

# Integration of Existing Wireless Communication Technologies in Respect to Future Generation

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**Abstract**— we are in need of sustainable future technology of wireless communication followed by existing generations like first, second, third and fourth etc. In present there are limitations for system capacity, range and reliability in wireless technologies. In this paper we are attempting to extract useful parameters or methodologies such as multi input multi output technology (MIMO) for integrating wireless technologies. We find that MIMO technique along with its special characteristic of spatial multiplexing and spatial modulation can adopt for Integrated System of Wireless Communication. Further we analyzed that both characteristics spatial multiplexing and spatial modulation with MIMO will provide different result in different scenarios.

**Keywords**—MIMO, MU-MIMO, Massive-MIMO, Spatial multiplexing, Spatial modulation, Wireless Communication, GSM

## I. INTRODUCTION

During the last century, the communication technology has crossed many phases. The transition from first generation (1G) analogue voice only communication to second generation (2G) digital voice communication has taken place quickly with the developments in digital techniques 3G

technology includes video telephony and Internet access with audio/video download services. 4G mobile service technology provides on-demand high quality audio and video services with huge data rates. In addition to the mobile technology, Wireless Exponential growth in consumers demands is need for developing the communication systems with higher reliability, improved Quality of Service (QoS) and supporting larger data rates. For resolving these issues a concept is used and that is multiple antennas at transmitter and receiver. Up to 3G we use SISO systems or single input and single output RF wireless communication systems usually governs the wireless communication systems.

In SISO a single antenna at the transmitter and receiver for data transfer shown in fig.1.

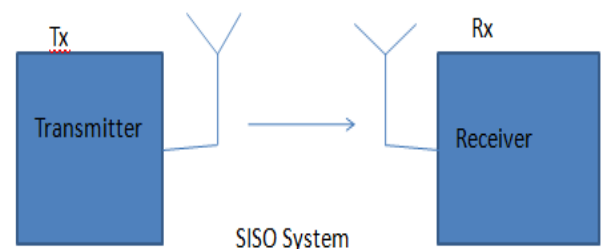


Fig. 1

The channel capacity of such systems is limited. According to Foschini, the data rate of any wireless system can be improved by employing multiple antennas at the transmitter and receiver in a rich multipath propagation environment, leading to the new technology known as Multiple Input Multiple Output (MIMO) [1].

"MIMO" refers to the simultaneous transmission of multiple signals to multiply spectral efficiency. MIMO is the first radio technology that treats multipath propagation phenomenon to be exploit space dimension.

#### A. Multi Input Multi Output

It is an antenna technology that is used both in transmission and receiver equipment for wireless radio communication shown in fig. 2.

MIMO systems can be divided into three stages:

1) **Pre-coding:** In common terms it is a multi-stream beam forming. In more common terms it was supposed to be all spatial processing which occurs at the transmitter end.

2) **Spatial multiplexing:** It converts a high rate signals to several lower rate signals and different signal is transmitted by a different transmit antenna in a common frequency channel.

3) **Diversity coding:** If no knowledge about channel at the transmitter end then Diversity coding technique is used. In this method a single stream is transmitted and signal is coded by SPACE-TIME CODING techniques.

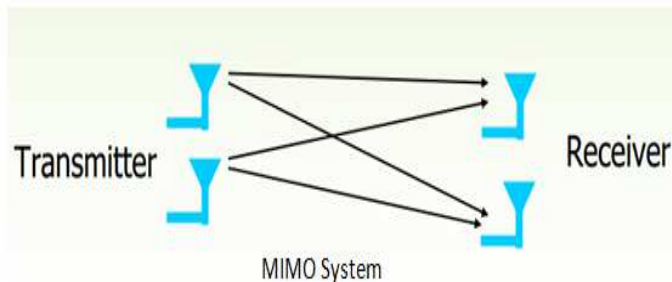


Fig.2

#### B. Multiuser-MIMO

When MIMO is used to communicate with several terminals at the same time, we speak of multiuser MIMO (MU-MIMO). It increased data rate, because the more antennas, the more independent data streams can be sent out and the

more terminals can be served simultaneously. Further it can enhance the reliability, due to the more antennas the more distinct paths that the radio signal can propagate over. Improved energy efficiency, because the base station can focus its emitted energy into the spatial directions where it knows that the terminals are located. Reduced interference, because the base station can purposely avoid transmitting into directions where spreading interference would be

harmful. The most modern standard, LTE-Advanced, allows for up to 8 antenna ports at the base station and equipment being built today has much fewer antennas than that.

#### C. M-MIMO

Massive-MIMO is also known as Large-Scale Antenna Systems or Very Large MIMO. In M-MIMO extra antennas help by focusing energy into every smaller regions of space to bring huge improvements in throughput and radiated energy efficiency. Massive MIMO include the extensive use of inexpensive low-power components, reduced latency. Massive-MIMO is a technique that improves system or channel capacity. Some challenges are also present with M-MIMO like complexity, cost efficiency, implementation etc. but M-MIMO is more beneficial in comparison than traditional MIMO. Use of Massive-MIMO is best suited for future generation [6].

#### D. Spatial Multiplexing

Spatial Multiplexing is also known as Space Division Multiplexing (SDM), In Spatial Multiplexing different data streams are transmitted simultaneously in parallel channels from each transmitting antenna. This data transmitting scheme is well suited only for high SNR environments as the receiver cannot identify the uncorrelated signal paths under low SNR conditions. A well known type of Spatial Multiplexing is BLAST. There is N number of transmitting and receiving antennas needs to increase the channel capacity by N times. Main drawback of Spatial Multiplexing is all antennas are active during communication so wastage of energy in Spatial multiplexing i.e. it is not energy efficient. [3]

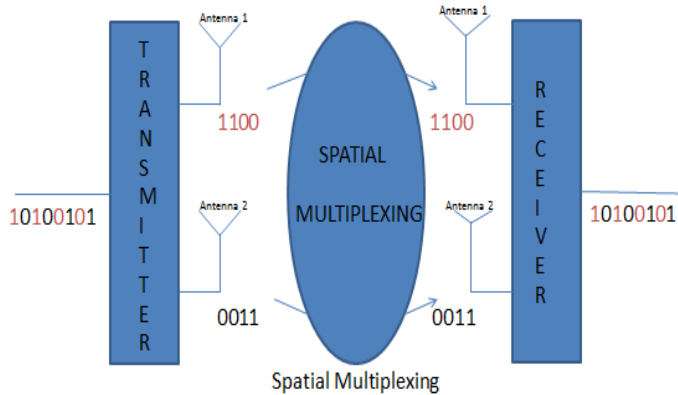


Fig. 3

		SNR(db)				
		0	5	10	15	20
C A P A C I T Y	SISO 1*1	1.00	1.75	2.90	4.25	5.95
	MIMO 2*2	1.75	3.60	5.75	8.15	11.10
	MIMO 3*3	2.5	8.50	8.20	12.25	16.90

**E. Spatial modulation:**

Spatial Modulation (SM) is used to increase Spectral efficiency of wireless communication. It combines digital modulation and multiple-antenna transmission to systems. In Spatial Modulation technique only one antenna is active for transmission at a time. So Spatial Modulation is energy efficient as compare to Spatial Multiplexing. Spatial Modulation works on the concept of Modulating symbol with phase or amplitude of the carrier and selection of the antenna for transmission of the carrier signal. [4]

Some disadvantages are also there so a new idea of using multiple active transmits antennas with spatial modulation are considered and this technique called as Generalized Spatial Modulation (GSM). We can say that GSM is a hybrid of Spatial Multiplexing and Spatial Modulation. It transmits the same symbol over the active antennas and uses a set of active antenna combinations as an information source to increase spectral efficiency.

**F. Analysis of Antenna Techniques**

**1) SISO vs. MIMO:**

As a comparison made by Sharony. J (2006) [7] for SISO and MIMO on the basis of their performance. SISO has one transmit antenna and one receiving antenna but MIMO have many combination e.g. 2\*2, 3\*3 etc. On the basis of Shannon’s theorem he observed that when we increase the no of transmitting antenna and no of receiving antenna system capacity will increase. [7]

**2) Massive MIMO with Spatial Multiplexing:**

The reliability of a MIMO wireless system can be improved using various data transmission schemes like Spatial Multiplexing (SM). Using this spatial multiplexing scheme, the channel capacity can be improved depending on the number of antennas employed at the transmitter and receiver. In massive MIMO there are huge no of antennas and all antenna are active during communication in Spatial Multiplexing so there are many disadvantages of this technique like inter channel interference, inter antenna synchronization etc.

**3) Massive MIMO with Spatial Modulation:**

Implementation of Massive MIMO with Spatial Modulation is less complex as compared to spatial multiplexing and it is Cost efficient and Energy efficient. In Spatial modulation all antennas are not active during communication. By this property it removes the drawbacks of Spatial Multiplexing e.g. inter channel interference, inter antenna synchronization. It also Supports Multiple RF chains to increase in multiplexing gain in Spatial Modulation with number of antenna increases but it does not improve the system capacity. To improve system capacity a new version of Spatial Modulation is introduced i.e. multiple active Spatial Modulation (MA-SM) also known as Generalized Spatial Modulation (GSM). It is a hybrid of Spatial Multiplexing and Spatial Modulation. A comparison by HALIL SAYGILI (2013), between Spatial Multiplexing (BLAST), Spatial Modulation and Multiple Active Spatial Modulation (MA-

TABLE 3.

Capacity Of BLAST( $N_t=2, N_r=2, M=4$ ) & SM( $N_t=2, N_r=2, M=8$ ) w.r.t. SNR

		SNR					
		-5	0	5	10	15	20
C A P A C I T Y	BLAST	0.75	1.70	2.80	3.70	3.90	4
	SM	0.75	1.70	2.75	3.65	3.85	4

TABLE 4.

Capacity Of BLAST( $N_t=N_r=4, M=2$ ), SM( $N_t=N_r=4, M=4$ ) & MA-SM( $N_t=N_r=4, N_a=M=2$ ) w.r.t. SNR

		SNR				
		-5	0	5	10	15
C A P A C I T Y	BLAST	1.38	2.75	3.80	4.00	4.00
	SM	1.25	2.60	3.75	4.00	4.00
	MA-SM	1.25	2.60	3.70	4.00	4.00

TABLE 2.

Capacity Of BLAST( $N_t=2, N_r=2, M=2$ ) & SM( $N_t=2, N_r=2, M=2$ ) w.r.t. SNR

		SNR				
		-5	0	5	10	15
C A P A C I T Y	BLAST	0.60	1.20	1.75	1.95	2.00
	SM	0.60	1.20	1.75	1.95	2.00

TABLE 5.

Capacity Of SM( $N_t=N_r=4, M=16$ ) & MA-SM( $N_t=N_r=4, N_a=2, M=4$ ) w.r.t. SNR

		SNR				
		-5	0	5	10	15
C A P A C I T Y	SM	1.40	3.00	4.70	5.70	6.00
	MA-SM	1.40	3.30	5.20	5.90	6.00

SM). Table 2, 3, 4, 5, 6, 7 shows that Multiple Active Spatial Modulation gives high system capacity between Spatial Multiplexing, Spatial Modulation and Multiple Active Spatial Modulation (MA-SM). If number of antennas is less then Spatial Multiplexing and Spatial Modulation give identical result but if number of antennas increases then Spatial Multiplexing give better result. Hybrid Version of Spatial Modulation (MA-SM) with MIMO gives logarithmic increase in system capacity but when MA-SM use with Massive MIMO it gives exponentially increase system capacity but complexity is an issue with this concept . [4]

TABLE 6.

Capacity Of BLAST( $N_t=N_r=8, M=2$ ), SM( $N_t=N_r=8, M=32$ ) & MA-SM( $N_t=N_r=8, N_a=2, M=4$ ) w.r.t. SNR

		SNR				
		-5	0	5	10	15
C A P A C I T Y	BLAST	2.60	5.35	7.65	8.00	8.00
	SM	2.70	5.00	7.00	7.85	8.00
	MA-SM	2.80	5.85	7.85	8.00	8.00

TABLE 7.

Capacity Of BLAST( $N_t=N_r=4, M=4$ ), SM( $N_t=N_r=4, M=64$ ) & MA-SM( $N_t=N_r=4, N_a=2, M=8$ ) w.r.t. SNR

		SNR					
		-5	0	5	10	15	20
C A P A C I T Y	BLAST	1.45	3.30	5.90	7.70	8.00	8.00
	SM	1.45	3.00	4.95	6.60	7.70	8.00
	MA-SM	1.45	3.30	5.80	7.60	8.00	8.00

## II. CONCLUSION

On the basis of existing techniques that have been studied in literature and analysis we became able to conclude that when number of antenna is less, then Spatial Multiplexing (BLAST) gives better result than Spatial Modulation so if we increase number of antenna at both transmitter and receiver end i.e. Massive-MIMO gives best result with Multiple Active Spatial Modulation (MA-SM) or Generalized Spatial Modulation (GSM). So Generalized Spatial Modulation with Massive- MIMO techniques helps to build future generation.

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