Radio Frequency IDentification (RFID) Trends

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***Abstract*- This paper provides a survey on radio frequency identification (RFID) technology. Initially RFID tags were developed to eventually replace barcodes in supply chains. Their advantages are that they can be read wirelessly and without line of sight, contain more information than barcodes, and are more robust. The paper describes the current technology, including the frequency ranges used and standards. With the increasing ubiquity of RFID tags, however, privacy became a concern. The paper outlines possible attacks that can violate one's privacy and it also describes counter measures. The RFID technology did not stop at item-level tagging. The paper also presents current research that focuses on locating and tracking labeled object that move. Since the uses for RFID tags are so widespread, there is a large interest in lowering the costs for producing them. It turns out that printing tags might become a viable alternative to traditional production. The paper reviews the current progress.**

***Index Terms*- Radio Frequency IDentification, RFID, RFID tags, Electronic Product Codes, EPC, Supply Chain Management, Security, organic printing, Location and Tracking**

I. INTRODUCTION

RFID tags, or simply "tags", are small transponders that respond to queries from a reader by wirelessly transmitting a serial number or similar identifier. They are heavily used to track items in production environments and to label items in supermarkets. They are usually thought of as an advanced barcode. However, their possible area of use is much larger. This paper presents a few new applications that are possible using RFID technology such as locating lost items, tracking moving objects, and others. RFID tags are expected to proliferate into the billions over the next few years and yet, they are simply treated the same way as barcodes without considering the impact that this advanced technology has on privacy. This paper presents possible exploits of RFID systems and some proposed solutions as well

II. HISTORY OF RFID

The first RFID application was the "Identification Friend or Foe" system (IFF) [Wiki-RFID] [Wizard Wars] and it was used by the British in the Second World War. Transponders were placed into fighter planes and tanks, and reading units could query them to decide whether to attack. Successors of this technology are still used in armies around the world.

The first commercial RFID application was the "Electronic Article Surveillance" (EAS). It was developed in the seventies as a theft prevention system. It was based on tags that can store a single bit. That bit was read when the customer left the store and the system would sound alarm when the bit was not unset. In the end-seventies RFID tags made its way into the agriculture for example for animal tagging.

In the eighties RFID technology got a boost when Norway and several US states decided to uses RFID for toll collection on roads [EZ-Pass]. In addition to toll collection the following decade brought a vast number of new applications, such as ski passes, gasoline cards [Speed Pass], money cards, etc.

In 1999 the Auto-ID Center at MIT was founded. Its task was to develop a global standard for item-level tagging. The Auto-ID was closed in 2003 after completing the work on the Electronic Product Code (EPC). At the same time the newly founded EPCglobal Inc. continues the work.

III. CURRENT RFID

This section describes out of which parts RFID tags consist of, how they work in principle, and what types of tags do exist. It focuses on how tags are powered and what frequency ranges are used. The section concludes by covering a few important standards.

RFID transponders (tags) consist in general of:

Micro chip

Radio Frequency IDentification - RFID file:

Antenna Case Battery (for active tags only)

The size of the chip depends mostly on the Antenna. Its size and form is dependent on the frequency the tag is using. The size of a tag also depends on its area of use. It can range from less

than a millimeter for implants to the size of a book in container logistic. In addition to the micro chip, some tags also have rewritable memory attached where the tag can store updates between reading cycles or new data like serial numbers. The antenna is clearly visible. As said before the antenna has the largest impact of the size of the tag. The microchip is visible in the center of the tag, and since this is a passive tag it does not have an internal power source.

3.1 FREQUENCY BAND

RFID tags fall into three regions in respect to frequency:

Low frequency (LF, 30 - 500kHz) High frequency (HF, 10 - 15MHz) Ultra high frequency (UHF, 850 - 950MHz, 2.4 - 2.5GHz, 5.8GHz)

Low frequency tags are cheaper than any of the higher frequency tags. They are fast enough for most applications, however for larger amounts of data the time a tag has to stay in a readers range will increase. Another advantage is that low frequency tags are least affected by the presence of fluids or metal. The disadvantage of such tags is their short reading range. The most common frequencies used for low frequency tags are 125 - 134.2 kHz and 140 - 148.5 kHz.

High frequency tags have higher transmission rates and ranges but also cost more than LF tags. Smart tags are the most common member of this group and they work at 13.56MHz.

UHF tags have the highest range of all tags. It ranges from 3-6 meters for passive tags and 30+ meters for active tags. In addition the transmission rate is also very high, which allows to read a single tag in a very short time. This feature is important where tagged entities are moving with a high speed and remain only for a short time in a readers range. UHF tags are also more expensive than any other tag and are severely affected by fluids and metal. Those properties make UHF mostly useful in automated toll collection systems. Typical frequencies are 868MHz (Europe), 915MHz (USA), 950MHz (Japan), and 2.45GHz.

Frequencies for LF and HF tags are license exempt and can be used worldwide; however frequencies for UHF tags differ from country to country and require a permit.

3.2 STANDARD

The wide range of possible applications requires many different types of tags, often with conflicting goals (e.g. low cost vs. security). That is reflected in the number of standards. A short list of RFID standards follows: ISO 11784, ISO 11785, ISO 14223, ISO 10536, ISO 14443, ISO 15693, ISO 18000. Note that this list is not exhaustive. Since the RFID technology is not directly Internet related it is not surprising that there are no RFCs available. The recent hype around RFID technology has resulted in an explosion in patents. Currently there are over 1800 RFID related patents issued (from 1976 to 2001) and over 5700 patents describing RFID systems or applications are backlogged

3.3 ENERGY SOURCE

We distinguish 3 types of RFID tags in relation to power or energy:

Passive Semi-passive Active

Passive tags do not have an internal power source, and they therefore rely on the power induced by the reader. This means that the reader has to keep up its field until the transaction is completed. Because of the lack of a battery, these tags are the smallest and cheapest tags available; however it also restricts its reading range to a range between 2mm and a few meters. Furthermore their lifespan is unlimited since they do not depend on an internal power source.

The second type of tags is semi-passive tags. Those tags have an internal power source that keeps the micro chip powered at all times. There are many advantages: Because the chip is always powered it can respond faster to requests, therefore increasing the number of tags that can be queried per second which is important to some applications. Furthermore, since the antenna is not required for collecting power it can be optimized for back scattering and therefore increasing the reading range. And last but not least, since the tag does not use any energy from the field the back scattered signal is stronger, increasing the range even further. Because of the last two reasons, a semi-active tag has usually a range larger than a passive tag.

The third type of tags is active tags. Like semi-active tags they contain an internal power source but they use the energy supplied for both, to power the micro chip and to generate a signal on the antenna. Active tags that send signals without being queried are called beacons. An active tag's range can be tens of meters, making it ideal for locating objects or serving as landmark points. The lifetime is up to 5 years

3.4 RFID SYSTEM

A RFID reader and a few tags are in general of little use. The retrieval of a serial number does not provide much information to the user nor does it

help to keep track of items in a production chain. The real power of RFID comes in combination with a backend that stores additional information such as descriptions for products and where and when a certain tag was scanned. In general a RFID system has a structure as depicted in figure 2. RFID readers scan tags, and then forward the information to the backend. The backend in general consists of a database and a well defined application interface. When the backend receives new information, it adds it to the database and if needed performs some computation on related fields. The application retrieves data from the backend. In many cases, the application is collocated with the reader itself. An example is the checkout point in a supermarket (Note that the given example uses barcodes instead of RFID tags since they are more common; however, the system would behave in exactly the same way if tags were used). When the reader scans the barcode, the application uses the derived identifier to lookup the current price. In addition, the backend also provides discount information for qualifying products. The backend also decreases the number of available products of that kind and notifies the manager if the amount falls below a certain threshold.

IV. RFID TRACKING &LOCATIONS

RFID tags can be used for more than just labeling items. This section presents two proposals that can locate tags and track the movements of them. presents a study on how to detect movements of an object tagged with a RFID chip. The use of handheld readers to monitor the worker's motion and acceleration detecting tags are dismissed as not applicable or too expensive. The proposed method works as follows: The reader polls the tag a certain number of times per second and counts the number of responses. The observation is that the number of responses decreases when the distance increases. By further analyzing changes in derived approximations of signal- intensity levels a one antenna system works only within a short radial range and limited angles. By increasing the number of readers and tags the systems accuracy can be improved.

In contrast to the other paper they use a robot with 2 antennae located 45 degree to the left and right with respect to the robot, also the robot (reader) is mobile. By comparing the signal strength received on both antennae they can estimate the position of a tag with the Monte Carlo localization algorithm. They show that their method works also in a highly dynamic environment where tags are attached to moving objects. In addition they show that their method can be used to derive the coordinates of the robot if a map of the environment is available.

V. SECURITY

The expected proliferation of RFID tags into the billions has raised many privacy and security concerns. A common concern is the loss of privacy when companies scan tags to acquire information about customers and then using data mining techniques to create individual profiles. This section describes possible scenarios where RFID tags can be exploited. Then it describes what mechanisms exist to defeat those threats make them harder to execute. After that the section concentrates on attacks that are directed against RFID systems.

As RFID technology becomes more sophisticated and item level tagging promises more control and large savings in the supply chain management, companies are tagging items within their production process. To maximize the benefits companies start to require their suppliers to label all items delivered to the company. For example, Wal-Mart, Proctor & Gamble, and the US Department of Defense require their suppliers to phase in item-level tagging. However, products are not the only entity tagged. Animal tagging is quite common at large farms to keep track of their moving "property". Also, tagging of humans started to appear. In the Spanish Baja Beach Club, VIP members can get an implant that they can use to pay for their drinks in the club. The implanted tag is a VeriChip.

VI. RFID APPLICATION

1.Attendence
2.transportation
3.Agriculture
4.Libary management
5.Security and access control
6.Construction

VII. ADVANTAGE OF RFID

1.Large coverage of area.
2.Non-line of sight identification of tags.
3.Abilityb to identify moving elements that have tags embedded.
4.RFID can be used in addition to bar code.

VIII .LIMITATIONS OF RFID

1.Expensive with barcode techniquie.

2.RFID are bulky due to emedding of electronics components in the tag.

3.It is prone to physical damage due to environment conditions.

IX. SUMMARY

This paper presented a survey on RFID technology. RFID technology has a big potential to become ubiquitous in the near future. Today it is already successfully used in supply chain management to track pallets of items. Tracking allows better coordination and control in the production cycle. Now the industry is pushing towards item-level tagging to increase the control even further. However, that also creates concerns, most common privacy concern, but also other security related issues. The paper presented possible scenarios how privacy can be compromised by RFID tags but also several solutions to protect against it. Since RFID technology becomes more and more common, attacks against the system itself start to appear. This paper listed the most common, starting from common sniffing and eavesdropping over denial of service to new RFID viruses.

The paper also showed that there is more to RFID than just supply chain management. The paper covers mechanisms that allow locating or tracking a possibly moving object. Last but not least the paper also surveys research for new production methods for tags. Currently printing tags with organic materials seems to be a promising approach. By printing tags, the cost-intensive assembly of the two main components, antenna and chip, can be eliminated. It also adds higher flexibility to production.

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