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AN OVERVIEW OF MASSIVE MIMO ANTENNAS FOR 5G IN FUTURE

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Abstract-This research article presents an overview on Massive MIMO Systems and its original signal processing applications in future trends unclose the aspects of 5G Cellular communication. Massive MIMO is expected to be strength and support for 5G Systems. The complete antenna system is a unique combination of a multiple- input, multiple-output (MIMO) Antenna system at microwave frequencies and a millimeter (mm)wave antenna array. Massive MIMO offers enhanced broadband services more in 5GNetworks and in future are expected to support a great variety of wireless services in areas like health care, smart homes and cities, manufacturing and many others. In practice, Massive MIMO has achieved a record spectral efficiency of 145bps/Hz in test bed equipment with 100 antennas at the base station. This shows an improvement of more than 20 times over 4G Systems.A novel integrated antenna solution for wireless handled devices is proposed for the existing 4G standards and upcoming 5G systems for broadband, high data rate communications. An overview of the research topic for massive MIMO Antenna array is presented. In fact with mm wave communications, a large number of antenna elements can be used to form large arrays of reasonable sizes. The standards for 5G will be set by 2020/2022. The main technologies that will be used in 5G are massive MIMO, mm wave communication, device to device communication, beam division multiple accesses etc., and we also discuss about channel estimation techniques in massive MIMO, Antenna selection in massive MIMO, capacity and energy efficiency in massive MIMO. Significant challenges that need to overcome in practical implementations. In this paper, we present an overview of important research topics related to massive MIMO Antenna arrays could lead to significant performance enhancements. In future 5G MIMO is going to be a technology which will be invisible and it will be a good area for research and implementations.

Keywords-MIMO, mm-wave antenna array, integrated 4G/5G antenna, channel estimate, energy efficiency, antenna selection

I. Introduction

This Massive MIMO also known as Very Large MIMO and Hyper MIMO is a concept in wireless communications research which addresses the massive capacity requirement for 5G systems. In Massive MIMO, the base station has a very large number of antennas, to serve multiple users devices, it also use extra antennas to helps in transmission and reception of signal energy into smaller regions of space .So that it is possible to improve energy efficiency. A rich multipath fading environment can be effectively utilized in multiple-input multiple-output (MIMO) wireless systems to dramatically increase system capacity and it increases independent spatial sub channels between transmitter (TX) and receiver (RX) antenna elements.

At mm wave frequencies, hundreds of antennas can be used on a transceiver to compensate free space path loss. With advances of mm Wave Communication and massive MIMO can be employed practically which allows the placement of a large number of antennas in a small space. Massive MIMO antennas can indeed have a earliest role in several aspects of 5G communications. Some of their interesting configurations are presented in Section II. Technologies of MIMO Antennas for 5G and their applications are described in Section III. Several other applications undergoing significant research are presented in Section IV, and the role of massive MIMO in these application scenarios, which has not yet received sufficient research attention, is outlined.

II. Inquire of Massive MIMO Antenna for 5G

Due to usage of large number of antennas, proximity and modes of operation are imposed on the design of the antennas in a massive MIMO. In the array configuration the individual patterns and mutual coupling all play roles in the performance of the system. Thus, antenna configurations for use in Massive MIMO for 5G should be analyzed. For example, cylindrical, rectangular and circular array configurations could be studied in terms of their element numbers, gain, mutual coupling, resulting pattern beam width and their effects on coverage, the received signal strength and the channel capacity.

The research can be done on 6 GHz, 27-28 GHz, and 60-70 GHz bands. Several antenna element types could be used, such as dipoles, horn antenna and slot antennas.

In Fig. 1, an antenna array disposition is shown. An array allow obtaining directive beams that lead to high antenna gains in assigned direction while leading to low side lobe levels in unwanted directions. The antenna gain is closely related to the directivity of the antenna, which is calculated directly from the array factor.

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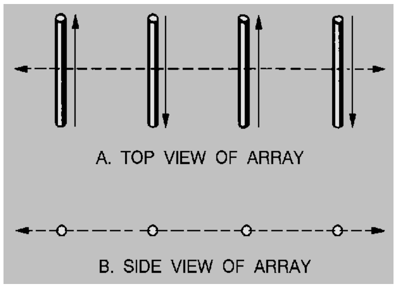

Fig. 1 An Antenna Array

An antenna arrays are obtained by placing linear arrays one parallel to the other such that the elements form a planar configuration, as depicted in Fig. 1. It was shown in [4] that the array factor of a planar array is equivalent to the multiplication of the array factors of two linear arrays in orthogonal directions. On the other hand, cylindrical antenna arrays are obtained by arranging circular arrays one above the other such that the elements form linear arrays in the vertical direction, as depicted in Fig. 2.

It was shown in [5] that the array factor of a cylindrical array is equivalent to the multiplication of the array factor of a linear array on the *z*-axis by that of a circular array in the $x - y$ plane. Thus use of circular arrays provides 360 degrees symmetry whereas their arrangement in the vertical direction provides increased gain and directivity.

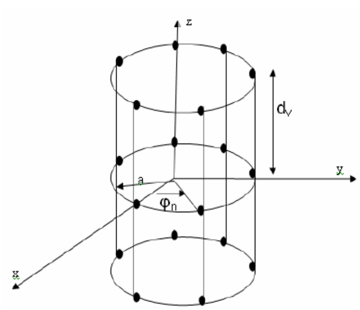

Fig. 2 Cylindrical Array

However, with the advances of 5G millimeter wave communications, stacking huge numbers of small antenna elements to form large arrays with reasonable dimensions in massive MIMO systems. Thus, cylindrical arrays and planar arrays with large number of elements would be interesting to build and investigate their performance in mm wave massive MIMO scenarios. Furthermore, the complexity of the feeding network of massive MIMO arrays is challenge not to be overlooked, especially at mm wave frequencies, and with the beam-steering required to serve multiple users simultaneously.

III. Technologies of MIMO Antennas for 5G

The technologies which can be used in massive MIMO for 5G are device to device communication in massive MIMO, Channel estimate in massive MIMO, Beam division multiple access technique in massive MIMO, antenna selection in massive MIMO, capacitive and energy efficiency in massive MIMO. These are key technologies include MIMO integration to emerging technologies like device to diverse propagation environments. It means massive MIMO works in line of sight (LOS) propagation.

A. Device to Device Communication

Local small cell wireless networks, mobiles are deciding factors for redefining new aspects of devices that supports by massive MIMO. D2D Support Real-time operation with low latency demands reliable data transfer a given time. It also supports Massive Device interconnection and Higher Reliability Linkage which is more safe and reliable than wired standards. This wireless link can be operated every time and everywhere effectively.

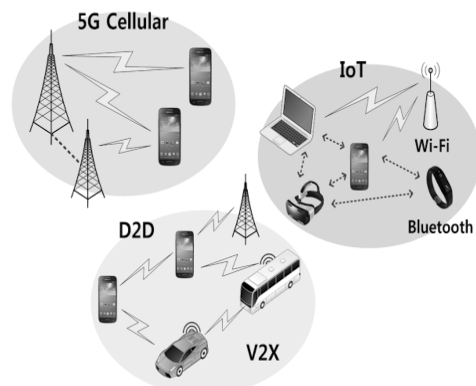

Fig. 3 Device-to-device communication through 5G Massive Communication

B. Channel Estimation in Massive MIMO

In massive MIMO the communication requires channel estimate in both uplink and downlink direction. Normally, in MIMO channel information is required at the base station (BS), downlink for pre coding and uplink for detection. Channel estimate in MIMO is proportional to number of transmitting antennas and is does not to consider for number of receiving antennas. In frequency division duplex (FDD), uplink and downlink use different frequencies to find the channel information in uplink and downlink separately. For uplink channel estimate a pilot sequence is send by all users to the BS, and this is independent of the number of antennas at the BS. However for downlink channel estimate can done by two stages, first the BS send a pilot symbol to all users, next the users send the feedback with estimate channel information to the BS. Large number of antennas at the BS the channel estimate becomes impractical. This problem can be reduced by using time division duplex (TDD), where the same channel is used for uplink and as well as down link. So the channel estimate in one direction is enough.

C.Beam Division Multiple Access

In 5G there will be more mobile station are increasing, the previous technique are not enough to manage. We need a new technique for 5G, so research and development came up with the idea of new multiple access technique called as Beam Division Multiple Access (BDMA). An orthogonal beam is provided by the base station to each mobile station. To allow multiple accesses in BDMA the beam is divided according to the location and improving the capacity. The base station and mobile station are in line of sight communication when they know each other's position, and hence avoiding the interference. BDMA is a new space division multiple access technique which uses phased antenna array, use beam forming technique to produce directive beam and uses multiple beam forming patterns for multiple access.

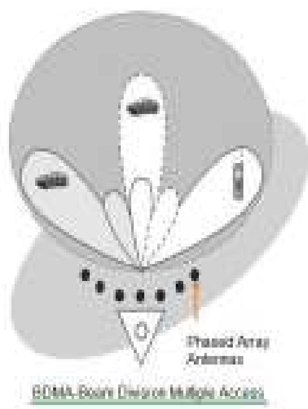

Fig. 4 Beam Division Multiple Access

D. Antenna selection

MIMO is one of the solutions for improve the channel efficiency and it handles increasing demands of the subscribers such that data rate and provides required quality of service. MIMO is able to provide the required performance using multiple transmitter and receiver antennas. By increasing the number of antennas we are improving our performance but it is costly in terms of size and hardware at the base station and the computation power at the base station. So we require a efficient method to reduce this cost, one way of doing this by using a fast antenna selection algorithm. Antenna selection algorithm can be applied at transmitter, receiver or both. For channel maximization we require a proper selection of transmitter antennas, there are some algorithms where selection is done based on power, channel correlation matrix and channel state information.

E. Capacity And Energy Efficiency

The capacity can be improved with the use of spatial multiplexing. Massive MIMO system will improve the capacity by 10 times and the energy efficiency by 100 times. BDMA technique to be used in massive MIMO will allot a beam for each antenna which are orthogonal to each other. The mobile users in same location will use the same beam using multiple access techniques like TDMA/FDMA, hence improving the capacity. Energy efficiency is also increasing due to focusing of the beam in a particular target location.

The integration of these new concepts, such as massive MIMO, device-to-device, and massive MIMO communications, will allow 5G to support the expected increase in mobile data volume in mobile communications can support beyond 2020. The MIMO in 5G is expected to support a huge number of wireless connections and energy efficiency, QoS in terms of reliability and security.

IV.Conclusion

Massive MIMO can offer enhanced broadband services more in the future. 5G networks are expected to support a great variety of wireless services in areas like healthcare, smart homes and cities, manufacturing, and many others. This paper concludes the series by looking at the future of massive MIMO and the challenges it faces. The channel estimation in massive MIMO is a great challenge so as to provide low bit error rate. By using a appropriate antenna selection algorithm the cost of infrastructure for 5G can be reduced by reducing the processing at the transmitter and receiver.

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