Chapter IX
RFID Tags and Transponders:
The New Kid on the Block

RADIO-FREQUENCY IDENTIFICATION TECHNOLOGY

Historical Overview

Radio frequency identification (RFID) in the form of tags or transponders is a means of auto-ID that can be used for tracking and monitoring objects, both *living* and *non-living.* One of the first applications of RFID was in the 1940s within the US Defense Force (Hodges & McFarlane, 2004, p. 59). Transponders were used to differentiate between friendly and enemy aircraft (Ollivier, 1995, p. 234; Scharfeld (1998, p. 9). Since that time, transponders continued mainly to be used by the aerospace industry (or in other niche applications) until the late 1980s when the Dutch government voiced their requirement for a live-stock tracking system. The commercial direction of RFID changed at this time and the uses for RFID grew manifold as manufacturers realized the enormous potential of the technology.

Before RFID, processes requiring the check-in and distribution of items were mostly done manually. Gerdeman (1995, p. 3) highlights this by the following real-life example: "[e]ighty thousand times a day, a long shoreman takes a dull pencil and writes on a soggy piece of paper the ID of a container to be key entered later… This process is fraught with opportunity for error." Bar code systems in the 1970s helped to alleviate some of the manual processing, but it was not until RFID became more widespread in the late 1990s that even greater increases in productivity were experienced. RFID was even more effective than bar code because it did not require items that were being checked to be in a stationary state or in a particular set orientation. As Finkenzeller (2001, p. 1) rightly underlines, *"[t]he omnipresent barcode labels that triggered a revolution in identification systems some considerable time ago, are being found to be inadequate in an increasing number of cases. Barcodes may be extremely cheap, but their stumbling block is their low storage capacity and the fact that they cannot be reprogrammed".* RFID limits the amount of human intervention required to a minimum, and in some cases eliminates it altogether (Hind, 1994, p. 215).

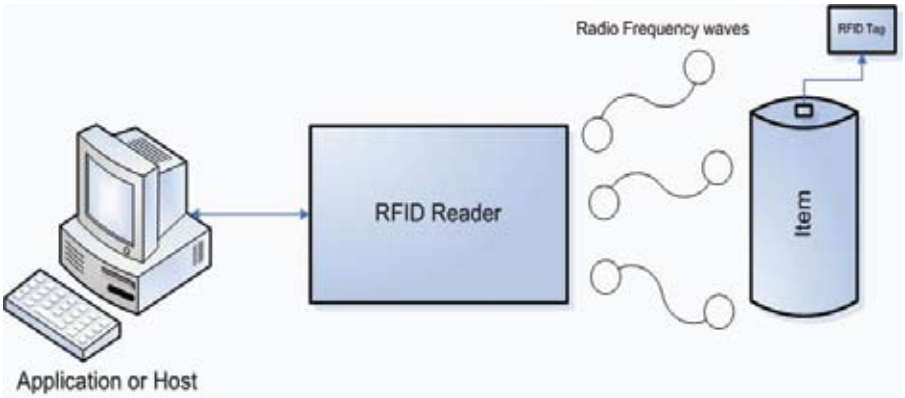
The fundamental electromagnetic principles that make RFID possible were discovered by Michael Faraday, Nikola Tesla and Heinrich R. Hertz prior to 1900. *"From them we know that when a group of electrons or current flows through a conductor, a magnetic field is formed surrounding the conductor.*

The field strength diminishes as the distance from the wire increases. We also know that when there is a relative motion between a conductor and a magnetic field a current is induced in that conductor. These two basic phenomena are used in all low frequency RFID systems on the market today" (Ames, 1990, p. 3-2). Finkenzeller (2001, pp. 25-110) provides a detailed explanation of fundamental RF operating and physical principles. Ames (1990, p. 3-3) points out that RFID works differently to normal radio transmission. RFID uses the near field effect rather than plane wave transmission. This is why distance plays such an important role in RFID. The shorter the range between the reader and the RF device the greater the precision for identification. The two most common RFID devices today are tags and transponders but since 1973 (Ames, 1990, p. 5-2) other designs have included contactless smart cards, wedges (plastic housing), disks and coins, glass transponders (that look like tubes), keys and key fobs, tool and gas bottle identification transponders, even clocks (Finkenzeller, 2001, pp. 13-20). The size and shapes of tags and transponders vary. Some more common shapes include: glass cylinders typically used for animal tracking (the size of a grain of rice), wedges for insertion into cars, circular pills, ISO cards with or without magnetic stripes, polystyrene and epoxy discs, bare tags ready for integration into other packaging (ID Systems, 1997, p. 4). RFID espouses different principles to smart cards but the two are closely related according to Finkenzeller (2001, p. 6). RFID systems can take advantage of contactless smart cards transmitting information by the use of radio waves.

The RFID System

RFID can be defined as an electronic tagging technology that allows objects to be automatically identified at a distance without direct line of sight, using an electromagnetic challenge/response exchange (Want, 2004). An RFID system primarily consists of RFID tags or transponders and RFID readers, but can be extended to include antennas, radio characteristics and the computer network used to connect RFID readers (Finkenzeller, 2003). Figure 1 illustrates the configuration, components and interactions present in an RFID system (Hamilton, Michael & Wamba, 2009). RFID readers contain radio frequency modules that emit pulses of radio energy that are detected by tags and responded to with information, such as the tag's serial number. RFID tags are the labels that are attached to the object to be identified. RFID tags consist of an antenna, a small silicon chip that contains a radio receiver, a radio modulator, control logic, memory and a power system (Garfinkel & Rosenberg, 2005). RFID tags are classified as

Figure 1. Components of an RFID system



Optimization of C5.0 Classifier With Bayesian Theory for Food Traceability Management Using Internet of Things
Balamurugan Souprayen, Ayyasamy Ayyanarand Suresh Joseph K (2020). *International Journal of Smart Sensor Technologies and Applications (pp. 1-21).*
www.irma-international.org/article/optimization-of-c50-classifier-with-bayesian-theory-for-food-traceability-management-using-internet-of-things/272125