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BER Improvement of MIMO-OFDM and Adaptive MIMO-OFDM System by using M-PSK

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Abstract

(Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing) MIMO-OFDM is one of the promising technologies to improve the spectral efficiency, enhance system capacity and mitigate inter-symbol interference in the fourth generation broadband mobile communication system. In this paper, we aim at the study of a communication system that employs MIMO-OFDM and adaptive modulation technologies. OFDM is one of the best solutions for achieving high data rates in mobile environment, due to its resistance to ISI, which is most common problem found in high speed data communication. A (Multiple-input Multiple-output) MIMO communication System along with the (Orthogonal Frequency Division Multiplexing) OFDM modulation technique can achieve reliable high data rate transmission over broadband wireless channels. In this paper we have achieved, (Bit Error Rate) BER and Channel capacity analysis for MIMO-OFDM and (Adaptive multiuser detection –Orthogonal Frequency Division Multiplexing) AMUD MIMO-OFDM by the use of M-ary (Phase Shift Keying) PSK modulation technique.

Keywords: Component; AMUD MIMO-OFDM ; BER; Channel Capacity; MIMO-OFDM; M-ary PSK

1. Introduction

The use of multiple antennas at both ends of a wireless link (MIMO technology)[1]-[2] holds the potential to fulfill the growing demand of high speed data transmission, drastic improvement in the spectral efficiency and link reliability in future wireless communications systems. A particularly promising technology for next-generation fixed and mobile wireless system is the combination of MIMO technology with OFDM.OFDM is a multicarrier modulation technique. This is generally providing a best solution, and an effective modulation technique in highly frequency selective channel conditions.

In this new information era, high data rate and strong reliability in wireless communication systems are becoming the dominant factors for a successful exploitation of commercial networks. MIMO-OFDM, a new wireless broadband technology, has gained great popularity for its capability of high rate transmission and its robustness against Multi-path fading and other channel impairments. One step ahead to MIMO-OFDM technology, there comes AMUD MIMO-OFDM in which adaptive filters are used which makes it more reliable and efficient then MIMO-OFDM technology. Above all main concern of this topic is on BER and channel capacity improvement with the help of modulation technique here used is PSK (M- PSK).

The objective is to analysis the results for BER and channel capacity for MIMO-OFDM and AMUD MIMO-OFDM with 16-PSK, 64-PSK, 256-PSK, 512-PSK & 1024 –PSK. After that , Section II is regarding MIMO system, Section III includes OFDM in addition to it PSK modulation scheme, BER is discussed in Section IV . Section V briefly describe MIMO-OFDM and AMUD MIMO-OFDM .And then in Section VI simulation results followed by Conclusion.

2. Mimo Technology

In MIMO technology multiple antennas are available at transmitter and multiple at receiver side to improve communication system. MIMO antenna is regarded as efficient solution to meet the needs of high capacity, assisting fading, improving link reliable without sacrificing bandwidth efficiency [4][11] .

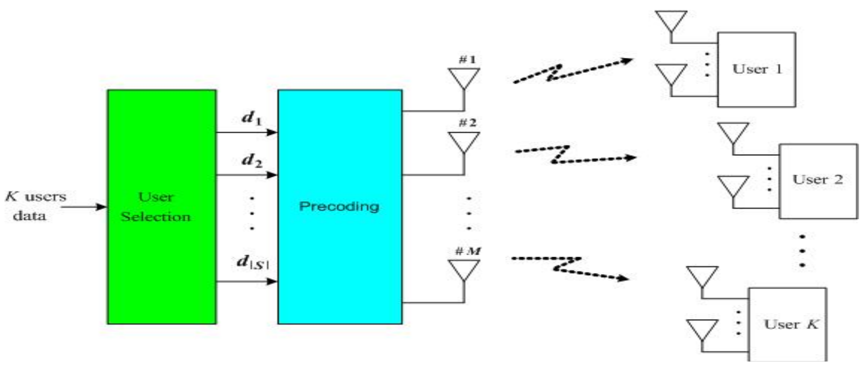

Fig. 1: MIMO system.

There are mainly three types of MIMO system which are as follows:-

1. Space Time Transmit Diversity: - Diversity (STTD): - In this type similar data is coded and then transmitted via. Different antenna's which actually doubles out the power in the channel. This further improves (Signal to Noise) S/N ratio for cell edge performance.
2. Spatial Multiplexing(SM):- SM transfers parallel data of stream to (Common Phase Error) CPE by exploiting multipath. It actually doubles MIMO capacity and throughput. SM provides higher capacity when (Radio Frequency) RF conditions are favourable and user is closer to the (Base Trans receiver Station) BTS.
3. Uplink Collaborative MIMO Link: - Leverages conventional single power amplifier at device. Tw device call collaboratively transmit the same subcarrier which ca also double uplink capacity.

To improve the data rate or throughput of wireless access even under condition of interference, signal fading for long distance along this use of limited bandwidth effectively.

3. OFDM System Model

OFDM is based on multicarrier communication techniques. The idea of multicarrier communications is to divide the total signal bandwidth into number of sub carriers and information is transmitted on each of the sub carriers. Unlike the conventional multicarrier communication scheme in which spectrum of each sub carrier is non-overlapping and band pass filtering is used to extract the frequency of interest, in OFDM the frequency spacing between sub carriers is selected such that the sub carriers are mathematically orthogonal to each

others. The spectra of sub carriers overlap each other but individual sub carrier can be extracted by base band processing. This overlapping property makes OFDM more spectral efficient than the conventional multicarrier communication scheme.

OFDM communication model as

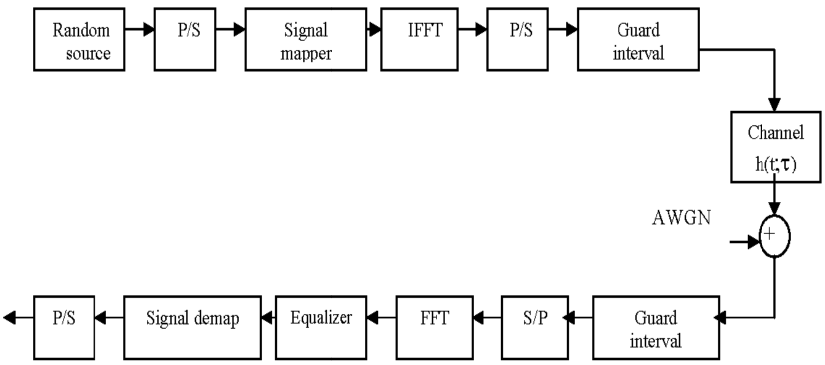

Fig. 2: OFDM system.

In this OFDM model both the sides at transmitter and receiver binary data is visible in the above figure. In between it contains couple of blocks that are, encoder, insertsymbol, low pass filter, A/D Converter, carrier modulation. Limitation of OFDM is basically sensitivity to frequency offset and phase noise. Peak to average problem reduces the power efficiency of RF amplifier at the transmitter.

4. MIMO-OFDM System Model

MIMO wireless technology in combination with OFDM i.e. MIMO-OFDM is an attractive air-interface solution for next-generation wireless local area networks (WLANs), wireless metropolitan area networks (WMANs), and fourth-generation mobile cellular wireless systems. When both MIMO-OFDM both these technologies are integrated, they cancel out disadvantages of each other and proved to be a good solution for LTE system. The main motivation for using OFDM in a MIMO channel is the fact that OFDM modulation turns a frequency-selective MIMO channel into a set of parallel frequency-at MIMO channels.

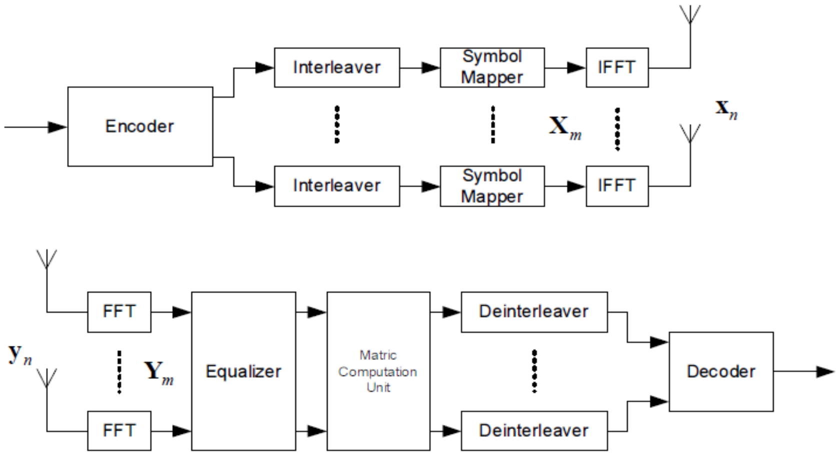

Fig. 3: MIMO-OFDM Model.

The main requirement of MIMO-OFDM system is encoder/decoder, FFT/IFFT, serial to parallel/parallel to serial converter, equalization technique, interleaver/ deinterleaver, modulation/demodulation techniques, multiple antennas at transmitter and multiple antennas at receiver. The main challenges faced by MIMO-OFDM technology is mainly PAPR, BER, Channel capacity, SNR etc . In this paper out of the above challenges main topic of concern is BER and Channel capacity.

5. Adaptive MIMO-OFDM System Model

The system model for an AMUD MIMO-OFDM ,with Nt and Nr transmit and receive antennas with k sub-carrier in one OFDM block. At time t, a data block b' [n.k]:

k=0,1,…,n transformed into different signal x1[n;k]:k=0,1,…..,k-1 and i=1,2,….,n, and I are number of sub-channels of OFDM system . Signal transmitted are modulated by x1[n,k][10]

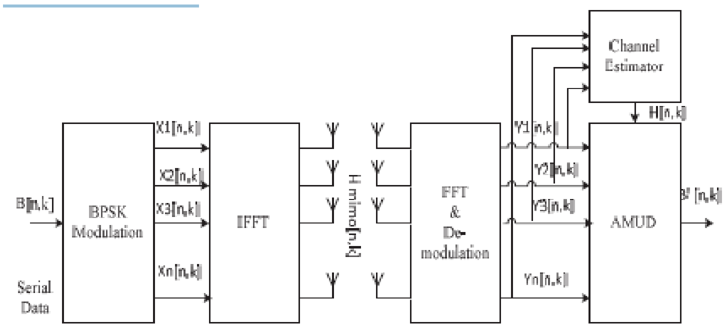

Fig. 4: Adaptive MIMO-OFDM system model.

The DFT received at each receive antenna is the superposition of the transmitted signals. The receive signal at jth receive antenna is

$$p_{j[n,\quad k]}=\sum_{i=1}^{N} H_{ij}[n,\quad k]x_i[n,\quad k]+n_j[n,\quad k]$$

Where $H_{ij}[n,\quad k]$ is channel frequency response from transmitter I to receiver j at the kth tone of the OFDM block at time n and noise $n_j[n,\quad k]$ is assumed to be zero mean with variance sigma n square and uncorrelated for different n's, k's or j's $H_{ij}[n,\quad k]$ denote the channel frequency response for the kth tone at time n, corresponding ti ith transmit and jth receive antenna. [1]

6. Bit Error Rate

6.1 BIT ERROR RATE(BER)

In digital transmission, the BER is the defined as the ratio of number of bits having errors divided by the total number of transferred bits during a particular interval of time interval when this study is going on. BER is a unit less performance measure, mainly expressed in percentage. The bit error probability is the expected value of the BER in any communication system, where there are chances of error due to addition of noise. The BER can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors. In a communication system, mainly we have two blocks, transmitter and receiver linked through channel. Then at the receiver side BER may be affected by transmission channel noise, interference, distortion, bit synchronization problems, attenuation, wireless multipath fading, etc.

The BER can be improved by choosing a signal of strong strength, by choosing a slow and robust and proper modulation scheme or line coding scheme, and by applying channel coding schemes such as redundant forward error correction codes.

The *transmission BER* is the number of detected bits that are incorrect, divided by the total number of transferred bit. The *information BER*, approximately equal to the **decoding error probability**, is the number of decoded bits that remain incorrect after the error correction, divided by the total number of decoded bits (the useful information). Normally, the transmission BER value is larger than that of information BER. The information BER is affected by the strength of the forward error correction code. In this paper we tried to improve BER with M-QAM.

7. Simulation Results

Simulation results of BER for MIMO-OFDM and AMUD MIMO-OFDM with 16-PSK, 64-PSK, 256-PSK, 512-PSK &1024 –PSK are given as:-

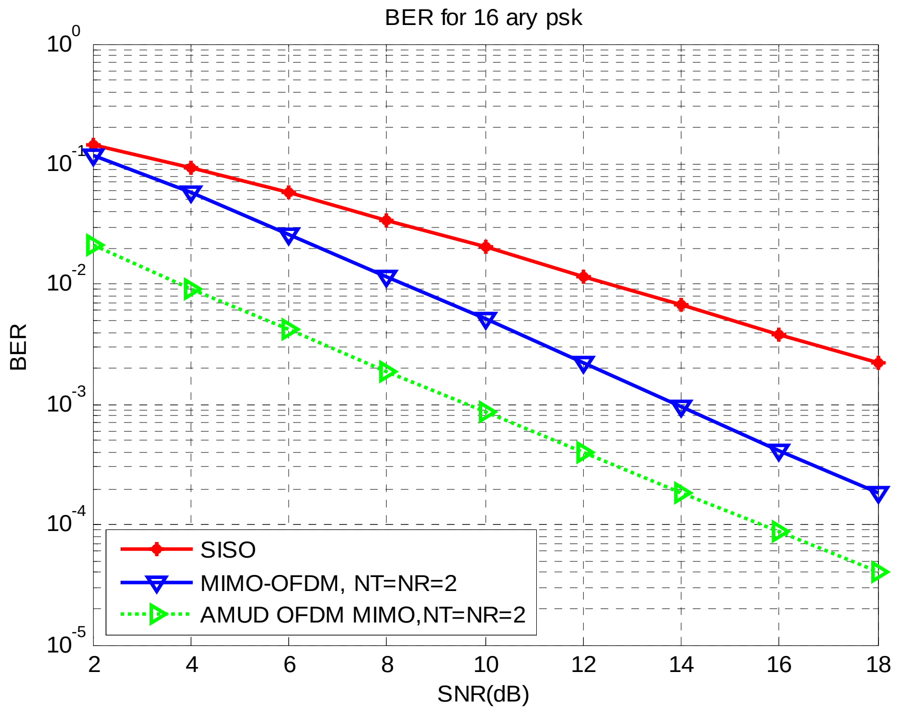

Fig. 5: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM(NT=NR=2) 16 ary psk.

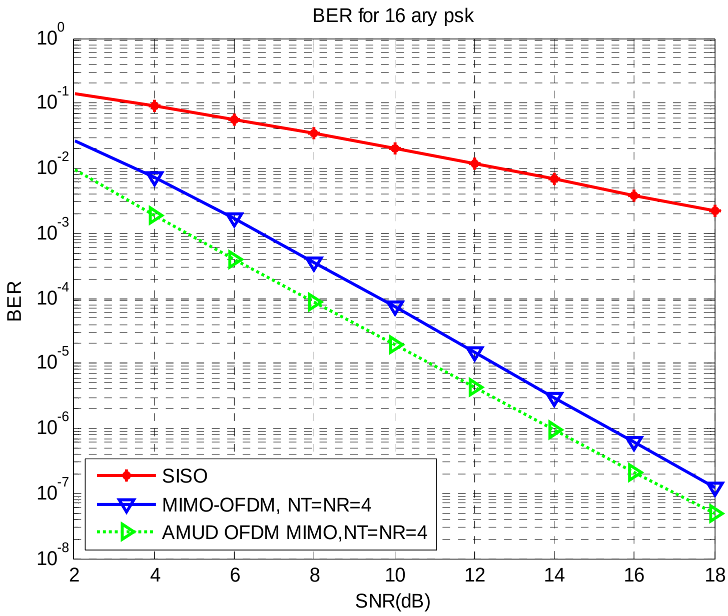

Fig. 6: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM (NT=NR=4) 16 ary psk

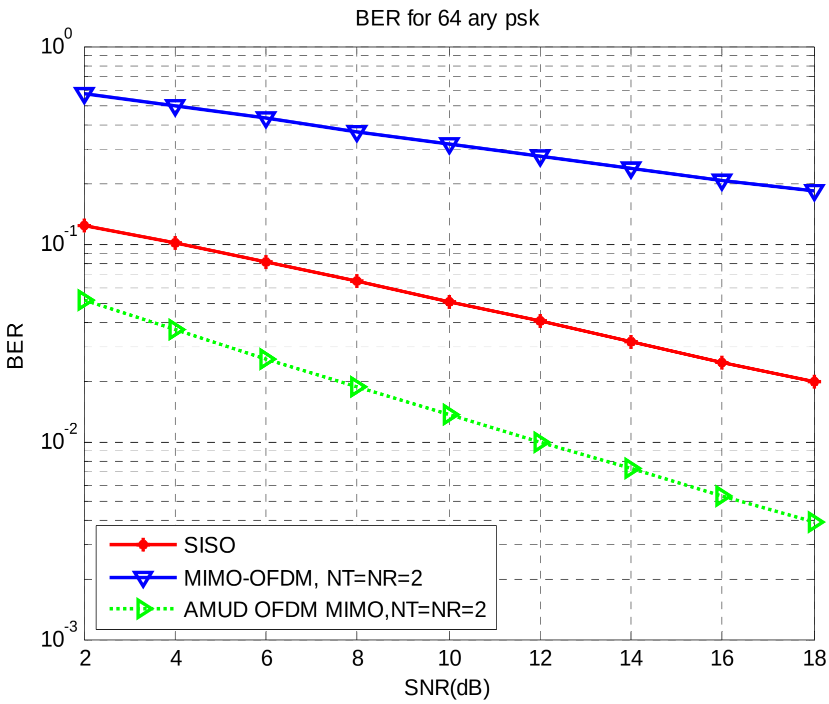

Fig. 7: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM(NT=NR=2) 64 ary psk

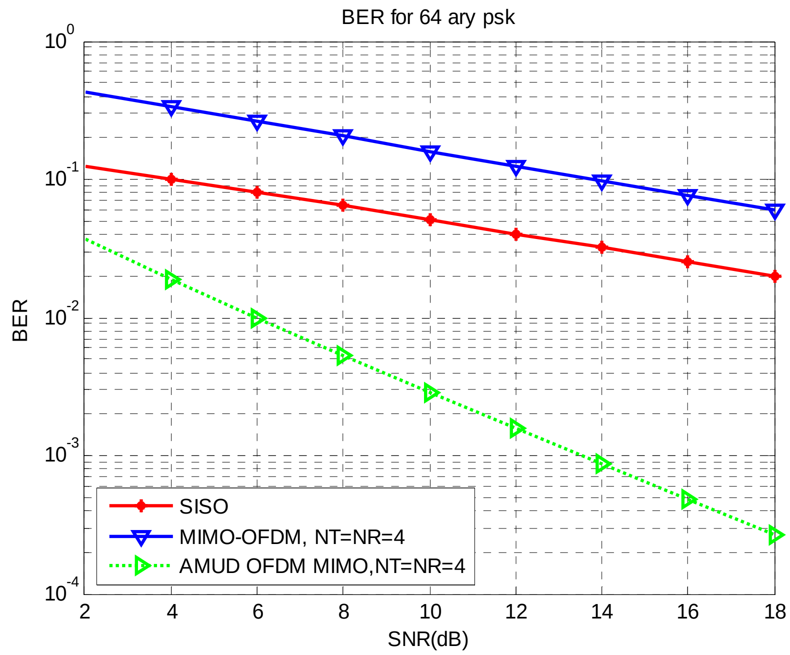

Fig. 8: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM(NT=NR=4) 64 ary psk

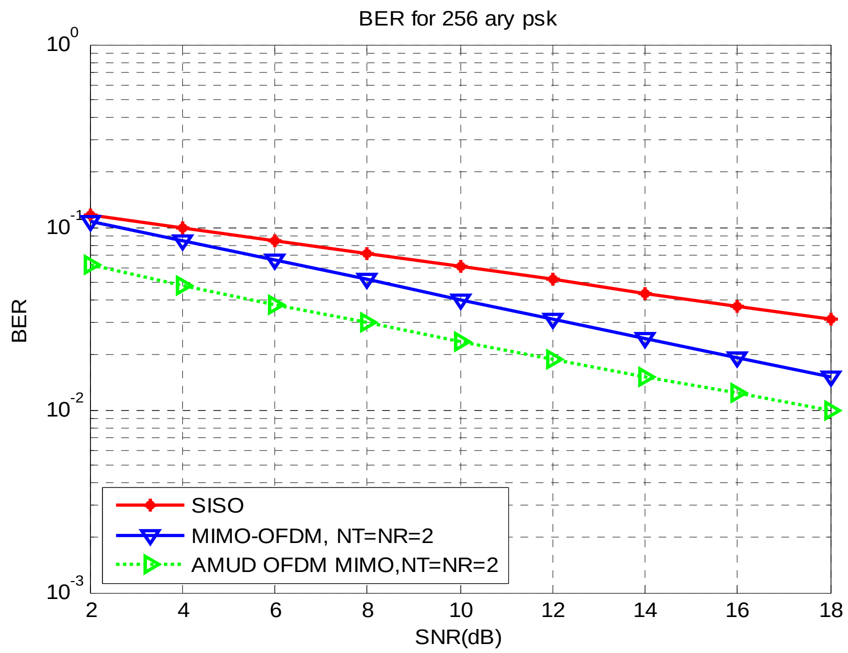

Fig. 9: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM (NT=NR=2) 256 ary psk

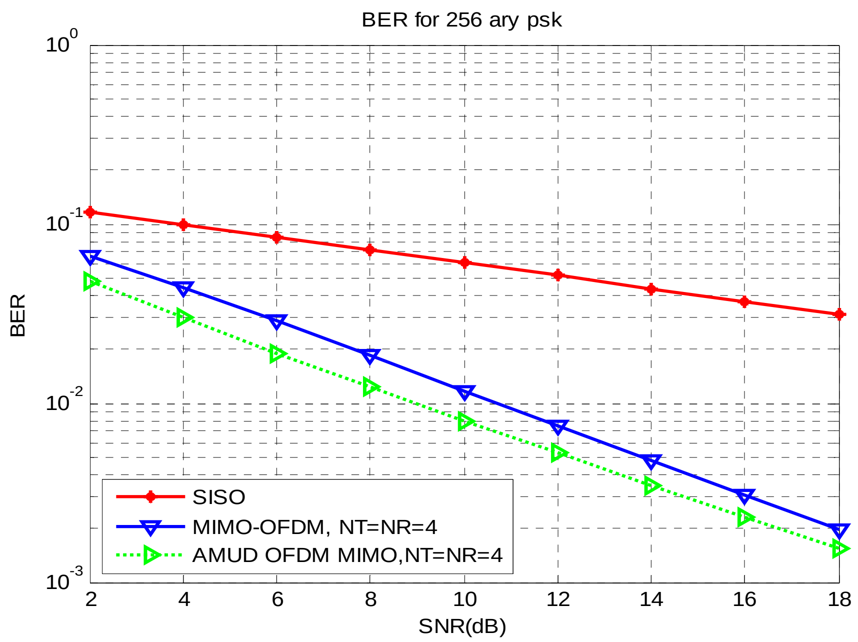

Fig. 10: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM(NT=NR=4) 256 ary psk

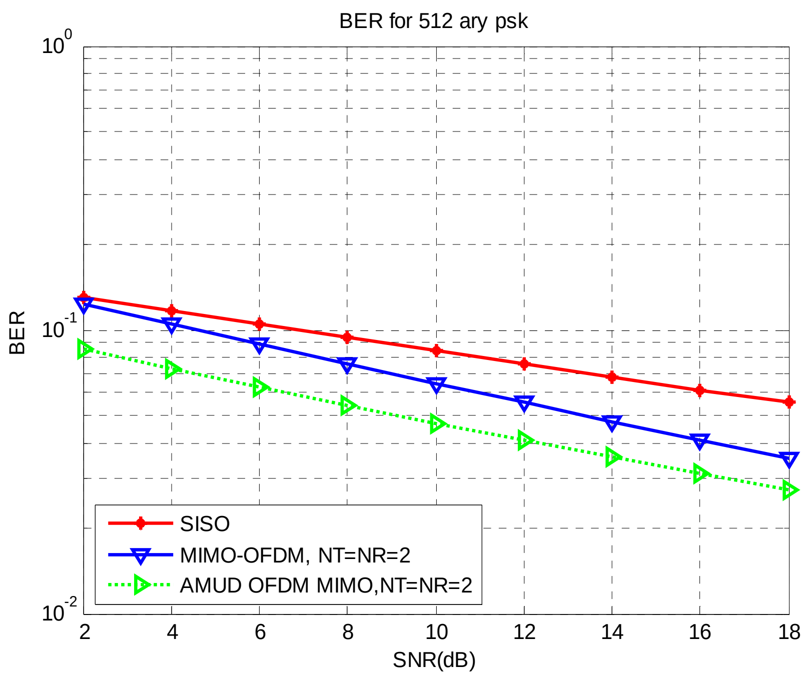

Fig 11: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM (NT=NR=2)512 ary psk

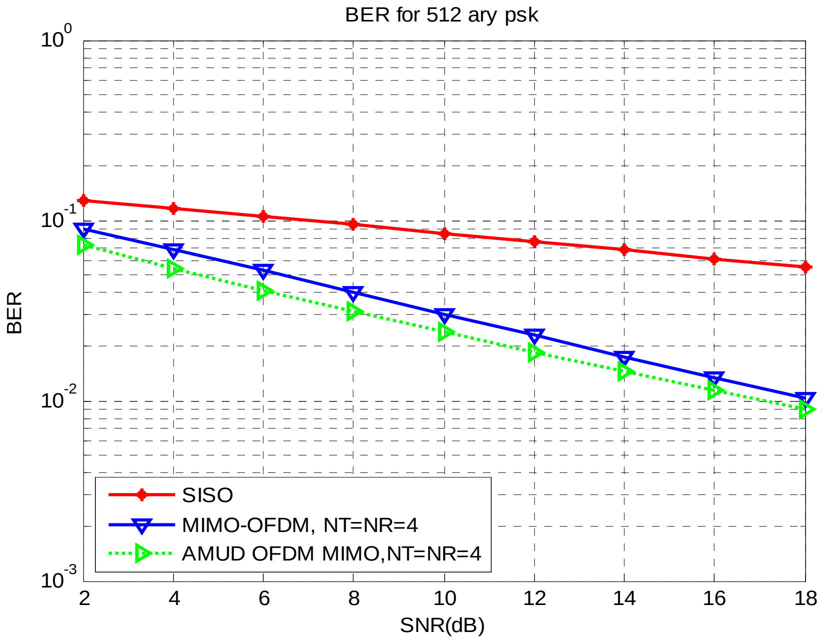

Fig. 12: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM(NT=NR=4) 512 ary psk

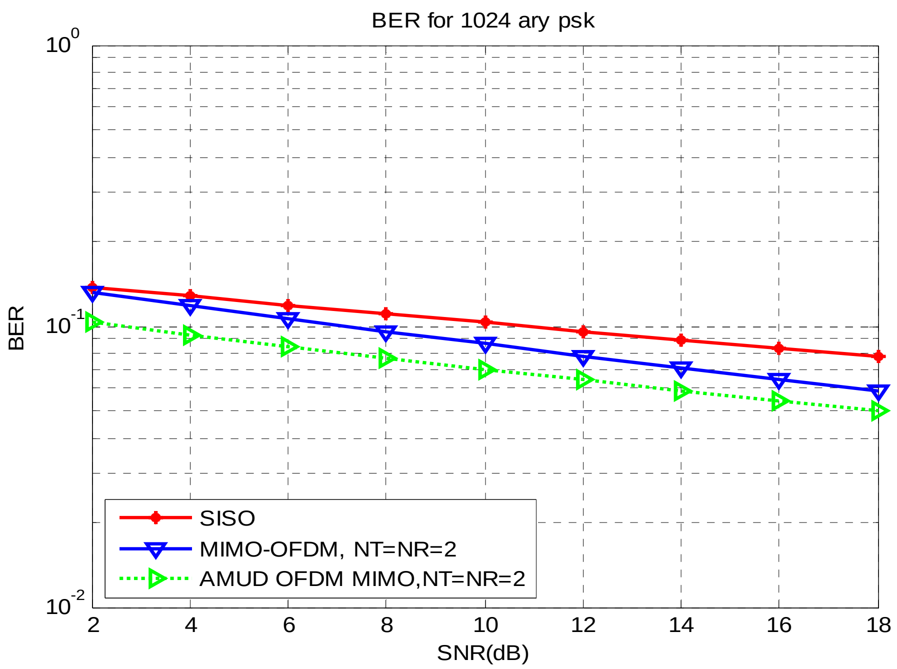

Fig. 13: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM (NT=NR=2)1024ary psk.

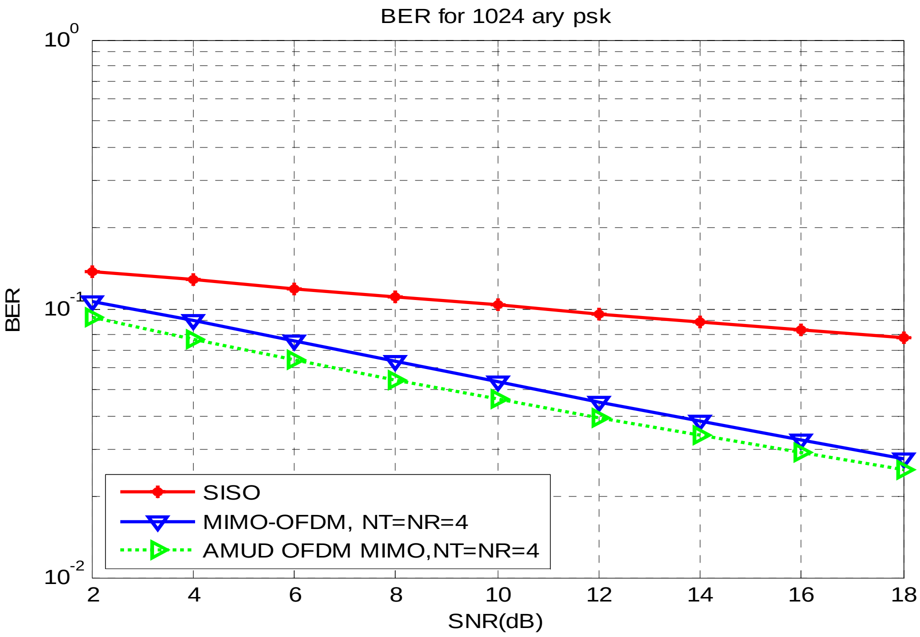

Fig. 14: BER Comparision for SISO, MIMO-OFDM and AMUD MIMO-OFDM(NT=NR=4) 1024ary psk

8. Conclusion

In this paper there is improvement in BER for SISO, MIMO-OFDM, AMUD MIMO-OFDM by applying M-PSK modulation. The achievable BER for three cases (SISO, MIMO-OFDM, AMUD MIMO-OFDM) have been found out using different antenna configurations. M-PSK modulation technique is used in the simulation, where value of M varies as 4, 16, 64, 256, 512, 1024. Simulation results show that AMUD MIMO-OFDM is spectrally efficient and out performs better than MIMO-OFDM, SISO. Along with variation in value of M ,the number of antenna used at transmitter and receiver also varied i.e. 2 for first case and 4 for second case. MIMO-OFDM, AMUD MIMO-OFDM with multiple antenna configurations are analyzed and their results show that AMUD MIMO-OFDM is a promising technique for future wireless communication. Modulation technique used for BER improvement is m-ary psk.

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