Chapter 23
Radio Frequency Identification

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ABSTRACT

Radio frequency identification (RFID) is a group of technologies used to identify or track electronic devices (RFID tags or transponders), typically applied to or incorporated into products, animals, or even persons, using radio waves or electromagnetic fields. RFID systems have various applications, with the most prevalent one being enterprise supply chain management to improve the efficiency of inventory tracking and management, as RFID transponders complement bar codes (allowing the reading from several meters, even beyond the line of sight), and may one day even take their place. Other uses include payment services (for example public transportation, toll roads, season parking tickets, ski tickets, proximity smart cards), asset and inventory tracking, patient identification in hospitals, animal identification, library systems, anti-theft technologies, or even race timing. The main reasons for blocking its even more widespread utilization are privacy and security related issues, originating from the wireless nature of the technology. Technological challenges and development directions include robust collision resolution (caused by simultaneously transmitting transponders or readers), the mitigation of the privacy concerns, and the creation of more intelligent chips (by adding cryptographic algorithms, new sensors, more memory, and processing power to the transponders) while retaining miniaturization and cost-efficiency efforts.

In this chapter, we will start by briefly summarizing the history of radio frequency identification systems. After that, we will introduce the components of such systems and classify them based on programmability, data capacity, frequency, and reading distance, as well as power supplement and reply transfer methods. We will describe the various coupling types used in RFID systems, present the common coding schemes and modulations, and give an overview of the standardization efforts. This chapter will focus on collision detection and resolution algorithms and conclude by practical suggestions on RFID system selection for different tasks.

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HISTORY OF RFID

The first radio frequency based identification technology (currently known as RFID) was developed during World War II. In 1939, Great-Britain, it was observed by chance that when a pilot makes a certain swinging maneuver with his aircraft, the shape of the reflected waves change, thus friendly airplanes became distinguishable from enemy ones on the radar screen. This can be considered the very first passive RFID system.

In 1948, Harry Stockman predicted the advent of applications based on reflected radio waves in his work titled “Communications by Means of Reflected Power”, but first he attracted attention to a large number of unresolved issues and the necessity and inevitability of extensive research in the field. As it turned out, some 30 years of research and development was needed until the effective deployment of the RFID technology.

The 1960s was the prelude to the technological explosion of RFID in the 1970s. The papers of R. F. Harrington regarding electromagnetic fields (“Field measurements using active scatterers” and “Theory of loaded scatterers”, 1963 and 1964) grounded the future popularity of RFID. In the 1970s serious development was conducted in both the US and Europe.

By the 1980s, the research and development phase was supplanted by the implementation of new results and their application in products. In the 1990s, the application of RFID technology broadened: electronic toll collection on toll roads, immobilizers, (ski) tickets, entry systems, and access control systems started to harness the possibilities provided by RFID. Products based on RFID solutions began to spread in other regions of the world too.

The first microwave Schottky diodes integrated on CMOS circuits made simple single-IC microwave RFID transponders possible. This meant greater reading distance and faster data transmission rates. UHF RFID got a boost in 1999 when the Uniform Code Council, EAN International, and industrial partners founded the Auto-ID Center at the Massachusetts Institute of Technology.

PARTS OF AN RFID SYSTEM

A wide spectrum of demands can determine the set-up of RFID systems. A configuration consisting of a single transponder and a reader, as used in electronic article surveillance, may be regarded as the simplest RFID system. A more complex system can contain thousands of transponders, a number of networked readers, controlling computers and back-end databases.

Radio based identification needs at least two devices: one to identify and another that identifies the first. The identifying device initiates some kind of data connection with the other, during which data is transmitted in one or both directions. Communication is transmitted over radio frequencies, so both devices need to have radio interfaces. Therefore, a basic RFID system consists of at least the following two components:

- A transponder that is attached to the object to identify
- A reader that is able to read and/or write the transponder

The above system, depending on the application, may be augmented with a controlling computer, which might be harmonizing the work of multiple readers and linking the readers to back-end databases. The devices between the reader and the end application are referred to as middleware. The back-end databases store information about the transponders in the range of the readers. Information can be queried, but also updated during data transmissions. (Want, 2006)

Reader

The reader’s goal is to establish a radio connection with the transponder, identify it, and to establish,