RFID
Research & Test Center

RFID TECHNOLOGY: A PARADIGM SHIFT IN BUSINESS PROCESSES

Alp ÜSTÜNDAĞ

Istanbul Technical University
Industrial Engineering Department

ABSTRACT:

Radio Frequency Identification (RFID) is fast becoming an icon of the mobile and wireless industry. RFID is an Auto-ID technology which uses radio waves to automatically identify the individual items. The system consists of two elements that communicate with each other via radio waves: a tag (or transponder) and a reader. Using RFID tags, it is possible to identify and track objects without time delays, without human intervention and thus without variable costs. With RFID, the business processes can be better optimized than with the barcode. This paper presents the characteristics, the various application areas and the potential benefits of the RFID technology. The possible implementation problems are also emphasized. The impact of the RFID technology on business processes especially on the supply chain is explained through various examples.

Keywords: Radio Frequency Identification Technology (RFID), Auto-ID, barcode, business process, supply chain

1. Introduction

Radio Frequency Identification (RFID) is an Auto-ID system consisting of a microchip with a coiled antenna and a reader. Data and energy are transmitted without any contact between the microchip and the reader. The reader sends out electromagnetic waves that form a magnetic field so the microchip's circuits are powered. The chip modulates the waves and sends back to the reader. The reader converts the new waves into digital data. (Fig. 1)

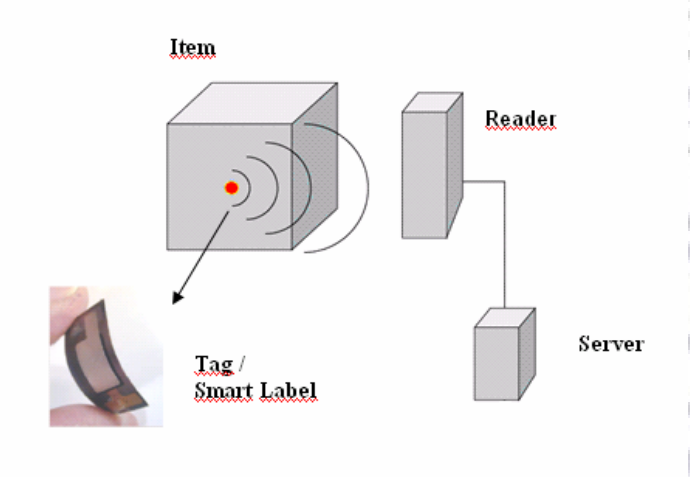

Fig. 1: RFID System

In this paper, the Auto-ID technologies are briefly introduced. The advantages of RFID systems over the Barcode systems are mentioned. Various applications and also some implementation problems of RFID technology are explained. The potential benefits on supply chain processes gaining from this technology are indicated.

2. RFID and Auto-ID Technologies

Automatic Identification (Auto-ID) systems consist of different technologies. Using OCR (Optic Character Recognition) machines, different writing types can be recognized. However, because of the high cost of these systems, the usage area is not so wide. As an example, OCR technology is used by reading the checks and saving them to the database of the bank. Biometric systems are used to identify the humans by recognizing the biological characteristics of them like face, voice or eyes. Barcode systems are mostly used to identify and track the products or materials. As these systems are not expensive, they are not programmable and have few data storage capacity. By using chip cards, some inadequacies of Barcode systems can be eliminated, but the mechanic contact between microchip and reader also has some disadvantages. If the contact surface is dirty and damaged, the reader can have some problems by recognizing the cards. RFID systems are similar to chip cards and have superiorities over the other Auto-ID technologies. (Fig 2)

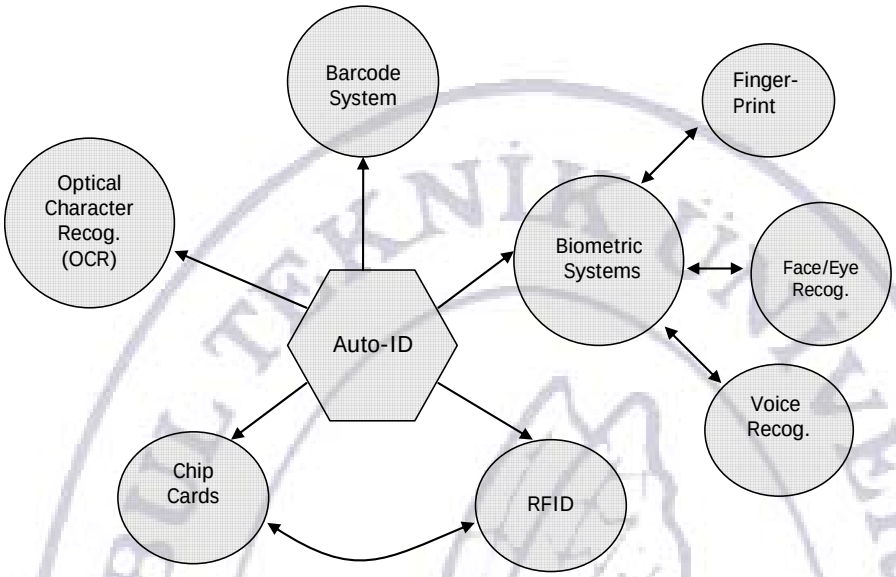

Fig 2 : Auto-ID Systems

2. The Characteristics of RFID Technology

A RFID tag can have very different forms. It can be formed as a small disk which has 1 to 10 mm diameter and a centered hole to screw. To inject under the skin of animals, it can be shaped as a glass capsule having length of 12 to 32 mm. (Fig 3) It can be put in a wrist watch to use for access control and it can also be a label to stick on a product in the supermarket.(Fig 4)

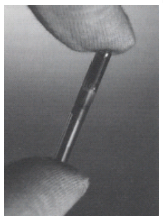

Fig 3: RFID glass capsule structure

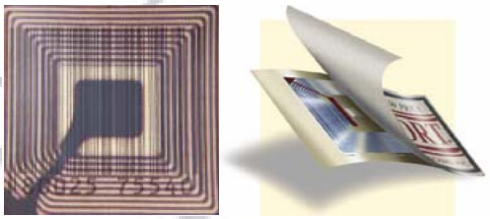

Fig 4: RFID smart label

RFID tags have two different types in terms of energy supply: Active vs. passive tags. Active RFID tags contain a battery to provide the microchip with power. This type of tag can send a signal independently to a reader. Active tags are often used to track high value goods over a distance of up to 300 meters.

Passive tags don't have a battery. This type of tag is powered indirectly via the electromagnetic radio waves from the reader. They have a limited read range and do not require maintenance.

RFID tags can be Read-Write, Read-Only or WORM (Write-Once, Read Many) types. The data on Read-Write tags can be changed or totally overwritten by any reader. Read-Only tags are written with a code by the tag manufacturer that can never be changed. WORM tags can be rewritten once by a reader. Read-Write tags are more expensive than WORM tags. So Read-Write tags can be better used in reusable packaging systems and WORM tags can be better used in disposable packaging systems.

It is very important for RFID systems, which frequency is used to send the electromagnetic waves. The higher the frequency is, the higher is the read range. Three different main frequencies are used by the readers.

- Low Frequency (LF, 30 kHz-300 kHz)
- High Frequency or Radio Frequency (HF, RF 3 MHz-30MHz)
- Ultra High Frequency (UHF, 300 MHz-3GHz) or Microwave (>3 GHz)

In high frequency systems, passive tags can be read up to 5 meters. In the table below, read range and data speed values are given for different frequencies.

Frequency	Short Descr.	Read Range (Meters)	Data Speed (Tags/ Sec)
125 – 134 kHz	LF	0,45	1-10
13,56 MHz	HF	<1	10-40
868 – 870 902 – 928 MHz	UHF	2-5	10-50

Tab. 1: Characteristics of the different frequencies

RFID systems have many advantages over Barcode systems:

- In RFID systems, data transfer between the tag and the reader is realized with no error. In Barcode systems, there is always a probability of occurrence of reading errors.

- Information in RFID tags can be changed if desired. As an example, temperature fluctuations can be written in RFID tags. In Barcode systems, information can not be changed. (new label is required)

- RFID tags have more data store capacity than Barcode labels.

- RFID tags don't need to be in the field of vision of the reader to be read. No line of sight is required. Barcode label must be visible to be read.

- RFID tags can deal with rough and dirty environments better, because tags can be integrated into the packaging materials. Barcode labels can not be read if they are dirty and damaged.

- RFID tags can be read in bulk. 10 to 100 smart labels can be read at once. Barcode labels must be read one by one.

- The average data reading speed of a RFID tag is 0,5 second. In Barcode systems, this value can reach up to 4 seconds.

- RFID tags are read automatically so no labor costs are incurred. Barcode labels are read manually and thus labor costs are incurred. Automated scanning demands standardization of barcode location.

- Passive RFID tags can be read in 5 meters but Barcode labels can be read in max. 50 centimeters.

- It is impossible to copy the RFID tags and their content can not be read by eyes. Barcode labels can be copied and changed easily.

3. The Application Areas of RFID Technology

RFID technology has been traced back to 1940s. It had military applications during the Second World War, but its commercial applications only began to be realized from the 1980s onwards. During the following 20 years, this technology is used in highway and bridge tolls, in tracing livestock movements, tracking and control of nuclear inventories and in tracking the vehicles through the assembly line in car manufacturing. Until recently, the technology has been too expensive and too limited for widespread mass commercial applications.

In 2000, the price of a passive RFID smart label was about $1. Today, the price of a passive tag has decreased to 20 cents. In a research in Europe, it is noted that the price of a WORM (write once read many) passive tag will be 0,05 Euro in 2008. In

another research which is done for the retail sector in 2002 by Frost and Sullivan it is noted that RFID market volume will reach to 8 billion dollar in the world in 2008.

RFID technology has a wide usage area today:

- Identification of objects
- Authenticity control of documents
- Maintenance, repair and recall of products
- Loss and theft control
- Entry and route control
- Tracking in natural environment
- Supply chain management: automation, control and process optimization

The cost of business processes will be reduced with the use of this technology in the future. In the RFID pilot projects over the world, the studies continue for the automation and optimization of the business processes.

The biggest companies of the retail sector, Metro, Wal-Mart and Tesco have begun RFID pilot projects. Metro established a retail store in Düsseldorf with the “Future Store” concept. IBM, SAP, Intel and other information technology companies give support to these studies in Germany. RFID smart labels are on each product in this retail store. All the products are being tracked in the shelves and depots using the readers. All the suppliers are controlling their product inventories on an electronic system. With the readers in the shopping baskets, the shopping details of the customers are tracked. There are also completely novel self check-outs where the customers themselves act as cashiers. They draw their articles across a scanner with RFID reader. Thus the prices are recorded. The customer may pay either cash or with credit card. Wal-Mart has begun RFID applications with its 100 suppliers on all

the pallets and boxes. In January 2003, Gillette ordered 500 million smart labels for its products. In a report of the consulting company A.T. Kearney for retail sector, it is noted that the inventory costs could be reduced by %10 and labor costs by %5 using the RFID technology.

The RFID technology will facilitate the use of warehouse and distribution centers. The products will not need to be stored according to the product types. They can be stored according to their size and shape. With the handheld computers, the products can be better located. Marks and Spencer tried the RFID technology on the 3,5 million reusable transport items (pallets, cases etc.). Thus, the time which is necessary to count the stocks is reduced by %80. Marks and Spencer estimated that the capital cost of RFID system will be %10 less than the annual cost of the Barcode system.

In the automotive sector, the RFID systems are usually used in the frequency of 2,45 GHz. In these systems, the tags can be read and written up to 10 meters and they can also stand 235o Celsius temperatures. These tags are used in the body shell work, painting and final assembly.

RFID technology can be used for product presentations and cross selling. As an example, if a cloth with a RFID tag is taken to the dressing room in the New York Prada store, the information about this product is presented to the customer visually using LCD monitors.

3. The Implementation Problems of RFID Technology

When implementing the RFID technology we need to take into account a number of physical characteristics that may lead to some problems. A possible problem with RFID is the overlap in the signal from different readers. (reader collision). Another

problem arises when too many RFID tags come within range of an RFID reader. (tag collision). Environment is also very important factor for implementation. As an example, high frequency electromagnetic waves are absorbed by water and low frequencies are influenced by metal objects.

Standardization is essential for the use of RFID in open supply chain. The content of the tag and the way in which the tag and the reader communicate must be standardized. In this respect, EPC (Electronic Product Code) developed by the Auto-ID Center is very important. European legislation currently limits the use of UHF technology. This issue must also be resolved for standardization.

Because of the lack of knowledge of the complex RFID technology, companies can have hardware and software installation problems. So they can fail their RFID projects.

4. Conclusion

The supply chain processes gain many benefits from the RFID technology:

- Better managing and tracking of the supply chain
- Better order fill rates
- Short order lead times
- Less time and lower cost for inventory management
- Less inventory shrinkage
- Lower labor requirements
- Improved customer service
- Better targeting of the customer
- Better modeling of the customer behavior

RFID provides efficiency, accuracy and security on the supply chain. Real time inventory and logistics information is shared at any stage of the supply chain by the supplier, manufacturer, distributor and retailer.

In the future, the business processes will be revised using the RFID technology. Supplier, distributor and retailer will take strategic investment decisions coming together. Customer relation management (CRM) will gain importance with the real time and accurate data. RFID technology will create a real paradigm shift in business processes.

So far today, the benefits of RFID are explained qualitatively in many studies. But there is a lack of quantitative evaluation of this technology. In further research, the performance indicators should be selected for a supply chain process to measure the benefits of the RFID technology. So the quantitative benefits of this technology can be indicated.

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