WIRELESS IOT COMMUNICATIONS AND NETWORKING: ENERGY EFFICIENCY, SPECTRAL EFFICIENCY, AND SECURITY

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Abstract:

While interest in Internet of Things (IoT) applications has surged in recent years, the broad diversity in their constraints, such as power consumption, channel bandwidth, link robustness, and packet latency, still challenges state-of-the-art technologies to enable efficient and ubiquitous wireless connectivity for IoT devices in many practical scenarios. In this thesis, we study three sets of primary constraints in developing IoT networks; energy efficiency, spectral efficiency, and physical-layer security. First, this thesis introduces EE-IoT, an energy-efficient wireless communication scheme for IoT networks. EE-IoT allows low-complex non-multi-carrier IoT devices to communicate with an orthogonal frequency division multiplexing (OFDM)-based wireless localarea network (WLAN) access point (AP) at a very low sampling rate, thereby leading to a significant reduction of IoT devices' hardware complexity and power consumption. This thesis further enables a transparent coexistence of IoT devices and legacy Wi-Fi devices. Second, to improve spectral efficiency of dense IoT networks, this thesis introduces UD-MIMO, a practical uplink distributed multiple-input multiple-output (MIMO) for WLANs, and MaLoRaGW, a first-of-itskind multi-antenna long-range (LoRa) gateway that enables multi-user MIMO (MU-MIMO) LoRa communications in both uplink and downlink. The key enablers of the proposed schemes are new co-channel interference management techniques that allow Wi-Fi APs and LoRa gateways to concurrently serve multiple users in the absence of fine-grained inter-node synchronization. Third, this thesis introduces two jamming-resilient receiver architectures to secure vehicular ad hoc networks (VANETs) and ZigBee communications against high-power, in-band constant jamming attacks. The proposed schemes leverage multi-antenna technology and new signal detection methods to suppress jamming signals and decode desired signals. This thesis provides detailed information regarding the implementation of the proposed schemes on real-world wireless testbeds and evaluates their performance in practice.