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Energy-efficient protocols for wireless networks with adaptive MIMO capabilities.

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Summary: Transmission power control has been used in wireless networks to improve the channel reuse and/or reduce energy consumption. It has been mainly applied to single-input single-output (SISO) systems, where each node is equipped with a single antenna. In this paper, we propose a power-controlled channel access protocol for MIMO-capable wireless LANs with two antennas per node. Our protocol, called E-BASIC, extends the classic CSMA/CA access scheme by allowing for dynamic adjustment of the transmission mode and the transmission power on a per-packet basis so as to minimize the total energy consumption. By transmission mode we mean one of the four possible transmit/receive antenna configurations: 1×1 (SISO), 2×1 (MISO), 1×2 (SIMO), and 2×2 (MIMO). Depending on the transmitter-receiver distance, any of the four modes can be the optimal one in terms of minimizing the total energy consumption. We study the performance of E-BASIC in both ad hoc and access point topologies. We also incorporate E-BASIC in the design of a power-aware routing (PAR) scheme that selects minimum-energy end-to-end paths. Our adaptive designs are first conducted assuming fixed-rate transmission, but later extended to multi-rate systems. To account for the energy-throughput tradeoff in our designs, we impose a constraint on the average packet delivery time. Simulations indicate that the proposed adaptations achieve a significant reduction in the overall energy consumption relative to non-adaptive MIMO systems.

Keywords: power control; MIMO; ad hoc networks; CSMA/CA; IEEE 802.11; power-aware routing; energy efficiency
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