Project Summary

Overview

Wireless devices are essential in our everyday lives, and every day more applications are being formed that push the boundaries of what is possible with wireless networks. Adaptability, whether it is adapting to dynamic spectrum use or RF-harsh environments, is vital to the next generation of wireless systems. New wireless protocols and hardware provide a promising future, but they leave behind millions of already deployed devices. It takes years for these older devices to get cycled out, making it hard to see the gains of any newly developed innovation until a majority of the devices are no longer in use. We have hit a critical mass of deployed wireless devices such that always looking to the future for protocol and hardware advancements to replace our devices is no longer sustainable. Wireless infrastructure is being put into place that needs to work for years and does not have the option of upgrading hardware to improve its performance.

To address the need of extending the capabilities of already deployed devices, this project is focused on adding capabilities to devices without changing anything about the hardware of the device. The innovation comes not in what the hardware of the device contains but in how the hardware of the device is used. To explore this concept, this project proposes the novel idea of wireless subprotocols. A wireless subprotocol is a protocol implemented completely in software that builds on top of a "native" base protocol. The purpose of a subprotocol is to extend the capabilities of the device in ways that are not possible with the base protocol alone. The project will explore ways of extending the range of communication, providing communication with heterogeneous wireless protocols, and creating new security associations. Wireless subprotocols provide an essential need that other solutions do not provide: the ability to extend the capabilities of currently *available hardware*. Wireless subprotocols are a path forward for more adaptable and resilient devices and networks without having to upgrade a device's wireless hardware.

Intellectual Merit

This project provides an innovative perspective on protocol design and introduces a new class of wireless protocols called wireless subprotocols. These are protocols that are defined in software and are built on top of other wireless protocols. Rather than starting from hardware, this project is starting with the software. Such a protocol allows users to make trade-offs that are not possible in the underlying protocol, such as extending the range of communication or enabling communication with heterogeneous networks for spectrum coordination. This unique project combines innovative signal processing, medium access control, and adaptability, with a truly deployable solution. This project emphasizes realistic deployability, integrating each innovation with commercially available off-the-shelf hardware. The techniques developed in this project are generalizable and will influence how protocols are designed in the future.

Broader Impacts

This project focuses on the deployability of the proposed technologies and systems. A truly deployable system means it can be easily integrated into new and existing devices, creating industry interactions. These interactions enable potential technology transfer and connect students to internships and jobs. This project will enable a new research area of wireless subprotocols, impacting future designs of wireless devices. Wireless subprotocols can be used to help coordinate the spectrum between heterogeneous networks, providing an important path forward for spectrum coordination. Since the innovation technique is implemented in software, it lowers the barrier of entry and is much more approachable to new students. Interactive activities and demonstrations will be developed that provide hands-on experience with this technology. The project's close integration with software design and signal processing will be a significant draw for underrepresented groups to participate in this research.