NeTS: Medium: Collaborative Research:
Coexistence of Heterogeneous Wireless Access Technologies in the 5 GHz Bands

Summary

Enabling harmonious spectrum sharing between heterogeneous wireless technologies is a challenging problem, but one that needs to be urgently addressed in order to quell the exploding demand for more spectrum by existing as well as burgeoning wireless applications. The importance of this problem is especially acute for the 5 GHz bands because these bands have emerged as the most coveted bands for launching new wireless applications and services. Access to spectrum in the 5 GHz bands has emerged as a major bone of contention between the LTE-U, Wi-Fi, and Dedicated Short-Range Communications (DSRC) stakeholders. More importantly, the 5 GHz bands have become a proving ground for demonstrating the viability of spectrum sharing between three heterogeneous technologies—viz., LTE-U, Wi-Fi (802.11ac/802.11ax), and DSRC. Recognizing the importance of this problem, we propose to embark on an in-depth study that focuses on two particular coexistence scenarios: (1) coexistence between LTE-U and Wi-Fi and (2) coexistence between DSRC and Wi-Fi.

Keywords: Spectrum sharing; interference mitigation; spectrum etiquette protocols.

Intellectual Merit: The proposed work on the coexistence of Wi-Fi and LTE-U is expected to have tangible impacts on today's technologies as well as those of the future. We will study *avant-garde* approaches that exploit the advanced functionalities envisioned in future technologies, such as 802.11ax, as well as *backward-compatible* techniques that can be applied to today's technologies (e.g., LTE-U, 802.11ac). The proposed work on DSRC-Wi-Fi coexistence will be one of the first systematic studies that investigates incumbent protection techniques designed for highly mobile incumbent users that are very sensitive to communication latency. Specifically, we propose to take on the following research thrusts:

(1) Avant-garde approaches for enabling LTE-U/Wi-Fi coexistence. We will develop and evaluate a simultaneous transmission-and-sensing technique that leverages the full-duplex (FD) and self-interference suppression capabilities of 802.11ax to mitigate interference due to coexisting wireless technologies. We will also develop an adaptive algorithm for switching between various modes at an FD-capable Wi-Fi device using rigorous mathematical models and simulation data. Finally, we will analyze the interactions between LTE-U and Wi-Fi subsystems and jointly adapt/optimize their interference mitigation control knobs using game-theoretic formulations.

(2) Backward-compatible approaches for enabling LTE-U/Wi-Fi coexistence. We will study backward-compatible techniques applicable to existing technologies, with a particular focus on techniques that enable *fair* spectrum sharing between Wi-Fi and LTE-U. These techniques include unilateral approaches that can be employed by LTE-U, à la *Carrier Sensing Adaptive Transmission (CSAT)*, but with more proactive mechanisms for ensuring fairness. We will also investigate approaches that enable indirect communications between LTE-U and Wi-Fi networks to ensure fair access to the spectrum.

(3) Enabling the coexistence of DSRC and Wi-Fi. In this scenario, our focus is on adequately protecting DSRC since DSRC devices are the incumbent users and Wi-Fi devices are the secondary users. We propose to characterize and quantify the impact of spectrum contention between DSRC and Wi-Fi on DSRC performance, with a particular focus on vehicular safety applications. In addition, we will develop techniques for protecting DSRC while enabling efficient utilization of fallow spectrum by Wi-Fi.

Broader Impacts: The collective expertise and experience of the PIs will ensure that the proposed research will not be a mere academic exercise, but rather a fruitful study that will produce findings which will serve as important references for implementing coexistence mechanisms and incumbent protection techniques for real-world spectrum sharing scenarios. Through industry and government outreach activities, the PIs will ensure that the project findings have maximum impacts on ongoing industry research/development efforts as well as on Government initiatives to open up more spectrum for spectrum sharing. The PIs will incorporate the outcomes of the project into courses currently offered at their respective institutions. The proposed work is expected to provide invaluable research experiences for the graduate students who will be involved in the project as well as produce high-quality hands-on exercises, project topics, and other pedagogical material that will enrich the undergraduate curriculum at the respective institutions.