THE IMPACT OF EMERGING RFID TECHNOLOGY IN THE WIREFREE ENVIRONMENT FOR AUTOMATIC IDENTIFICATION, DATA COLLECTION AND DEDICATED SHORT RANGE COMMUNICATION

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ABSTRACT

Radio Frequency Identification is a dedicated short range communication (DSRC) technology. With RFID, the electromagnetic or electrostatic coupling in the RF (radio frequency) portion of the electromagnetic spectrum is used to transmit signals. An RFID system consists of an antenna and transceiver, which read the radio frequency and transfer the information to a processing device (reader) and a transponder, or RF tag, which contains the RF circuitry and information to be transmitted. The antenna provides the means for the integrated circuit to transmit its information to the reader that converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can analyze the data. In RFID systems, the tags that hold the data are broken down into two different types. Passive tags use the radio frequency from the reader to transmit their signal. Passive tags will generally have their data permanently burned into the tag when it is made, although some can be rewritten. Active tags are much more sophisticated and have on-board battery for power to transmit their data signal over a greater distance and power random access memory (RAM) giving them the ability to store up to 32,000 bytes of data. RFID is used to describe various technologies that use radio waves to automatically identify people or objects. RFID is becoming increasingly prevalent as the price of the technology decreases.

Keywords: *Dedicated Short Range Communication (DSRC), Orlando/Orange County Expressway Authority (OOCEA), Application Family Identifier (AFI)*

1. INTRODUCTION

Radio frequency identification (RFID) is a general term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object wirelessly, using radio waves. RFID technologies are grouped under the more generic Automatic Identification (Auto ID) technologies. The barcode labels that triggered a revolution in identification systems long time ago are inadequate in an increasing number of cases. They are cheap but the stumbling block is their low storage capacity and the fact that they cannot be reprogrammed. A feasible solution was putting the data on silicon chips. The ideal situation is contactless transfer of data between the data carrying device and its reader. The power required to operate the electronic data carrying device would also be transferred from the reader using contact less technology. These procedures give RFID its name [1] [3] [7]-[15]. One grand commercial vision for RFID is to change the way demand-supply chain moves. In the current almost stone-age scenario, manufacturer produces goods based on forecasts and hopes all of them will be consumed before the shelf life gets them.

2. BENEFITS OF RFID

The following are the benefits of RFID Systems:

- Larger area of coverage. Up to several feet.
- Can be used in diverse environments, including live

stock, military, and scientific areas.

- RFID can be used in addition to Bar Code. These two technologies can be complementing each other.
- Automatic integration with back end software solutions provide end to end integration of data in real time.
- Non-line of sight identification of tags
- Unattended operations are possible, minimizing human errors and high cost.
- Ability to identify moving elements that have tags embedded.

3. USES OF RFID

RFID systems can be used just about anywhere, from clothing tags to missiles to pet tags to food - anywhere that a unique identification system is needed. The tag can carry information as simple as a pet owners name and address or the cleaning instruction on a sweater to as complex as instructions on how to assemble a car [7] [11]-[19].

Here are a few examples of how RFID technology is being used in everyday places:

- RFID systems are being used in some hospitals to track a patient's location, and to provide real-time tracking of the location of doctors and nurses in the hospital. In addition, the system can be used to track the whereabouts of expensive and critical equipment, and even to control access to drugs, pediatrics, and other areas of the hospital that are considered "restricted access" areas.
- RFID chips for animals are extremely small devices injected via syringe under skin. Under a government initiative to control rabies, all Portuguese dogs must be RFID tagged by 2007. When scanned the tag can provide information relevant to the dog's history and its owner's information.
- RFID in retail stores offer real-time inventory tracking that allows companies to monitor and control inventory supply at all times.

- The Orlando/Orange County Expressway Authority (OOCEA) is using an RFID based traffic-monitoring system, which uses roadside RFID readers to collect signals from transponders that are installed in about 1 million E-Pass and SunPass customer vehicles.

4. COMPARISON BETWEEN RFID AND BAR CODE TECHNOLOGY

The Table 1 shows the brief differences between the Barcode technology and RFID:

5. TECHNOLOGY AND ARCHITECTURE

RF (Radio Frequency) communication occurs by the transference of data over electromagnetic waves. By generating a specific electromagnetic wave at the source, its effect can be noticed at the receiver far from the source, which then identifies it and thus the information.

In an RFID system, the RFID tag which contains the tagged data of the object generates a signal containing the respective information which is read by the RFID reader, which then may pass this information to a processor for processing the obtained information for that particular application.

Thus, an RFID System can be visualized as the sum of the following three components:

- RFID tag or transponder
- RFID reader or transceiver
- Data processing subsystem

An RFID tag is composed of an antenna, a wireless transducer and an encapsulating material. These tags can be either active or passive. While the active tags have on-chip power, passive tags use the power induced by the magnetic field of the RFID reader. Thus passive tags are cheaper but with lower range (<10mts) and more sensitive to regulatory and environmental constraints, as compared to active tags.

An RFID reader consists of an antenna, transceiver and decoder, which sends periodic signals to inquire about any tag in vicinity. On receiving any signal from a tag it passes on that information to the data processor.

The data processing subsystem provides the means of processing and storing the data.

RFID systems can also be differentiated based on the frequency range it uses. The common ranges are Low-Frequency (LF: 125 - 134.2 kHz and 140 - 148.5 kHz), High-Frequency (HF: 13.56 MHz) and Ultra-High-Frequency (UHF: 868 MHz - 928 MHz).

Low-frequency systems have short reading ranges and lower system costs. They are most commonly used in security access, asset tracking, and animal identification applications. High-frequency systems, offering long read ranges (greater than 90 feet) and high reading speeds, are used for such applications as railroad car tracking and automated toll collection. However, the higher performance of high-frequency RFID systems incurs higher system costs [4][8][16][17]-[23].

6. RFID FREQUENCIES:

Much like tuning in to your favorite radio station, RFID tags and readers must be tuned into the same frequency to enable communications. RFID systems can use a variety of frequencies to communicate, but because radio waves work and act differently at different frequencies, a frequency for a specific RFID system is often dependant on its application. High frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer transmission ranges of more than 90 feet, although wavelengths in the 2.4 GHz range are absorbed by water, which includes the human body, and therefore has limitations.

There are several frequencies that are used for RFID. These include LF, HF, UHF, and Microwave frequencies. The exact frequencies may vary depending on the country where it is used.

The Table 2 shows several frequencies that are used for RFID.

7. STANDARDS

RFID standards deal with the following:-

- **Air Interface Protocol** - The way tags and readers communicate
- **Data Content** - Organizing of data
- **Conformance** - Tests that products meet the standard
- **Applications** - How applications are used

The way the world has gone about developing the standards is a bit complex. There are two major and somewhat conflicting organizations into the business - ISO and Auto-ID Centre (now handled by EPC Global). Without going too much into the conflict, we'll review the standards proposed by both these organizations.

Tags are required to be disposable (manufacturer may not get the tags back from the retailer to reuse it). Hence, the primary mission for any standard developer is to make the tags low cost. It should operate in UHF, as only UHF delivers read range needed for supply chain applications. And since the goods are needed to be tracked as they move across the globe, the standards must be open and globally accepted. There should also be an accompanying network architecture, which would enable anyone to look up information associated with a serial number stored on a tag. The network too needs to be based on open standards.

EPC standards for tags are the class 0 and class 1 tags:

- Class 1: a simple, passive, read-only backscatter tag with one-time, field-programmable non-volatile memory.
- Class 0: read-only tag that was programmed at the time the microchip was made

Class 1 and Class 0 have a couple of shortcomings, in addition to the fact that they are not interoperable. One issue is that they are incompatible with ISO standards. The new EPC standard ~V Gen2 is designed to be fast tracked with ISO standards but for some disagreements over the 8 bit Application Family Identifier (AFI).

ISO has developed RFID standards for automatic identification and item management. This standard, known as the ISO 18000 series, covers the air interface protocol for systems likely to be used to track goods in the supply chain. They cover the major frequencies used in RFID systems around the world [2][5][9]-[15][24].

The seven parts are:

1. 18000~V1: Generic parameters for air interfaces for globally accepted frequencies
2. 18000~V2: Air interface for 135 KHz
3. 18000~V3: Air interface for 13.56 MHz
4. 18000~V4: Air interface for 2.45 GHz
5. 18000~V5: Air interface for 5.8 GHz
6. 18000~V6: Air interface for 860 MHz to 930 MHz
7. 18000~V7: Air interface at 433.92 MHz

8. SECURITY

Through RFID In the near future every single object will be connected to the Internet through a wireless address and unique identifier was quipped by the global head of life science and consumer product industries at Sun Microsystems Inc.

Certainly feels impressive, and let me just help your imagination by setting a perfect scenario.

You are sitting at your home watching television on a Sunday afternoon, and you know that your television is connected to the internet. Your couch, table even your dining set is connected to the internet. That is great for the automation!? Now, imagine your shirt, jeans, even your undergarments connected to the internet! It is only a futuristic setup, but the privacy implications of RFID are equivalent in any application of RFID.

The basic privacy concerns associated with an RFID system is the ability of ubiquitous tracking of anybody without consent. And with RFID tags getting smaller and smaller, it is now even possible to hide tags in such a way that the consumer may be unaware of the presence of tags.

For example, the tags may be sewn up within garment, or molded within plastic or rubber. To the extent that researchers have already developed tiny coded beads invisible to human eye that can be embedded in inks to tag currency and other documents, or added to substances like automobile paint, explosives, or other products that law enforcement officers or retailers have a strong interest in tracking. Researchers say that the technology should be ready for commercial use in 3-6 years.

In summary we can note the following ways in which RFIDs can be used to bypass personal privacy:

- By placing RFID tags hidden from eyes, and using it for stealth tracking.
- Using the unique identifiers provided by RFID for profiling and identifying consumer pattern and behavior.
- Using hidden readers for stealth tracking and getting personal information.

With all these privacy concerns, there is bound to be some effort to thwart such attempt at privacy and maintain the popularity of RFIDs. Researches at various places have yielded the following methods of avoiding above-mentioned attacks.

- RSA Blocker Tags: These tags are similar in size and appearance to RFID tags, helps in maintaining the privacy of consumer by ~Sspamming~T any reader that attempts to scan tags without the right authorization, thus confusing the reader to believe that there are many tags in its proximity.
- Kill Switches: Newer RFID tags are being shipped with a ~SKill Switch~T, which will allow the RFID tags to be disabled. Thus a consumer will be given an option of disabling the RFID tag before leaving the store, thus avoiding the possibility of stealth tracking and profiling [1] [11]-[17] [21].

9. RFID IMPLEMENTATION

RFID implementation involves a number of complexities which can't be solved unless you have proper RFID knowledge. RFID implementation extends its benefits to business in various respects. Some of these advantages can be looked upon as under:

- Increased transparency of the Inventory
- Faster inventory turnovers
- Reduction in loss due to obsolescence
- Excellent product tracking methodologies

Table 1 - Differences between the Barcode Technology and RFID

Parameter	Bar Code	RFID
Frequencies used for tag reading	Optical frequencies	Radio frequencies
Type of communication	Line of sight communication	Non-line of sight communication
Data Volume	Physical limitation exists. It is very difficult to read a very long barcode.	Can carry relatively large volume of data.
Range of data readability	Very limited range, less than feet or two.	Can be read up to several feet.

Table 2 Frequencies that are used for RFID.

Frequency Range	Description	Typical Applications
<135KHz	Low Frequency, Inductive coupling	Access Control & Security Widgets identification through manufacturing processes Ranch animal identification OEM applications
13.56 MHz	High Frequency, Inductive coupling	Access Control Library books Laundry identification OEM applications
868 to 870 MHz 902 to 928 MHz	Ultra High Frequencies (UHF), Backscatter coupling	Supply chain tracking
2.400 to 2.483 GHz	SHF, Backscatter coupling	Asset tracking Highway toll tags Vehicle tracking

10. CONCLUSION

RFID is said by many in the industry to be the frontrunner technology for automatic identification and data collection. The biggest, as of yet unproven, benefit would ultimately be in the consumer goods supply chain where an RFID tag attached to a consumer product could be tracked from manufacturing to the retail store right to the consumer's home. Many see RFID as a technology in its infancy with an untapped potential. While we may talk of its existence and the amazing ways in which this technology can be put to use, until there are more standards set within the industry and the cost of RFID technology comes down we won't see RFID systems reaching near their full potential anytime soon.

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