Chapter 7
RFID Tag Anti-Collision Protocols

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ABSTRACT
A tag collision problem (or missed reads) in Radio Frequency Identification (RFID) system happens when multiple tags respond to a reader simultaneously. At this time, the reader cannot differentiate these tags correctly. This problem is often seen whenever a large volume of RFID tags are read together in the same radio frequency field. Tag collisions will degrade identification efficiency, and this unreliable identification will compromise the usefulness of RFID system. This chapter introduces tag collision problem and discusses tag anti-collision protocols, including ALOHA-based protocol, Binary Tree (BT) protocol, and Query Tree (QT) protocol. To date, most tag anti-collision protocols are QT protocols. Thus, in this chapter, the authors briefly describe some elegant researches on QT protocols, and also introduce their recent research results on QT protocols.

1. INTRODUCTION
Radio frequency identification (RFID) system consists of radio tags, readers, and the backend database system that associates RFID tag data collected by readers for verification or special need. A Reader communicates with tags at distance through wireless transmission. Its main tasks are to activate tags, communicate tags, and identify the tags uniquely. After the successful identification, a reader then sends the collected data from tags to a data processing system, which can be an application or database, according to the special application need (Shih, Sun, Yen, & Huang, 2006). Many manufacturers see the intended applications of RFID technology, and deploy RFID in

DOI: 10.4018/978-1-4666-2080-3.ch007
inventory control, distribution industry and supply chain management. As far, there are already many concrete applications using RFID, e.g., inventory control, distribution industry and supply chain management (Bardaki, Karagiannaki, & Pramatari, 2008; Bo, Yehua, & Caijiang, 2008; Chalasani & Boppana, 2007; Chuang & Shaw, 2007; Jea & Wang, 2008; Kapoor, Li & Ding, 2007; Liang & Li, 2007; Kapoor, Wei, & Piramuthu, 2008; Yan, Chen, & Meng, 2008). However, there are two types of collision problems in RFID system, the tag collision (see Figure 1(a)) and the reader collision (see Figure 1(b)), which will compromise the usefulness of RFID system. Tag collision happens when multiple tags respond to a reader simultaneously and the reader cannot differentiate these tags correctly (Floerkemeier & Lampe, 2004). On the other hand, when multiple readers are operating in proximity of one another, several readers interrogate one tag at the same time. This is so-called the reader collision (Sarma, Weis, & Engels, 2003). In this chapter, we discuss the tag collision problem in RFID system.

Several technologies on resolving tag collision had been proposed. There are two major types of anti-collision protocols. One is ALOHA-based protocol (Lee, Joo, & Lee, 2005) and the other is tree-based protocol. ALOHA-based protocol reduces the tag collisions, while it has the starvation problem (a tag cannot be identified for a long time). To address such problem, two tree-based protocols- binary tree (BT) protocol and the query tree (QT) protocol- were accordingly proposed. In the BT protocol (Cui, & Zhao, 2008; Feng, Li, Guo, & Ding, 2006; Lai, & Lin, 2009), every tag generates a binary random number (0 or 1). Afterwards, the tags having “0” transmit their EPCs to the reader first, and then the tags having “1” transmit later. This procedure is repeated until all tags are successfully identified. QT protocol does not need the additional memory and thus is referred to as the memoryless protocol. A reader sends a prefix of EPC to query tags, and the tags matching the prefix respond. By extending the prefixes until only on tag’s ID matches, the tag is identified successfully.

Most researches on RFID anti-collision protocol are QT-based protocols. Some QT-like protocols are briefly described in the following. Chiang et al. (2006) proposed a prefix-randomized QT protocol. A reader first scans the neighboring tags to determine the $M$-ary tree for querying tags. After finishing queries by $M$-ary tree, a reader then uses binary tree for inquiries. Adaptive query splitting protocol (Myung, Lee, Srivastava, & Shih, 2007) used extra candidate queue to store the prefix bits of responded tags to speed up the identification process. A hybrid QT (Ryu, Lee, Seok, Kwon, 2009)