An inquiry into the characteristics, applicability and prerequisites of Radio-Frequency Identification (RFID) solutions in transport networks and logistics

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Abstract: *The use of intelligent solution represents the key factor for developing both the logistics sector and the economic environment. This paper analyses the Radio-Frequency Identification (RFID) technology and its role in the Supply Chain Management (SCM) especially in logistics and transport networks. The main objective is to demonstrate that RFID represents a solution for improving the transport networks and logistics sector by implementing various complex and intelligent solutions that can improve the actual economic environment.*

Key words: RFID, technological development, transport networks, logistics, barcodes

JEL Classification: L91, L96, M14, M16, R40

1. Introduction

RFID (*Radio-Frequency Identification)* is an automatic identification method that relies on storing and retrieving data without touch, remotely, using radio waves and devices called RFID tags and RFID transponders. The technology requires the cooperation of a RFID reader with an RFID label.

RFID technology involves storing information not through bar codes, but by means of electronic chips embedded in RFID labels or tags. The information can be read from a distance of a few meters through radio waves. The use of RFID tags greatly reduce the time and cost of gathering information.

Since the time when radio-frequency identification (RFID) technology was invented around this subject appeared numerous controversies. Submitted more than 30 years as a technology that will revolutionize the efficiency of production lines and distribution chains, RFID has indeed, in different proportions contributed to the success of great companies and retail groups in the world.

Currently, labeling with RFID tags is still a desideratum, due to the costs involved. Instead, used on a wider-scale, RFID labeling of pallets for example that are used for transporting divers merchandises brings numerous benefits for companies and they justify their investment in equipment, training and implementation in this technology by reducing the transport, logistic and storage costs considerably.

RFID technology is becoming more and more an integral part of the distribution and retail chains, large retail companies have implemented and are currently using RFID solutions for a long time.

As obstacles related to implementing a RFID solutions-costs, process modeling, testing the solution, standardization and the allocation of radio frequencies are, one by one, outdated, the real benefits for retailers and vendors begin to come out to light.

Also barcode technology and RFID technology represent a powerful tool for better traceability of products, to eliminate human error and logistical costs. Practical experience of using RFID tags and Electronic Product Code (EPC-Electronic Product Code) reported significant gains for transport companies, but also for logistic suppliers, in relation to:

- improving the management of stocks;
- avoid situations like "zero inventory";
- reducing the cost of inventory;
- reducing losses;
- improving the quality of logistics information.

In a shorter term, a better control management of all goods that need to be transported increases profitability.

2. Literature review

RFID is an automatic identification method regarded by some researchers as one of the most popular technologies in history (Cooke J., 2001).

RFID relies on storing and remotely retrieving data using devices called tags or RFID transponders (Fishkin K., Sumit R., 2003).

The Auto-ID system, based on RFID technology, is an asset inventory system important for two reasons. Firstly, the visibility offered by this technology allows for exact knowledge of the inventory level by eliminating the discrepancy between recorded inventory and physical inventory. Secondly, RFID technology can prevent or reduce sources of error.

The benefits of using RFID include cutting labor costs, streamlining business processes and reducing inventory incorrectness (Garfinkel S., 2002).

RFID is a technology with great value in business and with a huge potential that promises to replace the old bar code and contribute to the visibility of goods in real time, regardless of the logistics chain in which the point lies. We can find RFID applications in the most diverse fields, but their main use is in tracking objects (Want R., 2004).

In the simplest form, RFID is a concept similar to the bar code technology, without the need for direct visibility of the monitored entities. As the bar code systems requires a corresponding optical reader and special labels stuck on objects, RFID reader and equipment requires special labels attached to articles or even to be integrated into them (Moore B., 1999).

At the european level, the European Committee for Standardization (ECS) promotes the development of international standards for identifying technologies and automatic data collection. European Institute of Standards in Telecommunications (EIST) has drawn up standards for RFID operating at a very high frequency, as well as generic standards for short range devices (SRD), applicable to the equipment that is operating in areas of low and high frequency and microwave (Gobioff H. & all 1996). The Commission appeals to the european standardization organisms, in collaboration with the industry forums and contortions, to ensure that european and international standards meet the requirements of the European Community, in particular with regard to the issues of privacy, security, property rights (intellectual and authorization), to identify gaps in standardization and to provide an appropriate framework for the development of future RFID standards.

The RFID systems present in the European Union are currently starting to use the same frequency but the implementation or conversion of them is a complicated task because of the multitude of frequencies used.

At present time, RFID systems used in the logistic or transport sector are very diverse, establishing classifications is becoming very difficult because of the multitude of technologies used to implement RFID solutions. However, there are some universally accepted

classification criteria, among which: power supply method, transmission method, frequency type that is used, the amount of data stored on the tags and others.

3. The structure of an RFID system

An RFID system includes two essential components: the transponder and reader that are distant from each other, so that the connection is made only through radio waves via antennas. Obviously, the information is encoded into the digital transponder and the radio link is actually a data transmission.

Data exchange between the RFID reader and tag can use a variety of schemes for encoding and modulation. The signal transmitted by the RFID label reader contains an unmodulated carrier. The RFID tag and RFID reader will respond when the carrier will receive the unmodulated emission during which the RFID label impedance will modulate the signal response (see fig. 1).

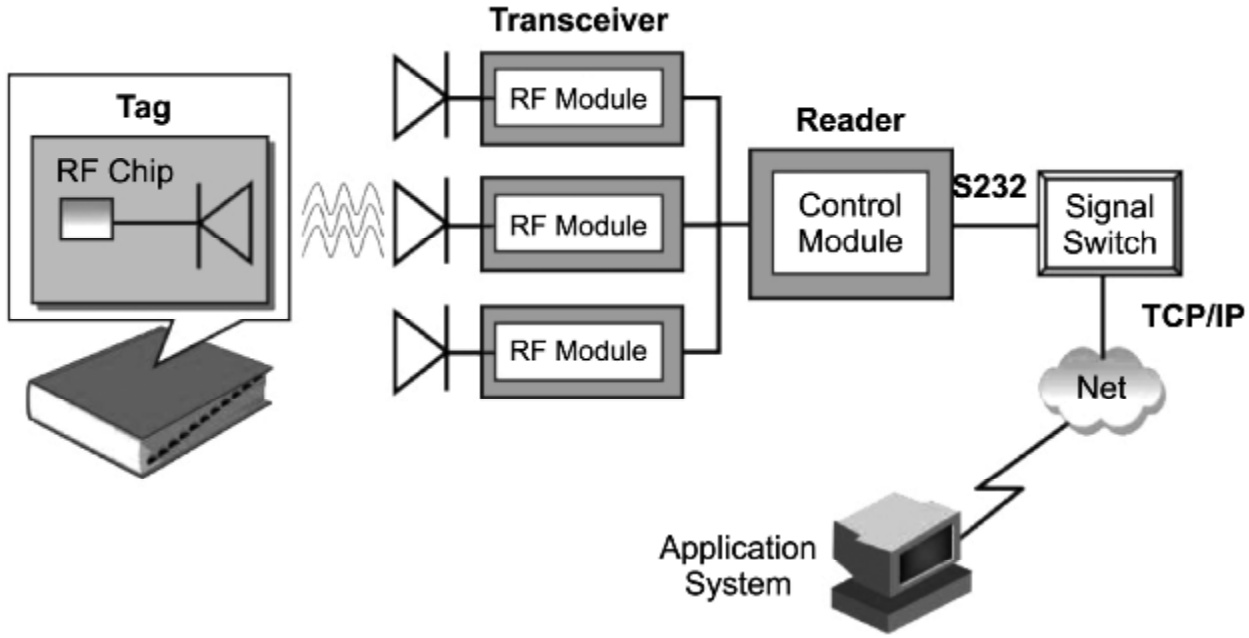


Figure 1: The main structure of an RFID system
Source: http://www.emeraldinsight.com

The integrated systems that are used for identifying RFID labels consist essentially from the following components:

• the labels themselves are movable components of the system and information carriers; they have a storage capacity of up to 3 KB and are used for writing and reading information ensuring the identification and traceability of the product and they are also available in various geometrical constructions covering a range of temperatures from -40 to + 210 °C;

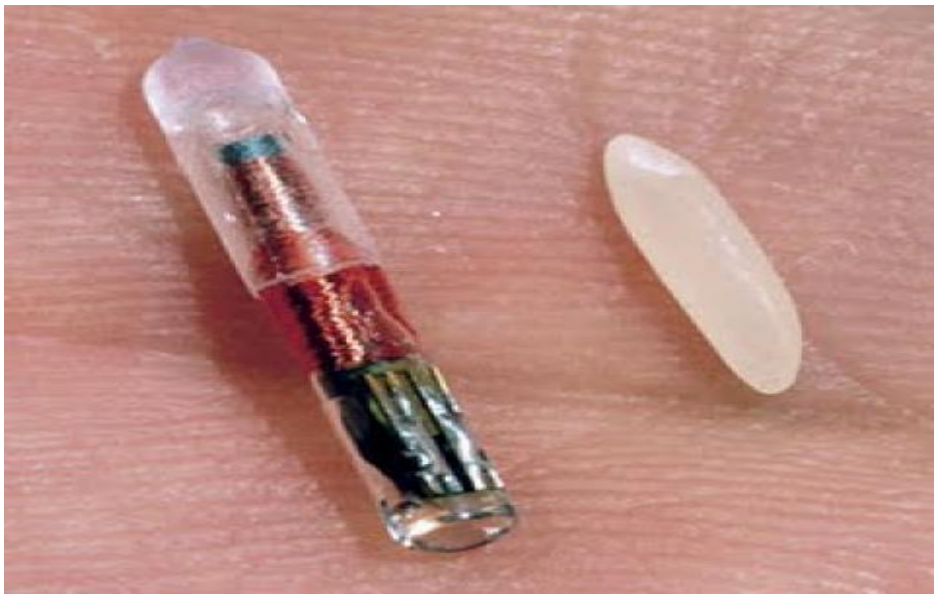
• the reading devices allows the enrollment of information and reading from/into RFID tags; connected over a network with specific equipment; they allow writing/reading RFID tags that are in motion;

• the communication interface ensures that the information is transmitted to/from the RFID tags;

• programming device labels - allows to enter data and program RFID tags;

• the antenna is considered to be part of a distinct RFID system and makes possible the transfer of information between the RFID tag and reading/writing device;

• the reading distance can vary between a few centimeters and a few tens of meters.



Picture 1: Increased picture of the latest generation of RFID device next to a grain of rice. This device is usually used for animal implant.
Source: http://en.wikipedia.org/wiki/Radio-frequency_identification

For data storage proposal, the RFID tag contains one of the following types of memory:

• a ROM memory that is used for registers and instructions from the operating system.

• a RAM memory that is used for communication and to store data temporally.

Due to the different radio spectrum in which RFID equipment and applications operate, they can be divided into several categories. The choice of optimal frequency band for RFID application is dictated primarily by the environmental conditions in which the system must function and application requirements.

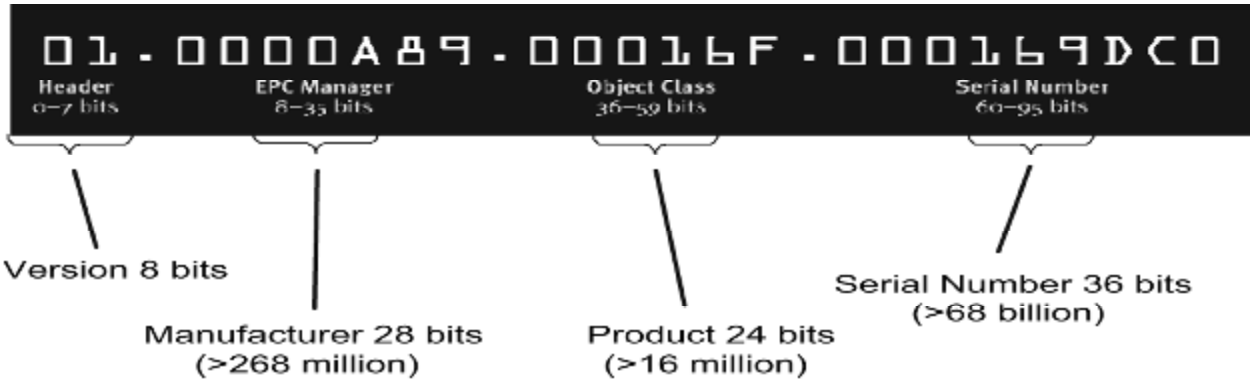


Figure 2: The format of an electronic code included in an RFID tag
Source: www.emeraldinsight.com

For Europe (see fig. 3) the operating bands are:

1. Low-frequency (LF):

F = 125/134 KHz - inductive coupled devices, for which most countries do not constitute approval for the use of this frequency from the E.U. (European Union).

The common applications for this frequency are:

• animal identification; • access control; • management of the containers.

The reading distance is 0.1m up to 1 m and is operating excellent near or in liquid metals.

2. High-frequency (HF):

F=13,56 MHz – this frequency is generally used for electronic surveillance elements.
The common applications for this frequency are:
• inventory; • documents control; • archiving; • storage; • transportation;
The reading distance is from 1m up to 3 m and has the most possible applications.

3. Ultra High Frequency (UHF/MW):

F = 850 MHz - 2,46 GHz – these frequencies are divided into two areas:

• the frequencies between 430 MHz up to 460 MHz which are used in industrial applications, scientific and medical applications;
• the hyperfrequency between 2,35GHz and 2,45 GHz.
The common applications for these frequencies are:
• transportation; • parking; • the management of containers.

The reading range is from 1m up to 12 m and it can be used also to identifying vehicles that are moving with speeds of over 100 km/h.

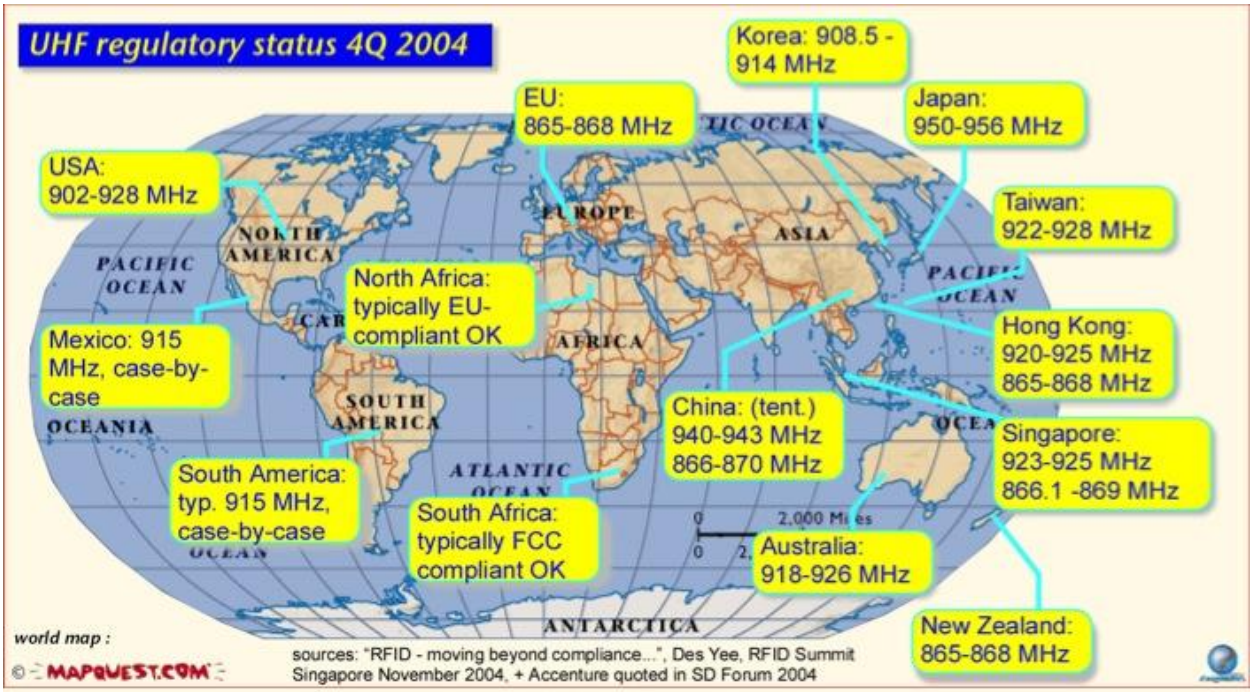


Figure 3: RFID frequencies around the world
Source: http://www.mapquest.com/

4. The implications of RFID technology in logistics and transport networks used as an intelligent transport system (ITS)

The implementation of new RFID technologies is slowly but surely substituting the barcode system which has become omnipresent in the logistics and transport companies. Starting with the middle 1980's the implementation of intelligent transport systems in the field of logistics and transport companies has become a necessity because of the growing worldwide economy. Thus, the implementation of RFID technology, which represents an intelligent tool in the transport sector and the Supply Chain Management (SCM) sector also, has overcome the barcode system which was not coping with the progress of the supply

sector. Compared to the barcode technology, RFID technology has the following classes of benefits:

- storage capacity: conventional labels based on the bar code can "memorize" a volume of information of only 20 characters. RFID technology offers the advantage of storage, of a larger volume of information;
- speed: compared to barcode technology, RFID technology can gather more rapidly information;
- the possibility of automation: reading the information stored in the RFID tag it does not imply the presence of the visual field and does not require a specific orientation of the product;
- flexibility: there are RFID tags that can be erased and rewritten again;
- selectivity: RFID technology allows the labels to respond to selectively requests.

Picture 2: RFID antenna for container access that are transported by truck
Source: http://en.wikipedia.org/wiki/Radio-frequency_identification

The logistics and transportation sector are two of the most important fields that RFID technology is applied. The use of RFID tags is used especially on container freight transport that is done on rail, highways, waterways or by air. The use of the RFID tags helps find out more easily the owner, characteristics, history, dimensions, load and the destination of a container.

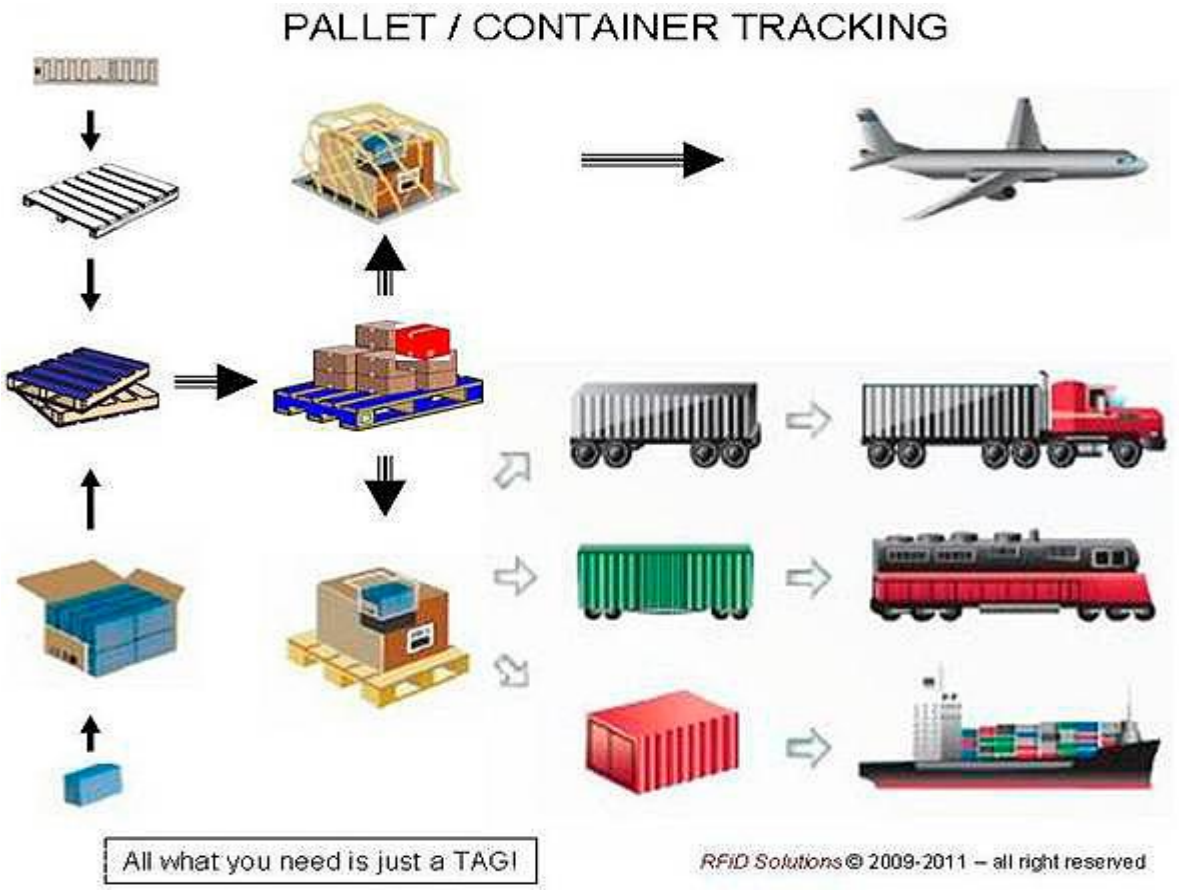


Figure 4: The use of RFID tags on locating a container or a pallet
Source: http://www.rfids.ro/wp-content/uploads/2009/11/image149.jpg

The implementation of RFID technology on a global scale can bring many benefits to transport and logistics companies such as:

• increasing efficiency and productivity by fully computerization the identification process of a container possible through metering, tracking, sorting and routing;
• streamline data collection and identification;
• reducing errors and losses;
• building a better inventory;
• streamlining the monitorization of mobility of objects;
• increasing profitability through cost reduction related to human resources and reducing the duration of processing of goods;
• efficiency on control quality;
• reduced maintenance costs in comparison with other systems of identification;
• increased customer satisfaction by providing the most accurate information;
• reducing subjectivity and support accountability;
• increasing the quality of products and services by offering competitive prices and most important rapid adaptation to market dynamics.

RFID identification technology streamlines data collection and removes human intervention. RFID technology is the most cost-effective solution for identifying if it is evaluated over the long term.

5. Conclusions / Recommendations:

The use of RFID technology in transport and logistics networks represents the future of the global economy. The importance of implementing this technology in all the major transport and logistics companies is represented by the fact that we need to streamline the costs that are involved, the time that is needed for identifying a pallet or a container and most important the time that is needed for the container / pallet to get from point A to point B. To better satisfy all the needs of the logistics and transport companies I recommend that we should use that same type of RFID systems all over the world that work and respond at the same frequency. Also the better cooperation between major companies can streamline the transport and logistics sector worldwide.

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