New Technologies for Dynamic RFID Systems: Problems, Applications, and Solutions (PI: Dr. Xiao Bin; 2013/14)

Radio-Frequency Identification (RFID) technologies not only improve industry efficiency for warehouse management and inventory control, but also profoundly affect our daily lives. The technology has been successfully applied to a wide range of our daily operations, such as the Octopus transportation card used in Hong Kong, books with embedded RFID tags in HK libraries, and tagged merchandise in more than 3,750 Wal-Mart U.S. stores. In Hong Kong, everyone, even a kid, has an Octopus RFID card to conveniently take public transportation, shop in supermarkets, and enter a private building.

Given the popularity of RFID technology, the research community has dedicated considerable efforts to monitoring RFID systems, most of which, however, focus on static systems. More efforts are needed to monitor real, complex RFID systems with dynamically changed tags and mobile readers. Simple solutions, such as deploying RFID readers at entrance and exit gates, cannot solve new pop-up problems, e.g., detecting missing tags or identifying misplaced tags. Under the dynamic framework, it is essential to design new protocols for efficient tag-reader communications. A more challenging job is to design protocols when a dynamic RFID system is under attacks. For instance, cloning attacks can use cloned tags to impersonate genuine tags. Blocking attacks can emit collision signals to block the normal communications between readers and tags.

The goal of the project is to propose efficient and secure solutions to fundamental questions in the RFID research community by addressing the challenge from tag/reader dynamic property. Fundamental questions of concern include the tag cardinality (or population) estimation and ID collection. Unlike previous work, the project will focus on dynamic tags, i.e., missing tags and new tags, and analyze their

effect on tag information collection efficiency. A further step is to consider the use of mobile readers, which can assist system management to relocate misplaced tagged items back to their original positions, e.g., in a library or a supermarket. Moreover, the project will design secure communication protocols in a malicious environment.

To achieve the goal, the project will present new technologies for dynamic RFID systems. We will propose differential estimators to accurately estimate tag population changes, design collision-empty slot pairing and multiple-hashing slot reselection technique to reduce slot collisions, exploit indicator technique to improve protocol time efficiency, and offer an anonymous ID-free approach for attack detection. Thus, the project will conduct a novel research movement from static to dynamic perspective to re-examine current solutions, and propose new ones with improved system throughput and reduced overhead to meet today's RFID application requirements.