International Journal of Future Generation Communication and Networking
Vol. 13, No. 3, (2020), pp. 1451–1477

A survey of recent trends and challenges in MASSIVE MIMO in terms of channel utilization and Antenna selection

[1] Dr.S.Ramesh, [2]S.Ranjith,[3]A.Divya

[1,3]Dept of ECE, Vignan Foundation for Science , Technology and Research, Guntur,AP,India

[2]Dept of ECE, Jeppiaar Engineering College ,Chennai,TN,India

[1]drsr_ece@vignan.ac.in, [2]Ranjithsubramanian90@gmail.com, [3]4evedivya@gmail.com

Abstract

The Massive Multiple Input multiple Output (MIMO) antenna is some sort of multiple antennasystems, that is used to massively make better use of spectral efficiency, robustness to interference, increased the bandwidth and reduced latency .and it is used to provide a solution for high demand communication systems like cellular mobile communication that requires high data rate less interference and better Mobile Node coverage and connectivity.The antenna that form the massive antenna system is organized in a somehow that allow a group of antenna to work as a transmitter and other make other jobs may be standby to the transmitter antennas also The channel that connect transmitter and receiver and which estimated with a sequence of signal called pilot signal, is important to simulate and model. Massive MIMO has some main issues that are related to the technique used in the antenna selection and channel utilization, we provide an overview of recent trends concerning channel utilization and antenna selection, we then compare them and provide some open research area.

Keywords

challenges in Massive MIMO, Antenna selection techniques, channel utilization, pilot contamination, MIMO cost reduction, 5G, and IoT.

I. Introduction

Sending a message from a source at a location to reach a destination somewhere far from the source is still and continue to be the objective of the communication systems through ages. Nowadays the communication system has some major challenges one challenge is multiple users that are to be served by theantenna, connection stability, and the bandwidth. The antenna system, the processing and communication technology has been evolved to fulfill the needs, one common application is the wireless LAN starting from a single antenna, multiple antenna, and MIMO.MIMO has been evolved from single user MIMO and multi-user MIMO. multi-user MIMO has been developed to provide multiple users simultaneous accessibility and connectivity to the network resources. That is taking into consideration the logic aspect of the capacity of users in the wireless LAN compared to the mobile cellular network users which require more and more capability, also radar system is a respective example with the related issue with the direct challenge of the fidelity and destruction of antenna signals. Massive MIMO has addressed the issues mentioned moreover provides better bit rate and bandwidth and connectivity, but there are some problems and questions related to the design and the operation of the Massive MIMO system one of those challenges is the antenna selection process, is there a common technique used to select the antenna that is to transmit the signal . Moreover the problem related to channel allocation between the receiver and transmitter antennas, also some other challenges and troubles may affect the Massive MIMO antenna system that is the sender device is using the pilot signal to determine the channel to connect to the user, while that is a vital signal but it may be contaminated by interference with other signal causing a serious issue in the channel allocation , some researchers found it's important to study the antenna selection issues and other researchers are interested in the channel allocation and pilot pollution issue, through that study we have made a survey regarding the research on both sides and we will provide a comparative study , also will provide open research points and at the end will have a look for the tangential research areas that are related to the Massive MIMO and are affected by our scope of study.

The next sections in the paper are organized as the following:

II. Antenna selection techniques
III. channel allocation issues
IV. open research areas
V. tangential research areas and field of interest.

II. Antenna selection techniques

in this section, I will provide a review of most recent trends and techniques used in Antenna Selection for Massive MIMO Antennas, the Brainstorming figure shown below describe the techniques based on the objective it has been used to achieve, along with the research papers that provide that work. Afterward, I will provide a brief describe of each paper and how it worked to achieve the objective of its work the following figure1 shows the criteria based Antenna Selection in a brainstorming graph.

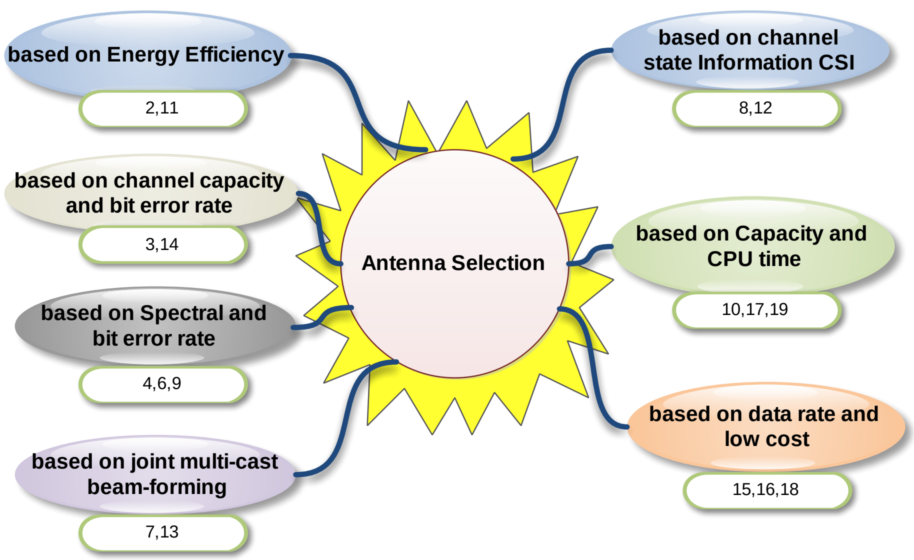
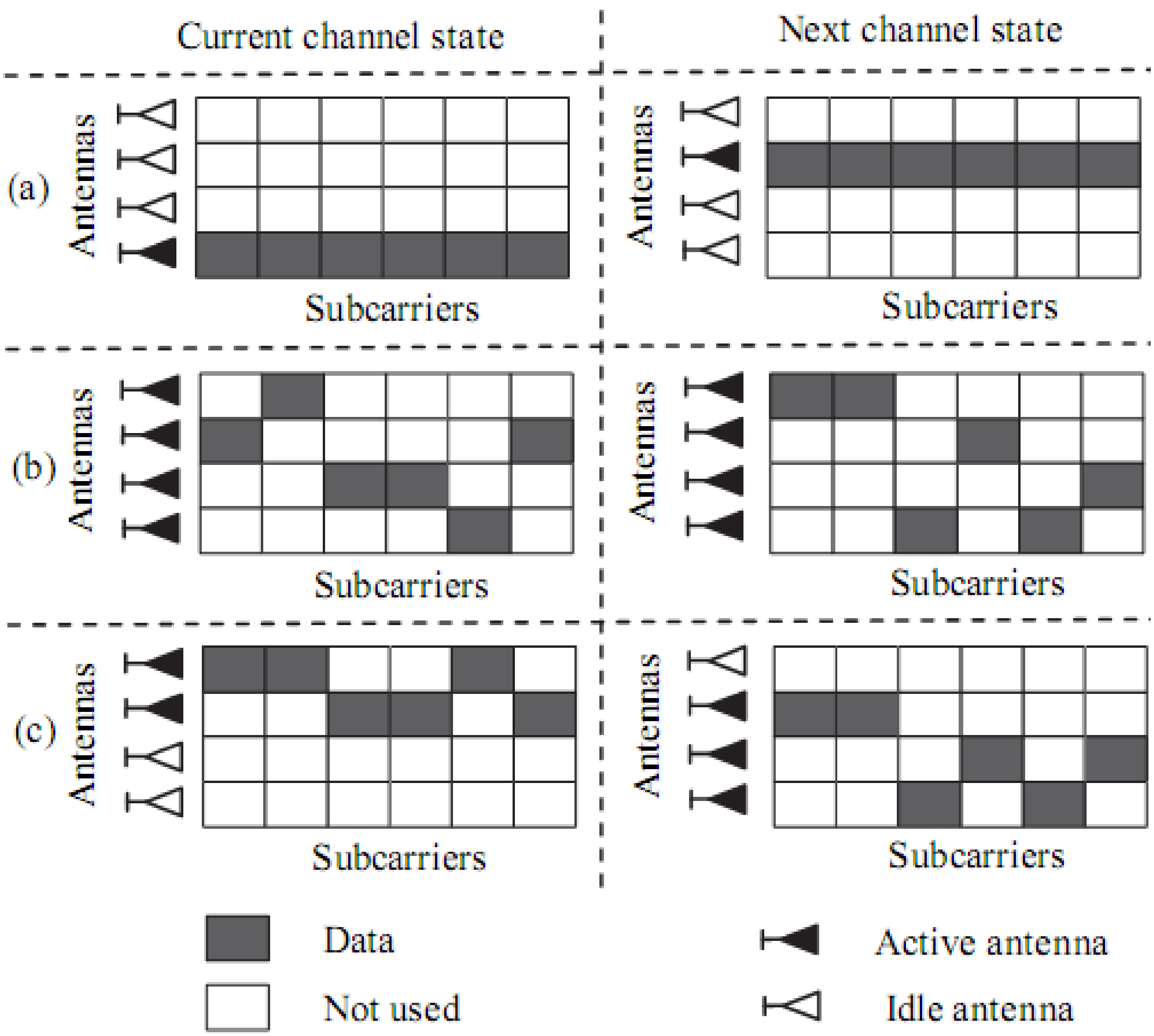


FIGURE 1 ANTENNA SELECTION BRAINSTORMING

a-Antenna selection based on energy efficient selection

Using Massive MIMO to provide better bit rate and availability to connect users and mobile devices is a challenge in terms of power consumption with Antenna selection in both direction as a sender and receiver some work was seeking a vitality productive radio wire determination the first depended on curved improvement was proposed for Massive MIMO remote correspondence frameworks. On the condition That the channel limit of the cell is bigger than a specific edge, the quantity of transmitting reception apparatus, the subset of transmitting radio wire and servable versatile terminals (MTs) were mutually streamlined to amplify vitality productivity. The joint can be improved by utilizing well-ordered advancement technique as vitality effectiveness is an exceptional inward capacity versus factors. The ideal arrangement can be acquired through the thorough hunt. The proposed calculation can understand an indistinguishable execution from the ideal with low multifaceted nature. Additionally, it has confirmed by investigation and numerical reproductions. The great executionpicks up of vitality proficiency is acquired contrasting and no receiving wire determination.

The 2nd work was interested in accomplishing vitality proficiency in reception apparatus choice with OFDM-based frameworks. OFDM framework with routine receiving wire determination approaches, including per-subcarrier choice (i.e., choosing reception apparatuses autonomously for each subcarrier) and mass choice (i.e., picking similar radio wires for all subcarriers), experiences a huge misfortune in vitality effectiveness. a superior vitalityeffectiveness execution has been picked up by utilizing a versatile receiving wire determination the method as long the quantity of dynamic RF (radio recurrence) chains as the reception apparatus records are chosen based upon the channel condition. Besides, the calculation that accomplishes a close idea execution with much lower intricacy when a number of reception apparatuses are huge has been given also.The proposed antenna selection method in compared to other methods is shown in figure 2.a and figure 2.b shows a comparative graph of antenna selection method versus energy efficiency.



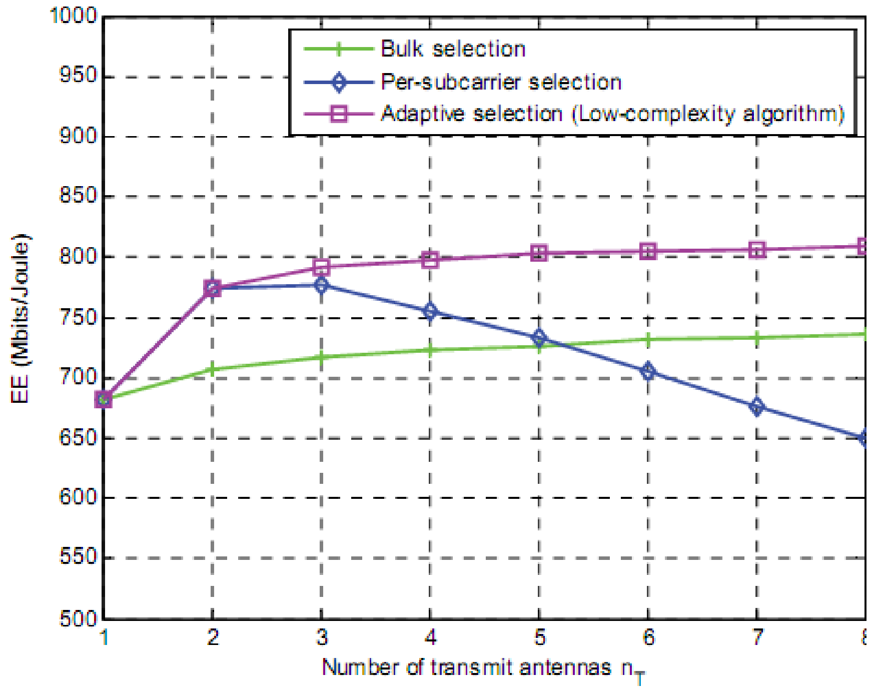


Figure 2.b Energy Efficiency versus the number of transmit antenna

<u>b-Antenna selection to achieve better channel capacity and bit error rate.</u>

Also, another study has been done in focusing on achieving better channel capacity and bit error rate while performing antenna selection algorithms in [3] an antenna selection techniques has been reviewed with considering different criterion i.e., channel capacity and bit error rate seeking both cost and hardware complexity reduction and It has proven that the massive number of antennas that are the receiver equipped with, the better the performance is achieved

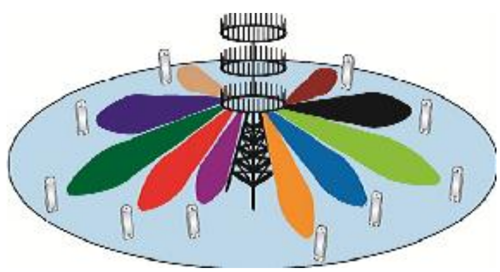


Figure 3 Massive MIMO Antenna Selection Techniques based on user allocation.

[14] improving data rate or capacity with the usage of Spatial multiplexing rose up out of the way that in a rich scrambling condition it is workable for the beneficiary to descramble signals that are transmitted all the while from the different Antennas, in this manner one can send parallel free information streams and accomplish general limit. An algorithm has been introduced that provide antenna selection based on a general capacity formula, that is the subset with maximum capacity will be chosen.

ISSN: 2233-7857 IJFGCN

[33] Antenna selection for better channel capacity is very important for Massive MIMO deployment for 5G technology, two algorithms are introduced to provide Antenna selection, one depends on the Matrix's operation that is by proving a sub-matrix due to a row operation and then a column operation and at last a vector is yield that represents the antenna elements to be used in transmitting and receive, another algorithm is based on the successive elimination idea by removing antennas that are less contribution to the system.

c-Antenna selection technique based on better spectral and transmitenergy

Upgrade in ghostly and transmit vitality effectiveness is the principle target and This is accomplished by permitting the number of radio wires and RF chains to become vast. Nonetheless, the difficulties incorporate high framework many-sided quality and equipment vitality utilization by performing reception apparatus determination the required number of RF chains has been diminished. [4] A choice in view of raised enhancement is almost ideal and utilized as a kind of perspective. The accomplished entirety rate is contrasted and that of an extremely basic plan that chooses the radio wires with the most noteworthy got control. The power-based plan gives execution near the raised advancement plot, for the deliberate channels. This perception shows a potential for significant decreases of monstrous MIMO execution intricacy, by lessening the quantity of RF chains and performing receiving wire determination utilizing straightforward calculations.
The same objective was in [6]but it used the norm and correlation based selection algorithm with low complexity for energy efficiency maximization has been proposed. selection metric considers the effect of the norm of each channel column and correlation between columns while attaining low computational complexity.

[9] Different information numerous yields (MIMO) can enhance the ghastly effectiveness (SE) mutually with the vitality proficiency (EE). Radio wire determination handle, that is essential for Massive MIMO remote correspondence framework in both transmitting and accepting theend. This paper likewise demonstrates some reception apparatus determination techniques for the enormously conveyed radio wire framework.

d- joint multicast Beamforming based antenna selection

While in [7] the issue of joint multicast Beamforming and radio wire determination for different co-channel multicast bunches was the motivation of work and the proposed algorithm has achieved areduction in the number of required Antennas that's essential to produce the wanted signal level along with less transmission power. The performance is satisfactory and has presented less complexity along with improvement in other attributes as shown in the figure below.

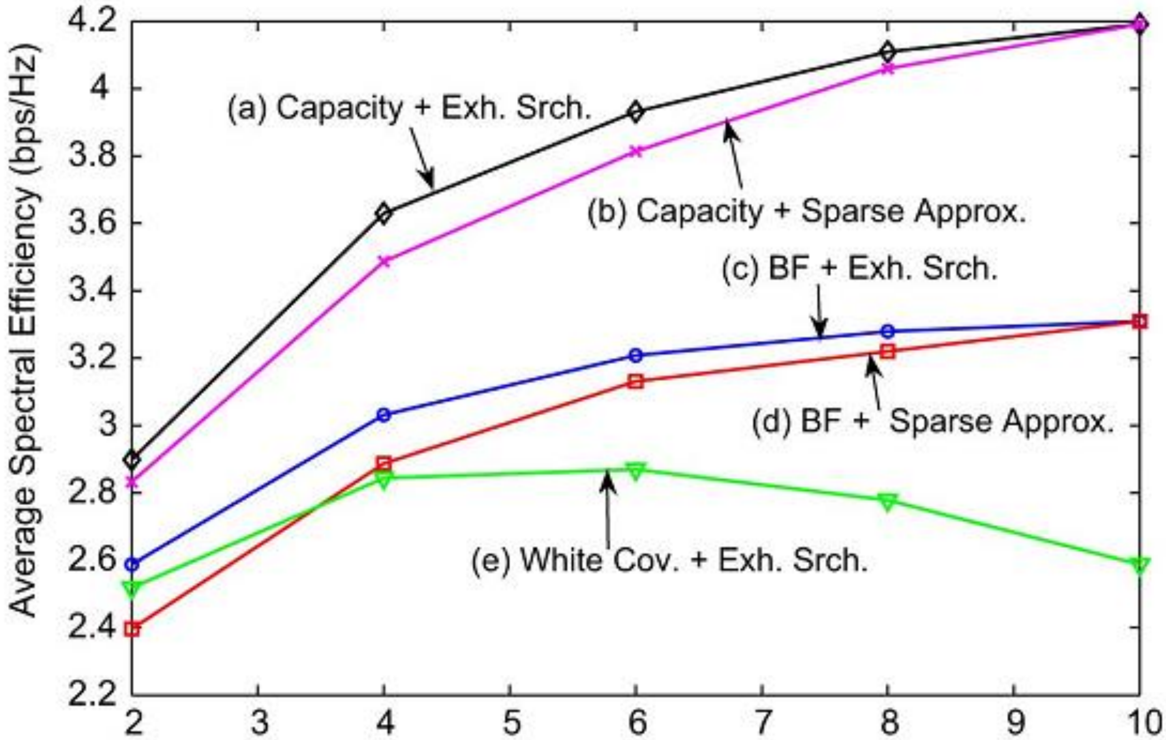


Figure 4 Average Spectral Efficiency Versus Selected Antennas

The goal is to augment the information rates. The ideal arrangement is [13] an exceptionally complex thorough savage drive seek (BFS) over every single conceivable blend of receiving wires and clients. The proposed calculation expects to boost the achievable aggregate rate and to make utilization of both the spatial selectivity pick up and multi-client differing qualities pick up offered by the radio wire choice and client planning, individually. The key thought of the proposed calculation was to progressively wipe out both undesired transmit radio wires, the proposed calculation can accomplish close ideal execution with low computational unpredictability.

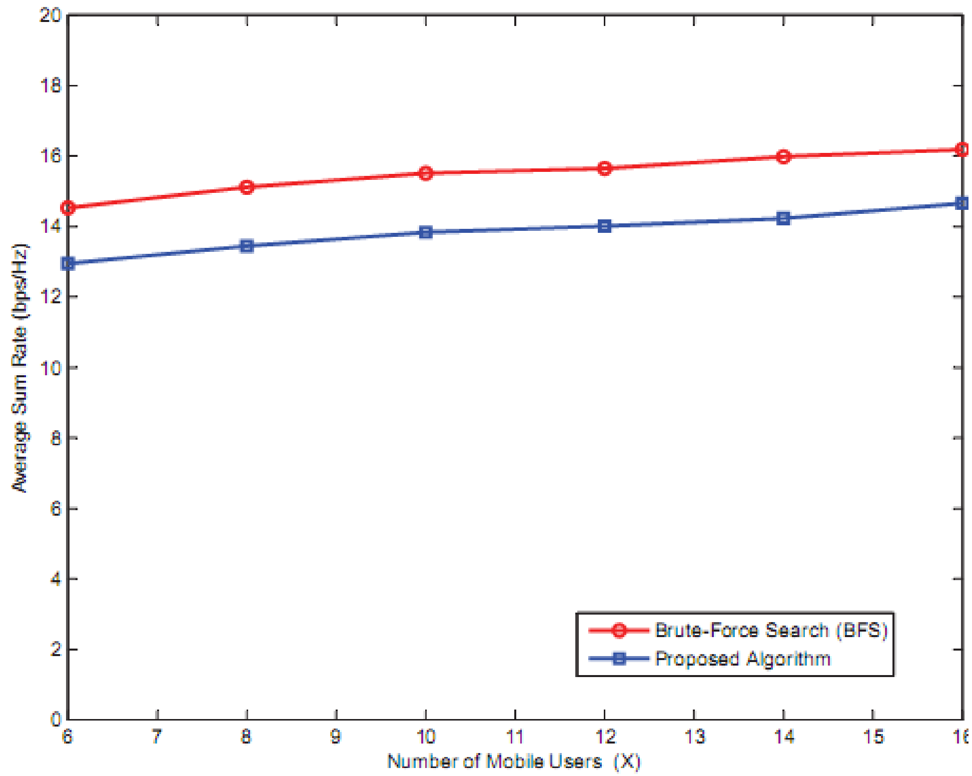


Figure 5 Performance comparison of sum-rate versus mobile users number for massive MIMO system

e-accurate transmit side and channel state information based Antenna selection

Another point of interest has been studied in [8] which is Precise transmit-side channel state information (CSI) and a new algorithm named antenna group scheduling (AGS) algorithm which joins reception apparatus choice and client booking for seeking after a further diminishment in criticism, overhead has been proposed. The AGS was built to enhance channel along with selecting best Antennas based on the best gain obtained. The Simulation has proven that the proposed method satisfy a noteworthy input overhead decrease over the ordinary pillar framing systems (33%~50%) inside a similar target aggregate rate needs.

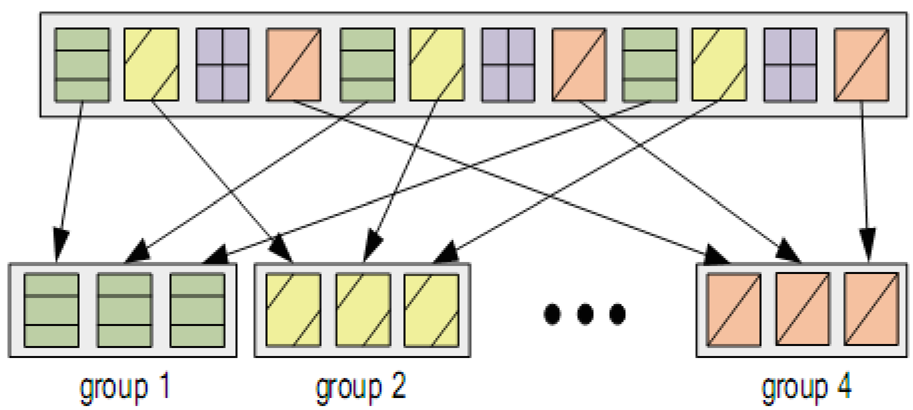


Figure 6 Antenna Selection groups

[12] This paper has focused its interest in the channel state information (CSI), acquiring the CSI assumes a focal part to give high framework execution. a proficient transmit receiving wire determination

ISSN: 2233-7857 IJFGCN

technique acquiringthe measure of the required CSI for a massive MIMO system in the broadcast channel has been used, the method is to use receiver chosen channel and feedback the selection to the transmitter in the form of a feedback till all receiver finish then the transmitter will determine which antennas will be used and which are to be neglected. The proposed antenna selection strategy is displayed at figure7.

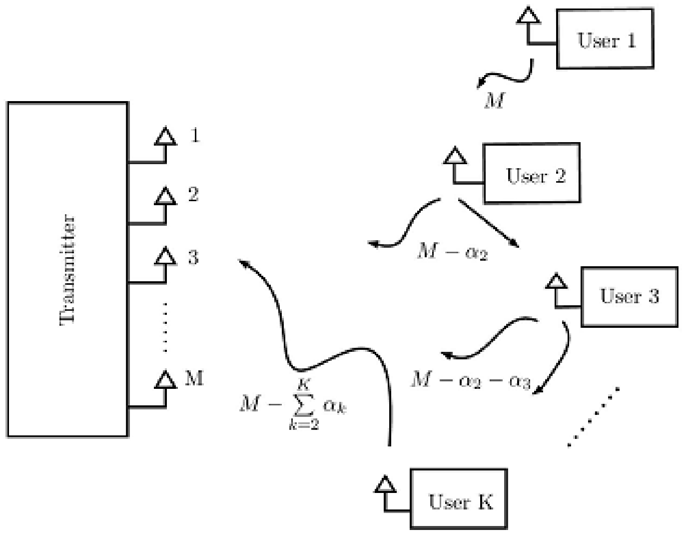


Figure 7 : Proposed Transmit Antenna Selection Strategy

f-Capacity and CPU time-based antenna selection

[10] In this paper, some algorithms "Molecule Swarm Optimization (PSO), Genetic Algorithm (GA), and Artificial Bee Colony (ABC) "has been used and compared and they are used to achieve better Antenna selection with Higher capacity and less CPU time, [17] As indicated by past methodologies consider the issue of transmitting-receiving wire decision for gigantic numerous information different yield frameworks by expanding the determinant modulus of the picked channel grid. In perspective of the most extraordinary volume sub-lattice finding strategy, an ongoing reception apparatus byradio wire iterative swapping improvement (RAISE) transmit receiving wire decision count with low memory cost and low computational disease quality. The converging of the estimation is exhibited and the execution of it is surveyed by amethod for numerical proliferations.

[19] Antenna selection with respect to system capacity and reasonable signal to noise ratio has been investigated also the effect of the Antenna selection techniques on the coding system and the channel capacity itself even if the channel capacity is one of the criterions. Performance comparison of antenna selection methods is shown in figure 8.

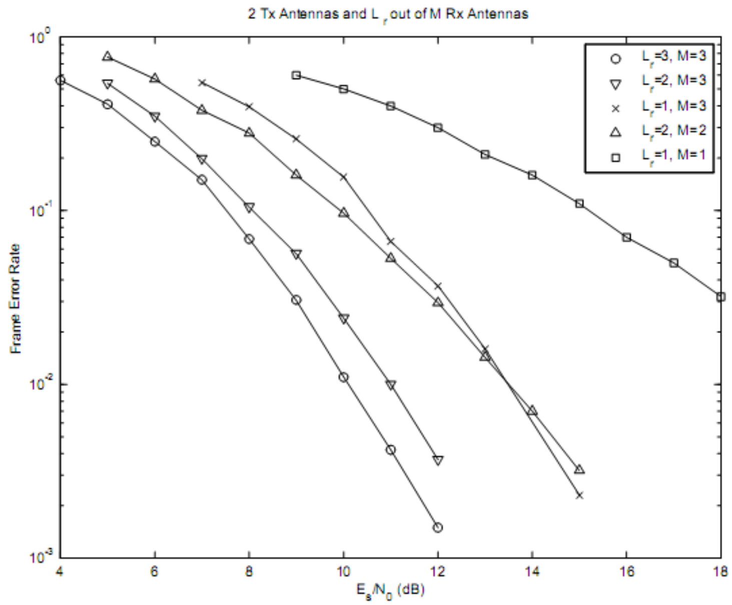


Figure 8 Performance comparison between various antenna selection scenarios

[27] Antenna selection techniques require more complex computation and that will be so difficult to be implemented for the Massive MIMO antenna, the work provides better computation for joint radio wire choice and Beamforming in Massive MIMO.The Antenna selection technique used will provide better capacity and S/N ratio as well and is based on weight vector that is updated by MVDR beamformer and the transmit antenna is selected.

e-Data rate and low cost based antenna selection.

[15] the proposed antenna selection is based on the idea of lowering the cost, size and the power consumption by ranking the antennas based on their channel gain to all mobile stations, then the transmitter compute the downlink sum rate with S(assumed the antenna to be used) consecutive antenna elements, the transmitter select the S that is giving the highest sum-rate, the selected S antennas are used to transmit and connect to n users however the rest are turned off for that time slot. The proposed antenna selection technique provide better and less computation

[16] In this paper, a low-unpredictability ravenous client choice plan with straight zero forcing pre-coding at the base station has been proposed. The complexity of the proposed algorithm is remarkably low i.e. O (MK) while the performance is same as that of best greedy algorithm known so far.

[18] in that research, the main objective is to develop a practical solution for the complexity of the RF switching by introducing binary switching system that performs the Antenna selection techniques and reduce system cost and complexity.

III. channel allocation issues

There are some issues and challenges in channel allocation process for massive MIMO system, and there are researches done to solve this issues and provide a more efficient and reliable system, in this section, I will list these areas based on the issue and provide the work done by researchers each per issue.

a-pilot contamination issue:

One of the greatest difficulties for massive MIMO is the pilot contamination. this paper has summarized which also includes the possible solution to this problem. It was observed that many parameters need to

be optimized during the implementation of massive MIMO based network structure. There is a possibility to use evolutionary methods to design an optimum network.[20]
A discrete Fourier transform (DFT) with spatial basis expansion model (SBEM) used to perform the uplink/downlink channels, the work shows that channel estimation of multi-users reduced training resources, which dramatically reduced both training and feedback cost. [23]

[28] a comprehensive survey concerning Massive MIMO Pilot defilement in 5G, the pilot defilement in Time division duplex has been investigated as it a result of the usage of non-orthogonal pilot due to the limitation of coherence time, hardware impairment(phase noise, amplifier Non-linearity, having QUADRATURE imbalance (I/Q) and quantization errors in receiver is leading to a pilot contamination due to its effect of the transmitted signal and the received signal as well as done in Bjornson work) and non-reciprocal transceiver(the uplink and downlink is considered reciprocal to each other. However, the existence of residual offset frequency spoil the reciprocity of the transceiver and in turn, lead to the pilot contamination. The effect of pilot contamination on energy efficiency using different pilot reuse factors.

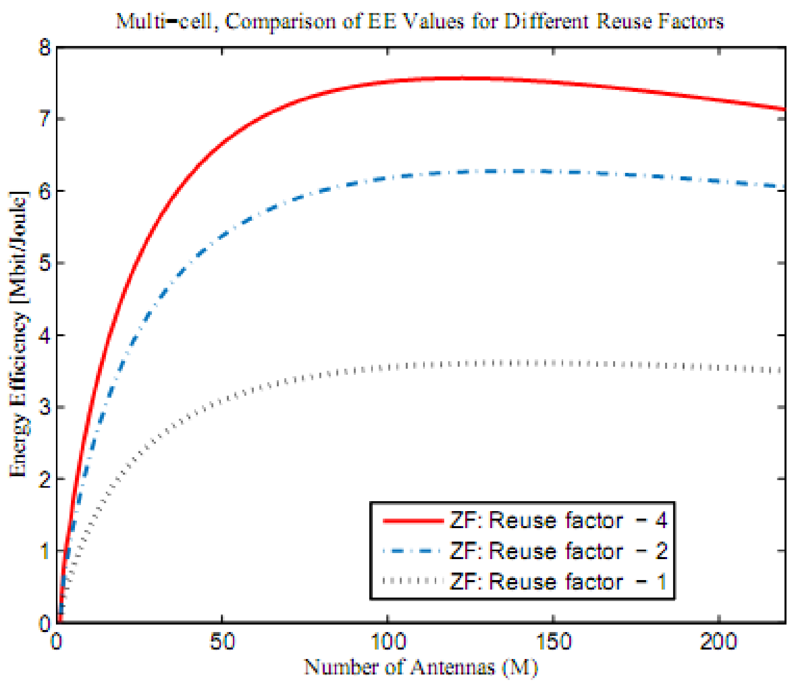


Figure 9 : Effect of pilot contamination on energy efficiency using different pilot reuse factors.

The pilot contamination for Massive MIMO is one of the channel allocation great issues and in [40] a pilot decontamination method has been provided for Massive MIMO in a cellular system, data and pilot are aligned in the time-frequency plane, and they are organized in a way that allows users to share data channel while the overlap of the pilot's channel is not allowed and channel state information was used as a guide to assigning them to the channels. The Pilot data alignment is shown with a respective cellular system layout in figure 10.

ISSN: 2233-7857 IJFGCN

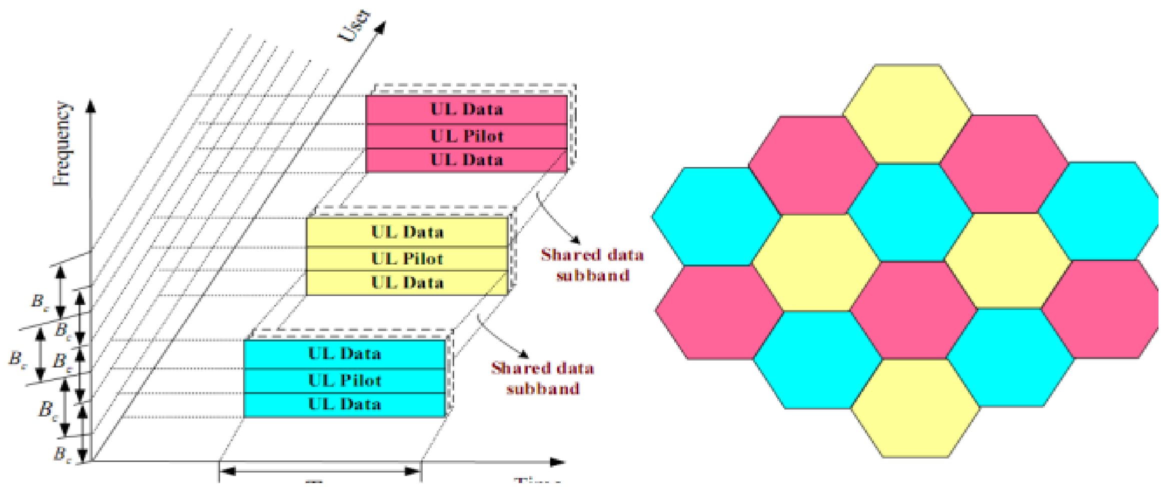


Figure 10 Pilot data Alignment along with Cellular system Layout

b-Interference and spectral efficiency

the problem of interference and spectral efficiency represents a resident issue in multi-user Antenna systems, but it has been solved in “massive MIMO” which allows asymptotic orthogonally and uses simple processing methods.[21]

Mathematical analysis forFDD primarily correlated Massive MIMO has been modeled and compared with TDD and provided abetter result.[22]

being a promising technology for 5G, Massive MIMO provide an essential gear in the train toward the new mobile technology as it require better spectral efficiency and bit rate and that is provided by Massive MIMO[24]

[30] provide a technology that will aid as a primary stone in building a new cellular system 5G system is a great concern and Massive MIMO plays the main role in that but it has some issues that should be carefully considered and allowed in order to play its role efficiently in the 5G team of top players technology , some of the issues that affecting the application of Massive MIMO are pilot contamination , beam-forming need huge number of channel state information and that represent a problem especially for the downlink , FDD is so difficult to be deployed however it's more than suitable for TDD due to the reciprocity between UL and DL and what makes it attractive for Massive MIMO is the royal rule of delivering multi-user better access to the network along with better bit rate and utilization.

[34] Massive MIMO deliver the requirements of spectral efficiency, multi-user and practical solution to the interference issue. Massive MIMO has the following capabilities Array Gain (require channel knowledge in uplink and downlink which require channel state information CSI), Diversity Gain (transmit signal over multiple fading path),Spatial Multiplexing gain (increase in capacity due to transmitting over multiple independent Antennas),Interference reduction(based on sensing and sending over empty channel) due to these four capabilities of the massive MIMO it manages to provide better channel capacity, throughput, and less interference.

[36] Massive MIMO has provided an advantage for interference reduction, using decoding techniques like constrained partial group decoding (CPGD),using multiple cell processing (MCP)

ISSN: 2233-7857 IJFGCN

along with (CPGD) to eliminate interference .moreover it provides a result signal sum rate reaches the sum rate obtainedby FDMA and TDMA.

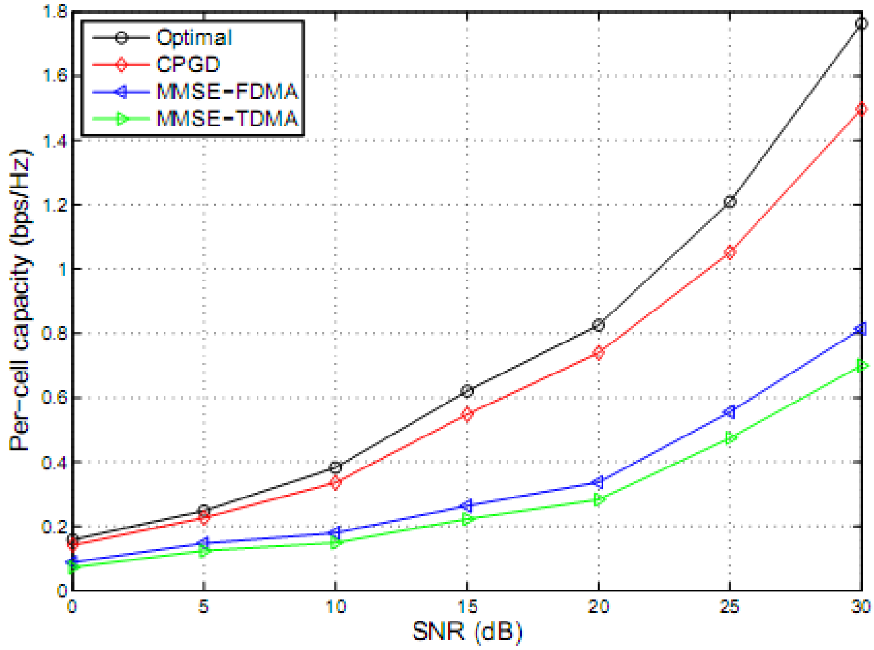


Figure 11 Per cell capacity versus SNR (dB) for fixed number of users per cell.

$H(t) = [\alpha_{11}(t),\alpha_{12}(t),.......\alpha_{1n}(t)\alpha_{21}(t),\ \alpha_{22}(t)...\alpha_{2n}(t);....\alpha m_{1}(t),\alpha m_{2}(t),....\alpha_{mn}(t)]$
The needs of both terahertz communication and required coverage distance as well has been addressed in [38], the massive MIMO antenna uses very cheap and small components in the design of the array elements, to satisfy the objective of terahertz communication the antenna should be

subtle which is in Micro and that is impossible for the metal, another material called Plasmatic material is used to support the propagation of surface Plasmon polariton waves (SPP). a square uniform PLASMONICNANO-antenna array is shown in figure 12.

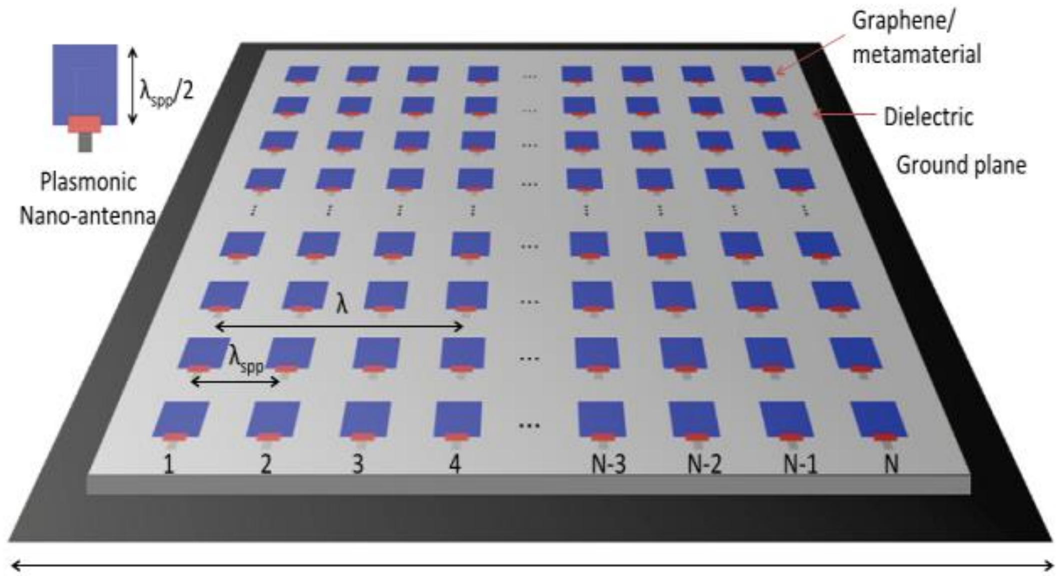


Figure 12 A square uniform PLASMONICNANO-antenna array

graphite is a material that supports such a setup and is used in designing the massive MIMO antennas, that deliver terahertz waves and propagate for more distance. Figure 13 shows the gain of metallic and PLASMONIC NANO-antenna arrays at different frequencies as a function of their footprint.

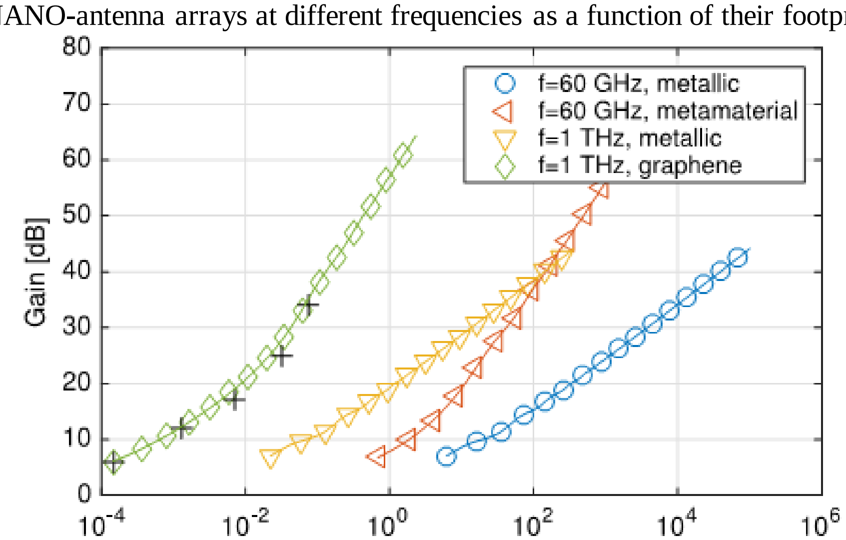


Fig. 13 Gain of metallic and PLASMONIC NANO-antenna arrays at different frequencies as a function of their footprint

[41] Nowadays there are heavily increment in the appeal of mobile wireless applications and devices,moreover, the upcoming wireless technologies that will require more and more bandwidth and channel that understand all of that needs. In [41] channel estimation and interference determination has introduced through a mechanism called sounding the channel , which depends on the estimation of the channel impulse response through transmitting a signal and receiving it , and then processing it to get the impulse response, the system relay in a MIMO system that's to evaluate the channel response and avoid interference.

ISSN: 2233-7857 IJFGCN

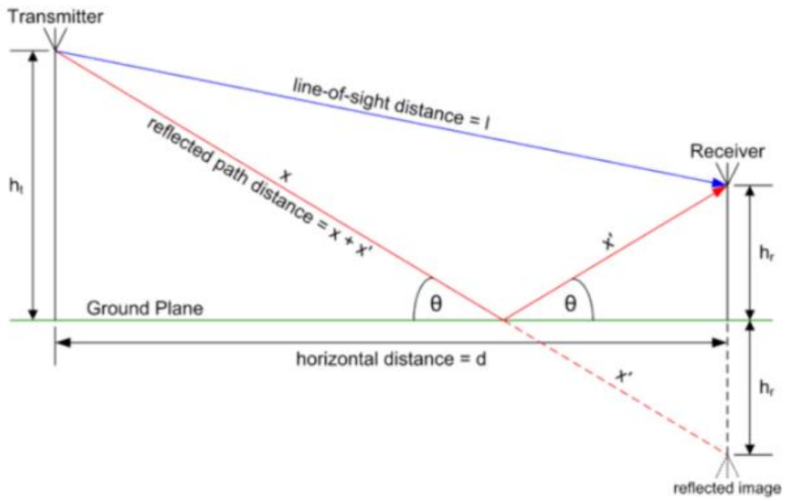


Figure 14 Example of a two-path model

Channel State Information CSI, is used to provide channel and range between sender and receiver in MU-MIMO, [43] a problem related to that is the range of the channel is up to square of the number of base station , despite before CSI the range is constant so it represent a problem to the efficiency and reliability of base station antennas in [43] a novel control channel design for MU-MIMO, Faros, has been shown to allow base station antennas to scale up to 100s.Faros used open loop beam-forming and coding gain to solve the issuemoreover, itprovides a smooth control over space, time and code resources.

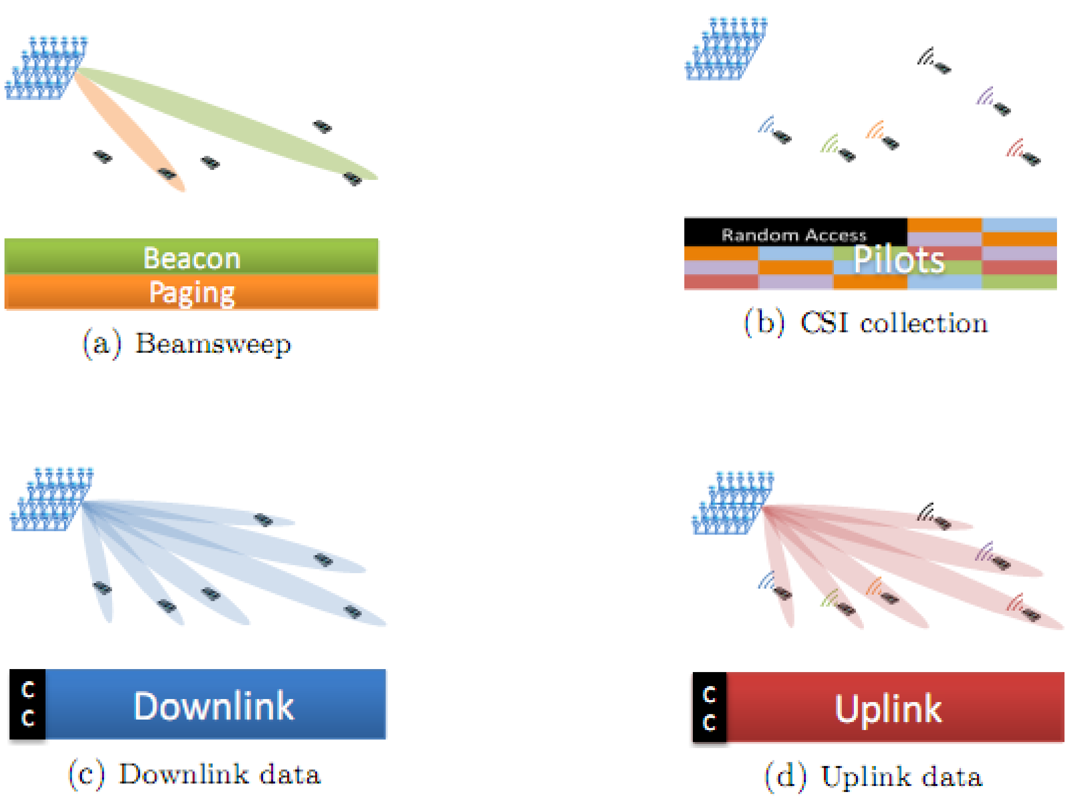


Figure 15 an example of faros frame structure

In Figure 15 (a), the base station beam sweeps a beacon that provides the users with time- frequency synchronization and the base-station ID. If a user needs to be paged, the base station will simultaneously beam a paging sequence towards that user. In Figure 15.(b), users send orthogonal uplink pilots in scheduled slots. Users that require random access or association send an uplink pilot in the one of the reserved slots.In Figure 15.(c) and (d), the base station leverages the acquired CSI to provide downlink and uplink data connectivity, as well as any remaining control channel information, over the efficient MU-MIMO link.

[44] High mobility is an issue in mobile communication system and in TDD Massive MIMO system require low latency signal processing and more spectral efficiency and bandwidth , the reciprocity between uplink and downlink is a challenge in [44] an implementation based on hardware has been proposed and provided a solution for the reciprocity issue along with channel estimation, moreover a switching based on router has been shown to provide better bandwidth and low latency. For better understanding the overall massive MIMO system is shown in figure 16.

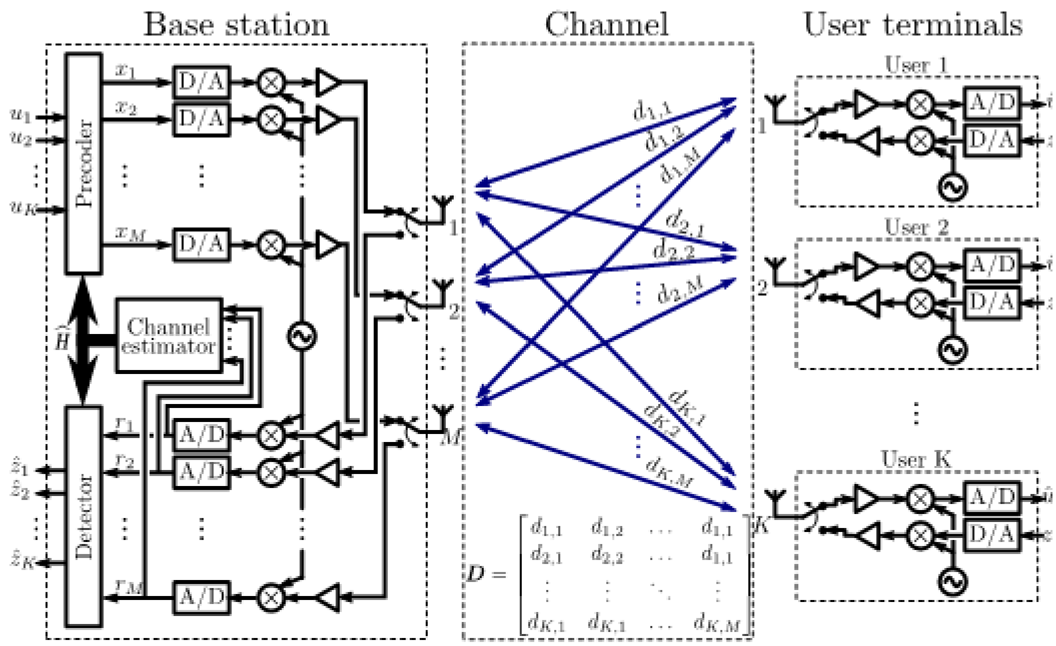


Figure 16 a simplified massive MIMO system.

being one of the most important technologies of 5G mobile technology ,Massive MIMO has a great issue in the deployment of 5G picocells as pico users will suffer severely from interference, two tier pre-coding algorithm has been introduced in [46] that is depends on the CSI between the Micro Base Station MBS and Pico Base Station PBS , it provided a solution for the interference issue as in inter-tier and inter-cluster form. A network layout of the Heterogeneous network is shown in figure 17.

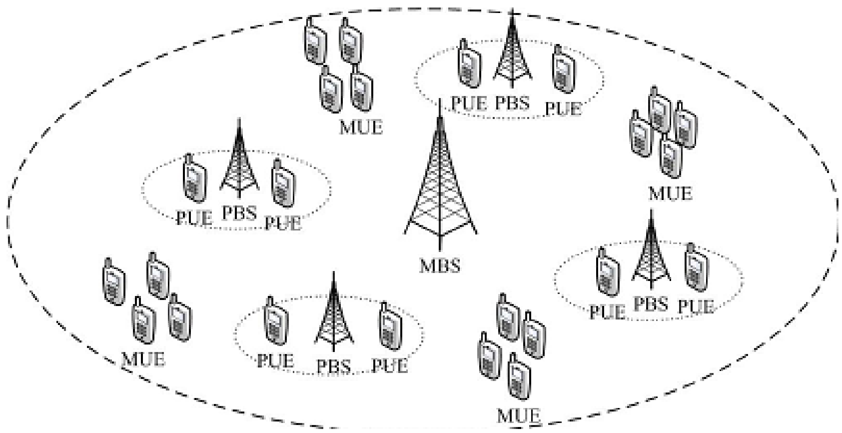


Figure 17 Network layout for the considered heterogeneous network.

c-Channel Model

Massive MIMO is still acting as the main stone on the 5G technology as it addresses channel requirements and heterogonousnetwork[25], in that study the channel modeling is defined to be a tradeoff between:

1-Accuracy: which mean how far is the model from the field of application.

2-Generality: how close is my model to my application

3-Simplicity: is it easy to deploy or use or difficult in terms of computational and implementation.

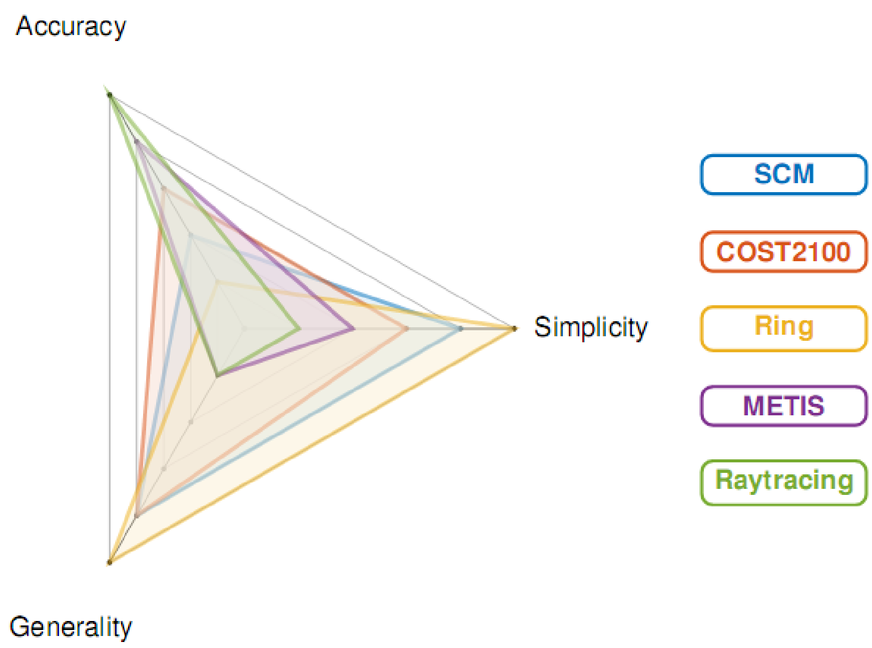


Figure 18 Categorization of the trade-offs made by different modern simulation and design models used for cellular network research and standardization.

the three factor used to compare and estimate the model is shown as a spiral graph and shows some famous models in color coded.

the application as stated before will require a modification to the channel model in order to meet the application needs, some trends to enhance the model are:

ISSN: 2233-7857 IJFGCN

ahigh spatial resolution
b-joint behavior across time, space, and frequency
c-Non-stationary model
d-Data-centric propagation model
the work was ended with the most required model Nowadays is the one that will fulfill the needs of the 5G application.
two main changes in the channel modelhave been introduced in [26], the used channel mode is anon-stationary wideband multi-conformalellipse and the spherical wave-front instead of plane wave-front, the numerical analysis performed in paper proved thatthe channel model used here is capable of capturing specific characteristics of the Massive MIMO channel.

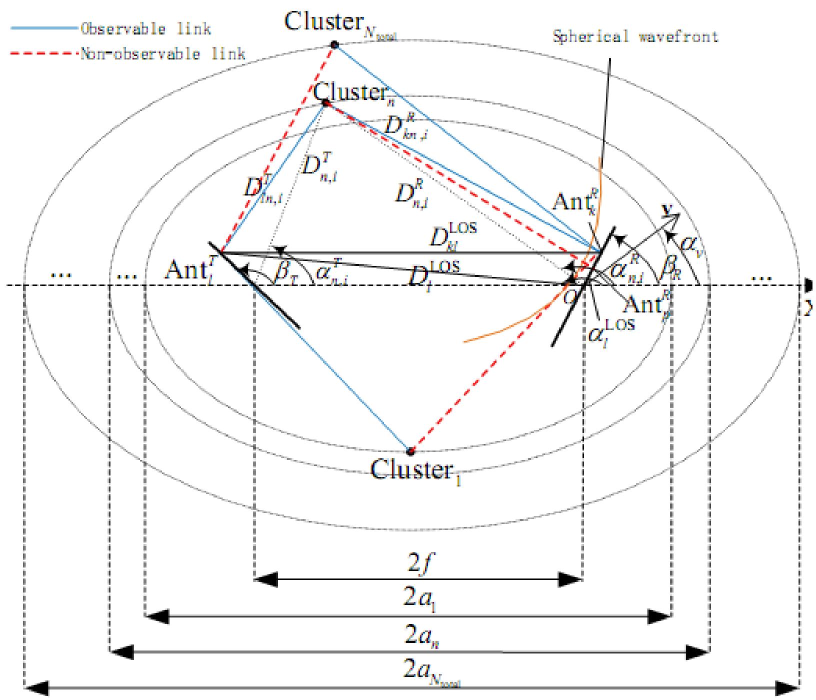


Figure 19. A wideband multi-confocal ellipse model for massive MIMO systems.

[29] delivering better channel throughput to multi-user and the enhancement of the channel utilization is considered thevery important aspect of the Massive MIMO and will address the urgent requirement of the 5G technology goals. a verified technique called MIMO/CON deliver concurrent channel access and estimation for achieving better channel throughput for all multi-users simultaneously.

[31] closer look to the problem of channel loss in FDD system and how to make Massive MIMO practical to be deployed,a drive for the scaling factor has shown that it's possible to estimate the downlink channel for anon-reciprocal system like FFD system.

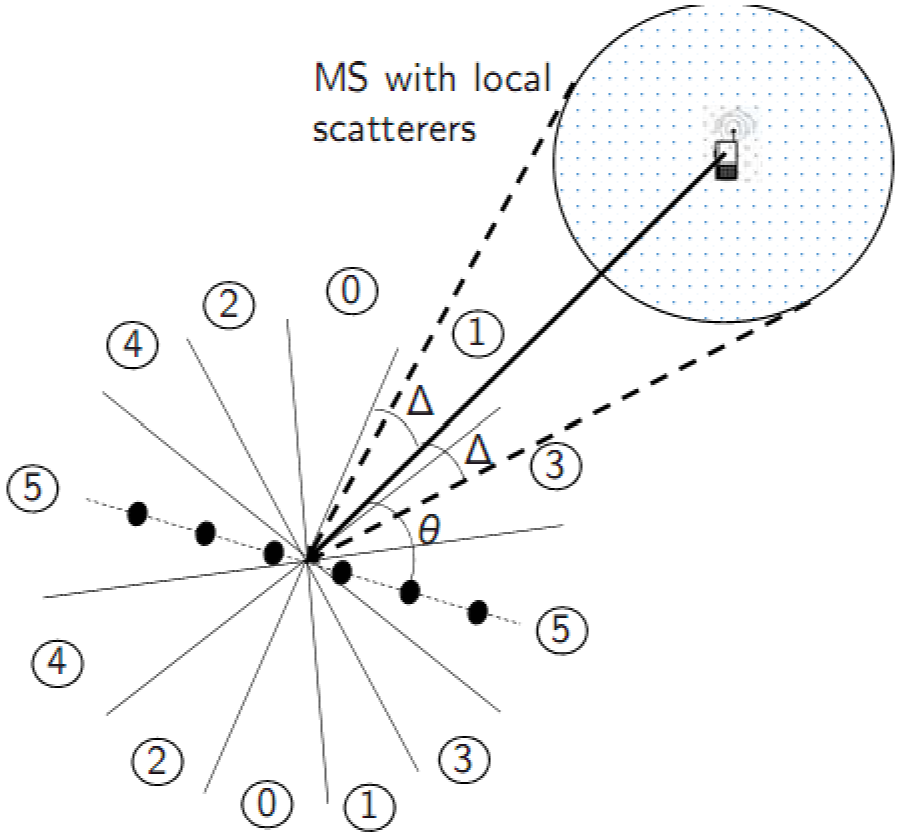
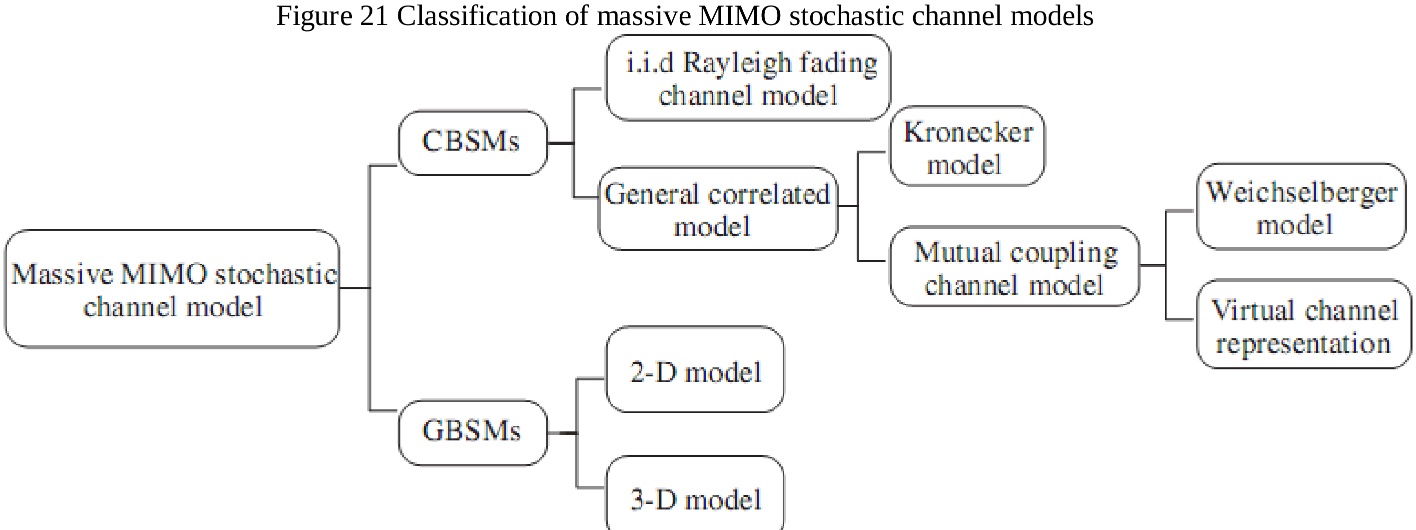


Figure 20. User-signal angular spread introduced by local scatters with direction- of-arrival (DoA) θ and angular spread Δ. The number of bins denotes the angular resolution of BS antennas.

[32]as being a 5G key Technology to provide better energy efficiency and spectral efficiency, a realistic channel model that provide the design and performance requirement is an essential. there is four recent channel model that are to be listed. Channel model is classified into two main classifications:
correlation based stochastic model(CBSMs)
Geometry based stochastic model (GBSMs)
the following graph provides an overview of the main and sub-categories of the channel model.

Figure 21 Classification of massive MIMO stochastic channel models



[35] MIMO channel model is very important as mentioned earlier and is the most wanted when it comes to design and implementation on the application to be used in,some practical channel model is described briefly as shown in the table below:

	Unit	SCM	SCME	WINNER II	SUI	WiMAX	IEEE 802.11n
Max bandwidth	MHz	5	100*	100**	2-20	2	100
Frequency range	GHz	2	2-6	2-6	1-4	2-11	2-5
No. of scenarios		3	3	12	6	3	6
No. of clusters		6	6	4-20	0	6	2-6
No. of taps		6	18-24	4-24	3-4	6	1-18
Doppler Spectrum		Classical	Classical	Classical	Standard Specific	Classical	Standard Specific
Normalised Delay spread	μs	1.2	1.2	1.2	0.9-20	2.51-10	0-1.05
Path azimuth spread at BS and MS	Degrees	2,5,35	2,5,35	5-50***	NA	2,35	20-40
Shadow fading (standard deviation)	dB	4-10	4-10	3-8	8.5-10.5****	8-12	3-6

Table 1. Comparison of standard channel model parameters

[37] MIMO performance is affected directly with the propagation parameters of the MIMO channel anexcellent study for the propagation parameters that provides a clear picture of the MIMO channel model has been provided in [37]

the received signal vector y(t) for M receiver Antennas is delivered as:

$Y(t) = [y_1(t), y_2(t), ... y_m(t)]^T$

Also the transmitted signal through N Transmitting Antennas is given by :

$S(t) = [s_1(t), s_2(t), ... s_n(t)]^T$

The Received signal Vector Y(t) is related to the Transmitting signal Vector S(t) by:

$Y(t) = S(t)*H(t) + N(t)$ where N(t) is the additive Gaussian Noise and H(t) is the MIMO radio channel matrix , then an analysis of the channel matrix H to get the power gain λ which is obtained using the Eigenvalue method. and the Eigenvector

$[\lambda_1\ \lambda_2\ \lambda_3\ \lambda_4\ \lambda_5 .... \lambda_k]$

Representing the sub-channel connection between the sender and receiver.

ISSN: 2233-7857 IJFGCN

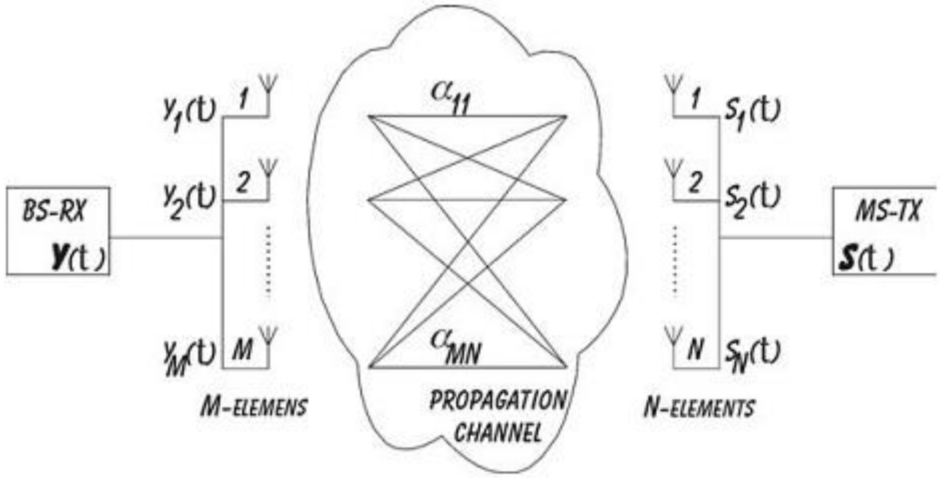


Figure 22. Two antenna arrays in a scattering environment. Representation of an uplink situation.

3 MIMO propagation scenarios are:

1-Uncorrelated Scenario: elements of H are completely de-correlated and the maximum value of the Eigenvalue is obtained.

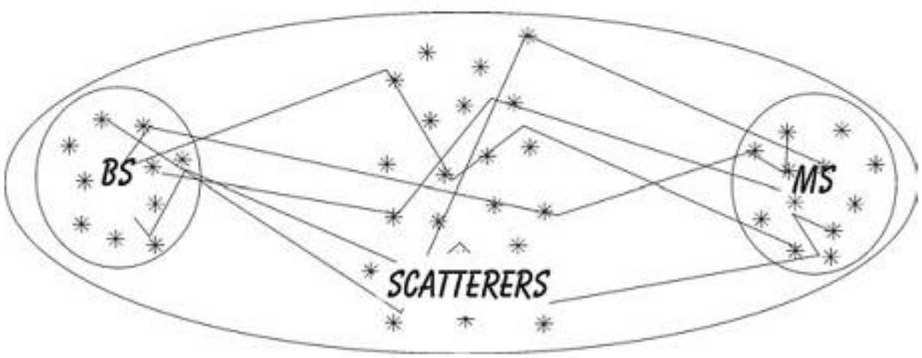
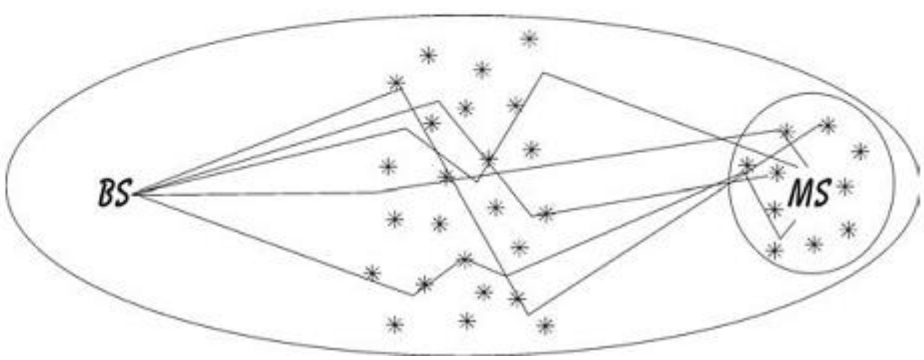


Figure 23 Uncorrelated MIMO propagation Scenario

2-Correlated Scenario

In theoccasion of Line of Sight (LOS), elements of H are correlated, then yield a lower number of Eigen values.



.

Figure 24 MIMO Correlated Propagation Scenario

3-The Pinhole or Keyhole

Signals at both the TX and RX are de-correlated this sounds like having a metallic wall with a hole in its half that allowing single sub-channel to be created.

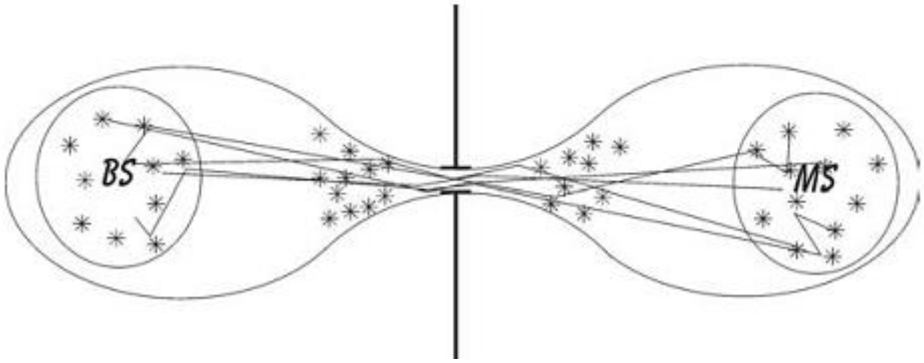


Figure 25 MIMO The Pinhole or Keyhole Propagation scenario.

(MIMO) systems has a problem with thecorrelated based system and in [39] an evaluation of MIMO in correlated Rayleigh system has been evaluated and a study to the bit error rate and nonlinear maximum likelihood receiver a mathematical based approach has been introduced that provide aunified analysis of correlated MIMO channel.

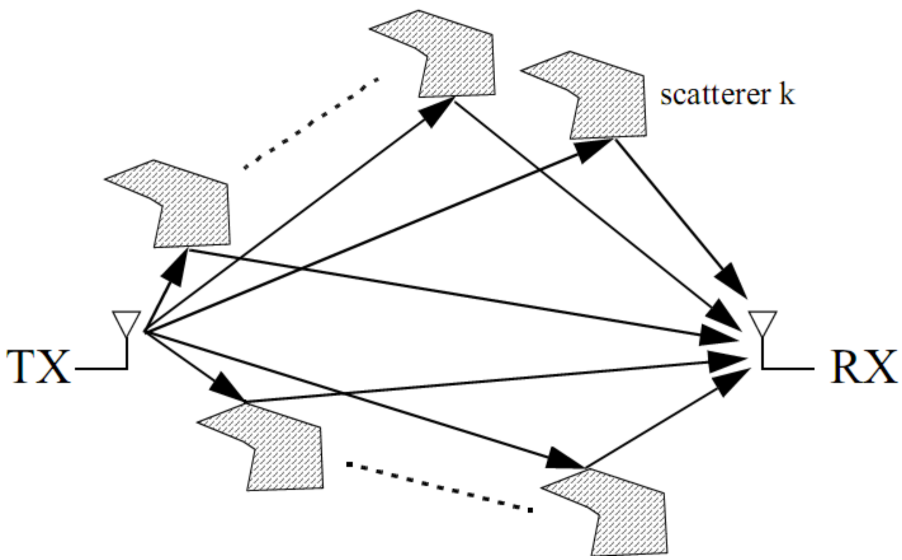


Figure 26 Multipath propagation

III Open research Areas

As Mentioned so many in that rich survey , Massive MIMO is a very important and interesting point of research and promised technology that is provide a support for all the upcoming technologies in cellular communication system as 5th generation mobile communication system , Military based application for aviation and navigation based systems , Radar based systems , Internet of Things IoT and Cognitive radio. in that section I will provide some points that require more work and some that are still not covered:

1-Channel modeling

Despite there are so many worksin that area, but still it needs more work to be done as stated in the survey it depends on the field of application,environment, and system.

2-Physical layer design of massive MIMO

Issues related to the antenna size and material used in the fabrication of the material is an issue and still, need more work

3-Milli-meter Wave

The design of Massive MIMO in such a system require, attention in relation to the design and channel model

4-coding and processing stage

That is a nonstop research point as long as code developed, and hardware more work will be required

5-Diversity and Multiplexing

Despite it's already implemented but a work still required concerning the speed and efficiency

6-complexity of the transceiver system

More work still required to make it better designed and less complex

7-link layer and the above

More protocols require more work and implementation on the system with a comparative result to the already deployed mode

8-Pilot contamination

Work still required to provide more and more solutions and alternatives with better result and reliable solutions.

9-Uplink and Downlink analysis

Some of the key points that are required belong to the channel modeling but is extended here is the geometry and mathematical modeling of the uplink and downlink along with the relation between theangle of arrival DOA and angle of departure DOD

10-Massive MIMO in FDD

More work required to deliver a modeling for the system in FDD.

11-system cost

More work is required to provide better management and save of resources.

VI. Tangential research areas and field of interest.

VII.

some areas provideideas, or use the massive MIMO to enhance and strength its capabilities and functionality, they are listed here and they are considered the top listed application for Massive MIMO in the near future:

1-Cognitive radio

Cognitive radio is an application that arouses from the basic idea of frequency reuse, and its idea is to use the bandwidth in case of being not used by its native application, and vacate that band when the patriot user appears to gain it. more and more points of research and applications related to Massive MIMO is provided here and some of them are

-usage of Massive MIMO in spectrum sharing for thecognitive radio system

-Energy Harvesting using Massive MIMO in cognitive radio

-Massive MIMO for cooperative cognitive radio

-Decontamination of pilot for cognitive Massive MIMO radio system

2-Internet of things

Internet of things is the technology which is considered the natural development of home automation and control, providing a platform for management and control in an application in your hand that is able to control and manage appliances inside the home , the vehicle being updated with the traffic and accidents while driving , patient being tested and examined remotely, ... massive MIMO provide also an aid to the application and implementation of such a system through the usage of cooperative Massive MIMO for

Wireless Sensor Networks WSN and gain the advantages of Massive MIMO for better channel bandwidth,modeling, and efficiency.

3-5th Mobile generation

One of the well-known technologies that will shape the future is the5th generation of mobile technology and there is no doubt that it depends on some major aspects of the usage of Massive MIMO systems to provide better bandwidth,speed, low cost and less power consumption.

4-Radar system

The radar system is used for navigation, aviation, air defense and missile system. using an antenna that delivers more capability regarding fading and scattering will make the radar system more precise in detecting objects, and here comes the rule of Massive MIMO that play in aradar system, researcher are working for modeling of Massive MIMO in radar system in order to be implemented and adapted.

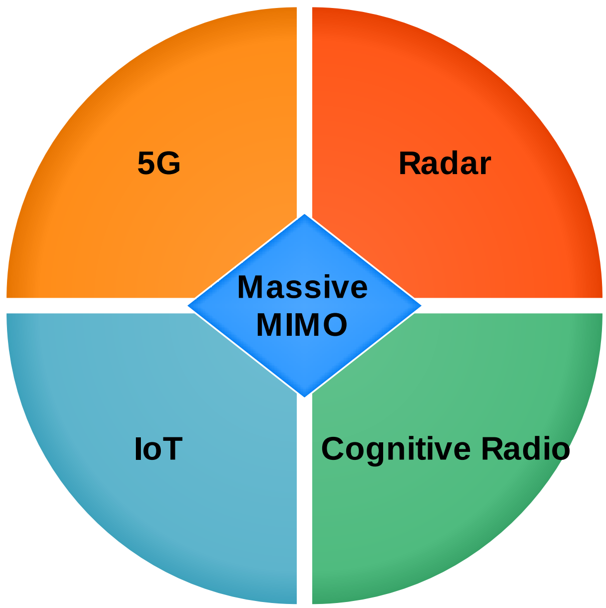


Figure 27 Tangential research areas

Conclusion

Massive MIMO is imperative and essential for the upcoming technologies, there are some issues related to the Antenna selection process and other related to channel allocation and estimation, all over that page I have provided a technical review of the most recent and important research papers that address both areas, moreover an open research point has been stated as well, at the end I have provided some tangential research areas that may provide a great source of information and expertise.

AUTHORS' CONTRIBUTIONS: Ramesh.S and T.Jagadesh havedone review part of the Antenna selection and concludes the open research area in that field.A.Divya has done analysis part of Channel estimation and reaches future research area in this area.Dr.J.VenuGoplaKrishnanguide all of three and approved the final manuscript.

COMPETING INTERESTS: The authors declare that they have no competing interests.

REFERENCES

[1]- Mobile and wireless communications Enablers for the Twenty-twenty Information Society (METIS)

[2]- HU Bi-bo1, LIU Yuan-an1, XIE Gang2, GAO Jin-chun1, YANG Ya-lin1"Energy efficiency of massive MIMO wireless communication systems with antenna selection"2014

[3]- Nayan A. Patadiya, Prof. Saurabh M. Patel Department of E & C, Sardar Vallabhbhai Patel Institute of Technology, Vasad, Gujarat, India " Antenna Selection in Massive MIMO System" 2016

[4] -Xiang Gao∗, Ove Edfors∗, Fredrik Tufvesson∗, Erik G. Larsson Department of Electrical Information and Technology, Lund University, Sweden "Massive MIMO in Real Propagation Environments: Do All Antennas Contribute Equally?"2015

[5]- Joao Vieira, Fredrik Rusek, Ove Edfors, Steffen Malkowsky, Liang Liu, Fredrik Tufvesson Dept. of Electrical and Information Technology, Lund University, Sweden " Reciprocity Calibration for Massive MIMO:Proposal,Modeling, and Validation"2016

[6]- Tzu-Hao Tai, Wei-Ho Chung, and Ta-Sung Lee-Department of Communications Engineering, National Chiao Tung University, Hsinchu, Taiwan" A Low Complexity Antenna Selection Algorithm for Energy Efficiency in Massive MIMO Systems"

[7]- Omar Mehanna, Student Member, IEEE, Nicholas D. Sidiropoulos, Fellow, IEEE,and Georgios B. Giannakis, Fellow, IEEE " Joint Multicast Beamforming and Antenna Selection"2013

[8]- Byungju Lee, Lua Ngo, and Byonghyo Shim Department of Electrical and Computer Engineering, Seoul National University, Seoul, Korea " Antenna Group Selection based User Scheduling for Massive MIMO Systems"2014

[9]- Gopesh Sharma1, Lokesh Tharani,Praval Kumar Udaniya - Department of Electronics engineering, Rajasthan Technical University, Kota " A SURVEY ON “MIMO” FOR ENERGY EFFICIENT WIRELESS COMMUNICATION SYSTEM"2016

[10] -Zaid Abdullah, Charalampos C. Tsimenidis, and Martin Johnston - School of Electrical and Electronic Engineering Newcastle University " Tabu Search vs. Bio-inspired Algorithms for Antenna Selection in Spatially Correlated Massive MIMO Uplink Channels"2016

[11]- Ngoc Phuc Le, Le Chung Tran, Farzad Safaei University of Wollongong "Adaptive antenna selection for energy-efficient MIMO-OFDM wireless systems"2014
[12]- Mouncef Benmimoune, Elmahdi Driouch, Wessam Ajib, Daniel Massicotte "Feedback Reduction and Efficient Antenna Selection for Massive MIMO System"2015

[13]- Mouncef Benmimoune, Elmahdi Driouch, Wessam Ajib, Daniel Massicotte --Department of Computer Science, Universit´ e du Qu´ ebec ` a Montr´ eal, Montr´ eal, QC, CANADA"Joint Transmit Antenna Selection and User Scheduling for Massive MIMO Systems"2015

[14]- Shital Shegokar Jangid -Assistant Professor/Poornima College of Engineering/Jaipur/Rajasthan/India "Antenna Selection with Spatial Multiplexing MIMO Systems"2015

[15]-Tae Won BAN, Bang chul "practical antenna selection technique in multiuser massive MIMO networks"2013

[16]- Geamel Alyami, Ivica Kostanic "A Low Complexity User Selection Scheme with Linear Precoding for Massive MIMO Systems"2016

[17]- Sachin Dogra, Atul Mishra, Mukti Verma "A Review of Transmit Antenna Selection for Massive MIMO Systems"2016

[18]- Xiang Gao, Ove Edfors, Fredrik Tufvesson, Erik G. Larsson -Department of Electrical Information and Technology, Lund University, Sweden"Multi-Switch for Antenna Selection in Massive MIMO"

[19]- Ali Ghrayeb -Department of Electrical and Computer Engineering-Concordia University, Montreal, Quebec, H3G 1M8 Canada"A Survey on Antenna Selection for MIMO Communication Systems"

[20]- Atul Kumar Mishra, Prof. Saurabh Gaur - PG Student, MIT Ujjain, Madhya Pradesh, India." REVIEW OF THE PILOT CONTAMINATION PROBLEM FOR MASSIVE MIMO AND POSSIBLE SOLUTION"2016

[21]-Madhusrhi.N.Kumar, Pappa.M-M.Tech Student, Dept. of Telecommunication, CMR Institute of Technology, Bengaluru, India "Performance Comparison of Massive MIMO & Conventional MIMO using Blind Channel Estimation Technique"2016

[22]-Zhiyuan Jiang, Andreas F. Molisch, Fellow, IEEE, Giuseppe Caire, Fellow, IEEE,and Zhisheng Niu, Fellow, IEEE "Achievable Rates of FDD Massive MIMO Systems with Spatial Channel Correlation"2014

[23]- Hongxiang Xie, Feifei Gao, Shun Zhang, and Shi Jin"A Simple DFT-aided Spatial Basis Expansion Model and Channel Estimation Strategy for TDD/FDD Massive MIMO Systems"2016

[24]-Mingjie Feng, Student Member, IEEE and Shiwen Mao, Senior Member, IEEE "Harvest the Potential of Massive MIMO with Multi-Layer Techniques"2016

[25]-Paul Ferrand, Member, IEEE, Mustapha Amara, Member, IEEE, Stefan Valentin, Senior Member, IEEE"Trends and Challenges in Wireless Channel Modeling for an Evolving Radio Access"2016

[26]-Shangbin Wu, Cheng-Xiang Wang, Senior Member, IEEE, Harald Haas, Member, IEEE"A Non-Stationary Wideband Channel Model for Massive MIMO Communication Systems"2014

[27]-Kun Qian,Wen-QinWang, and Huaizong Shao "Low-Complexity Transmit Antenna Selection and Beamforming for Large-Scale MIMO Communications"2014

[28]-Olakunle Elijah, Student Member, IEEE, Chee Yen Leow, Member, IEEE, Tharek Abdul Rahman, Member "A Comprehensive Survey of Pilot Contamination in Massive MIMO - 5G System'2015

[29]-Tsung-Han Lin and H. T. Kung "Concurrent Channel Access and Estimation for Scalable Multiuser MIMO Networking"2012

[30]-ZORAN BOJKOVIC, BOJAN BAKMAZ, MIODRAG BAKMAZ"Recent Trends in Emerging Technologies toward 5G Networks"

[31]-Zhiyuan Jiang, Student member, IEEE, Sheng Zhou, Member, IEEE, and Zhisheng Niu, Fellow"On Dimensionality Loss in FDD Massive MIMO Systems"

[32]-Cheng-Xiang WANG1,2*, Shangbin WU1, Lu BAI, Xiaohu YOU3, Jing WANG4 & Chih-Lin "Recent advances and future challenges for massive MIMO channel measurements and models" 2016

[33]- Xin Liu, Xianbin Wang, *The University of Western Ontario* "Highly Efficient Resource Allocation Techniques in 5G for NOMA-based Massive MIMO and Relaying Systems"2016

[34]- Mukesh Kumar, Satya Prakash Sinha, Jolis Gupta -M.Tech,ECE department, SRMS CET Bareilly, India"MIMO System for a 5G Wireless Communication Networks: A Key to Gigabit Wireless System"2015

[35]- Darbari, Faisal, Stewart, Robert W. and Glover, Ian-University of Huddersfield Repository "MIMO Channel Modelling"2010

[36]- OMAR ALI ABU-ELLA - university of Vaasa"Interference Mitigation Using Group Decoding in Multiantenna Systems"2014

[37]-Jean-Philippe Kermoal, Laurent Schumacher, Preben Mogensen " Channel Characterisation"2002

[38] Ian F. Akyildiz,Josep Miquel Jornet -Department of Electrical Engineering, University at Buffalo, The State University of New York, Buffalo, NY 14260,USA"Realizing Ultra-Massive MIMO (1024 × 1024) communication in the (0.06–10) Terahertz band"2016

[39]-Von der Fakultät Informatik, Elektrotechnik "Statistical Analysis and Transmit Prefiltering for MIMO Wireless Systems in Correlated Fading Environments" 2004

[40]-Majid Nasiri Khormuji - Huawei Technologies Sweden AB, Stockholm"Pilot-Decontamination in Massive MIMO Systems via Network Pilot–Data Alignment"

[41]-Jens Elofsson,Peter Seminar -Department of Electrical and Information Technology-Lund University "Software Defined Radio based MIMO channelsounding" 2016

[42]-Professor Robert W. Heath Jr. -Wireless Networking and Communications Group Department of Electrical and Computer Engineering University of Texas at Austin "Millimeter Wave MIMO: Opportunities and Challenges" 2015

[43] Clayton Shepard, Abeer Javed, and Lin Zhong -Department of Electrical and Computer Engineering Rice University, Houston, TX "Control Channel Design for Many-Antenna MU-MIMO"2015

[44] Malkowsky, Steffen; Vieira, Joao; Nieman, Karl; Kundargi, Nikhil; Wong, Ian; Öwall, Viktor; Edfors, Ove; Tufvesson, Fredrik; Liu, Liang - LUND University "Implementation of Low-latency Signal Processing and Data Shuffling for TDD massive MIMO Systems"2016

[45]-Dr. Emil Björnson -Division of Communication Systems Department of Electrical Engineering (ISY) Linköping University, Linköping, Sweden"The Path Towards 5G: Massive MIMO"

[46] Rui Peng and Yafei Tian - School of Electronics and Information Engineering, Beihang University, Beijing, China "Inter-Tier Interference Coordination in Massive-MIMO System based on Statistical Channel Information"

[47]-Clayton Shepard, Abeer Javed, and Lin Zhong - Department of Electrical and Computer Engineering "Control Channel Design for Many-Antenna MU-MIMO"

[48]-Maxime Guillaud. Transmission and Channel Modeling Techniques for Multiple-Antenna Communication Systems. domain other. Telecom ParisTech, 2005.

[49]-Khawla A. Alnajjar,Peter J. Smith,Graeme K. Woodward - Department of Electrical and Computer Engineering and Wireless Research Centre university of Canterbury"Receiver Design for Massive MIMO"2015

[50]-Mojtaba Soltanalian*, Mohammad Mahdi Naghsh, Nafiseh Shariati, Petre Stoica, and Babak Hassibi"Training Signal Design for Correlated Massive MIMO Channel Estimation"

[51]-Naga Raghavendra Surya Vara Prasad Koppisetti B.Tech., Indian Institute of Technology Bhubaneswar, India"Massive MIMO for 5G Wireless Networks: An Energy Efficiency Perspective"2012

ISSN: 2233-7857 IJFGCN