
STBC	Space Time Block Code
STD	Spatial Transmit Diversity
STTC	Space Time Trellis Coding

SU-MIMO	Single User MIMO
TX	Transmitter
Wi-MaX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
ZF	Zero Forcing

CHAPTER-1 INTRODUCTION

The wireless communication is a kind of connectionless services in which there is no physical connections through cables between transmitter and receiver. The data is transmitted from source to destination through air as the medium. It is useful for long distance communication because communication with wires is difficult process. In the current scenario, wireless communication is preferred more because it provides large advantages in terms of productivity and cost. MIMO will make a development in the field of remote correspondence. The correspondence framework has been created a considerable measure in the decade ago and this advancement is becoming quickly. Numerous information from different receiving and transmitter antenna ((MIMO) has been making this framework more successful and nowadays large MIMO will be presented for 5G to achieve high data rate and Wi-Fi and LTE, and new strategies are under review for future benchmarks like LTE Advanced. Massive MIMO is a technique to obtain QOS such as throughputs, reliability and more capacity. Main Component of wireless communication such as transmitter, receiver and channel.

The source is the starting purpose of the data that will be passed on. This data could be voice, content, picture, bundle information and so forward. After that the transmitted data transfer through different channels to extract the better information. The channels used for MIMO techniques are AWGN, Rayleigh and Rician channels. The baseband signal conveys no data all alone; however before achieving the transmitter, the data to be sent is added to it. The transmitter then conveys the message into the correspondence channel. The channel is a medium through which the transmitter yield is sent to the receiver. This in the wired framework could be a wire, a coaxial link, or an optical fiber. The broad coverage supported by MIMO system helps in supporting large number of subscribers per cell. The MIMO based system is widely adopted in latest technologies.

1.2 Rationale of study

The main motive of space time block coding in Massive MIMO is to transmit n number of copies of data streams across a multiple antenna and used to enhance the reliability of information exchange. Due to scattering, refraction and reflection the transmit signal may be corrupted. In this case the space time coding will be useful because in this case multiple copies of data will be received. At the receiving side, all the copies of data streams are combined in such a way that we can extract as much information as possible.

1.3 Aim and Objective

1) The objective of the thesis is to analyze the performance of Massive MIMO system using different space-time block coding techniques. For this the sub-objective is BER analysis for different modulation techniques.

2) Second step towards objective is to do performance analysis of MIMO system using different STBC techniques such as Alamouti scheme, OSTBC3, OSTBC4 and QOSTBC4 and implementation is done over the most ideal channel (AWGN) for M-PSK modulation for different antenna configurations.

3) Third step is to test the system under practical nonlinear fading channels like Rayleigh channel and Rician channel. Whole process has been repeated for M-PSK modulation for different antenna configurations.

4) Lastly, the implementation of massive MIMO system and analysis of system performance analysis using higher-order modulation techniques and different space-time block coding techniques.

1.4 MIMO System

MIMO has the capacity to interact with various antennas at a same time which are 2*2, 3*3, 4*4. It enhances the performance in case of beamforming and diversity. At the transmitter side as well as receiver side multiple antennas are use to improve the performance and thus achieving higher data rate or throughput.

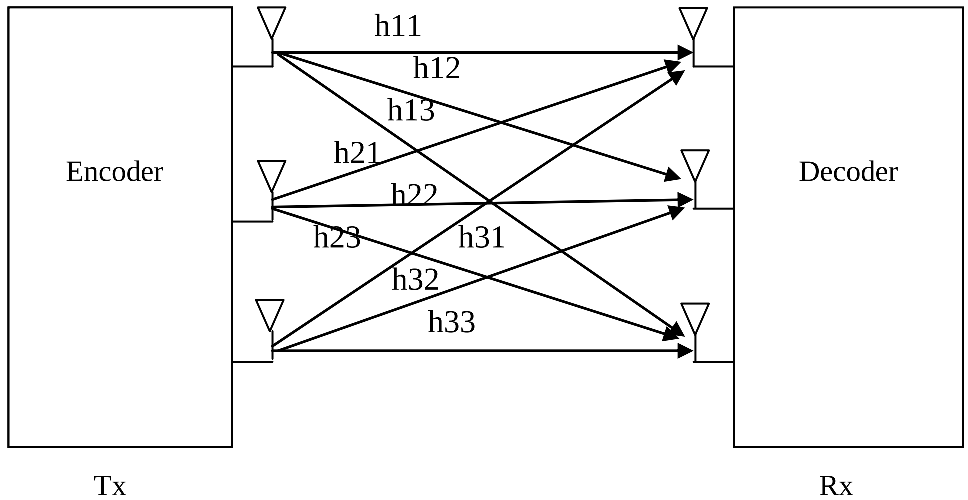


Fig. 1.1. MIMO System

Where Tx is the transmitter on the transmission side, Rx is the receiver at the reception side and h denotes the multiple.

This is likely due to some extent to the way that OFDM (orthogonal recurrence division multiplexing), which encourages the usage of MIMO, is presently normally utilized as a part of today's remote measures. MIMO methods are utilized today in advances like Wi-Fi and LTE, and new strategies are under review for future benchmarks like LTE Advanced. The primary element of MIMO frameworks is space-time preparing. Space-Time Codes (STCs) are the codes intended for the utilization in MIMO frameworks. In STCs, signs are coded in both transient and spatial areas. Here we use encoder at the transmitter side and decoder at the receiver side.

➢ Input/output configurations

SISO

SISO stands for single input single output. In SISO only one transmitter and only one receiver is required, so there is no diversity and no additional operation is required.

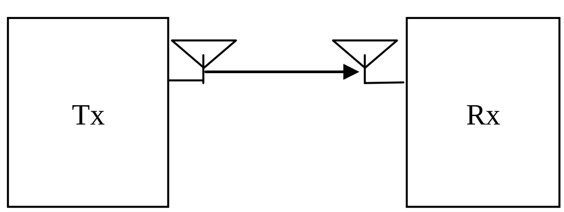


Fig. 1.2 SISO

SIMO

SIMO stands for single input multiple output. In this system there is transmitter which consist only single antenna and receiver has multiple antennas. Basically SIMO used for reduce the effect of fading and interference.

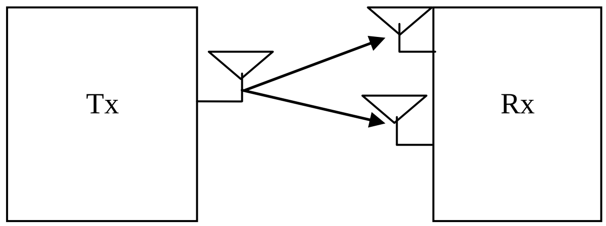


Fig. 1.3 SIMO

MISO

MISO stands for multiple input single output. MISO transmitted data from two or more Tx antenna but the receiver receives only single optimal signal. One advantage is that there is less battery consumption.

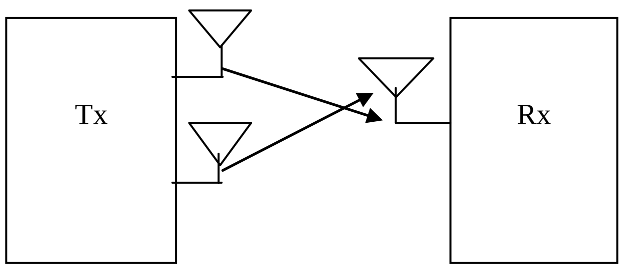


Fig. 1.4 MISO

MIMO

MIMO represents multiple input multiple output. It provides improvements in channel robustness as well as channel throughputs and faster speed with increase capacity.

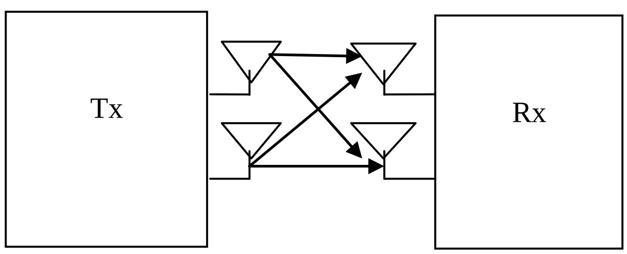


Fig. 1.5 MIMO

1.5 Types of MIMO System

There are two major classifications to determine types of MIMO:

(1) Single User MIMO (SU-MIMO) vs. Multi User MIMO (MU-MIMO)

(2) Open loop MIMO vs. Close loop MIMO

1.5.1 SU-MIMO Vs MU-MIMO

SU-MIMO:

In single user MIMO the base station communicates with single user. In case of lower signal to noise ratio the SU-MIMO provide higher throughputs. SU-MIMO has one advantage that is it reduces interferences. SU-MIMO provides high data rate because there is only single user. In single user MIMO there is no channel state information is required.

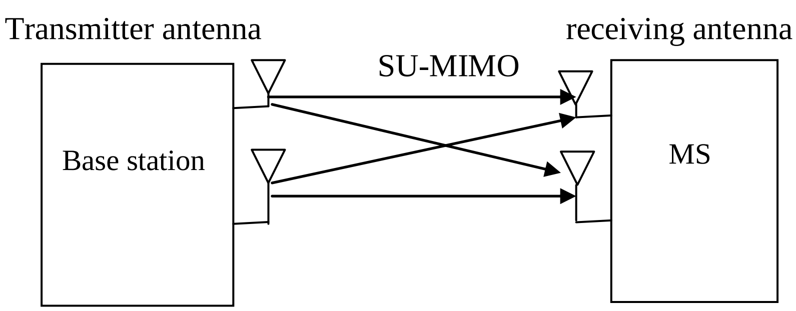


Fig.1.6. SU-MIMO

MU-MIMO:

In Multiple users MIMO the base station separately communicate with n number of users. MU-MIMO also provides high throughput but when signal to noise ratio is high. MU-MIMO has multiplexing gain. MU-MIMO provides capacity gain. In multi user MIMO channel state information is required.

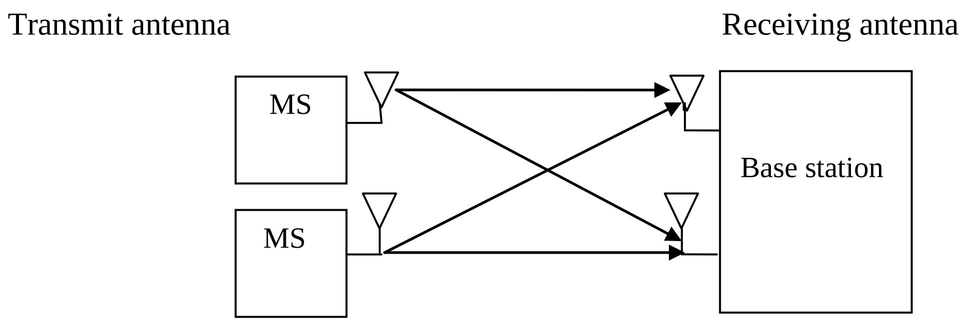


Fig.1.7 MU-MIMO

1.5.2 Open loop Vs Closed loop MIMO

Open loop MIMO:

Open loop MIMO does not require knowledge about channel at the transmitter. For a SIMO framework, the receiving side information streams from various transmit reception apparatuses utilizing most extreme proportion joining techniques to accomplish decent variety pick up. For numerous transmit reception apparatuses, the channel turns out to be more complex, and there is impedance or fading between various transmitted streams. In the event that the transmitter has no channel learning, the receiver is left from everyone else in misusing MIMO limit, which implies that a complex calculation is required.

Closed loop MIMO:

Closed loop MIMO require channel knowledge at the transmitter. the closed loop MIMO is very important in present day to get better performance in wireless. The BTS transmitter uses channel data to enables basic spatial diversity or beamforming procedures that expansion the framework's compelling SNR and conceivably rearrange the reception architecture.

For instance, consider a closed loop MIMO framework with two transmitter radio wires and two collector reception apparatuses. With complete knowledge of channel H, the transmitter can accomplish an ideal transmission scheme as appeared in Equation.

$$X=vws \tag{1}$$

Where x is the transmitted signal from antenna, v is the unitary matrix and w is the water filling matrix that is

$$w=\begin{bmatrix} \alpha & 0 \\ 0 & \beta \end{bmatrix} \tag{2}$$

The water filling matrix helps to maximize the capacity.

1.6 Functions of MIMO System

MIMO functions are divided into three categories that is precoding, spatial diversity and spatial multiplexing. These functions use for different issues and each function has different outcomes to perform well in the MIMO system. Further information given below:

- Precoding
- Spatial diversity
- Spatial multiplexing

1.6.1 Precoding

The beamforming technique is also called precoding. Further broad signals, it is thought to be all spatial handling is happens at the transmission side. In precoding and beamforming, a similar flag may be discharged from the both wires at the transmitter and receiver with proper stage or pick up data to such an extent where the flag power is expanded on the collector side. The advantages of precoding use for expand the gotten flag pick up - by making signals produced from various radio wires include helpfully - and to decrease the multipath blurring impact. In viewable pathway spread, beamforming brings about a very much characterized directional example. Be that as it may, traditional pillars are not a decent similarity in cell systems, which are for the most part described by multipath engendering. At the destination when the collector has various receiving antenna, the transmission beamforming or precoding can not all the while amplify the flag term level at all of the get gathering mechanical assemblies, and precoding with various streams is every now and again helpful. Observe that precoding requires learning of channel state information (CSI) at the transmission and the collector.

1.6.2 Spatial Multiplexing

Spatial multiplexing has MIMO radio frequency chain setup. In this technique, a greater-rate divided into different lower-rate streams and every stream is transmitting from another transmitted gathering device in a comparable repeat channel. If these signs meet up at the beneficiary radio wire display with enough special spatial imprints has exact CSI, it can segregate these streams into parallel channels. Spatial multiplexing is a skilled technique for extending channel restrain at higher banner to-upheaval extents (SNR). The most outrageous number of spatial streams is confined through the minimum of the amount of radio wires at the transmitter or beneficiary. The transmitter, however can be joined with precoding if CSI is available Spatial multiplexing will be used without CSI at the. Spatial multiplexing can in like manner be used for synchronous transmission to various recipients, known as space-division different for obtaining or multi-customer MIMO, in this case Channel State Information is required at the transmission side. The arranging of authorities with different spatial imprints licenses awesome uniqueness.

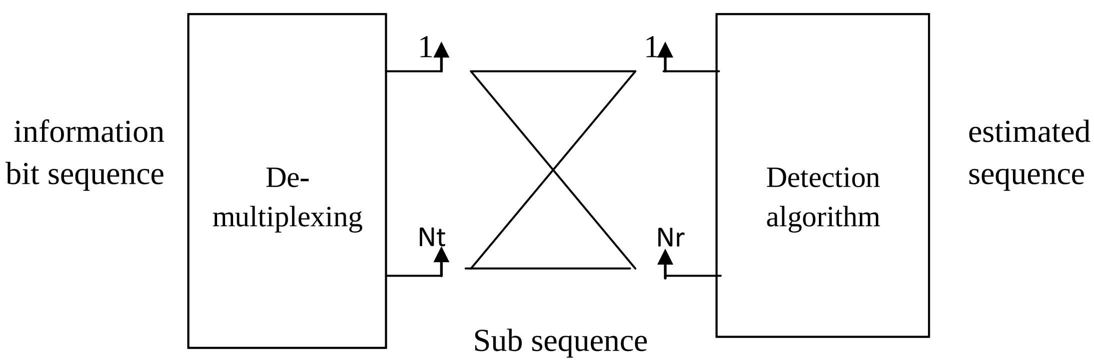
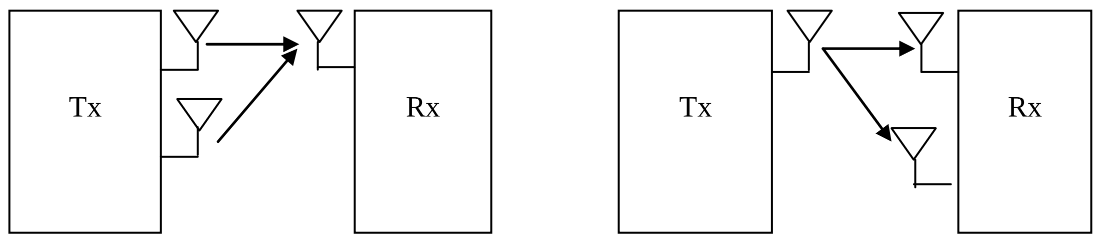


Fig.1.8. Spatial Multiplexing

1.6.3 Spatial Diversity

Various behavior coding or diversity technique frameworks are used, when there is no channel data at the transmitter. In this strategy a basic stream is transmitted, yet the flag or information is coded using strategies called space-time coding. The flag is delivered from all of the transmit antenna with full or close orthogonal coding. Assorted qualities coding manhandle the independent obscuring or fading in the various radio wire associations with update hail contrasts. Since there is no channel learning or acknowledgment, there is no beamforming or display get from assorted qualities coding. This coding can be joined with spatial multiplexing when some channel learning is available at the transmitter.



Transmit diversity receive diversity

Fig.1.9. Spatial Diversity

$$y_1(t) = \sum_{i-1}^{n} h_{i1}(t)\, c_i\,(t) + 1(t) \tag{3}$$

$$y_{mn}(t) = \sum_{i-1}^{n} h_{imn}(t)\, c_{in}\,(t) + mn(t) \tag{4}$$

Signals at the receiver side expressed in matrix

$$\begin{bmatrix} y_1(t) \\ y_2(t) \\ y_3(t) \\ | \\ y_m(t) \end{bmatrix} = \begin{bmatrix} h_{11}(t) & h_{21}(t) & h(t) & \dots & h_{n1}(t) \\ h_{12}(t) & h_{22}(t) & h(t) & \dots & h_{n2}(t) \\ h_{13}(t) & h_{23}(t) & h_{33}(t) & \dots & h_{n3}(t) \\ | & | & | & & | \\ h(t) & h(t) & h_{3m}(t) & \dots & h_{nm}(t) \end{bmatrix} \begin{bmatrix} c_1(\mathrm{t}) \\ c_2(\mathrm{t} \\ c_3(\mathrm{t} \\ | \\ c_m(\mathrm{t} \end{bmatrix} + \begin{bmatrix} 1(t) \\ 2(t) \\ 3(t) \\ | \\ m(t) \end{bmatrix} \quad (5$$

So diversity coding improves the system performance.

1.7 Nonlinear fading channels

A nonlinear choice based on equalizer good with differentially phase shift keying (PSK) is proposed for frequency specific fading channels. This equalization scheme is perfect at whatever point ordinary equalizers are not fit for following phase variation in specific fading channels. The outcome flag is first changed over to a baseband flag and afterward sent through a differential indicator. Nonlinear intersymbol obstruction at the yield of the differential detector is managed by limiting a error signal between the yield of the equalizer and the recognized information. There are different nonlinear channels as follows:

- AWGN
- Rayleigh

- Rician
- Nakagammi

1.7.1 AWGN

AWGN stands for additive white gaussain noise channel. According to this channel, the channel does not know the situation of interference but add a white Gaussian noise to the banner going through it. Blurring does not exist by adding gaussion noise. The main calculation is presented by the AWGN.

$$y(t)=x(t)+n(t) \quad (6$$

Here, n(t) refer to additive white gaussion noise and x(t) is transmitted signals.

1.7.2 Rayleigh channel

Constructive and deconstructive behave as multilevel components in fading propagation and it can be approximated through Rayleigh nonlinear channel when there is no LOS that implies in case of there is no direct path amongst transmit and recipient. The receiver can be streamlined to:

$$y(t)=x(t)*c(t)+n(t)$$

(7

Where,
c(t) refer to channel information
n(t) refer to added substance white Gaussian commotion.

1.7.3 Rician channel

Rician fading is a model that is used for radio propagation anomaly cause by limited deletion of a radio signal through the signal obtained at the received side through various ways. This sort of signal is approximated by Rician appropriation. As the dominate segment keep running into more blur the signal feature goes from Rician to Rayleigh distribution.

$$f(x|\,\upsilon,\sigma)=\frac{x}{\sigma^2}\exp\left(\frac{-(x^2+1)^2}{2\sigma^2}\right)I_0\left(\frac{x}{\sigma^2}\right) \quad (8)$$

Where,

$I_0(z)$ is defined as Bessel function of the first kind with order zero, the allotment is often also rewritten through the Shape Parameter K=$\frac{2}{\sigma^2}$, which is the ratio of the power contributions by line-of-sight path to the remaining multipath.

1.8 MIMO with ZF (Zero Forcing) decoder

In MIMO we consider the multiple transmitters and receiving antenna which is performing the MIMO channel. Here we discuss about 2x2 MIMO with zero forcing equalizer and consider the flat fading that is Rayleigh channel with BPSK modulation.

First we will transmit x_1 in the first time slot and x_2 in the second time slot and so on.

This x_1 data sending throughh_{11} *and* h_{12} channel, similarly x_2 sending through h_{21} and h_{22} .

Let we understand mathematically,

The first received signal through first antenna,

$$y_1 = x_1 h_{11} + x_2 h_{12} + n_1 \tag{9}$$

The second received signal through second antenna,

$$y_2 = x_1 h_{21} + x_2 h_{22} + n_2 \tag{10}$$

We can also express through matrix:

$$Y = H\,x + n \tag{11}$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \end{bmatrix} \tag{12}$$

To calculate x first we find the matrix W that is WH=I, for zero forcing decoder we just meet the constraint that is

$$W = (H^H H)^{-1} H^H$$

$$H = \begin{bmatrix} h11* & h21* \\ h12* & h22* \end{bmatrix} \begin{bmatrix} h11 & h21 \\ h12 & h22 \end{bmatrix} \quad (13)$$

Sometimes diagonal terms are not zero, so zero forcing equalizer is useful to null the interfering or diagonal terms for equalization that means solving for x1 the interfering from x2 is tried to null and same solving for x2 the term x1 will be nulled. It is easy to implement for amplification of noise.

1.9 Organization of thesis

This thesis consists of total five chapters which are structured as below:

Chapter 1: Introduction, it is consisting of an overview, the rationale of study, scopes and objectives of the study, introduction to MIMO system, then a brief introduction about the nonlinear channels and ZF receiver.

Chapter 2: Literature Review, the study of work done in the field of MIMO systems and effects of fading on the system is discussed; research papers of related field in sequence are also discussed.

Chapter 3: MIMO, includes the basic concepts of MIMO system along with classification of MIMO techniques, benefits of MIMO system, MIMO system with Space Time Coding Techniques, modulation technique and channels have been discussed in detail. The various detection algorithms for signal detection in MIMO system are also discussed. The research methodology used is also discussed.

Chapter 4: Results and Discussion, in this chapter the expected outcome of the study is discussed. All the results simulated in MATLAB-2014 has been discussed for the various fading channels, starting with AWGN channel, Rayleigh channel and Rician channel for our model, for M-PSK modulation technique and different antenna configurations. A complete analysis of BER is presented for the various fading channels.

Chapter 5: Conclusion, in this chapter the whole work has been concluded, on the basis of results and also future scope has been discussed.

CHAPTER-2 LITERATURE SURVEY

2.1 Overview of Massive MIMO system

The Massive MIMO innovation utilized almost numerous numbers of excellent receiving wires at the base stations. Erik G. Larsson et.al [1] discussed about the massive MIMO by n number of antenna at the transmitter side and receiving side. There are a few straight motivations to large scale MIMO Is preferable for Millimeter-Wave Bands (mm-wave). It is well recognized as one of the key enabling technologies for 5G that could provide superior spectral and energy efficiencies. This is due to two environments, non LOS and LOS. In LOS the edge is appropriated uniformly and there are perfect direct state data and in the event of non LOS the data is normal and in LOS there are 10% danger of coordinating the point implies likelihood of two terminals have comparable edge. It works in TDD mode, because the massive MIMO cannot support the FDD in low frequency and low mobility. Yet, it is still unclear to at which degree the large scale MIMO can be connected in Frequency Division Duplexing mode. Second, the uplink estimation overhead is in respect to the amount of terminals, however free of M, making the tradition flexible concerning the amount of organization receiving wires.

There are two key issues presented by Marcus Karlsson et.al [2]. The first one is that no CSI is available at the transmitter in any of the case. The issue with transmission of control motioning without CSI at the base station does not give off an impression of being as troublesome as it appears at first sight. The achievable rates per terminal with and without beamforming are basically indistinguishable in various circumstances of interest. For the case without CSI at the base station, when there is adequate coding over the repeat domain, repeating the transmission over social affairs of radio wires realizes a decently minor loss of ergodic rate. The repetition component may be chose non a case by case introduce. Future work will consolidate looking at the perfect structure of the pilot organize, and furthermore the data used for the control hailing. One of the key components of cutting edge remote correspondence frameworks will be the utilization of frequencies in the range limit 10-100 GigaHertz for populated indoor and open air situations.

2.2 Spatial diversity in massive MIMO

To transmit and broadcasting any information from the base station through omnidirectional. It is based on precoding extended alamouti code addressed by Xin Meng et.al [3] which has following features: The transmitted signal is omnidirectional means its DFT has constant envelop, each antenna has constant envelop for obtaining high power efficiency, Maximum diversity order is 2 it is simple for channel state estimation at the receiving side. In this paper each cell is divided into k=3 sectors with same signal is transmitted to equal no. of users. Which indicates separating the entire part azimuth angle into N canisters, to ensure the Omni-directional transmission, it is normally required that the transmission controls in all these N directional receptacles are equivalent. At that point the Omni-directional exhibitions use to confirm whether the clients with various LOS bearings regarding the BS have comparable BER exhibitions, which is an essential necessity for Omni-directional scope.

Haiquan Wang et.al [4] illustrated the information about STBC (space time block code). In massive MIMO the base station are prepared with multiple of antennas at the receiving side to serve with numerous users at the same time for QOS such as throughputs, reliability and efficiency. So we use different channel from the user to base station but it is mutually orthogonal because it can remove the interference. The channel is expected to experience Rayleigh blurring and subject to way path loss and shadowing impacts. Before STBC we use STTC but significantly the cost is very high for decoding complexity, to overcome these disadvantages the STBC developed, it provide full diversity with high data rate and it can be use for more than two transmitted antenna. In this paper we use M=100 antenna at the base station and K=10 users, each user has two antenna so at the receiving side we use approximately 20 antenna. After coding, the BS continues with decoding of the received signals by zero focus and minimum mean square error. Simple decoding, Minimum error probability, Maximum signal information are main method. The BER is inversely proportional to SNR so, the BER for double antenna user has better performance instead of single antenna user.

The omnidirectional transmission for space time blocks code proposed by Xiang-Gen Xia et.al [5]. Massive MIMO recognized for 5G to broadcast information to all directions so we use omnidirectional. STBC and transmission power at transmitter antenna are constant for achieving spatial diversity. At receiving side all the receiving signals will be combined in various time slot at any angle. For transmission power for every antenna -$|st(m)|^2 = c$, it is used for obtaining the constant receiving power. Criteria for constant receiving power, It accomplishes: the steady total of the gotten flag controls in two back to back availabilities at any consistent flag control at any transmit reception apparatus at any moment time, differences arrange 2, so full segment rank of the low value of space time block code. Moreover, it has the quick symbol wise ML decoding. For this we use alamouti code: The precoded Alamouti code provides diversity order 2 and has sharp single symbol Maximum Likelihood decoding. For this we use BS=64 at the transmitter and single user at the receiving side

Arti M.K. [6] represented the use of large numbers of antenna at the transmission side and receiving side to achieve data rate, high capacity and to improve the reliability. So alamouti code used to achieve overall rate orthogonal space time block code (OSTBC). One advantage of OSTBC is that it has no requirement of channel state information at the transmitter for obtaining the diversity. OSTBC supports up to 32 transmitter and 32 receiving antennas. For large dimension OSTBC not satisfied for complex functions, if it exist then the data rate may be reduced. One important thing is that in OSTBC the transmitted antenna should be less than the receiving antenna. Suppose we have Tx=8 and Rx=20, 16, 14, 12, 10 then result that diversity is equal to Tx*Rx/2. Using BPSK, it gives estimation about channel state information but analysis obtains the perfect channel state information through moment generating function.

Khin Zar Chi Winn et.al [7] focus to reduced the bit error rate by the quasi orthogonal space time block code (QOSTBC) in large MIMO. Due to increasing demand related to data rate, high efficiency, high reliability we use full rate massive MIMO. When we use more than 2 transmitted antennas than the rate of OSTBC cannot be more than 3/4. For obtaining rate more than 3/4 for 2 transmitted antennas we use QOSTBC method. We know we use alamouti code for achieving full rate diversity. Here alamouti codes are used but for more than 2 transmitted antenna. QOSTBC is a full rate STBC for more than one transmit antenna. To configuration full rate codes with complex grouping, we consider non-orthogonal codes for the 4 transmit antenna and for 8 transmitted antennas at transmission rate one so QOSTBC constructed by using alamouti code. To calculate BER we use QOSTBC with modulation BPSK. If we place greater number of transmitted and receive antenna then the SNR increases and BER performance decreases rapidly so QOSTBC used for transmission rate up to 1, 1/2, 3/4. So QOSTBC overcome the disadvantage of OSTBC.

2.3 Spatial multiplexing

In Massive MIMO we use large number of antenna at the base station for improvement in throughputs and for link reliability. For this process it requires a large number of radio frequency chain or we can say equal to transmitting antenna it is a major drawback. To overcome this drawback we use spatial modulation to improve the overall spectrum efficiency. In this the information is splits into bits and measure into two constellations with QAM modulation: single constellation, spatial constellation. At any instant of time only one transmit antenna is active and other behave as a radiated zero power. According to this the interference at the receiver antenna will be reduced. Example we consider N=4 no. of transmitted antenna, k=2 RF chains then N/K=2 means it contain two groups of information and bits are modulated using M-QAM and the information is divided into two parts with limited no. of RF chain. Laconically, Garimella Rama Murthy et.al [8] explained using SM that need less no. of RF complexity, size, and cost and remove the interference, and improve the spectral efficiency with spatial multiplexing.

Joyatri Bora et.al [9] analyzed that we use scheduling algorithm to decrease the downlink data rate slower as the result feedback quantity increased through getting feedback from the users. For different number of antenna we use different numbers of feedback bits. For spatial diversity and multiplexing with approximate 70 users sending feedback from the users to the base station using different number of bits. We observe that for higher feedback bits the downlink data rate will be higher with lower number of users. The all process depends upon scheduling parameters. According to the author first collect the feedback from all users and compare with given technique after observe that the users which have feedback above the threshold value the downlink data rate decreases with small changes for the users.

Massive MIMO has more advantages then MIMO system. It is current research topic on 5 generation. By Ruonan Zhang et.al [10] described that countless antenna in a 2D array, an eNodeB (eNB) can shape various vertical angles and track moving vehicles for the spatial multiplexing productivity in the vehicle-to-foundation (V2I) get to can be expanded fundamentally Using elevation beamforming. According to the research of author, the channel spread qualities and the between vehicle obstruction in the elevation domain spatial multiplexing for V2I the author said that place a large number of antennas in two dimensional arrays then it forms a multiple narrow beam in azimuth and elevation domains. Basically it depend on sigma for closed street like there are buildings on both sides so we observe that when vehicle is moving toward eNodeB then sigma is increasing rapidly and for open street it is decreasing eNobe placed on the top of building for pointing out the moving vehicles .

2.4 Beamforming

Generally base station sending directional beams to the users by using downlink beamforming. Xun Zou et.al [11] demonstrated inter beam interference are performing by user grouping in massive MIMO. Those user which are serious for inter beam interference are separate into groups so users can use different time slot. The grouping method is achieved by flowchart using absolute value of x, azimuth of user identity and finally we use groups to store the output in grouping. After this process the downlink beam will be transferring. In downlink, clients in indistinguishable gathering are served at the same time while clients in various gatherings are served in various vacancies. Through reproduction, we check our plan's plausibility also, consider its framework execution. From reenactment we make our inference that the shadow blurring and transmit SNR won't impact the ideal bar number.

The main focus on performance of massive MIMO for zero forcing beamforming by using time shifted scheme for finite and infinite antenna regimes. Here the flat fading channel used to find the characteristics of channel. Here we require channel reciprocity and TDD operation for that we prefer reverse link pilot to find channel estimation and then each coherence distinguish into four conditions: to begin with, clients send turn around interface pilot groupings of length τ ; next is, BSs remove channel vector gauges from these pilots, which takes N image periods; at that point, BSs transmit precoded forward-interface information to their clients utilizing the channel gauges for D images; the last one is every one of the clients in the framework transmit turn around interface information to their BSs for U image periods. So total rate and SINR expressions, we explored how the framework execution impacted by the transmit powers, the cell bunch number also, the quantity of BS receiving wires and planned UTs, which given bits of knowledge that is addressed by Shi Jin et.al [12] to the plan of an enormous MIMO framework with time-moved pilots.

Beamforming under spatial precoding use beam-grouping, Precoding and feedback scheme in frequency division Duplexing for Massive MIMO, due to reduce channel state problems. This solution is addressed by Ming-Fu Tang et.al [13] to decrease the downlink working out overhead; through the precoder beamforming-based downlink training is done. In this manner, the correspondence system for FDD frameworks can be separated as three stages: 1) Downlink training: to assess the channel and decide the path for every UE. 2) Uplink feedback: to encourage the Channel SI back to the Base station. 3) Downlink transmission: through these techniques use not only to reduce downlink training but also reduce the CSI feedback overhead and to transmit the data information. It is observe that the projected plot has a somewhat input fixed cost as the quantity of UEs increments.

2.5 Performance using linear and non linear channel in MIMO

Catalina Munoz Morales et.al [14] demonstrated on performance analysis for both channels that is linear or non linear prediction in 4G technology. These linear prediction algorithms are based on Autoregressive (AR) model and Kalman filter. On the other hand non linear prediction based on neural networks (NN). We use MIMO OFDM for transmission and receiving system with three stages (1) forward error control (FEC)(2) spatial multiplexing technique(3)Inverse fast Fourier transformer (IFFT)in OFDM. On the other hand at the receiving end decode the information using viterbi coding, zero forcing decoder, OFDM modulation using fast Fourier transformer. It has merits in case of latency and MSE. In this paper we observe that if order is highest the errors are smallest. In non linear prediction we using NN have the smaller mean square error with value 0.0811 for RNN and for time delay the value is 0.0875 but latency rate increases from 0.7150 to 0.7700. on the other hand using kalman filter show higher error it shows better performance in case of Doppler spread changes.

Jiayi Zhang et.al [15] proposed on spectral efficiency of massive MIMO by using hybrid antenna at the BS. Through this research the use of maximum ratio combining, zero forcing and minimum mean square error improve the performance. By applying some expressions we observe that maximum ratio combining receiver is non optimal for space constrained. On the other side the ZF and MMSE continuously provide high spectral efficiency with increasing base station. Through expository and numerical comes about, For ZF beneficiary, we inferred new lower and upper limits on the whole SE, which increments for a higher number of UEs, as long as M = K. Besides, the proposed bring down bound is more tightly than the upper bound. From this we observe that spectral efficiency increases with the base station antennas. All is depend upon SINR of ZF and MMSE receivers expect MRC because it works with low SINR.

2.6 Signal detection in MIMO

For signal detection scheme in massive MIMO, the number of receiving antenna is less than the transmitted signal. By studying signal detection the performance is done using joint detection and decoding. The different signal detection techniques such as zero forcing, Minimum mean square error and maximum likelihood detection etc. By placing n number of antenna at the transmitter and receiving side the channel may undergo intersymbol interference that is the big issues which are reduce using different detection techniques. The main focus on linear and non linear detection technique in the condition of AWGN, Rayleigh and Rician channel. The final result observe that the performance of the receiving antenna in AWGN channel are all most 3dB enhanced over Rayleigh fading channel. In comparison to Rician fading channel for all fading variable of K, all recipients in AWGN channel are better. In case of Rician channel, there is a worst result as compare to AWGN. B. Jethva et.al [16] discussed about all detectors but the MMSE detectors are better than ZF for detection technique.

2.7 Massive MIMO with different receiver structures

Pilot contamination is the big issue in large scale MIMO system. Liang Wu et.al [17] analyzed about channel estimation scheme under Rician fading channel. Suppose the pilot for same cell user is orthogonal but for separate users use identical cells. The channel state information for pilot structure is derived from different cell users through pilot contamination. Basically the base station estimate through LOS and data is also decoded using line of sight. The decoded data are used to update the channel state information. The achievable SE and control scaling law of the proposed scheme are observed. The proposed information helped calculation accomplishes a higher Spectral effectiveness than the LOS-segment based calculation in feeble Rician channels, and the LOS-part based calculation accomplishes a higher SE in solid Rician channels.

By using the pilot signals the base station (BS) estimates the channel state information (CSI transmitted from the clients, practically each BS will have imperfect CSI. Van-Dinh Nguyen et.al [18] derived new outcomes with a ZF receiver for the achievable rate of the uplink in a MIMO system. After that using the pilot signals BS estimates the CSI and the data transmission users estimated CSI to detect the independent transmit data streams from the users. The spectral efficiency increases, when the SNR is low and the spectral efficiency reaches a saturated value, at a high SNR, This implies that increasing the transmit power for each user. Furthermore, the effect of the pilot contamination on the system performance was investigate. When the gain factor increases from 0 to 1 and the variance of the channel estimation error increases from 0.01 to 0.85, the spectral efficiency decreases significantly. In particular, when the cross gain factor is almost equal to the gain of the desired link, the spectral efficiency becomes very low regardless of the number of antennas *M*.

Paul Harris et.al [19] proposed the single cell over uplink channel for large MIMO (Multiple-Input-Multiple-Output). The author provided algorithm for explaining the spatial degrees of freedom for massive MIMO to obtaining the highest signal to interference-plus-noise ratio (SINR) for each client, by considering the mutual spatial association arising from other clients. It also minimizes the necessary uplink transmit power to achieve the highest possible uplink SINR per user without increasing the density at the user equipment. The base station (BS) controled the client transmission power using only two bits in a Transmission Power Control (TPC) command and the newly introduce algorithm is likely to increase both the energy efficiency (EE) and single cell spectral efficiency (SE) with reduced transmission overhead, latency and complexity in the receiver. The proposed algorithm supports several popular linear MIMO decoders and precoders including Minimum Mean Square Error (MMSE), Zero-Forcing (ZF) and Matched Filtering (MF).

Stefano Buzz et.al [20] explained about the less wavelength, at minimum on a fundamental level, correspondence joins wherein not just the base-station, additionally the client gadget, are furnished with exceptionally huge receiving wire clusters. It can be demonstrated that preparing a base station (BS) with a huge (> 100) no. of receiving wires, gets an enormous increment the system limit, primarily because of the ability of serving a few clients on a similar recurrence space with almost orthogonal vector channels. In the large scale MIMO writing, while the number of reception apparatuses at the BS develops huge, in reality, at sub- 6 Giga Hertz frequencies the wavelength is in the request of a few centimeters, hence making it hard to pack numerous receiving wires on little estimated client gadgets. For instance, at a transporter recurrence of frequency 30 Giga Hertz the wavelength is 1 cm, and for a planar receiving wire cluster with $\lambda/2$ dispersing, more than 180 reception apparatuses can be put in a zone as huge for a specific charge card; this number trips up to 1300 at a bearer recurrence of 80 GHz. While staying alerted that there are various genuine functional requirements – e.g., substantial power utilization, low proficiency of control speakers, equipment unpredictability.

To transmit and broadcasting any information from the base station through omnidirectional. It is based on precoding extended alamouti code that is analyzed by Xin Meng et.al [21]. Which has following features: The transmitted signal is omnidirectional means its DFT has constant envelop, each antenna has constant envelop for obtaining high power efficiency, Maximum diversity order is 2 It is simple for channel state estimation at the receiving side. In which we use omnidirectional scheme for transmitting the signals in an envelope of users In this paper each cell is divided into k=3 sectors with same signal is transmitted to equal no. of users, to ensure the Omni-directional transmission, it is normally required that the transmission controls in all these N directional receptacles are equivalent. At that point we have the accompanying recommendation. In addition parallel power transmission on every receiving wire is an essential execution pointer for MIMO frameworks, particularly gigantic MIMO frameworks. This is on the grounds that when add up to transmission power is settled, meet power transmission on every radio wire permits us to utilize littler and less expensive PA for the radio wire exhibit. At that point we the omni-directional exhibitions to confirmed, whether the clients with various LOS bearings regarding the BS have comparable BER exhibitions, which is an essential necessity for Omni-directional scope.

Vahid Tarokh et.al [22] Prasad explained that, encode the data using STBC and encoded data split into n streams and then transmitted using transmit antenna. STBC technique is configuration to get most extreme assorted qualities. These codes accomplish the most extreme conceivable transmission rate for any number of transmit receiving wires utilizing any subjective genuine star grouping, for example, PAM. For a self-assertive complex heavenly body, for example, PSK and QAM, space–time piece codes are outlined that accomplish 1/2 of the most extreme conceivable transmission rate for any number of transmit radio wires. For the particular instances of two, three, and four transmit reception apparatuses, space–time square codes are planned that accomplish, individually, every one of the, 3/4, and 3/4 of greatest conceivable transmission rate utilizing complex star groupings. The best tradeoff between the disentangling delay and the quantity of transmit radio wires is additionally registered and it is demonstrated that a number of the codes exhibited here are ideal in this sense too

2.8 Massive MIMO development for 5G

Massive MIMO developed for future broadband wireless communication system. K. N. R. Surya Vara et.al [23] described bout on energy efficiency, throughputs and reliability. MIMO can expand the limit 10 times or all the more all the while, enhance the transmitted vitality productivity in the request of 100 times Current LTE advancements. This article has explored a couple opportunities to help the EE grabs publicized by gigantic MIMO (MM) structures. This article has in like manner investigated about where MM works close by other rising 5G headways, for instance, millimeter wave and heterogeneous frameworks. Shared advantages rising up out of the conjunction of these 5G developments were explored to understand why creamer MM structures have a huge potential to finish greater EE gets than conventional MM systems. An essential study of the best in class on the arrangement of essentialness capable hybrid MM systems allowed us to recognize a couple open research issues for future work.

An investigation of broadcasting in gigantic MIMO (numerous info and different yield) frameworks with a restricted soundness interim is displayed. When broadcasting normal data, for example, control signals, the base station does not have channel state information to the terminals. Emil Bjornson et.al [24] suggested that the base station conveys this normal information using a low dimensional orthogonal space-time square code (OSTBC) while the 443 code is better if the mistake likelihood is under 10^3. So the alamouti code to be the favored choice. Alamouti code is ideal in this sense, for high standardized transmit powers. The Alamouti code performs well qualities, however falls behind codes with more spatial assorted qualities when time or recurrence diversity is constrained. In a low assorted qualities situation, where the message just observes one channel acknowledgment extra differences by the code appears to be necessary, especially when the unwavering quality imperative is fixed.

Gervais N. Kamga [25] demonstrated the information about spectral efficiency by using huge MIMO. In which we use distributed or automated antenna and centralized configuration for the designing, location and analysis all are depend upon the antenna. Distributed antenna has greater advantages such as low transmission power, higher multiplexing gain, high efficiency etc. both distributed and centralized MIMO perform a task :create a scientific channel display, where way misfortune, shadowing impact also, multi-way blurring are represented; lead diagnostic execution assessment and evaluate key variables that decide framework execution. Specifically, for D-MIMO frameworks, diverse way misfortunes and shadowing impacts w.r.t. distinctive Base station radio wires are basic to the acknowledgment of Tx/Rx assorted qualities. So the spectral efficiency of centralized and distributed antenna in terms of medium to peak level SNR the work is perfectly for both antenna setting.

Muhanned Al-Rawi et.al [26] addressed about Massive MIMO has huge no. of advantages, wide application so it is use for future development. it consist of uplink model, channel model and linear detection process. The nakagami-m fading is used to model the distribution in communication. If nakagami fading channel has m=1 then it behaves same as a Rayleigh fading. If m>1 then the fluctuation is decreases compared to Rayleigh fading. If m is infinity then nakagami-m fading become non fading. If m=0 then it behaves as a Rician fading. utilizing the MRC and ZF direct discovery plans. ZF is a straightforward flag handling that functions admirably in obstruction restricted situations, yet since ZF dismisses and With MRC the BS amplifies the got flag to-commotion part (SNR) of each stream, disregarding the impact of multiuser impedance. The overall analysis observe that the quantity of BS radio wires. Likewise, the execution with ZF is superior to that with MRC. So in the overall analysis the ZF perform well than MRC.

Siavash M. Alamouti [29] explained about the diversity improvement in different environment such as macro, micro and Pico cellular areas. This phenomena use for increase the quality and decreasing the effective error in multiple way fading. In added additive white gaussion noise (AWGN), utilizing average coding schemes, for decreasing the bit error rate (BER) from limit 10^-2 to 10 ^-3may require just 1-or 2-dB signal to- noise proportion (SNR). Accomplishing the equal in a multipath blurring can be reduced by transmitting power control. The Encoding and Transmission Sequence: the encoding is done in frequency and time (space–time coding). The

Combining Scheme: The two consolidated signs that are sent to the most extreme probability indicator: The Maximum Likelihood Decision Rule: The main contrast is stage revolutions on the commotion segments which don't debase the viable SNR. It is like MRRC. At the point when contrasted and MRRC, if the aggregate emanated power is to continue as before, the transmitted differing qualities conspire has a 3-dB weakness as a result of the concurrent transmission of two particular images from two radio wires.

Kamsani Samingan et.al [30] introduced a receiving wire synchronization and mover recurrence counterbalances pre-relief method, which is proposed for conveyed monstrous MIMO system. The method's execution is reliant to the SNR and in addition the quantity of OFDM images per transmission parcel. This paper presents beneficiary reception apparatus synchronization and CFO pre-moderation strategy focusing on appropriated gigantic MU-MIMO TDD framework concentrating on the uplink channel. The SNR additionally assumes a critical part in genuine framework. The next some portion of the paper indicates researches the execution of the proposed radio wire synchronization system. Essentially, the strategy requires adequate Signal to noise ratio at the beneficiary. On account of our framework, 50 OFDM images for each transmission parcel are regard too expensive for the synchronization and moderation system to deal with, while the extent of 30 OFDM images for each parcel is discovered more reasonable.

3.1 Massive MIMO

MIMO (Multiple input multiple output) is useful in wireless communication for multiplying the capacity of radio channel through multiple transmitting and receiving antennas. Generally it is a technique to send and receive more than one data rate signal over air medium which is actually used to perform two main functions i.e. beamforming and diversity.

The main concern of MIMO system is space time processing. This technique has many advantages. Using some algorithms and codes we can perform well in any channel situation.

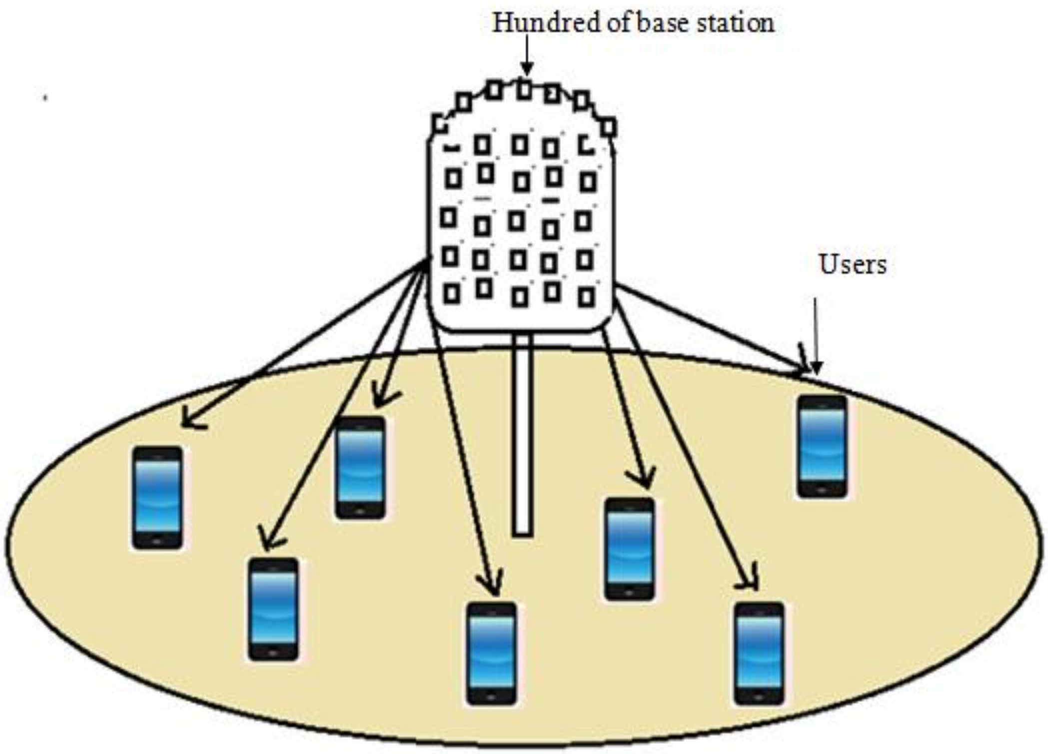


Fig.3.1. Massive MIMO system

It is extremely possible that we will utilize high frequency (mm Wave) motion in 5G. High frequency involve that the span of single receiving wire will be little and the opening (the range for accepting vitality) will be little. To defeat this little opening on receiver side at high recurrence, we have to utilize countless reception apparatus. Massive MIMO improve the capacity 10 times or greater than that. Large MIMO increases the data rate due to hundred of antenna that transmit the data streams independently. This acquires colossal changes throughput and vitality productivity, in especially when joined with synchronous planning of an extensive number of client terminals (e.g., tens or hundreds). It obey the beamforming to reduce the fading. Huge MIMO was at first envisioned for time division duplex (TDD) operation, yet can possibly be associated also in repeat division duplex (FDD) operation. Other benefits of massive MIMO include the extensive use of inexpensive low-power components, reduced latency, simplification of the media access control (MAC) layer, and robustness to interference and intentional jamming. It uncovers entirely new problems that urgently need attention; While massive MIMO renders many traditional research problems irrelevant for example, the challenge of making many low-cost low-precision components work effectively together, the need for efficient achievement scheme for channel state information, resource allocation for newly-joined terminals, the exploitation of extra degrees of freedom provided by an excess of service antennas, reducing internal power consumption to achieve total energy efficiency reductions, and finding new deployment scenarios.

3.2 Space Time Coding

A space–time coding (STC) is a strategy utilized for enhance the reliability and quality of information transmitted in remote correspondence signal utilizing numerous transmit reception apparatuses. STCs depend on transmitting different, repetitive duplicates of an information stream to the recipient with the expectation that at any rate for optimal state to reliability.

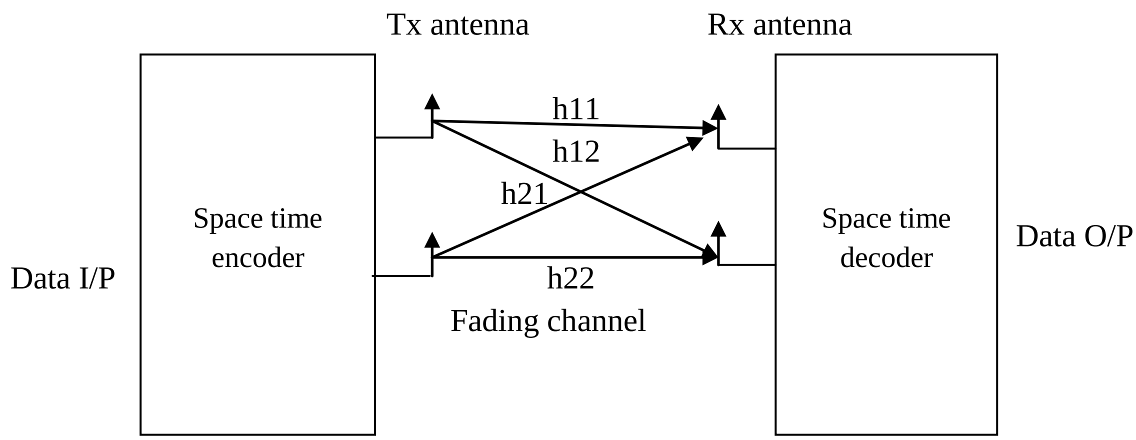


Fig. 3.2. Space Time Coding

The different Space-time block coding techniques are as mentioned below:

- Alamouti scheme
- Space Time Block Coding
- Omnidirectional space time block coding
- Qausi space time block coding

3.2.1 Alamouti Scheme

The alamouti method is used to achieve spatial diversity for two antennas in MIMO. In this page, the Alamouti coding perform for 2transmitters-1receiver system(2x1) and 2transmitters 2receivers system(2x2). In the first time period the data send through first antenna and in second time period the data send by second antenna for alamouti code.

For 2 transmitter and 2 receiving antenna

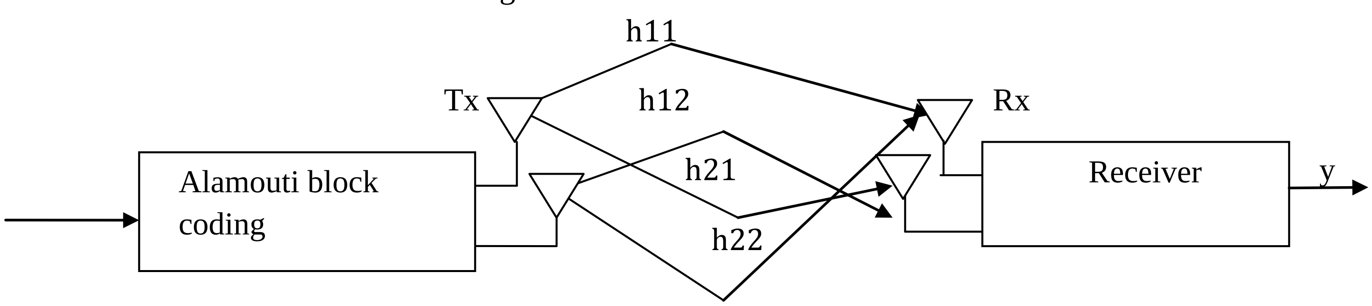


Fig.3.3. Alamouti Scheme

	Time slot	
Space (antenna)	X1	-X2*
	X2	X1*

$$Y = HX + N \quad (14)$$

Here y represent the receiving signal, X define the transmitted signal with additive white gaussion noise (N).

Assume, we have two transmitter antennas as above matrix

I. First we send two transmission symbol in first we transmit x1 in first schedule and x2 in the next time slot

The first receiving signal is

$$Y1=h1x1+h2x2+n1=[h1 \quad h2]\begin{bmatrix} x1 \\ x2 \end{bmatrix}+n1 \tag{15}$$

II. So alamouti prefer to send the symbols in groups in the first schedule vacancy transmit x1 and x2 and in second time slot send -x2*and x1*

The second receiving signal is

$$Y2=-h1x2^*+h2x1^*+n2=[h1 \quad h2]\begin{bmatrix} -x2\,* \\ x1\,* \end{bmatrix}+n2 \tag{16}$$

This is the simple transmission by Alamouti space time coding. Alamouti have some drawback that it does not have much. This is an exceptionally unique STBC. It is the main orthogonal STBC that accomplishes rate-1.

$$\begin{bmatrix} y1 \\ y2 \end{bmatrix} = \begin{bmatrix} h1 & h2 \\ h2\,* & -h1\,* \end{bmatrix}\begin{bmatrix} x1 \\ x2 \end{bmatrix}+\begin{bmatrix} n1 \\ n2 \end{bmatrix} \tag{17}$$

According to the main STBC that can achieve its full opposed behavior pick up its information rate without expecting to give up. Entirely, this is valid for complex tweak images. Since all star grouping graphs depend on complex numbers notwithstanding, this property typically gives Alamouti code a critical preferred standpoint over the higher-arrange STBCs in spite of the fact that they accomplish a superior blunder rate execution. coding rate and can't achieve always most noteworthy data rate.

3.2.2 Space Time Block Coding

Space–time block codes (STBCs) follow up on a square of information without a moment's delay (comparably to square codes) and furthermore gives diversity gain however does' nt provide coding gain. It is advance type of alamouti plan and it holds all the vital elements of Alamouti plan also some headway. These summed up codes are orthogonal in nature and transmit receiving wires can accomplish full differences through this.

$$\text{Time slot}\overset{\text{Transmit antennas}}{\begin{bmatrix} S11 & S12\cdots & S1n \\ S21 & S22 & \vdots S2n \\ Sm1 & Sm2\cdots & Smn \end{bmatrix}} \quad (18)$$

$$Y=Hs+n \quad (19)$$

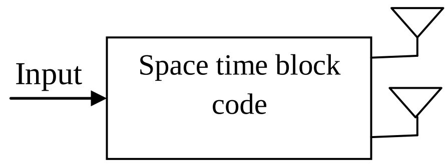


Fig.3.4. Space Time Block Coding

As of now specified that STBC are the development of Alamouti Space time code in which the encoding and disentangling arrangements when Alamouti on both the transmission and beneficiary sides are the same as there in the are used for MIMO systems to enable the transmission of various copies of a data stream over different radio wires and to manhandle the diverse got types of the data to upgrade that reliability of data trade. Space-time coding solidifies each one of the copies of the got movement in a perfect way to deal with eject however much information from all of them as could be normal. Space time square coding utilizes both spatial and fleeting assorted qualities and along these lines empowers noteworthy additions to be made. Space-time coding includes the sending of different copying information. This makes up for the multi path issues, for example, blurring and warm commotion. In spite of the fact that there is repetition in the information a few duplicates may arrive less defiled at the recipient. When utilizing space-time square coding, the information stream is encoded in pieces preceding transmission. These information pieces are then appropriated for the numerous reception apparatuses and the information is likewise divided crosswise over time. STBC does not use for more than 2 antenna. There is some drawback that Sensitivity to channel estimation error, Delay Effects, Antenna Configurations.

Transmission by utilization of 2 antennas,

$$H2=\begin{bmatrix} x(t)1 & x(t)2 \\ -x(t)2* & x(t)1* \end{bmatrix} \quad (20$$

By utilization of 4 antenna

$$H4 = \begin{bmatrix} x(t)1 & x(t)2 & x(t)3 \\ -x(t)2 & x(t)1 & -x(t)4 \\ -x(t)3 & x(t)4 & x(t)1 \\ -x(t)4 & -x(t)3 & x(t)2 \\ x(t)1* & x(t)2* & x(t)3* \\ -x(t)2 & x(t)1* & -x(t)4* \\ -x(t)3* & x(t)4* & x(t)1* \\ -x(t)4* & x(t)3 & x(t)2* \end{bmatrix} \quad (21$$

3.2.3 Orthogonal space time block coding (OSTBC)

OSTBC stands for orthogonal space time block coding. It gives more advantages then space time coding. OSTBC use more than 2 antennas. The OSTBC accomplish full diversity qualities with low decoding multifaceted nature. The exhibitions of STBC and OSTBC codes are performed in regard of Bit Error Rate (BER) and diversity qualities pick up by the Rayleigh blurring or fading channel. The OSTBC use linear STBC and all signals are orthogonal to each other.

Table 3.1. OSTBC

Transmitted Antenna	Rate	OSTBC codeword matrix
2	1	$g = \begin{bmatrix} g1 & g2 \\ -g2* & g1* \end{bmatrix}$
3	½	$\begin{bmatrix} g1 & g2 & 0 \\ -g2* & g1* & 0 \\ 0 & 0 & g1 \\ 0 & 0 & -g2* \end{bmatrix}$
3	¾	$\begin{bmatrix} g1 & g2 & g3 \\ -g2* & g1* & 0 \\ -g3* & 0 & g1* \\ 0 & S3* & -g2* \end{bmatrix}$
4	½	$\begin{bmatrix} g1 & g2 & 0 & 0 \\ -g2* & g1* & 0 & 0 \\ 0 & 0 & g1 & g2 \\ 0 & 0 & -g2* & g1* \end{bmatrix}$
4	¾	$\begin{bmatrix} g1 & g2 & g3 & 0 \\ -g2* & g1 & 0 & g3 \\ g3* & 0 & -g1* & g2 \\ 0 & g3* & -g2* & g1 \end{bmatrix}$

3.2.4 Quasi Orthogonal space time block coding

QOSTBC stands for qausi orthogonal space time block coding. Another approach for Quasi-Orthogonal space time piece coding (QO-STBC) is proposed. When we use more than 2 transmitted antennas than the rate of OSTBC cannot be more than 3/4. For obtaining rate more than 3/4 for 2 transmitted antennas we use QOSTBC method. If we place greater number of transmitted and receive antenna then the SNR increases and BER performance decreases rapidly so QOSTBC used for transmission rate up to 1, 1/2, 3/4. So QOSTBC overcome the disadvantage of OSTBC .

$$\text{A12}=\begin{bmatrix} s_{11} & s_{12} \\ -s_{12}^{*} & s_{11}^{*} \end{bmatrix} \qquad \text{A34}=\begin{bmatrix} s_{13} & s_{14} \\ -s_{14}^{*} & s_{13}^{*} \end{bmatrix} \tag{22}$$

$$\text{A56}=\begin{bmatrix} s_{15} & s_{16} \\ -s_{16}^{*} & s_{15}^{*} \end{bmatrix} \qquad \text{A78}=\begin{bmatrix} s_{17} & s_{18} \\ -s_{18}^{*} & s_{17}^{*} \end{bmatrix} \tag{23}$$

- **Matrix for 8*8 antenna using QOSTBC**

$$\text{B}=\begin{bmatrix} A12 & A34 \\ -A34* & A12* \end{bmatrix} = \begin{bmatrix} s_{11} & s_{12} & s_{13} & s_{14} \\ -s_{12}^{*} & s_{11}^{*} & -s_{14}^{*} & s_{13}^{*} \\ -s_{13}^{*} & -s_{14}^{*} & s_{11}^{*} & s_{12}^{*} \\ s_{14}^{*} & -s_{13} & -s_{12} & s_{11} \end{bmatrix} \tag{24}$$

$$\text{C}= \begin{bmatrix} A56 & A78 \\ -A78* & A56* \end{bmatrix} = \begin{bmatrix} s_{15} & s_{16} & s_{17} & s_{18} \\ -s_{16}^{*} & s_{15}^{*} & -s_{18}^{*} & s_{17}^{*} \\ -s_{17}^{*} & -s_{18}^{*} & s_{15}^{*} & s_{16}^{*} \\ s_{18}^{*} & -s_{17} & -s_{16} & s_{15} \end{bmatrix} \tag{25}$$

On Combined equation (14) and (15) the antenna configuration is

$$\text{Q}=\begin{bmatrix} B & C \\ -C* & B* \end{bmatrix} =$$

$$\begin{bmatrix} s11 & s12 & s13 & s14 & s15 & s16 & s17 & s18 \\ -s12* & s11 & -s14* & s13* & -s16* & s15 & -s18* & s17* \\ -s13* & -s14* & s11* & s12* & -s17* & -s18* & s15* & s16* \\ s14* & -s13 & -s12 & s11 & s18* & -s17 & -s16 & s15 \\ -s15* & -s16* & -s17* & -s18* & s11* & s12* & s13* & s14* \\ s16 & -s15 & s18 & -s17 & -s12 & s11 & -s14 & s13 \\ s17 & s18 & -s15 & -s16 & -s13 & -s14 & s11 & s12 \\ -s18* & s17* & s16* & -s15* & s14* & -s13* & -s12* & s11* \end{bmatrix}$$

This method improve Quasi Orthogonal-STBC execution with iterative receiving antennas to obtain as much as information.

3.4 STTC (Space time trellis code)

Space-time-trellis-coding(STTC) is an appealing and promising arrangement, which accomplishes data transfer capacity efficient transmit diversity by utilizing exceptionally planned channel codes at the transmitter end in combining with some extra flag handling at the recipient. Use with MIMO-OFDM for enhances the information rate and the reliability of wireless domain. The decoding of flag STTC codes are simulated by utilizing three main decoding techniques, these are MMES (least mean square mistake), ZF (zero constraining), ML (maximum probability) utilizing delicate choice decoding with viterbi calculation. Space Time Trellis Coded Modulation (STTCM) is acquired by assuming channel coding with the Numerous Input Multiple Output (MIMO) idea to enhance the information rate and the reliability of MIMO system interchanges. Numerous execution criteria have been built up to increase both diversity and coding gain of STTC. Finally the rank and determinant criteria for moderate blurring channels and the Euclidian separation the item separate criteria for quick blurring channels. Convolution encoders with a similar structure however with various weighting coefficients are allocated to transmitting different branches in STTC . The state changes of the encoders are subsequently the same, yet their yields vary, as indicated by the past sources of info. A most extreme probability arrangement estimator (i.e., a Viterbi decoder) can be connected at the output side.

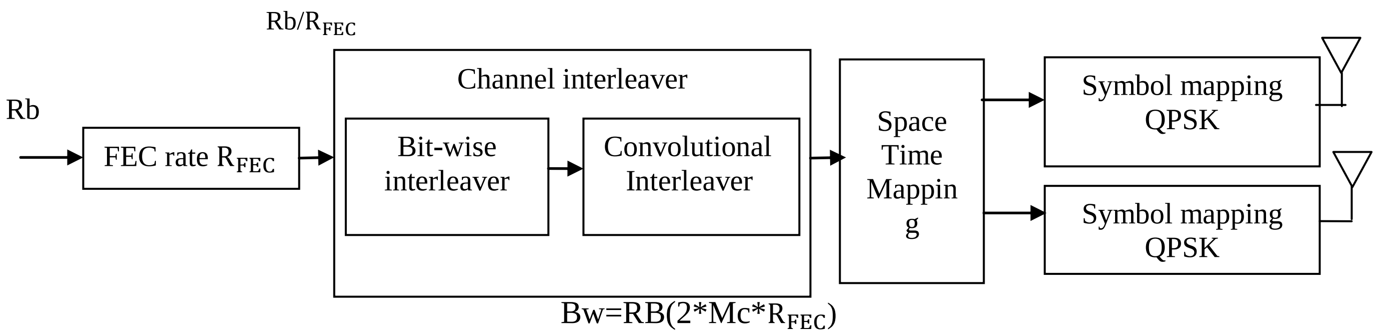


Fig.3.5. STTC block diagram

3.5 Benefits of Massive MIMO:

(1) Huge throughput efficiency and high correspondence unwavering quality: Massive MIMO acquires all additions from traditional MU-MIMO, i.e., with M-radio wire BS and K single-receiving wire clients, we can accomplish an assorted qualities of request M and a multiplexing pick up of min (M, K). By expanding both M and K, we can get a enormous unearthly efficiency and high correspondence unwavering quality.

(2) High energy efficiency: In the uplink Massive MIMO, intelligible consolidating can accomplish a high cluster pick up which takes into consideration significant diminishment in the transmit energy of every client. In the downlink, the BS can center the vitality into the spatial bearings where the terminals are found. For number of clients, by multiplying the quantity of BS radio wires, while diminishing the transmit control by two, we can keep up the first the unearthly efficiency, furthermore, consequently, the transmitted vitality efficiency is multiplied.

(3) Simple signal prepare: For most spread situations, the utilization of an unnecessary number of BS reception apparatuses over the quantity of clients yields positive engendering where the channel vectors between the clients and the BS are nearly orthogonal. Subsequently, basic straight handling plans are about ideal. Another key property of Massive MIMO is channel solidifying. Under a few conditions, at the point when the quantity of BS receiving wires is extensive, the channel turns out to be (almost) deterministic.

3.6 Drawback:

(1) Pilot contamination the reason is that less no. of orthogonal pilot subcarriers as of bounded rational period with bandwidth.

(2) Large signal processing complication due to deployment of large number of antennas and multiplexing of UEs (or Mobile subscribers).

(3) Sensitive to beam alignment, as exceptionally narrower beam is use that is sensitive to progress antenna array.

(4) Channel reciprocity statement is used in TDD mode of large MIMO.

4.1 Expected outcome of the study

The Bit Error Rate is used as the measure for presentation analysis of MIMO system over different fading channels for Zero Forcing receiver. When the bit error rate explain for MIMO system over Rayleigh channel is compared to the AWGN case, around 5 dB degradation occurs due to the multipath channel. This is both good and bad: bad because we need to spend so much energy to get a reliable wireless link up (in this era of global warming), and good as efforts are made to figure out ways for improving the performance. Due to space diversity as the number of transmitting and receiving antennas increases and BER keeps on decreasing. It enhanced BER performance as compare to the other antenna configurations or AWGN channel.

4.2 Preliminary Research/Experimental work done

In preliminary research, using STBC code configuration in MIMO system will be done for various Modulations techniques over different disappearance channels through BER study. MIMO system cover through M-PSK for The BER analysis of over AWGN channel, Rayleigh fading channel and Rician fading channel, here M values are 32, 64, 128, 256, 512 and 1024 using Alamouti Space Time – Coding. Then the BER study of MIMO system by M-PSK is presented over different fading channels that includes AWGN channel, Rayleigh channel, and Rician channel, where M can be 32, 64, 128, 256, 512 and 1024 OSTBC3, OSTBC4 and QOSTBC4 Space Time – Coding for different antenna configurations.

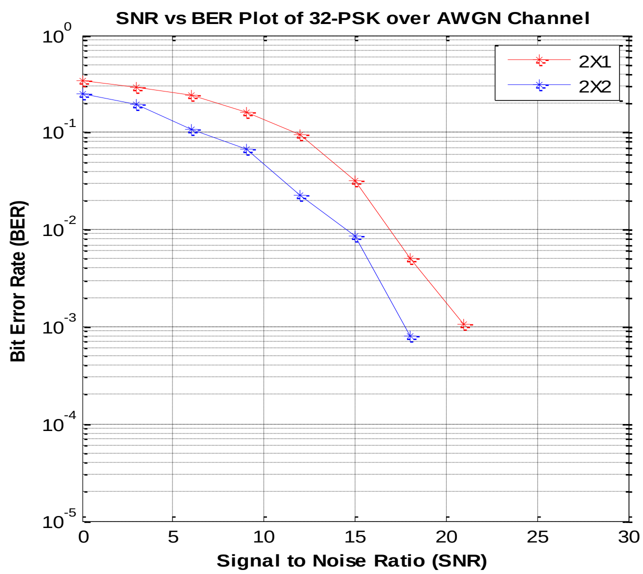
4.3 BER Analysis of MIMO System

For higher order modulations over different fading channels, the BER study of MIMO system using STBC code structure is done. Firstly, MIMO system using M-PSK is presented over diverse fading channels by Alamouti Space-Time Coding and then the analysis of MIMO system for M-PSK is presented over different fading channels using OSTBC3, OSTBC4 and QOSTBC4 Space-Time Coding. Here at present, the fading channels used for this purpose are AWGN, Rayleigh and Rician channels.

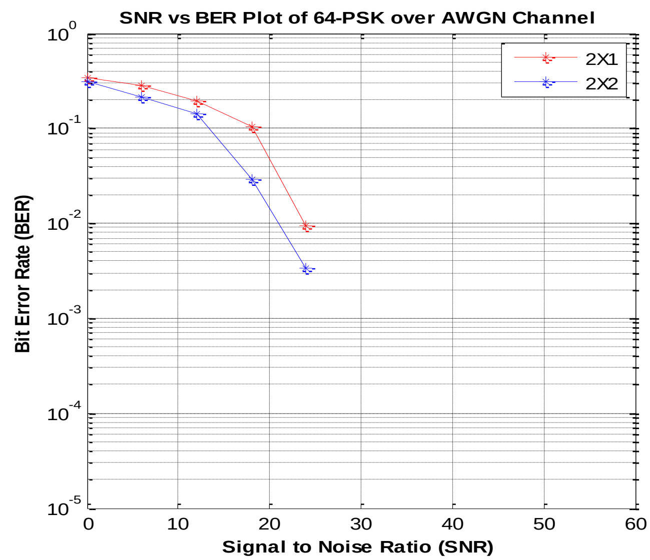
4.3.1 M-PSK over different Fading channels using Alamouti Space-Time Coding

In this section, the BER performance of MIMO system is analyzed using M-PSK over different fading channels using Alamouti Space-Time Coding.

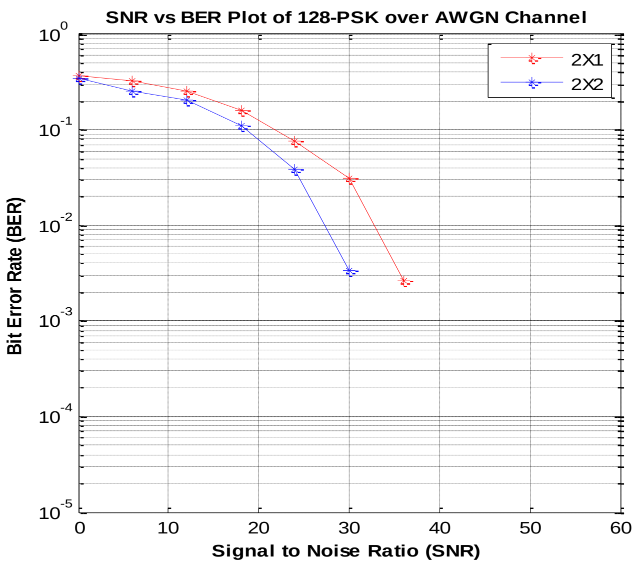
4.3.1.1. M-PSK over AWGN channel



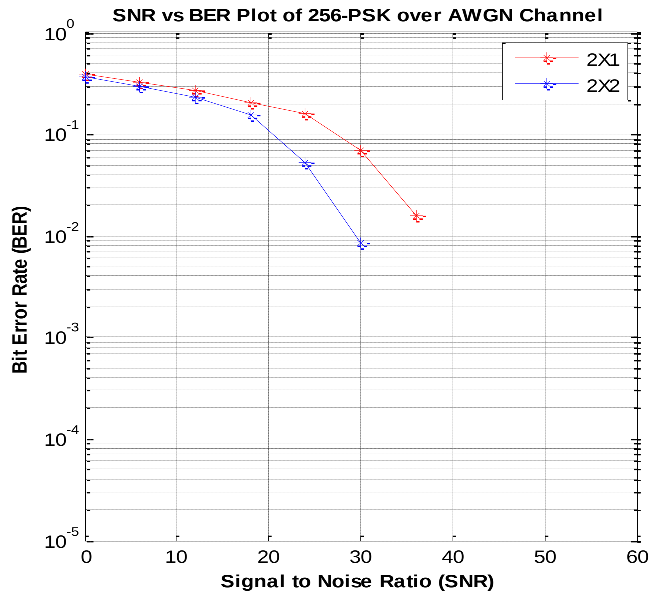
(a) 32-PSK



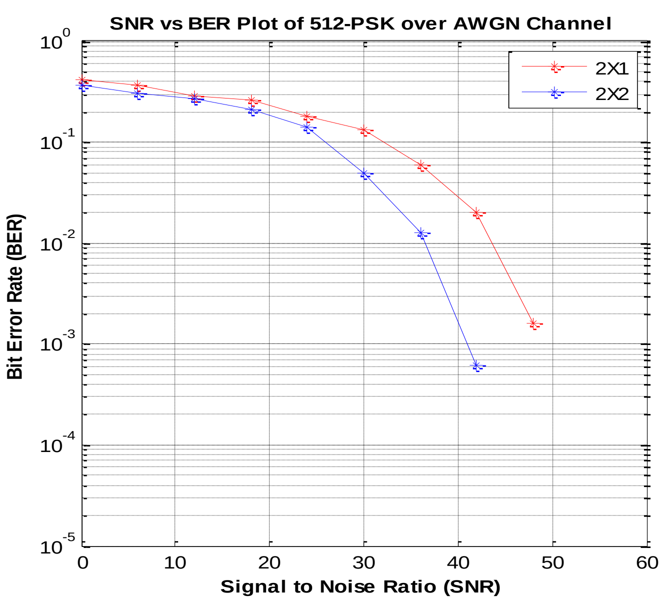
(b) 64-PSK



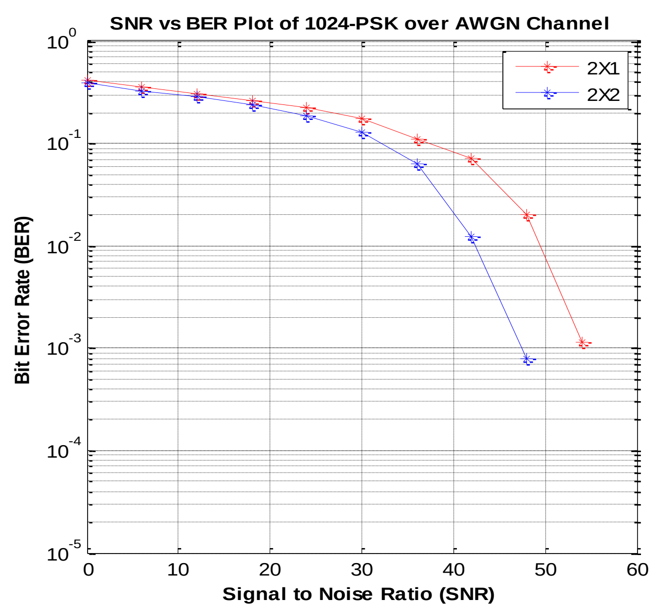
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

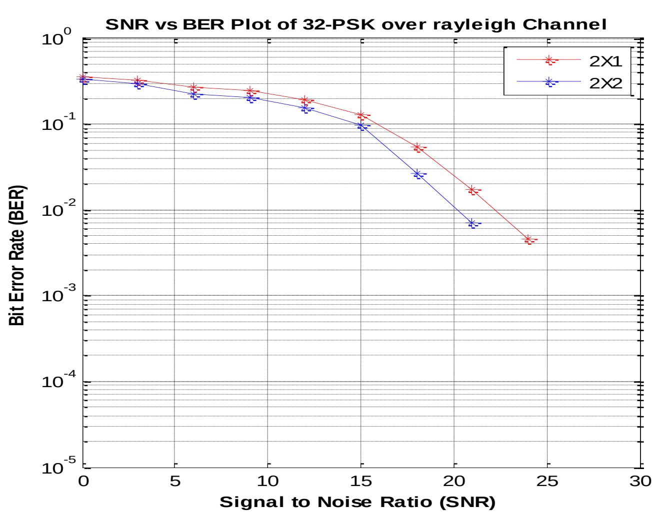
Fig. 4.1 SNR vs BER Plots for different values of M using M-PSK and Alamouti Space Time Coding technique through an AWGN channel

Plots for SNR vs BER using M-PSK through AWGN channel MIMO system for Alamouti Space-Time Coding for employ diverse antenna analysis has presented in fig. 4.1 (a) to (f). According to graphs illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. With the variation in number of receiving antennas from NR = 1 to NR = 2, the SNR changes from 2 dB to 6 dB as shown in this tables 4.1. With the variation in antenna configuration and order of modulation, the performance of system is improved.

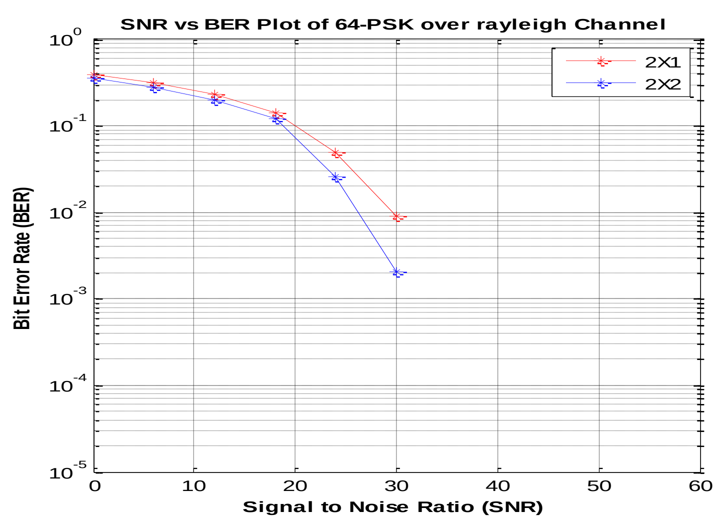
Table 4.1 Variation in SNR values for higher order M-PSK using Alamouti as Space time block coding through an AWGN channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	64	128	256	512	1024
1	17	24	33	35	43	48
2	15	21	28	29	38	42

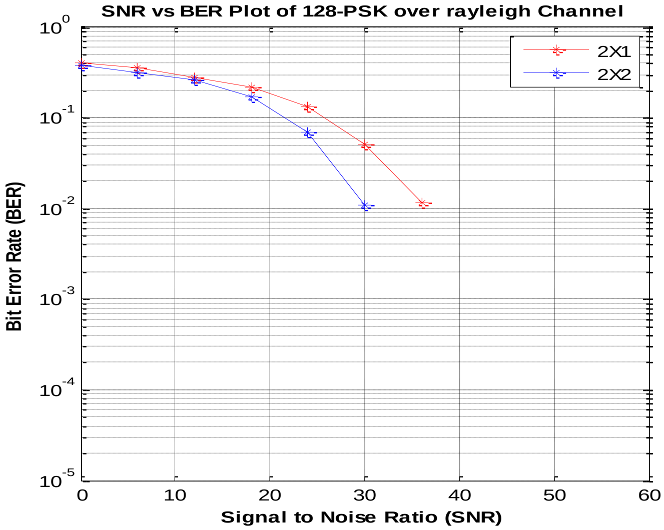
4.3.1.2 M-PSK over Rayleigh channel



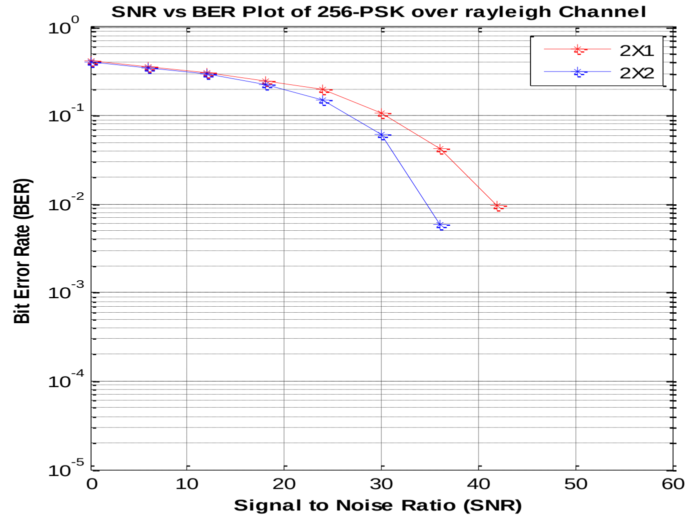
(a) 32-PSK



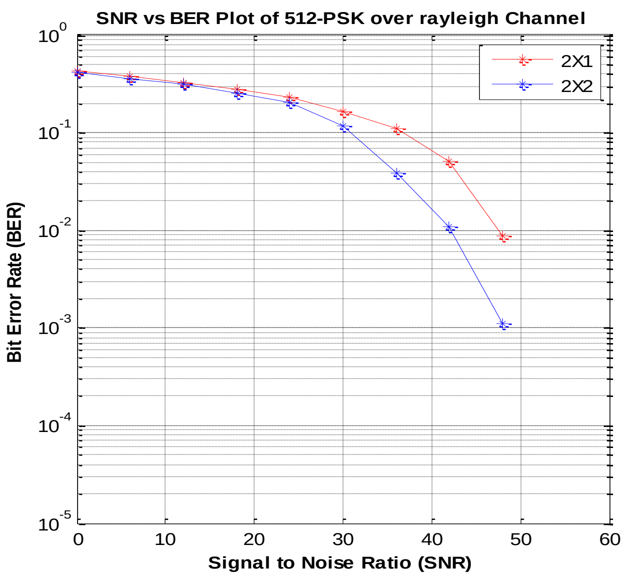
(b) 64-PSK



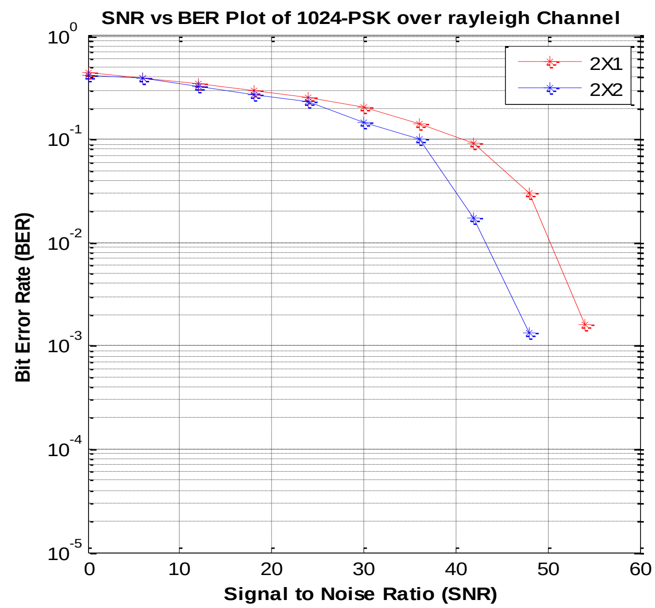
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

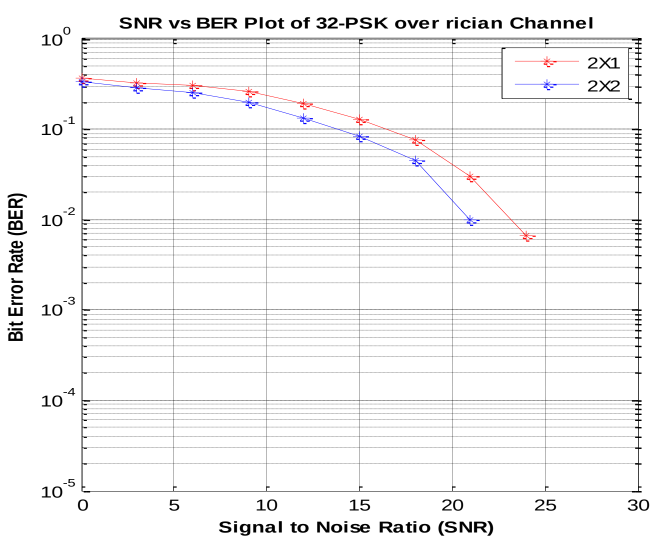
Fig. 4.2 SNR vs BER Plots for different values of M using M-PSK and Alamouti Space Time Coding technique through a Rayleigh channel

Plots for SNR vs BER using M-PSK through Rayleigh channel MIMO system for Alamouti Space-Time Coding for employ diverse antenna configurations as presented in Fig. 4.2 (a) to (f). According to graphs for MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. According to changing in number of receiving antennas at the receiver side from NR = 1 to NR = 2, the SNR changes from 1 dB to 6 dB as represent in bench 4.2. With the variation in antenna configuration and order of modulation, the performance of system is improved.

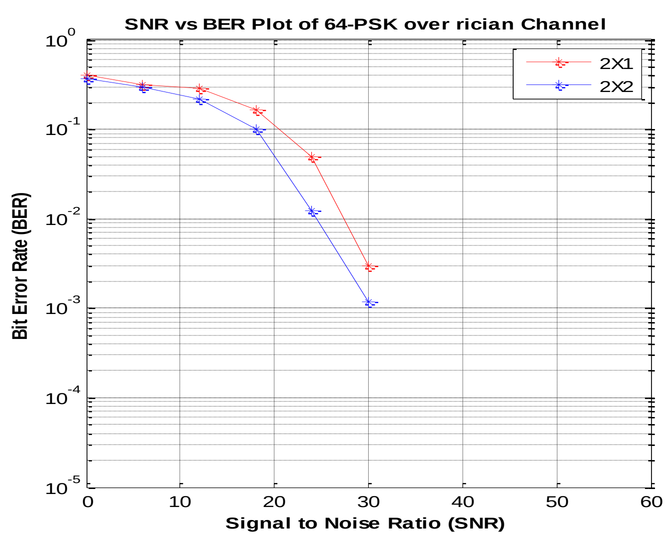
Table 4.2 Variation in SNR values for higher order M-PSK using Alamouti as Space time block coding through a Rayleigh channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	**64**	**128**	**256**	**512**	**1024**
1	22	30	33	42	48	50
2	21	27	28	36	43	44

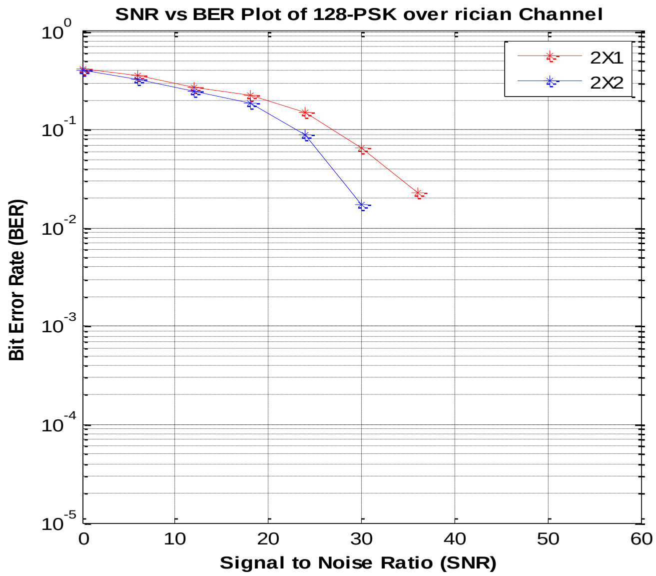
4.3.1.3 M-PSK over Rician channel



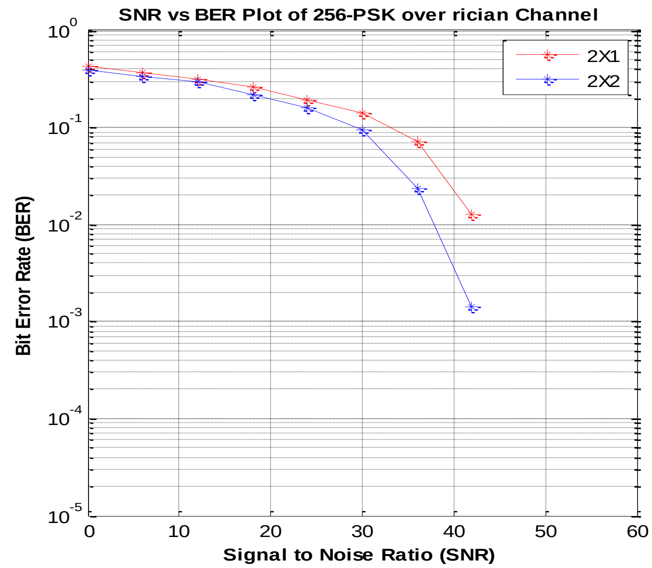
(a) 32-psk over rician channel



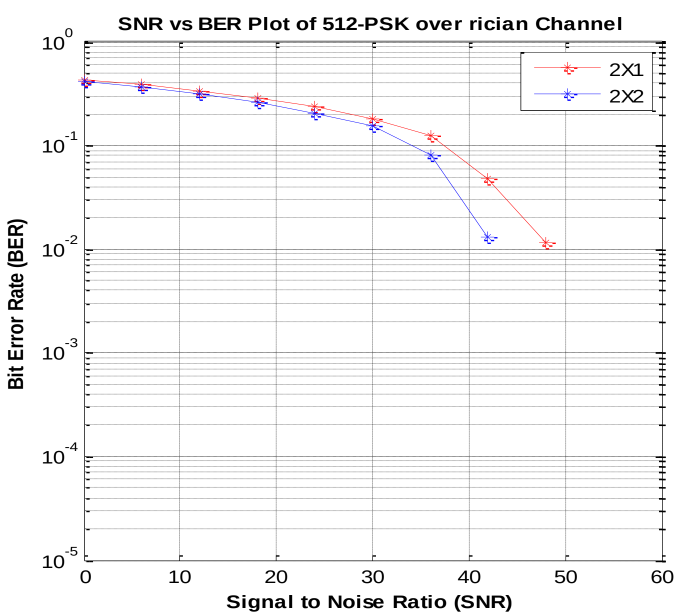
(b) 64-psk over rician channel



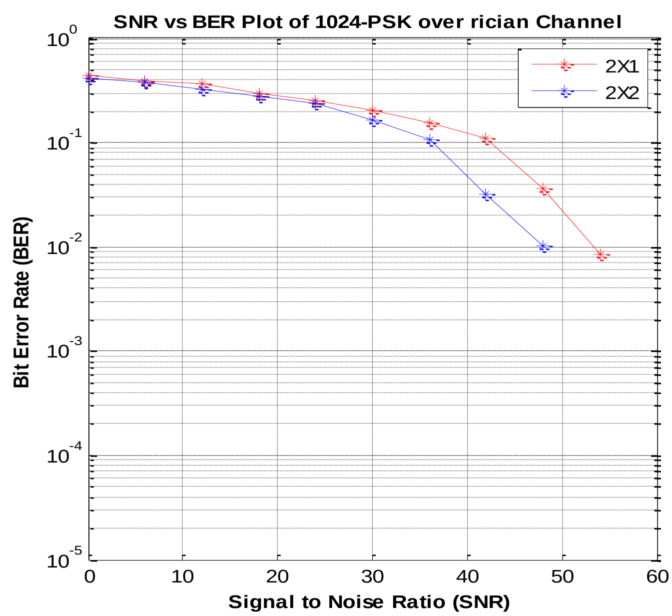
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

Fig. 4.3 Plots for SNR vs BER for various values of M using M-PSK and Alamouti Space Time Coding technique through a Rician channel

Plots for SNR vs BER using M-PSK through Rician channel MIMO system for Alamouti Space-Time Coding for employ diverse antenna analysis as presented in Fig. 4.3 (a) to (f). According the graph illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. According to changing in number of receiving antennas at the receiving side, from NR = 1 to NR = 2, then SNR reading varies from 3 dB to 6 dB as exposed in bench 4.3. With the variation in antenna configuration and order of modulation, the performance of system is improved.

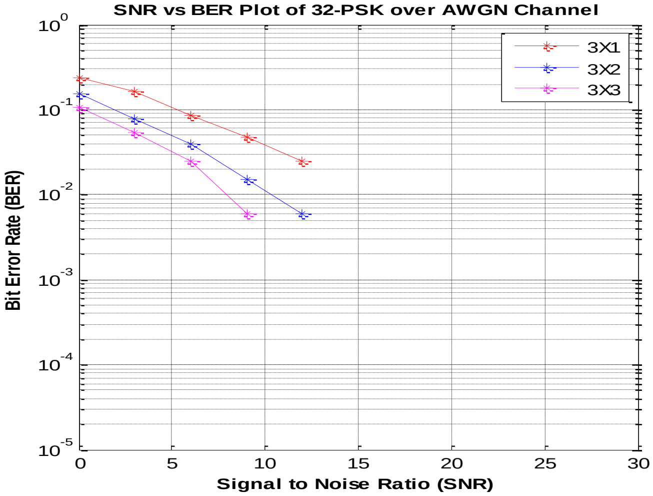
Table 4.3 Variation in SNR values for higher order M-PSK using Alamouti as Space time block coding through a Rician channel

Number of Receiving Antennas	**SNR for different M values of M-PSK Modulation Scheme (in dB)**					
	32	**64**	**128**	**256**	**512**	**1024**
1	23	26	34	40	45	50
2	20	23	30	36	40	44

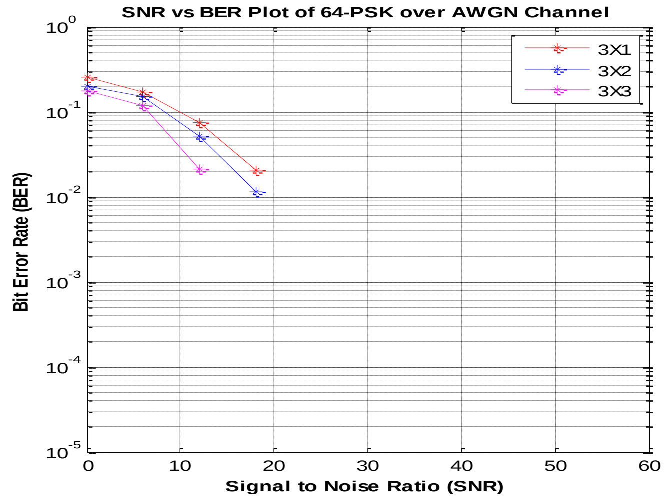
4.3.2 M-PSK over different Fading channels using orthogonal Space-Time Coding3

According to this part, the using M-PSK through different fading channels BER performance of MIMO system is analyzed using OSTBC3.

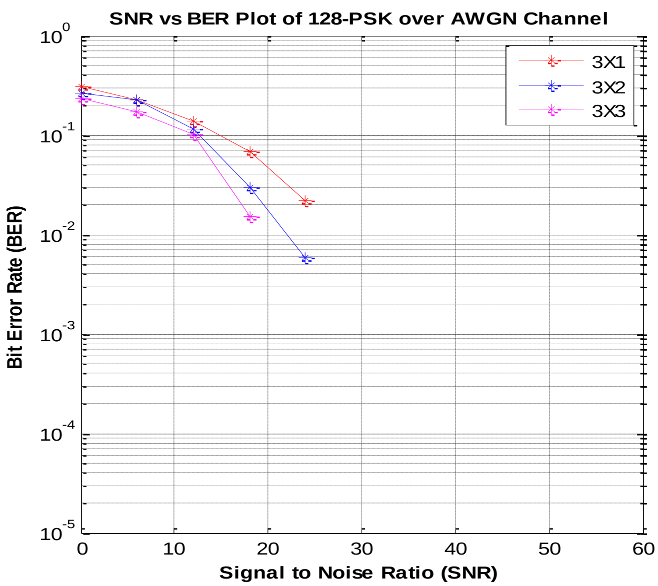
4.3.2.1 M-PSK over AWGN channel



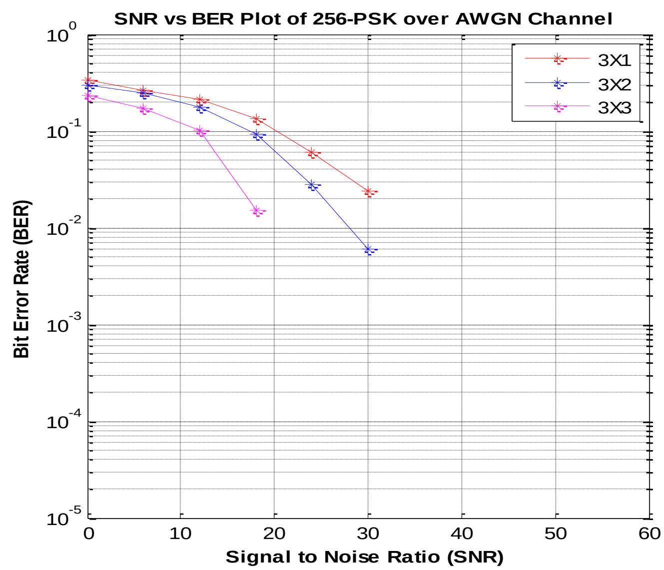
(a) 32-PSK



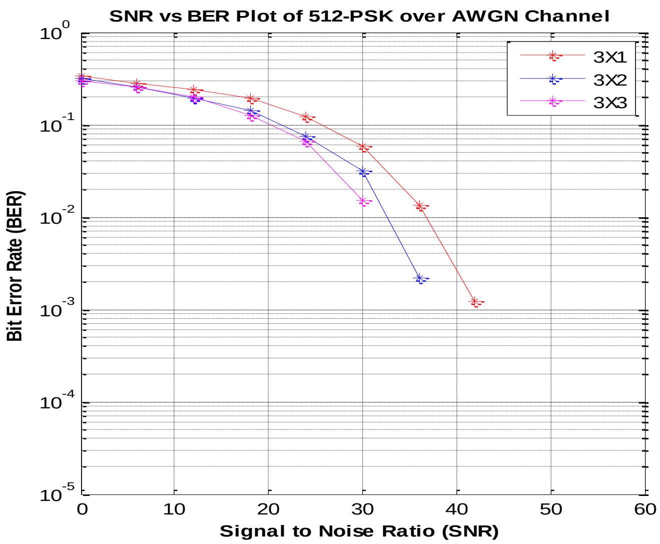
(b) 64-PSK



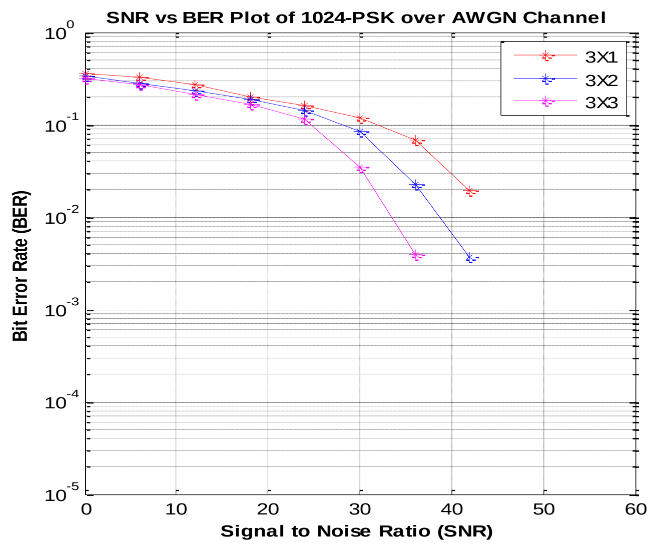
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

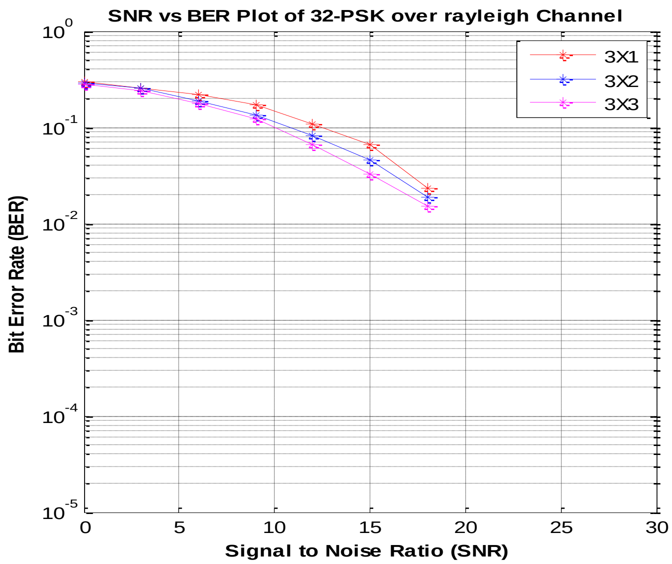
Fig. 4.4 SNR vs BER Plots for various values of M using M-PSK and OSTBC3 technique through an AWGN channel

Plots for SNR vs BER using M-PSK through AWGN channel MIMO system for Alamouti Space-Time Coding for employ diverse antenna analysis are presented in Fig. 4.4 (a) to (f). According to the graphs illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. According to changing in no. of receiving antennas at the receiving side towards NR = 1 to NR = 3, then SNR values changes from 1 dB to 5 dB as shown in bench 4.4. By variation the no. of antenna configuration and order of modulation, the performance of system is improved.

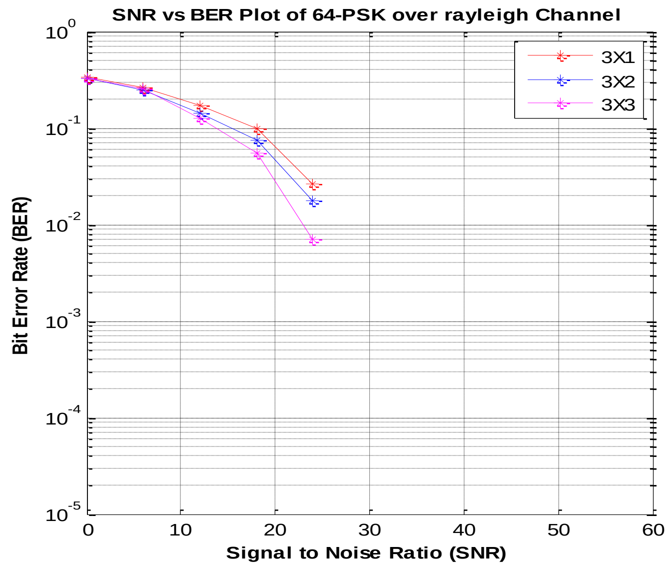
Table 4.4 Variation in SNR values for higher order M-PSK using OSTBC3 through an AWGN channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	**64**	**128**	**256**	**512**	**1024**
1	8	19	24	30	36	42
2	7	18	20	25	33	37
3	6	13	18	19	30	31

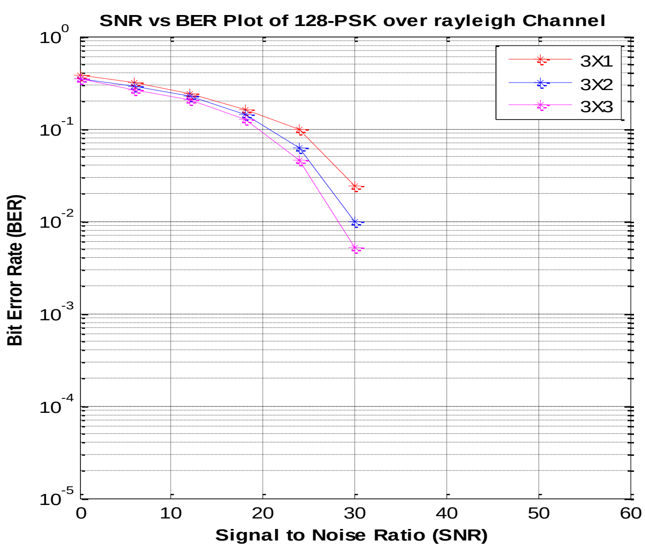
4.3.2.2. M-PSK over Rayleigh channel



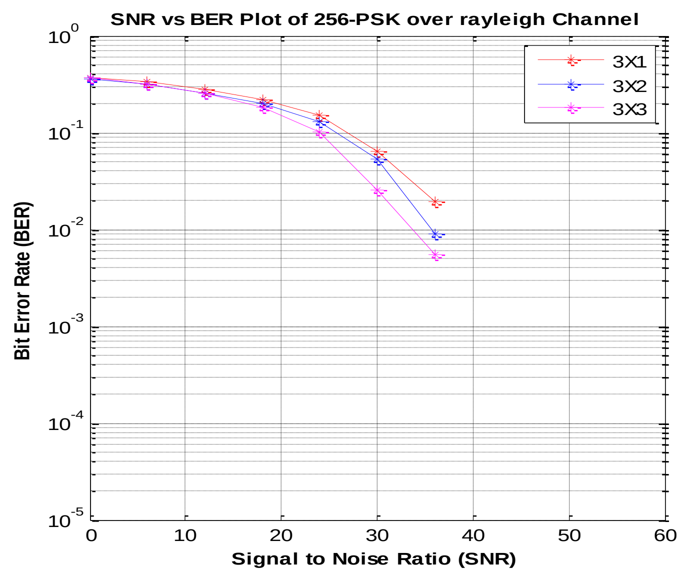
(a) 32-PSK



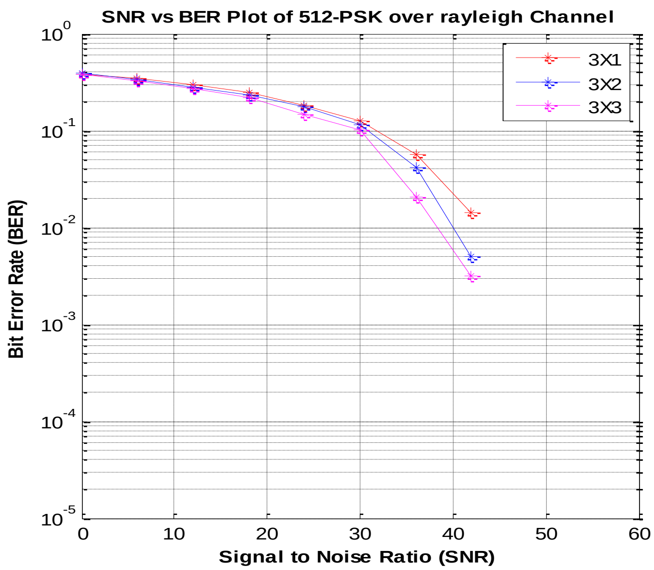
(b) 64-PSK



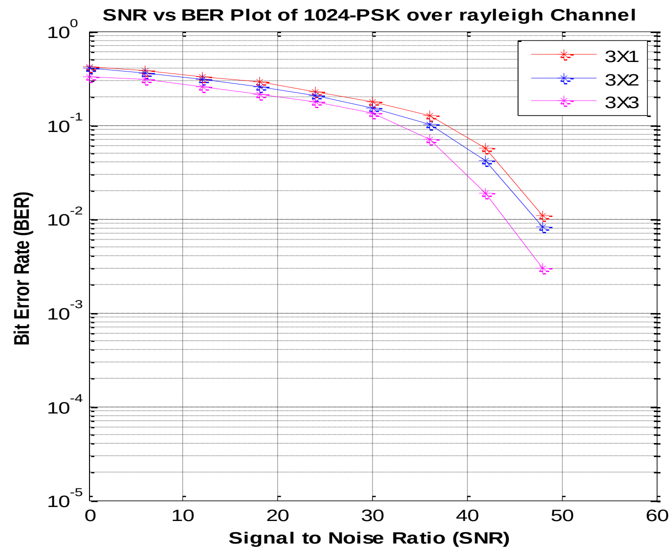
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

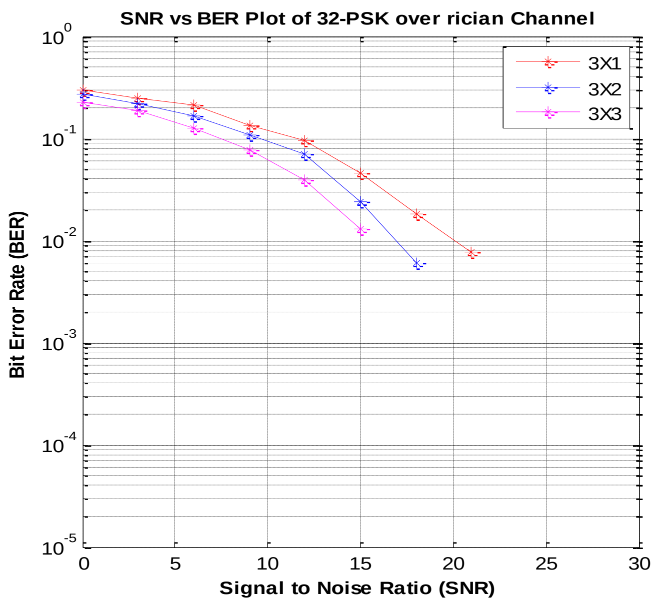
Fig. 4.5 Plots for SNR vs BER for diverse values of M using M-PSK and OSTBC3 through Rayleigh channel

Plots for SNR vs BER using M-PSK through Rayleigh channel MIMO system for OSTBC3 for employ diverse antenna analysis as shown in fig. 4.5 (a) to (f). The representation of graph illustrates that in MIMO system, when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. According to changing in no. of receiving antennas from NR = 1 to NR = 3, then SNR values is changed 1 dB to 3 dB as shown in bench 4.5. With the variation in antenna configuration and order of modulation, the performance of system is improved.

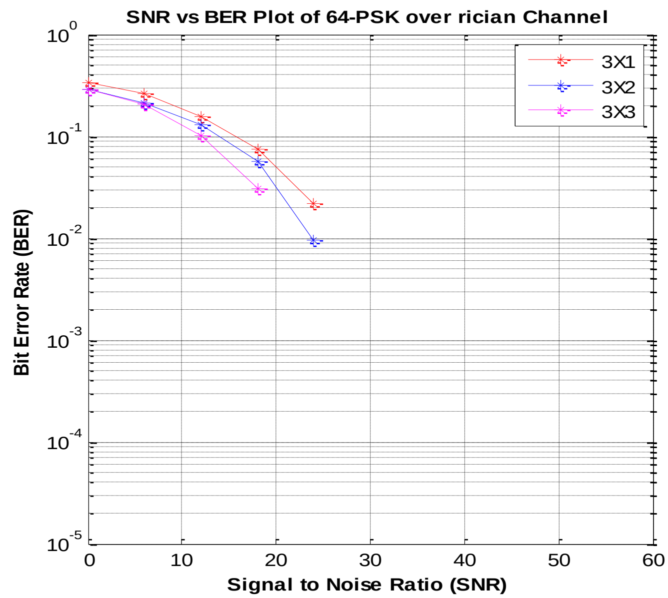
Table 4.5 Variation in SNR values for higher order M-PSK using OSTBC3 over a Rayleigh channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	64	128	256	512	1024
1	18	19	30	35	40	47
2	13	18	28	33	38	45
3	12	16	26	30	35	42

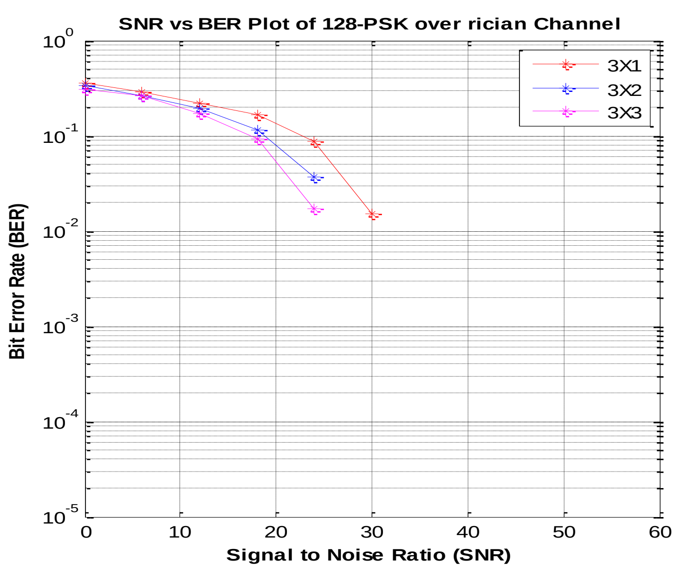
4.3.2.3 M-PSK over Rician channel



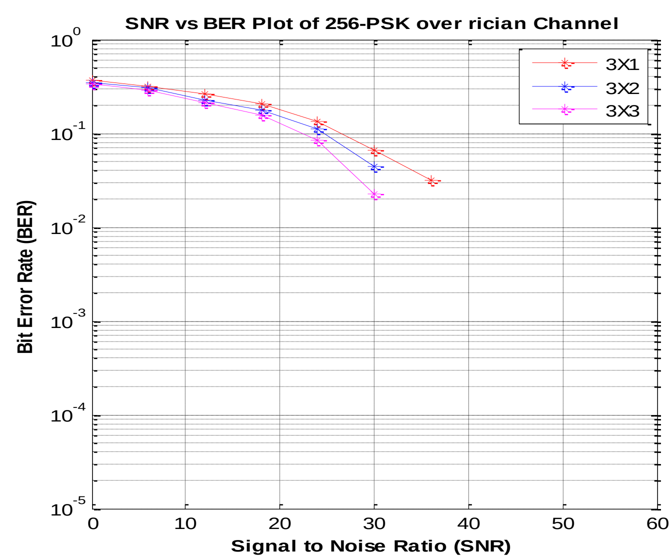
(a) 32-PSK



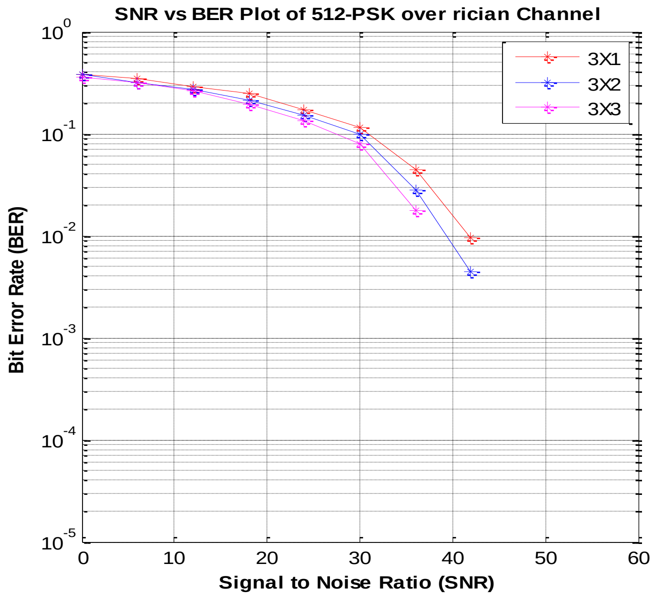
(b) 64-PSK



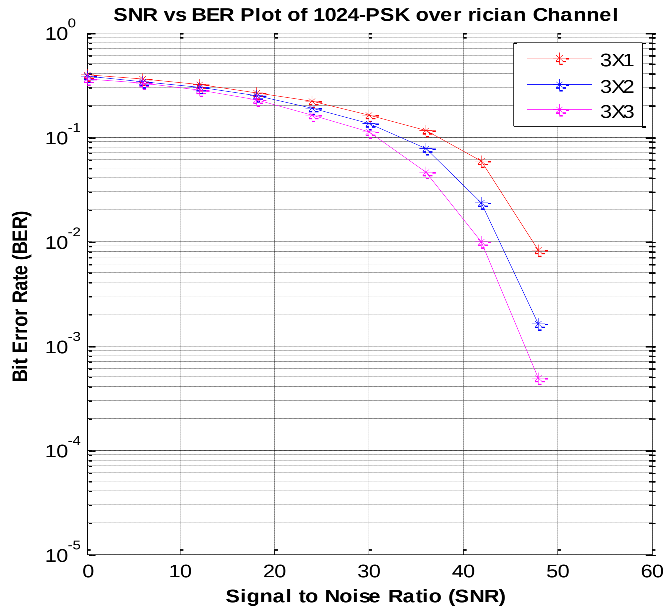
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

Fig. 4.6 SNR vs BER Plots for different values of M using M-PSK and OSTBC3 through Rician channel

Plots for SNR vs BER using M-PSK over Rician channel MIMO system for OSTBC3 for employ diverse antenna analysis have been shown in Fig. 4.6 (a) to (f). the graph illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. With the variation in number of receiving antennas from NR = 1 to NR = 3, then SNR values is changed 2 dB to 4 dB as shown in bench 4.6. With the variation in antenna configuration and order of modulation, the performance of system is improved.

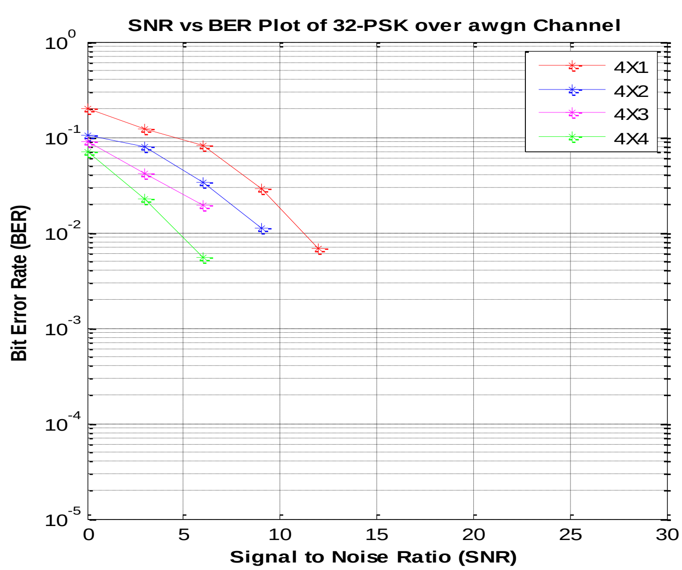
Table 4.6 Variation in SNR values for higher order M-PSK using OSTBC3 over a Rician channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	**64**	**128**	**256**	**512**	**1024**
1	18	23	28	39	40	45
2	16	22	25	33	37	42
3	14	19	23	30	34	38

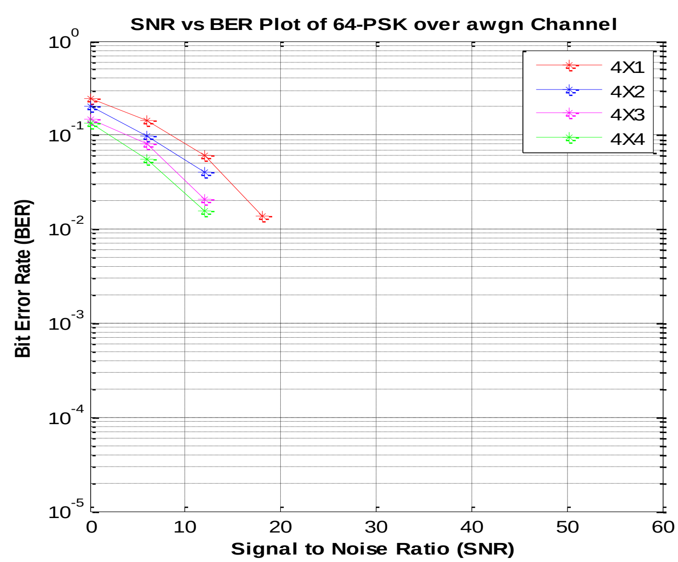
4.3.2 M-PSK over different Fading channels using orthogonal Space-Time Coding4

According to this part, using M-PSK through different fading channels the BER performance of MIMO system is analyze for OSTBC4.

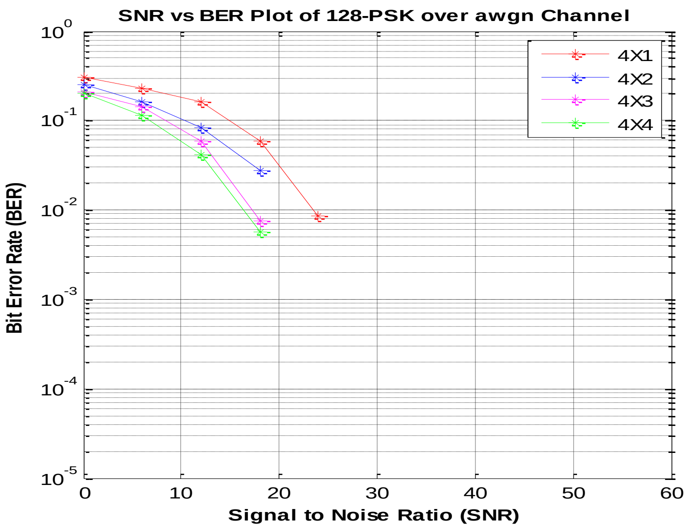
4.3.3.1 M-PSK over AWGN channel



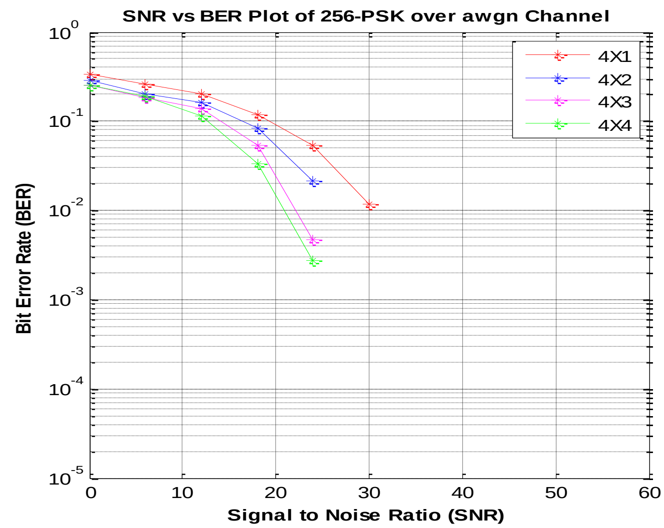
(a) 32-PSK



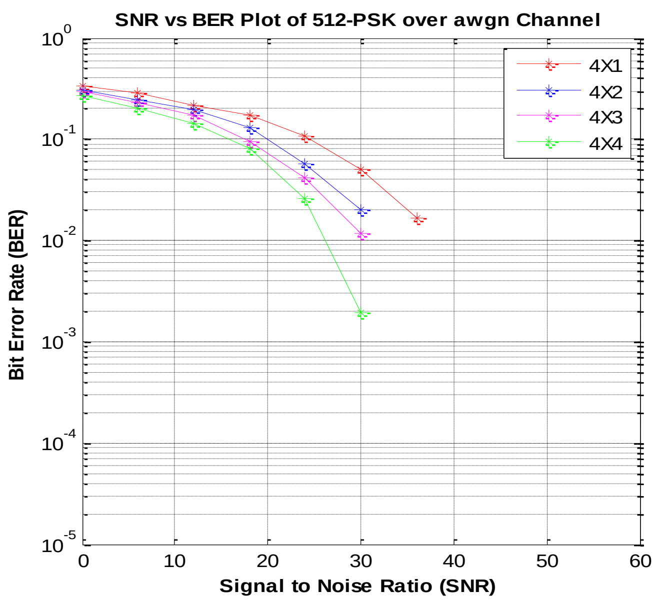
(b) 64-PSK



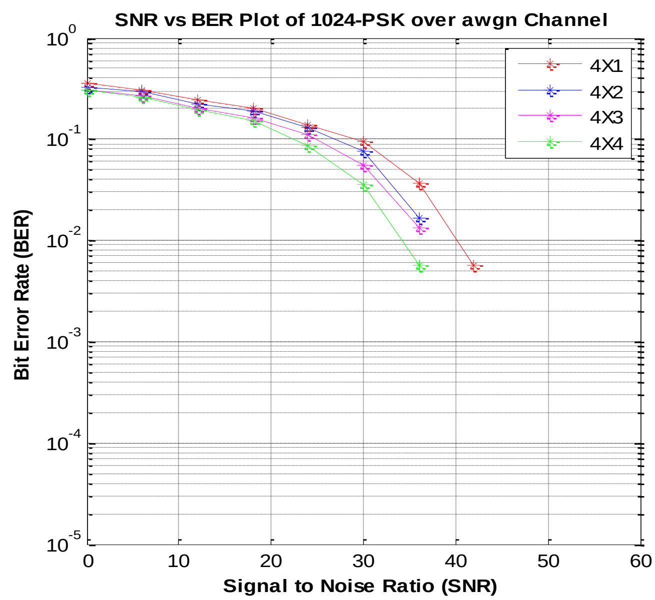
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

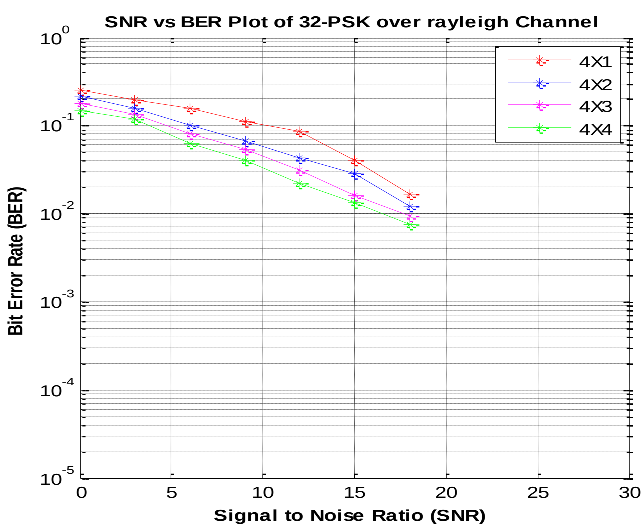
Fig. 4.7 SNR vs BER Plots for different values of M using M-PSK and OSTBC4 through AWGN channel

Plots for SNR vs BER using M-PSK through AWGN channel MIMO system for OSTBC3 for employ diverse antenna analysis as represent in fig. 4.7 (a) to (f). According to graphs illustration that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. According to changing in no. of receiving antennas at the receiving side, from NR = 1 to NR = 4, then SNR values is changed 2 dB to 4 dB as represent in bench 4.7. With the variation in antenna configuration and order of modulation, the performance of system is improved.

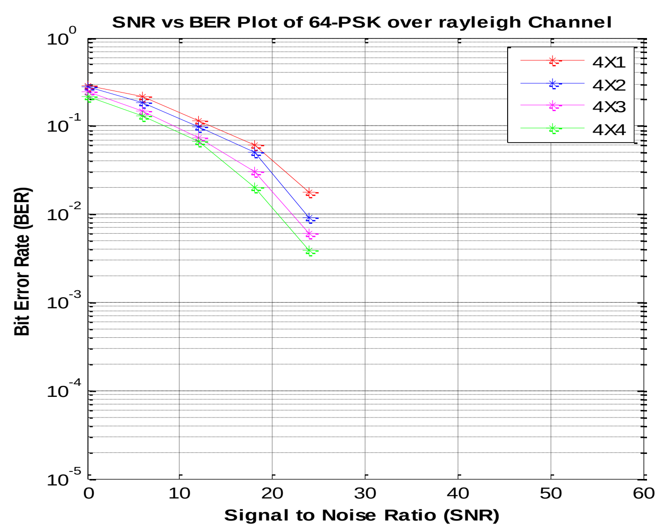
Table 4.7 Variation in SNR values for higher order M-PSK using OSTBC4 through an AWGN channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	**64**	**128**	**256**	**512**	**1024**
1	10	18	22	28	35	39
2	8	15	19	25	30	35
3	6	13	16	20	27	33
4	5	11	14	18	24	31

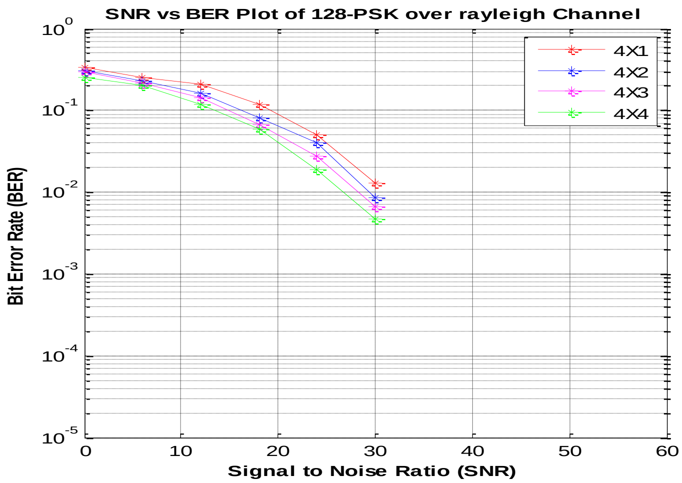
4.3.3.2 M-PSK over Rayleigh channel



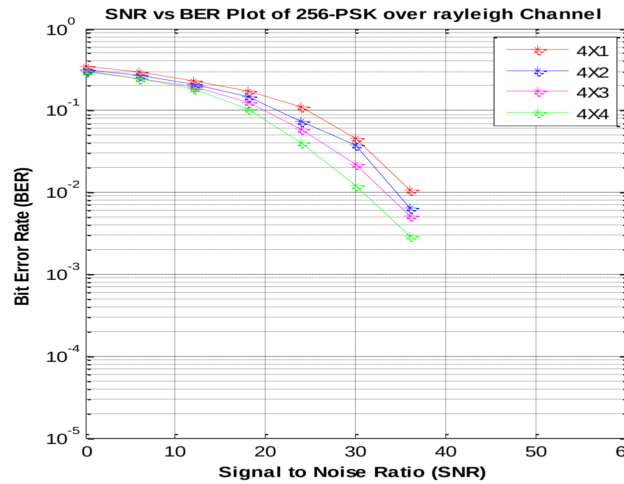
(a) 32-PSK



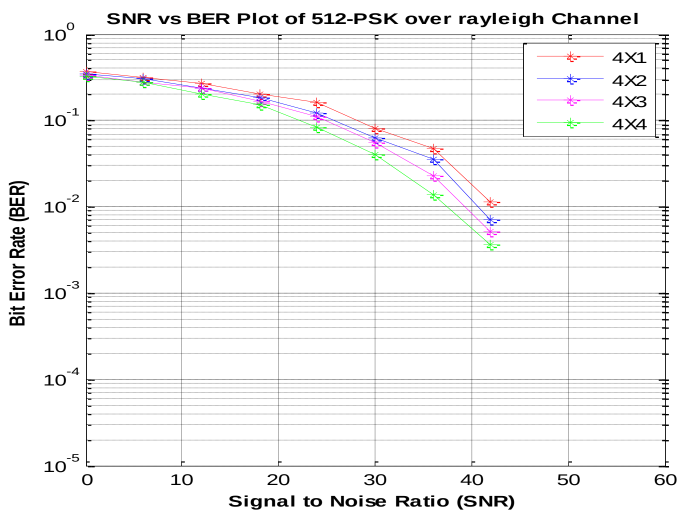
(b) 128-PSK



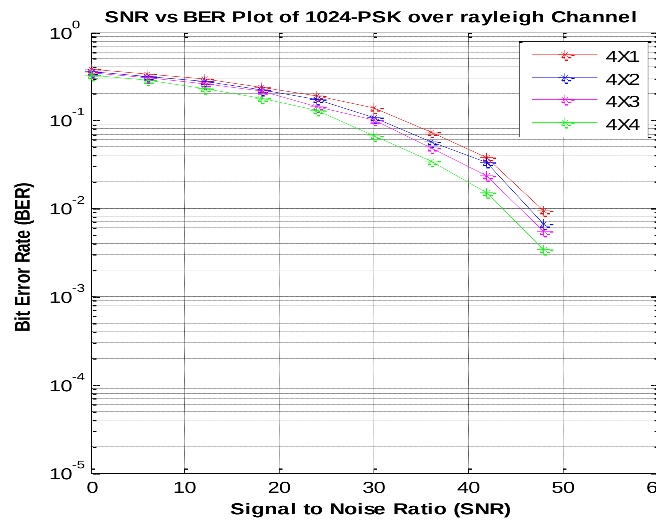
(c) 128-PSK



(d) 256-psk PSK



(e) 512-PSK



(d) 1024-PSK

Fig. 4.8 SNR vs BER Plots for different values of M using M-PSK and OSTBC4 through Rayleigh channel

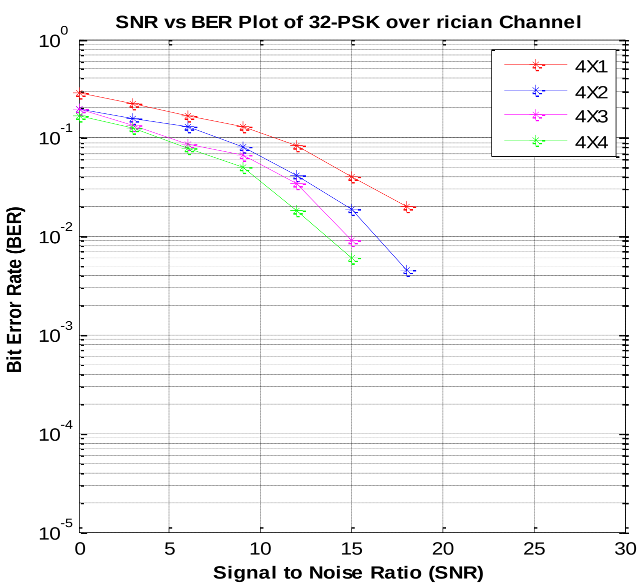
Plots for SNR vs BER using M-PSK through Rayleigh channel MIMO system for OSTBC3 for employ diverse antenna analysis are shown in fig. 4.8 (a) to (f). These graphs illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives enhanced BER performance in comparision to additional antenna configration. With the changing in no. of receiving antennas at the receiving side, from NR = 1 to NR = 4, then SNR values is changed 1 dB to 3 dB as shown in bench 4.8.

With the variation in antenna configuration and order of modulation, the performance of system is improved.

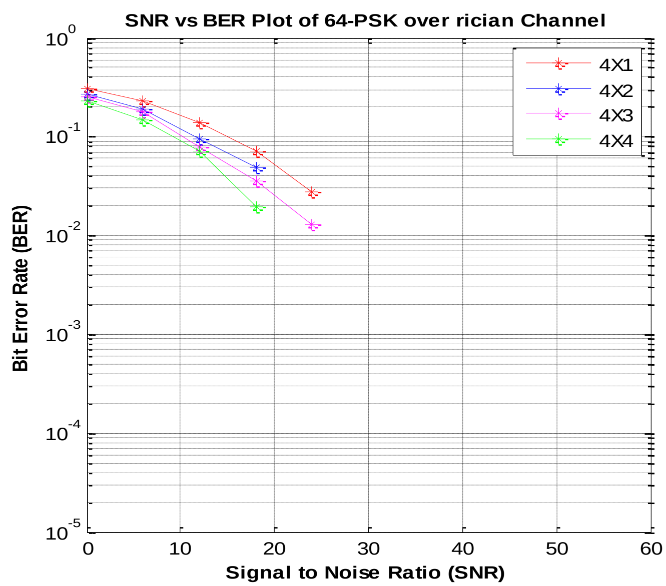
Table 4.8 Variation in SNR values for higher order M-PSK using OSTBC4 through a Rayleigh channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	64	128	256	512	1024
1	17	23	28	34	40	45
2	16	22	26	32	38	43
3	15	20	25	30	36	42
4	13	18	23	27	33	40

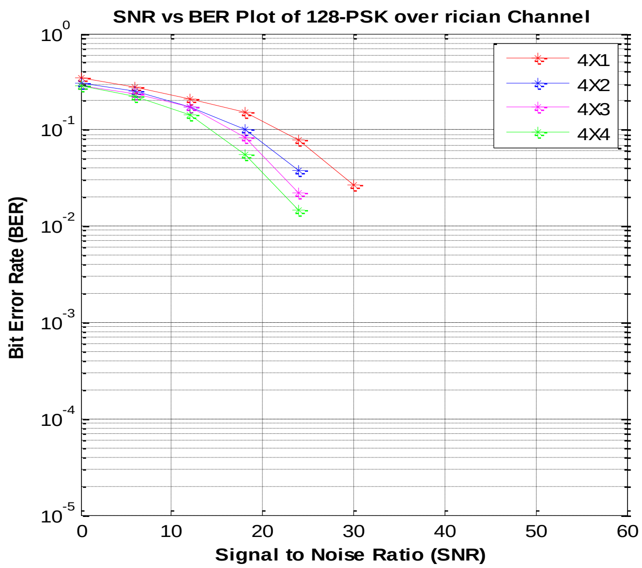
4.3.3.3 M-PSK over Rician channel



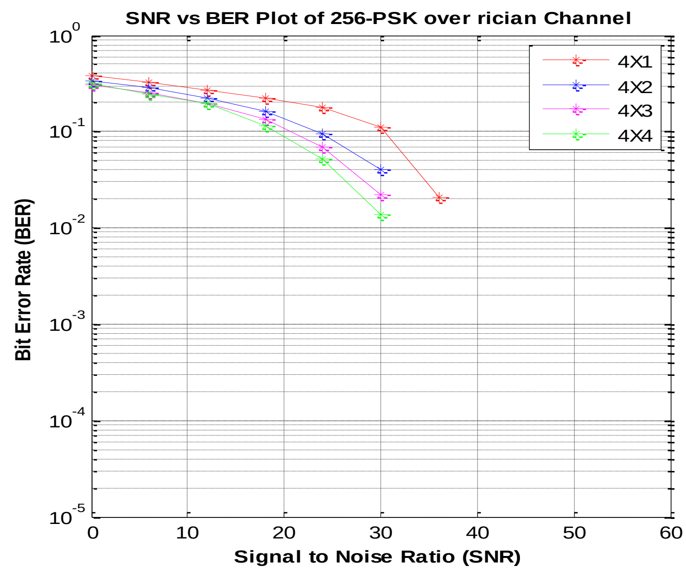
(a) 32-PSK



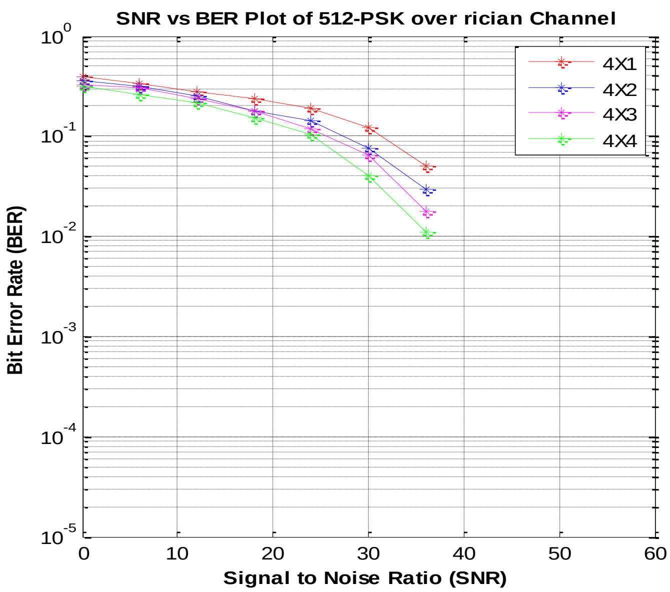
(b) 64-PSK



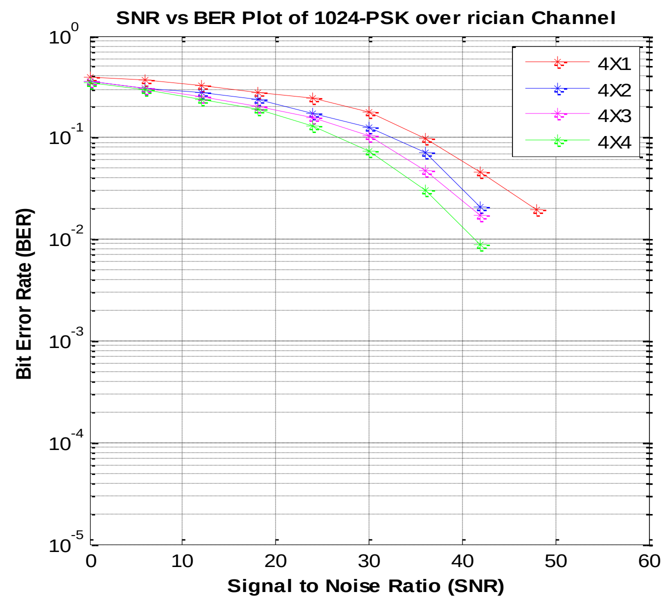
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

Fig. 4.9 SNR vs BER Plots for different values of M using M-PSK and OSTBC4 through rician channel

Plots for SNR vs BER using M-PSK over Rician channel MIMO system for OSTBC4 for employ diverse antenna analysis shown in Fig. 4.9 (a) to (f). According to graph representation that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. With the changing in no. of receiving antennas from NR = 1 to NR = 4, then SNR values is changed 2 dB to 7 dB as representation in bench 4.9. With the variation in antenna configuration and order of modulation, the performance of system is improved.

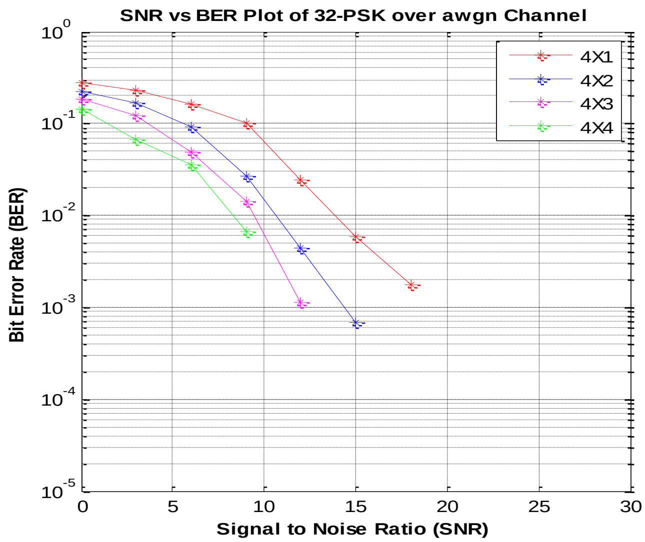
Table 4.9 Variation in SNR values for higher order M-PSK using OSTBC4 through a rician channel

Number of Receiving Antennas	**SNR for different M values of M-PSK Modulation Scheme (in dB)**					
	32	**64**	**128**	**256**	**512**	**1024**
1	17	25	30	38	39	49
2	15	24	28	33	36	42
3	13	22	25	30	34	40
4	12	19	22	28	32	37

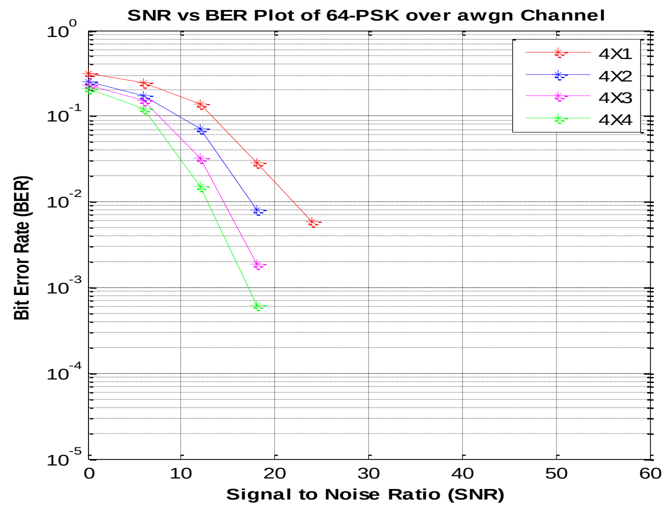
4.3.3 M-PSK over different Fading channels using Quasi orthogonal Space-Time Coding4

According to this section, using M-PSK over different fading channels for the BER performance of MIMO system is analyzed using QOSTBC4.

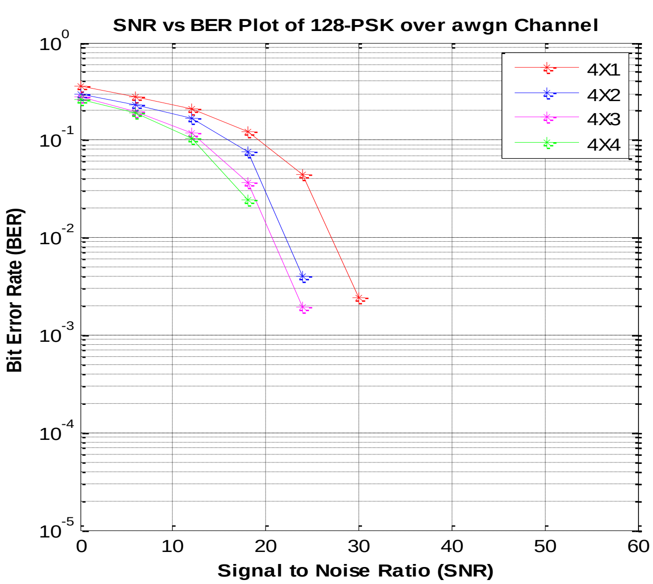
4.3.4.1 M-PSK over AWGN channel



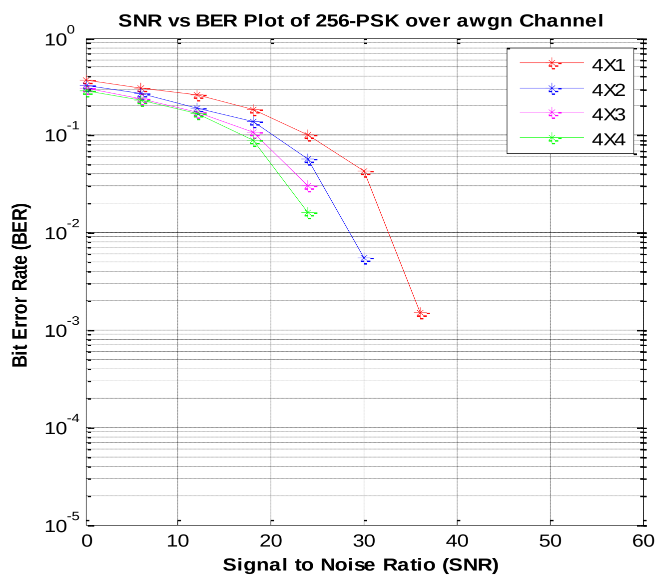
(a) 32-PSK



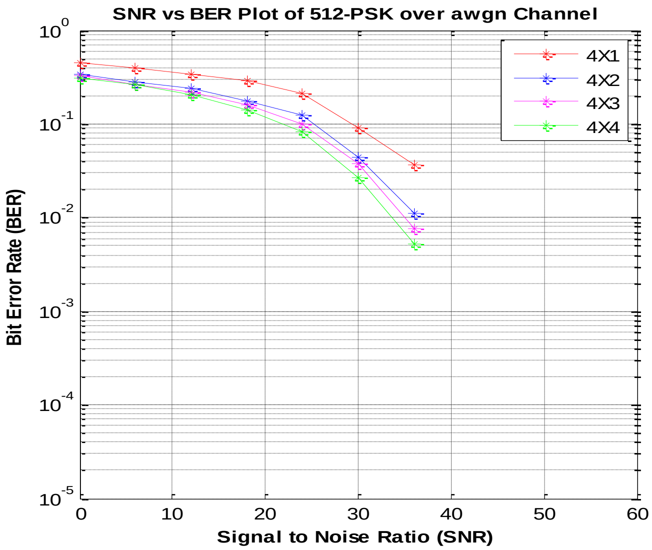
(b) 64-PSK



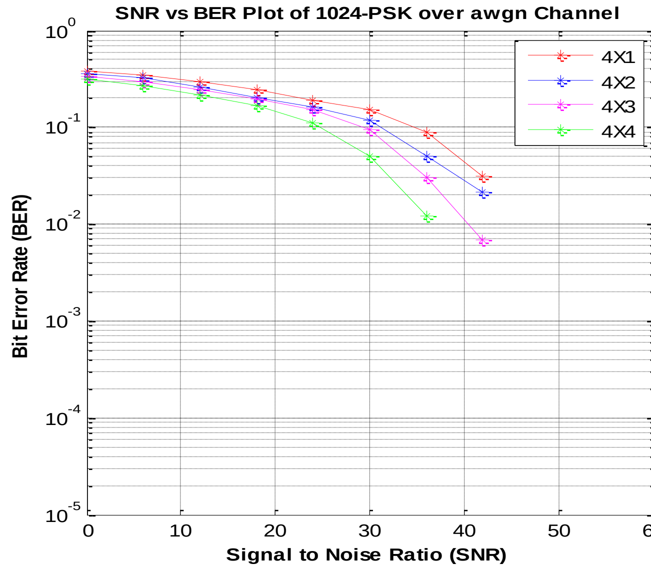
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

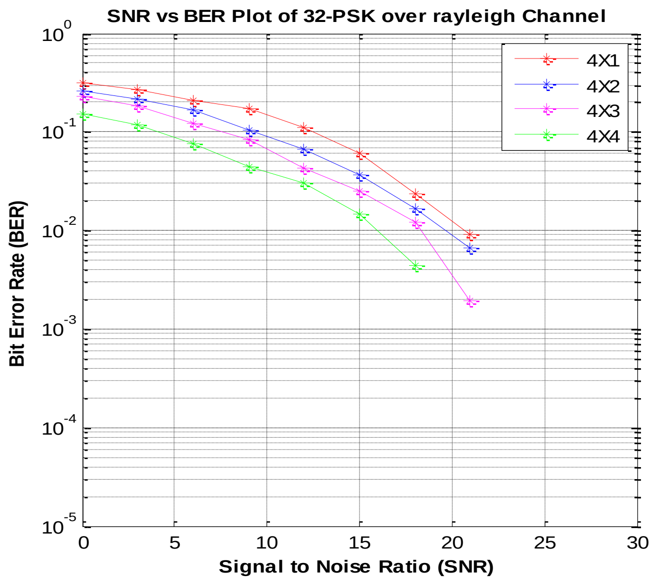
Fig. 4.10 SNR vs BER Plots for different values of M using M-PSK and QOSTBC4 through AWGN channel

Plots for SNR vs BER using M-PSK through AWGN channel MIMO system for QOSTBC4 for employ diverse antenna analysis shown in fig. 4.10 (a) to (f). Here the representation of graph illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. With the changing in number of receiving antennas at the receiver side, from NR = 1 to NR = 4, then SNR values is changed 2 dB to 4 dB as shown in bench 4.10. By the variation in antenna configuration and order of modulation, the performance of system is improved.

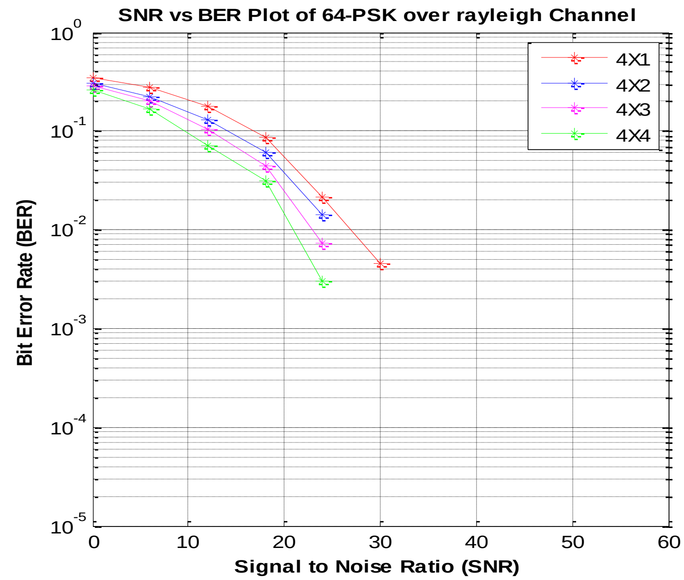
Table 4.10 Variation in SNR values for higher order M-PSK using QOSTBC4 through AWGN channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	64	128	256	512	1024
1	17	25	30	31	38	45
2	13	23	25	27	35	43
3	11	19	23	25	33	38
4	10	17	21	23	31	34

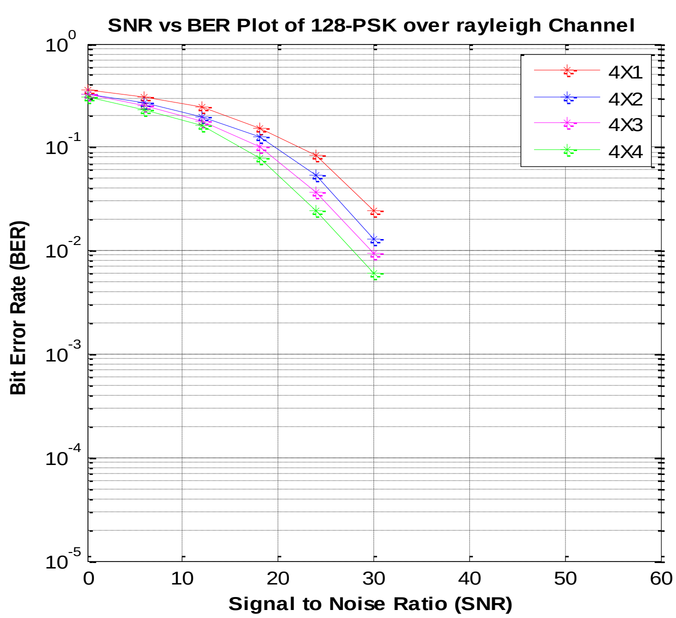
4.3.4.2 M-PSK through Rayleigh channel



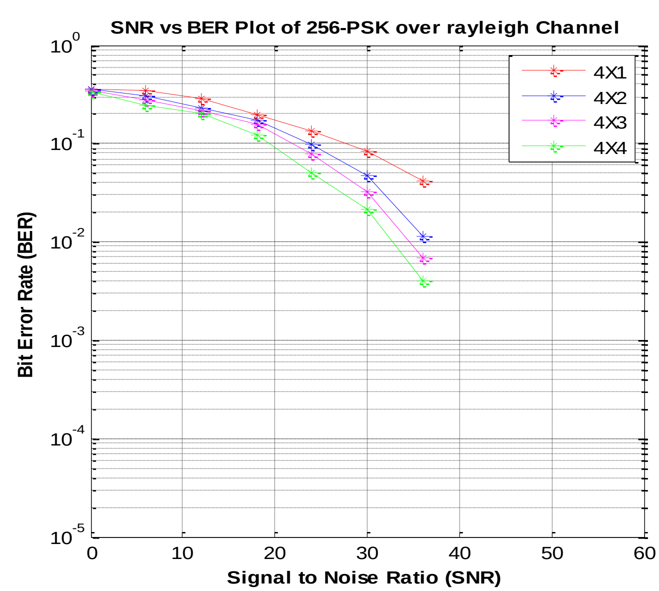
(a) 32-PSK



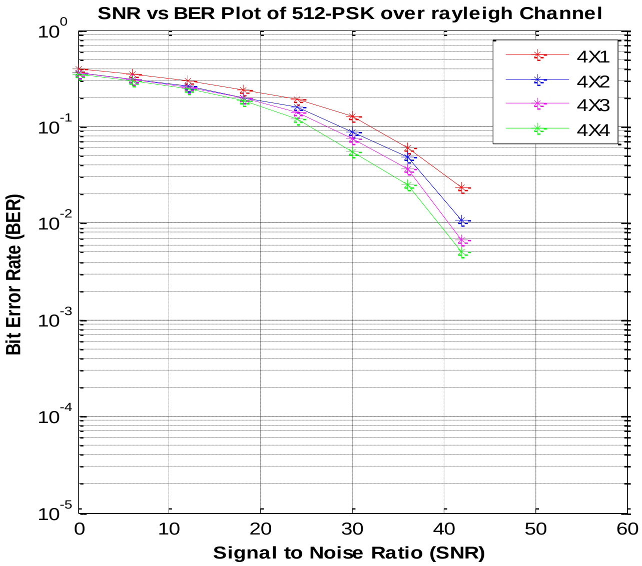
(b) 64-PSK



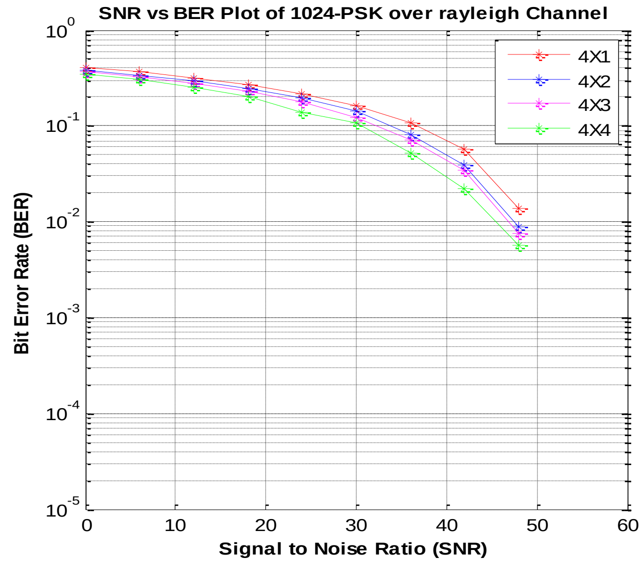
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

Fig. 4.11 SNR vs BER Plots for different values of M using M-PSK and QOSTBC4 through Rayleigh channel

Plots for SNR vs BER using M-PSK through Rayleigh channel MIMO system for QOSTBC4 for employ diverse antenna analysis have been shown in Fig. 4.11 (a) to (f). the graph illustrates that in MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. According to the changing in number of receiving antennas from NR = 1 to NR = 4, then SNR values is changed 2 dB to 4 dB as represent in bench 4.11. According to changing antenna configuration and order of modulation, the performance of system is improved.

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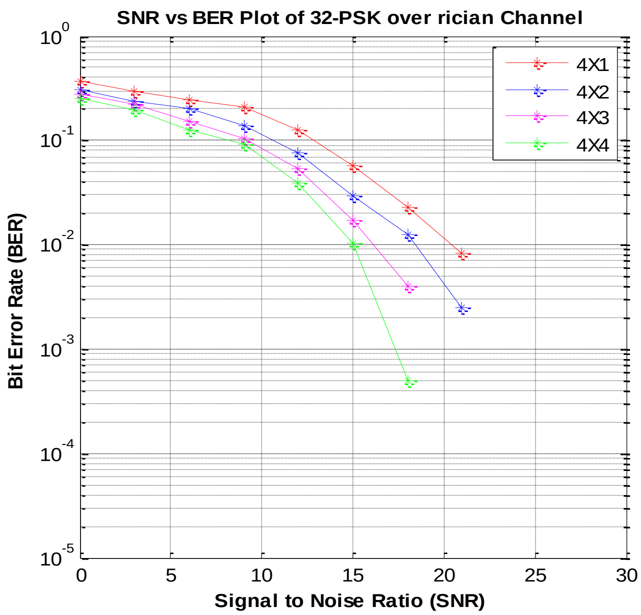
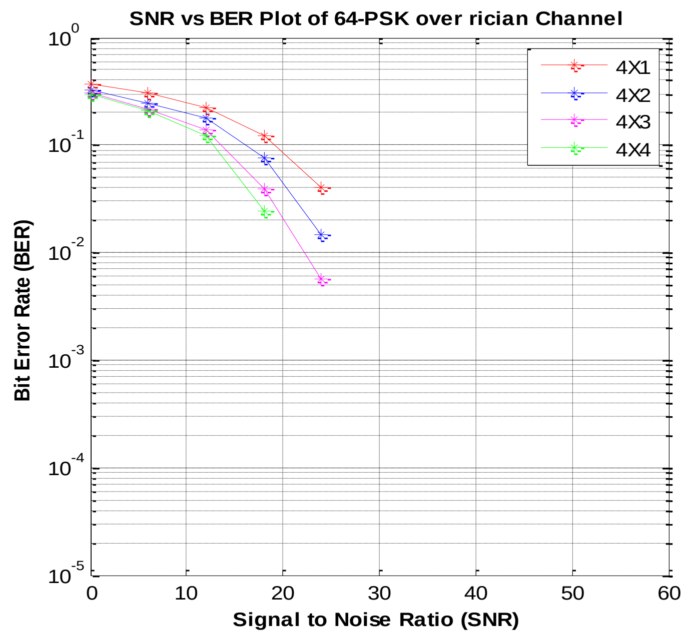
Table 4.11 Variation in SNR values for higher order M-PSK using QOSTBC4 through Rayleigh channel

Number of Receiving Antennas	SNR for different M values of M-PSK Modulation Scheme (in dB)					
	32	**64**	**128**	**256**	**512**	**1024**
1	18	25	30	39	42	45
2	16	24	27	34	39	43
3	15	22	25	32	38	38
4	14	20	24	30	36	34

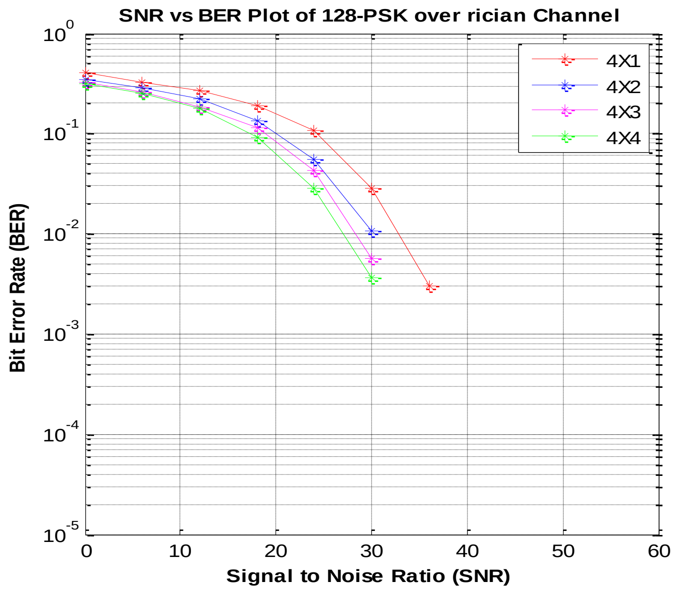
4.3.4.3 M-PSK over Rician channel



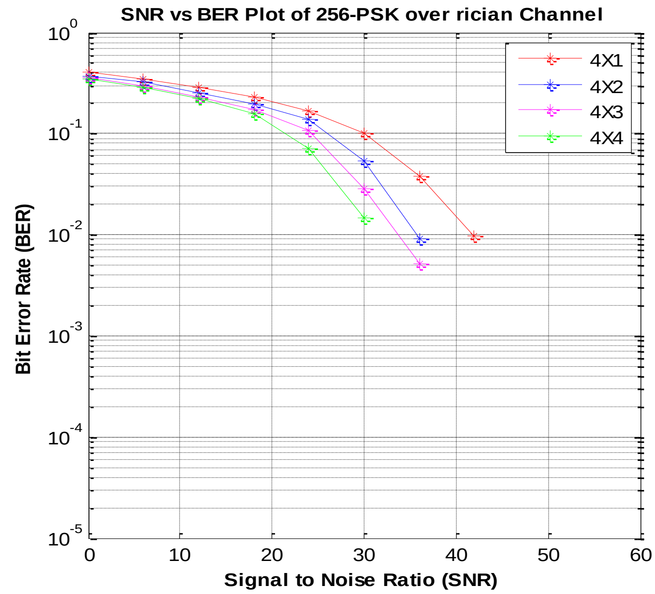
(a) 32-PSK



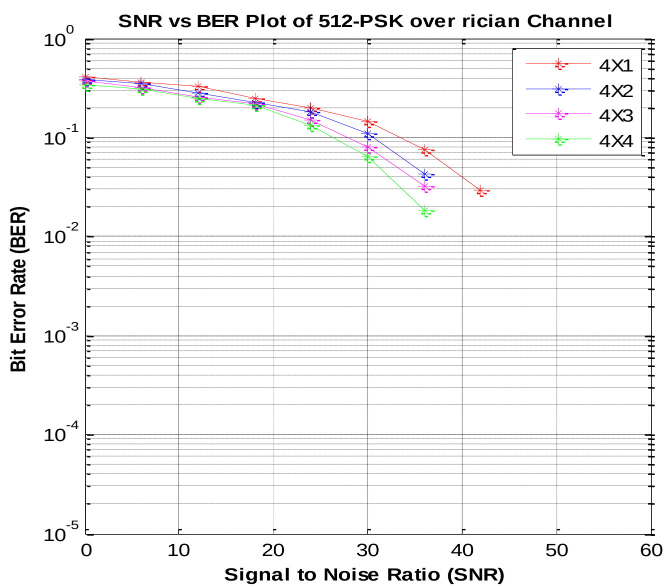
(b) 64-PSK



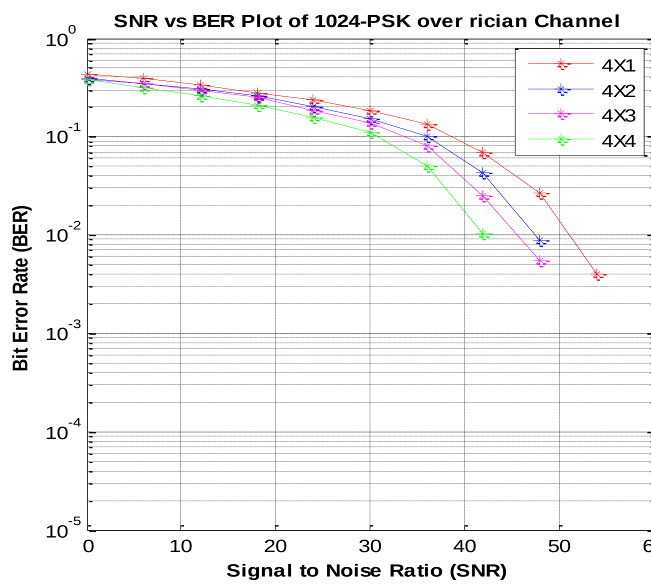
(c) 128-PSK



(d) 256-PSK



(e) 512-PSK



(f) 1024-PSK

Fig. 4.12 SNR vs BER Plots for different values of M using M-PSK and QOSTBC4 through an Rician channel

Plots for SNR vs BER using M-PSK through Rician channel MIMO system for QOSTBC4 for employ diverse antenna analysis shown in Fig. 4.12 (a) to (f). The above graph illustrates that according to MIMO system as when the no. of receiving antennas are increased then BER decreasing due to spatial diversity and thus this system would gives better BER performance in comparision to other antenna configration. With increasing the number of receiving antennas towards NR = 1 to NR = 4, then SNR readings is changed 2 dB to 3 dB as exposed in bench 4.12. With the variation in antenna configuration and order of modulation, the performance of system is improved.

Table 4.12 Variation in SNR values for higher order M-PSK using QOSTBC4 through rician channel

Number of Receiving Antennas	**SNR for different M values of M-PSK Modulation Scheme (in dB)**					
	32	**64**	**128**	**256**	**512**	**1024**
1	13	19	31	38	42	48
2	14	20	28	33	39	45
3	16	23	26	30	37	42
4	18	25	24	28	35	39

CHAPTER-5 CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

In large MIMO system, we conclude that with the use of large no. of antenna in case of different technique such as Alamouti, OSTBC3, OSTBC4 and QOSTBC4 the performance of system is improved. In all the graphs we use different M values that are 32, 64, 128, 256, 512 and 1024 to the compare the performance for different receiving antennas.

Here we use different antenna through different channels such as AWGN, Rayleigh and Rician for the comparison of SNR with BER using different values of M-PSK as modulation technique thus the variation in order of modulation for the system is improved.

5.2 Future scope

A lot of future work on a number of issues such as highly linked antenna systems, hardware impairments, interference mitigation techniques, modulation and practical implementation, is necessary to build up the profit of the large-MIMO technology in future communication system.

Large MIMO is a broad area for analyzing configuration of Massive MIMO to develop the smart antenna. One another area for research that is decreases the effects of pilot contamination to obtain the better performance. Already incorporated into 4G, organization will be part of 5G as well.

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