Resource Allocation and Interference Management for Heterogeneous Networks Governed by Massive MIMO Macro Cell

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論 文 名　：Resource Allocation and Interference Management for Heterogeneous Networks Governed By Massive MIMO Macro Cell
（多素子MIMOを用いるマクロセルにより統治された異種混合無線ネットワークのためのリソース割当と干渉制御）

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論　文　内　容　の　要　旨

Given the 1000x capacity increase requirement for the next-generation cellular networks, massive multiple input multiple output MIMO (mMIMO), small cells (SCs) and cognitive radio (CR) have been proposed as important techniques. Therefore, the mMIMO coexists with CR or SCs to form an mMIMO heterogeneous network (HetNet), i.e., mMIMO-CR HetNet and mMIMO-SC HetNet, will be promising schemes. However, it brings more challenges due to the combination, especially for pilot contamination and interference management. The theme of this thesis is to propose advanced schemes for improving the achievable capacities (including per-user transmission rate and system sum rate) in mMIMO-HetNet by reducing the pilot contamination and coordinating the interference, which is divided to three parts.

For the first part (i.e., chapter 2), we study the pilot allocation problem in mMIMO homogeneous network for reducing the pilot contamination. To reduce the required complexity for finding the optimum pilot allocation, we propose a low-complexity pilot allocation algorithm. In addition, to improve users' fairness, we formulate a fairness aware pilot allocation problem and solve the formulated problem using a similar algorithm. Simulation results show that our proposed pilot allocation scheme can improve per-user transmission rate by about 17% in comparison with the conventional pilot allocation scheme.

For the second part (i.e., chapters 3 and 4), we study the pilot and power allocation problems in mMIMO-CR HetNet. We first propose a price-based iterative pilot allocation algorithm to obtain a win-win paradigm between primary network (PN) and cognitive network (CN) in chapter 3. The results show that the PN and CN can obtain positive revenue, which implies that pilot sharing concept between PN and CN is effective in improving the performance of both PN and CN. Next, to avoid producing serious interference from the CN to PN, we investigate the power allocation problem of the CN in mMIMO-CR HetNet with pilot contamination in chapter 4. We propose an orthogonal pilot sharing scheme at pilot transmission phase, where cognitive users are allowed to use pilots for channel estimation only when there are temporarily unused orthogonal pilots. Following this, we formulate the power allocation optimization problem of the CN to maximize the downlink sum rate of the CN subject to the total transmit power and primary users' signal to interference plus noise ratio (SINR) constraints. Then, we propose an iterative algorithm to solve the formulated problem. The numerical results show that our proposed scheme can improve the sum rate of the CN by about 10% in comparison with the conventional scheme.

For the third part (i.e., chapters 5 and 6), we investigate the pilot allocation and interference management problems in mMIMO-SC HetNet. We first propose a pilot allocation scheme for maximizing ergodic downlink sum rate of the system in chapter~5, where the uplink pilot overhead and inter-tier interference are jointly considered. Then, we propose a low complexity one dimensional search algorithm to obtain the optimum pilot allocation. In addition, we propose two suboptimal pilot allocation algorithms to simplify the computational process and improve users' fairness, respectively. Simulation results show that our proposed scheme can improve the sum rate of the system by about 12% in comparison with the conventional scheme.

Based on this, we investigate the dynamic SC clustering strategy and their precoding design problem for interference coordination in mMIMO-SC HetNet in chapter 6. An interference graph-based dynamic SC clustering scheme is proposed. Based on this, we formulate an optimization problem to design precoding weights at macro base station and clustered SCs for maximizing the downlink sum rate of SC users subject to the power constraint of each SC base station. A non-cooperative game-based distributed algorithm is proposed to solve the formulated problem. Simulation results show that our proposed scheme can improve the sum rate of SC users by about 40% in comparison with the conventional scheme.