## Abstract

Opportunistic selection reaps the benefits of multiuser diversity in many wireless applications. For example, it increases throughput of cellular networks, lifetime of wireless sensor networks, and improves diversity in cooperative relay systems. In it, the best node is selected for data transmission. The ability of a node to improve the system performance is quantified by a real-valued metric. The best node is the one with the highest metric.

Since the nodes are geographically separated, no node in the network knows beforehand who the best node is. Hence, distributed selection schemes are required. We investigate the role of power control in distributed selection schemes. Power control allows the nodes to choose their target receive power from a set of pre-specified power levels. These levels are set such that a node can be selected even if some other nodes transmit with it but do so with lower power levels. Without power control, this would have resulted in a wasteful collision.

First, we propose a new timer-based selection scheme with power control. In it, each node sets its timer and its target receive power level as a function of its metric. We develop several structural insights, about the optimal metric-to-timerand-power mapping, which maximizes the probability of selecting the best node. These significantly reduce the computational complexity of finding an optimal mapping and lead to valuable asymptotic insights. We show that the proposed scheme significantly outperforms the conventional timer-based selection scheme. Performance improvements as large as 28.2% are achieved even with only two target receive power levels.

We also analyze the performance of the proposed scheme with imperfect power

control, which is inevitable in practice. It randomly changes a node's receive power and, thus, its signal-to-interference-and-noise ratio. Consequently, it affects the probability of selection of the best node and of no node getting selected. It can even lead to a sub-optimal node getting selected. We derive the probability of each of these effects. We observe that by increasing the lowest target receive power level enough, the reduction in probability of selection of the best node can be restricted to be within 9%.

Lastly, we characterize the effect of imperfect power control on an alternate scheme known as the splitting-based selection scheme with power control. This scheme maintains a set of thresholds for each slot, which determine the nodes that transmit in that slot and their target receive power levels. The outcome of a slot is used to update the thresholds for the next slot. In case of a collision, the set of colliding nodes is split in two smaller subsets, the nodes in one of which transmit in the next slot. We analyze the average number of slots required for selection with perfect and imperfect power control. We also compute the probability that the best node or a sub-optimal node gets selected in each slot, and the probability that no node ever gets selected due to imperfect power control. The implications of imperfect power control on system throughput are also investigated. We show that imperfect power control reduces the system throughput. We also evaluate the effect of peak power constraint on the performance of the timer-based and splitting-based selection schemes with power control. We show that it can reduce the probability of selection of the two schemes by as much as 19.1% and 9.7%, respectively, when the metric and channel gain are uncorrelated depending on the system parameters.