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A Novel Rate Improvement Technique of Power Domain NOMA in Wireless 5G

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Error performance (EP) and capacity improvement (CI) are two important aspects essentially addressed using NOMA in the future cellular networks. In a dense user environment, transmit antenna selection NOMA (TAS-NOMA) algorithm if often employed to save the power. Apart from this antenna selection scheme, it is significant to manage sum rate calculation (i.e., spatial diversity) and delay (latency). In this paper, we propose ensemble average sum rate (EASR) algorithm which is capable of controlling the sum rate while minimizing the latency. However, it is significant to note that the system suffers non-linearity when the number of antennas enhanced in the transmitting side. The proposed technique produced better results in terms of enhanced power allocation than the conventional selection algorithm.

Keywords: EASR, Latency, TAS-NOMA, Spatial diversity

Introduction

The 5G systems are capable of providing data rates as high as 1000x times which is far better than 4G which is 10x times.[1] In addition, the reliability levels are high and capable of managing random growth of the mobile data and Internet of Many (IoM). The reliability can be either with upload or download while the corresponding transferring of information and data is huge.[2] Currently the network providers are providing the $3G_{PP}$- LTE platform which is not suitable to the user demands at their Region of Internet (RoI). Due to this they are not able to provide the trade-off between Quality of service and Quality of experience. For these reasons we explored a new optimized technology which is Energy Efficient (EE) and spectral Efficient (SE) which in turn leads to Green Radio Source Communication.[3–7] To the large extent whenever the density is more connection of massive device is not possible.[6] Therefore, OFDMA technology is not suitable for above said short comes. For improving throughput and low system cost NOMA is better suited multiple access schemes. The NOMA uses superposition coding (SC) at the T_x and Successive interference Cancellation (SIC) or Maximal likelihood Decoding (MLD) at the R_x.

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Experimental Details

Basic System Model of Power Domain NOMA

In Power domain NOMA the number of end users is L, the j[th] UE signal at the BS can be represented as (t), (j=1, 2, ….., L). p_j is the power allocated from j[th] mobile user. Then the total power transmitted from BS to each UE user is P, where $P = p_1 + p_2 + \cdots + p_L$.

The best antenna selection with detailed analysis is available in literature.[8] The received signal under facing environment along with Gaussian Channel Condition can be represented as

$$y^{[DL]}(t) = (t) * \sum_{j=1}^{L} \sqrt{p_j} s_j(t) + n(t) \quad \dots (1)$$

Where (t) is the channel gain and $n(t)$ is the Gaussian noise based independent and identically distributed random variables with μ=0 and σ^2=1. The user which is nearer to the BS knows the optimal order to decode the received signal. Therefore, the user with high channel gain can correctly decode the signal. For example, consider three users labeled as a, b, c. The optimal order for decoding in terms of channel gain is shown in the Fig. 1.

Transmitting antenna selection (TAS) at BS used in the first time slot (T_1) and Ensemble average sum rate used in the second time slot (T_2). Let us assume homogenous network topology, all terminals are synchronized together. During T_1 BS sends information signal to EASR from selected antenna, at

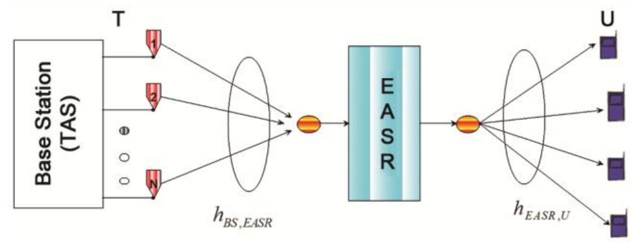

Fig. 1 — Proposed System model for MIMO-Power Domain NOMA with EASR

T_2 by EASR (R_{Sum}^{Avg}) with fixed gain forwarded to received signal to end users. Therefore, each mobile user receives the signal i.e. R_{Sum}^{n} (avg).The received signal at the EASR can be can be split into power and information processing, the power in the EASR can be written as $P_{EASR} = \varsigma k. P_{sSR}$ where $0 \leq \varsigma \leq 1$.

Therefore,

$$y_{EASR,DL} = {}_{bs,easrs}\sqrt{P_s}\sum_{i=1}^{N}\sqrt{a_i x_i} + \psi_{easr} \quad \dots (2)$$

With reference to the above expressions, the drawbacks are listed and discussed in the following two cases.

Case 1: If the number of transmitting antennas at the BS is limited, then only one single RF chain gives better sum rate, sometimes performance decreases with the increased number of antennas at BS i.e. uncorrelated signals, which indirectly add error (BER) to users.

Case 2: Always sum rate enhancement depends on power allocation at the BS. If the power allocation to the BS is low, only near user allocation is possible, but for far users power allocation somewhat difficult, which leads to failure of SIC. i.e. Introduce errors to users.

Results and Discussion

In this section discussion related to the MATLAB based simulation process and analysis of the results is presented. The performance of P-NOMA over Rayleigh fading channel under number of transmitting antennas at the BS and users on sum rate at the receiver with respect to total power transmitted from BS_P_{tot} is evaluated. Allocation of power to near user and Far user is a major task in -NOMA.

The simulation-based experimentation is carried out for the study of trade-off between sum capacity and the total transmitter power from the BS by fixing the different set of antennas to the different number of users. The investigation explains clearly about the rate region which is more in P-NOMA based TAS compared to conventional OMA. The data presented in Table 1 can be used to conclude that the proposed EASR increases the sum rate which is better than ERS because even though the number of antennas placed at the BS is more, the increment in power leads to better sum capacities at the user side.

Table 1 — ESR vs. EASR for N= [1 2 4 8 10]

No. of Antennas from BS (N)	ESR (Mbps)	EASR (Mbps)
1	7.964	8.082
2	8.268	8.586
4	8.828	9.156
8	9.254	9.467
10	9.368	9.474

Table 2 — ESR vs. EASR for U= [2 4 8]

No. of Mobile users (U)	ESR (Mbps)	EASR (Mbps)
2	8.49	8.516
4	8.74	8.796
8	9.14	9.276

Similarly, the trade-off between sum capacity and the total transmitted power from the BS by fixing the number of antenna beam spaces to the different users is also studied. The corresponding data and the outcomes in terms of ESR and EASR are tabulated in Table 2 from which it is clearly possible to mention that the number of users increases only when the sum capacity is increased. But this entirely depends on the availability of power at the BS. Apart from this some capacity mismatches are also there is ESR, but from EASR point of view of all the users of the beam space experience equal sum capacities. The bit error rate and the capacity performance with respect to the enhanced power allocation using the EASR algorithm are presented in Fig. 2 (a) and (b) respectively.

Simulation Results for Enhanced Optimal Power Allocation

Simulation results shows that case 1 and case 2 are rectifed by considering the Enhanced power allocation EASR algorithm,which automatcally mitigates the errors introduced by the imprroper SIC .

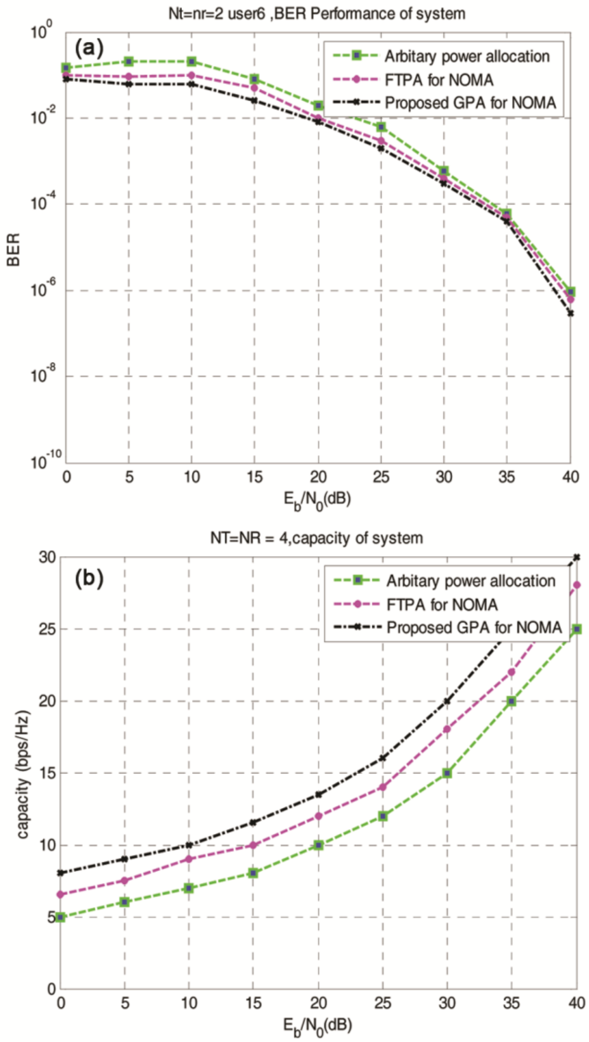

Fig. 2 — (a) BER of Enhanced Powrr Allocation -EASR for N_t x N_r = 2 & 6 users, (b) Capacity performance of Enhanced Power Allocation -EASR for N_t x N_r = 4

Conclusions

The main objective of this research paper is to study about the P-NOMA schemes which are based upon 2 parameters ESR and EASR. Introduction of TAS scheme at BS experiences better sum capacity in which rate regions reaches out to maximum number of users but due to mismatch of power experiencing of equal rates to all users is not possible. So, to avoid this EASR holds a very great increase in user fairness and also this method is most suitable for low SNR’s. SIC errors are introduced by varying the power allocation from BS side. The capacity rates are improved by reducing the effect with Enhanced Power Allocation EASR algorithm. In future improving of sum rates will be done by introducing any filter at the receiver.

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