ACHIEVING GREEN TRANSMISSION WITH ENERGY HARVESTING BASED COOPERATIVE COMMUNICATION

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ABSTRACT:

The cooperative communication with simultaneous wireless information and power transfer can provide a potential solution to meet the demands of next-generation green transmission. In this paper, we consider a cooperative system where each user has the capability of energy harvesting (EH) from the radio frequency and relays the data of other users. Our target is to minimize the overall energy consumption while satisfying the quality-of-service constraints of each user in terms of minimum required data rate. The time division scheme is adopted for data transmission and relaying while power splitting protocol is used at each node to receive information and energy, concurrently. We optimize the transmit power for data and relay transmission at each node and find the optimal time sharing for user cooperation. Unfortunately, under the decode and forward relaying the complex primal problem is not convex. Thus, we first re-formulate the problem into standard optimization and then transform to a convex problem. We solve the problem through duality theory and derive the closed form solution of the primal variables. Further, we consider the cooperative communication without EH and non-cooperative transmission with EH, and then optimal solutions are obtained from similar techniques. Finally, simulation results are provided where the performance of the proposed solutions is compared with the non-optimized cooperation time and without EH models.

INTRODUCTION

FOR cellular systems, nonorthogonal multiple access (NOMA) has been studied to improve the downlink 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 as. In practical NOMA schemes, called multiuser superposition transmission (MUST) schemes, are considered for downlink transmissions (with two users). In NOMA is employed for coordinated multipoint (COMP) downlink in order to support a cell-edge user without degrading the spectral efficiency. 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 downlink NOMA. In this paper, we study the effective capacity for downlink NOMA with two users (to the best of our knowledge, no study of the effective capacity for NOMA exists yet) to accommodate delay QoS constraints so that NOMA can be employed for delay-sensitive transmissions. We find that the optimal power control problem to maximize the sum effective capacity under average transmission power and delay QoS constraints is not a convex problem. Non-orthogonal multiple access (NOMA) is a power domain multiplexing technology that allows users to transmit signals on the same time-frequency resources.

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 allocate the remaining power to other mobile user to maximize the overall system capacity. A price-based power optimization scheme was presented in downlink 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 downlink NOMA systems. 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. In addition, resource optimization techniques for NOMA in multi-cell communications networks have also been investigated. In Reference a KKT-based efficient power management technique was presented by Khan et al. to enhance the sum capacity of multi-cell multi-user NOMA network. In similar study, a KKT-based closed form solution for power optimization was provided by Yang et al. in multi-cell network to minimize the total system power and maximize the system sum capacity. The study in Reference considered a downlink heterogeneous network (HetNet) based on power multiplexing. The authors formulated a non-convex optimization problem to improve the network capacity and outage probability. They provided sub-optimal algorithm for user scheduling and power allocation. They first transformed non-convex optimization to a convex problem and then employed dual method for sub-channel and power allocation. In another Besides the aforementioned advances, a joint power and code multiplexing scheme was presented in 5G and 5GB networks to improve the symbol error rate and sum rate of the system. The proposed framework was compared with conventional power multiplexing and code multiplexing.

EXISTING SYSTEM

Orthogonal multiple access (OMA) for cellular future radio access

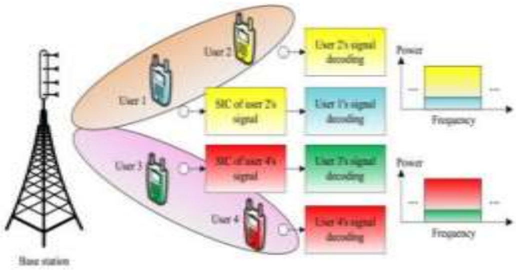
Orthogonal multiple access (OMA) concept for future radio access (FRA) towards the 2020s information society. Different from the current LTE radio access scheme (until Release 11), OMA superposes multiple users in the power domain although its basic signal waveform could be based on the orthogonal frequency division multiple access (OFDMA) or the discrete Fourier transform (DFT)-spread OFDM the same as LTE baseline. In our concept, OMA adopts a successive interference cancellation (SIC) receiver as the baseline receiver scheme for robust multiple access, considering the expected evolution of device processing capabilities in the future.

Orthogonal multiple access in a downlink multiuser beamforming system

Orthogonal multiple access (OMA) has been recognized as a promising multiple access technology for fifth generation (5G) mobile communication system. However, the advantage of OMA is only verified under the ideal condition that the transmitter has the perfect knowledge of channel state information (CSI). In this paper, OMA downlink multiuser system, in which the transmitter acquires the CSI through limited feedback channel, is studied. Two traditional beamforming technologies, zero-forcing beamforming and random beamforming, are investigated in the OMA downlink multiuser system. Making use of the imperfect CSI feedback, channel direction information (CDI), and channel quality indicator (CQI), we propose the user selection scheme to reduce the interference between the OMA users.

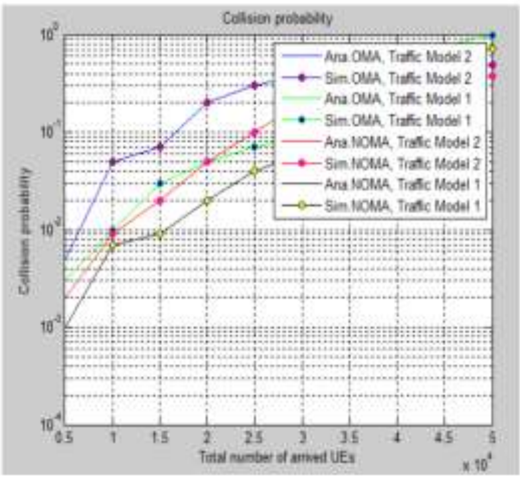
PROPOSEDSYSTEM

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.

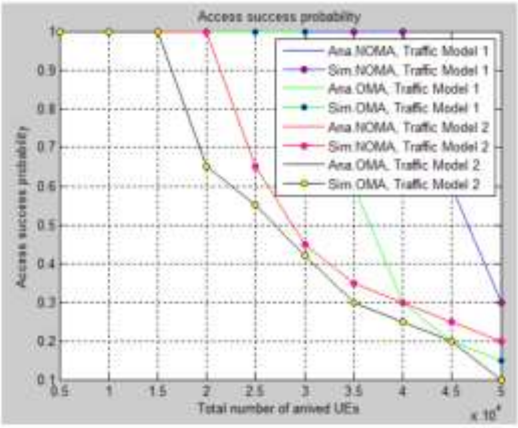


RESULTS EXPLANATION

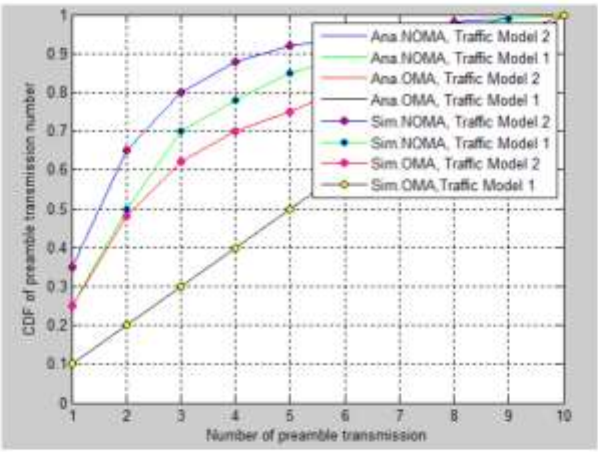
A number of Monte Carlo simulations are conducted in MATLAB to analyze the performance of the proposed approach. We consider a generic multi-source energyharvesting model that collects energy from both microbial fuel cells[38] and acoustic harvester. Fig. 1 compares the expected sum rates achieved by DPC [11] and NOMA for the following two scenarios. In the first scenario, the base station is equipped with massive antennas while each user is equipped with a single antenna (m = 1 and n = 32), whereas in the second scenario, the base station and the two users have moderate numbers of antennas (m = 4 and n = 5). Moreover, it is assumed that d1 = d2 = 10 m. Furthermore, we consider system parameters _ = 2, N0 = −35 dBm.



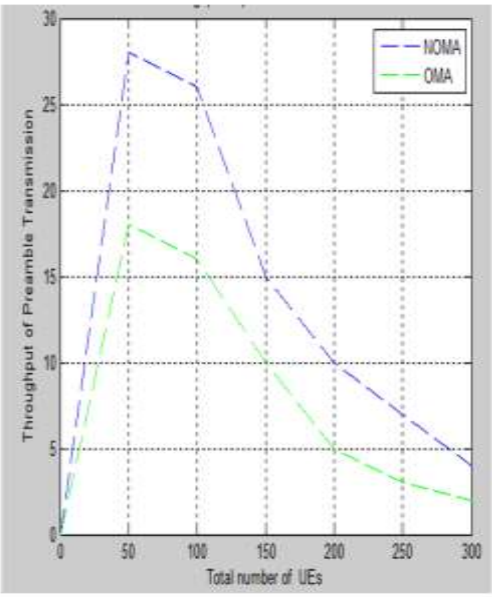
From this figure, we observe that the proposed NOMA scheme outperforms conventional OMA10 by a considerable margin. Moreover, when _ = mn changes from 45 to 25 , i.e., the number of transmit antennas increases, the expected normalized sum rate achieved by OMA stays practically constant while the expected normalized sum rate achieved by the proposed NOMA scheme increases considerably. This can be explained as follows. With OMA, the base station performs SVD to convert the m × n MIMO channel of each user into k1 parallel SISO channels, where k1 = min{m; n}.



compares the expected normalized sum rates achieved by OMA and NOMA as a function of d2 when m = 28, d1 = 50 m, _ = 2, P = 30 dBm, N0 = −35 dBm, and l22 = 0:2. From this figure, we observe that the proposed NOMA outperforms conventional OMA for all considered values of d2. In fact, regardless of whether d1 < d2 or d1 > d2, the proposed NOMA achieves higher sum rate than conventional OMA.



From the figure, one can observe that no matter how the users are grouped, the proposed NOMA scheme always achieves a larger expected normalized sum rate than OMA. Moreover, pairing user 1 with user 2 results in the worst performance among the three possible pairing strategies. This suggests that it is preferable to pair users which are close to the base station with users which are far from the base station11. In addition, the performance gap between NOMA and OMA grows as the transmit power P increases.



CONCLUSION

In this work, we proposed a two-user cooperative model where each user harvests the energy from the transmission of other users and pays back in the form of relaying the data. A sum power minimization problem was considered with transmit power and TD ratio optimization at each user node. Under DF relaying strategy, the optimal solution was obtained from convex optimization subject to the minimum rate requirement of each user and the independent power constraint at each transmitting node. Moreover, the solutions are designed for the same objective under limited system capabilities, i.e., the transmission without EH and/or relaying. Finally, the simulation results showed the superiority of the proposed framework and its optimality is validated such that the duality gap becomes zero at the solution points.

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