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Review on BeamSpace Massive MIMO NOMA System for 5G Wireless System

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ABSTRACT: - There is a dire urge to satisfy the exploding throughput demand of mobile and wireless communication systems in imminent times. The operating fourth generation (4G) systems are incompetent to encounter expected throughput requirements. Equipping a large number of antennas at base station (BS) can serve multiple user equipments (UEs) simultaneously termed as massive multiple input multiple output (M-MIMO), leads to a significant increase in spectrum efficiency (SE) of system. Millimeter wave (mmWave) communication offers abundant frequency spectrum resources and much more than legacy sub 6 GHz communication. By exploiting these two key technologies together, system throughput requirements can be approached and these are most likely expected in fifth generation (5G). The 5G mobile and wireless communication systems will require integration of more such leading advancements, like non-orthogonal multiple access (NOMA), beamforming with lens antenna array, cooperative relaying system (CRS) and many more.

KEYWORDS: - Non Orthogonal Multiple Access (NOMA), Fifth Generation, Spectral Efficiency, 5G Wireless System

I. INTRODUCTION

Traditionally wireless communications were based on single input single output (SISO) antenna systems. Nowadays, multiple input multiple output (MIMO) antenna systems have turned out to be the core of wireless communications. Fast developing mobile communications derive exploding data traffic usage and massive connectivity that will bring significant economic growth all over the world. Adding antennas at both transmitter and receiver end becomes an effective way to enhance the spectrum efficiency (SE) of system. With present fourth generation (4G) communication technology, only up to 8 antennas at base station (BS) are permissible, which includes mobile worldwide interoperability for microwave access release 2 (WiMAX-2) and long-term evolution advanced (LTE-A) [1, 2].

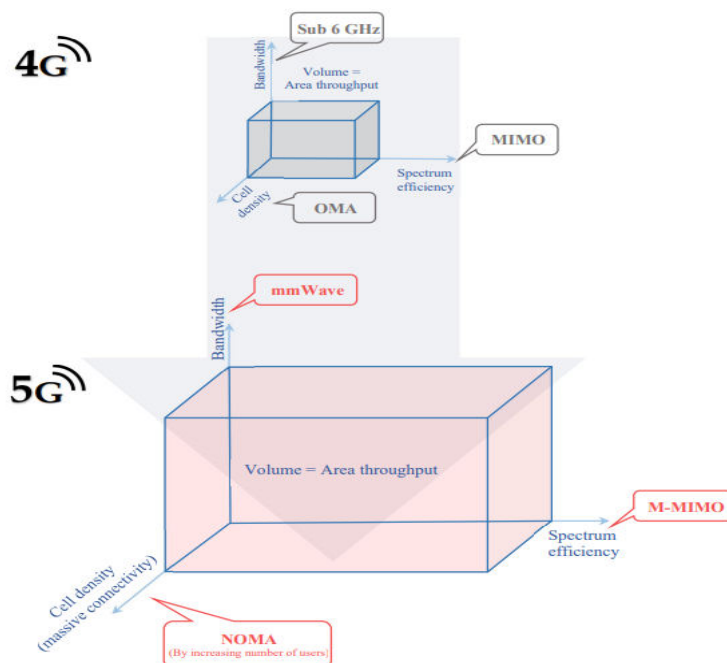


Figure 1: Technologies related to area throughput in 4G and 5G

Latest step forward in mobile communication is fifth generation (5G) and it is poised to provide ever increasing throughput reliably by upgrading technologies which brings overall improvement in area throughput. Figure 1 shows increase in area throughput induced by deviation of technologies from 4G to 5G. The bandwidth in frequency range below 6 GHz is densely occupied and high densification leads to inter cell interference and frequent handovers. So, 4G cellular networks have approached their saturation for further improvement in cell density and bandwidth resources. In 5G, by moving from sub 6 GHz towards millimeter wave (mmWave) band, the bandwidth gets improved. The cell density can be improved by accommodating a greater number of users per unit area by using a better multiple access technique, i.e., non-orthogonal multiple access (NOMA). The SE can be enhanced many folds by implementing massive MIMO (M-MIMO) systems in 5G [3, 4].

II. RELATED WORK

GanesanThiagarajan et al. [1], present day correspondence frameworks utilize various radio wires at the transmitter and recipient for expanding the client information rate and association dependability. This comes at the expense of expanded equipment and sign handling multifaceted nature. Cross breed beam formers, which are mixes of the simple and advanced beam formers, offer a decent compromise between the equipment, signal preparing intricacy and execution. The simple beam formers work on the radio recurrence signals while the advanced beam formers work on the base-band signals. Dissimilar to the completely advanced or completely simple beam formers, the loads calculation for the half breed beam formers is more muddled and it requires a answer for a multi-boundary, non-raised streamlining issue. This paper proposes a novel, easy-to-actualize strategy, which tends to the disadvantages in the current writing. The proposed beam former configuration is tended to in three basic advances specifically, send just, get just and consolidated communicate and get mixture beam formers. The utility of the plan methodology is outlined with regards to the 5G monstrous MIMO beam former, where the equipment unpredictability for a completely computerized beam former isn't financially practical. Mathematical outcomes are given to uphold the hypothesis.

TasneemAssafet al. [2], in this paper, the negative impacts of intra-cell pilot pollution for actual layer secure correspondence in intellectual multi-client monstrous various info numerous yield frameworks with underlay range sharing are explored. The channel gauges at the essential base-station and optional base-station are acquired by utilizing non-symmetrical pilot arrangements sent by the essential client hubs and auxiliary client hubs, individually. Henceforth, these channel gauges are influenced by intra-cell pilot defilement. Moreover, a detached multi-receiving

wire snoop is thought to listen in upon either the essential or optional secret transmissions. In this unique circumstance, an actual layer security methodology is provisioned for the essential and auxiliary transmissions through counterfeit commotion age at the PBS and zero-driving precoders. For this framework set-up, the normal and asymptotic feasible mystery rate articulations are determined in shut structure, and subsequently, the mystery rate debasement due to intra-cell pilot tainting is evaluated. Our examination uncovers that an actual layer secure correspondence can be provisioned for both essential and auxiliary huge MIMO frameworks even with channel assessment mistakes and pilot pollution.

Mustafa S. Aljumaily et al. [3], MIMO frameworks, spatial connection is one of the components, which essentially influences the spot mistake rate execution. Hence, in this paper, straight recognition is utilized with various decay strategies to improve the presentation. At a BER of 10^{-3} , with the channel pick up is multiplied by multiplying the request for the MIMO framework when contrasted with Cholesky and QR deterioration. Further, the BER stays unaltered for location independent of the kind of decay methods utilized. Nonetheless, it is additionally seen that for 32×32 MIMO framework, at a BER of 10^{-3} , MMSE gives almost 10 dB to 15 dB channel pick up when contrasted with ZF. By dividing the range among D2D clients and cell clients, the impedance created by D2D clients is utilized as a wellspring of sticking to befuddle the snoops. We initially infer the association likelihood of the D2D joins and the mystery blackout likelihood of the cell interface dependent on stochastic calculation apparatuses. We at that point propose a joint gatekeeper zone and limit based admittance control conspire for the D2D clients to boost the feasible mystery throughput.

Linglong Dai et al. [4], propose a helpful way to deal with improve the security of both essential and auxiliary frameworks in intellectual radio multicast correspondences. During their admittance to the recurrence range authorized to the essential clients, the optional unlicensed clients help the essential framework in sustaining security by sending a sticking clamor to the snoops, while at the same time shield themselves from listening in. The fundamental goal of this paper is to augment the mystery pace of the optional framework, while clinging to all individual essential clients' mystery rate limitations. On account of dynamic snoops and amazing channel state data at the handsets, the utility capacity of interest is nonconcave and the elaborate limitations are nonconvex, and accordingly, the ideal arrangements are inconvenient. To take care of this issue, we propose an iterative calculation to show up at any rate to a nearby ideal of the first nonconvex issue. This calculation is ensured to accomplish a Karush-Kuhn-Tucker arrangement. At that point, we stretch out the improvement way to deal with the instance of uninvolved busybodies and defective CSI information at the handsets, where the requirements are changed into a straight network imbalance and arched imperatives, to encourage the ideal arrangement.

Arun Kumaret al. [5], in this paper, the detrimental effects of intra-cell pilot contamination for physical layer secure communication in cognitive multi-user massive multiple-input multiple-output (MIMO) systems with underlay spectrum sharing are investigated. The channel estimates at the primary base-station (PBS) and secondary base-station are obtained by using non-orthogonal pilot sequences transmitted by the primary user nodes and secondary user nodes, respectively. Hence, these channel estimates are affected by intra-cell pilot contamination. Furthermore, a passive multi-antenna eavesdropper is assumed to be eavesdropping upon either the primary or secondary confidential transmissions. In this context, a physical layer security strategy is provisioned for the primary and secondary transmissions via artificial noise generation at the PBS and zero-forcing precoders. For this system set-up, the average and asymptotic achievable secrecy rate expressions are derived in closed-form, and thereby, the secrecy rate degradation due to intra-cell pilot contamination is quantified. Our analysis reveals that a physical layer secure communication can be provisioned for both primary and secondary massive MIMO systems even with channel estimation errors and pilot contamination.

SuprajaEduruet al. [6], in this paper, the unfavorable impacts of intra-cell pilot defilement for physical layer secure correspondence in subjective multi-client huge numerous information different yield (MIMO) frameworks with underlay range sharing are researched. The channel gauges at the essential base-station (PBS) and auxiliary base-station are gotten by utilizing non-symmetrical pilot successions transmitted by the essential client hubs and optional client hubs, separately. Henceforth, these channel appraisals are influenced by intra-cell pilot sullying. Besides, an inactive multi-receiving wire busybody is thought to spy upon either the essential or auxiliary secret transmissions. In this specific circumstance, a physical layer security procedure is provisioned for the essential and auxiliary transmissions by means of fake commotion age at the PBS and zero-compelling preorders. For this framework set-up, the normal and asymptotic feasible mystery rate articulations are inferred in shut structure, and in this manner, the mystery rate debasement due to intra-cell pilot sullying is evaluated. Our examination uncovers that a physical layer secure



correspondence can be provisioned for both essential and auxiliary enormous MIMO frameworks even with channel estimation mistakes and pilot defilement.

H. Q. Ngo et al. [7], a Cell-Free Massive MIMO (different info numerous yield) framework involves countless disseminated passageways (APs), which all the while serve an a lot more modest number of clients over a similar time/recurrence assets dependent on legitimately estimated channel attributes. The APs and clients have just a single reception apparatus each. The APs gain channel state data through time-division duplex activity and the gathering of uplink pilot sign transmitted by the clients. The APs perform multiplexing/de-multiplexing through conjugate beamforming on the downlink and coordinated separating on the uplink. Shut structure articulations for individual client uplink and downlink throughputs lead to max-min power control calculations. Max-min power control guarantees consistently great administration all through the region of inclusion. A pilot task calculation mitigates the impacts of pilot sullyng, yet power control is unquestionably progressively significant in such manner. Massive MIMO has significantly improved execution regarding an ordinary little cell conspire, whereby every client is served by a devoted AP, as far as both 95%-likely per-client throughput and resistance to shadow blurring spatial connection. Under uncorrelated shadow blurring conditions, the phone free plan gives almost fivefold improvement in 95%-likely per-client throughput over the little cell plot, and ten times improvement when shadow blurring is related.

Huang A. Burr et al. [8], in this paper, we consider the uplink of sans cell huge MIMO frameworks, where countless conveyed single reception apparatus passageways (APs) serve an a lot more modest number of clients at the same time by means of restricted backhaul. Just because, we explore the presentation of register and-forward (C&F) in such a ultra-thick system with a reasonable channel model (counting blurring, path-loss and shadowing). By using the normal for path-loss, a low unpredictability coefficient determination calculation for C&F is proposed. We likewise give a covetous AP determination technique for message recuperation. Moreover, we contrast the presentation of C&F with some other promising straight systems for conveyed monstrous MIMO, for example, little cells (SC) and most extreme proportion consolidating (MRC). Numerical outcomes uncover that C&F lessens the backhaul load, yet additionally fundamentally expands the framework throughput for the symmetric situation.

III. ADVANTAGE OF NOMA

High spectrum efficiency:

Spectrum efficiency is one of the well accepted performance metrics in wireless networks. NOMA exhibits a high spectrum efficiency to improve the sum system throughput, which is attributed to the fact that NOMA allows one resource block (RB) (e.g., time/frequency/code) to be occupied by multiple users [7].

Fairness-throughput tradeoff:

One key feature of NOMA is to allocate more power to the weak user, which is different from the conventional popular power allocation (PA) policies such as water filling PA1. By doing so, NOMA is capable of guaranteeing a good tradeoff between the fairness among users and system throughput.

Ultra-high connectivity:

The future 5G systems are envisioned to support the connection of billions of smart devices (e.g., Internet of Things (IoT)). The existence of NOMA offers a promising approach to efficiently solve this non-trivial task by fully exploiting the non-orthogonal characteristic. More specifically, unlike conventional orthogonal multiple access (OMA) which requires equal number of RBs to support these equal number devices; NOMA is able to serve them with occupying much less RBs.

Good compatibility:

From the theoretic perspective, NOMA can be an “add-on” technique to any exiting OMA techniques (e.g., TDMA/FDMA/CDMA/OFDMA), due to the fact that it exploits a new power dimension. Also, with the mature development of superposition coding (SC) and SIC technologies both in theory and practice, it is very promising that NOMA is capable of achieving good compatibility with the existing MA techniques.

Open flexibility:

Compared to other existing techniques for MA, such as multiuser shared access (MUSA), pattern division multiple access (PDMA), sparse code multiple access (SCMA), NOMA provides an easy-understanding and low complexity design [8]. In fact, the fundamental principle of the aforementioned MA schemes and NOMA are very similar, which is to allocate multiple users in a single RB. Taking the comparison of NOMA and SCMA as an example, SCMA can be regarded as a developed technology of NOMA which integrates appropriate sparse coding, modulation and subcarrier allocation.

IV. NOMA IN DOWNLINK TRANSMISSION SCENARIOS

Let us consider a downlink NOMA transmission with a single antennas BS and single antenna m number of users with distinct channel gains. In such m-user downlink NOMA, the BS transmitter non-orthogonally transmits m different signals by superposing them over the same spectrum resources; whereas, all m UE receivers receive their desired signals along with the interferences caused by the messages of other UEs.

To obtain the desired signal, each SIC receiver first decodes the dominant1 interferences and then subtracts them from the superposed signal. Since each UE receives all signals (desired and interfering signals) over the same channel, the superposing of different signals with different power levels is crucial to diversify each signal and to perform SIC at a given UE receiver.

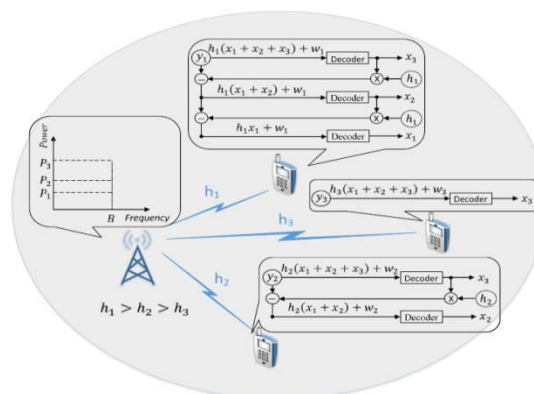


Figure 2: Illustration of a 3-user downlink NOMA transmission with SIC at user ends.

Let us also consider that the messages of NOMA users are superposed with a power level which is inversely proportional to the their channel gains, that is, a particular user is allocated for low power than the users those have lower channel gain while that allocated power is higher than all the users those have higher channel gain than the particular user. As such, the lowest channel gain user (who receives low interferences due to relatively low powers of the messages of high channel gain users) cannot suppress any interference. However, the highest channel gain user (who receives strong interferences due to relatively high powers of the messages of low channel gain users) can suppress all interfering signals.

NOMA in Uplink Transmission Scenarios

The working principle of uplink NOMA is quite different from the downlink NOMA. In uplink NOMA, multiple transmitters of different UEs non-orthogonally transmit to a single receiver at BS over same spectrum resources. Each UE independently transmits its own signal at either maximum transmit power or controlled transmit power depending on the channel gain differences among the NOMA users. All received signals at the BS are the desired signals, though they make interference to each other. Since the transmitters are different, each received signal at SIC receiver (BS) experiences distinct channel gain. Note that, to apply SIC and decode signals at BS, we need to maintain the distinctness among various message signals. As such, conventional transmit power control (typically intended to equalize the received signal powers of all users) is not feasible in NOMA-based systems.

Let us consider a general m-user uplink NOMA system in which m users transmit to a common BS over the same resources, at either maximum transmit power or controlled transmit power. The BS receives the superposed message signal of m different users and applies SIC to decode each signal. Since the received signal from the highest channel gain user is likely the strongest at the BS; therefore, this signal is decoded first. Consequently, the highest channel gain



user experiences interference from all other users in the NOMA cluster. After that, the signal for second highest channel gain user is decoded and so on. As a result, in uplink NOMA, the achievable data rate of a user contains the interference from all users with relatively weaker gain channels. That is, the highest channel gain user experiences interference from all users and the lowest channel gain user enjoys interference-free data rate.

V. METHODOLOGY

The remarkable growth of smart devices has led to 1,000-fold expected traffic enhancement for the future 5G network system, compared to which the existing spectrum resource is quite constrained. To support a great number of users as well as explosively increased network capacity with limited spectrum, 5G networks depend on critical transmission technologies to provide extremely high spectrum efficiency. NOMA, which provides concurrent transmissions for multiple users, is recognized as one promising solution for high spectral efficiency in 5G. In traditional OMA, messages intended for different users are transmitted in different time slots under TDMA protocol, or in different frequency bands under OFDMA protocol.

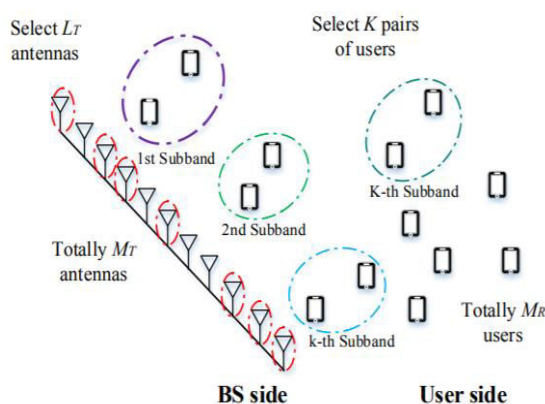


Figure 3: Massive MIMO-NOMA system with antenna selection and user scheduling

Instead, NOMA allows several users to share the same time and spectral resources. Specifically, NOMA serves different users by transmitting multiple messages at different power levels to achieve non-orthogonal reuse, which induces inter-user interference. At user side, the receivers apply successive interference cancellation (SIC) to remove the interference and separate these messages for corresponding users. The performance of NOMA system can be improved if suitable users are clustered as a NOMA group for SIC.

Massive MIMO is also a technology which archives high spectral efficiency in 5G. The very large antenna array is able to transmit massive data streams with different spatial patterns concurrently at the same frequency band to achieve spatial reuse. As a result, the throughput within the same spectrum is significantly improved. Another application is the massive antennas can transmit the same message to for the receiver side to achieve diversity gain, which increases the receive SNR. Moreover, beamforming technology in massive MIMO can potentially transmit messages in an specific angle, which is targeted at relevant NOMA user group. With the transmit power concentrated at that angle, the energy efficiency is increased and interference to other user groups is reduced.

Therefore, the integration of massive MIMO and NOMA technologies becomes a promising solution in obtaining extremely high spectral efficiency in 5G systems. However, massive MIMO-NOMA system brings certain major technical challenges at the same time. Firstly, MIMO RF chain elements, containing RF amplifier and analog-to-digital/digital-to-analog converter, increase the hardware cost along with system complexity, since each antenna should be match with one RF chain for signal processing.

So one critical scheme is to operate MIMO-NOMA with limited RF chains is to select the best subset of antennas for these RF chains. Different antennas correspond to different performance; even the same antenna subset has different performance over time due to random user distribution and user mobility. Hence, we should select the antenna subset with good performance in each time slot.

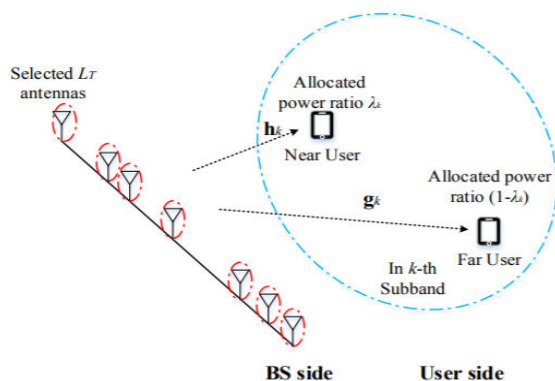


Figure 4: User service in k-th sub-band of massive MIMO-NOMA system.

Furthermore, since channel conditions vary over time and frequency, it is more cost-effective to schedule users into good channels at each time slot. Moreover, NOMA requires user pairing for SIC, where typically one near user (with strong channel gain) and one far user (with weak channel gain) are scheduled as a user pair. The inter-user channel gain different influences the SIC effect. Moreover, there will be very broad bandwidth in the future 5G, including licensed band and unlicensed band.

VI. CONCLUSION

In particular, firstly, the principles of massive MIMO, NOMA to achieve high spectral efficiency and relaying technology to achieve power efficiency are introduced. Following this, relevant problems, including antenna selection, user scheduling, power allocation and relaying scheme design, are described with the necessity to be solve. A literature survey on currently available approaches is also provided. Next, the antenna selection and user scheduling strategies in massive MIMO-NOMA system is investigated. With power allocation scheme among NOMA users figured out as the basis, efficient antenna selection algorithm is proposed for single-band scenario. It searches desired antennas from candidate antennas beneficial to relevant users.

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