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PERFORMANCE COMPARISION OF MASSIVE MIMO SYSTEM USING ORTHOGONAL AND NON-ORTHOGONAL MULTIPLE ACCESS FOR UPLINK IN 5G SYSTEMS

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ABSTRACT

In the attempt to respond to market demands, new techniques for wireless communication systems have been proposed to ensure, to all active users that are sharing the same network cell, an increased quality of service, regardless of any environmental factors, such as their position within the cell, time, space, climate, and noise. One example is the nonorthogonal multiple access (NOMA) technique, proposed within the 5G standard, known for supporting a massive connectivity and a more efficient use of radio resources. This project presents two new sets of complex codesmultiple-user shared-access (MUSA) and extended MUSA (EMUSA), and an algorithm of allocation such that the intercorrelation should be as reduced as possible that can be used in MUSA for 5G NOMA-based technique scheme.

Also, it analysis the possibility of creating complex codes starting from PN (cPN), which is a novel idea proposed in this project, whose results are promising with respect to the overall system performances. First, a description of the basic principles of MUSA are presented; next, the description of the proposed system will be provided, whose performance will be tested using Monte Carlo MATLAB simulations based on bit error rate (BER) versus signal-to-noise ratio (SNR). The system performances are evaluated in different scenarios and compared with classical code division multiple access (CDMA) having the following system parameters in sight: the number of antennas at the receiver side and the number of active users.

INTRODUCTION

FOR cellular systems, nonorthogonal multiple access (NOMA) has been studied to improve the uplink spectral efficiency. In NOMA, a radio resource block is shared by multiple users and their transmission power difference plays a key role in multiple access. In general, a pair of users of different transmission powers is considered to share a radio resource block. In practical NOMA schemes, called multiuser superposition transmission (MUST) schemes, are considered for uplink transmissions (with two users). In NOMA is employed for coordinated multipoint (CoMP) uplink in order to support a cell-edge user without degrading the spectral efficiency. In addition, an opportunistic base station (BS) or access point (AP) selection is studied for CoMP with NOMA to improve the spectral efficiency. NOMA is extended to multiple-input multiple-output (MIMO) systems in

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and capacity analysis of NOMA-MIMO can be found.While NOMA has been extensively studied to apply to various transmission systems (e.g., CoMP and MIMO), there are also fundamental issues for NOMA. NOMA is based on superposition coding and successive interference cancellation (SIC). Due to SIC, the receiver's complexity can increase at users. Thus, NOMA without SIC in would be helpful to decrease the receiver's complexity at users. In addition, the performance comparison with multiuser diversity schemes (e.g., the opportunistic user selection scheme in is also an important issue in terms of the tradeoff between spectral efficiency and fairness. To address this issue, in NOMA and multiuser diversity schemes are compared when a proportional fairness scheduler is employed.

In wireless communications, the power control has been extensively studied to overcome fading In NOMA, the power allocation between users and the power control are also important issues not only to overcome fading, but also guarantee fairness between users. In an optimal power allocation to maximize the minimum rate is studied with known channel state information (CSI). In partial CSI or statistical CSI is considered for the power allocation between users for uplink NOMA.

LITERATURE SURVEY

Optimization of resource management for NOMA transmission has been studied extensively in literature. For instance, the authors of Reference formulated a resource management problem to enhance the sum capacity of two-user NOMA system. The proposed framework first guarantees the minimum quality of service (QoS) of one mobile user and then allocates the remaining power to other mobile user to maximize the overall system capacity. A price based power optimization scheme was presented in uplink wireless network. The objective was to maximize the revenues and average achievable rate of the proposed network by adopting game theoretic approach. To deal with non-convex optimization, they decouple the problem and use alternating optimization algorithm to obtain the efficient solution. The research in Reference provided a low complexity power allocation to enhance the weighted sum capacity in uplink NOMA systems. They considered two cases, namely a two-use case and a multi-user case and exploited low complex and closed form solutions to solve the non-convex optimization. Yang et al. in Reference proposed a Karush–Kuhn–Tucker (KKT) based solution for power management to enhance the sum capacity of the network subject to a minimum user rate. Ding et al. in Reference investigated the outage performance and ergodic capacity for uplink NOMA network. Under the constraint of interference threshold from the secondary system to the primary system, the power management problem for capacity enhancement and outage probability in two-user cognitive radio NOMA network was proposed in Reference.

A proportional fairness scheduling approach was considered for fair power allocation to maximize the sum rate and

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maximize the minimum of normalized rate in a two-user network. Tan et al. proposed the channel estimation and power management problem for two-user system to maximize the average effective signal to interference plus noise ratio (SINR) of the strong user with bounded average effective SINR of the weak user. To maximize the effective sum capacity with delay QoS constraint, Choi et al. provided a sub-optimal solution based on truncated channel inversion power control in a two-user uplink system.

PROPOSED SYSTEM

NOMA overcomes the near-far problems of the 3G systems and improve the fairness in resource allocation in the 4G systems. NOMA is a multi-user multiplexing scheme that exploits the frequency domain, time domain, and power domain similarly. Compared with the traditional orthogonal transmission, NOMA uses non-orthogonal transmission at the sending terminals, introducing interferenced information deliberately, and realizes the demodulation by the successive interference cancellation (SIC) technology at the receiving terminals .

NOMA technologies can still use the OFDM symbol as the smallest unit in the time domain, and insert the cycle prefix (CP) between the symbols to prevent inter-symbol interference (ISI). While, in the frequency domain, the smallest units can still be the sub-channels, and OFDM technologies are used in each subchannels to keep the sub-channels are orthogonal and non-interference with each other. However, the power of each sub-channel and the OFDM symbol is shared by multiple users instead of only for one user. In particular, the signal power of different users on the same subchannel and OFDM symbol is non-orthogonal, which led to MAI for shared channels.

In order to overcome the interference, NOMA at the receiver using a SIC technology for multi-user interference detection and deletion to ensure the normal communication of the systems .Thus, the receiver complexity of NOMA has improved compared with orthogonal transmission, but it can get higher spectral efficiency.

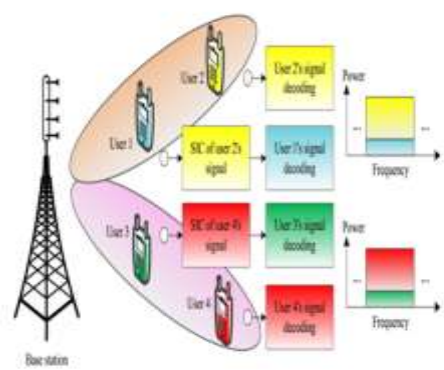

Fig.1: A uplink NOMA system model

NOMA technology has the characteristics of high spectrum utilization, high flexibility, and improved system capacity. According to the non-orthogonal transmission strategies' difference between users, NOMA technologies can be divided into two categories: signal domain segmentation technology and waveform design technology . Signal domain segmentation technology is based on the overall optimization of multiuser communication system. At the transmitting terminal, the user is

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differentiated based on the non-orthogonal features of multiple signal domains (e.g. power domain, generalized spatial domain, coding domain). At the receiving terminal, the multi-user detection receiver can be realized by using the SIC method or other sub-optimal detection algorithm based on the feature structure of the users' pattern. Signal domain segmentation multiple access representative technology mainly as power domain NOMA bit division multiplexing (BDM) multiple access superposition modulation (SM) pattern division multiple access (PDMA) space coupled multiple access (SCMA) low density signature multiple access (LDSMA) inter-leave division multiple access (IDMA) etc.

SIMULATION RESULTS

The performance achieved by the proposed system is evaluated in this section. Extensive simulations have been made in MATLAB using the Monte Carlo technique to increase the degree of confidence in the results. The parameters are summarized in Table 1. The number of transmitting antennas at the relay has been considered as Ntr = 1. To have a reference, first, we present the performance of an uplink massive MU-MIMO system when active users are separated by Walsh, PN spreading codes and then by complex spreading codes. Simulations with BPSK modulation have been performed too, but the obtained errors were very low and are not presented in the paper.

In order to quantify the effect of the subcarrier loading(L), Fig. 5 shows the Jain's fairness index for the proposed NOMA technique with L= 2;3;and4. As the results show, by allowing more users to share the subcarriers, better fairness levels can be achieved. However, this will increase the receiver complexity, thus, selecting the maximum number of users per subcarrier need to be chosen carefully to keep the complexity affordable. On the other hand, increasing the number of users per subcarrier results in marginal increase in spectral efficiency. Due to space limitation, the spectral efficiency comparison is not presented here. Considering the results altogether, it can concluded that the proposed NOMA technique achieves better system performance in terms of spectral efficiency and fairness comparing to OFDMA. Also, the spectral efficiency achieved by the proposed NOMA is relatively closer to the system upper bound.

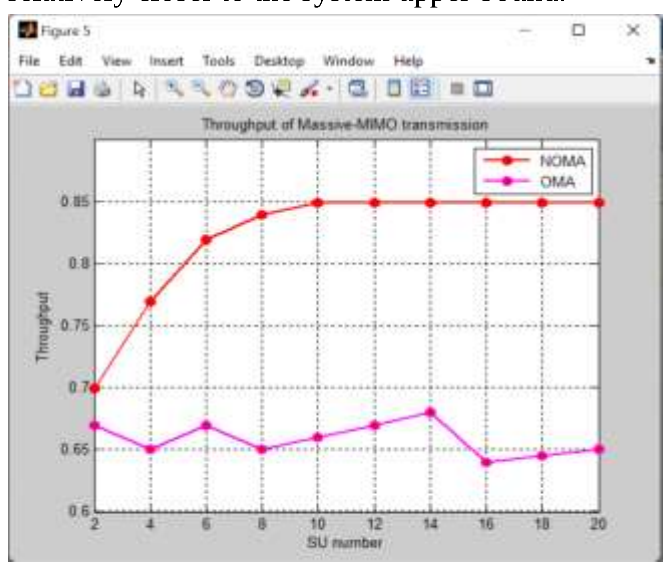

Fig: 5 Throughput of Massive-MIMO Transmission

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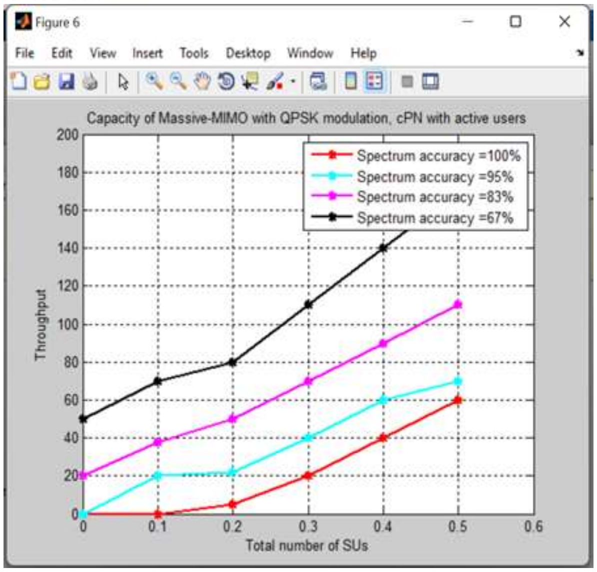

Fig.2: Capacity of Massive-MIMO with QPSK Modulation, CPN with Active users

APPLICATIONS

A defined quality of service may be desired or required for certain types of network traffic, for example:

- Streaming media specifically
- Internet protocol television (IPTV)
- Audio over Ethernet
- Audio over IP
- Voice over IP (VoIP)
- Videotelephony
- Telepresence
- Storage applications such as iSCSI and Fibre Channel over Ethernet
- Circuit emulation service
- Safety-critical applications such as remote surgery where availability issues can be hazardous
- Network operations support systems either for the network itself, or for customers' business critical needs
- Online games where real-time lag can be a factor
- Industrial control systems protocols such as EtherNet/IP which are used for real-time control of machinery

These types of service are called inelastic, meaning that they require a certain minimum bit rate and a certain maximum latency to function. By contrast, elastic applications can take advantage of however much or little bandwidth is available. Bulk file transfer applications that rely on TCP are generally elastic.

CONCLUSION

The project presents the performance obtained by an uplink massive MIMO system with relay as intermediary between source and destination, using LDPC channel coding and OFDM modulation when active users are separated using complex spreading codes from four new sets of codes, MUSA, MUSA0, EMUSA, and EMUSA0. For the MUSA set, 32 codes with low correlation properties have been selected as the intercorrelation should be as low as possible. For the MUSA0 set, 25 codes, in ascending order of their intercorrelation value, have been chosen from the MUSA set previously defined, and the rest of the 7 codes have been replaced with ones with zero cross-correlation. The EMUSA set of codes was created by extending the MUSA and MUSA0 from length 8 to length 32, obtaining thus EMUSA and EMUSA0 sets. The results were obtained using the QPSK modulation scheme, when the transmission was made over a channel affected by Rayleigh fading using a MIMO configuration of (1 × 26 × 30) and (1 × 30 × 30), with 26 or 30 antennas at the relay. The

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performance was highlighted by comparing them with classical Walsh and PN spreading codes, and the new sets of codes proved to outperform the classical ones. This project also analyzed the situation in which the number of receive antennas at the relay was different from the number of receive antennas at the destination, and some discussion was made with respect to the compromise that has to be reached between the processing complexity, total rate, and occupied bandwidth and the required level of performances in terms of BER obtained at certain SNRs. Another novel idea, that was described and tested within this project, was the one in which complex spreading codes cPN were obtained starting from PN spreading codes. The results obtained are promising, leading to very low BER values, showing that in this case, the number of antennas can be reduced and, thus, the overall system cost. As future work, we will focus our attention on implementing a higher number of parallel relays between source and destination and comparing their performance when using DF or amplify-and-forward (AF) protocols and trying to find a compromise between performance, hardware, and a low cost of implementation.

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