Escola Tècnica Superior d'Enginyers
de Camins, Canals i Ports de Barcelona
UNIVERSITAT POLITÈCNICA DE CATALUNYA

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Títol

Business Application Study of RFID Technology

Autor/a

Jacinto Jiménez Fuentes

Tutor/a

Antonio Batlle Fornells i Álvaro Garola Crespo

Departament

Infraestructura del Transport I Territori

Intensificació

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Introduction

The present work deals with RFID (radio-frequency identification) technology, which is nowadays mainly used to identify and track products, items or even employees. This technology facilitates the collection, storing and processing of information in order to, for instance, provide a higher stock visibility, eliminate manufacturing errors or increase production speeds. It is replacing more and more the less efficient bar code system, and its increasing importance in a various number of sectors, as well as its many different ways of using the technology, give reasons and motivation to look with more detail into the subject.

As mentioned, bar code applications have many deficiencies and disadvantages in comparison with an RFID system they are becoming old-fashioned in the meantime, and are more rarely applied by companies in a multitude of industries. But RFID technology is not just meant to substitute the bar code system, it is a technology that opens new ways and new possibilities of affecting positively many industrial, administrative, stocking and transporting processes, among others that will be seen.

This work is meant to be a reference for engineers and managers, providing in the first place, an introduction to get more familiar with the subject through description of the physical phenomena and technical characteristics of RFID. Further more, the work is meant to be used as a tool for managers and engineers to evaluate the implantation of RFID in their respective companies and business unites, which is the way to extract the most value out of this document.

In this sense, the core and innovating part of this work will be the mapping table in the third chapter with specific results that could be used by any company to find the appropriate applications of RFID within their field of business. It will serve as a primary selection and evaluation tool that would precede future next steps to find out in which fields the application would be more profitable, like for example the deep economic analysis of the applications considered.

Basically, the approach will be as follows. An evaluation table has been elaborated and structured to point out the relation between specific industry sectors, the advantages of the RFID technology and business units within a company such as supply chain, logistics and maintenance. A numerical value will be extracted to compare values with each other so as to support and propose the application of RFID in a specific business unit. Finally through interpretation of the relationship between advantages, business unites and industry sectors, it will be possible to extract valuable information from the table and be able to answer some concrete questions from it, which any manager would like to have solved in advance when dealing with the possibility of implantation of RFID technology in his company.

1. Intoduction to technical features and characteristics of RFID technology

1.1 RFID Components

There are two basic components of an RFID system: The reader (in literature also called interrogator) and a tag (or transponder which is an abbreviation for TRANSmitter and resPONDER). Furthermore, there is a database the reader communicates with to exchange and store information. The process of the whole RFID technology can be described as follows.

The reader emits an electromagnetic field with a specific frequency which will be captured by the antenna of the tag. The latter is connected with a silicon microprocessor on which a certain code or a digital information is memorized. This code will be „read“ by the reader and the information will be sent back to its source. In fact, the transponder doesn't create its own magnetic field to send a certain information back, but it rather causes changes in the field of the reader to communicate with it.

Reader:

The reader contains a microprocessor to control the actual reading process, a middleware with interfaces to other data-processing systems and to filter data and up to 8 antennas that emit radio waves and receive signals back from the tag. The reader then passes the information in digital form to a computer system. Apart from reading and passing the information to the database, some types can rewrite and change the stored information on the chip of the transponder and that's why readers can be named also as writers.

According to the application the interrogator can generate a varying magnetic field for low ranges or high frequency radio waves to reach higher distances. The waves also provide passive tags (see below) with energy through their antennas.

Moreover, as a particularity of a reader it can be mentioned that most newer readers have Ethernet, Wi-Fi or USB ports.

Transponder:

The transponder is fixed on a substrate and can either be embedded in a packaging or stuck on with adhesive. It consists of an antenna, a microchip, the casing and a memory that can be rewritable or invariant. Size and shape of the components depend on the frequency or wavelength. For example, the bigger the antenna is (to bridge longer

distances) the higher the expenses for the materials are due to the dimensions. But costs aren't always proportional with the dimensions. Tags with a size of a rice grain can be expensive due to their technological level. For example, the Japanese corporation Hitachi presented on 16.02.2007 a microchip as small as a dust particle (0.05mm x 0.05mm) with higher costs.

Tags are usually distinguished by their power supply:

Passive tags are provided with energy by the reader. The antenna captures this energy and sends back his identification code. They have an information capacity of 32 to 128 bits and since their code is unmodifiable they don't need any sensors, which results in remarkable cost advantages (see cost table below). For this reason, passive tags are commonly used to track items functioning as a wireless barcode. All things considered, they are relatively cheap and they have a quasi-endless life.

Active tags on the other hand have an onboard power supply and may have onboard sensors. Some can even draw energy from the sun. Compared with passive tags, active tags can be read in very long distances.

Battery assisted passive (BAP) tags (also called semiactive or semipassive tags): Semipassive tags have an intern battery as well and may incorporate sensors. The existence of sensors allow to store information in regular intervals and that's why these tags are used for example in the area of product and food transportation on given temperature conditions checking the temperature regularly.

Costs:

It's not possible to provide a list of every element because there is a huge variety of the components depending on their size, the frequency, memory capacity, design and dimensions of the antenna (copper in the materials), battery and packaging around. Therefore, since applications are all different, costs vary widely from implementation to implementation. That is why the following table will rather try to provide some guidelines for costs.

	Costs
A UHF reader	500 to 3000 dollars
An active transponder	10 to 50 dollars
A passive transponder	15 cents up to several dollars

Tabla 1

In general, it can be said that passive tags are the cheapest of the three transponders but they have the least capability. Passive tags are commonly used to track items

functioning as a wireless barcode. Semipassive tags are more expensive than passive tags, but cheaper than active tags, with capabilities falling in the middle as well. Because of their cost, semipassive tags are ideal in cases where a large number of assets must be monitored (with sensors), or in situations where the tag cannot be reused. Active tags are the most expensive, but offer the greatest capabilities. Currently, the military and highway drivers are the primary users of active tags.

Database:

When a tag passes through the magnetic field of a reader, the code will be decrypted and will be sent through the reader to the database. The database acts as the interface between humans and the decoded information in the transponder. Here, information can be prepared, edited, corrected, erased and used for the further utilization and individual product histories can be drawn up.

1.2 RFID Process:

Basic Overview:

The process RFID technology enables the carrying of data in the transponders known as tags, and retrieving this data whenever and wherever desired, by means of reading apparatus. The intended process starts then with by entering or programming data into the tags, task that can be undertaken at origin by the manufacturer, or at destiny by the user. Once this is done, the tag will respond to the reading device's request by giving back the information stored. The reading or interrogating apparatus retrieves the tags information and sends it to a host computer or information management system for its storage, as well as displaying it on a screen for example.

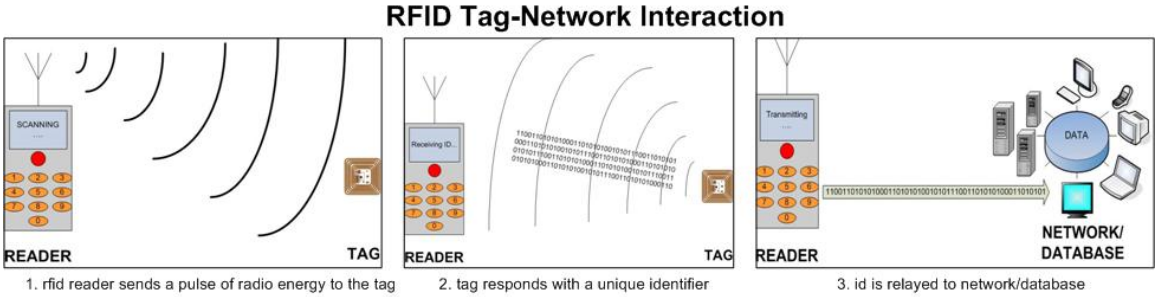


Ilustración 1

The tag is then the means of storing and sending information. It is conformed by an electronic circuit attached to an antenna or electronic inductible coil. This disposition has the property of transmitting an electromagnetic signal as a response to electromagnetic stimuli (sent by the reader), and is therefore usually referred to as transponders as well. The energy necessary for sending back a signal is obtained

differently depending of the kind of tag considered. For active and semi-active tags, energy is obtained out of a battery integrated to them, whereas in passive tags energy is obtained through movement of the tag through an electromagnetic field that induces then an electric current. These properties will be addressed and explained later on. On the other side, the storage memory comprehended in a transponder is usually separated in ROM (read only memory), which is responsible for the operating system of the tag by storing the operating instructions and security access codes. The RAM (random access memory), which is used for temporary storage of information during the interrogation and response processes. And finally the programmable memory that holds the information the client may consider desirable.

The manner in which communication of the tag's information to the reader is achieved, is through wireless communication technology. Two methods are distinguished, one based upon close proximity **electromagnetic or inductive coupling** and the other based upon **propagation of electromagnetic waves**. Coupling is via copper coils, in both tags and readers, in which electric current is inducted. These coils are generally called 'antennas', even though this term is more adequately used for the second system involving the propagation of electronic waves through them.

Conception of RFID:

Radio frequency identification is has its starting point in discoveries made by Faraday during the mid-nineteenth century on the one side and discoveries made between 1900 and 1940 in radio and radar technologies on the other. Faraday discovered the concept of mutual induction, which is the basic principium for powering passive short-range tags. On the contrary, high range tags must harvest energy to operate and backscatter the interrogation signal transmitted by the reader to communicate with it. Two discoveries form the basis for far-range passive RFID tags, first, the development of crystal set radios that provides for the ability of a tag to power itself by using the energy contained in the radio frequency signal to move a diaphragm that recuperated energy. Second, the discoveries of backscatter communication in the field of radar during the Second World: all objects reflect radio waves, and the tag can change the characteristics of the radio waves it reflects by changing the matching at the connection between the chip and the antenna making up the tag.

Tags capabilities:

There are many types of RFID tags in existence and they are all normally arranged in three main groups: passive, semi-passive and active tags. Passive tags are the cheapest of the four but have the least capabilities. Passive tags are commonly used to track items functioning as a wireless barcode. Semipassive tags are more expensive than passive tags, but cheaper than active tags, with capabilities falling in the middle as well. Because of their cost, semipassive tags are ideal in cases where a large number of assets

must be monitored by the tag, or in situations where the tag cannot be reused. Active tags are the most expensive, but offer the greatest capabilities. Currently, the military and highway drivers are the primary users of active tags.

Semipassive tags have an on-board power source that serves two purposes: it provides continuous power for the sensors and it allows the intelligence contained in the chip to function without harvesting energy. When monitoring an asset, it is critical to take sensor readings at the required intervals to obtain the complete history of the asset. The on-board power supply ensures that the semipassive tag can take these readings whereas passive tags become unpowered in absence of a reader. Another use of semipassive tags is to increase the read range. Because a battery powers the chip in a semipassive tag, the tag is not required to harvest energy to produce a stronger signal that is easier for the reader to detect, resulting in increased range.

Active tags have an on-board power supply, active receiver, distinct active transmitter, and may establish connection with each other conforming a network. Active tags are very similar to nodes in a sensor network. Their signal can be transmitted to a reader several hundred meters away. Similarly, the active receiver enables the active tag to receive a very weak signal from devices up to several hundred meters away. The active communications hardware enables active tags to be used in places with large amounts of metal, which is typically very unfriendly to passive and semipassive tags. Moreover, more memory can be incorporated into an active tag, and sensors may be incorporated on them as well in order to monitor any specific property of the elements they accompany. On the other hand, the performance of active tags depends on battery life, which is critical as an active tag cannot harvest energy from the reader signal as a passive or semipassive tags can.

Physical phenomena:

As exposed in the brief historical introduction in the “Conception of RFID” point, there are two modes of communication or coupling used by RFID technology: inductive coupling and capacitive coupling. Inductive coupling involves the reader emitting a magnetic field. When a tag enters the field, the chip will vary the impedance of the circuit that conforms the coiled antenna, this creates a response in form of a perturbation of the magnetic field, which can be detected by the reader. The strength of a magnetic field drops sharply with distance from the emitter, hence inductive systems are inherently short range. This is the mode of operation at high frequencies.

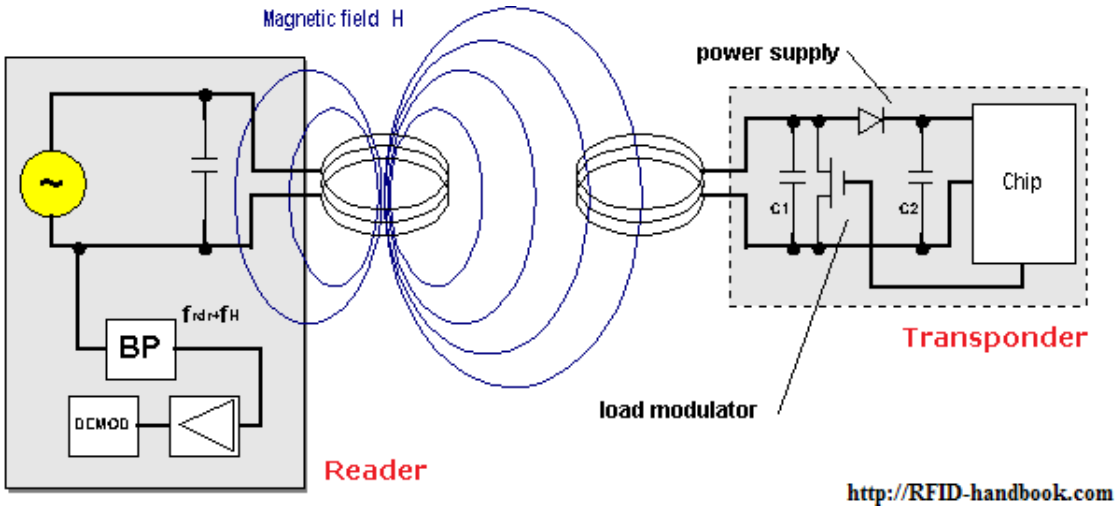


Ilustración 2

Capacitive coupling involves the reader propagating electromagnetic wave. In this case the reader sends an RF wave (radio frequency) and not a magnetic field. The problem is the extracting a direct current voltage from the RF wave. The tag needs to get this DC power from an incoming RF signal whose polarity changes about 900 million times per second, providing an alternate voltage through the antenna to the tag. The approach is to place in series with the voltage from the antenna, a diode that will ideally allow current only in one sense. Also, a capacitor is used to store the current between RF cycles.

The other part of the job is done by the Backscatter Communication principles. All objects reflect radio waves, these reflected waves are the basis for pulsed radar systems location and for radio frequency identification (RFID). Pulsed radar allows distance and direction to be determined. Backscatter takes advantage of the reflection of radio waves. The passive tag contains an antenna, which is used for two purposes: first to harvest energy from the reader signal command, and carrier wave, and second to communicate with the reader.

Communication of information through this backscatter signal is now to be addressed. The impedance matching between the antenna and the tag circuitry determines the amount of energy that can be transferred between the antenna and the tag circuitry. When matched, the maximum amount of energy is transferred between the antenna and the tag circuitry and this occurs when the imaginary parts of the complex tag circuitry impedance and antenna impedance completely cancel each other resulting only in a real resistance. When the matching is not optimal, a parasitic imaginary part is present in the impedance quantity. This can be either capacitive or inductive, and results in less power being transferred from the antenna to the tag circuitry. As a result, deliberately matching and mismatching impedances is used for backscatter communication. The tag can alter the matching by adding or removing an impedance, typically a capacitor, by means of a switch that creates a different path within the circuit for the current to pass through. When the capacitance is included in the circuit, the matching is not optimal and the tag reflects a lower amount of energy while, on the

other hand, when the capacitance is not in the circuit, the matching is optimal and the tag reflects another bigger quantity of energy. Using these differences between the two levels of energy in the return signal, the tag can modulate data onto the reflected radio waves and communicate with the reader. The modulation of information within a wave will be addressed later on.

Modulation:

Transferring data efficiently through air or space requires the data to be superposed upon a sinusoidal field or carrier wave. This process of superimposition is referred to as modulation, and various schemes are available for these purposes, each having particular attributes that favour their use. They are essentially based upon changing the value of one of the primary features of an alternating sinusoidal source, whether it is its amplitude, frequency or phase. The manipulation or modulation of these parameters is made in accordance with the data carrying bit stream (binary coding), and can be detected and reinterpreted by the reader dispositive. On this basis one can choose between amplitude shift keying (ASK) and phase shift keying (PSK) for RF communication, and also frequency shift keying (FSK) for induction communication.

Line of sight:

At this point, a distinction can also me made between non-contact data transfer and non-line-of-sight communication. Non-contact data transfer works, as explained, through the transmission of information by means of electromagnetic waves or by electromagnetic induction. However it requires adequately directing the signal sent by the reader at the tag so that this signal arrives properly at the tag and is then correctly sent back to the reader. This requires establishing visual contact of the tag for the reader to point at it adequately, whereas non-line-of-sight communication does not. On the other hand, in order to transmit considerable quantities of information faster, very high frequency systems are more useful, but are conditioned to more restrictive directionality limitations.

Interference:

The transmission of data is subject to interference of other waves, fields or channels of communication. Noise, interference and distortion generate data corruption and therefore communication channels must be guarded against in seeking to achieve error free data recovery. Moreover, the bit stream can be built in order to accommodate these needs, like for example through the introduction of redundant information that becomes useful when part of the information gets jammed or lost. Options concerning beat streaming are often referred to as channel encoding schemes and, although transparent to the user of an RFID system, the coding scheme applied appears in system

specifications, and defines different benefits and performance features for each different system.

Frequency ranges:

Common RFID Bands :

- Low Frequency : 125/134 Khz
- High Frequency 13,56 Mhz
- Ultra High Frequency 860-960 MHz & 2,4 GHz

For Low and High frequencies, all around the world people use the same frequencies (125 KHz (Low) / 13,56 MHz (High)). For Ultra High Frequencies and Super High Frequencies they depend on the region.

Region 1: Europe, ex-USSR and Africa

Region 2: America (North and South)

Region 3: Asia and Australia

Ilustración 3

Region	Region 1	Region 2	Region 3
UHF(MHz)	865-868	902-928	950
SHF(GHz)	2,446-2,454	2,427-2,47	2,4-2,4835

Tabla 2

These differences create advantages for some regions, for example America has more powerful passive UHF tags thanks to a higher frequency used compared to Europe and Africa.

These specific spectrums that are used for UHF tags are then divided into different channels or sub-bands. For example, in the United States, channels are 500 KHz wide, whereas in Europe it is 200 KHz. This enables the US to have approximately 50 available channels to operate in which operation in one channel is limited to 400ms after which the reader must select another channel to transmit. In Europe as they only have a 3 MHz wide total band they only have 10 channels to operate in a similar way.

	<135KHz	13.56MHz	863 to 950 MHz	2.45GHz
Memory capacity	64 bits (read only) 2Kbits Read-Write	512 bits to 8 Kbits	32 bits to 4 Kbits	128 to 32 kbits
Available Products	Read-only and Read/Write	Read-only and Read/Write	Read-only and Read/Write	Read-only and Read/Write
Data Transfer	1 Kbits/s	25 Kbits/s	28 Kbits/s	Around 100 Kbits and up to 1 Mbits/s
Reading Range	0,5 m	1 m	1-5 m	Few centimeters if passive and can go up to 100 m if active
Read Mode	Single and Multiple Reading	Single and Multiple Reading	Single and Multiple Reading (in all directions)	Single and Multiple Reading
Operating limits	-40 to 85°C	-25 to 70°C	-25 to 70°C	-25 to 70°C
Water effect	None	Mitigation	Mitigation	Disruption
Human Body effect	None	Mitigation	mitigation	Disruption
Applications	Manufacturing Process Vehicle ID Access Control Animal ID	Vehicle Fleet Luggage Libraries Laundry Service Logistics	Logistics Vehicle Fleet	Enterprise Automatisation Access Control Military Logistics Automatic Toll

Tabla 3

These different frequency modes are generally used in different conditions. Here is a table that characterizes those differences.

Most reading ranges don't exceed a few meters because of the small reading range provided by passive tags. However if RFID systems are to be used for bigger areas (10000 m^2) it is possible thanks to active tags that provide their own signal thanks to a battery.

Shielding:

One of the problems that can appear with RFID is the problem of data security. Imagine a world in few years where everyone has RFID tags in some of their belongings, anyone who as a reader could walk next to you in the street and steal information about you. This is why one of the ways of protecting you from this is Shielding.

In this specific case Shielding refers to a data protection that prevents people from being able to read the information you have on your RFID tags. On the ways of ensure this is to enclose your tag with metal. However this technic doesn't have the same efficiency depending on the frequency of your TAG.

Low frequency tags (125-134 KHz), such as those used for implantable devices for humans and pets and are quite resistant to shielding, tich metal is need in order to prevent most reads.

High Frequency tags (13,56 MHz) are more sensitive to shielding and few centimeters are sufficient to prevent reads.

UHF tags (860-950 MHz) are very difficult to read when within few millimeters of a metal surface. However if the distance between your tag and the metal is around 2-4 cm then it will be increased due to the poisitive reinforcement of the reflected wave and the incident wave at the tag. Another way of successfully shielding most reads of an UHF tag is to it within an antistatic plastic bag.

Collision and Anti-collision

We understand by collision the phenomenon by which different information arrives at the same time at the same point and at the same frequency. This leads to the incapacity of identifying and reading this information. In the RFID case there are two main collision types: reader collisions and tag collisions. A reader collision occurs when the readers that are near interrogate the same tag at the same time. The tag can't decode any reader signal. If different tags send a signal simultaneously at the reader, the signals collide and the read can't read any of the tags.

This is why a tag anti-collision protocol is needed to avoid this problem. They can be divided into two broad categories: ALOHA-based protocols and tree-based protocols.

The Aloha system is based on the fact that you send your message and if it collides with another transmission, you try to send it « later ». It tends to reduce the occurrence probability of tag collisions since they are going to try to send them at randomly selected times. The problem with this protocol is that, if you are unlucky, you might have to wait for a long time sometimes in order to be able to read your tag or even leading to the « tag starvation problem » which means some tags had no chance of transmission for a long time.

Tree-based protocols don't have this problem event though they have relatively long identification delays compared to ALOHA. In this system the reader sends a query to the tags and some answer. On passive devices tags aren't able to detect collisions, therefore the reader is going to do this part and adapt the next query depending on the fact a collision appears or not. On receiving a query from the reader a tag decides to transmit or not. The reading of a tag is successful only if a single tag transmits in a reading cycle. The goal of this method is to define little by little the right query to have a single response.

Therefore the reader tries to identify a set of tags in a reading cycle. If there are more than one tag responding we have a collision. If this happens, the mechanism splits the set of tag into two groups by tag ID's or random binary numbers. Successive splits lead to a single tag and then the reader goes back up to read the other tags from the other sub-sets using the same protocol to identify them.

Tree-based protocols are divided into two groups, binary tree protocols and query tree protocols. In the first case, when a collision occurs the reader gives randomly a binary number to two subsets. A tag not involved in collision has his value increased by 1. And when the reader detects no collision the all values decrease by 1 (which corresponds to going back up in the tree). Query tree protocols are based on tags IDs, the reader sends a bit string (starting with a 1 bit string, 0 or 1), and if the first numbers of the tag's ID correspond to the string then the tag responds to the reader. If two or more tags respond at the same time, the reader adds a number to the string (0 or 1) in order to separate the different tags. The advantage of this method is that it is memoryless, you do not have to give to the tag a number it has to remember after each reading cycle, it only needs an ID in order to identify it. However one of the problems that can appear is that if tags have very similar Ids the delay will increase. These systems are far from being perfect and other protocols based on those two protocols exist and have a lower collision rate.

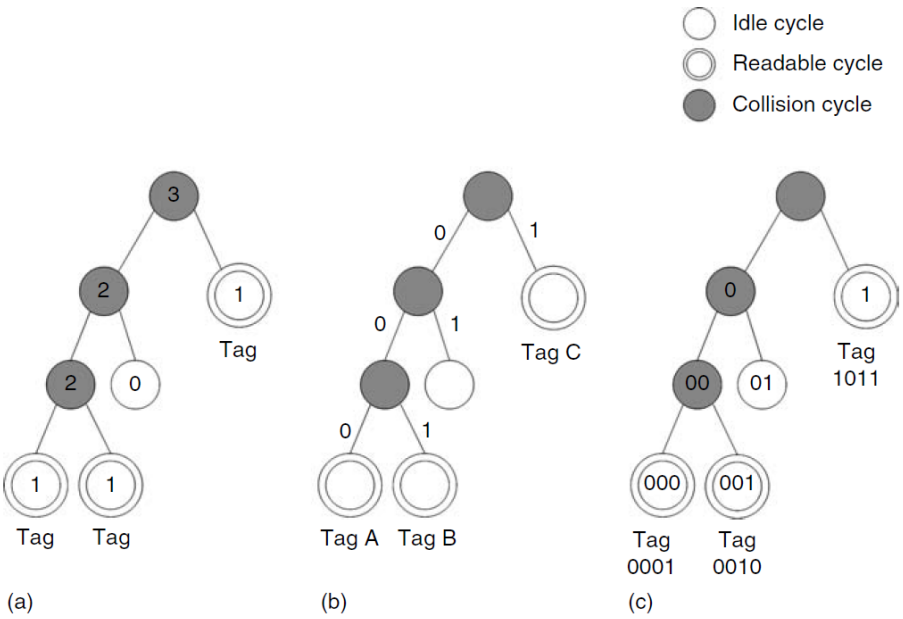


Ilustración 4

- *Idle cycle*: No transmission is attempted. The idle cycle does not make the reader fail to notice a tag, but it is a source of an unnecessary increment of identification delay.
- *Readable cycle*: Exactly one transmission is attempted. The reader recognizes a tag successfully.
- *Collision cycle*: More than one transmission is attempted. A tag collision occurs and the reader is unable to recognize any tags. The collision cycle defers tag identification and the tag's communication is pure overhead. The reader sends a query (or a feedback) conducting the split of the set including conflicting tags.

1.3 Advantages and Disadvantages of RFID:

As mentioned earlier, a series of advantages was defined after studying the properties and process particularities of operating with RFID. These advantages were used as the criteria upon which to scan and analyse a list of 25 examples of industrial application of RFID covering a wide diversity of industrial sectors or activities. Since these advantages are key to the construction of the table, their description will be left for later, when the table is to be presented.

1.4 RFID products/designs

Depending on the application and the environmental conditions such as cold, wet and windy conditions RFID transponders can have different visual appearances and designs. In this subchapter we will show few examples for illustration purposes.

In industrial environments RFID tags are normally used behind a metal barrier for protection and they transmit their data via small slots in the objects they are attached to. Here is a possible product design:

Ilustración 5

Some transponders need to be welded to metallic surfaces such as metal pipes or tools for the oil, gas, construction or other heavy industrial sectors. In this case the tag may have one of the following looks.

Ilustración 6

Transponders used in libraries usually have one of the following appearances.

Ilustración 7

On the pictures below we see an application example from the medical industry. The left picture illustrates a hand with the planned location of the RFID chip whereas on the lefthand side the hand can be seen after the operation to insert the RFID tag was completed. The yellow colour is from the iodine disinfection before inserting the chip.

Ilustración 8

Last but not least, too more different plastic casings for tags. The left image below shows the RFID transponder mounted on a container, which allows to track and locate it during the loading and unloading process of an oil platform. The image on the right-hand side shows an RFID tag used for electronic toll collection.

Ilustración 10

Ilustración 9

2. Survey of industrial applications of RFID and elaboration of mapping table

2.1 Introduction to the mapping table

In order to be able to adapt a new RFID system to a specific client it was desirable to create a tool that could enable anyone to classify different industries and ways of using the RFID system. This classification is mainly based on the advantages that having an RFID system can provide to the client who wants to implement this kind of technology and the organization that comes with it.

Therefore, our first goal was to set the advantages that could be graded using this RFID system. A list of 25 advantages was developed, advantages that were linked to the use of an RFID system and the graduation for scoring was defined (0-5) to answer the question: to what degree do RFID system/organization advantages help on any given industry? After having set these advantages the different sectors where one would find examples of applications were categorized, and cases of industries linked to this sector were studied. A scoring process was then made to grade every industry and specific system based on the list of advantages.

To have a clear view of what each system could bring, the advantages were classified in different categories/business units (12). Some of the advantages could be linked to more than one category of advantages; this is why it was decided to set a system of multiple choice crossing rather than a tree in which each advantage would fit in a specific category. This way, any given advantage can have positive influences among many categories of activities within a company. This also helps us calibrate better the scorings of each advantage by ponderation with a coefficient depending on the number of activities the referred advantage affects (coefficient = number of crosses). Thanks to this organization it was possible to evaluate for each industry the advantages RFID could bring, also calibrate which of these advantages have the most positive and widest impact on the company, and finally, quantify to what degree the implementation of RFID has positively changed the companies' activity.

This table is not only a way to classify the different industries and the way they use the RFID system. It is a real tool that can help further industries to use the RFID the way they want depending on what they want from this technology. Thanks to this table you just need to define the goals you want to achieve by installing an RFID system in your firm and depending on the graduation you can choose easily a system that has advantages that match with your goals. This table gives an opening to a narrow view one can sometimes have. For example for EDF, the solution that could fit them doesn't necessarily come from the energy sector they already know very well. It could come from a very different industry that uses the RFID system in a way that can provide to EDF the advantages they're looking for.

2.2 Applications of RFID to industry sectors

2.2.1 Direct industrial applications:

- Supply Chain management
- Traceability of the delivery
- Administration of the stock
    - Control and visibility of inventory
    - Localization (tracking objects during manufacturing)
- Control of dangerous materials/hazardous goods (no need of staff → prevention of accidents)
- Sorting out and sorting in the factories
- Identification of machines, cars, lorries
- MRO (Maintenance, Repair and Operations)
- Textile and clothing industry (anti-theft system and payment at cashier station)
- Naval industry (for example Identification of containers)
- Waste management

2.2.2 Non direct industrial applications

- Security
- Identification in airports (chips in identity cards)
- Bus and metro tickets (e.g.: Navigo in Paris)
- Money market: Integration of transponders in banknotes (forgery)
- Combating forgery of medicaments
- Credit cards
- School bags of pupils of elementary schools not to get lost

Others:

- Medical technology (artificial respiratory equipment, heart pacemaker, apparatus of dialyse etc.)
- Identification of animals
- Automobile industry (immobilizer system)
- Retail industry

2.3 Mapping – RFID meets Industry (Explanation of the Table)

Introduction

In order to be able to adapt the new RFID systems to a specific client the creation of a tool was considered, which could enable us to classify different industries and ways of using the RFID system. This classification is mainly based on the advantages that having an RFID system can provide to the client who wants to implement this kind of technology and procedures. Therefore our first goal was to set the advantages that could be granted by the use of RFID systems. A list of 25 advantages that were linked to the use of RFID systems was defined. After having set these advantages I tried to see the different sectors where to find examples of applications and study cases of industries linked to each sector. A scoring process was then made to grade every industry and specific system based on the list of advantages.

To have a clear view of what each system could bring, the advantages were classified in different categories of business units (12). Given that many of the advantages could be classified under different business units it was decided to set a matricial system of classification, rather than a tree in which each advantage would fit in a specific category. This way one manifests the fact that any given advantage can have positive influences among many categories of activities within a company. This also helps us calibrate better the scorings of each advantage by ponderation with a coefficient depending on the number of activities the referred advantage affects. Thanks to these and other considerations it was managed managed to evaluate for each industry the advantages RFID could bring, also calibrate which of these advantages have the most positive and widest impact on the company, and quantify to what degree the implementation of RFID has positively changed the companies activity, among several other achievements.

Therefore, this table is not only a way to classify the different industries and the way they use the RFID system, but also a real tool that can help further industries to use the RFID the way they want depending on what they want from this technology. Thanks to this table you just need to define the goals you want to achieve by installing an RFID system in your firm and depending on the graduation you can choose easily a system that has advantages that match with your goals. This table opens up to the initial narrow view one has when confronted to a problem of this magnitude. For example, in the case of the company EDF, the solution that could fit them will probably not come from studying solutions already applied in the energy sector, which they already know well enough. It could come from a very different industry that uses the RFID system in a way that can be applied by EDF and provide the desired benefits.

2.3.1 Objectives of the Table:

The following table expresses the means by which to study the application of the RFID technology in the vast world of business. The table includes the many dimensions in which RFID is useful as well as the industry sectors in which it is applied and also the concrete business units it is integrated in. By means of this table, and as will be explained as follows, t will be possible to give quantified answers to the following questions.

1) **How important is RFID technology for any given industrial application?**
2) **What business units does RFID generally most positively affect?**
3) **What business units does RFID most positively affect for certain industrial sectors?**
4) **When certain RFID advantages are pursued, to what degree are each generally required (and therefore is RFID required)?**
5) **What Advantages of RFID technology commonly cause the most positive impact within the industries?**
6) **What industries do I need to look at as an example of RFID applications if I want to improve performance of certain business unit in my industry?**

These questions will be referred to when the moment of explaining how to answer them with the table comes (when each part of the table is explained). The order of appearance may change, but the question will be identified according to the previous numbering.

The answers to these questions are a great starting point from which to start considering the areas for implantation of RFID systems. Of course, once this has been done, further study concerning costs and viability will have to be undertaken. The value of this work stems from the fact that it allows to clearly identify the business areas in which RFID has the highest potential to succeed and to draw the most results.

In order to complete the table, an in depth study of many different industries, categorized in many different industry sectors has been done. A brief description of all the cases studied will be presented in order to understand that the evaluation that has been undertaken is justified by in depth knowledge of each of the industrial applications studied. The advantages used in RFID applications will be analysed, and it will be required to know precisely which of these advantages the industry is using and to what degree.

In order to understand the way the table works it is convenient to start by addressing the attention to the key element of evaluation: the advantages that RFID provides for.

2.3.2 Advantages and Disadvantages of RFID:

Advantages used in the evaluation of RFID application:

As mentioned earlier, a series of advantages was defined after studying the properties and process particularities of operating with RFID. These advantages were used as the criteria upon which to scan and analyze a list of 25 examples of industrial application of RFID covering a wide diversity of industrial sectors or activities. **The degree to which RFID has an impact by means of the advantages it provides to the industry, was then evaluated for each of the industrial applications examples.** To put it simpler: RFID has advantages, each of these advantages is more ore less important for a certain industry, and therefore RFID is more or less important to the industry. Evaluation of the importance of the advantages is therefore correlated to the importance of RFID within the industry. For each advantage it is also defined the industry that applies RFID, the sector of this industry and, as explained, the scoring of the advantage impact or importance within the industry (see annex).

The advantages and disadvantages that derive from the way Radio Frequency Identification works are as follow.

- New business/service: this advantage concerns the possibility of deriving a completely new business out of the use of RFID. It is the most entrepreneurial advantage of the use of the technology for direct income of benefits, and not just a quest for efficiency.
- Size: very small sizes of RFID are another advantage that may be useful to the company. The degree to which the tags satisfy the size restrictions of the company is what the scorings will evaluate.
- Link to database: the information transmitted by the tags is usually to be stored into databases. These advantage concerns the possibility of having a direct link between the reader and the database for automatic actualization of the data.
- Process time consumption: reduction of the amount of time invested in any given activity where RFID is introduced.
- Process materials consumption: reduction of the amount of materials invested such as roar materials, supplier merchandise, etc. in any given activity where RFID is introduced.
- Process Human Resources consumption: reduction of the amount of labor invested in any given activity where RFID is introduced.
- No line of sight: no need of visual contact for information reading. It is an option inside RFID varieties of solutions. The operator (human or automate) does not need to spot the location of the tag in order to point the reader at it and obtain a lecture.
- Unlimited readings: the number of data readings is a given capability of passive tags. The degree to which this advantage is required by the company, and ergo to which RFID enables, is what is to be scored.

- Quick reading of data: refers to the immediacy with which data flows from tag to reader. This is sometimes a critical factor in some industries where there is an immediate action to be taken shortly after the reading is performed and checked.
- Unlimited rewritings: unlimited number of data rewritings of the tag through space, without need of direct physical contact manipulation.
- No batteries: passive tags do not need batteries, which is obviously an advantage.
- High range: active tags enable higher distance readings thanks to the inclusion of batteries that empower the return signal with a higher reach.
- Automatic reading: automatic detection and transmission of data when passing through portico doors, reader portals, checkpoints, reader desks, etc.
- Simultaneous readings: when information of many tags is to be obtained as quickly as possible for posterior analysis it becomes useful to be able to perform the reading of many tags at the same time. Also when tags can be located very close to each other, it is necessary to have certainty that their signals do not interfere with each other, and that all tags are read.
- Great storage capacity: for certain applications the amount of data to be supported by a tag may become considerable enough as to consider the use of tags with larger memory capabilities.
- Transmission of data through space: refers to the fact that information for RFID is transmitted through the air, without need of physical contact, like would require for example a USB stick, memory cards and cartages, etc. The degree to which this property is exploded is to be rated with the scoring.
- Durability: lifespan of decades. RFID tags are easily largely perdurable, especially passive tags, which not even need substitution or maintenance.
- Comfort: it can be expressed in three categories of ergonomics.
    - Physical: related to the bodies well-being. For example RFID allows workers to simply point the reader device approximately at the tag, without need to adapt the body's position, or even search for the location of the tag making any physical effort.
    - Cognitive: related to the minds well-being. Putting at ease mental processes, such as perception, memory, reasoning, and motor response. For example by liberating the workers mind from the concentration needed in order to find a code bar or to read a small serial number.
    - Organizational: concerned with the optimization of social systems within a company, including organization, policies, and processes. RFID changes the way of many processes, meaning the way to perform old tasks has to change, affecting the way people are organized for this purpose. For example, before RFID was installed, a whole team of people may have been in charge of identification of certain merchandise, whereas with RFID maybe a single person can perform the task changing the priority activity of the rest of the group.

- Miniaturization capabilities: one of RFID developers focus is to perfect and reduce the dimensions of RFID tags in order for this technology to be applicable to industrial sectors where size of the attached tag may be a problem. Such sectors are the medical sector, with RFID tags in pills and chirurgical material, or the electronics sector, in which components are already small themselves.

- Synergy capabilities: when RFID tags have been applied for a certain purpose, it is not uncommon that other segments of a supply chain also want to benefit from its application. Also maintenance can take profit of it for example. Possibilities and options are large once the first step inside RFID is given. Integration with databases or with new multiple software applications with new possibilities.

- Installation simplicity: tags are conceived with the purpose to facilitate installation. From the example of simple thin glued tags that can be stuck to surfaces or tags that can be magnetically clipped to clothes, all the way to tags that are included to any given device while its fabrication is performed.

- Monitoring / Real time alerting / actualization: refers to the capacity of a tag to self-actualize or gather new information before it transmits any data, by means of sensors measuring any information or property of interest. This allows to monitor a property of the object the tag is attached to, to alert in case that the property reaches a certain magnitude (by automatic reading of the tag), and to constantly have actualized information and a history of the properties evolution.

- Flows monitoring / traceability: advantage that allows tracking moving objects and determining their position in, for example, a production or supply chain. Traceability is possible by the detection of tags when going through reading checkpoints, portal readers, etc.

- Information security: refers to safeness of the information that is considered protected property of the company. RFID allows different options of codification and encrypting.

- Security enabling: refers to the fact that by installing RFID systems, the new processes the company obtains may be safer for the workers. This is especially pertinent to industries in which workers work in unhealthy or unfriendly environments, like meat frigorifics, siderurgical manufactures, etc. If RFID reduces or eliminates exposition to these situations this will mean that an increase in the security of companies' activities has been enabled by RFID.

- Resistance/reliability: RFID systems must are also challenged by extreme usages in which, climate, humidity, temperature, magnetic fields etc. can affect their performance. Solutions for these problems are already an option within the industry and therefore an advantage to be considered.

Disadvantages

About the disadvantages that are about to be discussed, the choice has been made of not including them when addressing the evaluation of RFID within the industries. The reasons are, in the first place, that certain disadvantages are controversial issues that I

am not suited, nor willing, to decide upon or evaluate. Intervention on these topics would make the analysis become too subjective. Therefore it is enough to explain and elaborate on the disadvantages for the interested company to judge whether application is or not finally appropriate from a social point of view and corporate image.

In second place, some disadvantages as for example cost are on their own suitable of complete analysis that would allow for a whole new study (for each company!). Finally, other disadvantages are merely contextual, as for example those concerning interferences with information waves or materials that absorb or interact with RF signals like metals and water, and are easy enough to spot when the time of considering installation of this technology in a specific context.

- Privacy issues in social applications. When personal information carried by RFID tags may be suitable of interception, like for example in passports, or in paying RFID systems in which bank account information may be subtracted. Also on specific applications like traffic monitoring, pinpointing drivers' position, velocity, movements or trajectories.

- High cost: the costs of RFID implementation are considerably higher than traditional methods like the code bar (especially when considering the very high cost of active tags), but this matter must anyway be topic of specific study because advantages can easily outweigh disadvantages like this. Moreover, it is even probable that costs end up being another advantage in the long run when considering the achievement of higher degrees of efficiency, reduction of process time, materials and human resources. Also thanks to savings concerning maintenance.

- Signal problems: transponders can be surrounded by materials that absorb the RF signals or interfere or modify them. Water or metal may sometimes be problematic concerning RFID some possible applications.

- Limited lecture distance: more than a disadvantage, this is only a requirement to remember. Reading distance varies between the RFID tags in the market.

- "Invisibility" of tags: it is referred by this the fact that for certain tags the operator still need to find the tag, what is called line of sight requirement. Some other tags do not need this and therefore this aspect is also considered as an advantage. On the other hand, the fact of not needing to find the tag can also become a problem if one forgets it is there and reads its signal instead of the signal of another tag that was the intended one to be read.

2.3.3 RFID Applications Studied for Evaluation of the Advantages:

In this section the applications of RFID technology studied are explained in detail. To see the scoring and categorization proceed to the annex. 25 applications have been studied in order to create the table, obviously, as more applications are studied, more valuable and representative the table becomes in delivering the intended conclusions.

1. RFID Protects Casino Against Theft

The article, written by Justin Rohrlich, reports: "At 3:50 am this morning, a man in a full-face motorcycle helmet walked up to a craps table at the Bellagio hotel-casino in Las Vegas, pulled a gun, and made off with approximately $1.5 million in chips, ranging in value from $100 to $25,000. However, while the chips were worth seven-figures at 3:50 a.m., at 3:51 a.m. they weren't worth a thing—and any potential financial damage to the Bellagio is exactly none."

According to the article, the Bellagio has a secondary set of chips with a different design, which can immediately be used to replace every chip in the house, so that the stolen chips can no longer be used. Moreover, most chips with a face value of $100 or more, as well as some with a face value as low as $25, have embedded RFID transponders. Thus, each chip can be uniquely identified.

Criteria: Advantages (what RFID allows to obtain), scores (how much useful is the previous RFID advantage within this application), and category (which of the enterprise's topics does it address):

2. Emirates RFID Bag-Tracking Pilot Takes Off

Feb. 19, 2008—Emirates Airline has begun a six-month technology trial to test the use of RFID to improve the tracking of checked luggage. Instead of using the standard, bar-coded ID tags that airlines normally employ to identify baggage, Emirates is placing tags with embedded UHF EPC Gen 2 inlays onto each checked bag.

The airline hopes using RFID combined with automated bag sortation equipment will increase the amount of luggage it can accurately identify and sort, thereby decreasing the number of bags that fail to reach their destination on time.

To track the bags from the point of departure to the point of arrival, RFID interrogators read the unique ID from the inlays in each luggage tag as the bags are moved through a number of chokepoints within each airport. Conventionally, bar-code scanners are employed to identify the tags, but because bar-code technology requires a clear line of sight between the scanner and a printed bar code, the read is often missed due to the orientation of the label to the scanner.

Bags that aren't automatically identified through their bar code or RFID number are diverted and manually handled, thus increasing the likelihood that a bag will be delayed and not loaded onto the same flight as its owner. According to the International Air Traffic Association (IATA), a trade group composed of airlines around the globe, the annual cost of mishandled baggage to the industry is more than $3 billion.

3. IBM Offering IT Asset-Tracking Solution

May 13, 2008—IT giant IBM is launching a packaged RFID solution enabling companies to track valuable IT assets. Four data centers operated by IBM—three in Europe, one in the United States—as well as a data center operated by a major insurance provider located in Germany, are already employing the RFID-based system to improve the speed and accuracy with which they can track valuable, mobile IT assets such as blade servers, laptops and peripherals. Based on the success of those deployments, IBM is now marketing the RFID solution to other companies as well.

4. Boeing Tracks Assets at Kennedy Space Center

RFID Global Solution's real-time locating system allows Boeing to track its tools as they are used on NASA spacecraft in real time, and to ensure none are left at the launch pad. Nov. 13, 2008 Boeing is using a real-time location system (RTLS) at NASA's Kennedy Space Center (KSC) to reduce man-hours spent inventorying tools, and ensure that none are left at the launch pad.

Much of the work performed on spacecraft and at the launch pad is conducted at night, so as not to interfere with KSC's daytime activities and limit the impact on the majority of the center's personnel. In the dark, however, tools can be difficult to locate, and that means a diligent contractor must spend as much time as necessary to locate all tools used at the site before leaving. A stray piece of equipment or tool left behind at the pad could be disastrous, since it could damage a spacecraft during takeoff. Harm to even one tile could render the vessel fatally damaged.

After an initial deployment of about 600 tags, the company plans to attach tags to 3000 other tools and pieces of equipment. The company uses active RFID tags to provide tracking in real time.

in 2007,the firm was still using a team of employees to track and inventory its assets on a regular basis by simply seeing them and recording them on paper.

5. USDA Approves First UHF Tag for Animal Identification System

The agricultural department says an EPC Gen 2 RFID tag from Eriginate can serve as an alternative to low-frequency RFID tags for use with its National Animal Identification System (AIN).

Since the outbreak of mad-cow disease, RFID has become crucial in animal identification management.

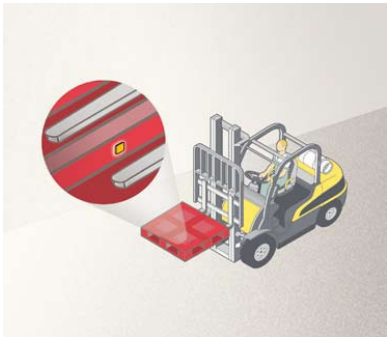
Tags currently employed by ranchers and cattle auction companies help to track the movements and health of cattle.

6. Rugged Tags Enable Accurate Pallet Tracking

Pallets are subjected to harsh conditions. They may be left outside for extended periods, hit or scraped repeatedly by forklifts, or damaged during transport. For these reasons alone, using barcodes to individualize the pallets is impractical, not to mention the additional labor cost such an approach would require.

The tag also needed to be orientation insensitive, because forklifts (which have RFID readers directly attached to them) access pallets from any side.

Mighty Card's rugged tags - readable up to 10 meters distance - will enter full production in the second quarter of 2009. (product :"Mighty card", a specially packaged tag chip that withstands more stress. Mighty Card put the tag through environmental stresses, including dropping it three meters onto concrete, temperature cycling it from -20 ºC to 85 ºC, immersing it in water down to 1 meter, and subjecting it to 95% humidity. The tag passed all tests successfully).



7. ClearCount's RFID-Enabled Surgical Sponges Now Available (Chapter: hospital operating rooms in wikipedia)

In 2008, ClearCount Medical introduced the SmartSponge System, the first RFID-based system approved for use in the operating room. The system incorporates RFID tags into surgical disposable gauze, sponges, and towels to help prevent medical teams from inadvertently leaving sponges inside surgical patients. The system automatically

provides a device-reconciled count by directly matching the unique identifier on each tagged item both entering into and then out of the surgical case.

8. RFID Sensors Detect Corrosion

A solution being developed at Oklahoma State University could provide early warnings of possible structural failures.

The researchers developed a sensor using a low-frequency RFID transponder. Initial versions used the metal on which corrosion was to be detected to connect the RFID chip to the antenna. If the connection eroded, the RFID transponder would stop working, indicating a potential problem.

9. RFID Tracks Oil Co. Containers and Ships in Newfoundland

A. Harvey is tagging its containers, as well as some vessels and trucks, to increase the visibility of its operations providing equipment, tools and food to offshore oil rigs.

A. Harvey, a Canadian provider of marine and offshore oil and gas support services, is installing an active real-time locating system (RTLS) to locate and track the movements of containers as they are stored and then moved onto and off of vessels destined for oil rigs in the northern Atlantic Ocean.

10. Payment by mobile phones

Since summer 2009, two credit card companies have been working with Dallas, Texas-based DeviceFidelity to develop specialized microSD cards. When inserted into a mobile phone, the microSD card can be both a passive tag and an RFID reader. After inserting the microSD, a user's phone can be linked to bank accounts and used in mobile payment.

Dairy Queen in conjunction with Vivotech has also begun using RFIDs on mobile phones as part of their new loyalty and rewards program. Patrons can ask to receive an RFID tag to place on their phone. After activation, the phone can receive promotions and coupons, which can be read by ViVOtech's specialized NFC devices.

Similarly, 7-eleven has been working alongside Mastercard to promote a new touch-free payment system. Those joining the trial are given a complimentary Nokia 3220 cell phone, which after activation can be used as an RFID-capable MasterCard credit card at any of 7-Eleven's worldwide chains.

Nokia’s 2008 device, the 6212, has RFID capabilities also. Credit card information can be stored, and bank accounts can be directly accessed using the enabled handset. The phone, if used as a vector for mobile payment, has added security in that users would be

required to enter a passcode or PIN before payment is authorized. Technology: RFID Micro SD Cards.

11. Traffic monitoring

Governments use RFID applications for traffic management, by measuring the travel time of cars with toll-collection transponders in order to provide commuter updates. The Orlando/Orange County Expressway Authority (OOCEA) is deploying an RFID-based traffic-monitoring system in central Florida. RFID readers collect signals from transponders already installed in about 1 million E-Pass and SunPass customer vehicles, which are both automatic toll payment methods used in central Florida. Containing a passive tag, these E-Pass and SunPass transponders are slightly larger than a credit card and attach to a car's windshield. The goal is to implement a system that would trace the travel time of individual cars as they pass the roadside readers, create an average trip time and then disseminate that information to the public.

Ilustración 11

The installation of readers above the road on the expressway authority's system, positioned about half mile apart on the expressway, will track travel time and send traffic-flow data to be monitored by the Florida Department of Transportation (FDOT) and the OOCEA. There, data will provide for calculations done by a data server and then results will be sent back to the FDOT to be distributed to the public. Information about commute times will be sent to the public on dynamic message signs, installed at motorists' decision points around the roadway system to provide up-to-date traffic information. Motorists will also be able to access traffic information by calling the national travel information telephone number or by accessing a web site or maybe even mobile phone applications.

The roadside readers capture the transponder's unique ID number. Privacy issues have already been raised by people in California, however the company and the FDOT have stated that the technology does not allow for privacy violations. Once a driver's ID number is captured by a roadside reader, the number will be encrypted and sent to the FDOT server to be temporarily stored. Farther along the road, the next reader will read the same toll tag ID number, encrypt it again and send that information to the server. After the data server receives data for the same toll tag from two separate readers, it calculates and saves the travel time, and erases the encrypted ID number.

12. Toll Roads:

RFID technology is used on the paying points distributed along toll roads. This is an already well extended application of RFID, and though there are different varieties of ways of implementation, the most common one is through the installation of an RFID passive tag sticker on the cars windshield. When the car arrives to the toll spot, it enters

the readers magnetic field and gives back the information required for the opening of the tolls gate. This is done without need of stopping the car, at about different speeds that can easily be of 50km/h. Though RFID technology allows even higher speeds, toll spots are not safe enough to bee past faster, due to the concentration of cars at different speeds and the narrowness of the lanes.

13. Public Transport Access (bus, train, subway…):

The main way in which to take profit of RFID technology the public transportation purpose is to integrate a passive tag on the card users use to get access the subway, train or bus. The RFID allows users to not need to search for their card inside wallets or bags, but rather to simply hold these close to the tag reader, which then opens the gates or validates access. This capability offers great saving of time by address the queue management problem in rush hours, by accelerating the interaction between the queue server and the user.

The RFID tag can be recharged with money that is deduced when the user travels through the different possible journeys. Another possibility is to purchase unlimited number of journeys for a month or any time extent the transport authority may want to tariff. Any of these options require the tag information to be able rewritable.

The next natural evolution of the process is the use of tags with a higher distance reading capability in order for the tag to be detected without need of visually locating the reader and holding the tag close to it. This would be a “no line of sight need” advantage, but is not extended in today’s market and scorings below will not be referring to it.

14. Manufacturing Examples:

UC Davis Winery Tracks Fermentation Via RFID Sensors:

The system allows the school's new facility to track the sugar content and temperatures of its wine within each of its 152 fermenting vats, putting an end to manual measurements.

The teaching and research winery at the University of California, Davis, reports that an RFID sensor system used on several dozen fermenters to measure temperature and sugar content of its wine mixes saved manual labor and provided more data about the fermenting wine than most wineries can typically gather.

With the data from the system, the winery expects to conduct testing not previously possible. Each grape mix can vary according to the type of grape used, the environmental factors in effect while the fruit was growing, and the vineyard's location. The way to test the different performances of various types of grapes, is to track the fermenting conditions. With a manual method of tracking fermentation, this had not

been possible, but with the RFID sensor system, researchers will now have information regarding the mix's condition, taken every five minutes.

15. Engine Maintenance:

Vector Aerospace Engine Services Atlantic (VAESA) is using RFID to gain visibility of aircraft engine components as they pass through different departments for repair. When aircraft engines arrive at Vector Aerospace for repairs or maintenance, each engine component could undergo a complex route that includes cleaning, inspection and repair, with the work taking place on as many as a dozen different machines and stations. In this industrial activity tracking every component is absolutely critical; if any one of them is missing, delays can result, caused by manual searches for that item and its order paperwork. The objective is achieved by means of installation of permanent fixed reader portals, desktop interrogators at workstations, and passive RFID tags attached to equipment paperwork.

16. Gas Manufacturer Fills Up More Often With RFID

Indian oxygen and nitrogen supplier Kay Nitroxygen is using RFID to record the status of its reusable gas cylinders, resulting in increased productivity. The company has reduced its product turnaround time by using an RFID system to record the status of its reusable cylinders. Since October 2009, the company has been utilizing the technology not only to track which cylinders are loaded, shipped to customers and returned, but also to identify which need to be tested before being reused, in keeping with federal guidelines.

Gas tanks, are steel cylinders, approximately 1,5 metres tall and 20 centimeters in diameter and weight 60kg, and cost about $300 apiece. Kay Nitroxygen's facility fills empty cylinders with oxygen or nitrogen, and ships them to customers. After depleting the gas within the tanks, customers then send back the empties. It was responsibility of staff members to read the ID number painted on the side of each cylinder every time it was received from a customer, every time it was refilled with gas, or every time it was shipped back to that sender, as well as to write down the ID number. Employees in the office would then input that data into a computer.

In fact, each cylinder's ID number was typically recorded and entered into the system 18 times every month, including all check-in, filling and check-out events. What's more, the process of recording ID numbers on paper required three employees to work eight hours apiece to receive and enter 1,000 cylinders into the system before they could be refilled and shipped to customers. Moreover, the cylinder ID numbers were often smudged or unreadable, and the low lighting during the night shift made reading the painted ID numbers even more challenging.

17. Libraries

Among the many uses of RFID technology is its deployment in libraries This technology has slowly begun to replace the traditional barcodes on library items (books, CDs, DVDs, etc.). The RFID tag can contain identifying information, such as a book's title or material type, without having to be pointed to a separate database (but this is rare in North America). The information is read by an RFID reader, which replaces the standard barcode reader commonly found at a library's circulation desk. The RFID tag found on library materials typically measures 50×50 mm in North America and 50×75 mm in Europe. It may replace or be added to the barcode, offering a different means of inventory management by the staff and self service by the borrowers. It can also act as a security device, taking the place of the more traditional electromagnetic security strip.

18. Passports

The first RFID passports ("E-passport") were issued by Malayia in 1998. In addition to information also contained on the visual data page of the passport, Malaysian e-passports record the travel history (time, date, and place) of entries and exits from the country.

Other countries that insert RFID in passports include Norway (2005), Japan (March 1, 2006), most EU countries (around 2006) including Spain, Ireland and the UK, Australia, Hong Kong and the United States (2007), Serbia (July 2008), Republic of Korea (August 2008), Taiwan (December 2008), Albania (January 2009), The Philippines (August 2009), Republic of Macedonia (2010).

Standards for RFID passports are determined by the International Civil Aviation Organization (ICAO), and are contained in ICAO Document 9303, Part 1, Volumes 1 and 2 (6th edition, 2006). ICAO refers to the ISO/IEC 14443 RFID chips in e-passports as "contactless integrated circuits". ICAO standards provide for e-passports to be identifiable by a standard e-passport logo on the front cover.

In 2006, RFID tags were included in new US passports. The US produced 10 million passports in 2005, and it has been estimated that 13 million will be produced in 2006. The chips inlays produced by Smartrac will store the same information that is printed within the passport and will also include a digital picture of the owner. The US State Department initially stated the chips could only be read from a distance of 10 cm (4 in), but after widespread criticism and a clear demonstration that special equipment can read the test passports from 10 meters (33 ft) away, the passports were designed to incorporate a thin metal lining to make it more difficult for unauthorized readers to "skim" information when the passport is closed. The department will also implement Basic Access Control (BAC), which functions as a Personal Identification Number (PIN) in the form of characters printed on the passport data page. Before a

passport's tag can be read, this PIN must be entered into an RFID reader. The BAC also enables the encryption of any communication between the chip and interrogator.

Security expert Bruce Schneier has suggested that a mugger operating near an airport could target victims who have arrived from wealthy countries, or a terrorist could design an improvised explosive device which functioned when approached by persons from a particular country if passengers did not put their cards in an area close to their body (high liquid and saline content) or in a foil-lined wallet.

Some other European Union countries are also planning to add fingerprints and other biometric data, while some have already done so.

19. Schools and universities

School authorities in the Japanese city of Osaka are now chipping children's clothing, back packs, and student IDs in a primary school. A school in Doncaster, England is piloting a monitoring system designed to keep tabs on pupils by tracking radio chips in their uniforms. St Charles Sixth Form College in west London, England, started September, 2008, is using an RFID card system to check in and out of the main gate, to both track attendance and prevent unauthorized entrance. Similarly, Whitcliffe Mount School in Cleckheaton, England uses RFID to track pupils and staff in and out of the building via a specially designed cards. In the Philippines, some schools already use RFID in IDs for borrowing books and also gates in those particular schools have RFID ID scanners for buying items at a school shop and canteen, library and also to sign in and sign out for student and teacher's attendance.

20. Museums

RFID technologies are now also implemented in end-user applications in museums. An example was the custom-designed temporary research application, "eXspot," at the Exploratorium, a science museum in San Francisco, California. A visitor entering the museum received an RF Tag that could be carried as a card. The eXspot system enabled the visitor to receive information about specific exhibits. Aside from the exhibit information, the visitor could take photographs of themselves at the exhibit. It was also intended to also allow the visitor to take data for later analysis. The collected information could be retrieved at home from a "personalized" website keyed to the RFID tag.

21. Social retailing

When customers enter a dressing room, the mirror reflects their image and also images of the apparel item being worn by celebrities on an interactive display. A webcam also projects an image of the consumer wearing the item on the website for everyone to see.

This creates an interaction between the consumers inside the store and their social network outside the store. The technology in this system is an RFID interrogator antenna in the dressing room and Electronic Product Code RFID tags on the apparel item.

22. Race timing

Many forms of RFID race timing have been in use for timing races of different types since the early 1990s. The practice began with pigeon racing, introduced by a company called deister electronic Gmbh of Barsinghausen, Germany. It is used for registering race start and end timings for animals or individuals in large running races or multi-sport races where it is impossible to get accurate stopwatch readings for every entrant.

In the race, the racers wear passive or active tags that are read by antennae placed alongside the track or on mats across the track. UHF based tags instead of low or high frequency last-generation tags provide accurate readings with specially designed antennas. Rush error, lap count errors and accidents at start time are avoided since anyone can start and finish any time without being in a batch mode.

Lap scoring:

Passive and active RFID systems are used in off-road events such as Orienteering, Enduro and Hare and Hounds racing. Riders have a transponder on their person, normally on their arm. When they complete a lap they swipe or touch the receiver which is connected to a computer and log their lap time. The Casimo Group Ltd sells such a system, as does Sweden's SportIdent and Japan'sMicro Talk Systems Corp. which sells the J-Chip system shown in the photo left.

RFID is being adapted by many recruitment agencies which have a PET (Physical Endurance Test) as their qualifying procedure especially in cases where the candidate volumes may run into millions (Indian Railway Recruitment Cells, Police and Power sector).

23. Ski resorts

A number of ski resorts, particularly in Scandinavia, the French Alps and in the Spanish and French Pyrenees, have adopted RFID tags to provide skiers hands-free access to ski lifts. Skiers do not have to take their passes out of their pockets. The Vail Resorts in Colorado have been using RFID equiped season passes. In 2010, Vail announced that it will be collecting information – vertical feet skied, number of runs taken, lifts used, etc – and all the information will be available to the user online. They are calling this new system EpicMix.

24. U.S. Department of Energy Employs RFID to Safeguard the Country

There are scores of asset-tracking applications that improve security or save money, time and labor, but it's hard to imagine items for which precise and continuous monitoring is more vital than drums of hazardous nuclear materials. That's why the U.S. Department of Energy (DOE) and its Packaging Certification Program, which certifies safe packaging for hazardous materials, turned to one of the DOE's oldest and largest research centers, the Argonne National Laboratory, in Illinois, to develop a customized, sophisticated approach for using radio frequency identification technology to continuously track radioactive and fissile materials, both while in storage and during transport. The number of drums holding such materials is estimated to be in the tens of thousands.

Spent nuclear materials are stored in facilities such as Argonne's Alpha-Gamma Hot Cell Facility, where irradiated materials from various U.S. research and test reactors are kept in specialized, locked drums. Detailed paper-based records are maintained for each container, says Yung Liu, Argonne's senior nuclear engineer and RFID project manager. These records include the serial number assigned to each drum, what the drum contains and its exact location within the storage area. But the only way to closely monitor the condition of each drum—including the integrity of its seal, and environmental factors that could compromise safety—was with manual inspections (a process that is not performed frequently) to limit personnel's exposure to radiation.

25. Fuel Security and inventory

Paz Energy, an Israeli energy company, is using active RFID to track when the fuel valves and hatches on its tanker trucks are opened and closed as drivers deliver fuel to filling stations around the country.

Paz owns gas stations and convenience stores, and it also has its own distribution company, which supplies the stores with fuel from its own refinery. In late 2004, the company began working with Hi-G-Tek to design a system that would help Paz secure the valves on tanker trucks (as required by Israeli law), as well as deter fuel thefts and improve the efficiency of the fuel-delivery process.

Consequently, Hi-G-Tek—formerly based in Israel but now operating a worldwide sales and marketing network out of Rockville, Md.—designed the Tanker Truck Monitoring System (TTMS), which utilizes active RFID tags built into tanker valves and hatches. Each time a valve or hatch is opened or closed, its RFID tag transmits a signal that is picked up by an interrogator mounted in the cab of the truck. The interrogator then relays the data, via a general packet radio service (GPRS) connection, to a computer in a central command center in Tel Aviv, where managers oversee tanker trucks and their deliveries. TTMS works in conjunction with a GPS-enabled fleet management system from Starcom Systems, a Hi-G-Tek partner, so Paz can also track its trucks' locations.

Paz began implementing the vehicle-tracking and fuel-monitoring solution on its trucks in 2005, taking the application operational by the end of 2006. By May of this year, most of the 50 trucks in the Paz fleet, and many belonging to third parties that deliver fuel for Paz, were equipped with the hardware. A total of 100 trucks are expected to be outfitted by year's end.

Before Paz implemented TTMS, drivers used mechanical clip seals on the valves and hatches. They had to keep track of seal numbers, writing them down by hand. Later, the company began using electronic reusable seals provided by Hi-G-Tek, and it has now moved to the RFID-enabled seals.

The fact that GPS tracks the exact location of each vehicle and RFID records any opening and closing of fuel hatches and valves provides Paz a strong theft deterrent. "The main problem was that we wanted to assure that our trucks arrive at our gas stations filled up, and that nobody opened the compartment along the way," says Moshe Sabag, Paz's vice president of IT. "We took the system to be sure that the compartments are opened just in the locations where we want it. With the system, we get real-time reporting and real-time information."

Now, when a driver arrives at a station and begins pumping fuel from one of the truck's 12 valves or hatches, managers at the command centre can oversee which types of fuels are being pumped, and for how long, enabling them to calculate the amount of fuel delivered to a station.

2.3.4 Table Construction:

As has just been mentioned in the previous section, RFID can satisfy all of the previous advantages, thanks to the diverse options and configurations the technology allows. Then, these advantages are the object of desire of the companies that decide to install the technology. The problem is that it is crucial to identify which of these advantages are the ones that the company is looking for in order to install RFID systems (not all RFID solutions satisfy the same needs). To be able to separate what is specifically useful for each user is to be able to know why RFID was selected as a solution within an industry. This is why the approach for the scorings is to evaluate the degree to which an advantage provided by RFID is taken profit of or pursued by a company (the importance of this advantage for the company). In other words: RFID has advantages… but to what degree are each of these advantages exploited, and an objective for the industry that uses RFID? Is the question the scorings allow to answer, and the first step to all of the conclusions that will be drawn.

Another way to put it is to repeat the exact words used in the previous section: "evaluation of the degree to which RFID has an impact by means of the advantages it provides to the industry, is evaluated for each of the industrial applications examples. RFID has advantages, each of these advantages is more or less important for a certain industry, and therefore RFID is more or less important to the industry. Evaluation of the importance of the advantages is therefore correlated to the importance of RFID within the industry."

The scoring system has been defined with scores from 0 to 5, in which 0 means the advantage is not being used by the industry, 1 means the advantage is being used by the industry but is not especially important, and 5 means the advantage is vital.

It is important to add here that we are talking about "advantages", and this word automatically implies the question: Advantage in relation to what? The answer to the question is simply: in relation to most conventional systems. The answer must be vague because, there may be systems that allow for some properties as well as RFID but do not allow for others, whereas other systems are completely overwhelmed by RFID advantages (except for the price). Therefore, to answer the comparison issue, each advantage needs to be addressed individually, but given the fact that finding alternatives to RFID is not at all the main issue of the study, vagueness in this area is more than admissible.

Moreover, if after the evaluation, one is able to find which RFID advantages are most important, the research of alternative products that satisfy too these advantages can always be undertaken, perhaps finding a better solution than RFID. But even in this case, the study presented will have been valuable as if it had not been for it, an alternative would have not been so easily found, given the fact that this study spotted the areas of comparison.

Advantages vs. Industries:

This is the main part of the table. Advantages are related to the industries they satisfy by means of a score that quantifies the degree to which these advantages each are important to the industry considered at each time. Advantages are once again the ones listed before:

New business/service, Size, Link to database, Process time consumption, Process materials consumption, Process Human Resources consumption, No line of sight, Unlimited readings, Quick reading of data, Unlimited rewritings, No batteries, High range, Automatic reading, Simultaneous readings, Great storage capacity, Transmission of data through space, Durability, Comfort or Ergonomics (Physical, Cognitive and Organizational), Miniaturization capabilities, Synergy capabilities, Installation simplicity, Monitoring / Real time alerting / actualization, Flows monitoring / traceability, Information security, Security enabling and finally Resistance / reliability.

And the industries are classified within Industry Sectors: administration, chemistry, energy, entertainment / culture, health care, logistics, labelling, manufacturing, retail, security and transportation. It is to be clarified that this sectorization has been defined to most appropriately separate between RFID applications.

	Administration				Chemistry			
ADVANTAGES	People Identification/Passports		School & Universities		Corrosion Detection		Tracking management	
	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring
New business/services	0	0	4	8	4	8	1	2
Size	3	4	2	3	3	4	1	1
Link to database	4	9	2	5	0	0	3	7
Process: time consumption	3	12	2	8	4	16	3	12
Process: material consumption	0	0	0	0	4	12	1	3
Process: HR consumption	3	9	1	3	4	12	3	9
No need of visual contact	0	0	5	8	4	7	3	5
Unlimited readings	2	2	4	4	3	3	2	2
Quick reading data	2	6	5	15	3	9	1	3
Unlimited rewritings	4	20	2	10	0	0	0	0
No batteries	4	16	4	16	3	12	1	4
High range	0	0	5	20	0	0	1	4
automatic reading	0	0	5	35	5	35	1	7
simultaneous readings	0	0	5	23	4	19	4	19
great storage capacity	1	6	1	6	0	0	0	0
transmission of data through space	2	11	4	23	3	17	1	6
durability	3	6	3	6	4	8	2	4
miniaturization capabilities	1	2	2	5	1	2	1	2
synergy capabilities	1	5	1	5	3	15	1	5
installation simplicity	2	4	2	4	1	2	4	8
Monitoring/real time alerting/actualization	0	0	3	27	3	27	0	0
Flows monitoring/tracking/traceability	0	0	3	12	0	0	4	16
Information security	3	6	1	2	1	2	1	2
Security enabling	4	8	3	6	5	10	1	2
Resistance/reliability	2	4	4	8	3	6	1	2

Tabla 4

Relative Scorings / Absolute Scorings

Within these industry sectors we find the industries or activities in which application of RFID has been analyzed. Therefore, under each of the industries we then find the scorings associated to each advantage evaluated. However, we find 2 different columns of scorings under each industry. The first one is the already mentioned evaluation of the

degree to which RFID advantages are important to a certain industry (scores from 0 to 5). This is the scoring that will be called: relative scores. By stating a score as relative it is expressed that the scoring allows to compare directly which of the advantages is of more use for an industry. However, it does not allow knowing which of the advantages is more significant for an industry, lets see why. That usefulness is related to giving use: an advantage is relevant because it relevant to complete the process, whereas significance to the industry means that the advantage considered positively affects different departments or areas of improvement of the business, which will be referred to as business units. The first column therefore describes how useful the advantage is in terms of usability, while the second describes how important the advantage becomes for the industry, as a breakthrough that helps improve many different areas.

Therefore the second column under each industry has the meaning of an absolute scoring that determines the importance of each advantage inside an industry, compared to the importance of the rest of the advantages. Advantages may be equally used (first column), but their impacts may be considerably different (second column). This scoring is achieved by ponderation or weighing of the importance of each advantage by finding a coefficient that represents the importance of each. These coefficients are determined for each advantage, and then each relative score (from 0 to 5) is multiplied by the weighing coefficient to determine the absolute score.

The multiplier coefficients determine the importance of the advantages in relation to the number of business units where the advantages have an impact. The criterion for obtention of these coefficients is explained in the next section (*Ponderation according to impact on business unit, and absolute scorings).*

ADVANTAGES CORRESPONDANCE WITH BUSINNES UNITS													
BUSINESS UNITS													
				Comfort									
entrepreneurship	Process/Service	Supply chain	Logistics	physical	cognitive	organizational	use of resources	efficiency	maintenance	IT/IS	Security	Coefficient	ADVANTAGES
☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	2,0	New business/services
☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	1,3	Size
☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☑	2,3	Link to database
☐	☑	☐	☐	☑	☑	☑	☑	☑	☐	☐	☐	4,0	Process: time consumption
☐	☐	☐	☐	☑	☑	☑	☑	☑	☐	☐	☐	3,0	Process: material consumption
☐	☐	☐	☐	☑	☑	☑	☑	☑	☐	☐	☐	3,0	Process: HR consumption
☐	☑	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐	1,7	No need of visual contact
☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	1,0	Unlimited readings
☐	☑	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐	3,0	Quick reading data
☐	☐	☑	☑	☐	☐	☐	☑	☐	☑	☑	☐	5,0	Unlimited rewritings
☐	☑	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	4,0	No batteries
☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐	☑	4,0	High range
☐	☑	☑	☑	☑	☑	☑	☐	☑	☐	☑	☑	7,0	automatic reading
☐	☑	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐	4,7	simultaneous readings
☐	☑	☑	☑	☐	☐	☐	☑	☐	☑	☑	☐	6,0	great storage capacity
☐	☑	☑	☑	☑	☑	☐	☐	☐	☑	☐	☑	5,7	transmission of data through space
☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐	☐	2,0	durability
☐	☑	☑	☐	☑	☐	☐	☐	☐	☐	☐	☐	2,3	miniaturization capabilities
☑	☐	☑	☑	☐	☐	☐	☑	☑	☐	☐	☐	5,0	synergy capabilities
☐	☑	☐	☐	☑	☑	☑	☐	☐	☐	☐	☐	2,0	installation simplicity
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	9,0	Monitoring/real time alerting/actualization
☐	☐	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐	4,0	Flows monitoring/tracking/traceability
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	2,0	Information security
☐	☐	☐	☐	☑	☑	☑	☐	☐	☐	☐	☑	2,0	Security enabling
	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	2,0	Resistance/reliability

Tabla 5

However, at this point we are all ready in disposition to obtain the answer to the first of the questions, which is the 4th one stated at the beginning of chapter 2:

QUESTION 4 : When certain RFID advantages are pursued, to what degree are each generally required (and therefore is RFID required)?

The left column under each industry indicates the relative score of each advantage, which is the value of how useful the advantage is for the industry. Therefore, if for each of all advantages we add the relative scores obtained for each industry, we will obtain a total value that represents the overall utility of this advantage within the whole industry. These values are then comparable by means of a table that will express which advantages are generally most required by the industry, answering question number 4).

Ponderation according to impact on business units, and absolute scorings:

This section of the table is found to the left of the advantages column. We find the correlation of the advantages to what we call business units. These business units are simply the different business areas that constitute a company's internal structure (example: supply chain, maintenance…), as well as the areas of attention (example: security, use of resources…). The correlation is established if the advantage considered has positive impact on a certain business unit (objective negative impacts rarely appear). As a result, if an advantage positively affects 4 of these business units, its ponderation coefficient will simply be 4. It is important to understand that affectation of business units by the advantages is considered in general and not specifically for each industry. The overall knowledge of all the cases studied allows for these general conclusions about how business units are usually most affected.

This approach will allow to present the result for question 2):

QUESTION 2 : What business units does RFID generally most positively affect?

By obtention of all the correlations, we can directly compare which business units incorporate within them the highest number of RFID advantages. In other words, RFID advantages affect more often certain business units that are therefore more benefited by RFID implantation. By simply summing the number of correlations under each business unit we obtain a numerical result, which allows comparing the units. A sector graphic may be displayed as a visual result.

At this point in which absolute scorings and the way to obtain them is already clear, we are as well in conditions to give an answer to question number 1):

QUESTION 1 : How important is RFID technology for any given industrial application?

If, as explained, the absolute scorings represent the value that the incorporation of each advantage has for the industry, if we add the value of all of the advantages an industry profits of, we will obtain, for each industry, comparable results that will indicate which industrial applications take most profit out of RFID implantation.

Finally, before explaining the last part of the table (that will answer the last 2 questions), we are also in conditions to obtain the answer to question number 5):

QUESTION 5 : Which Advantages of RFID technology commonly cause the most positive impact within the industries?

We could have the illusion that we can answer this question by saying that the advantages that most commonly cause the most positive impact are those that affect the highest number of business units, using the *Ponderation to business unit impact*. This would be a mistake for it is incomplete, and here is why. Not only one needs to consider how many business units do RFID advantages affect, but also the degree to which this advantages are useful to the business unit. Luckily, we already have a measure for this value because the degree to which an advantage is useful within an industry is precisely what the relative scoring measures! (We must use the relative scoring here because we must compare advantages, not industries). Therefore, by matching these two pieces of information: the number of business units an advantage affects, and the degree to which the advantage is generally useful for the industries, we can obtain a result for the question by finding the advantages that commonly cause the most important positive impact within the industries.

The matching of the two pieces of information is tricky though. We have on the one side the numerical evaluations for the number of business units the advantage affects: the ponderation coefficients. On the other side, the degree to which advantages are generally useful for industries is expressed by the sum for each advantage of the relative scorings for each industry. If we simply multiplied the two values to obtain a value that expressed the importance of the combination of the factors, we would overestimate the ponderation factor and distort the results. We can therefore resolve to apply the square root to the ponderation coefficient and the multiply it to the other value. The final result can be displayed as a value of the impact the advantages have within the industries. A table with the result of this value can then be displayed comparing all advantages.

Scorings Industry/Business Unit

This part of table is built thanks to the upper part and to the crossing that establishes a relation between the advantages and the Business Units they are related to. The intention was to have a scoring that could be understandable and useful to match with the need of the client. Therefore in this table the scorings of a business unit for an industry correspond to the sum of the relative scorings of the advantages related to this business unit for this industry. For example if we take the first example of the table “People Identification/Passport” and we want to have the result for the Business unit “Use of resources” we will add the scorings related to it in the grid and we get 3+0+3+2+4+4+0+1+3+1+0=21 which corresponds to the scoring we have in the box linked to the Business Unit “Use of resources” and “Passports”.

6	175	8	259	7	224	1	262	Entrepreneurship		3,38	8
35		44		42		38		Process/Service		34,69	49
18		25		21		28		Supply Chain		22,19	36
15		25		21		27		Logistics		20,69	35
8,0		12,0		11,3		12,0		Physical	COMFORT	10,05	15,33
7,3		12,7		11,0		12,0		Cognitive		9,76	14,67
2,7		6,3		6,3		6,7		Organizational		5,42	8,67
18		31		29		31		TOTAL		25,31	39
20		29		28		33		Use of Resources	BUSINESS UNITS	25,65	39
14		30		25		30		Efficiency		21,00	30
17		17		18		25		Maintenance		17,88	25
15		25		17		26		IT/IS		17,54	26
17		25		16		23		Security		20,42	33

Tabla 6

This is why this table can answer first, the third question we had:

QUESTION 3 : What Business Units does RFID most positively affect for certain industrial applications and sectors?

This table helps to answer this question because we are going to be able to know which industrial applications of RFID have the most effect upon each business unit. We are going to be able to give scores that reflect the impact of an RFID application unpon each business unit. Therefore we will be able to make a comparison between these scores and see in which business units an RFID application has the most positive impact. Putting it the other way round it enables us to identify the Business Units mostly affected by an industrial application, and generally within industrial sector of applications.

However this is not the only answer we can get from this table because if we read it the other way around we can answer the question:

QUESTION 6 : What industries do I need to look at as an example of RFID applications if I want to improve performance of a certain business unit in my industry?

In deed if we read the table by starting on the Business Units side we can take a look for each business unit which industry has the best scoring. Therefore if we want to improve a specific business unit of our industry we can take a look at this scoring and it will give the industry that fits better to improve this business unit. Then by taking a look at the system they use we could adapt it to our industry to improve a specific Business Unit.

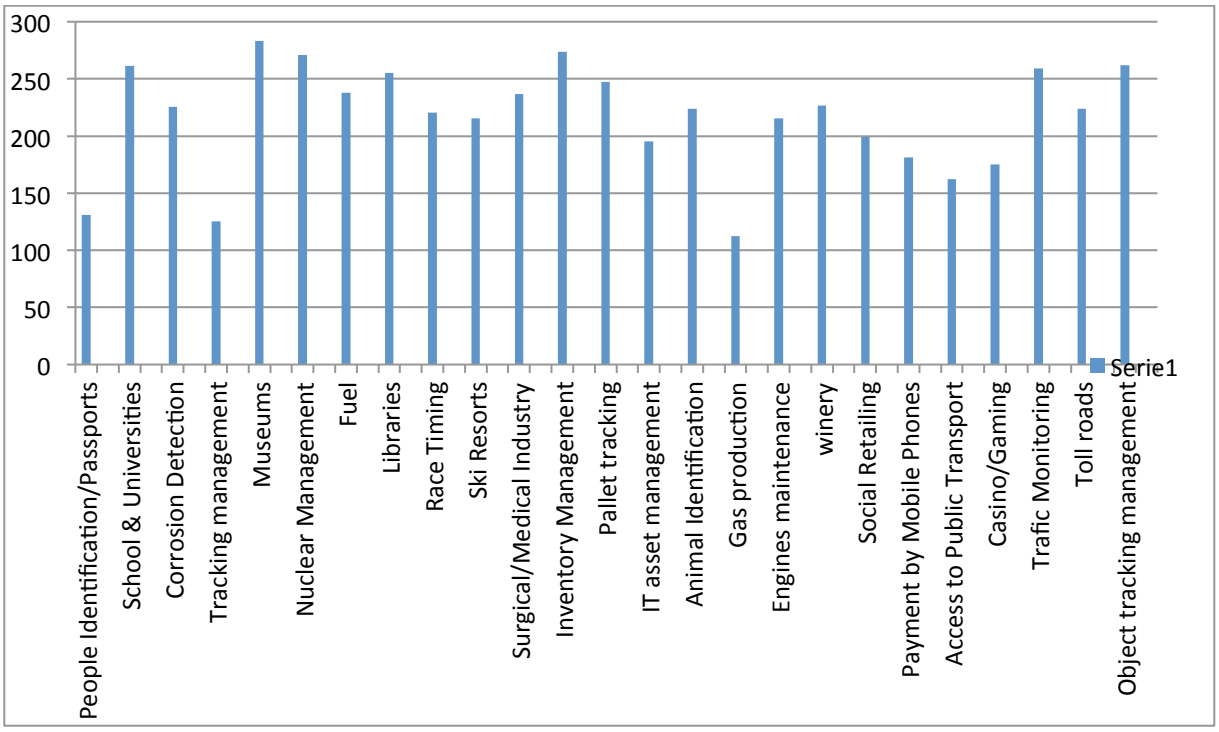
In this part it is important to understand that we are trying to evaluate a system through the industry that uses it. By evaluating this system we are evaluating its potential in the different Business Units. This information about its potential will guide us to choose the right solution depending on the needs of the firm. We will then try to adapt a system that has a potential that fits with these needs.

3. RFID Results

3.1 Answers to the previous questions

3.1.1 QUESTION 1: How important is RFID technology for any given industrial application?

Absolute scorings have been specified previously. We have here the bar diagram that describes the different absolute scorings for the industries we've studied :



Gráfica 1

This gives us a ponderated value of the way RFID is used. This score will highly depend on the number of Business Units affected by the RFID system installed as well as with the relative scorings that correspond to each Business Units (or its advantage). We can see that 3 applications here have a scoring very low compared to the others: Passports, Tracking Management, Gas production. Some others on the other hand are very high such as: Museums, Schools and Universities, Nuclear Management, Inventory management, Traffic Monitoring and Object tracking Monitoring.

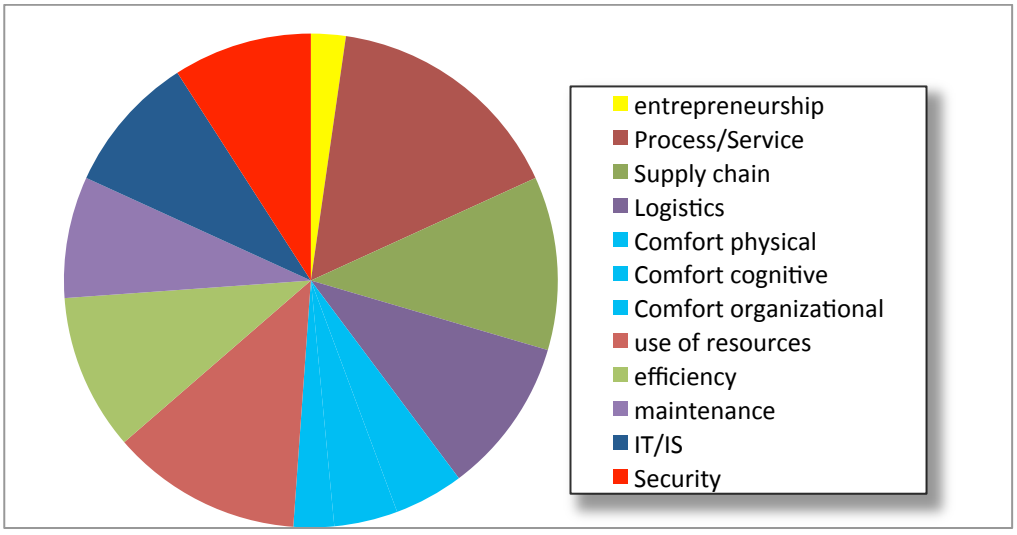
What do these results mean? The first mistake would be to say well, le low scores mean RFID is useless in these industries and the high scores mean that RFID is extremely important. This isn't really the way these results should be interpreted. Actually the high

values mean that they certainly have a very high ponderation in many Business units and therefore these systems will maybe be suited to different needs from the client. These models can be then used in different situations because they affect many Business Units in good ways.

On the other hand, the low scores will be clearly more specific. It doesn't mean that they can't be applied in other situations it means that they will be suited to very specific applications that correspond precisely to what this system needs. To understand it well, an industry like Schools and Universities could be an example for an industry that needs RFID help in Logistics or Maintenance or Service. However the low scoring industries will only be able to be efficient for one Business Units, 2 in the best cases (but still in an efficient way).

3.1.2 QUESTION 2: What business units does RFID generally most positively affect?

As explained before we have a system with scorings that relate each advantage to each industry. However this kind of view is rather messy in the way that we don't really know how the system is really affected by the implementation of RFID in this industry. This is the reason why we chose to use Categories of Advantages that we called Business Units. The grid used to give a correspondence between the advantages and the Business Units gives us a view of the sectors that can be mostly affected by the use of RFID. By giving one point to each Business Unit for every advantage that refers to this Business Unit we get this diagram:



Gráfica 2

This gives us a view of the different Business Units that are affected by an RFID system. We can see that that these Business Units are mainly well balanced even though entrepreneurship concerns a very small part of the RFID. The reason of this result comes

from the fact that RFID is mostly considered to be a tool, therefore the fact that the activity is related to entrepreneurship is very little and depends only on the objectives of the industry that wants to use this system. For the other Business Units we see that it helps a lot your Process and Service which means that you are able to bring a better quality to your client thanks to RFID. The Business Unit "Use of Resources" is also very affected because helps to win time and you can sometimes need less people or machines to do a certain task thanks to RFID.

This result show us an overview of the Business Units that should be affected without taking into account the scorings made before. In a way this diagram must be understood in this way : in most cases Business Units like Process and Use of Resources are going to be affected by the use of RFID and not "When you use RFID in your industry you're are going to affect mostly your Process/Service Business Unit" because every situation is different. Therefore an industry that wants to incorporate RFID to help their maintenance system will be able to do it in an efficient way even if it doesn't correspond to the biggest part of this diagram.

3.1.3 QUESTION 3: What Business Units does RFID most positively affect for certain industrial sectors?

The result of this part is a combination of the two previous results. In a way we could consider this result as a refining of the first result where the scores of advantages that refer to a Business Unit are summed. It gives us a more precise and much clearer view of the way RFID is used and how it affects the industry. Setting here an exhaustive list of all the different industries isn't a necessity here, the table being clear enough get the information from it. Nevertheless if we want to take an example and we want to know where RFID helps for the industry "Ski Resorts", thanks to this table we can know that the two strong points are Process/Service and Comfort. Reading this table from the Industry point of view gives interesting information that an industry could ask us to analyze to see if the system they use is really adapted to the goals they have. It gives you thanks to a quick look to have a view thanks to the scorings and the colors of the strong points and the weaknesses of certain systems that use RFID.

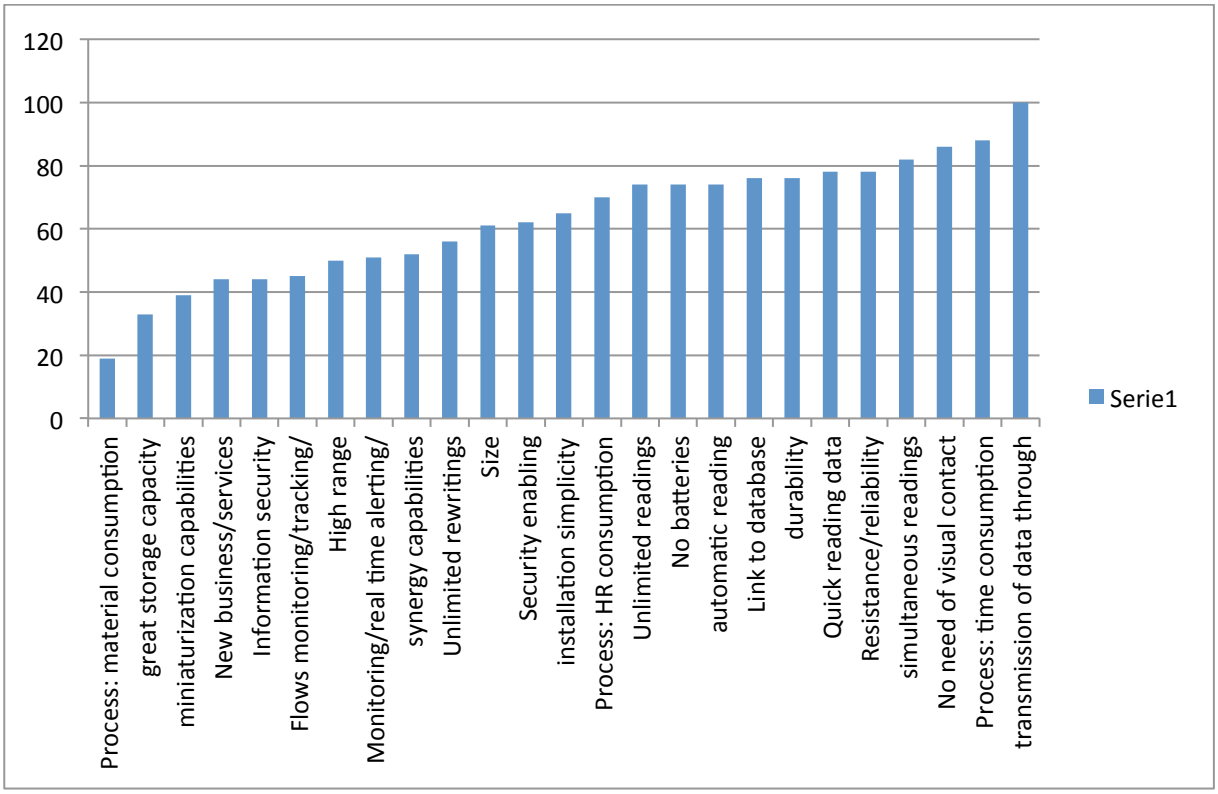
However we will see further on that this table can be read from another angle, the other way around, by reading it from the Business Unit point of view. This new perspective will enable firms to find RFID solution systems that fit their needs. This will be the basis of our solution solving method for EDF's needs.

3.1.4 QUESTION 4: When certain RFID advantages are pursued, to what degree are each generally required (and therefore, is RFID required?)

This corresponds to the first information we used in our table, the relative scoring (0-5) for each advantage regarding the industry where the RFID system was used. It gives us an overview for each single industry of the way RFID is used by looking at the importance of each advantage provided by the RFID system.

A way of reading this table tells us for example that for the first industry you have in this table, People Identification/Passports, the strongest advantages provided by this way of using RFID are: the link to a database, the possibility of having unlimited rewritings, the fact that it doesn't batteries and Security enabling because they all received a scoring of 4. This method enables us to have a database to be able to give scores to the different industries to see the strong points of every RFID system regarding the different advantages that an RFID system can have. This first result done on 25 different industries that use an RFID system gives us a panel of the way RFID can be used. Reading the table we built this way gives more a description of industries that use RFID rather than a solution for the person who uses the table. This result is definitely not the most important because it's raw usefulness is very restricted but it is essential because it represents the basis of the other results. Almost all the other results, which contribute to solving the problem: How should I use RFID in my industry?, depend on this one and therefore it is vital to keep it to be able to understand how the rest of table works and how we got all our other results.

Summing the relative scores of an advantage for all the industries we have studied brings us to this diagram:



Gráfica 3

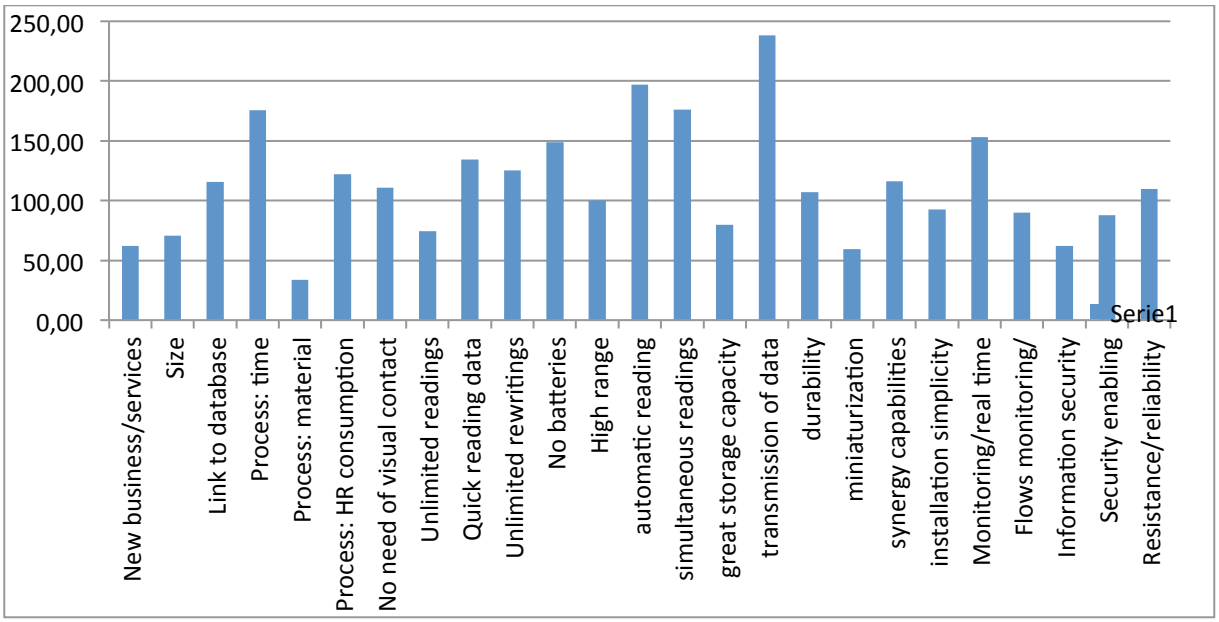
This bar diagram gives us the importance of each advantage linked to the relative scorings we've given. It provides us the strong points of RFID and its advantages that are not really used mainly because not needed. What can we say about it then? That the big advantages of the RFID system that are used in industries are the fact of having the possibility of transmitting data through space, getting a better Time process, the fact of not needing a visual contact and the possibility of reading simultaneously different chips. These four advantages are linked because if you can transmit data through space you generally don't need a visual contact, and the fact of being able to read simultaneously different chips enables to win a lot of time during a process.

This gives us the true real hint on why we could use RFID in an industry. The reasons would be the possibility provided by RFID to have a transmission of data through space and the need of having a quicker process where you can do things faster and at the same time (simultaneous readings).

On the other hand, if we look at the four advantages with the lowest scores we have Process: Material Consumption because most of the time an RFID system needs to be added or only replaces a previous material system, great storage capacity is low as well even though a chip can store a high quantity of information because for most objects we only store in the RFID device a description and the actual state of the object. Miniaturization capabilities are low as well because the chip and its antenna is rarely smaller than a bar code because it is not really need. Finally the New Business advantage depends indirectly from the RFID system and relies more on the will of the user of this system.

3.1.5 QUESTION 5: Which advantages of RFID technology commonly cause the most positive impact within the industries?

We considered that the previous tool was very interesting because it could show us the raw effect of each advantage. However by using it only this way we were forgetting a part of the information we. This is why we decided to use a modification we find pertinent regarding this information. In deed if an advantage gets good scoring but only touches a very specific business unit maybe it will help less than an advantage that gets a scoring slightly lower but with a wider range. Therefore we set a new way of seeing the problem by multiplying the score we get previously by the square root of the number of business units it touches (Score*$\sqrt{Number\ of\ Business\ Units\ Concerned}$). This way we get this diagram:



Gráfica 4

This changes slightly the situation with still a very good position for transmission of data through space which definitely seems to be the strong point of this system. Other advantages appear with this model such as automatic reading which appears to be very handy because it helps a lot to quicken the processes. Process Time Consumption and the fact of being able to do simultaneous readings still keep a big importance. This diagram strengthens the thought that RFID is mainly used accelerate processes thanks to simultaneity and transmission through space. Others strong points (those above 100) can be seen thanks to this diagram and give a hint on the advantages an RFID system gives compared to a classic bar-code installation : the fact of being able to rewrite on your tag whenever you want compared to bar-codes gives a good advantage and enables to tour RFID system to act as a monitoring system (which is a strong point as well of RFID) thanks to a live transmission of data that corresponds to what is happening

right now. We can also underline some other points such as a link to the database and no need of visual contact which give to RFID a strong advantage on bar-codes because of the flexibility of this system and Resistance/Reliability that enable this system to be used during many years without needing to replace the components.

The four weak points almost remain except for the fact information security appears in this list. The reason there is a concern about security comes from its advantages. The fact of being able to read very easily a chip that sends information in the space near him brings the problem that people who are not intended to read your information can come with a reader and try to read it. Encrypting measures can be taken to protect your data but readers able to hack these data could be used to get this information. This is why the security of the information provided by an RFID is not really high and can sometimes be dangerous for the user in order to be protected from hackers.

3.1.6 QUESTIION 6: What industries do I need to look at as an example of RFID applications if I want to improve performance of a certain business unit in my industry?

Here we come to what might me the most important part of our table. All the previous results give information about RFID in our world today and how it's used, its advantages based on different criteria. However the purpose of the table we've built is mainly to be reused to adapt a system which corresponds to the needs of your firm.

We're coming back to the "Color Scoring". The first way of reading it that we saw already before corresponds to looking for each industry at the business units they affect mostly. Now we are going to look at it from the other side. By reading the table from the business units' point of view we can see which industry and (then which way of using RFID) can suit in the best way to the business unit you want to satisfy thanks to this scoring. We've looked at the top scores for each business unit and "circled" the industry where we had that top score. This way if we look for example at the business unit "Use of Resources" because we want to reduce the costs of our process we just have to take the table, we see that the maximum is at 39 and the industry which satisfies the best this need is winery. Even if your industry doesn't have any to do with winery it can be very interesting to see what is the system they use and see if there are sectors of your industry where you can adapt a system that looks like the one they use. We can also see that three industries have many top scores and could be seen as examples for the others: the use of RFID in Museums, Inventory Management and Object Tracking Management. It doesn't mean that the system one should use is necessarily linked to these three systems but they seem to be a very strong basis of the way RFID can be used in a very efficient way.

The strength of this part of the scoring is that it doesn't score an industry directly nor RFID in general. In this part what we want is to be able to evaluate the potential of a system. When we give a scoring to an industry here we give a scoring about the way

RFID is used here, we want to be able to say for example “This system has a big potential in maintenance”. This is the reason why the reading of this part of the table has to be put in correlation with the Annex that describes the way each industry uses RFID. What really matter here isn’t the fact that they use a system for Maintenance or Logistics, what matters is the fact that even though a system may be used for a certain utility it can have a very high potential in other domains and therefore it could be applied to other industries that need this potential in their system. It enables to see beyond the normal purpose of the system and to evaluate how it could be used in other conditions. And from the results we have, we can definitely say that there are applications were we have found new potentials and new possibilities of using their system such as for Museums that will inspire in the next part a solution we could give to EDF.

3.2 Table Application Example for EDF

3.2.1 Classical Approach (Conventional)

This first proposition is a very basic one that only refers to other close industries and we’ll not necessarily add a great value to what EDF already knows about this subject. However not talking about these systems that already exist for energetic industries would be a mistake.

The first approach we could think of to help EDF would be to see how other energetic industries use RFID in their system to see if it could be interesting for them. This is the reason why we studied in our table the case of two different industries related to the energy sector. One of them is related to fuel. In this specific case we find a very solid system that seems to satisfy many different Business Units in a very good way. In deed this system had better grades than the average in every business unit except for Process/Service. This system is described in the annex and helps to keep track on the movement of the valves to know how the fuel is transferred, at what speed, the quantity transferred. It was installed on trucks and helped monitoring the entire delivery and distribution of fuel in different gas stations and other customers of the Israelite company, Paz Energy.

The other system we studied is related to Nuclear Management. This system seems to be even more interesting than the previous one because it has a top score in our scorings. Nuclear Energy is a very efficient, cheap and with very pollution way of producing energy. However it represents a big danger because of the radioactive products used to provide this energy. We have reached very good levels of security that enable countries to develop such energy productions (especially for France). Apparently using RFID in this domain could help even more. In deed this is the industry that gets the top score in Security. In this system RFID chips are used to during the storage and the transport of hazardous materials. Using RFID in this domain provides a double security for the firm that uses it. First of all, being able to monitor every second the state of your

material thanks to the chips helps you to prevent yourself from having very important accidents that could damage entire regions. The second reason comes from the fact that if you want to be able to monitor your materials you cannot send men there whenever you want because of the radiations produced by the materials. Therefore using a system like this one helps you to monitor your materials every single second thanks to the chip that sends information through space and you don't have any risks related to the health of your workers because they don't need to come near those materials to get the information they need.

These are the two first ways EDF could try to use RFID to improve the way they collect information from their different sources of energy or from their distribution systems. However we think that looking only at the other energy industry gives us a very narrow view on the huge possibilities RFID provides us. Looking only at what already exists in other energetic industries and trying to apply it as well is not the real point of our work. We wanted to be able to use the table and all the information it has as a tool in order to find new solutions and new applications of RFID for EDF. We based the next approach on the evaluations of the different systems to able to find the one that suits better to EDF needs because we think that the best way of finding the best solution comes from innovation.

3.2.2 Innovative approach

As it has been said before, we don't consider the table we used as just a table you can look at to see how the industries of different sectors use RFID to satisfy their needs. The table we've built linked to the annex (which is very important because it describes the different systems that are used in the industries we've evaluated we've studied) is supposed to be a tool that will guide us to find the right solution to your needs whether the solution comes from an industry that is very similar to yours or from a completely different industry which has the same need. In this solution we are going to see which system used can suit better to the needs of EDF thanks to the evaluation we made.

In this specific case, contrarily to the first approach which could help EDF in a global way, EDF asked us to see how we could help them to set an RFID system related to Maintenance. This is where we are going to use the lower part of the table, where industries are related to business units. One of the Business Units we had chosen was maintenance; the best score in this category is 25 and is satisfied by two different industries. One of them is Object tracking concerning bags for flight industries. Here the goal is to put RFID tags in the luggage instead of bar-codes which enable to track the bags through the entire airport to sort very quickly and without making mistakes, where the bags need to go. We could imagine a similar thing with EDF where objects that are routed from one place to another could be traced easily thanks to chips and the information of the location they have to reach would be given by the information held by the RFID device. However, even if this system could be used, the real efficiency regarding maintenance wouldn't be huge.

Let's take a look at the other system. An energetic industry and EDF can seem to be very distant and different industries. Nevertheless it looks like this system would be adapted to EDF in an efficient way to help in maintenance. In this museum, a visitor entering the museum would be given a RF tag that could be carried as a card. He would then receive information of the exhibits and the paintings depending on his location in the museum. Another possibility would be to take pictures from the exhibit and grab some information and keep it related to your RFID tag, and then when you come back home you could retrieve this information or photos from a website.

What is this going to give in an industry like EDF? We could imagine a system where the electrical panels and other devices would be incorporated with an RFID tag, information of the panel would be written on the tag and sent to a reader related to the informatics system and would give a signal whenever a problem is detected. A technician could then come and repair it knowing what the problem is thanks to the signal send by the tag. In this method we need the machine to able to know by itself when something goes wrong and in many cases this is not always possible or cost-efficient.

If we want to stick to method seen in the museum, we would have panels with information about for example their state. A supervisor would come to inspect the installations with an RFID reader and would collect it very quickly thanks to this system but he's also going to check by himself if everything seems to be working properly, if some parts of the devices seem to be becoming old, rusty or need to be changes thing that a machine can't detect and that can only be left to the appreciation of a human being. The reader he has could be equipped with a camera and an inside RFID tag (an active one for example able to send data 300 feet away, this way one power plant would only need few readers to read the tags from the supervisors) where he can write the information he gathers whether it's a text information or a photograph. The supervisor could take pictures of the damaged parts that need a further inspection or need to be changed and could write a note related to it where he explains the problem. This way he would be able to check everything and send immediately information with pictures and notes to the maintenance technicians so that they can operate quickly knowing very precisely what the problem is. Thanks to this system, the technicians would be able to arrive to the location of the problem with the tools they need to fix it in a very short time without losing time trying to understand what the matter is because the photographs and the note they will have received and they will have while they operate will have already given them the information they need to know what they have to do.

The benefits from this system will come from the fact that maintenance technicians will be able to operate very quickly after a problem is reported and will have full knowledge of the problem before the operation. This way the operation time will be highly reduced as well because they will increase their efficiency; panels and other broken devices will be fixed in a much smaller time and will enable the power plant or any other building of EDF to be more efficient. The key of this system is to send data as fast as possible to the technicians and giving them all the information they need to be efficient. Hopefully RFID seems to fit perfectly to these needs.

We think that this view of the problem brings an innovative solution because it comes from a sector that doesn't have anything to do with energy (Museums). We also wanted to be able to use new tools to get to this solution, and that was one of the purpose of the table we built. This table was supposed to be used as a tool to find new ways of seeing the problem by evaluating systems from very different industries. Our goal here was to get to an efficient and innovative solution by an innovative way.

4 References

[1] CRC Press Taylor & Francis Group. *RFID handbook : applications, technology, security, and privacy* / edited by Syed Ahson and Mohammad Ilyas. ISBN: 13: 978-1-4200-5499-6

[2] The RFID Journal, http://www.rfidjournal.com 2002 (online)

[3] HID Global, http://www.hidglobal.com 2011 (online)

[5] Wikimedia foundation, http://www.wikipedia.com 2001 (online)

[6] IML Group PLC http://www.controlengeurope.com 2007 (online)

[7] Impinj, http://www.impinj.com 2010 (online)

[8] Klaus Finkenzeller, http://rfid-handbook.com 1998 (online)

5. Annex

5.1 Mapping Table

ADVANTAGES CORRESPONDANCE WITH BUSINNES UNITS

BUSINESS UNITS													
				Comfort									
entrepreneurship	Process/Service	Supply chain	Logistics	physical	cognitive	organizational	use of resources	efficiency	maintenance	IT/IS	Security	Coefficient	ADVANTAGES
☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	2,0	New business/services
☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	1,3	Size
☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☑	2,3	Link to database
☐	☑	☐	☐	☑	☑	☑	☑	☑	☐	☐	☐	4,0	Process: time consumption
☐	☐	☐	☐	☑	☑	☑	☑	☑	☐	☐	☐	3,0	Process: material consumption
☐	☐	☐	☐	☑	☑	☑	☑	☑	☐	☐	☐	3,0	Process: HR consumption
☐	☑	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐	1,7	No need of visual contact
☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	1,0	Unlimited readings
☐	☑	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐	3,0	Quick reading data
☐	☐	☑	☑	☐	☐	☐	☑	☐	☑	☑	☐	5,0	Unlimited rewritings
☐	☑	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	4,0	No batteries
☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐	☑	4,0	High range
☐	☑	☑	☑	☑	☑	☑	☐	☑	☐	☑	☑	7,0	automatic reading
☐	☑	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐	4,7	simultaneous readings
☐	☑	☑	☑	☐	☐	☐	☑	☐	☑	☑	☐	6,0	great storage capacity
☐	☑	☑	☑	☑	☑	☐	☐	☐	☑	☐	☑	5,7	transmission of data through space
☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐	☐	2,0	durability
☐	☑	☑	☐	☑	☐	☐	☐	☐	☐	☐	☐	2,3	miniaturization capabilities
☑	☐	☑	☑	☐	☐	☐	☑	☑	☐	☐	☐	5,0	synergy capabilities
☐	☑	☐	☐	☑	☑	☑	☐	☐	☐	☐	☐	2,0	installation simplicity
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	9,0	Monitoring/real time alerting/actualization
☐	☐	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐	4,0	Flows monitoring/tracking/traceability
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	2,0	Information security
☐	☐	☐	☐	☑	☑	☑	☐	☐	☐	☐	☑	2,0	Security enabling
	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	2,0	Resistance/reliability

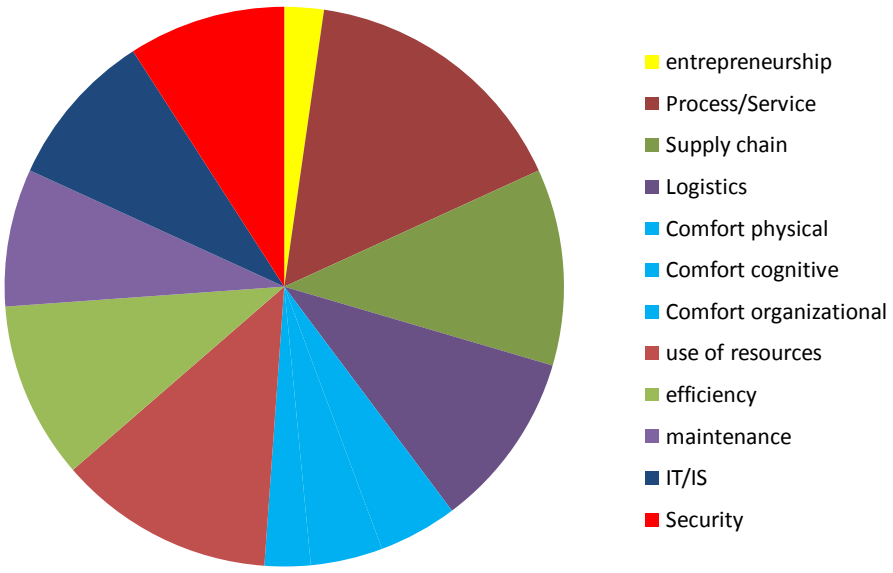
	Administration				Chemistry				Culture			
ADVANTAGES	People Identification/Passports		School & Universities		Corrosion Detection		Tracking management		Museums		Nuclear Management	
	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring
New business/services	0	0	4	8	4	8	1	2	3	6	0	0
Size	3	4	2	3	3	4	1	1	3	4	1	1
Link to database	4	9	2	5	0	0	3	7	4	9	3	7
Process: time consumption	3	12	2	8	4	16	3	12	0	0	4	16
Process: material consumption	0	0	0	0	4	12	1	3	0	0	1	3
Process: HR consumption	3	9	1	3	4	12	3	9	3	9	5	15
No need of visual contact	0	0	5	8	4	7	3	5	2	3	3	5
Unlimited readings	2	2	4	4	3	3	2	2	4	4	4	4
Quick reading data	2	6	5	15	3	9	1	3	3	9	1	3
Unlimited rewritings	4	20	2	10	0	0	0	0	5	25	1	5
No batteries	4	16	4	16	3	12	1	4	2	8	1	4
High range	0	0	5	20	0	0	1	4	4	16	5	20
autonatic reading	0	0	5	35	5	35	1	7	3	21	4	28
simultaneous readings	0	0	5	23	4	19	4	19	5	23	4	19
great storage capacity	1	6	1	6	0	0	0	0	4	24	2	12
transmission of data through space	2	11	4	23	3	17	1	6	4	23	4	23
durability	3	6	3	6	4	8	2	4	4	8	4	8
miniaturisation capabilities	1	2	2	5	1	2	1	2	1	2	1	2
synergy capabilities	1	5	1	5	3	15	1	5	4	20	1	5
installation simplicity	2	4	2	4	1	2	4	8	5	8	1	2
Monitoring/real time alerting/actualization	0	0	3	27	3	27	0	0	4	36	5	45
Flows monitoring/tracking/traceability	0	0	5	12	0	0	4	16	5	20	5	20
Information security	3	6	1	2	1	2	1	2	1	2	2	4
Security enabling	4	8	5	6	5	10	1	2	0	0	5	10
Resistance/reliability	2	4	4	8	3	6	1	2	2	4	5	10
	1	131	5	281	7	228	2	125	7	283	1	271
	18		40		28		22		41		36	
	9		31		19		13		39		32	
	8		29		18		12		38		31	
	6,0		11,3		13,7		7,7		9,5		12,7	
	6,0		10,7		12,3		8,0		9,3		13,0	
	4,0		5,3		8,7		4,5		4,5		8,3	
	16		27		35		20		33		34	
	21		26		32		17		35		32	
	13		24		29		15		34		27	
	10		21		16		5		25		22	
	14		22		12		10		30		23	
	15		27		20		9		22		33	

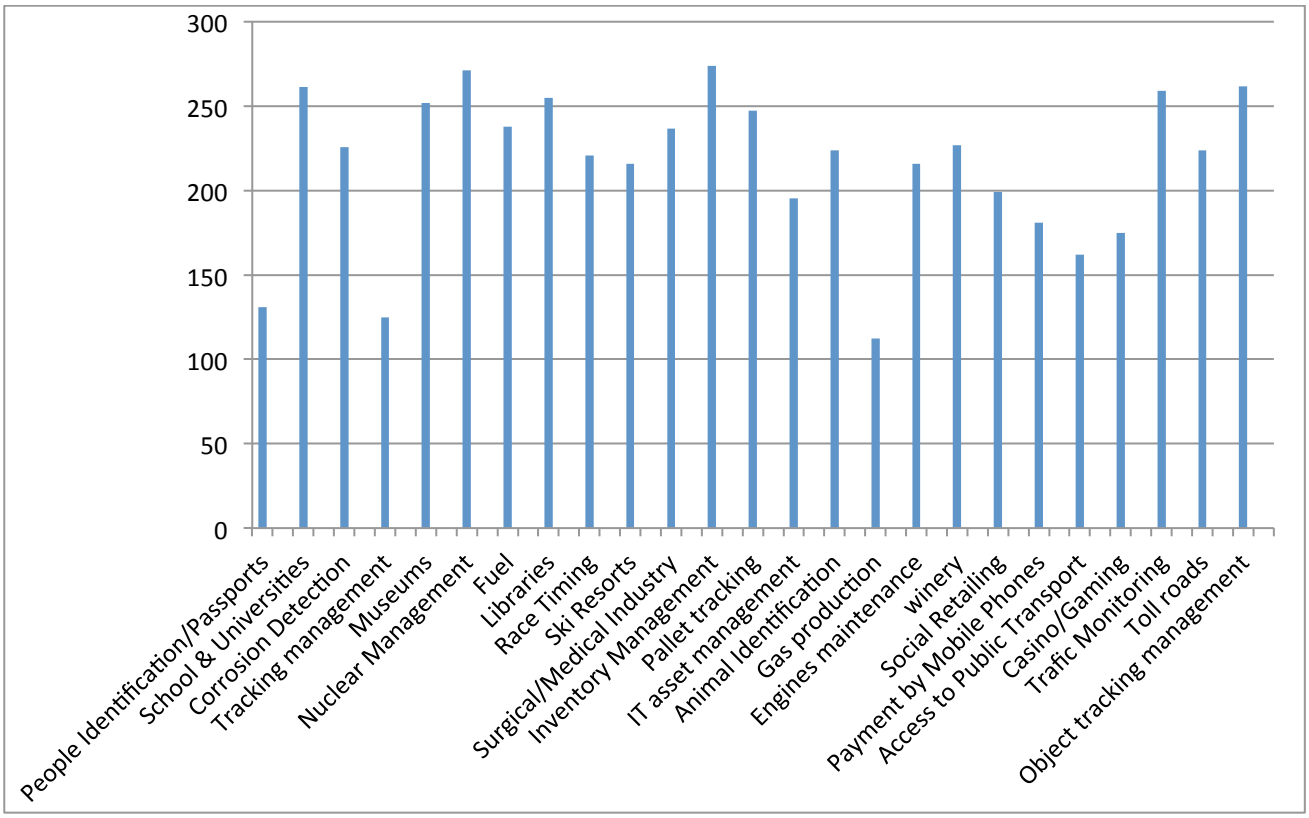
SECTOR											
Energy		Enternainment / Culture						Health care		Logistics	
INDUSTRY/ACTIVITY											
Fuel		Libraries		Race Timing		Ski Resorts		Surgical/Medical Industry		Inventory Management	
Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring
0	0	0	0	0	0	0	0	4	8	0	0
1	1	3	4	4	5	3	4	3	4	3	4
4	9	5	12	1	2	1	2	3	7	4	9
4	16	4	16	0	0	5	20	3	12	4	16
2	6	1	3	0	0	0	0	0	0	0	0
5	15	4	12	2	6	3	9	0	0	4	12
4	7	4	7	4	7	5	8	4	7	5	8
4	4	2	2	1	1	4	4	1	1	3	3
3	9	3	9	5	15	4	12	3	9	4	12
3	15	4	20	2	10	1	5	0	0	0	0
0	0	4	16	3	12	4	16	4	16	0	0
5	20	0	0	5	20	2	8	0	0	3	12
2	14	4	28	5	35	3	21	5	35	5	35
1	5	5	23	4	19	1	5	4	19	4	19
2	12	2	12	1	6	1	6	1	6	2	12
4	23	3	17	5	28	5	28	4	23	5	28
3	6	4	8	0	0	1	2	1	2	4	8
0	0	4	9	4	9	3	7	2	5	3	7
1	5	1	5	0	0	2	10	4	20	4	20
1	2	1	2	4	8	4	8	4	8	4	8
3	27	4	36	1	9	2	18	4	36	4	36
5	20	0	0	5	20	2	8	0	0	0	0
1	2	1	2	0	0	1	2	1	2	3	6
5	10	4	8	0	0	1	2	5	10	5	10
5	10	2	4	4	8	5	10	4	8	4	8
1	238	1	255	0	221	2	216	8	237	4	274
30		41		45		42		45		46	
26		27		32		22		24		30	
26		23		28		19		22		27	
10,7		13,7		11,0		11,7		12,7		15,3	
11,7		13,0		8,7		10,0		12,0		14,7	
7,3		7,3		4,0		6,0		7,0		8,7	
30		34		24		28		32		39	
28		35		14		24		22		29	
25		25		21		25		23		25	
20		23		16		19		18		19	
23		23		20		15		17		22	
29		23		21		20		26		33	
238		255		221		216		237		274	

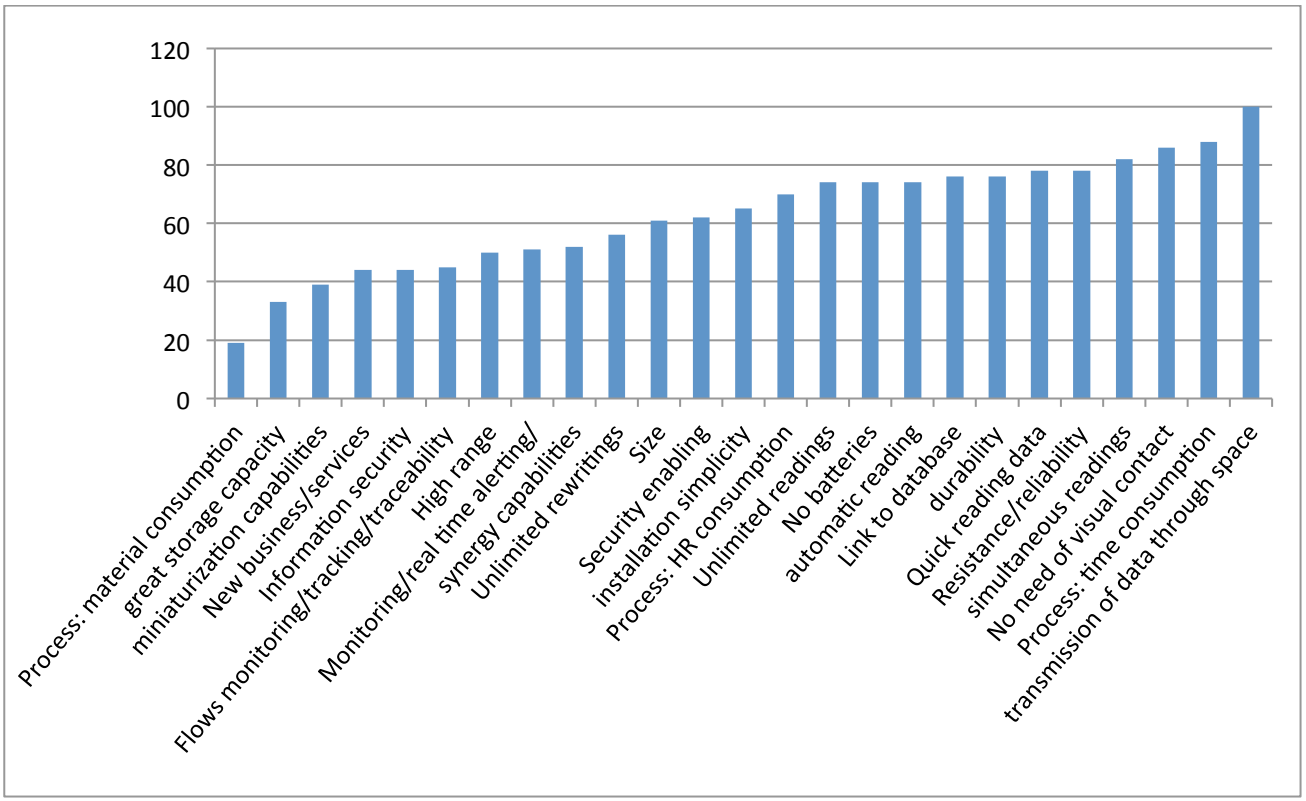
SECTOR											
Logistics		Labelling				Manufacturing					
INDUSTRY/ACTIVITY											
Pallet tracking		IT asset management		Animal Identification		Gas production		Engines maintenance		winery	
Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring
0	0	0	0	0	0	0	0	0	0	0	0
2	3	2	3	3	4	1	1	3	4	1	1
3	7	2	5	2	5	3	7	4	9	5	12
4	16	4	16	3	12	4	16	4	16	4	16
0	0	0	0	0	0	2	6	1	3	3	9
3	9	3	9	3	9	4	12	3	9	5	15
4	7	5	8	3	5	1	2	4	7	3	5
3	3	4	4	2	2	2	2	2	2	5	5
3	9	3	9	3	9	1	3	1	3	1	3
4	20	0	0	2	10	1	5	3	15	5	25
4	16	4	16	4	16	3	12	4	16	1	4
4	16	4	16	3	12	0	0	1	4	3	12
3	21	0	0	3	21	0	0	5	35	0	0
4	19	4	19	4	19	0	0	5	23	3	14
2	12	1	6	1	6	0	0	1	6	1	6
4	23	5	28	4	23	2	11	4	23	4	23
2	4	5	10	3	6	4	8	2	4	5	10
2	5	2	5	2	5	0	0	2	5	0	0
2	10	1	5	2	10	1	5	2	10	2	10
2	4	1	2	3	6	3	6	3	6	2	4
3	27	3	27	3	27	0	0	0	0	5	45
0	0	0	0	0	0	0	0	2	8	0	0
3	6	2	4	3	6	1	2	1	2	1	2
1	2	1	2	2	4	3	6	1	2	1	2
5	10	1	2	4	8	4	8	2	4	2	4
2	247	1	195	2	224	1	112	2	216	2	227
41		38		39		15		37		28	
28		20		24		4		25		23	
26		18		22		4		23		23	
10,7		10,0		11,0		6,7		11,7		10,3	
10,3		9,3		10,0		7,3		11,3		11,7	
5,3		4,0		5,7		5,3		5,7		6,7	
26		23		27		19		29		29	
31		29		27		21		27		39	
22		18		21		15		22		21	
24		19		21		14		16		23	
21		11		17		6		17		18	
26		18		24		13		18		21	
247		195		224		112		216		227	

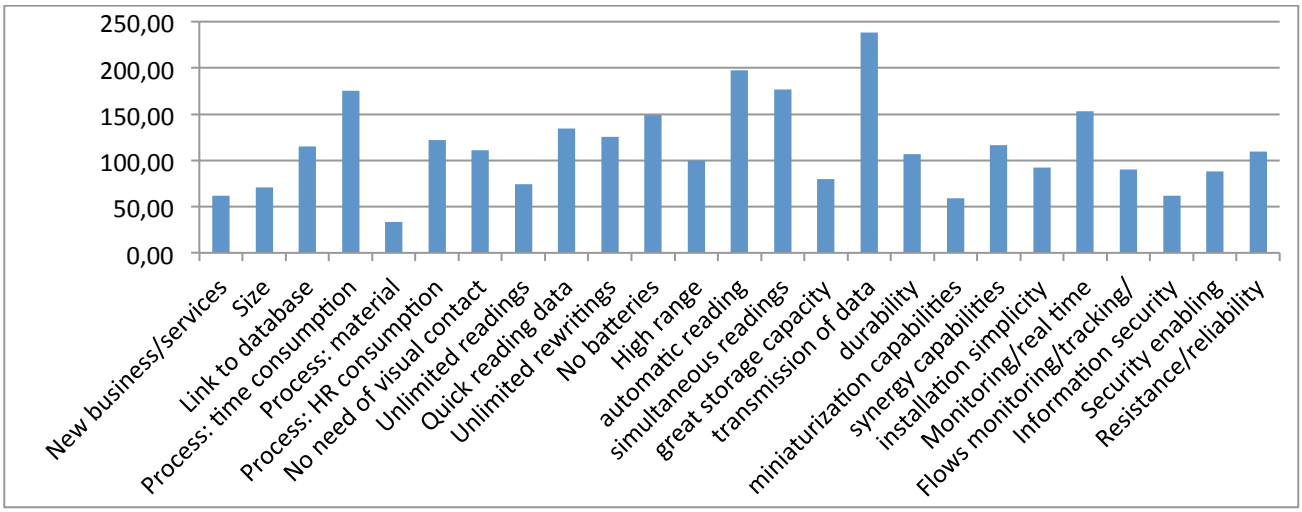
SECTOR											
Retail				Security				Transportation			
INDUSTRY/ACTIVITY											
Social Retailing		Payment by Mobile Phones		Access to Public Transport		Casino/Gaming		Trafic Monitoring		Toll roads	
Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring	Relative Scoring	Ponderated Scoring
5	10	5	10	5	10	4	8	4	8	4	8
2	3	3	4	3	4	2	3	3	4	3	4
3	7	3	7	2	5	3	7	5	12	2	5
4	16	4	16	4	16	2	8	5	20	4	16
1	3	0	0	0	0	0	0	1	3	2	6
0	0	0	0	2	6	0	0	1	3	4	12
2	3	0	0	0	0	4	7	5	8	5	8
4	4	2	2	3	3	3	3	4	4	2	2
3	9	4	12	4	12	3	9	5	15	4	12
1	5	3	15	4	20	2	10	1	5	3	15
4	16	2	8	3	12	4	16	4	16	3	12
3	12	0	0	0	0	0	0	0	0	1	4
2	14	0	0	0	0	3	21	5	35	5	35
5	23	0	0	0	0	3	14	5	23	2	9
2	12	1	6	1	6	1	6	1	6	2	12
5	28	4	23	5	28	4	23	4	23	5	28
1	2	3	6	2	4	3	6	3	6	3	6
2	5	1	2	0	0	3	7	0	0	0	0
3	15	3	15	2	10	2	10	4	20	3	15
2	4	4	8	3	6	2	4	3	6	4	8
0	0	3	27	0	0	0	0	0	0	0	0
0	0	0	0	3	12	0	0	5	20	0	0
2	4	5	10	1	2	3	6	3	6	1	2
1	2	4	8	1	2	1	2	4	8	0	0
1	2	1	2	2	4	3	6	4	8	2	4
8	199	8	181	7	162	6	175	8	259	7	224
41		31		28		35		44		42	
23		15		15		18		25		21	
21		14		15		15		25		21	
8,7		7,7		6,0		8,0		12,0		11,3	
8,3		7,3		5,7		7,3		12,7		11,0	
3,3		5,0		3,3		2,7		6,3		6,3	
20		20		15		18		31		29	
25		21		21		20		29		28	
17		16		18		14		30		25	
14		17		17		17		17		18	
13		19		15		15		25		17	
17		20		11		17		25		16	
199		181		162		175		259		224	

Transportation									
Object tracking management									
Relative Scoring	Ponderated Scoring								
0	0	New business/services	43	44		62,05	Process: material consumption	19	
2	3	Size	60	61		70,70	great storage capacity	33	
3	7	Link to database	74	76		115,34	miniaturization capabilities	39	
4	16	Process: time consumption	86	88		175,51	New business/services	44	
0	0	Process: material consumption	19	19		33,58	Information security	44	
4	12	Process: HR consumption	69	70		121,95	Flows monitoring/tracking/traceability	45	
5	8	No need of visual contact	84	86		110,66	High range	50	
3	3	Unlimited readings	73	74		74,49	Monitoring/real time alerting/actualization	51	
4	12	Quick reading data	76	78		134,32	synergy capabilities	52	
4	20	Unlimited rewritings	55	56		125,49	Unlimited rewritings	56	
4	16	No batteries	73	74		148,98	Size	61	
0	0	High range	49	50		100,00	Security enabling	62	
5	35	automatic reading	73	74		197,08	installation simplicity	65	
4	19	simultaneous readings	80	82		176,35	Process: HR consumption	70	
1	6	great storage capacity	32	33		79,98	Unlimited readings	74	
4	23	transmission of data through space	98	100		238,05	No batteries	74	
5	10	durability	74	76		106,79	automatic reading	74	
1	2	miniaturization capabilities	38	39		59,23	Link to database	76	
1	5	synergy capabilities	51	52		116,37	durability	76	
1	2	installation simplicity	64	65		92,36	Quick reading data	78	
3	27	Monitoring/real time alerting/actualization	50	51		153,06	Resistance/reliability	78	
5	20	Flows monitoring/tracking/traceability	44	45		89,80	simultaneous readings	82	
1	2	Information security	43	44		62,05	No need of visual contact	86	
3	6	Security enabling	61	62		88,03	Process: time consumption	88	
4	8	Resistance/reliability	76	78		109,67	transmission of data through space	100	
1	262	Entrepreneurship			BUSINESS UNITS	3,38	8		
38		Process/Service				34,69	49		
28		Supply Chain				22,19	36		
27		Logistics				20,69	35		
12,0		Physical	COMFORT			10,05	15,33		
12,0		Cognitive				9,76	14,67		
6,7		Organizational				5,42	8,67		
31		**TOTAL**				25,31	39		
33		Use of Resources				25,65	39		
30		Efficiency				21,00	30		
25		Maintenance				17,88	25		
26		IT/IS				17,54	26		
23		Security				20,42	33		
	262					Moyenne	Maximum		


entrepreneurship
Process/Service
Supply chain
Logistics
Comfort physical
Comfort cognitive
Comfort organizational
use of resources
efficiency
maintenance
IT/IS
Security


300
250
200
150
100
50
0
People Identification/Passports
School & Universities
Corrosion Detection
Tracking management
Museums
Nuclear Management
Fuel
Libraries
Race Timing
Ski Resorts
Surgical/Medical Industry
Inventory Management
Pallet tracking
IT asset management
Animal Identification
Gas production
Engines maintenance
winery
Social Retailing
Payment by Mobile Phones
Access to Public Transport
Casino/Gaming
Trafic Monitoring
Toll roads
Object tracking management


120
100
80
60
40
20
0
Process: material consumption
great storage capacity
miniaturization capabilities
New business/services
Information security
Flows monitoring/tracking/traceability
High range
Monitoring/real time alerting/
synergy capabilities
Unlimited rewritings
Size
Security enabling
installation simplicity
Process: HR consumption
Unlimited readings
No batteries
automatic reading
Link to database
durability
Quick reading data
Resistance/reliability
simultaneous readings
No need of visual contact
Process: time consumption
transmission of data through space


250,00
200,00
150,00
100,00
50,00
0,00
New business/services
Size
Link to database
Process: time consumption
Process: material
Process: HR consumption
No need of visual contact
Unlimited readings
Quick reading data
Unlimited rewritings
No batteries
High range
automatic reading
simultaneous readings
great storage capacity
transmission of data
durability
miniaturization capabilities
synergy capabilities
installation simplicity
Monitoring/real time
Flows monitoring/tracking/
Information security
Security enabling
Resistance/reliability

5.2 Scorings of the advantages within RFID applications

1. RFID Protects Casino Against Theft

The article, written by Justin Rohrlich, reports: "At 3:50 am this morning, a man in a full-face motorcycle helmet walked up to a craps table at the Bellagio hotel-casino in Las Vegas, pulled a gun, and made off with approximately $1.5 million in chips, ranging in value from $100 to $25,000. However, while the chips were worth seven-figures at 3:50 a.m., at 3:51 a.m. they weren't worth a thing—and any potential financial damage to the Bellagio is exactly none."

According to the article, the Bellagio has a secondary set of chips with a different design, which can immediately be used to replace every chip in the house, so that the stolen chips can no longer be used. Moreover, most chips with a face value of $100 or more, as well as some with a face value as low as $25, have embedded RFID transponders. Thus, each chip can be uniquely identified.

Criteria: Advantages (what RFID allows to obtain), scores (how much useful is the previous RFID advantage within this application), and category (which of the enterprise's topics does it address):

Sector: Security

Industry: Casino/Gaming

Advantage, score, category:

- New business
- 4
- Service
-
- Size
- 2
- Service
-
- Link to database
- 3
- Security/IT
-
- Process time consumption:
- 2
- Service
-
- Process: material consumption
- 0
- Use of resources
-
- Process: human resources consumption
- 0
- Use of resources
- No need of visual contact
- 4
- Service
-
- Unlimited readings
- 3
- Service
-
- Quick reading of data
- 3

- Service
-
- Unlimited rewritings
- 2
- Service
-
- No batteries
- 4
- Use of resources
-
- High range
- 0
- Service
-
- Automatic reading: automatic detection and transmission of data
- 3
- IT
-
- Simultaneous readings
- 3
- Service
-
- Great storage capacity
- 1
- Service
-
- Durability
- 3
- Use of resources
-
- Synergy capabilities
- 2
- Service
-
- Installation simplicity
- 2
- Comfort
-
- Monitoring
- 0
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Security
-
- Information security
- 3
- Service
-
- Security enabling
- 1
- Security
-
- Resistance/reliability
- 3
- Service

2. Emirates RFID Bag-Tracking Pilot Takes Off

Feb. 19, 2008—Emirates Airline begun a six-month technology trial to test the use of RFID to improve the tracking of checked luggage. Instead of using the standard, bar-coded ID tags that airlines normally employ to identify baggage, Emirates is placing tags with embedded UHF EPC Gen 2 inlays onto each checked bag.

The airline hopes using RFID combined with automated bag sortation equipment will increase the amount of luggage it can accurately identify and sort, thereby decreasing the number of bags that fail to reach their destination on time.

To track the bags from the point of departure to the point of arrival, RFID interrogators read the unique ID from the inlays in each luggage tag as the bags are moved through a number of chokepoints within each airport. Conventionally, bar-code scanners are employed to identify the tags, but because bar-code technology requires a clear line of sight between the scanner and a printed bar code, the read is often missed due to the orientation of the label to the scanner.

Bags that aren't automatically identified through their bar code or RFID number are diverted and manually handled, thus increasing the likelihood that a bag will be delayed and not loaded onto the same flight as its owner. According to the International Air Transport Association (IATA), a trade group composed of airlines around the globe, the annual cost of mishandled baggage to the industry is more than $3 billion.

Sector: Transportation

Industry: product tracking management

Advantage, score, categories:

- New business
- 0
- Service
-
- Size
- 2
- Service
-
- Process time consumption
- 4
- Service
-
- Process: material consumption
- 0
- Use of resources
-
- Process: human resources consumption
- 4
- Use of resources
-
- Link to database
- 3
- Security/IT
-
- No need of visual contact
- 5
- Service
-
- Unlimited readings
- 3
- Service

-
- Quick reading of data
- 4
- Service
-
- Unlimited rewritings
- 4
- Service
-
- Transmission of data through space
- 4
- Service
-
- No batteries
- 4 (passive tag (no battery) just needs to be read at each chokepoint)
- Use of resources
-
- High range
- 0
- Service
-
- Automatic reading: automatic detection and transmission of data
- 5
- IT
-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 1
- Service
-
- Durability
- 5
- Use of resources
-
- Miniaturization capabilities
- 1
- Service
-
- Synergy capabilities
- 1 (saving time and money: see text above)
- Service
-
- Installation simplicity.
- 1
- Comfort
-
- Monitoring
- 3 (hard to say; identification at many chokepoints is actually monitoring)
- Service
-
- Monitoring of flows/tracking/traceability
- 5
- Security
-
- Information security
- 1
- Service
-
- Security enabling
- 3 (more security for bags by moving through less chokepoints; less damage)
- Security
-
- Reliability
- 4
- Service

3. IBM Offering IT Asset-Tracking Solution

May 13, 2008—IT giant IBM is launching a packaged RFIDsolution enabling companies to track valuable IT assets. Four data centers operated by IBM—three in Europe, one in the United States—as well as a data center operated by a major insurance provider located in Germany, are already employing the RFID-based system to improve the speed and accuracy with which they can track valuable, mobile IT assets such as blade servers, laptops and peripherals. Based on the success of those deployments, IBM is now marketing the RFID solution to other companies as well.

Sector: Electrics

Industry: IT Asset management (e.g. tracking a laptop)

Advantage, score, categories:

- New business
- 0
- Service
-
- Size
- 2
- Service
-
- Process time consumption
- 4
- Service
-
- Process: material consumption
- 0
- Use of resources
-
- Process: human resources consumption
- 3
- Use of resources
-
- Link to database
- 2
- IT
-
- No need of visual contact
- 5
- Service
-
- Unlimited readings
- 4
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 0
- Service
-
- Transmission of data through space
- 5
- Service
-
- No batteries
- 4
- Use of resources
-
- High range
- 4
- Service
-
- Automatic reading: automatic detection and transmission of data
- 0
- IT

-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 1
- Service
-
- Durability
- 5
- Use of resources
-
- Miniaturization capabilities
- 2
- Service
-
- Synergy capabilities
- 1
- Service
-
- Installation simplicity.
- 1
- Comfort
-
- Monitoring
- 3
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Service
-
- Information security
- 2
- Service
-
- Security enabling
- 1
- Security
-
- Resistance/reliability
- 1
- Service

4. Boeing Tracks Assets at Kennedy Space Center

RFID Global Solution's real-time locating system allows Boeing to track its tools as they are used on NASA spacecraft in real time, and to ensure none are left at the launch pad. Nov. 13, 2008—Boeing is using a real-time location system (RTLS) at NASA's Kennedy Space Center (KSC) to reduce man-hours spent inventorying tools, and ensure that none are left at the launch pad.

Much of the work performed on spacecraft and at the launch pad is conducted at night, so as not to interfere with KSC's daytime activities and limit the impact on the majority of the center's personnel. In the dark, however, tools can be difficult to locate, and that means a diligent contractor must spend as much time as necessary to locate all tools used at the site before leaving. A stray piece of equipment or tool left behind at the pad could be disastrous, since it could damage a spacecraft during takeoff. Harm to even one tile could render the vessel fatally damaged.

After an initial deployment of about 600 tags, the company plans to attach tags to 3000 other tools and pieces of equipment. The company uses active RFID tags to provide tracking in real time.

In 2007,the firm was still using a team of employees to track and inventory its assets on a regular basis by simply seeing them and recording them on paper.

Sector: Aerospace

Industry: inventory management

Advantage, score, categories:

- New business
- 0
- Service
-
- Size
- 3
- Service
-
- Process time consumption
- 4
- Service
-
- Process: material consumption
- 0
- Use of resources
-
- Process: human resources consumption
- 4
- Use of resources
-
- Link to database
- 4
- Security/IT
-
- Quick reading of data
- 4
- Service
-
- No batteries
- 0
- Use of resources
-
- High range

- 3
- Security
-
- Automatic reading: automatic detection and transmission of data
- 5
- IT
-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 2
- Service
-
- Durability
- 4
- Use of resources
-
- Miniaturization capabilities
- 3
- Service
-
- Synergy capabilities
- 4 (saving time, labor and thereby money, reducing risks and fatalities)
- Service
-
- Installation simplicity.
- 4
- Comfort
-
- Monitoring
- 4
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Security
-
- Information security
- 3
- Service
-
- Security enabling
- 5
- Security
-
- Resistance/Reliability
- 4
- Service

5. USDA Approves First UHF Tag for Animal Identification System

The agricultural department says an EPC Gen 2 RFID tag from Eriginate can serve as an alternative to low-frequency RFID tags for use with its National Animal Identification System (AIN).

Since the outbreak of mad-cow disease, RFID has become crucial in animal identification management.

Tags currently employed by ranchers and cattle auction companies help to track the movements and health of cattle.

Sector: Health care

Industry: animal identification management

Advantage, score, category:

- New business
- 0
- Service
-
- Size
- 3
- Service
-
- Process time consumption:
- 3
- Service
-
- Process: material consumption
- 0
- Use of resources
-
- Process: human resources consumption
- 3
- Use of resources
-
- Link to database
- 2
- IT
-
- Unlimited readings
- 2
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 2
- Service
-
- Transmission of data through space
- 4
- Service
-
- No batteries
- 4
- Use of resources
-
- High range
- 3
- Service
-
- Automatic reading: automatic detection and transmission of data
- 3
- IT
-

- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 1
- Service
-
- Durability
- 3
- Use of resources
-
- Synergy capabilities
- 2
- Service
-
- Installation simplicity
- 3
- Comfort
-
- Monitoring
- 3
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Service
-
- Information security
- 3
- Service
-
- Security enabling
- 2
- Security
-
- Resistance/reliability
- 4
- Service

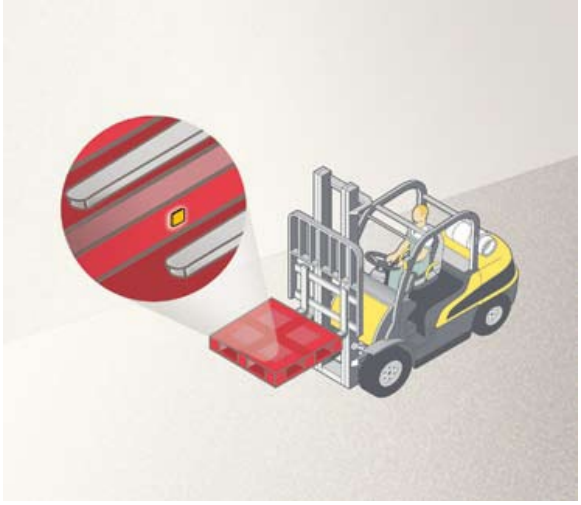
6. Rugged Tags Enable Accurate Pallet Tracking

Pallets are subjected to harsh conditions. They may be left outside for extended periods, hit or scraped repeatedly by forklifts, or damaged during transport. For these reasons alone, using barcodes to individualize the pallets is impractical, not to mention the additional labor cost such an approach would require.

The tag also needed to be orientation insensitive, because forklifts (which have RFID readers directly attached to them) access pallets from any side.

Mighty Card's rugged tags - readable up to 10 meters distance - will enter full production in the second quarter of 2009. (product :"Mighty card", a specially packaged tag chip that withstands more stress. Mighty Card put the tag through environmental stresses, including dropping it three meters onto concrete, temperature cycling it from -20 ºC to 85 ºC, immersing it in water down to 1 meter, and subjecting it to 95% humidity. The tag passed all tests successfully).

http://www.impinj.com/Applications/Case_Studies.aspx



Sector: Transportation and Logistics

Industry: Asset management

Advantage, score, categories:

- New business
- 0
- Service
-
- Size
- 2
- Service
-
- Process time consumption
- 4
- Service
-
- Process: material consumption
- 0
- Use of resources
-

- Process: human resources consumption
- 3
- Use of resources
-
- Link to database
- 3
- IT
-
- No need of visual contact
- 4
- Service
-
- Unlimited readings
- 3
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 4
- Service
-
- Transmission of data through space
- 4
- Service
-
- No batteries
- 4
- Use of resources
-
- High range
- 4
- Service
-
- Automatic reading: automatic detection and transmission of data
- 3
- IT
-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 2
- Service
-
- Durability
- 2
- Use of resources
-
- Miniaturization capabilities
- 2
- Service
-
- Synergy capabilities
- 2 (aesthetic advantages)
- Service
-
- Installation simplicity.
- 2
- Comfort
-
- Monitoring
- 3
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Service
-
- Information security
- 3
- Service
-
- Security enabling
- 1
- Security
-
- Resistance/reliability
- 5
- Service

7. RFID-Enabled Surgical Sponges

In 2008, ClearCount Medical introduced the SmartSponge System, the first RFID-based system approved for use in the operating room. The system incorporates RFID tags into surgical disposable gauze, sponges, and towels to help prevent medical teams from inadvertently leaving sponges inside surgical patients. The system automatically provides a device-reconciled count by directly matching the unique identifier on each tagged item both entering into and then out of the surgical case.

Sector: Health care

Industry: Medical industry

Advantage, score, categories:

- New business
- 3
- Service
-
- New business
- 4
- Service
-
- Size
- 3
- Service
-
- Link to database
- 3
- Security/IT
-
- Process time consumption
- 3
- Service
-
- Process: material consumption
- 0
- Use of resources
-
- Process: human resources consumption
- 0
- Use of resources
-
- No need of visual contact
- 4
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 4
- Service
-
- Transmission of data through space
- 4
- Service
-
- No batteries
- 4
- Use of resources
-
- High range
- 0
- Security
-
- Automatic reading: automatic detection and transmission of data
- 5
- IT

-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 1
- Service
-
- Durability
- 1
- Use of resources
-
- Miniaturization capabilities
- 2
- Service
-
- Synergy capabilities
- 4 (security of the patient)
- Service
-
- Installation simplicity.
- 4
- Comfort
-
- Monitoring
- 4
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Security
-
- Information security
- 1
- Service
-
- Security enabling
- 5
- Security
-
- Reliability
- 4
- Service

8. RFID Sensors Detect Corrosion

A solution being developed at Oklahoma State University could provide early warnings of possible structural failures.

The researchers developed a sensor using a low-frequency RFID transponder. Initial versions used the metal on which corrosion was to be detected to connect the RFID chip to the antenna. If the connection eroded, the RFID transponder would stop working, indicating a potential problem.

Sector: Chemistry

Industry: detecting Corrosion

Advantage, score, category:

- New business
- 4
- Service
-
- Size
- 3
- Service
-
- Link to database
- 0
- Security/IT
-
- Process time consumption:
- 4
- Service
-
- Process: material consumption
- 4
- Use of resources
-
- Process: human resources consumption
- 4
- Use of resources
-
- No need of visual contact
- 4
- Service
-
- Unlimited readings
- 3
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 0
- Service
-
- No batteries
- 3
- Use of resources
-
- High range
- 0
- Service
-
- Automatic reading: automatic detection and transmission of data
- 5
- IT
-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity

- 0
- Service
-
- Transmission of data through space
- 3
- Security
-
- Durability
- 4
- Use of resources
-
- Miniaturization capabilities
- 1
- Service
-
- Synergy capabilities
- 3
- Service
-
- Installation simplicity
- 1
- Comfort
-
- Monitoring
- 3
- Service
-
- Monitoring of flows/tracking/traceability
- 0
- Security
-
- Information security
- 1
- Service
-
- Security enabling
- 5
- Security
-
- Resistance/reliability
- 3
- Service

9. RFID Tracks Oil Co. Containers and Ships in Newfoundland

A. Harvey is tagging its containers, as well as some vessels and trucks, to increase the visibility of its operations providing equipment, tools and food to offshore oil rigs.

A. Harvey, a Canadian provider of marine and offshore oil and gas support services, is installing an active real-time locating system (RTLS) to locate and track the movements of containers as they are stored and then moved onto and off of vessels destined for oil rigs in the northern Atlantic Ocean.

Sector: Chemistry

Industry: tracking management

Advantage, score, category:

- New business
- 1
- Service
-
- Size
- 1
- Service
-
- Link to database
- 3
- Security/IT
-
- Process time consumption:
- 3
- Service
-
- Process: material consumption
- 1
- Use of resources
-
- Process: human resources consumption
- 3
- Use of resources
-
- No need of visual contact
- 3
- Service
-
- Unlimited readings
- 2
- Service
-
- Quick reading of data
- 1
- Service
-
- Unlimited rewritings
- 0
- Service
-
- No batteries
- 1
- Use of resources
-
- High range
- 1
- Service
-
- Automatic reading: automatic detection and transmission of data
- 1
- IT
-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity

- 0
- Service
- Transmission of data through space
- 1
- Service
-
- Durability
- 2
- Use of resources
-
- Miniaturization capabilities
- 1
- Service
-
- Synergy capabilities
- 1
- Service
-
- Installation simplicity
- 4
- Comfort
-
- Monitoring
- 0
- Service
-
- Monitoring of flows/tracking/traceability
- 4
- Security
-
- Information security
- 1
- Service
-
- Security enabling
- 1
- Security
-
- Resistance/reliability
- 1
- Service

10. Payment by mobile phones

Since summer 2009, two credit card companies have been working with Dallas, Texas-based Device Fidelity to develop specialized micro SD cards. When inserted into a mobile phone, the micro SD card can be both a passive tag and an RFID reader. After inserting the micro SD, a user's phone can be linked to bank accounts and used in mobile payment.

Dairy Queen in conjunction with Vivotech has also begun using RFIDs on mobile phones as part of their new loyalty and rewards program. Patrons can ask to receive an RFID tag to place on their phone. After activation, the phone can receive promotions and coupons, which can be read by ViVOtech's specialized NFC devices.

Similarly, 7-eleven has been working alongside Mastercard to promote a new touch-free payment system. Those joining the trial are given a complimentary Nokia 3220 cell phone, which after activation can be used as an RFID-capable MasterCard credit card at any of 7-Eleven's worldwide chains.

Nokia's 2008 device, the 6212, has RFID capabilities also. Credit card information can be stored, and bank accounts can be directly accessed using the enabled handset. The phone, if used as a vector for mobile payment, has added security in that users would be required to enter a passcode or PIN before payment is authorized.

Technology: RFID Micro SD Cards. (http://www.rfidjournal.com/article/view/7224)

- Industry: payment by mobile phones
- Sector: retail
- Advantages:
    - New businesses and services,
    - 5 (great potential gains),
    - Services
    -
    - Size
    - 3 (integration to bigger device),
    - Services / comfort
    -
    - Link to database (bank…)
    - 3
    - Information Systems/Technology (IS/IT)
    -
    - Process: time consumption: reduction of the amount of time
    - 4
    - Comfort / use of resources / efficiency
    -
    - Process: materials consumption
    - 0
    - use of resources
    -
    - Process: Human Resources consumption
    - 0
    - use of resources
    -
    - Line of sight: no need of visual contact
    - 0
    - Service
    -
    - Unlimited readings
    - 2
    - Service

-
- Quick reading of data
- 4
- service
-
- Unlimited number of data rewritings
- 3
- Service
-
- No batteries
- 2
- Use of resources
-
- High range: Active tags with batteries for higher distance readings
- 0
- Service
-
- Automatic reading: automatic detection and transmition of data when passing through portico doors, reader portals…
- 0
- Service
-
- Simultaneous readings: of many tags.
- 0
- Service
-
- storage capacity
- 1
- Service
-
- Transmission of data through space
- 4
- Service
-
- Durability
- 3
- Use of resources
-
- Miniaturization capabilities
- 1
- Service / Comfort
-
- Synergy capabilities
- 3
- Service
-
- Installation simplicity
- 4
- Service
-
- Monitoring / Real time alerting/actualization
- 3
- Service
-
- Flows monitoring/traceability: moving objects traceability when passing through checkpoints
- 0
- Service
-
- Information security
- 5
- Security
-
- Security enabling
- 4 (PIN requirement directly on the phone)
- Service
-
- Resistance/reliability
- 1
- Security

11. Traffic monitoring

Governments use RFID applications for traffic management, by measuring the travel time of cars with toll-collection transponders in order to provide commuter updates. The Orlando/Orange County Expressway Authority (OOCEA) is deploying an RFID-based traffic-monitoring system in central Florida. RFID readers collect signals from transponders already installed in about 1 million E-Pass and SunPass customer vehicles, which are both automatic toll payment methods used in central Florida. Containing a passive tag, these E-Pass and SunPass transponders are slightly larger than a credit card and attach to a car's windshield. The goal is to implement a system that would trace the travel time of individual cars as they pass the roadside readers, create an average trip time and then disseminate that information to the public.

The installation of readers above the road on the expressway authority's system, positioned about half mile apart on the expressway, will track travel time and send traffic-flow data to be monitored by the Florida Department of Transportation (FDOT) and the OOCEA. There, data will provide for calculations done by a data server and then results will be sent back to the FDOT to be distributed to the public. Information about commute times will be sent to the public on dynamic message signs, installed at motorists' decision points around the roadway system to provide up-to-date traffic information. Motorists will also be able to access traffic information by calling the national travel information telephone number or by accessing a web site or maybe even mobile phone applications.

The roadside readers capture the transponder's unique ID number. Privacy issues have already been raised by people in California, however the company and the FDOT have stated that the technology does not allow for privacy violations. Once a driver's ID number is captured by a roadside reader, the number will be encrypted and sent to the FDOT server to be temporarily stored. Farther along the road, the next reader will read the same toll tag ID number, encrypt it again and send that information to the server. After the data server receives data for the same toll tag from two separate readers, it calculates and saves the travel time, and erases the encrypted ID number.

- Industry: traffic monitoring: information and flow management
- Sector: transport
- Advantages, scores, and category:
    - New public service
    - 4
    - Service
    -
    - Size
    - 3
    - Service
    -
    - Link to database
    - 5
    - Information Systems/Technology (IS/IT)
    -
    - Process time consumption: reduction of the amount of time
    - 5
    - Service

-
- Process: materials consumption
- 1
- use of resources
-
- Process: Human Resources consumption
- 1
- use of resources
-
- Line of sight
- 5
- Service
-
- Unlimited readings
- 4
- Service
-
- Quick reading of data
- 5 (fast passing cars)
- Service
-
- Unlimited rewritings
- 1
- Service
-
-
- No batteries
- 4
- Service
-
- High range: Active tags with batteries for higher distance readings
- 0
- Service
-
- Automatic reading: automatic obtaining and transmition of data when passing through portico doors, reader portals…
- 5
- Service
-
- Simultaneous readings
- 5
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space
- 4
- Service
-
- Durability
- 3
- Service
-
- Miniaturization capabilities
- 0
- Service
-
- Synergy capabilities
- 4
- Service
-
- Installation simplicity
- 3
- Comfort
-
- Monitoring / Real time alerting/actualization: events “trigger” the tags, which are then read.
- 0
- Information technology
-
- Flows monitoring/traceability
- 5
- Service
-
- Information security
- 3
- Service
-
- Security enabling
- 4
- Security
-
- Resistance/reliability
- 4
- Security

12. Toll Roads:

RFID technology is used on the paying points distributed along toll roads. This is an already well extended application of RFID, and though there are different varieties of ways of implementation, the most common one is through the installation of an RFID passive tag sticker on the cars windshield. When the car arrives to the toll spot, it enters the readers magnetic field and gives back the information required for the opening of the tolls gate. This is done without need of stopping the car, at about different speeds that can easily be of 50km/h. Though RFID technology allows even higher speeds, toll spots are not safe enough to bee past faster, due to the concentration of cars at different speeds and the narrowness of the lanes.

- Industry: traffic
- Sector: transport
- Advantages, scores, and category:
    - New service
    - 4
    - Service
    -
    - Size
    - 3
    - Service
    -
    - Link to database
    - 2
    - Information Systems/Technology (IS/IT)
    -
    - Process time consumption
    - 4
    - Service
    -
    - Process: materials consumption
    - 2
    - use of resources
    -
    - Process: Human Resources consumption
    - 4
    - use of resources
    -
    - Line of sight: no need of visual contact for information reading
    - 5
    - Service
    -
    - Unlimited readings
    - 2
    - Service
    -
    - Quick reading of data: data flow is quik from tag to reader.
    - 4
    - Service
    -
    - Unlimited rewritings
    - 3
    - Service
    -
    - No batteries: Passive tags
    - 3
    - Service
    -
    - High range (without active tags)
    - 1
    - Service
    -
    - Automatic reading: automatic detection and transmition of data when passing through portico doors, reader portals…
    - 5
    - Service
    -
    - Simultaneous readings: of many tags.

- 2
- Service
-
- Great storage capacity.
- 2
- Service / Information technology
-
- Transmision of data through space
- 5
- Service
-
- Durability: lifespan of decades.
- 3
- Comfort / use of resources
-
- Miniaturization capabilities.
- 0
- Service
-
- Synergy capabilities: Integration with multiple applications (example: integration with the previous transportation application for obtaining traffic information)
- 3
- Service
-
- Installation simplicity.
-
- 4
- Comfort
-
- Monitoring / Real time alerting / actualization: events “trigger” the tags, which are then read.
- 0
- Information technology
-
- Flows monitoring/traceability: moving objects traceability when passing through checkpoints.
- 0
- Service
-
- Information security: safeness of the information (codification...).
- 1
- Information technology
-
- Security enabling
- 0
- Service
-
- Resistance/reliability: to usage, climate, humidity, temperature…
- 2
- Use of resources

13. Public Transport Access (bus, train, subway…):

The main way in which to take profit of RFID technology the public transportation purpose is to integrate a passive tag on the card users use to get access the subway, train or bus. The RFID allows users to not need to search for their card inside wallets or bags, but rather to simply hold these close to the tag reader, which then opens the gates or validates access. This capability offers great saving of time by address the queue management problem in rush hours, by accelerating the interaction between the queue server and the user.

The RFID tag can be recharged with money that is deduced when the user travels through the different possible journeys. Another possibility is to purchase unlimited number of journeys for a month or any time extent the transport authority may want to tariff. Any of these options require the tag information to be able rewritable.

The next natural evolution of the process is the use of tags with a higher distance reading capability in order for the tag to be detected without need of visually locating the reader and holding the tag close to it. This would be a "no line of sight need" advantage, but is not extended in today's market and scorings below will not be referring to it.

- Industry: public transportation access and tariffication
- Sector: security
- Advantages, scores, and category:
    - New public service
    - 5
    - Service
    -
    - Size: very small sizes
    - 3
    - Service / Comfort
    -
    - Link to database
    - 2
    - Information Systems/Technology (IS/IT)
    -
    - Process time consumption: reduction of the amount of time
    - 4
    - Service / Comfort
    -
    - Process: materials consumption
    - 0
    - Use of resources
    -
    - Process: Human Resources consumption
    - 2
    - Use of resources
    -
    - Line of sight: no need of visual contact for information reading
    - 0
    - Service
    -
    - Unlimited readings: number of data readings.
    - 3
    - Service
    -
    - Quick reading of data: data flow is quick from tag to reader.
    - 4
    - Service / Comfort
    -

- Unlimited rewritings: number of data rewritings (through distance).
- 4
- Service / Comfort / use of resources
-
- No batteries: Passive tags do not need batteries
- 3
- Service / Comfort
-
- High range: Active tags with batteries for higher distance readings
- 0
- Service
-
- Automatic reading: automatic detection and transmition of data when passing through portico doors.
- 0
- Service
-
- Simultaneous readings: of many tags.
- 0
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space: Certain distances covered
- 5
- Service / Comfort
-
- Durability: lifespan of decades.
- 2
- Comfort / use of resources
-
- Miniaturization capabilities.
- 0
- Service
-
- Synergy capabilities: Integration with databases, Integration with multiple software applications.
- 2
- Service
-
- Installation simplicity
- 3
- Service
-
- Monitoring / Real time alerting/actualization
- 0
- Service
-
- Flows monitoring/traceability: moving objects traceability when passing through checkpoints.
- 3
- Information technology
-
- Information security: safeness of the information (codification...)
- 1
- Service
-
- Security enabling
- 1
- Service
-
- Resistance/reliability: to usage, climate, humidity, temperature…
- 2
- Service / use of resources / comfort

14. Manufacturing Examples:

UC Davis Winery Tracks Fermentation Via RFID Sensors:

The system allows the school's new facility to track the sugar content and temperatures of its wine within each of its 152 fermenting vats, putting an end to manual measurements.

The teaching and research winery at the University of California, Davis, reports that an RFID sensor system used on several dozen fermenters to measure temperature and sugar content of its wine mixes saved manual labor and provided more data about the fermenting wine than most wineries can typically gather.

With the data from the system, the winery expects to conduct testing not previously possible. Each grape mix can vary according to the type of grape used, the environmental factors in effect while the fruit was growing, and the vineyard's location. The way to test the different performances of various types of grapes, is to track the fermenting conditions. With a manual method of tracking fermentation, this had not been possible, but with the RFID sensor system, researchers will now have information regarding the mix's condition, taken every five minutes.

• Industry: winery
• Sector: manufacturing
• Advantages, scores, and category:
    - New business/service
    - 0
    - Service
    -
    - Size: very small sizes
    - 1
    - Service / Comfort
    -
    - Link to database
    - 5
    - Information Systems/Technology (IS/IT)
    -
    - Process time consumption: reduction of the amount of time
    - 4
    - Service / Comfort
    -
    - Process: materials consumption
    - 3
    - Use of resources
    -
    - Process: Human Resources consumption
    - 5
    - Use of resources
    -
    - Line of sight: no need of visual contact for information reading
    - 3
    - Service
    -
    - Unlimited readings: number of data readings.
    - 5
    - Service
    -
    - Quick reading of data: data flow is quick from tag to reader.
    - 1
    - Service / Comfort
    -

- Unlimited rewritings: number of data rewritings (through distance).
- 5
- Service / Comfort / use of resources
-
- No batteries: Passive tags do not need batteries
- 1
- Service / Comfort
-
- High range: Active tags with batteries for higher distance readings
- 3
- Service
-
- Automatic reading: automatic detection and transmition of data when passing through portico doors.
- 0
- Service
-
- Simultaneous readings: of many tags.
- 3
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space: Certain distances covered
- 4
- Service / Comfort
-
- Durability: lifespan of decades.
- 5
- Comfort / use of resources
-
- Miniaturization capabilities.
- 0
- Service
-
- Synergy capabilities: Integration with databases, Integration with multiple software applications.
- 2
- Service
-
- Installation simplicity
- 2
- Service
-
- Monitoring / Real time alerting/actualization
- 5
- Service
-
- Flows monitoring/traceability: moving objects traceability when passing through checkpoints.
- 0
- Information technology
-
- Information security: safeness of the information (codification...)
- 1
- Service
-
- Security enabling
- 1
- Service
-
- Resistance/reliability: to usage, climate, humidity, temperature…
- 2
- Service / use of resources / comfort

15. Engine Maintenance:

Vector Aerospace Engine Services Atlantic (VAESA) is using RFID to gain visibility of aircraft engine components as they pass through different departments for repair. When aircraft engines arrive at Vector Aerospace for repairs or maintenance, each engine component could undergo a complex route that includes cleaning, inspection and repair, with the work taking place on as many as a dozen different machines and stations. In this industrial activity tracking every component is absolutely critical; if any one of them is missing, delays can result, caused by manual searches for that item and its order paperwork. The objective is achieved by means of installation of permanent fixed reader portals, desktop interrogators at workstations, and passive RFID tags attached to equipment paperwork.

- Industry: Engines maitenance
- Sector: manufacturing
- Advantages, scores, and category:
    - New business/service
    - 0
    - Service
    -
    - Size: very small sizes
    - 3
    - Service / Comfort
    -
    - Link to database
    - 4
    - Information Systems/Technology (IS/IT)
    -
    - Process time consumption: reduction of the amount of time
    - 4
    - Service / Comfort
    -
    - Process: materials consumption
    - 1
    - Use of resources
    -
    - Process: Human Resources consumption
    - 3
    - Use of resources
    -
    - Line of sight: no need of visual contact for information reading
    - 4
    - Service
    -
    - Unlimited readings: number of data readings.
    - 2
    - Service
    -
    - Quick reading of data: data flow is quick from tag to reader.
    - 1
    - Service / Comfort
    -
    - Unlimited rewritings: number of data rewritings (through distance).
    - 3
    - Service / Comfort / use of resources
    -
    - No batteries: Passive tags do not need batteries
    - 4
    - Service / Comfort
    -
    - High range: Active tags with batteries for higher distance readings
    - 1
    - Service
    -

- Automatic reading: automatic detection and transmition of data when passing through portico doors, reader portals, checpoints…
- 5
- Service
-
- Simultaneous readings: of many tags.
- 5
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space: Certain distances covered
- 4
- Service / Comfort
-
- Durability: lifespan of decades.
- 2
- Comfort / use of resources
-
- Miniaturization capabilities.
- 2
- Service
-
- Synergy capabilities: Integration with databases, Integration with multiple software applications.
- 2
- Service
-
- Installation simplicity
- 3
- Service
-
- Monitoring / Real time alerting/actualization
- 0
- Service
-
- Flows monitoring/traceability: moving objects traceability when passing through checkpoints.
- 2
- Information technology
-
- Information security: safeness of the information (codification...)
- 1
- Service
-
- Security enabling
- 1
- Service
-
- Resistance/reliability: to usage, climate, humidity, temperature…
- 2
- Service / use of resources / comfort

16. Gas Manufacturer Fills Up More Often With RFID

Indian oxygen and nitrogen supplier Kay Nitroxygen is using RFID to record the status of its reusable gas cylinders, resulting in increased productivity. The company has reduced its product turnaround time by using an RFID system to record the status of its reusable cylinders. Since October 2009, the company has been utilizing the technology not only to track which cylinders are loaded, shipped to customers and returned, but also to identify which need to be tested before being reused, in keeping with federal guidelines.

Gas tanks, are steel cylinders, approximately 1,5 metres tall and 20 centimeters in diameter and weight 60kg, and cost about $300 apiece. Kay Nitroxygen's facility fills empty cylinders with oxygen or nitrogen, and ships them to customers. After depleting the gas within the tanks, customers then send back the empties. It was responsibility of staff members to read the ID number painted on the side of each cylinder every time it was received from a customer, every time it was refilled with gas, or every time it was shipped back to that sender, as well as to write down the ID number. Employees in the office would then input that data into a computer.

In fact, each cylinder's ID number was typically recorded and entered into the system 18 times every month, including all check-in, filling and check-out events. What's more, the process of recording ID numbers on paper required three employees to work eight hours apiece to receive and enter 1,000 cylinders into the system before they could be refilled and shipped to customers. Moreover, the cylinder ID numbers were often smudged or unreadable, and the low lighting during the night shift made reading the painted ID numbers even more challenging.

Industry: Gas production

Sector: manufacturing

Advantages, scores, and category:

- New business/service
- 0
- Service

- Size: very small sizes
- 1
- Service / Comfort

- Link to database
- 3

- Information Systems/Technology (IS/IT)

- Process time consumption: reduction of the amount of time
- 4
- Service / Comfort

- Process: materials consumption
- 2
- Use of resources

- Process: Human Resources consumption
- 4
- Use of resources

- Line of sight: no need of visual contact for information reading
- 1
- Service

- Unlimited readings: number of data readings.
- 2
- Service

- Quick reading of data: data flow is quick from tag to reader.
- 1
- Service / Comfort

- Unlimited rewritings: number of data rewritings (through distance).
- 1
- Service / Comfort / use of resources

- No batteries: Passive tags do not need batteries
- 3
- Service / Comfort

- High range: Active tags with batteries for higher distance readings
- 0
- Service

- Automatic reading: automatic detection and transmission of data when passing through portico doors, reader portals, checkpoints…
- 0
- Service

- Simultaneous readings: of many tags.
- 0
- Service

- Great storage capacity
- 0
- Service

- Transmission of data through space: Certain distances covered
- 2
- Service / Comfort

- Durability: lifespan of decades.
- 4
- Comfort / use of resources

- Miniaturization capabilities.
- 0
- Service

- Synergy capabilities: Integration with databases, Integration with multiple software applications.

- 1
- Service

- Installation simplicity
- 3
- Service

- Monitoring / Real time alerting/actualization
- 0
- Service

- Flows monitoring/traceability: moving objects traceability when passing through checkpoints, portal readers…
- 0
- Information technology

- Information security: safeness of the information (codification...)
- 1
- Service

- Security enabling
- 3
- Service

- Resistance/reliability: to usage, climate, humidity, temperature…
- 4
- Service / use of resources / comfort

17. Libraries

Among the many uses of RFID technology is its deployment in libraries This technology has slowly begun to replace the traditional barcodes on library items (books, CDs, DVDs, etc.). The RFID tag can contain identifying information, such as a book's title or material type, without having to be pointed to a separate database (but this is rare in North America). The information is read by an RFID reader, which replaces the standard barcode reader commonly found at a library's circulation desk. The RFID tag found on library materials typically measures 50×50 mm in North America and 50×75 mm in Europe. It may replace or be added to the barcode, offering a different means of inventory management by the staff and self service by the borrowers. It can also act as a security device, taking the place of the more traditional electromagnetic security strip.

Sector : Culture and entertainment

Industry : Library

Advantages, Scores and Categories

- New Public Service
- 0
- Service
-
- Size
- 3
- Service
-
- Link to database
- 5
- Information Systems/Technology (IS/IT)
-
- Process Time consumption
- 4
- Use of resources
-
- Process : material resource consumption
- 1
- Use of resources
- Process : human resources consumption
- 4
- Use of resources
-
- Line on sight
- 4
- Service
-
- Unlimited readings
- 2
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 4
- Service
-
- No batteries
- 4
- Service

-
- High range
- 0
- Service
-
- Automatic reading : automatic detection and transmission of data
- 4
- Service
-
- Simultaneous readings
- 5 (reading an entire shelf at a time)
- Service
-
- Great Storage Capacity
- 2
- Service
-
- Transmission of data through space
- 3
- Service
-
- Durability
- 4
- Service
-
- Miniaturization capabilities
- 4
- Service
-
- Synergy capabilities
- 1
- Service / Organization
-
- Installation simplicity
- 1 (11 months for an average size library)
- Comfort
-
- Monitoring / Real time alerting
- 4 (if a book is being stolen)
- Information technology / Security
-
- Flow monitoring/traceability
- 0
- service
-
- Information Security
- 1 (anyone can come and scan the books if there isn’t a code in the chip)
- Security
-
- Security enabling
- 4
- Service
-
- Resistance / Reliability
- 2
- Service

18. Passports

The first RFID passports ("E-passport") were issued by Malayia in 1998. In addition to information also contained on the visual data page of the passport, Malaysian e-passports record the travel history (time, date, and place) of entries and exits from the country.

Other countries that insert RFID in passports include Norway (2005), Japan (March 1, 2006), most EU countries (around 2006) including Spain, Ireland and the UK, Australia, Hong Kong and the United States (2007), Serbia (July 2008), Republic of Korea (August 2008), Taiwan (December 2008), Albania (January 2009), The Philippines (August 2009), Republic of Macedonia (2010).

Standards for RFID passports are determined by the International Civil Aviation Organization (ICAO), and are contained in ICAO Document 9303, Part 1, Volumes 1 and 2 (6th edition, 2006). ICAO refers to the ISO/IEC 14443 RFID chips in e-passports as "contactless integrated circuits". ICAO standards provide for e-passports to be identifiable by a standard e-passport logo on the front cover.

In 2006, RFID tags were included in new US passports. The US produced 10 million passports in 2005, and it has been estimated that 13 million will be produced in 2006. The chips inlays produced by Smartrac will store the same information that is printed within the passport and will also include a digital picture of the owner. The US State Department initially stated the chips could only be read from a distance of 10 cm (4 in), but after widespread criticism and a clear demonstration that special equipment can read the test passports from 10 meters (33 ft) away, the passports were designed to incorporate a thin metal lining to make it more difficult for unauthorized readers to "skim" information when the passport is closed. The department will also implement Basic Access Control (BAC), which functions as a Personal Identification Number (PIN) in the form of characters printed on the passport data page. Before a passport's tag can be read, this PIN must be entered into an RFID reader. The BAC also enables the encryption of any communication between the chip and interrogator.

Security expert Bruce Schneier has suggested that a mugger operating near an airport could target victims who have arrived from wealthy countries, or a terrorist could design an improvised explosive device which functioned when approached by persons from a particular country if passengers did not put their cards in an area close to their body (high liquid and saline content) or in a foil-lined wallet.

Some other European Union countries are also planning to add fingerprints and other biometric data, while some have already done so.

Sector : Administration

Industry : People identification

Advantages, scores and categories :

- New Public Service
- 0
- Service
-
- Size
- 3
- Service
-
- Link to database
- 4
- Service
-
- Process Time Consumption
- 3
- Service / Comfort
-
- Process : Material Resource Consumption
- 0
- Service
-
- Process : Human Resource Consumption
- 3
- Service
-
- No need of line of sight
- 0
- Service
-
- Unlimited readigs
- 2
- Service
-
- Quick reading data
- 2
- Service
-
- Unlimited rewritings
- 4
- Service
-
- No batteries
- 4
- Service / Comfort
-
- High range
- 0 (No need of high distance reading – on the contrary)
- Service
-

- Automatic reading : automatic detection and transmission of data when passing through portico doors
- 0
- Service
-
- Simultaneous reading
- 0
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space
- 2
- Service / Comfort
-
- Durability : lifespan
- 3
- Service
-
- Miniaturization capabilities
- 1
- Service
-
- Synergy capabilities
- 1
- Service
-
- Instalation simplicity
- 2
- Service
-
- Monitoring / Real time acquisition
- 0
- Service
-
- Flows monitoring / traceability
- 0
- Information technology
-
- Information security : safeness of information
- 3 (People could read the passport if partially open)
- Security
-
- Security enabling
- 4
- Service
-
- Resistance / Reliability
- 2
- Service / comfort

19. Schools and universities

School authorities in the Japanese city of Osaka are now chipping children's clothing, back packs, and student IDs in a primary school. A school in Doncaster, England is piloting a monitoring system designed to keep tabs on pupils by tracking radio chips in their uniforms. St Charles Sixth Form College in west London, England, started September, 2008, is using an RFID card system to check in and out of the main gate, to both track attendance and prevent unauthorized entrance. Similarly, Whitcliffe Mount School in Cleckheaton, England uses RFID to track pupils and staff in and out of the building via a specially designed cards. In the Philippines, some schools already use RFID in IDs for borrowing books and also gates in those particular schools have RFID ID scanners for buying items at a school shop and canteen, library and also to sign in and sign out for student and teacher's attendance.

Sector : Administration

Industry : Education

Advantages, Scorings and categories

- New Service
- 4
- Service
-
- Size
- 2
- Service
-
- Link to database
- 2
- IT/IS
-
- Process time consumption
- 2
- Service / Comfort / Use of resources
-
- Process : Material Consumption
- 0
- Service
-
- Process : Human Resource Consumption
- 1
- Service
-
- Line of sight : No need of visual contact
- 5
- Service
-
- Unlimited readings
- 4
- Service
-
- Quick data reading
- 5
- Service
-
- Unlimited rewritings
- 2
- Service
-
- No batteries

- 4
- Use of resources
-
- High range
- 5
- Service
-
- Automatic reading : automatic detection and transmission of data
- 5
- IT
-
- Simultaneous readings
- 5
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space
- 4
- Service
-
- Durability
- 3
- Use of resources
-
- Miniaturization capabilities
- 2
- Service
-
- Synergy capabilities
- 1
- Service
-
- Installation simplicity
- 2
- Comfort
-
- Monitoring
- 3
- Service
-
- Flows Monitoring / Traceability
- 3
- Service
-
- Information security
- 1
- Service
-
- Security enabling
- 3
- Service
-
- Resistance / reliability
- 4
- Service

20. Museums

RFID technologies are now also implemented in end-user applications in museums. An example was the custom-designed temporary research application, "eXspot," at the Exploratorium, a science museum in San Francisco, California. A visitor entering the museum received an RF Tag that could be carried as a card. The eXspot system enabled the visitor to receive information about specific exhibits. Aside from the exhibit information, the visitor could take photographs of themselves at the exhibit. It was also intended to also allow the visitor to take data for later analysis. The collected information could be retrieved at home from a "personalized" website keyed to the RFID tag.

Sector : Culture

Industry : Museum

Advantages, scores and categories

- New service
- 3
- Service
-
- Size
- 3
- Service
-
- Link to database
- 4
- IT/IS
-
- Process time consumption
- 0
- Service
-
- Process : Material Consumption
- 0
- Service
-
- Process : Human Resource Consumption
- 3
- Service
-
- No need of visual contact
- 2
- Service
-
- Unlimited readings
- 4
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewriting
- 5 (taking photographs etc, different exhibits …)
- Service
-
- No batteries
- **2**
- Service
-

- High range
- 4
- Service
-
- Automatic reading: automatic detection and transmission of data
- 3
- IT
-
- Simultaneous readings
- 5
- Service
-
- Great storage capacities
- 4
- Service
-
- Transmission of data through space
- 4
- Service
-
- Durability
- 4
- Use of resources
-
- Miniaturization capabilities
- 1
- Service
-
- Synergy capabilities
- 4
- Service
-
- Installation simplicity
- 3
- Comfort
-
- Monitoring
- 4
- Service
-
- Monitoring of flows traceability
- 5 (to see which parts of the exhibition are most seen)
- Service
-
- Information security
- 1
- Service
-
- Security enabling
- 0
- Service
-
- Resistance/ Reliability
- 2
- Service

21. Social retailing

When customers enter a dressing room, the mirror reflects their image and also images of the apparel item being worn by celebrities on an interactive display. A webcam also projects an image of the consumer wearing the item on the website for everyone to see. This creates an interaction between the consumers inside the store and their social network outside the store. The technology in this system is an RFID interrogator antenna in the dressing room and Electronic Product Code RFID tags on the apparel item.

Sector : Retail

Industry : Clothing

Advantages, Scores and Categories

- New Business
- 5
- Service
-
- Size
- 2
- Service
-
- Link to database
- 3
- IT/IS
-
- Process time consumption
- 4
- Use of resources
-
- Process : Material Resource Consumption
- 1
- Service
-
- Process : Human Resource Consumption
- 0
- Service
-
- No need of visual contact
- 2
- Service
-
- Unlimited readings
- 4
- Service
-
- Quick Data reading
- 3
- Service
-
- Unlimited rewritings
- 1
- Service
-
- No batteries
- 4
- Service
-
- High range
- 3
- Service
-
- Automatic reading : automatic detection and transmission data
- 2

- IT
-
- Simultaneous readings
- 5 (Testing some clothes together)
- Service
-
- Great storage capacity
- 2
- Service
-
- Transmission of data through space
- 5
- Service
-
- Durability
- 1
- Use of resources
-
- Miniaturization capabilities
- 2
- Service
-
- Synergy capabilities
- 3
- Service
-
- Installation simplicity
- 2
- Comfort
-
- Monitoring
- 0
- Service
-
- Monitoring of flows / traceability
- 0
- Service
-
- Information security
- 2
- Service
-
- Security enabling
- 1
- Service
-
- Resistance / Reliability
- 1
- Service

22. Race timing

Many forms of RFID race timing have been in use for timing races of different types since the early 1990s. The practice began with pigeon racing, introduced by a company called deister electronic Gmbh of Barsinghausen, Germany. It is used for registering race start and end timings for animals or individuals in large running races or multi-sport races where it is impossible to get accurate stopwatch readings for every entrant.

In the race, the racers wear passive or active tags that are read by antennae placed alongside the track or on mats across the track. UHF based tags instead of low or high frequency last-generation tags provide accurate readings with specially designed antennas. Rush error, lap count errors and accidents at start time are avoided since anyone can start and finish any time without being in a batch mode.

Lap scoring:

Passive and active RFID systems are used in off-road events such as Orienteering, Enduro and Hare and Hounds racing. Riders have a transponder on their person, normally on their arm. When they complete a lap they swipe or touch the receiver which is connected to a computer and log their lap time. The Casimo Group Ltd sells such a system, as does Sweden's SportIdent and Japan'sMicro Talk Systems Corp. which sells the J-Chip system shown in the photo left.

RFID is being adapted by many recruitment agencies which have a PET (Physical Endurance Test) as their qualifying procedure especially in cases where the candidate volumes may run into millions (Indian Railway Recruitment Cells, Police and Power sector).

Sector : Entertainment

Industry : Sport in Competition

Advantages, Scores and categories

- New service
- 0
- Service
-
- Size
- 4
- Service
-
- Link to database
- 1
- IT/IS
-
- Process time consumption
- 0
- Use of resources
-
- Process : Material Consumption

- 0
- Service
-
- Process : Human Resource Consumption
- 2
- Service
-
- No need of visual contact
- 4
- Service
-
- Unlimited Readings
- 1
- Service
-
- Quick reading of data
- 5
- Service
-
- Unlimited rewritings
- 2
- Service
-
- No batteries
- 3
- Service
-
- High range
- 5 (In some races a high range is very important)
- Service
-
- Automatic reading : Automatic detection and transmission of data
- 5
- Service
-
- Simultaneous Readings
- 4
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission of data through space
- 5
- Service
-
- Durability
- 0
- Service
-
- Miniaturization capabilities
- 4

- Service
-
- Synergy capabilities
- 0
- Service
-
- Installation simplicity
- 4
- Comfort
-
- Monitoring
- 1
- Service
-
- Monitoring of flows / traceability
- 5
- Service
-
- Information security
- 0
- Service
-
- Enabling security
- 0
- Service
-
- Resistance/Reliability
- 4 (Sometimes hard conditions)
- Service

23. Ski resorts

A number of ski resorts, particularly in Scandinavia, the French Alps and in the Spanish and French Pyrenees, have adopted RFID tags to provide skiers hands-free access to ski lifts. Skiers do not have to take their passes out of their pockets. The Vail Resorts in Colorado have been using RFID equiped season passes. In 2010, Vail announced that it will be collecting information – vertical feet skied, number of runs taken, lifts used, etc – and all the information will be available to the user online. They are calling this new system EpicMix.

Sectors : Entertainment

Industry : Ski resorts

Advantages, scores and categories

- New Business
- 0
- Service
-
- Size
- 3
- Service
-
- Link to database
- 1
- IT/IS
-
- Process time consumption
- 5
- Service/Comfort
-
- Process : Material Consumption
- 0
- Service
-
- Process : Human resource consumption
- 3
- Service
-
- No need of visual contact
- 5
- Service/Comfort
-
- Unlimited readings
- 4
- Service
-
- Quick reading of data
- 4
- Service
-
- Unlimited rewritings
- 1
- Service
-
- No batteries
- 4
- Service
-
- High range
- 2
- Service
-
- Automatic reading : automatic detection and data transmission
- 3
- IT

-
- Simultaneous readings
- 1
- Service
-
- Great storage capacity
- 1
- Service
-
- Transmission data through space
- 5
- Service
-
- Durability
- 1
- Service
-
- Miniaturization capabilities
- 3
- Service
-
- Synergy capabilities
- 2
- Service
-
- Installation simplicity
- 4
- Service
-
- Monitoring
- 2
- Service
-
- Monitoring of flows / traceability
- 2
- Service
-
- Information Security
- 1
- Security
-
- Enabling Security
- 1
- Security
-
- Resistance / Reliability
- 5 (Very cold and wet conditions)
- Service

24. U.S. Department of Energy Employs RFID to Safeguard the Country

There are scores of asset-tracking applications that improve security or save money, time and labor, but it's hard to imagine items for which precise and continuous monitoring is more vital than drums of hazardous nuclear materials. That's why the U.S. Department of Energy (DOE) and its Packaging Certification Program, which certifies safe packaging for hazardous materials, turned to one of the DOE's oldest and largest research centers, the Argonne National Laboratory, in Illinois, to develop a customized, sophisticated approach for using radio frequency identification technology to continuously track radioactive and fissile materials, both while in storage and during transport. The number of drums holding such materials is estimated to be in the tens of thousands.

Spent nuclear materials are stored in facilities such as Argonne's Alpha-Gamma Hot Cell Facility, where irradiated materials from various U.S. research and test reactors are kept in specialized, locked drums. Detailed paper-based records are maintained for each container, says Yung Liu, Argonne's senior nuclear engineer and RFID project manager. These records include the serial number assigned to each drum, what the drum contains and its exact location within the storage area. But the only way to closely monitor the condition of each drum—including the integrity of its seal, and environmental factors that could compromise safety—was with manual inspections (a process that is not performed frequently) to limit personnel's exposure to radiation.

Sector : Energy

Industry : Nuclear Management

Advantages, Scores and Categories

- New Business
- 0
- Service
-
- Size
- 1
- Service
-
- Link to database
- 3
- IT/IS
-
- Process time consumption
- 4
- Service/Comfort
-
- Process : Material Consumption
- 1
- Service
-
- Process : Human resource consumption
- 5
- Service
-
- No need of visual contact
- 3
- Service/Comfort
-
- Unlimited readings

- 4
- Service
-
- Quick reading of data
- 1
- Service
-
- Unlimited rewritings
- 1
- Service
-
- No batteries
- 1
- Service
-
- High range
- 5
- Service
-
- Automatic reading : automatic detection and data transmission
- 4
- IT
-
- Simultaneous readings
- 4
- Service
-
- Great storage capacity
- 2
- Service
-
- Transmission data through space
- 4
- Service
-
- Durability
- 4
- Service
-
- Miniaturization capabilities
- 1
- Service
-
- Synergy capabilities
- 1
- Service
-
- Installation simplicity
- 1
- Service
-
- Monitoring
- 5
- Service
-
- Monitoring of flows / traceability
- 5
- Service
-
- Information Security
- 2
- Security
-
- Enabling Security
- 5
- Security
-
- Resistance / Reliability
- 5
- Service

25. Fuel Security and inventory

Paz Energy, an Israeli energy company, is using active RFID to track when the fuel valves and hatches on its tanker trucks are opened and closed as drivers deliver fuel to filling stations around the country.

Paz owns gas stations and convenience stores, and it also has its own distribution company, which supplies the stores with fuel from its own refinery. In late 2004, the company began working with Hi-G-Tek to design a system that would help Paz secure the valves on tanker trucks (as required by Israeli law), as well as deter fuel thefts and improve the efficiency of the fuel-delivery process.

Consequently, Hi-G-Tek—formerly based in Israel but now operating a worldwide sales and marketing network out of Rockville, Md.—designed the Tanker Truck Monitoring System (TTMS), which utilizes active RFID tags built into tanker valves and hatches. Each time a valve or hatch is opened or closed, its RFID tag transmits a signal that is picked up by an interrogator mounted in the cab of the truck. The interrogator then relays the data, via a general packet radio service (GPRS) connection, to a computer in a central command center in Tel Aviv, where managers oversee tanker trucks and their deliveries. TTMS works in conjunction with a GPS-enabled fleet management system from Starcom Systems, a Hi-G-Tek partner, so Paz can also track its trucks' locations.

Paz began implementing the vehicle-tracking and fuel-monitoring solution on its trucks in 2005, taking the application operational by the end of 2006. By May of this year, most of the 50 trucks in the Paz fleet, and many belonging to third parties that deliver fuel for Paz, were equipped with the hardware. A total of 100 trucks are expected to be outfitted by year's end.

Before Paz implemented TTMS, drivers used mechanical clip seals on the valves and hatches. They had to keep track of seal numbers, writing them down by hand. Later, the company began using electronic reusable seals provided by Hi-G-Tek, and it has now moved to the RFID-enabled seals.

The fact that GPS tracks the exact location of each vehicle and RFID records any opening and closing of fuel hatches and valves provides Paz a strong theft deterrent. "The main problem was that we wanted to assure that our trucks arrive at our gas stations filled up, and that nobody opened the compartment along the way," says Moshe Sabag, Paz's vice president of IT. "We took the system to be sure that the compartments are opened just in the locations where we want it. With the system, we get real-time reporting and real-time information."

Now, when a driver arrives at a station and begins pumping fuel from one of the truck's 12 valves or hatches, managers at the command center can oversee which types of fuels are being pumped, and for how long, enabling them to calculate the amount of fuel delivered to a station.

Sector : Energy

Industry : Fuel

Advantages, Scores and Categories

- New Business
- 0
- Service
-
- Size
- 1
- Service
-
- Link to database
- 4
- IT/IS
-
- Process time consumption
- 4
- Service/Comfort
-
- Process : Material Consumption
- 2
- Service
-
- Process : Human resource consumption
- 5
- Service
-
- No need of visual contact
- 4
- Service/Comfort
-
- Unlimited readings
- 4
- Service
-
- Quick reading of data
- 3
- Service
-
- Unlimited rewritings
- 3
- Service
-
- No batteries
- 0
- Service
-
- High range
- 5
- Service
-
- Automatic reading : automatic detection and data transmission
- 2
- IT
-
- Simultaneous readings
- 1
- Service
-
- Great storage capacity
- 2
- Service
-
- Transmission data through space
- 4
- Service
-
- Durability
- 3
- Service
-
- Miniaturization capabilities

- 0
- Service
-
- Synergy capabilities
- 1
- Service
-
- Installation simplicity
- 1
- Service
-
- Monitoring
- 3
- Service
-
- Monitoring of flows / traceability
- 5
- Service
-
- Information Security
- 1
- Security
-
- Enabling Security
- 5
- Security
-
- Resistance / Reliability
- 5
- Service