Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 03, March -2018

A Survey - Various Challenges for Secure Wireless Data Transmission in Massive MIMO

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Abstract— *Wireless Communication is such a vast field and one of the trending topics among the researchers nowadays. In this filed an increase growth is seen in the use of Massive Multiple Input Multiple Outputs (M-MIMO). This technology refers to employ the multiple base stations with multiple antennas. M-MIMO has an advantage that it improves the energy and spectral efficiency of the communication network by using simple processing. The M-MIMO utilizes the large antenna arrays which directly enhances the energy and spectral efficiency in comparison to single antenna. The power of used components is low that result in reduce Massive MIMO cost. In this paper, the M-MIMO and its channel estimation overview are given thoroughly.*

Keywords—*Wireless Communication; Massive Multiple Input Multiple Output; Channel Estimation*

I. INTRODUCTION

The multiple-input multiple-output (MIMO) is scaled up by some magnitude by invent of Massive- MIMO compared to exiting one. From last few years MIMO has become a topic of concern due to its efficiency in terms of wireless systems capacity and reliability. In case of M-MIMO and Multi user MIMO (MU-MIMO) a large number of antennas is used in base station [1]. Only a few numbers of antennas are allowed to be used at the base station by using Long-Term Evolution (LTE) standard. So, a use of massive MIMO results in increase of magnitude as compared to conventional one. In same response of time frequency a large number of single antenna users can be served by the use of large number of antennas along with base station [2].

The fifth generation wireless communication systems needs can be fulfilled by the use of Massive MIMO. A large number of antenna units consist cellular model based Time division duplexing (TDD) is contradict as massive MIMO that is further deployed in single cell Base Transceiver Station (BTS) [3]. In models of multiple cell there is need to use a non-orthogonal pilot sequences it is the case of orthogonally pilot sequences. If channel coherence is not very large then its time maintenance has become very difficult.

In Massive MIMO base station a thousands of antenna elements is mounted rather than small units that help in achieving better link reliability and very high data rate [4].

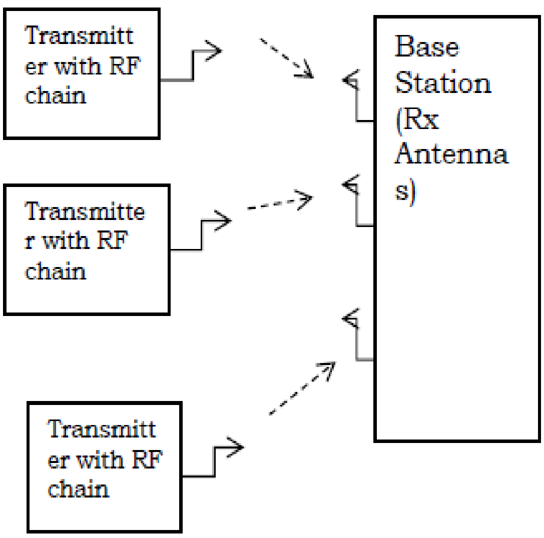

Figure 1 Massive MIMO System [4]

TDD operation is prove to be feasible in case of Massive MIMO and downlink data transmission, uplink data transmission and channel estimation are three operation performed during a coherence interval. A TDD Massive MIMO protocol is shown in Figure 3.

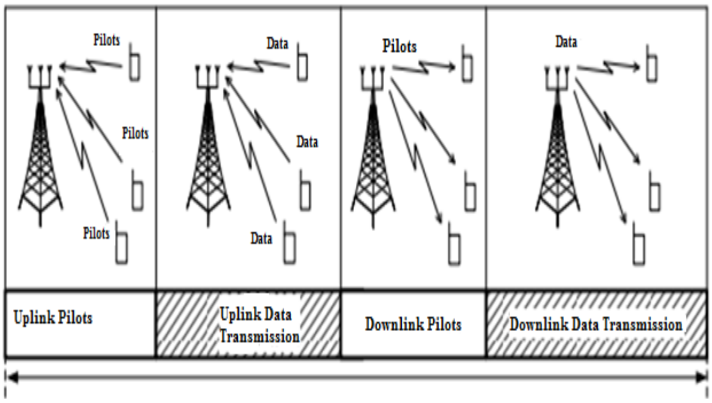

Figure 2. Transmission protocol of TDD Massive MIMO

1.1 CHALLENGES IN MASSIVE MIMO

There is large number of advantages achieved by the use of Massive MIMO but number of issues also comes with it. Out of number of challenges some of the main challenges are given below:

1.1.1 Pilot Contamination

The single cell setups have been considered in the last section and it has been found that number of cells makes a practical cellular networks. The same time frequency resources are shared by various cells due to very small availability of frequency spectrum. So, there is need to consider multi cell setups and all user cells orthogonal pilot sequences can't be assigned in multi cell systems. The sequences of orthogonal pilot are needed to be reuse. There is also need to consider a channel coherence limitation. In a given cell obtained channel estimation will get infected by other cells user transmitted pilots [7]. The performance of system gets reduced by this effect known as pilot contamination. In case of Massive MIMO a pilot contamination the above mentioned effect is considered as a big limitation. When there is increase in without bound BS antennas than also that effect can't be vanished

1.1.2 Unfavorable Propagation

In Massive MIMO working, its basis is to have a favorable environment of propagation. The channels are not in favorable condition in case of some of the propagation environments. When number of users is more than number of scatterers than a not favorable propagation environment condition occur or even when common scatterers are shared by BS different users' channels. If in a large area the BS antennas are distributed then the possibility of that problem will get reduced.

1.1.3 New Standards and Designs are required

If in LTE like current systems a use of massive MIMO can be done than it is prove to be efficient. But at BS only 8 number of antenna ports are allowed to be used in case of standard LTE [8]. The assumed channel information is used by LTE as an example the reference signals transmitted by BS is passes through various beams is one of the LTE downlink option. In response to it a strongest beam is sent to BS by users which are further used for downlink transmission. So, an estimated channel information is used by massive MIMO so in order to reduce its usage there is need of new standards.

1.3 Benefits of Massive MIMO

The below given example helps in getting an idea of massive MIMO most important existing benefits.

The 2 transmit antennas are denoted by N_t and large number of antennas is considered in receiving BS which is denoted by N_r. The ρ ($\mathbb{E}[|y_1|^2] = \mathbb{E}[|y_2|^2] = 1$) is s normalized transmit power which is used by two y_1 and y_2 different complex symbols that is further received at BS:

$$z = \sqrt{\rho}Hy + s \dots\dots\dots\dots\dots . (1)$$

The s ~ (0, I_{N_k}) normalized noise or $\mathbf{t}_1$, $\mathbf{t}_2 \sim \mathcal{CN}(0, I_{N_k})$ and $\mathbf{t}_1$, $\mathbf{t}_2$ channel vectors are not dependent on each other. At BS y1 detection is considered and BS can be formed with perfect CSI as given below:

$$z^{\sim} = \frac{1}{N_k} T^T z \dots\dots\dots\dots\dots . . (2)$$

In $z^{\sim}$ vector first element is

$$\frac{1}{N_R}(t_1^T t y_1 + t_1^T y x_2 + t_1^T s) \dots\dots\dots\dots (3)$$

Due to scaled inner products, large numbers law the value of N_r will also be large in their expected values are used to approximate it.

$$\frac{t_1^T t_1}{N_R}, \frac{t_1^T t_2}{N_R}, \frac{t_1^T s}{N_R} \dots\dots\dots\dots\dots . . (4)$$

When value of N_r is large so deterministic and effective scalar channel coefficient is close to each other in another words channel are hardens.

If $t_1^T t = 0$ we have favorable propagation and if

$$\lim_{N_R \to \infty} \frac{t_1^T t}{N_R} = 0 \ldots\ldots\ldots\ldots\ldots\ldots .(5)$$

have asymptotic favorable propagation. The deterministic channel gain can be achieved if there is AWGN channel along with favorable propagation and channel hardening. In addition, we have the array gain

$$\frac{E[\left|\frac{1}{|t_1|} t_1^T t_1\right|^2]}{E[\left|\frac{1}{|t_1|} t_1^T t_2\right|^2]} = \frac{E[\left|\frac{1}{|t_1|} t_1^T t_1\right|^2]}{E[\left|\frac{1}{|t_1|} t_1^T s\right|^2]} = N_R \ldots\ldots\ldots\ldots\ldots. (6)$$

1.4 Channel Estimation

The uplink transmitted signals from users is detected using Channel State Information (CSI) by Base Station (BS) and further it is precoded in the downlink. The uplink training is used to obtain CSI and an orthogonal pilot sequence is assigned to every user which is further send to BS. The different users transmitted pilot sequences are known to BS and then based on received pilot signals channels are estimated. The BS transmitted signals is coherently detected using CSI partial knowledge by each user. The different blind channel estimation and downlink training can be used to acquire an information. The signals is beam formed to users by the use of linear precoding techniques by BS and in order to detect effective channel gain only effective channel gain is required by user [3][4]. In the downlink, pilots are beam form by spending a short time by BS for CSI acquisition at different users.

II. RELATED WORK

The time division duplex (TDD) MIMO systems based time shifted pilot (TSP) has been focused by **Bule Sun et al, (2017) [1]**. In this paper, authors have evaluated a signal to interference plus noise ratios (SINR). The analysis of channel estimation error is performed after that a successive interference cancellation based TSP (SIC-TSP) scheme is proposed by them. In data communication, an uplink pilot downlink are eliminated by precoding vectors among BSs, shared downlink data and channels estimation. At frame beginning a spatial time slot is employed in SIC-TSP that helps in getting accurate estimation in which orthogonal pilots is transmitted by each BS.

Chen. B et al. (2016) [2] that helps in defending unlimited antennas armed eavesdroppers. In proposed OSPR scheme main aim is the usage of original symbols random phase ration at base station (BS) and this process takes place before sending the data. So, the intercepted signals make an eavesdropper massive MIMO confused that result in not presenting the true information of symbols. A good security performance can be achieved by the use of OSPR proposed scheme. In this a most of the original symbols are enable to be recovered by eavesdropper in case of thousands of antennas are used.

The common support posterior probability is enhanced by the use of Bayesian sparse channel estimation algorithm group proposed by **Huajian Chen and Chenhao Qi, (2017) [3].** Before it a received BS signal is jointly processed that result in reduction in Bayesian estimation computational complexity as main support set is genuinely approximated. A set of uplink channels is supported by it. The channel sparsity estimation is also derived by author.

The Aged CSI results in increase of spatial multiplexing gain to get rid of it **Hyunjoong Lee et al., (2017) [4]** proposed an Opportunistic user Scheduling algorithm (OPSAC). The additional pilot overhead are not included in it and developed a heuristic solution that uses a CSI samples correlation which is prove to be efficient that is concluded from results analysis and channel conditions are exploited for channel variation estimation. It results in spectral efficiency enhancement that show the use of OpSAC gives near optimal performance as compared to current CSI used conventional user scheduling algorithm.

The analytical method is presented by **João Guerreiro et al. , (2017) [5]** for transmitted signal statistical characterization and to obtain different precoding analytical performance a general framework is obtained. The condition is considered to obtain a performance in which CSI is considered as imperfect. The non-linearity of channel is also considered by authors. It has been found that nonlinear distortion associated penalty performance is under tolerable state and number of independent data streams is lesser than transmit antennas.

The **Khaled M. Humadi et al., (2014) [6]** given a concept of spatial modulation (SM) scheme that proves to be helpful in MU-MIMO. The large number of antennas is used for k users and BSTx are used for providing joint service in MU-MIMO. At BSTx appropriate precoding scheme is used whose main idea is user sub channel index utilization that helps in conveying extra useful information. In case of multiuser system along with large number of users a significant throughput enhancements has been provided by the use of proposed scheme.

The Original Symbol Phase Rotated (OSPR) is proposed by The different existing proposed techniques, architectures and designs by different researchers understanding has been built by comprehensive study done by **Piyush Vardhan et al., (2016) [7].** The Massive MIMO systems practical implementation and system model has been considered for that study. The different folds result in increase of data as at base station multiple antenna systems with large number of antenna elements are considered in by which there is no need of extra bandwidth as compared to existing technologies. The good

simulation results has been achieved in terms of beam forming like suitable signal detection schemes by the use of Massive-MIMO combined with multiple carrier systems (Massive-MIMO-OFDM).
The hundreds of M-MIMO systems channels parameters has been estimated by **Lei Cheng et al. (2017) [8].** They have used only one training symbol along with three dimensional antenna arrays and it has been assumed that there is no knowledge of path gain, number of path, direction of arrival (DOA) statistics and power of noise. A DOA acquisition scheme has been taken along with low complexity by exploiting a received data structure and closed form computations. The proposed scheme is tested in terms of DOA acquisition and channel estimation and its simulation results show that it is efficient.
For frequency division duplex a MU- massive MIMO systems is found by **Xiantao Cheng et al. , (2017) [9]** in which main focus is given to estimation of downlink channel. In order to estimate a channel a new approach has been used based on Bayesian interference by author. In each channel matrix, various channel matrix shared individual sparsity is captured efficiently by designing a Gaussian mixture prior model. Along with it a channel matrices and prior model based hyper parameters were introduced in variational expectation maximization strategy.
An new method is proposed by **Zhengquan Li et al., (2017) [10]** it is an advanced MMSE method in which weighted Kapteyn series N-order polynomials expansion is used to approximate a covariance matrix inversion. This has been used due to its low truncation errors and established an unconstrained non linear optimization model which is further solved using coordinate rotation based iterative algorithm. As compared to Kapteyn-MMSE or Taylor-MMSE estimator the performance of ordinary MMSE is improved by the use of proposed method. So, in order to approach MMSE estimation a lower N-order is required by proposed method.

III. CONCLUSION

To sum up, this study generates an overview to the Massive MIMO and also discuss other concepts like challenges in massive MIMO, benefits in massive MIMO, channel estimation etc. Massive MIMO can be described as a system which comprised of large amount of antennas which are mounted on more than one BS. The objective behind using multiple antennas is to provide efficient link reliability along with largest coverage area by the communication system. As per the massive MIMO system it is defined that the large array configuration on base stations leads to the enhancement in the spectrum and energy efficiency.

REFERENCES

[1] Bule Sun, "Successive Interference Cancellation Based Channel Estimation for Massive MIMO Systems", IEEE, GLOBECOM 2017,
[2] Chen. B, "Original Symbol Phase Rotated Secure Transmission Against Powerful Massive MIMO Eavesdropper", IEEE, vol 4, 2016
[3] Huajian Chen and Chenhao Qi, "Group Bayesian Sparse Channel Estimation for Massive MIMO Systems", IEEE, GLOBECOM 2017,
[4] Hyunjoong Lee, "An opportunistic scheduling algorithm using aged CSI in massive MIMO systems", ELSEVIER, vol 129(1), pp 284-296, 2017,
[5] João Guerreiro, "Analytical Performance Evaluation of Precoding Techniques for Nonlinear Massive MIMO Systems with Channel Estimation Errors", IEEE, vol pp(99), 2017,
[6] Khaled M. Humadi, "Spatial Modulation Concept for Massive Multiuser MIMO Systems", Hindawi, vol 2014, pp 1-9, 2014
[7] Piyush Vardhan, "Massive-MIMO- Past, Present and Future: A Review", IJST vol 9(48), pp 1-14, 2016
[8] Lei Cheng, "Channel estimation in full-dimensional massive MIMO system using one training symbol", IEEE, 18th International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), 2017,
[9] Xiantao Cheng, "Channel Estimation for FDD Multi-User Massive MIMO: A Variational Bayesian Inference-Based Approach", IEEE, vol 16 (11), pp 7590 – 7602, 2017,
[10] Zhengquan Li, "Low-complexity channel estimation based on weighted kapteyn series expansion for massive MIMO systems", IEEE, International Conference on Wireless Communications and Signal Processing (WCSP), 2017
[11] P. Wang and B. Henz, "Efficient Approaches to Resource Allocation in MIMO-based Wireless Mesh Networks", IEEE, pp 1-7, 2015
[12] X. Lu, Q. Ni, W. Li, H. Zhang , "Dynamic User Grouping and Joint Resource Allocation With Multi-Cell Cooperation for Uplink Virtual MIMO Systems", IEEE Transactions on Wireless Communications, Vol 16, Issue 6, 2017
[13] Xiaoyu Sun, Xiqi Gao, Ye Geoffrey Li, Wei Han, " Single-Site Localization based on a New Type of Fingerprint for Massive MIMO-OFDM Systems", IEEE, Issue 99, pp 1, 2018
[14] Hayder Al-Salihi, Trinh Van Chien, Tuan Anh Le, Mohammad Reza Nakhai, "A Successive Optimization Approach to Pilot Design for Multi-Cell Massive MIMO Systems", IEEE, Issue 99, pp 1, 2018
[15] Xiang Chen, Chen Cheng, Xuming Lu, Jie Gong, " Iterative interference cancellation based channel estimation for multi-cell massive MIMO systems", IEEE, pp 1-6, 2017

[16] Xintong Lu, Xi Yang, Shi Jin, Chao-Kai Wen, Wen-Jun Lu, “ TDD-based massive MIMO system with multi-antenna user equipments”, IEEE, pp 1-6, 2017
[17] Zhiyuan Jiang, Sheng Zhou, Zhisheng Niu, “A block coordinated update method for beam-based massive MIMO downlink scheduling based on statistical CSI”, IEEE, pp 1-6, 2017
[18] Yi Wang, Pengge Ma, Rui Zhao, Yongming Huang, Chunguo Li, Jun Zhu,, “Near-Optimal Pilot Signal Design for FDD Massive MIMO System: An Energy-Efficient Perspective”, IEEE, Issue 99, pp 1, 2018
[19] Aqiel Almamori, Seshadri Mohan, “Improved MMSE channel estimation in massive MIMO system with a method for the prediction of channel correlation matrix”, IEEE, pp 670-672, 2018
[20] Aqiel Almamori, Seshadri Mohan, “Estimation of channel state information for massive MIMO based on received data using Kalman filter”, IEEE, pp 665-669, 2018

