

ABSTRACT

Multiple-input multiple-output (MIMO) and cognitive radio (CR) are key techniques for present and future high-speed wireless technologies. On the other hand, there are rising energy costs and greenhouse emissions associated with the provision of high-speed wireless communications. Consequently, the design of high-speed energy efficient systems is paramount for next-generation wireless systems.

This thesis studies energy-efficient antenna selection for spatial multiplexing multiple-antenna systems from a cross-layer perspective, contrary to the norm, where physical-layer energy efficiency metrics are optimized. The enhanced system performance achieved by cross-layer designs in wireless networks motivates this research. The aim of the thesis is to propose and analyze novel cross-layer energy-efficient transmit antenna selection schemes that enhance energy efficiency and system performance - with regard to throughput, transmission latency, packet error rate and receiver buffer requirements.

Firstly, this thesis derives the analytical expression for data link throughput for point-to-point spatial multiplexing multiple-antenna systems - which include MIMO and underlay CR MIMO systems - equipped with linear receivers with N-process stop-and-wait (N-SAW) as the automatic repeat request (ARQ) protocol. The performance of cross-layer transmits antenna selection, which maximizes the derived throughput metric, is then analyzed. The impact of packet size, number of SAW processes and the stalling of packets inside the receiver reordering buffer is considered in the investigation. The results show that the cross-layer approach, which takes into account system characteristics at both the data link and physical layers, has superior performance in comparison with the conventional physical-layer approach, which optimizes capacity.

Secondly, this thesis proposes a cross-layer energy efficiency metric, based on the derived system throughput. Energy-efficient transmit antenna selection for spatial multiplexing MIMO systems, which maximizes the proposed cross-layer energy efficiency metric, by jointly optimizing the transmit antenna subset and transmit power, subject to spectral efficiency and transmit power constraints, is then introduced and analyzed. Additionally, adaptive modulation is incorporated into the proposed cross-layer scheme to enhance system performance. Cross-layer energy efficient transmit antenna selection for underlay CR MIMO systems, where interference constraints now come into play, is then considered.

Lastly, this thesis develops novel reduced complexity versions of the proposed cross-layer energy efficient transmit antenna selection schemes - along with detailed complexity analysis - which shows that the proposed cross-layer approach attains significant energy efficiency and performance gains at affordable computational complexity.