MASSIVE MIMO: CHANNEL MEASUREMENTS AND THEIR MODELS & FORTHCOMING ASPECTS

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ABSTRACT

Massive MIMO is also known as very-large MIMO (VLMIMO) and large scale antenna systems (LSAS), Hyper MIMO (HMIMO), Full dimension MIMO (FDMIMO) is advance techniques that potentially can offered the large network capacities in multi-user circumstances. With a massive MIMO system, we consider the case where a base station equipped with a large number of antennas elements instantaneously serves the multiple single-antenna users in the same time and frequency source. A massive MIMO system equipped with tens or several hundreds of an antennas which is capable of providing significant improvements to an energy efficiency and robustness of the system. While for the design, performance evaluation and an optimization of massive MIMO wireless systems, realistic channel measurement and their models are indispensable. An emerging the next generation wireless communication systems raises the new requirements on a spectral efficiency and an energy efficiency.

Keyboard: 5G, massive MIMO, channel measurement, channel models, energy efficiency.

I. INTRODUCTION

An increasing the high speed reliable communication with improved a user's may drives the development of the fifth generation wireless communication networks.

It has been commonly accepted the capacities of the wireless communication would achieving several of hundreds times of that of 4G long term evolution advanced (LTE-A) and wireless communication networks. Whileit is more required to reach 3-5 times w.r.t recent 4G LTE-A system over 5G systems for spectral efficiency and an energy efficiency, In accumulation to conventional spectral efficiency necessitiesmust be considered in the design of 5G wireless communication networks in contrast to 4G networks. In these networks, to allow longer battery lifetime for devices, energy efficiency that measures the transmitted $bit/joule$ desires to improve by ten times. Moreover, high speed communication would be supported in fifth generation (5G). Advanced technologies such as millimetre wave (mmWave) techniques, denser small cells, soft distinct air interface (SDAI), and high-efficiency various antenna techniques would be vital components of 5G wireless communication networks. It consists of three kind of spectrum which is:-

- It was recommended in that under-utilized allocated spectrum would be better explored.
- Spectrum edibility may be improved by authorized shared access (ASA), which is optimal for small cells, and using unpaired spectrum allocations.

- Higher frequency bands such as mmWave bands are capable to provide large BWs for 5G wireless communication systems.

A massive MIMO system may be made with low-cost components because the linear necessity of the antenna amplifiers is small when each antenna is assigned with less power. By appropriately using multi-user MIMO (MU-MIMO) in massive MIMO systems, the multiple access control (MAC) layer design can be simplified by avoiding complex scheduling algorithms. So, these main benefits enable the massive MIMO technique to be a capable candidate for the 5G wireless communication networks.

II. CHANNEL MEASUREMENTSOF MASSIVE MIMO FOR FUTURE

It depends on several limitations which are used in the measurements on benefits and effects produced by the increasing number of antennas. The limitations are:-

Capability: -The low density linear processing algorithms were capable to provide suitably very performance in terms of capacity due to high inter-channel orthogonally of massive MIMO. By the same time, High complexity processing algorithms were accomplished of providing quite small gains but with considerable higher computational complexity. Essentially, it was validated via measurement that massive MIMO systems may significantly advance spectral efficiency.

Eigen value distribution: - Eigen value of massive MIMO channels was measured, and showing that massive MIMO increases channel orthogonality between terminals by increasing the number of transmitted antennas.

Spherical wave front and non-stationarity: - Amounts on massive MIMO channels in established that the channel can't be observed as wide sense stationary (WSS) over the large antenna array. First, the far field assumption, which is equivalent to plane wave front estimate, is violated because the distances between the transmitter and receiver (scattered) may not be elsewhere the Rayleigh distance. Second, certain clusters are not observable over the entire array. That is to say that, respectively antenna element on the large array may have its own set of clusters. Third, power disparity and Rician K-factor variation over the antenna array are seen as well. These three factors of massive MIMO channels specify that the conventional modelling method of MIMO channels desires to be extended.

Channel characteristics

Additional channel features such as angle probability density function (PDF), root mean square (RMS) delay spread, power delay profile (PDP), angular power spectrum (APS), and correlation between sub-channels were similarlydeliberate. It is alsomeasured practical outdoor-to-indoor transmissions and observed that the correlation between sub-channels reduces with the increasing number of antennas. As a result, there is hardly any extra gain for more than 20 antennas.

Future directions for massive mimo channel measurements

Currently, many published measurement results were obtained via virtual antenna arrays.

To acquire more realistic channel characteristics, a large physical antenna array is required. In this case, the mutual coupling effect between antenna elements will be considered.

Also, cluster behaviours on the array axis need further investigations. Although cluster appearance and disappearance, and angles of arrival (AOA) shifts were observed in measurements, birth and death rates of clusters and values of AOA shifts are yet to be determined. Moreover, elevation characteristics of massive

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MIMO channels are less investigated in the literature. The impact of receiver location within the building on measurements is still an open problem to study.

Another future direction will be the measurement of massive MIMO in high-speed train (HST), M2M, and mmWave channels. Since HST, M2M, and mm Wave communications are key technologies in 5G wireless networks, massive MIMO can be applied to these technologies to boost their performance. In this case, massive MIMO channel characteristics with these technologies will be essential to the system design.

III. CHANNEL MODELS OF MASSIVE MIMO FOR FUTURE

Usually, the stochastic channel models may be classified into following types which is:-

- Correlation based models
- Geometry based models

Furthermore, CBSMs can be categorized into two types known as classic IID. Rayleigh fading channel model and correlated channel models. Correlated channel models contain the Kronecker-based stochastic model (KBSM), the Weichsel Berger model, and the virtual channel representation (VCR). For KBSM, the three-dimensional correlation matrices transmitter (Tx) and receiver (Rx) are expected independent. Equally, mutual coupling effects between spatial correlation matrices at the transmitter and receiver are modelled in the Weichsel Berger model and VCR. CBSMs are widely used tothe evaluateabstract capacity and performance of massive MIMO System because they are of lower implementation complexity and mathematically controllable.

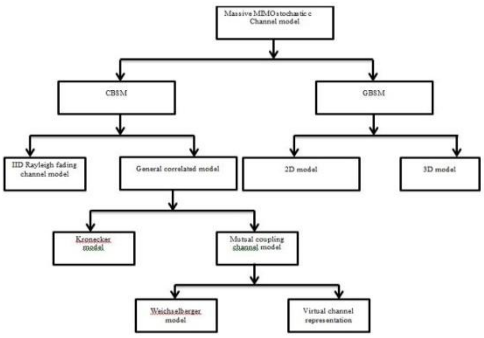

Figure 1 Classification of massive MIMO stochastic channel models

IV. CORRELATION-BASED STOCHASTIC MODELS

In classic IID Rayleigh fading channel procedures was utilized as the channel model for massive MIMO systems. Meanwhile the channel coefficients are IID, the central limit theory as well as the random matrix theory can be simply applied to the analysis of huge MIMO channel matrices. Though, the IID, Rayleigh channel model ignores the correlation between antennas. Consequently, they are additionalappropriate for widely separated antennas such as massive MIMO systems with scattered antennas than co-located antenna arrays.

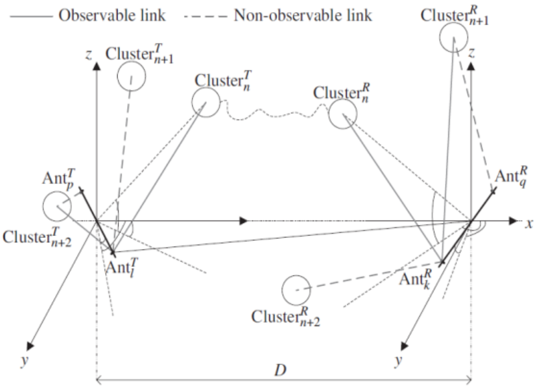

Figure 2: A 3-D wideband twin-cluster massive MIMO channel model

V. GEOMETRY-BASED STOCHASTIC MODELS

A GBSM for narrowband fading channels is used to perfect massive MIMO channel. It supposed that there were almost no scatters around a highlyraised base station and an infinite number of nativescatters were randomly distributed on a ring around the mobile station (MS). The APS observed the von Mises distribution and the correlation between angle of arrival (AOA) and angle of departure (AOD) was changing.

In above figure, examples of non-stationary properties of clusters on the array axis are assumed. The nth cluster $(Cluster_n)$ can be observed by both the lth transmit antenna (Ant^T_l) and the kth receive antenna (Ant^R_k)However, $Cluster_{n+1}$is observable to Ant^R_kbut not observable to Ant^T_lor Ant^R_q, and $Cluster_{n+2}$is observable to Ant^T_lbut not observable to Ant^T_p or Ant^R_k. These effects remained all modelledin the birth-death process framework.

VI. CHALLENGES AND FUTURE ASPECTS FOR MASSIVE MIMO CHANNEL MODELING

- The mm Wave communication, which is capable of operating very large bandwidth $(\geq 1GHz)$, occurs as a key combination of 5G wireless communication networks.
- The arrangement of massive MIMO and mm Wave techniques is accomplished of compensating the huge path loss and atmosphere absorptions of mm Wave with huge beamforming gain. The design and optimization of forthcoming mm Wave massive MIMO communication systems is highly subjective by the characteristics of the wireless channel.
- An array-time evolution of clusters is exhibited by birth-death processes. Applying other stochastic methods to modelling array-time evolution would be challenging. At the similar time, replacing stochastic processes with novel methods to model array-time evolution is substance exploring.

VII. CONCLUSION

In this paper, latest advances, challenges, and future aspects of channel measurements and channel models for massive MIMO communication systems have been analysed. Measurementsshownthat certain benefits and effects of channel models for conventional MIMO systems aren't effective for massive MIMO channels.

Massive MIMO channel features such as the spherical wave front effect and non-stationary properties on the antenna array have significant impacts on channel models.

Consequently, they must be taken into account in massive MIMO channel model developments. Modern CBSMs and GBSMsfor very large MIMO channels must be comparedand challenges and future aspects for massive MIMO channel modelling.

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