Explore a Novel Cross-Layer Interference Resistant Multiple Access Approach for WiFi Networks: System Design and Prototype Implementation (PI: Dr. Lou Wei; 2012/13)

Though carrier sense multiple access is widely used in wireless networks for collision avoidance, it is noted to suffer both hidden terminal and exposed terminal problems. The current WiFi standard mainly uses the four-way handshake (RTS/CTS/DATA/ACK) mechanism to combat the hidden terminal problem and acknowledge the reception of the data packet, but it leaves the exposed terminal problem unsolved. This mechanism only works normally under the assumptions that a node's data transmission range is equal to its interference range and that all control packets are correctly received. However, in a real wireless network, these two assumptions do not hold all the time which make the RTS/CTS mechanism fail to clear the interferences from neighboring nodes, leading to both remote hidden terminal problem and CTS collision problem. Moreover, introducing the ACK to acknowledge the data transmission prevents the exposed terminals from transmitting concurrently. All these problems can dramatically reduce the throughput of wireless networks. There is no good solution to address these problems altogether.

This project is proposed to solve these problems by using a novel symbol correlation and detection approach. We aim to design and implement a cross-layer interference resistant multiple access (IRMA) approach to detect and resolve the interferences introduced by these hidden and exposed terminals. Specifically, we will study the symbol pattern's correlation and detection techniques, design effective network-wide unique symbol patterns to represent different types of information especially the NAV time information, revise the format of standard control frames to embed symbol pattern information, design a new channel access scheme that can remove external terminals, design a new decoder framework that can completely

silence all hidden terminals, implement a prototype of proposed scheme, conduct experiments with both simulations and real test-beds, and explore the potentials of applying the symbol correlation mechanism to other scenarios.

The outcomes of this project are a series of novel and systematic designs and implementations that achieve the cross-layer IRMA mechanism, which can solve both hidden and exposed terminal problems all-in-one to greatly improve the throughput of wireless networks under both high and low signal-to-noise-ratio and signal-to-interference-plus-noise-ratio environments. The proposed IRMA is designed to be compatible with current WiFi standards and can be incorporated into WiFi technologies, protocols and products seamlessly. Moreover, the symbol correlation mechanism has broader potentials to solve other system issues. All these outcomes will make important contributions to the improvement of the overall performance of future WiFi networks.