A Precoding Compensation Scheme for Heterogeneous Communication Networks with CSI Feedback Delay

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Abstract—In the 5th generation cellular systems, heterogeneous communication networks allow multiple base stations (BSs) to serve the users cooperatively, which can satisfy the requirement of growing data rate and optimum coverage. However, suffering from the imperfect channel state information (CSI) feedback, optimal performance may not be guaranteed for coordinated multiple point (CoMP) scenarios when certain users are served by multiple BSs, simultaneously. To this end, it is essential to develop transmission schemes with imperfect CSI to improve the performance in CoMP systems. Under the circumstance that an edge user is served by a primary BS and coordinated BS with the same time-frequency resource, at which the CSI can be outdated at the coordinated BS, in this paper, we propose a precoding compensation scheme at the primary BS to eliminate the interference caused by outdated CSI at the coordinated BSs. Two algorithms, namely, maximum signal-to-interference-plus-noise ratio (MaxSINR) and minimum-mean-square-error (MMSE), are proposed for the precoding at the transmitter and the detection at the receiver, respectively, to further improve the performance as well as mitigate the interference. Simulation results show that our proposed transmission scheme is able to provide sufficiently good performance comparing to that of the perfect CSI feedback scenario.

Index Terms—Heterogeneous communication networks, coordinated multiple point, interference cancellation, channel state information, precoding compensation.

1 Introduction

Heterogeneous communication networks is considered as an efficient technology to cope with the challenge of dramatically growing data rate and optimum coverage in future generation networks (5G and beyond) [1], [2], [3], [4]. In part of the heterogeneous cellular communication networks, the edge users can be served by several base stations (BSs) simultaneously to enhance the quality of service (QoS) [5], [6]. The heterogeneous network based cloud radio access network architecture can realize a coordinated cross-cell radio resource management to enhance the system performance [7], [8]. The employ of heterogeneous network technology in satellite cooperative communication system can effectively improve the coverage and capacity in remote areas [9], [10], [11], and the heterogeneous communication networks with unmanned aircrafts can satisfy the communication demands in various scenario [12], [13]. In addition, the heterogeneous networks technology can be used in millimeter-wave (mmWave) communication system to realize higher data rates and seamless coverage [14], [15], [16].

In the most general heterogeneous communication networks, the coordinated multiple point (CoMP) technologies could allow to improve the communication performance [17], [18], [19], especially when the network operates on an impeded cellular network manner. The QoS of users can be satisfied by coordinated resource management among multiple transmit points [20], [21], [22]. In the CoMP schemes, the joint transmission (JT) is a common transmission technology, which can be further divided into two categories namely coherent JT (CJT) and non-coherent JT (NCJT). In the CJT scheme, the channel state information (CSI) should be exchanged between all the BSs and then the precoding matrices are designed cooperatively. On the other hand, the BSs can perform precoding independently with the obtained CSI in the NCJT scheme, which can reduce the overhead of information exchange obviously [23]. Since the BSs transmit signals to the users utilizing the same time-frequency resource in the NCJT scenario, it can significantly improve the communication quality of edge users and improve the system throughput [24], [25]. However, due to all the BSs reuse the same time-frequency resource, the inter-BS interference will be significant at the user equipments (UEs). It is necessary to design effective algorithm to eliminate the interference to enhance the system performance.

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