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Cooperative Techniques in Wireless Networks
無線通訊網絡中的協作技術

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I Abstract

Research in wireless communication has been aiming for higher transmission efficiency. Cooperative transmission is a promising technology, which enjoys increased diversity and lowered power consumption. It is being standardized for the next-generation wireless communication system such as LTE-Advanced and WiMAX for IMT-Advanced (4G). In cooperative transmission from one wireless device to another, many other devices in the network will be employed to assist; they might be base stations, access points, mobile stations, user terminals and so forth. The idea of cooperation in wireless networks started from early study of relay channel for applications of terrestrial microwave relay communications and relaying among satellites. Recently, multi-hop relaying has been studied intensively and various cooperation schemes proposed. However, such studies are often conducted in a conventional way that assume perfect channel information and centralized processing. Multi-hop cooperation is usually applied in low-rate and unreliable scenarios, such as Ad Hoc Wireless LAN and Wireless Sensor Network. In multi-hop cooperative networks, each node is considered to be homogenous and limited in processing capability. However, conventional cooperation schemes usually deploy centralized control, and thereby contradict the distributed properties of cooperating relays.

The first solution to this contradiction is to design practical distributed cooperative schemes, which has been achieved in the first part of our research. In this part, we investigate the two-hop multi-relay cooperative network and design a simple and practical relay selection scheme. The proposed distributed relaying scheme is based on local processing at each relay, and each relay autonomously decides whether to cooperate. This relay selection scheme is implemented in a distributed manner requiring no centralized control, and thereby eliminating overhead for inter-relay coordination. Since the exact behavior of such a distributed system is unpredictable at any specific moment of time, outage probability is a crucial indicator of the overall performance of the distributed cooperative system. The system outage probability of the distributed relaying network has

been solved and expressed in a simple form.

The second solution to the aforementioned contradiction is quite intuitive: to return centralized processing and avoid being distributed. Cooperation in cellular systems is very different from cooperation in multi-hop networks. The principal factor for this difference is the network architecture: the cellular network has a mesh structure with a remarkably powerful base station in each cell. Cooperation among base stations in cellular networks, called Multi-Cell, is another very active area of research in wireless cooperative communications. In multi-cell networks, it is feasible to set up dedicated broadband fiber links between two adjacent cells. Shared information of channels and signals among cells leads to inter-cell cooperation. In the second part of our research, we investigate a cooperative transmission scheme between two adjacent cells, which is indicated as pragmatic in some literature. Then, we consider the inter-cell cooperation scheme for relaying cells, because 4G systems have an inherent problem of limited transmission distance so that relaying is a mandatory option in large cells. Cooperative joint transmission is a candidate technology to be standardized in 4G, as well as relaying transmission. The objective of our system design is to find the optimal transmitting precoders at base stations subjective to power constraint in the cluster of several cells. Our optimization is based on MMSE criteria. Closed-form solutions are derived for optimal precoding scheme at the base stations.

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