Downlink NOMA and OMA Comparison for Power Allocation with Minimum Target Rate

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Abstract

Non-Orthogonal Multiple Access (NOMA) implies successive interference cancellation (SIC) for signals at the receiver side to recover intended data from superposed transmitted signal. A fundamental upper limit bounds the target rate and user fairness because of effected user fairness which depends on the power allocation at the transmitter. In this paper well managed power allocation strategy is discussed to enable NOMA to outperform OMA in per-user outage probability performance. Simulated results show that overall system throughput Is enhanced in comparison to OMA, which is implemented conventional systems.

Ⅰ. Introduction

The fifth-generation (5G) wireless communication is the most wrangled topic in the recent times. Expats from all over the world are working substantially in this area. Several technologies have been presented by the researchers to coop with the requirements of 5G communication i.e. high data rate, reduced latency, reliability and massive user connectivity. Non-Orthogonal Multiple Access (NOMA) is a multiplexing technique and is presented as a best suitable candidate in order to meet all the 5G requirements formerly discussed [1]. In NOMA, the users send their data collectively in a single carrier occupying the complete resource blocks instead of sharing the equal space as in conventional Orthogonal Multiple Access (OMA) systems. In power domain NOMA, the power allocation strategies normally can outperform OMA in terms of channel capacity for multi-user cellular systems. In the literature works, several researches have been presented to formulated a solution for power allocation to NOMA users. The idea in [2], presents several algorithms for NOMA power allocation problem for strict constraints to follow the SIC order and its relation to minimum required rate. The outage probability for NOMA is discussed in [3], to accommodate multiple users by implementing uniform power assigning method.

In [3], the researchers provide intuition for any power and resource allocation in FDMA in which power allocation strategy is considered all the time either providing a superior sum-rate or ergodic rate for NOMA over OMA. To maintain a stable system for user induction a user connectivity scheme is also presented by keeping the sum-rate performance as a priority. But this joint resource and power allocation strategy increases the systems complexity and computational power [4].

The prime focus of this work is to mention a comprehensive solution for power allocation issues associated with the throughput or system capacity. To acquire the power allocation strategy by using the baseline to have superiority of NOMA over OMA and also keeping all the conditions presented along with its performance.

Ⅱ. System Model

A downlink cellular system is considered for this work in which K users are multiplexed at the BS. An assumption is made for the whole setup, in which channel gain is assumed to be known at the BS. Let each user n is transmitting at the target rate R_n and the point here is important that the NOMA is playing a vital role to outperform OMA in terms of outage probability. OMA outage probability is normalized by the ratio of fractional time for resource allocation and over the target rate. Several studies consider the fixed power allocation for the NOMA users with some advantages of fixed power coeffects. These advantages include, less computation and no prior knowledge of channel state information (CSI) at the BS. Therefore, this type of power allocation is not suitable to achieve user fairness and targeted rate for the users.

This work comprises the dynamic power allocation for NOMA system based on the values of CSI at the BS which is already assumed at the BS in the former discussion. There are several traditions to realize dynamic power allocation which are completely application dependent. The scheme considered in this paper is impartial power allocation which provides user fairness and can also satisfy the system throughput. Power allocation coefficients are calculated in such a way that far user's target rate must be under observation and only after meeting that target rate all the remaining power will be assigned to the near user. Let R be the target rate of far user:

After satisfying the rate of the far user we can allocate rest of the power to the near user. Data is transmitted by the BS using Binary phase shift keying (BPSK) modulation over Rayleigh fading channel.

Minimum-Mean-Squared-Error (MMSE) equalization is considered at the receiving end.

Ⅲ. Results

In the Table 1, simulation parameters are defined for the comparison of NOMA and OMA for bit error rate (BER), Outage probability and sum-rate. Binary phase shift keying (BPSK) is applied at the transmitter side for the modulation and MMSE is used as equalization technique at the receiver. From the figure 1, it is clearly verified that for OMA the power allocation is performing weak in terms of outage probability because it is saturating to 1 for the whole time when far user target rate is almost achieved to 1.2bps/Hz. Figure 2 shows that, for the same power allocation to the system for both OMA and NOMA, non-orthogonal behavior outperforms the OMA in terms of BER. The NOMA users are experiencing the low BER at two regions of the plot. At the initial stage where, value of alpha is less than 0.1 or at the end where alpha is almost 0.8. For the increasing power to the near user we can see that OMA is having less BER because of the OMA system benefit towards near user with good channel gains. While NOMA allocates only suitable power to the near user compared to OMA and satisfy the requirement of far user with poor channel conditions.

IV. Conclusion

In this work, it was demonstrated that for downlink OMA and NOMA systems with a BS which have the knowledge of the channel gains, the power allocation strategy must be carefully designed in order to avoid certain outages for multiple users. This proposed strategy can successfully provide high priority NOMA with higher rates than provided in OMA.

ACKNOWLEDGMENT

This work was supported by Priority Research Centers Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2018R1A6A1A03024003).

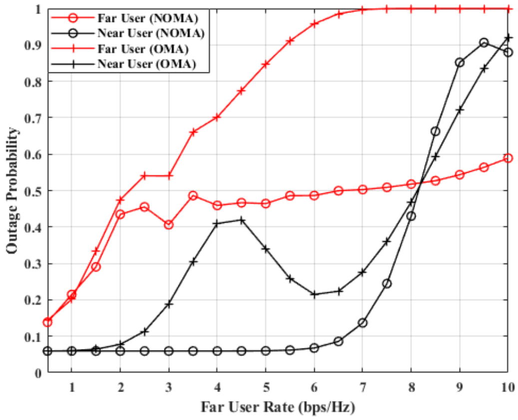

Figure 1. Outage Probability for OMA and NOMA versus target rate for far user

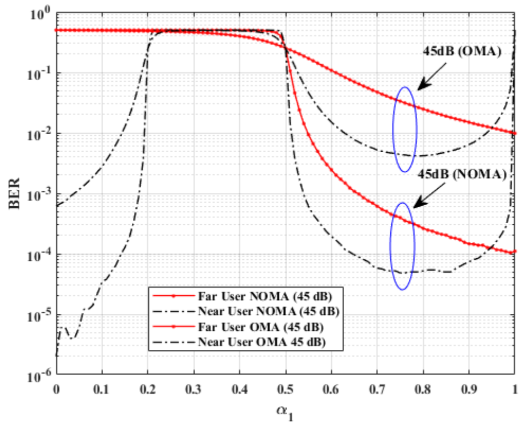

Figure 2. BER for OMA and NOMA versus Near user power coefficient

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