# Capacity & Performance Comparison of SISO and MIMO System for Next Generation Network (NGN)

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***Abstract-*** **The World always wants to use a better wireless network that's why it always needs to be improved. Due to limited range, capacity and data rates of these wireless devices a MIMO (multiple-input multiple-output) system is introduced to overcome these limitations. This paper is aimed at studying the performance analysis of MIMO and also the basic idea about the SISO, SIMO & MISO. This study is basically focused on the MIMO technology as MIMO could increase the capacity and data rates of the wirelesscommunication system as compared to SISO, SIMO, and MISO system. It allows multiple of antennas at the transmitting side and the receiving side to produce multiple paths in between transmitting and receiving end for radio links. The multiple antennas allow MIMO systems to perform multiplexing gain, diversity gain interference reduction gain. Finally, these techniques are implemented in MATLAB-2009; theoretical and simulated results of SISO &MIMO are analyzed and compared by using BPSK modulation techniques.**

***Keywords- BPSK, AWGN, SISO, SIMO, MISO, MIMO***

## I. INTRODUCTION

The rapid development of communication systems with mobile receivers at high data rates and higher channel capacity has led to the importance of studies both theoretical and practical in wireless communication systems in time varying channels. To meet the recent demand of the users, wireless networking systems continue to struggle for ever higher data rates (to achieve Gbps range). This is fully challenging task for the wireless system that are power transmission spectral efficiency, bandwidth efficiency design robustness reliability quality of service and complexity limited. MIMO uses multiple antennas for dividing wide band of signals into narrow band of signals with increasing of data rates [2, 10]. Channel capacity can be increased by the help of multiple transmit and receive antennas of the system.In MIMO system if any one path is faded; there is a high probability that the other paths are not, so the signal still gets through. The channel capacity of a MIMO antenna system can be improved without using additional transmit power and spectral bandwidth over SISO antenna system. MIMO is an IEEE 802.11n standard for worldwide [5].

## II. BINARY PHASE SHIFT KEYING (BPSK)

A popular and easier digital modulation technique is binary phase shift keying (BPSK), where the phase of carrier is modulated according to the modulating signal.It has one fixed phase when the data is at one level, the phase is different by 180 degree. The proper demodulation of BPSK is used to recover the original signal at the receiver side. It provides good SNR value with MIMO system for next generation network systems [6, 11].

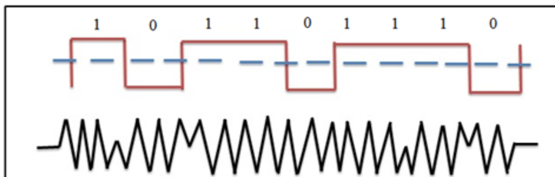



Fig.1 BPSK signal in time domain

## III. TRANSMISSION SCHEMES

Depends upon number of antennas used transmission scheme is divided into SISO, SIMO, MISO, and MIMO for wireless communication system as bellows [1].

### A. SINGLE INPUT SINGLE OUTPUT (SISO)

Single input single output (SISO) isless complex and easier to make for wireless communication system to transmit and receive signal .Assume input data stream is ‘S’, channel is h11and output data stream be the ‘Y’. Antenna configuration and input output relation of SISO system is given in the Fig. 2.

The Channel capacity is poor as compare to other Technique but System design is not Complex.

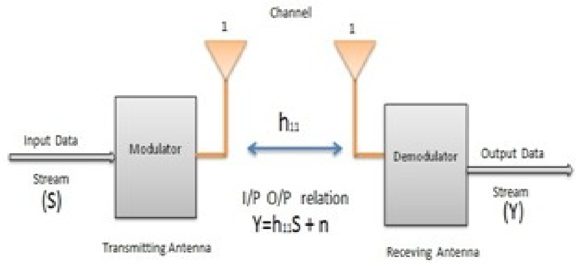



Fig. 2 SISO model

The SISO channel capacity is given by,

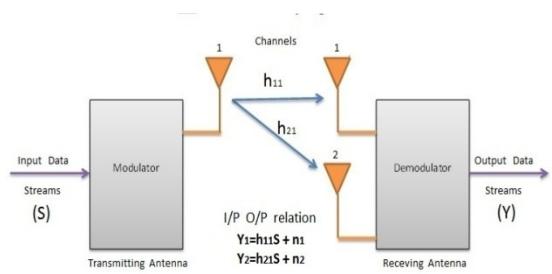
$C_{SISO} = Blog_2(1+S/N)$ (1)

Where C is known as capacity of channel, B is known as bandwidth of the signal, S/N is known as signal to noise ratio.

C. SINGLE INPUT MULTIPLE OUTPUT (SIMO)

SIMO refers to the familiar wireless configuration with a single antenna at the transmitter and multiple antennas at receiver site. Now we assume we have two receiving signals’Y1’ and ‘Y2’ with different fading channel coefficient ‘h1’ and ‘h2’ with input data stream ‘S’ .Antenna configuration and input output relation of SIMO (Receive Diversity)system is given by,

Fig. 3 SIMO model




The channel capacity has not increased. The multiple receive antennas can help us get a stronger signal through diversity. The SIMO channel capacity is given by,

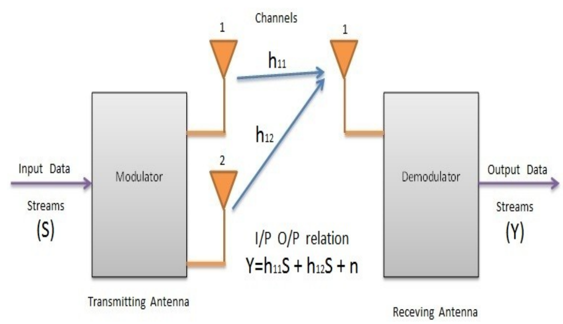
$C = M_r Blog_2(1 + S/N)$ (2)

Where C is known as capacity, B is known as bandwidth, S/N is known as signal to noise ratio. $M_r$ is the number of antennas used at the receiver side.

D. MULTIPLE INPUT SINGLE OUTPUT (MISO)

MISO system has multiple antennas at the transmitter and single antennas at receiver site. Now we assume we have two transmitting signals ’S1’ and ‘S2’ with different fading channel coefficient ‘h1’ and ‘h2’ with output data stream ‘Y’. Antenna configuration and input output relation of MISO (Transmit Diversity) is given by,

Fig. 4 MISO model




The channel capacity has not really increased because we still have to transmit two signals at a time 2.The MISO capacity is given by,

$C = M_t Blog_2(1 + S/N)$ (3)

Where C is known as capacity, B is known as bandwidth, S/N is known as signal to noise ratio. $M_t$ is the number of antennas used at the transmitter side.

D. MULTIPLE INPUT MULTIPLE OUTPUT (MIMO)

MIMO is a method of transmitting multiple data streams at the transmitter side and also receiving multiple data streams at the receiver side. MIMO

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antenna configuration describes that use of multiple transmit and multiple receive antennas for a single user produces higher Capacity, spectral efficiency and more data rates for wireless communication. When the data rate is to be increased for a single user, this is called single user MIMO (SU-MIMO) and when the individual streams are assigned to various users; this is called multiuser MIMO (MU-MIMO) [3, 4].

Antenna configuration and input output relation of MIMO (Transmit Diversity) is given by [12],

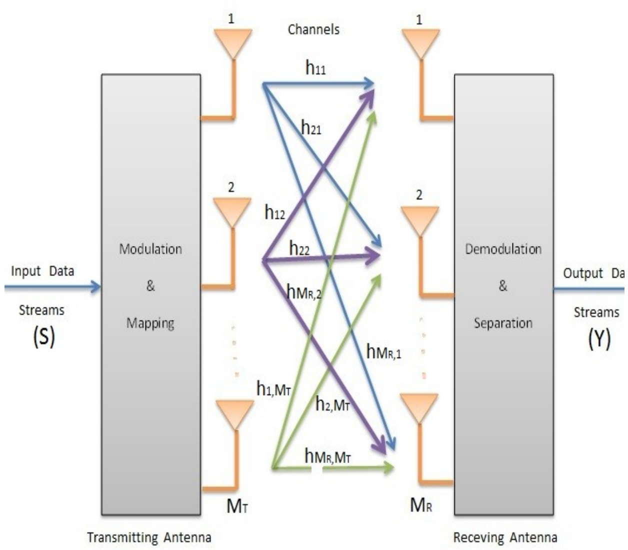


Fig. 5 MIMO model

From the above fig. 4 Output user data stream $y = Hs + \eta$ (input output relation of MIMO channel), where $s = [s_1\ s_2 \dots s_M]^t$ is the transmitted data vector, $y = [y_1\ y_2 \dots y_M]^t$ is the received data vector, and $\eta = [\eta_1\ \eta_2 \dots \eta_M]^t$ is the Additive White Gaussian noise (AWGN). BPSK modulation is used in each block modulation of signal for long distance transmission also it satisfies the good signal-to-noise ratio (SNR).

Let us consider a MIMO system with $M_T$ transmit antennas and $M_R$ receive antennas, denote the impulse response between the $j^{th}$ (j= 1, 2, … $M_T$) transmit antenna and the $i^{th}$ (i= 1, 2, … $M_R$) receiving antenna.

The MIMO channel can be represented using a $M_R \times M_T$ matrix format H is given by,

$$H = M_R \begin{bmatrix} h_{11} & h_{12} \dots & h_{1MT} \\ h_{21} & h_{22} \dots & h_{2MT} \\ \vdots & \vdots & \vdots \\ h_{MR,1} & h_{MR,2} & h_{MR,MT} \end{bmatrix}$$
$$M_T$$

Where $h_{ij}$ is a complex Gaussian random variable that models fading gain between the ith transmit and jth receive antenna.

If a signal $S_j(t)$ is transmitted from the $j^{th}$ transmitted antenna, the signal receive at the $i^{th}$ receive antenna. The input output relation is given by [10],

$$y_i(t) = \sum_{j=1}^{M_T} h_{i,j}\, S_j(t),\ i= 1, 2, \dots M_R \qquad (4)$$

Here we take $M_T$ transmit and $M_R$ receive antennas with input data stream is S and output data stream is Y. MIMO has higher capacity as compare to other system..The MIMO capacity is given by,

$$C = M_t M_r B log_2(1 + S/N) \qquad (5)$$

Where C is known as capacity, B is known as bandwidth, S/N is known as signal to noise ratio. $M_t$ is the number of antennas used at the transmitter side & $M_r$ is the number of antennas used at receiver side.

## IV. RESULT ANALYSIS

### A. CAPACITY OF SISO AND SHANNON SYSTEM

The capacity of SISO system is given by the formula as,

$$C_{SISO} = B log_2(1+S/N) \qquad (6)$$

Where C is known as capacity of channel, B is known as bandwidth of signal, S/N is known as signal to noise ratio.

  

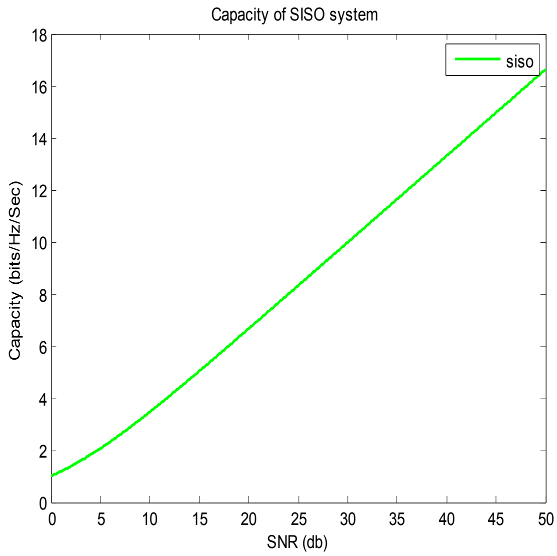


Fig. 6 (a) Capacity of SISO system

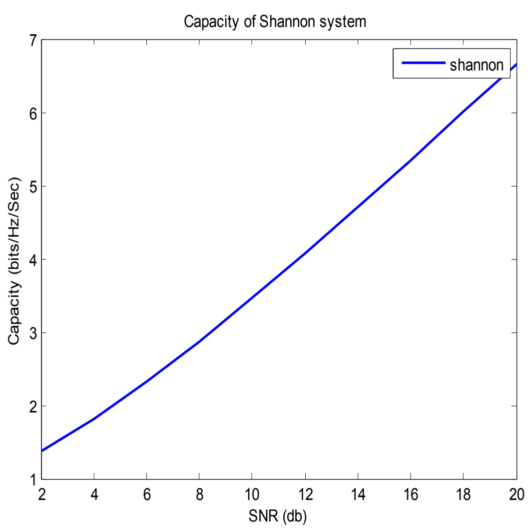


Fig. 6 (b) Capacity of Shannon system

From the above fig. 6 (a) & (b) we obtained capacity versus SNR of SISO and Shannon system by using MATLAB 2009 Software with single input and single out put antenna i.e. only single path is between transmitter and receiver. Its channel capacity is poor but system design is very much easier to any 2G mobile phone.

## B. MIMO ANTENNA COMBINATION

The possible combination and comparison of minimum transmitting antennas ($M_T$) and number of receiving antennas ($M_R$) is given in Table 1 & 2 [9].

TABLE.1 Antenna combination at transmitter and receiver end.

| Combination | No. of Tx antenna | No. of Rx antenna |
|---|---|---|
| 1. | 1 | 1 |
| 2. | 2 | 2 |
| 3. | 2 | 3 |
| 4. | 3 | 2 |
| 5. | 4 | 4 |

## C. CAPACITY COMPARISON OF SISO AND MIMO SYSTEM

The capacity of MIMO system is given by the formula as [7, 8],

$$C = M_t M_r B log_2(1 + S/N)$$

Where C is known as capacity of channel, B is known as bandwidth of the signal, S/N is known as signal to noise ratio. $M_t$ is the number of antennas used at the transmitter side & $M_r$ is the number of antennas used at receiver side.

TABLE. 2 comparison of different antennas system.

| Type | $T_X$ antenna | $R_X$ antenna | Data rates | Capacity | Coverage |
|---|---|---|---|---|---|
| SISO | single | single | less | less | less |
| MIMO | multiple | multiple | greater | greater | greater |

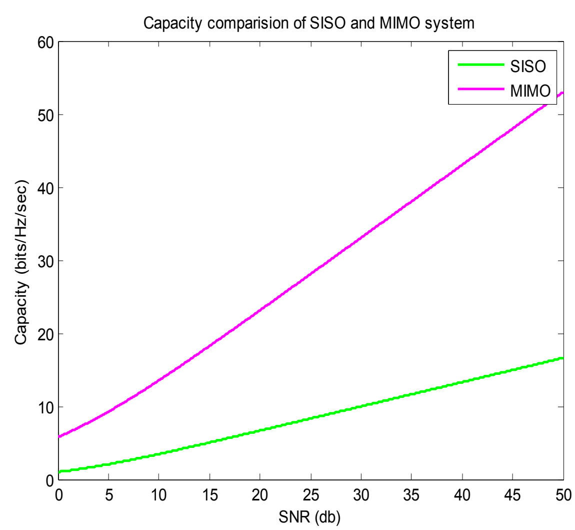


Fig. 7 Capacity comparison of SISO and MIMO system

From the above fig. 7 we illustrate capacity of MIMO system versus the average SNR, for $N_T = N_R=1$ and $N_T = N_R=3$, observe that at high SNR, the capacity of the $(N_T, N_R) = (3, 3)$ MIMO system is approximately three times the capacity of the SISO system. Thus, at high SNR, the capacity increases linearly with the number of antennas at both transmitter and receiver side.

## V. CONCLUSION

This paper provides the major features technologies & performance of MIMO links as well as SISO and MIMO capacity comparison for next generation wireless network systems. High data rates & performance of the system is achieved by proper system design of MIMO system. It is cleared that the success of MIMO system integration into commercial standards such as 3G, 4G, WiMAX, WLAN, LTE etc. We obtained MIMO system is approximately three times the capacity and data rates of the SISO system with BPSK modulation technique. Thus, at high SNR, the capacity increases linearly with the number of antennas at both transmitter and receiver side of the MIMO system. Further, the performance result analyses are obtained by using MATLAB 7.8.0 (R2009a).

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