Energy-Efficiency Analysis and Optimization for Virtual-MIMO Systems

Virtual multiple-input-multiple-output (MIMO) systems using multiple antennas at the transmitter and a single antenna at each of the receivers have recently emerged as an alternative to point-to-point MIMO systems. This paper investigates the relationship between energy efficiency (EE) and spectral efficiency (SE) for a virtual-MIMO system that has one destination and one relay using compress-and-forward (CF) cooperation. To capture the cost of cooperation, the power allocation (between the transmitter and the relay) and the bandwidth allocation (between the data and cooperation channels) are studied. This paper derives a tight upper bound for the overall system EE as a function of SE, which exhibits good accuracy for a wide range of SE values. The EE upper bound is used to formulate an EE optimization problem. Given a target SE, the optimal power and bandwidth allocation can be derived such that the overall EE is maximized. Results indicate that the EE performance of virtual-MIMO is sensitive to many factors, including resource-allocation schemes and channel characteristics. When an out-of-band cooperation channel is considered, the performance of virtual-MIMO is close to that of the MIMO case in terms of EE. Considering a shared-band cooperation channel, virtual-MIMO with optimal power and bandwidth allocation is more energy efficient than the noncooperation case under most SE values.