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Chapter 1

Introductory Chapter: RFID: A Successful History

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Radio frequency identification (RFID) is a part of our daily life. This term is used to define any process that, by means of a radio communication, can exchange information between a stationary unit and a mobile unit or between mobile units [1].

In one end of the link, simpler devices, called tags, are used and, and at the other end, more complex devices such a multiprocessor unit can be found. Tags are generally small and inexpensive units that can be bulk acquired and are easily attached to the objects to be identified, and can be automatically operated.

Nevertheless, the roots of RFID date back to World War II. At that time, radar—which had been discovered in 1935 by Scottish physicist Sir Robert Alexander Watson-Watt—was used to alert of approaching aircrafts. Would they be our pilots returning home or would it be an enemy attack?

Germans, for instance, used an interesting maneuver in which their pilots rolled their planes as they return to base, so it would change the reflecting radio signal. This simple procedure alerted the ground radar crew of German planes returning and not allied aircrafts. It can be considered one of the first passive ways to identify an object by means of a radio frequency signal.

Still during the WWII, British researchers led by Watson-Watt developed a new system with a very clever idea. They put transmitter on all British planes, and when they received signals from radar stations on the ground, they began broadcasting a signal back that identified the aircraft as friendly. That is the basic concept of RFID operation: a signal is sent to a transponder, which wakes up and either reflects back a signal (this means a passive system) or broadcasts a signal (active system). This system was known as "identify friend or foe (IFF)."

Radar and RF communications had a great development in the 1950s and 1960s mainly with the contribution of researches in the USA and in Europe. Many scientific articles explain in

detail how an energy in the RF range can be used in the detection and identification of objects and, more importantly, remotely.

In a remarkable article—Communications by Means of Reflected Power—dated from 1948, Harry Stokman wrote "Evidently, considerable research and development work has to be done before the remaining basic problems in reflected-power communication are solved, and before the field of useful applications is explored." This paper can be considered one of the first works exploring the RFID subject [2].

In the 1960s and 1970s, RFID systems were still embedded within a context of "secret technology." As an example, Los Alamos National Laboratory was asked by the Energy Department of United States of America to develop a system for tracking nuclear materials and control sensitive materials. Inventors, developers, academic institutions and government laboratories were intensively working on RFID.

Considered to be one of the first patents involving RFID, Mario W. Cardullo received the US patent for an active RFID tag with rewritable memory on January 23, 1973.

Technological developments in the 1980s and 1990s led to the manufacture of more sophisticated and comprehensive RFID systems in addition to reducing the costs involved. An important task has also begun: standardization for the interoperability of RFID equipment or systems. In the 1990s, the RFID systems reach a significant mark of millions of tags only in the USA, especially from the automotive sector.

In 1999, the Massachusetts Institute of Technology (MIT) created a research center (financed by Uniform Code Council, EAN International, Procter & Gamble and Gillette) specialized in automatic identification (including UHF RFID) named the Auto-ID center. Between 1999 and 2003, the Auto-ID center gained the support of more than 100 large end-user companies, plus the US Department of Defense and many key RFID vendors. It opened research laboratories in Australia, the United Kingdom, Switzerland, Japan and China and developed two air interface protocols.

The MIT Auto-ID center became the global Electronic Product Code, an organism in charge of promoting the EPC standard. Some of the biggest retailers in the world and the US Department of Defense have said they plan to use EPC technology. The Auto-ID center closed its doors in October 2003, and its research responsibilities were passed on to Auto-ID Labs.

In December 2004, EPC global emerged as a second-generation standard way for broad adoption. Many industries are moving to adopt this technology.

In 2010s, the decreased cost of equipment and tags, increased performance to a reliability of 99.9% and a stable international standard brought a major boost in the use of RFID systems. In March 2010, a Korean laboratory successfully created a printed chip using carbon nanotubes that resulted in a significant decrease in cost.

RFID technologies are used for hundreds, if not thousands, of applications and industrial sectors (aerospace, automotive, logistics, transport, health, life, etc.), and the International Standard Organization (ISO) took part in establishing technical and applicative standards that led to a high degree of interoperability or interchangeability.

Today, there are various RFID frequency bands from a few kilohertz to a microwave frequency band (2.4–2.5 GHz). One of the most recent is the UHF Generation 2, which operates at 860–969 MHz [3].

Summarizing, RFID is a fantastic technology that brings together a wide range of professionals and knowledge areas such as systems engineering, circuit technology, software development, integrated circuit design, network engineering, antenna theory, propagation theory, microware technology, materials technology, receiver and transmitter design, encryption theory and mechanical design [4].

And what about the future? Are there still challenges to overcome? Efforts to reduce costs, miniaturize tags, use of alternative energy sources and standardization are likely to be part of these challenges.

In this book, the reader can find very important contributions not only to understand the RFID systems but also to visualize interesting new search fields and approaches.

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