

Cooperative NOMA Networks with Half-Duplex Relay using Successive User Relaying

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ABSTRACT: Non-orthogonal multiple access (NOMA) has been considered as a promising various access innovation for the fifth-generation (5G) remote correspondence frameworks since it empowers vitality and ghastrly proficient correspondence for becoming diverse nature of administration (QoS) necessities. A successive user relaying (SR) to improve the spectral efficiency of C-NOMA system. In the proposed SR scheme, pair of HD users decodes the received signal and relay the decoded signal successively to improve the spectral efficiency. A novel algorithm is proposed to optimize power split factor in order to improve fairness of outage performance between users. The performance of the proposed SR scheme is superior to existing HD relaying scheme in C-NOMA system and existing SR in cooperative orthogonal multiple access system in terms of outage probability and ergodic sum rate.

KEYWORDS: NOMA, SR, AR, 5G, IoT, QOS.

I. INTRODUCTION

The internet of things (IoT) refers to the interconnection of uniquely-identifiable embedded devices within the internet infrastructure. It is forecast that in the next few years we will witness a deployment of billions more connected devices, enabling new, wide-ranging use cases, including energy and utility monitoring, health-care, autonomous vehicles (AVs) and mission-critical services. This will generate significant amount of traffic, transmitted over the radio frequency spectrum. For example, it is predicted by 2025, AVs alone will upload over one terabyte (TB) of vehicle and sensor data per month to the cloud. Typically wireless IoT traffic is transmitted over unlicensed spectrum such as the instrument, scientific and medical (ISM) bands. For future sustainability of the IoT technology, however, the question is whether the ISM bands, used by the underlying internet architecture, such as LoRa, Sigfox, Weightless and many other platforms will be flexible enough to stretch to the potential of IoT. The use of NOMA is not only expected to support the users with good channel conditions but also the users with poor channel conditions, utilizing the same bandwidth resources. Research in this area has demonstrated that NOMA can also support massive connectivity, an important characteristic in the forth- coming 5G networks in order to support the IoT industry. In addition to the capabilities of NOMA to increase spectrum utilization of future cellular communications, network slicing is another enabling technology that is developed from Core Network (CN) to radio link. Radio slices, the physical layer subset of network slicing, are created to fulfil communication requirements and to improve efficiency of radio frequency usage. NOMA and radio slices form the basis in which dynamic spectrum allocation is modelled in this paper. Radio spectrum is an essential part of the IoT infrastructure. IoT devices demand both uplink and downlink connectivity, however, it has been noted that IoT traffic is dominantly uplink and therefore in this paper we have focused only on uplink channel requirements. In addition to overlooking the downlink channel requirements, the control channels, required for periodic update traffic, are also not considered, since the data size in such channels are inherently small.

OBJECTIVES

- To improve spectrum utilization and signal to noise ratio(SNR) in 5G cellular networks.
- To fulfill communication requirements and to improve efficiency of radio frequency usage.
- To enhance resource allocation and to manage the mobility of IoT devices using NOMA technique.
- To mitigate intra-cell interference, efficient NOMA design (e.g., user clustering and resource allocation) along with successive interference cancellation (SIC) technique.

II. RELATED WORKS

The [17] joint use of subgrouping multicast techniques and NOMA in an eMBMS-like scenario which results the demerits of multiplexing techniques requires more time and the hardware complexity increase. In [18] an edge

computing aware NOMA technique which can enjoy the benefits of uplink NOMA in reducing MEC users' uplink energy consumption. Congestion problem is high. Problem for the transmission power control to be solved independently. Task-balance method (TBM) [15] and first-link descending order (FDO) to determine the relay order and data partition in a given relay set. Half-duplex mode to transmit data only can be done.

III. METHODOLOGY

An IoT-SP may enter the bidding round once the auction has started within the time duration TX. Once the time is elapsed, new IoT-SP are not allowed to place bids. Further- more, the owner of the sub-carriers, the incumbent CSP, may decide to limit the number of bidders to minimize the time spent on deciding the winner of the auction and to avoid crashing or entering infinite loops. This is achieved by setting a threshold value, which represent the maximum number of bidders allowed in one auction. To guarantee efficient usage of spectrum, a minimum number of participants in an auction are not considered.

IoT-SPs who want to place a bid, submit their requests to the auction handler, where requests are registered and all the available RBs from one or more CSPs are found. If a request has not been received earlier in the round, before the time TX is up, then the request is added giving that the maximum number of bids is not exceeded. IoT-SPs violating the rules of bidding are charged and blocked from subsequent auctions. Events such as connection failure and users moving from inactive (disconnected) state to active (connected) (or from active/connected to inactive/disconnected state) should also be treated as part of the mobility. Prior to placing bids, the only information available to the IoT-SPs are details of sub-carriers being offered for lease along with the lease time and the maximum number of bidders allowed. The latter can provide an indication to the IoT-SPs on the probability of winning an auction to determine whether to enter an auction. In addition, the proposed scheme achieves a degree of privacy by limiting access to information on the IoT-SPs involved. Although it is pivotal to inform auction participants of the outcome, privacy can still be protected by keeping the participants and the winners anonymous. The IoT-SPs are informed of the auction outcome, but without information linking to the identity of the winner IoT-SP. This can be achieved by assigning a new random identity code to each IoT-SP to keep them from being identified.

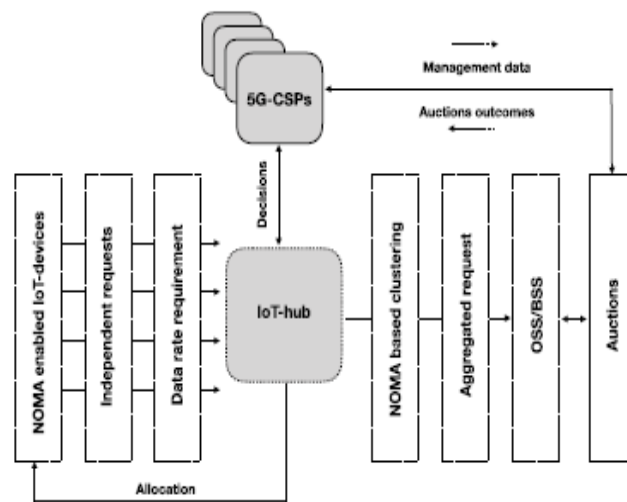


Figure 1 Existing Block Diagram

EXISTING DRAWBACKS

- ❖ Dynamic spectrum sharing (DSS) is not possible.
- ❖ The problem of calculating the bandwidth requirements to support guaranteed bit rate (GBR) in NOMA , has not been addressed.
- ❖ Joint allocation of communication and computing resources greatly improves the performance of the system. In other words, it may happen that one type of resources is wasted due to congestion of other type of resources
- ❖ High Inter symbol Interference (ISI)

Proposed Method

Our proposed allocation techniques also take into consideration the fact that, in certain situations and on specific sub bands, NOMA may not constitute the appropriate solution. Therefore, a dynamic switching between NOMA and a classical OFDMA (i.e. OFDMA without the additional non-orthogonal signalling layer) is allowed under certain conditions. First, we demonstrate how the distribution and QoE requirements of IoT devices impact the required number of radio resources in real time. Second, we prove that using an extended auction algorithm by implementing a series of complementary functions enhance the radio resource utilization efficiency.

5G cellular systems, with its promised reliability, scalability, and efficiency in terms of cost and spectrum utilization, is expected to be a key enabler for IoT technology. Therefore, IoT provision in 5G networks is addressed in the literature to enhance wireless connectivity to IoT devices and to meet the heterogeneous requirements of various IoT use cases. For example, a low-cost and low-complexity operation of IoT communications in 5G networks to support massive connectivity of low-rate and low-power devices. Low latency IoT applications and their requirements in the context of 5G networks are discussed and characterized the potential of 5G for the IoT, considering both the technological aspects and their implications on business models and strategists, the set selection algorithm, which selects 2N users based on orthogonally and gain-difference between their channels, reduces the interference users.

UPLINK NOMA TRANSMISSION

In uplink NOMA transmission, multiple users transmit their own uplink signals to the BS in the same RB. The BS detects all the messages of the users with the aid of SIC. Note that there are several key differences between uplink NOMA and downlink NOMA, which are listed as follows:

- ❖ Transmit Power
- ❖ SIC Operations
- ❖ Performance Gain

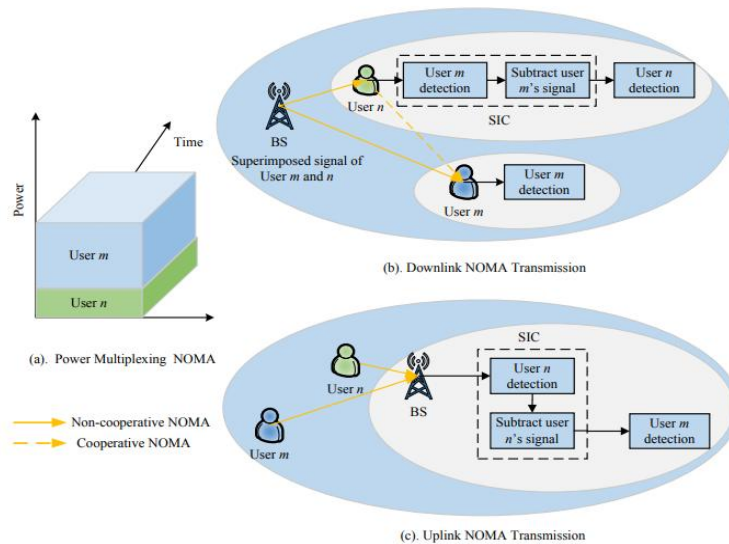


Figure 2 Proposed Block diagram

A uplink (UL) non-orthogonal multiple access (NOMA) systems equipped with multiple antennas to enhance the sum capacity of UL. In the proposed UL NOMA system, a base station (BS) with N antennas can support 2N users by sharing the space resource. However, sharing the space resource leads to interference between users. Therefore, to mitigate the interference and improve the sum capacity, we additionally propose a set selection algorithm and power control scheme.

In uplink NOMA systems, pilot symbols, as well as data symbols can be superimposed onto shared resources. The error rate performance can be severely degraded due to channel estimation errors, especially when the number of superimposed packets is large. A uplink NOMA schemes with channel estimation errors, assuming that quadrature phase shift keying (QPSK) modulation is used. The set selection algorithm, which selects 2N users based on

orthogonally and gain-difference between their channels, reduces the interference between users. Furthermore, the power control scheme can maximize the sum capacity with ensuring minimum target rate.

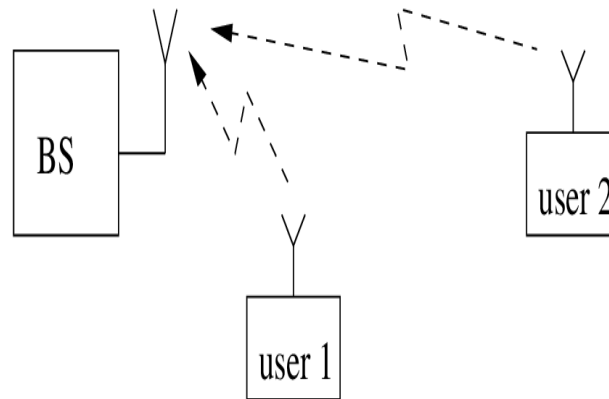


Figure 3 Uplink Transmission

Numerical results show that the proposed system improves the sum capacity over that of the conventional orthogonal multiple access (OMA) system. One of the key requirements for next generation wireless or cellular communication systems is to efficiently support a large number of connections for Internet of Things (IoT) applications, and uplink non-orthogonal multiple access (NOMA) schemes can be used for this purpose.

DOWNLINK NOMA TRANSMISSION

Downlink NOMA transmission employs the SC technique at the BS for sending a combination of the signals and the SIC technique may be invoked by the users for interference cancelation. Numerous valuable contributions have investigated the performance of NOMA in terms of downlink transmission. NOMA downlink transmission relying on SIC receivers was proposed. Upon considering a range of further practical conditions in terms of the key link-adaptation functionalities of the LTE. A practical method for user grouping and decoding-order setting in a successive interference canceller (SIC) for downlink non-orthogonal multiple access (NOMA). While the optimal user grouping and decoding order, which depend on the instantaneous channel conditions among users within a cell, are assumed in previous work, the proposed method uses user grouping and a decoding order that are unified among all frequency blocks.

The proposed decoding order in the SIC enables the application of NOMA with a SIC to a system where all the elements within a codeword for a user are distributed among multiple frequency blocks (resource blocks). The unified user grouping eases the complexity in the SIC process at the user terminal. The unified user grouping also reduces the complexity of the efficient downlink control signaling in NOMA with a SIC. The unified user grouping and decoding order among frequency blocks in principle reduce the achievable throughput compared to the optimal one. However, based on numerical results, the proposed method does not significantly degrade the system-level throughput in downlink cellular networks. Furthermore, the power control scheme can maximize the sum capacity with ensuring minimum target rate.

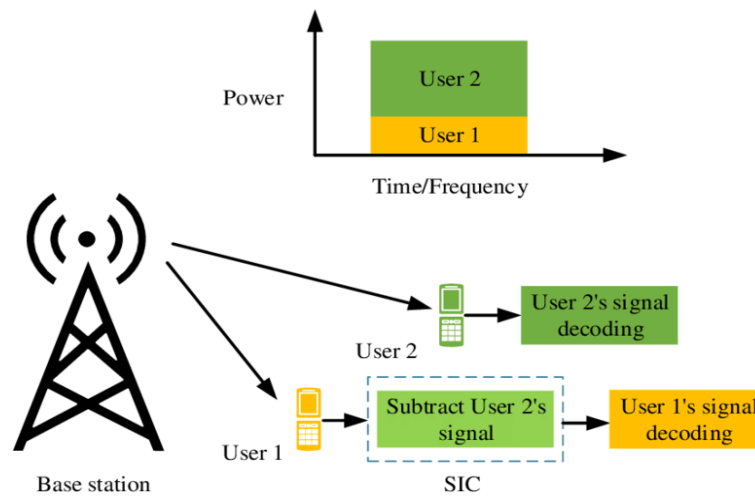


Figure 4 Downlink Transmission

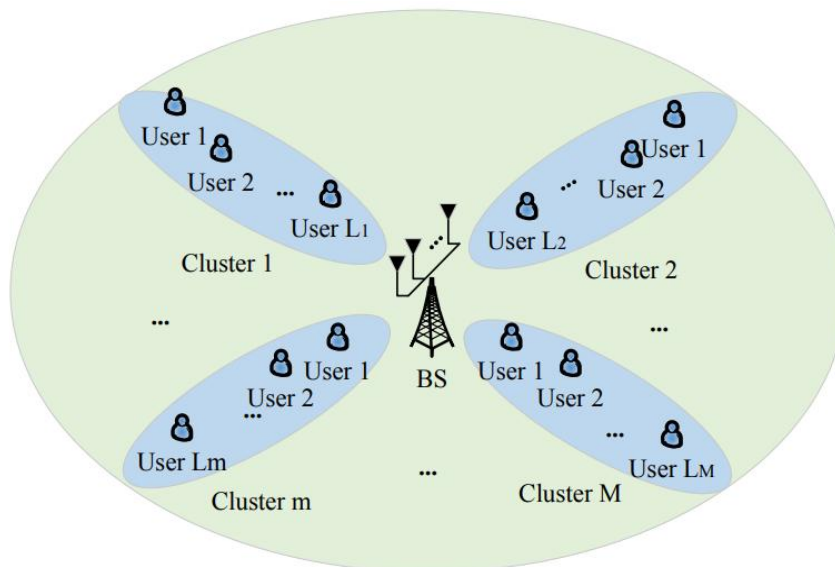


Figure 5 Cluster-Based MIMO-NOMA

RESOURCE MANAGEMENT IN NOMA NETWORKS

One of the main challenges in NOMA networks is to strike an attractive compromise between the bandwidth efficiency and energy efficiency of the networks by intelligently controlling the PA of the superimposed signals, dynamically scheduling the users for the sub-channels or by forming spatially correlated clusters. Motivated by this, in this section, we provide a comprehensive review of the existing resource allocation contributions, mainly with a special emphasis on power control and user/resource allocation.

Radio spectrum is an essential part of the IoT infrastructure. As IoT networks develop towards maturity, diverse bands are perceived to be more attractive to IoT operations. It is expected that the spectrum bands which could be most appropriate for the IoT services would have a wide range of properties, and thus frequencies which serve different types of IoT use cases are increasingly associated with IoT services. Traditionally, most of the existing IoT services rely on unlicensed spectrum to facilitate wireless links between the IoT devices and their associated access point. Unlicensed spectrum will continue to be an important enabler for IoT technology due to its low cost and maturity. However, as the technology evolves to demand more spectrum and the unlicensed spectrum becomes overloaded, an alternative to the unlicensed spectrum is required.



IV.RESULTS AND DISCUSSIONS

PROBABILITY OF OUTAGE AND SNR IN UPLINK TRANSMISSION ORDERED NOMA

The individual-rate outage performance of the system for $s = 5$ dB and different values of threshold SINRs. As expected, outage performance degrades with increasing the threshold SINRs. More importantly, the induced interference between NOMA users due to the non-orthogonal operation limits the outage performance for large values of threshold SINRs and prevents achieving small enough outage probabilities even for large values of the transmitted power. Consequently, the system performance saturates where the saturation limit is larger for the larger values of threshold SINRs.

A comparison between the efficiency of NOMA and OMA in respect to sub-carrier demand is provided. The required number of resource blocks for OMA are calculated through simulations based on the theoretical equations for average system throughput . It is observed from simulation results that at lower throughput demands the difference between the two techniques is small, however, as throughput demand grows, NOMA requires less sub-carriers to deliver the same QoS. The simulation results also demonstrate that to achieve average system throughput of 20 bits/s/Hz, OMA requires 22% and 27% more resource blocks than NOMA requires for cluster size 2 and 3 respectively. Moreover, for achievable average system throughput of 40 bits/s/Hz, OMA requires 23.5% and 16% additional resource blocks for cluster size 2 and 3 respectively. Therefore, NOMA performs better than OMA technique as it can achieve more system throughput by exploiting the power domain for multi-user multiplexing and utilizing SIC to harness inter-user interference

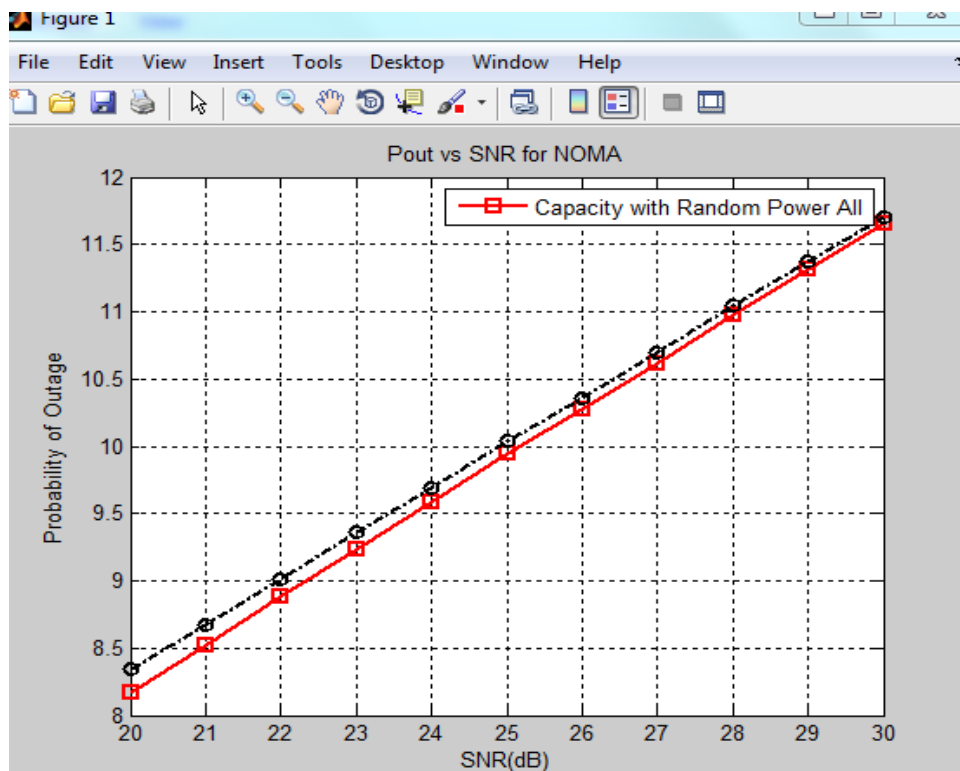


Figure 6Probability Of Outage and SNR(dB) in Uplink Ordered NOMA

The results are presented to estimate the cost of acquiring resource blocks for different application requirements such as Guaranteed Bit Rate (GBR) and Non-GBR. presents the cost estimation for the acquisition of 60 to 100% of required resource blocks to meet the targeted throughput demand. Where, the price of each resource block is assumed to be one unit of price.IoT service providers may control their spectrum acquisition.

The attention is focused on the 5G candidate frequencies to support IoT spectrum demands through dynamic spectrum sharing. For instance, according to 3GPP, Release 15, FR1 (450-6000 MHz) and FR2 (24250- 52600 MHz) are considered in 5G cellular networks. In respect to NOMA, the lower end of the Ultra high frequency (UHF) radio are difficult to control, since the signal in such bands propagate much further and filtering of unwanted RF signals at the receiver end becomes more complex and challenging, as the IoT devices filter out signals with narrow margin of power

levels. This in turn increases error probability, undesirable in NOMA. Upper end of the UHF and the millimeter wave- otherwise known as the V-Band- frequencies are considered more viable for NOMA.

IoT devices demand both uplink and downlink connectivity, however, it has been noted that IoT traffic is dominantly uplink and therefore in this paper we have focused only on uplink channel requirements. In addition to overlooking the downlink channel requirements, the control channels, required for periodic update traffic, are also not considered, since the data size in such channels are inherently small.

PROBABILITY OF OUTAGE AND SNR IN DOWNLINK TRANSMISSION ORDERED NOMA

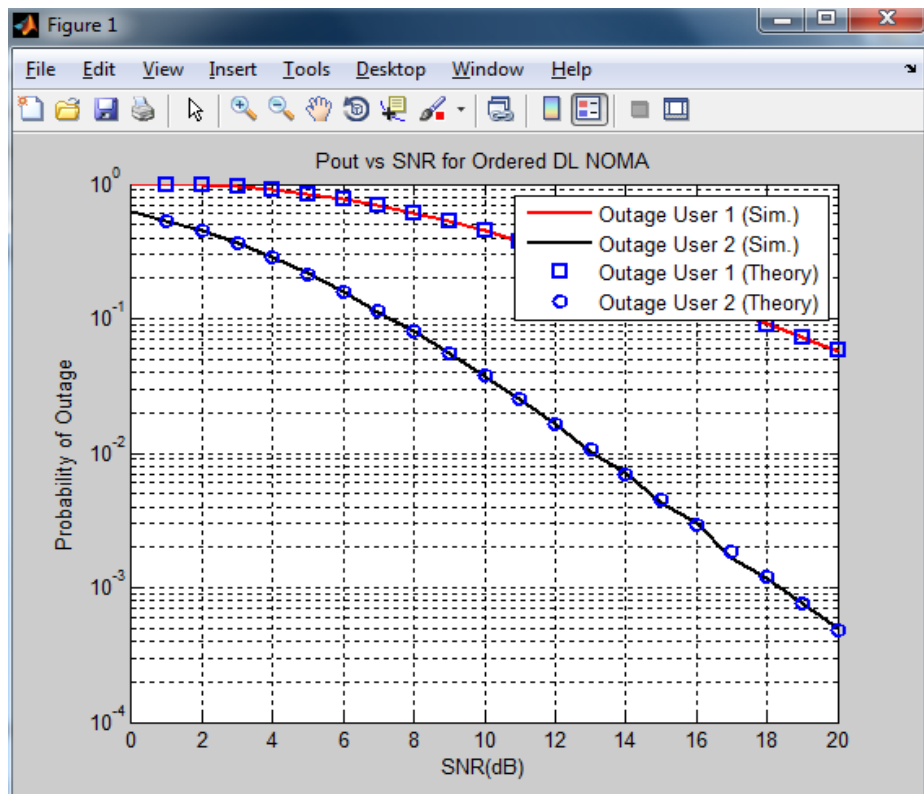


Figure 7 Probability Of Outage and SNR(dB) In Downlink Ordered NOMA

In fig 5.2 signal to noise ratio(SNR) dB increases with decreasing of probability of outage. Theoretically, the User1 of signal to noise ratio (SNR) increases with decreasing of probability of outage without packet loss shown in fig 5.2. Similarly, the User 2 of signal to noise ratio (SNR) increases with decreasing of probability of outage without losing of packets shown in fig 5.2

Average Sum Rate

Note that the joint effect of small-scale fading and large scale propagation loss are assumed in the channel model. However, in this subsection, the NOMA systems are based on SOS, which means the channels are ordered by the distance. In this case, always guarantee that the joint channel gain is dominated by distance. It is well known that the SIC depends on the order of the joint channel gain, therefore the NOMA based on SOS cannot assure that a user can remove the signals from the users whose distance are larger than himself with probability one. The proposed decoding order in the SIC enables the application of NOMA with a SIC to a system where all the elements within a code word for a user are distributed among multiple frequency blocks (resource blocks). The unified user grouping eases the complexity in the SIC process at the user terminal. The unified user grouping also reduces the complexity of the efficient downlink control signaling in NOMA with a SIC. The unified user grouping and decoding order among frequency blocks in principle reduce the achievable throughput compared to the optimal one. However, based on numerical results, the proposed method does not significantly degrade the system-level throughput in downlink cellular networks.

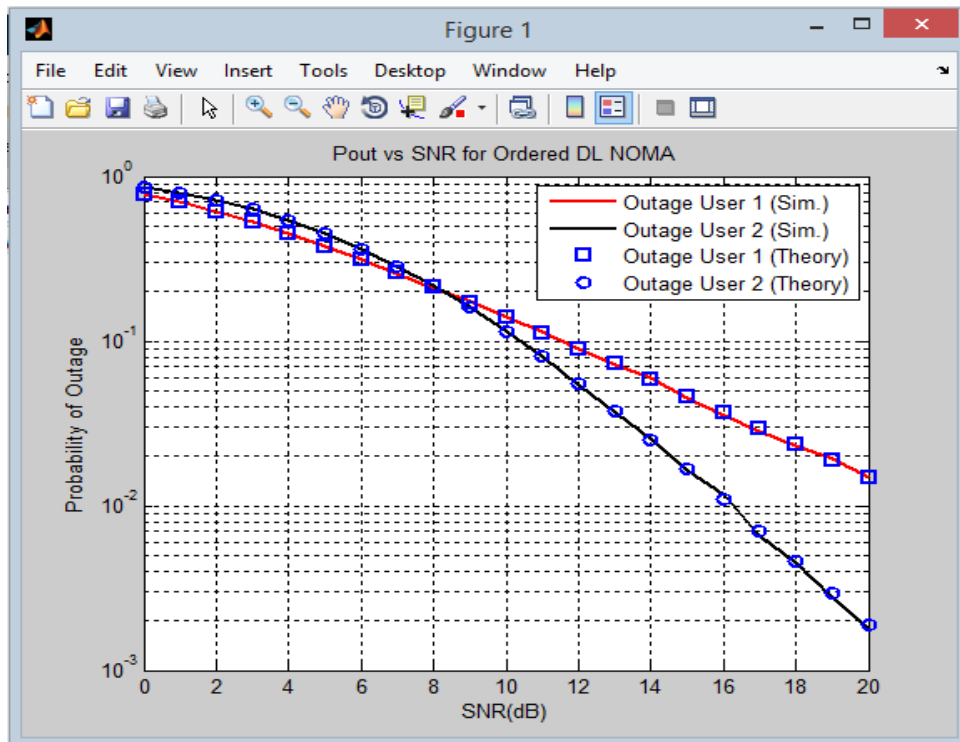


Figure 8 Probability of Outage and SNR (dB) In Downlink Unordered NOMA

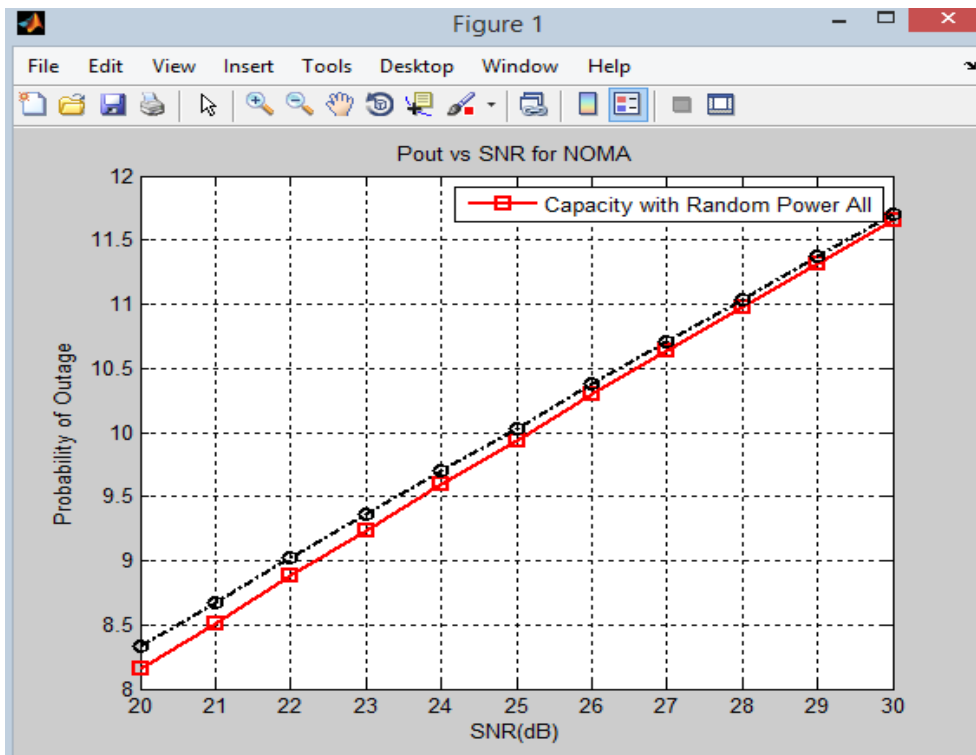


Figure 9 Probability of Outage and SNR (dB) in Uplink Unordered NOMA

V. CONCLUSION

In this paper has provided methodological contributions to compute radio resource demand for IoT devices within 5G networks by formulating a new algorithm which takes into account the characteristics of NOMA such as throughput calculation and k-means clustering. This approach is based on recent advancements made in realizing the potential of 5G in support of IoT technology. The paper also includes the algorithm for efficient sub-carriers trading between the IoT-SP and CSP, based on Second Price Auction (SPA). The algorithm also provide methods to model penalties and incentives as well as account balance, important for maintaining the integrity of the spectrum market design in future settings. The effectiveness of the proposed algorithm and its role to facilitate spectrum borrowing strategies has also been quantified. In addition, to address IoT device mobility, such as devices deployed to enable autonomous vehicles, the algorithm offers a solution for minimizing complexity of re-arranging NOMA clusters to respond to the dynamics of the cells. For next generation cellular networks' context, where network slicing will play crucial role to have access to radio resources the proposed framework offers robust allocation, revenue generation and regulation strategies for both CSP and IoT-SP. There are other issues that can be solved in the context of IoT device mobility within NOMA clusters. One issue that would come to light is the effect of mobility in intra-cell on re-establishing links to keep the communication rate within a given QoS.

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