Performance Analysis of NOMA and TDMA under Channel State Information

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***Abstract*— In the wireless communication services reliability and availability of real time communication are the important factors. In this scenario a popular technique called multiple access techniques are used. A promising multi-client access scheme, nonorthogonal multiple access (NOMA) with successive interference cancellation (SIC), is presently concentrated for 5G systems. NOMA's execution highly depends on the power split among the data flows and the associated power allocation (PA) problem. In this paper, it deals optimized power and channel allocation in NOMA and investigates PA techniques that ensure fairness for the downlink clients under instantaneous channel state information (CSI) at the transmitter and average CSI.**

***Keywords*— 5G, fairness, NOMA, outage probability**

I. INTRODUCTION

5G provide a new frequency bands along with the wider spectral bandwidth per frequency channel. To increase the spectral efficiency various multiple access technique are used in wireless system. Multiple access techniques are the way to access a single channel by multiple users that is how the same bandwidth channel is used by the different number of users. Non-orthogonal access code-division multiple accesses (CDMA) based on direct sequence-code division multiple access (DS-CDMA) is widely used in the 3rd generation mobile communication system. In the 4th generation (4G) mobile communication systems such as LTE and LTE-Advanced adopt orthogonal multiple access based on orthogonal frequency multiple access (OFDMA) in the downlink and signal carrier (SC)-FDMA in the uplink[1]. It is a reasonable choice for achieving good system-level throughput execution to orthogonal access in packet-domain services.

However, considering the future radio access in the 2020s, further enhancement to achieve significant system throughput and client fairness has become one of the key issues in handling this explosive data traffic increase in 5th generation (5G) mobile communication systems and need for enhanced delay-sensitive high-volume services. Non-orthogonal multiple accesses (NOMA) with successive interference cancellation (SIC) is considered to be a promising technology that improves the sum throughput [2]. Because the communication resources (time and frequency) in a NOMA system are shared by all the users, the sum throughput can be enhanced over what is possible, compared with orthogonal multiple access (OMA)[4].

II. RELATED WORKS

Towards future 5G communication systems, some candidate access schemes are under investigation in recent research activities, e.g., sparse code multiple access (SCMA) and NOMA. Non-orthogonal multiple access (NOMA) allows allocating one carrier to more than one user at the same time in one cell. It is a promising technology to provide high throughput due to carrier reuse within a cell. Superposition coding (SC) is an effective technique to increase capacity in the NOMA system. When SC is applied, multiple users' signals are multiplexed over the same subcarrier with different received power at the base station. It deals with the capacity region for NOMA and by assuming predefined client groups for each sub channel, a heuristic algorithm for NOMA power allocation in downlink has been proposed and system-level simulations have been conducted. It addresses various implementation issues of NOMA. It considered sum-rate utility maximization problem for dynamic NOMA resource allocation and the outage execution of NOMA has been evaluated. The fairness in NOMA can be improved via using and adapting the so-called power allocation coefficients. For uplink NOMA, it provides a suboptimal algorithm to solve an uplink scheduling problem with fixed transmission power. In this work, a weighted multi-client scheduling scheme is proposed to balance the total throughput and the cell-edge client throughput. It proposes a greedy-based algorithm to improve the throughput in uplink NOMA and evaluated client grouping/pairing strategies in NOMA. It has been shown that, from the outage probability perspective, it is preferable to multiple clients of large gain difference on the same subcarrier.
It addresses subcarrier allocation and power assignment in downlink NOMA, with the objective of balancing the throughout with the number of scheduled clients the solution approach uses matching theory. In, a monotonic optimization method is developed for NOMA subcarrier and power allocation. The method potentially approaches the global optimum, at the cost of high complexity in the number of clients per subcarrier.

Apart from investigation of NOMA execution in cellular networks, from an optimization perspective, the complexity and tractability analysis of NOMA resource allocation is of significance. Here, tractability for an optimization problem refers to whether or not any polynomial-time algorithm can be expected to find the global optimum. Tractability results for resource allocation in OMA and interference channels have been investigated in a few existing works, e.g., for OFDMA, for SC-FDMA, and for interference channel.

III. METHODOLOGY

In order to support higher throughput and massive and heterogeneous connectivity for 5G networks, we can adopt novel modulations NOMA with effective interference mitigation and signal detection methods. Power-domain NOMA is considered as a promising MA scheme for 5G networks. In spite of the existing literature of execution evaluation for NOMA, there is lack of a systematic approach for NOMA resource allocation from a mathematical optimization point of view. The existing resource allocation approaches for NOMA are typically carried out with fixed power allocation, predefined client set for sub channels, or parameter tuning to improve execution, e.g., updating power allocation coefficients. NOMA can support multiple users within the same resource block by distinguishing them with different power levels. As a result, NOMA is able to support more connectivity and provide higher throughput with limited resources.

The downlink transmission of NOMA for the two user case is shown in Figure 1 where the users are served at the same time/frequency/code resource block with a total power constraint. NOMA allocates less power for the users with better downlink CSI (channel state information), to guarantee overall fairness and to utilize diversity in the time/frequency/code domains.

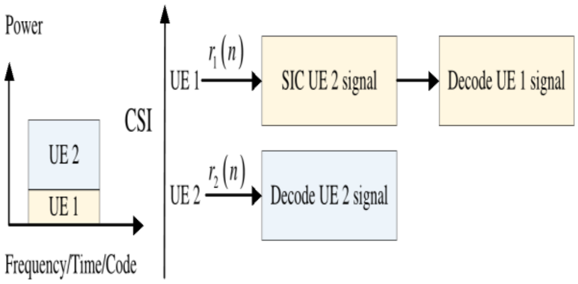

Figure 1: Downlink power-domain non-orthogonal multiple access (NOMA).

In this work, the solutions of joint channel and power allocation for NOMA are subject to systematic optimization, rather than using heuristics or ad-hoc methods. It deals with the maximum weighted sum-rate (WSR) and sum-rate (SR) utilities, it formulates the joint power and channel allocation problems (JPCAP) mathematically. Unlike previous works, this approach contributes to delivering near-optimal solutions, as well as performance bounds on global optimum to demonstrate the quality of near-optimal solutions.

Here, the number of clients to be multiplexed on a subcarrier is fixed, and execution evaluation consists of rule-based multiplexing policies. a significant amount of additional theoretical analysis of problem tractability, the development of the performance bound on global optimality, as well as the consideration of client fairness in execution evaluation. Outage probability is a metric for the channel, it talks about the capacity or throughput of data that can be transmitted through the channel due to noise and fading assuming to have a low-level margin for signal to noise ratio .Comparative study of the outage probability between NOMA and TDMA under average CSI information is performed. In, TDMA shares a single carrier frequency with several users where each user makes use of non-overlapping time slots.

IV. NUMERICAL RESULTS

It evaluates the performance of the developed algorithms by solving 1000 randomly generated problems for different parameter configurations.

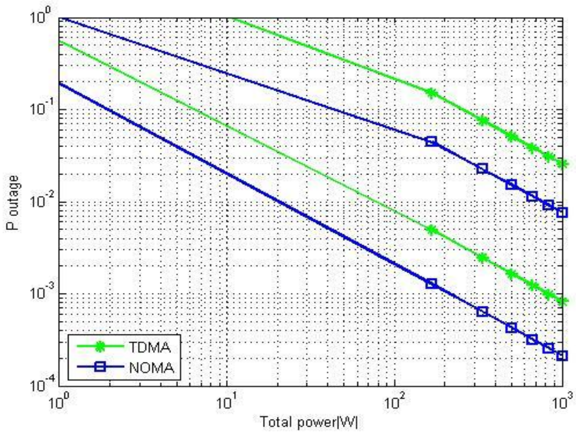

Figure 2.Comparative outage probability performance between NOMA and TDMA.

Figure 2 compares the outage probability between NOMA and TDMA under average CSI information as a function of the total transmitted power. NOMA outperforms TDMA by an order of magnitude. NOMA also has at least five times better performance compared to the fixed NOMA PA scheme. As expected, higher target spectral efficiency results in worse outage probability because it is more difficult to be satisfied.

V. CONCLUSION

It considered jointly optimizing power and channel allocation for NOMA. The proposed algorithm is capable of providing near-optimal solutions as well as bounding the global optimum tightly. Numerical results demonstrate that the proposed algorithmic notions result in significant improvement of throughput and fairness in comparison to existing TDMA and NOMA schemes. This can be formulated as to minimize the total power, with constraints specifying the throughput target value and client-individual power limits.

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