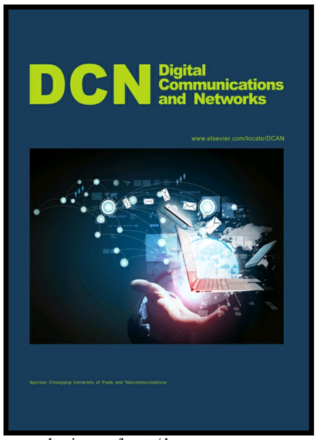

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On Distributed Power Control in Full Duplex Wireless Networks

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Abstract

In this paper, we first consider the problem of distributed power control in a full duplex (FD) wireless network consisting of multiple pairs of nodes, within which each node needs to communicate with its corresponding node. We aim to find the optimal transmit powers for the FD transmitters such that the network-wide capacity is maximized. Based on the high signal-to-interference-plus-noise ratio (SINR) approximation and a more general approximation method for logarithm functions, we develop effective distributed power control algorithms with the dual decomposition approach. We also extend the work to the general FD network scenario, which is shown to be decomposed into isolated nodes, paths, and cycles. The corresponding power control problem can then be solved with the distributed algorithm. The proposed algorithms are validated with simulation studies.

Keywords: Dual decomposition; Distributed algorithm; Full duplex transmission; Power control.

1. Introduction

Due to the broadcast nature of wireless transmissions, a receiver is usually interfered by undesired signals that it overhears from neighboring transmitters. The capacity of a wireless network is mainly limited by interference. Consider people chatting at a party. In order to be heard clearly, one may want to increase his/her voice. However, if everyone tries to do so, they will end up shouting at the top of their voices, but, unfortunately, still get bad reception. To this end, a medium access control (MAC) protocol can be used to exclude transmission within a footprint centered at the receiver. Alternatively, an effective power control scheme can be used to find the optimal transmit powers for the transmitters, such that the network capacity can be maximized [2].

In this paper, we investigate the problem of distributed power control for a wireless network where the nodes are capable of full duplex (FD) transmissions. Although FD transmission has been used in wireline network for years (e.g., Asymmetric Digital Subscriber Line (ADSL) based on echo cancellation), FD transmission in wireless networks has become feasible only in recent years. Wireless FD systems are made possible by breakthroughs in self-interference cancellation [3, 4], such as propagation-domain suppression (PDIS) [5, 6], analog-domain interference cancellation, and digital domain interference cancellation (ADIC) [7]. Practical FD systems have been demonstrated that can achieve more than 70 dB [7] or 80 dB [8] reduction of self-interference.

FD can be incorporated in a wireless network in two ways: (i) two-node mode, where two nodes transmit to each other simultaneously, and (ii) three-node mode, where a node (e.g., a cellular base station (BS)) simultaneously receives from a node and transmits to another node. The three-node mode can be extended to the more general N-node model, where all the nodes either form a path or a cycle, to receive from the upstream node and transmit to the downstream node simultaneously. FD brings about new challenges to the design of power control algorithms. In a traditional half-duplex (HD) network, if a node increases its power, the signal-to-interference-plus-noise ratio (SINR) at its target receiver can be improved, but with larger interference to other receivers. In an FD network, an increased power causes not only larger interference to other receivers, but also larger residual self-interference to the node itself, which may even degrade its own SINR. To fully harvest the high potential of FD wireless networks, the power control problem should be carefully addressed with effective algorithms developed.

In this paper, we first consider an FD wireless network consisting of multiple node pairs, where the two nodes in each pair transmit to each other (i.e., the two-node mode). We analyze the basic case with a single pair of nodes [9]. Taking advantage of the structure of the formulated optimal power control problem, we show that the optimal solution should be at the vertex of the feasible region. Furthermore, we consider the case of multiple node pairs in the FD network. Based on a high SINR approximation, we can transform the optimal power control problem into

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