IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 13, Issue 2, Ver. I (Mar. - Apr. 2018), PP 29-34
www.iosrjournals.org

Hyper-Mimo Spectral Efficiency Enhancement Techniques in 5g

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Abstract: *Hyper-MIMO systems are regarded as one of the most upcoming research areas today, given to the next generation of mobile networking. This is due to the fact that Hyper-MIMO channel can offer a noteworthy capacity gain over a traditional multiple-input multiple output (MIMO) channel. In Hyper-MIMO we are increasing number of transmitting antennas at base station to improve performance. In this paper we discuss about Hyper-MIMO, enhanced spectral efficiency using various precoding over traditional MIMO system. Hyper-MIMO contributes an immense channel potential and spectral efficiency for the users with high data rate. This paper discusses and simulates the potential and the Spectral efficiency improvement of Hyper-MIMO using MR Precoding ,MMSE Precoding and Zero-forcing Precoding with and without pilot sgnals of Hyper-MIMO systems..*

Index Terms: *Capacity, Hyper-MIMO, 5G, MIMO, MM-WAVE, Spectral efficiency*

Date of Submission: 26-02-2018 Date of acceptance: 17-03-2018

I. Introduction

One of the prominent wireless technologies is Mobile networking, which can yield voice and/or data network connectivity through wireless. Most famous application of mobile networking is cellular phone [5]. In mobile as well as fixed, demand for radio transmission throughput will always increase. One can definitely predict that, in coming decades, millions of users in a large city will want to transmit and receive holographic video more or less continuously, about 100 Mbps per consumer in each direction. Hyper- MIMO often called Massive MIMO is a promising technology for meeting this demand.

Hyper-MIMO provides greater channel potential improvements over 4 G technologies. Thus the channel potential can be achieved without the need for more bandwidth or additional base stations, if the channel potential is improved. With the help of various advanced technologies

like Hyper-MIMO, MM-wave communication, etc consumers definitely will replace 4G by 5G. There has been prominent growth in the data rates and the spectral efficiency of the radio transmission. Mobile communication starting from cellular generation like 2G, 3G and now 4G with varying the data rates from 12kbps in 2g to100Mbps in 4g [8].This shows that the increase in data rates comes with the increase in the potential of the systems. So here going to discuss and simulate the potential of systems like MIMO systems and hyper MIMO systems.

II. 5g Architecture

The next generation of wireless connectivity is 5G. Fifth generation will yield great speeds and a good potential. It will provide data rate between 10Gbps and 100Gbps.In real time applications latency is very important, in 4G its range between 40ms and 60ms. Even though this is a very low latency but not able to provide day to day applications like in a video-game player, we want our system to respond in single sweep of time when a button is pressed. While moving to 5G, they have assured a ultra-low latency range between 1ms to 10ms. Then in future we can actually watch any live telecast without any delay. For improving the potential, Management of the available bandwidth is very prominent factor to be taken in account; one idea is that as not all systems need the same bandwidth, we may improve the capacity by providing bandwidth according to their needs.

As research have shown that a mobile user stays inside for about 85 percent of time and outside for about 15 percent of time. In this scenario for a user inside will receive a call that signal will undergo many losses and hence efficiency

be less, data bit rate will be reduced and energy efficiency also reduced. The reason behind is that there is only single base station at the middle of the cell site that manage all these. While moving to 5G architecture both outside and inside have different models. Thus the penetration losses can be reduced to some extent. This will be implemented using Hyper- MIMO technology by employing more number of antennas.

Usually in MIMO system we utilize three or five antennas, by using Hyper-MIMO, we are increasing number of trans-mitter and receiver antennas approximately between ten to hundred. By doing this capacity gain has been increased [5]. In Hyper- MIMO network for establishing a well grounded network two things have to be setup.

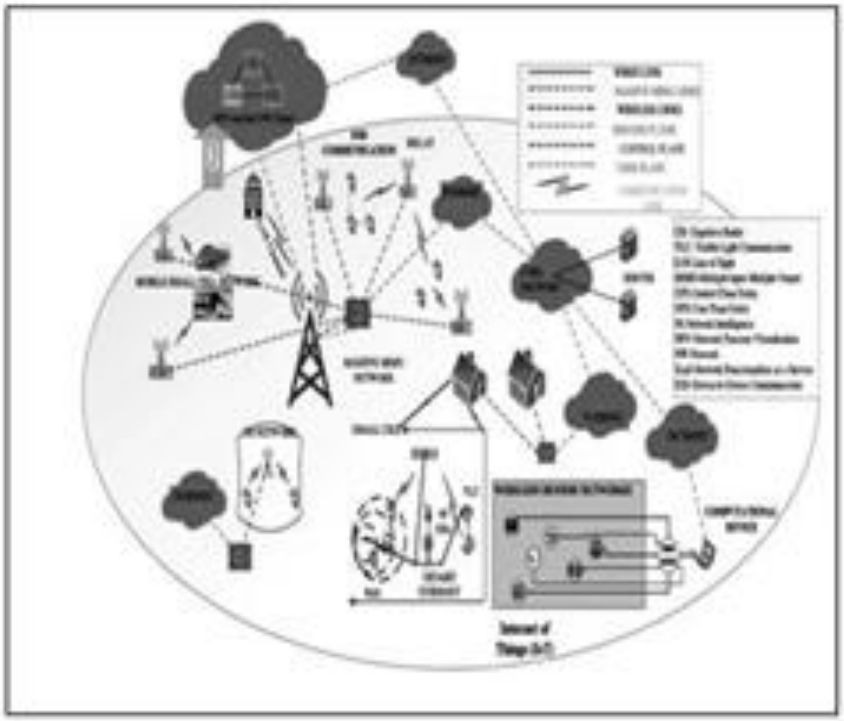

Fig. 1: General 5G cellular network architecture [5]

First, a base station will be establish in a cell site with array of antennas on it and these base station are connected using optical fibre cables. When a user is outside he/she is connected to the base station directly or connected via multiple hops from the antennas by creating virtual Hyper-MIMO network. Next step an antenna array will be establish in every building, these antennas array will be in line of sight with the base station. The communication inside is done using by various technologies like Wi-Fi, visible light communication, MM-wave communication etc [5].

III. Hyper-Mimo

Hyper-MIMO is a multi-user MIMO (MU-MIMO) technology where K user systems are serviced on the same time-frequency resource by a base station (BS) with M antennas, such that M>>K .Hyper-MIMO utilized spatial-division multiplexing. A breakthrough in wireless communication to perform wireless spatial multiplexing is an array of independently-controlled antennas.

The data streams are carried on focused beams of data under LOS propagation conditions, where as in a cluttered propagation environment, the data streams can arrive from

many directions simultaneously. If the signal is desired, then the streams tend to strengthen each other constructively, and where they are unwanted then interfere destructively. In order to carry out multiplexing the antenna array needs to know the frequency response of the propagating channels between each of its elements and each of the users. In pre-coding section channel state information (CSI) is utilized and the data streams are mapped into the signals that drive each of the antennas. [7].

By using Hyper-MIMO technology one advantage is that we can increase the potential and reliability, and also we can reduce the error rate. By transmitting multiple versions of our message through different channels the probability all the signals will be affected same will be less. At the receiver section these multiple copies are received and processed to retrieve our original message.

With the help of diversity techniques communication link can be stabilize, improve its capacity, performance, and reduces data error rate. Due to these benefits by MIMO technology is deployed as a part of communication standards such as 802.11 (WiFi), 802.16 (WiMAX), and LTE [5].

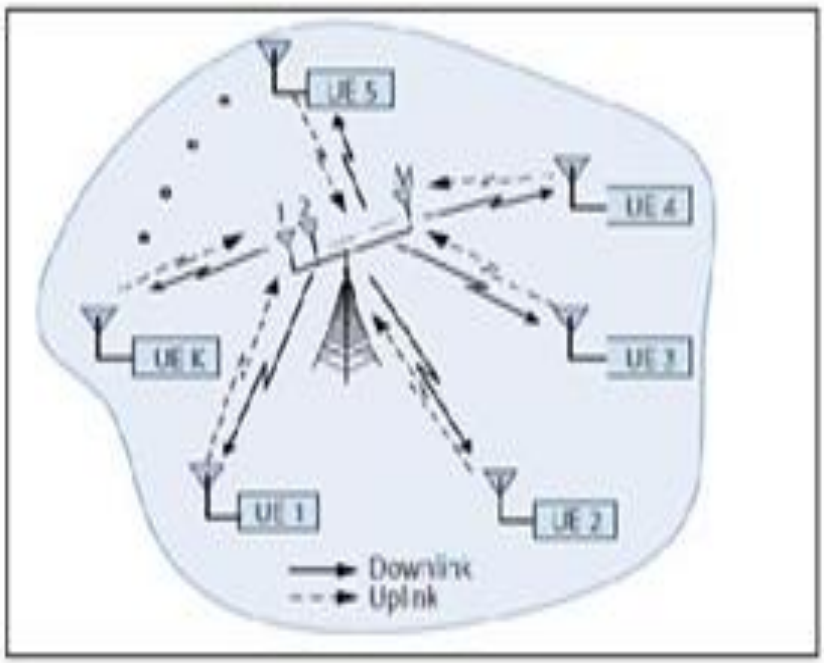

Fig. 2: Hyper- MIMO: a multi-user MIMO technology [7]

IV. Energy Efficiency & Channel Capacity aspects in Hyper-Mimo

In Hyper-MIMO systems can achieve large energy efficiency when compared to conventional MU-MIMO systems. This gain can be in two major ways, both based on increasing the size of the system that is (M, K). First, for a given system throughput, transmission power of the user equipments in Hyper-MIMO systems can be reduced significantly, by raising M well beyond the maximum limit of eight antennas per base station in current LTE systems. Thus resulting EE levels are improved 100 times that of conventional MIMO systems.

The capacity improvement is due to the use of spatial multiplexing. In Hyper- MIMO beam division multiple access (BDMA) techniques can be used. It will allot beam for each user which are orthogonal to each other. The subscriber will use same beam if the users are in same location by using multiple access techniques like FDMA/TDMA thus improving the capacity. The energy efficiency is also improving due to focussing of beam in particular target location [9].

V. Spectral Efficiency of Her-Mimo

To keep up with the rapid traffic growth, a key goal of the 5G technologies is to improve the area throughput by orders of magnitude; 100X and even 1000X higher throughput are regularly mentioned as 5G design goals. [10] The area throughput of a wireless network is measured in bit/s/km2 and can be modeled as follows:

Area throughput= Bandwidth Cell density Spectral efficiency This simple formula reveals that there are three main components that can be improved to yield higher area throughput: (1) more bandwidth can be allocated for 5G services; (2) the network can be densified by adding more cells with independently operating access points; and (3) the efficiency of the data transmissions (per cell and fora given amount of bandwidth) can be improved.[10].

In order to increase spectral efficiency Precoding in Hyper-MIMO systems is essentially, Precoding can be done in transmitting side. ZF and MR precoding can be increased the spectral efficiency, In general, ZF precoder performs well under high SNR conditions. The ZF precoder outperforms MR. It also suppresses inter-cell interference at the cost of reducing the array gain. It is noted that spectral efficiency increases as the number of BS antennas grows.[9]

VI. Discussion & Simulation Results

The potential/capacity for Hyper-MIMO system are shown in the following figure3.The capacity of the system capacity is implemented in Matlab for the simulation.

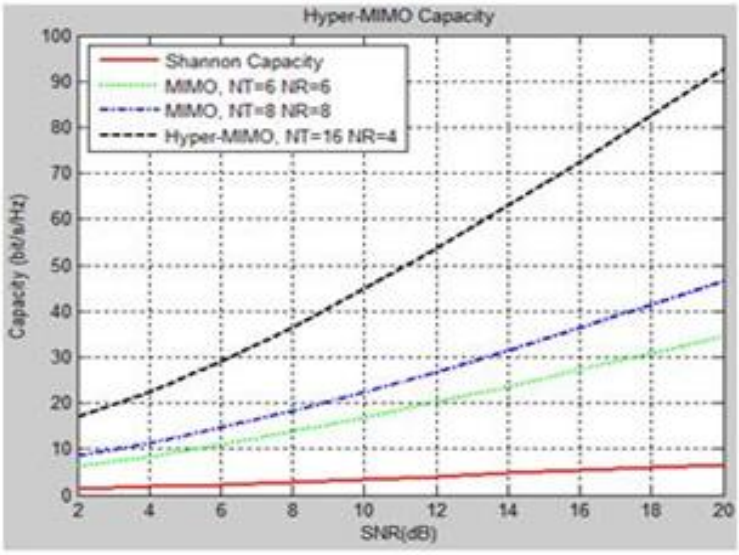

Fig. 3: Potential of Hyper-MIMO systems

We can see that as increase in number of antennas in transmits side, potential/capacity is increasing. Here the black line is showing the capacity of Hyper-MIMO systems and green and blue lines show the system capacity for 6x6 and

8x8 MIMO systems respectively. Thus, at high SNR, the capacity increases linearly with the number of antennas at both transmitter and receiver side. Hyper-MIMO system is approximately three times the capacity of the MIMO systems. Thus, at high SNR, the capacity/potential increases rapidly with the number of antennas at transmitter side.

The Spectral Efficiency vs Maximal Ratio Precoding with and without pilot signal of the Hyper-MIMO during d transmission is shown in Fig 4. Here concrete for downlink transmission with K = 10 users, an SNR of 5 dB,and uncorrelated Rayleigh fading channels.

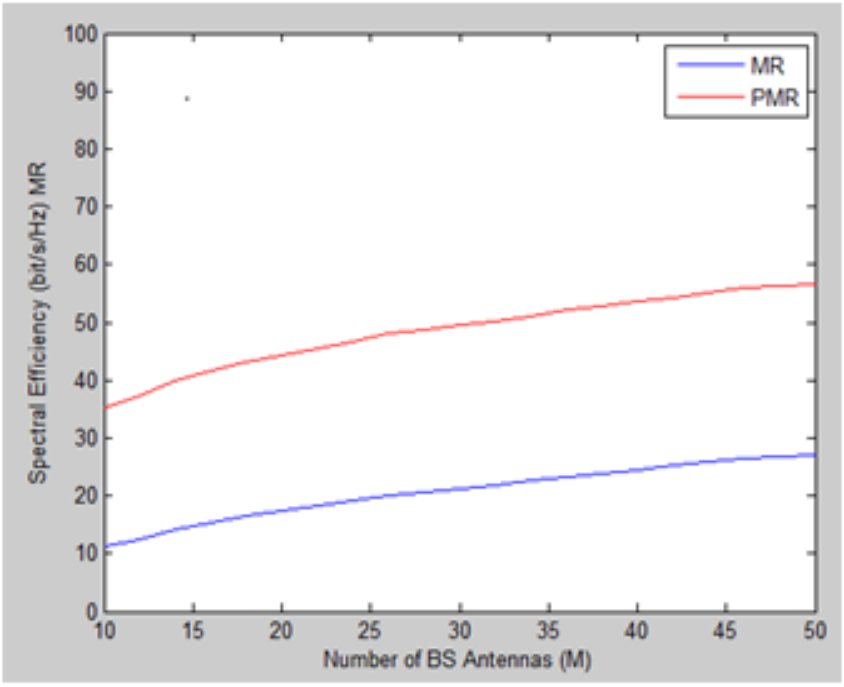

Fig. 4: Simulation with MR Precoding

The Spectral Efficiency Vs Zero - Forcing Precoding with and without pilot-signal of the Hyper-MIMO during transmission is shown in figure 5.

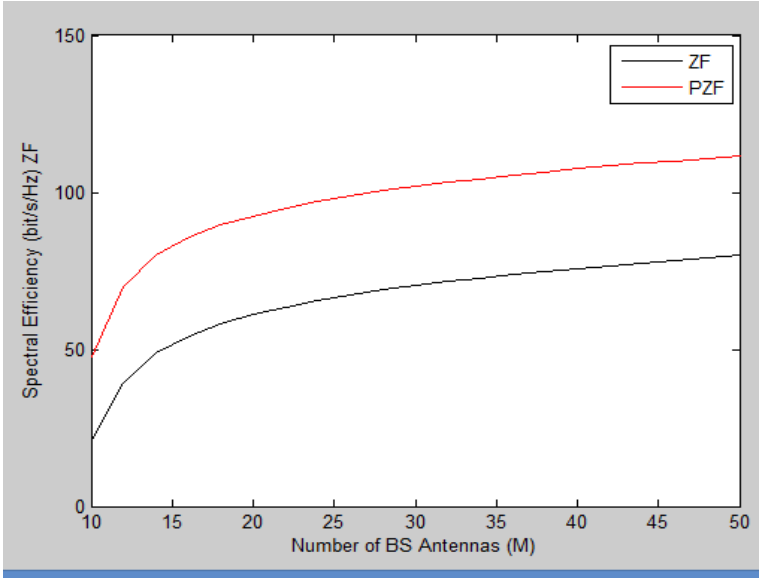

Fig. 5: Simulation with ZF Precoding

The Spectral Efficiency Vs MMSE Precoding with and without pilot-signal of the Hyper-MIMO during transmission is shown in figure 6.

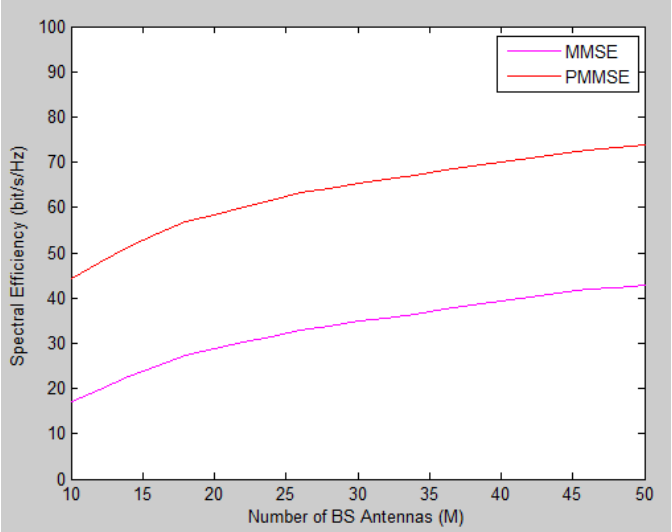

Fig. 6: Simulation with MMSE Precoding

VII. Conclusion

The simulation result shows that the number of transmit antennas increases, the channel capacity/potential increase quite rapidly,as well as spectral efficiency with and without pilot signal as shown in figure. ,which is required to implement in 5G. The Hyper- MIMO system shows the maximum capacity and spectral efficiency which has been proved by simulations. If the values of transmit antennas can be reached in thousands, the channel capacity and spectral efficiency will be large and high data rate is possible without any doubt, it can be very useful to full- fill the hope of 5G and even more.

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IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) is UGC approved Journal with Sl. No. 5016, Journal no. 49082.

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