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PhD Dissertation Announcement

Toward Reliable and Robust Wireless Personal Area Networks

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In recent years, wireless personal area networks (WPANs) have been widely deployed to replace cable connections and provide low power, low cost wireless connectivity to facilitate seamless operation among wireless devices centered around an individual person. However, pervasive deployment of WPANs has introduced a lot of challenging problems on coexistence and resource provisioning. First, commercial-of-the-shelf (COTS) WPAN devices typically provide limited information regarding the current condition of wireless channels. The lack of detailed PHY knowledge usually leads to misinformed decisions and under-utilization of available resources. In this dissertation, we revisit the issue of link quality prediction in IEEE 802.15.4 low rate WPANs analytically and experimentally. By deciphering LQI readings available in Zigbee radios with CC2420 chipset, we demonstrate for the first time that LQI truly reflects the signal-to-noise ratio (SNR) at the receiver. Furthermore, to predict the instantaneous link quality, we develop an inference model under different channel environments that uses instantaneous LQI as input. We believe it will lead to more informed resource management decisions in WPANs.

Second, by sharing same unlicensed ISM bands, one WPAN device not only has to coexist with other WPAN devices, but also other co-channel nearby wireless technologies like WiFi. Without the knowledge of neighbors and contention graph, they may interfere with each other, resulting in severe quality-of-service (QoS) degradation. To achieve better coexistence in ad-hoc WPANs where the peer-to-peer topology is adopted, we propose efficient solutions to joint neighbor discovery and contention graph inference. Specifically, two inference approaches are presented analytically, a binary inference model and a location based inference model.

Lastly, the newly developed WPAN applications demand high data rate and stringent requirements on service disruption, which poses more challenges on designing reliable and robust WPANs. In this dissertation, we consider IEEE 802.15.3c WPANs and propose a robust relay placement and routing selection solution for better resource provisioning. Specifically, two robust problems are formulated, robust minimum relay placement (RMRP) and robust maximum utility relay placement (RMURP). We first consider an interference-free model, and then extend the work by incorporating a classic directional antenna model and characterizing the link contention. Efficient algorithms are developed to solve both problems and have been shown to incur less service disruption in presence of moving subjects that may block the LOS paths in the environment.

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