

Spectrum Efficient and Low Complexity Interference Coordination Schemes for NOMA Heterogeneous Networks

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Schemes for NOMA Heterogeneous Networks

(非直交多元接続を用いる異種無線網のための高スペクトル効率かつ低演算量の干渉制御法)

区 分 : 甲

論 文 内 容 の 要 旨

Demand for high data rates is increasing rapidly due to the emerging of new applications that generate a huge number of wireless data. Three promising technologies are adopted to achieve such high requirements; heterogeneous networks (HetNets), non-orthogonal multiple access (NOMA), and multiple input multiple output (MIMO). MIMO and NOMA coexist with HetNets to form MIMO-NOMA HetNets cellular system. HetNets adopt different types of tiers or cells ranging from micro cell then pico cell and femto cell under the coverage of a macro cell. One of the major problems in the MIMO-NOMA HetNets is the interference among cells of the same type (i.e., co-tier interference) or interference among cells of different types (i.e., cross-tier interference), which results in serious data transmission errors. Consequently, interference mitigation (IM) is necessary for MIMO-NOMA HetNets. The objective of this thesis is to develop spectrum efficient IM approaches to increase the capacity of MIMO-NOMA HetNets while reducing the required complexity and reducing the signaling overhead between the cells. In this thesis, we propose three new techniques to manage the interference in MIMO-NOMA HetNets based on the following three approaches; beamforming base, power allocation (PA) base, and resource block (RBs) allocation base.

In the first proposed algorithm (i.e., Chapter 2), we study the beamforming based IM due to the deployment of MIMO technology in NOMA HetNets. To reduce the cross-tier interference in MIMO-NOMA HetNets with a limited signal overhead, we propose a cross-tier interference alignment and coordinated beamforming (CrIA-CB) technique. The proposed CrIA-CB utilizes the available degrees of freedom to design the beamforming vector in the null space of the cross-tier interference. Simulation results show an improvement on average of 60% in the capacity and 20% in the outage probabilities for the proposed CrIA-CB over conventional schemes as long as the number of antennas at BSs side is enough to completely cancel the interference.

In the second proposed algorithm (i.e., Chapter 3), we study the PA as an effective technique even when the number of antennas at BSs is not sufficient for cross-tier interference mitigation in MIMO-NOMA HetNets. To relax the non-convex PA problem into a convex problem, we

propose to model the PA problem as a non-cooperative competitive game between the macro cell and the small cell to maximize the total sum rate while guaranteeing users' quality of service (QoS). Simulation results show an improvement on average of 30% in the capacity and 10% in the outage probabilities for the proposed PA algorithm over conventional schemes as long as the cross channel state information (CrCSI) of the worst user is available at a central control unit (CCU).

In the third proposed algorithm (i.e., Chapter 4), we study the joint problem of power and RBs allocation as an efficient technique even when the number of antennas at BSs is not sufficient for both co-tier and cross-tier IM in NOMA HetNets. We propose a low-complexity algorithm, where the compressive sensing (CS) is utilized to exploit the sparsity property of the RBs allocation to relax the NP-hard joint problem into an equivalent l_1 -norm problem for a near-optimum solution. Then, based on CS theory, an interference management technique with a restricted weighted fast iterative shrinkage-thresholding (R-WFISTA) algorithm is proposed to solve the equivalent sparse l_1 -norm problem. Simulation results show an improvement on average of 25% in the capacity and 10% in the outage probabilities for the proposed PA algorithm over conventional schemes as long as the CSI and CrCSI information of all users are available at a CCU. Moreover, the proposed algorithm reduces the complexity on average by 80% compared to the exhaustive search by considering the quadratic time complexity of CS instead of exponential time complexity in the exhaustive search.

Based on the above summary and results, this thesis clarifies that the proposed schemes for beamforming, PA, and RBs allocation are effective in suppressing the interference and increasing the capacity of NOMA HetNets. Besides, the system requirements and restrictions decide the choice of the adopted IM algorithm. Such improvement in the capacity can improve human life and participate in economic growth towards the future sustainable society.