RFID and IT - 2020

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Abstract

Radio frequency identification (RFID) is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or person. The advantage of RFID is that it does not require direct contact or line-of-sight scanning. RFID is evolving as a major technology enabler for tracking goods and assets around the world. It can help hospitals locate expensive equipment more quickly to improve patient care, pharmaceutical companies to reduce counterfeiting and logistics providers to improve the management of moveable assets. It also promises to enable new efficiencies in the supply chain by tracking goods from the point of manufacture through to the retail point of sale (POS). As a result of the potential benefits of RFID, many of the world's major retailers have mandated RFID tagging for pallets and cases shipped into their distribution centres. Many are still unfamiliar with RFID and the benefits it can offer. Lack of good information about RFID and its benefits will potentially impede uptake of the technology. In the face of this need for clear, comprehensive information about RFID and its benefits, this paper gives a clear insight into the technology and its applications.

Key words: RFID , Tag, Antenna..

I. INTRODUCTION

Automatic identification, or auto ID for short, is the broad term given to a host of technologies that are used to help machines identify objects. Auto identification is often coupled with automatic data capture. That is, companies want to identify items, capture information about them and somehow get the data into a computer without having employees type it in. The aim of most auto-ID systems is to increase efficiency, reduce data entry errors and free up staff to perform more value-added functions, such as providing customer service. There is a host of technologies that fall under the auto-ID umbrella [1,2]. These include bar codes, smart cards, voice recognition, some biometric technologies (retinal scans, for instance), optical character recognition (OCR) and radio frequency identification (RFID). RFID has taken over bar-codes due to the reasons listed in Table 1.

Radio frequency identification, or RFID, is a generic term for technologies that use radio waves to automatically identify people or objects [3,4,5]. RFID system as shown in Figure 1 consists of three components: an antenna and transceiver and a transponder (the tag). The antenna uses radio frequency waves to transmit a signal that activates the transponder. When activated, the tag transmits data back to the antenna. Tags contain a unique identification number called an Electronic Product Code (EPC), and potentially additional information of interest to manufacturers, healthcare organisations, military organisations, logistics providers and retailers, or others that need to track the physical location of goods or equipment.

The technology, which was first used during World War II to track military vehicles, has already been piloted for animal tracking and identification, speed pass lanes on toll roads, controlling access to restricted buildings and enabling electronic payment processing at petrol stations. All information stored on RFID tags accompanies items as they travel through a supply chain or other business process. All information on RFID tags, such as product attributes, physical dimensions, prices or laundering requirements, can be scanned wirelessly by a reader at high speed and from a distance of several metres.7-115.

Capability	Bar Code	RFID	RFID Benefit Example
Line of sight requirement	Required	Not required	No need to orientate scanned items
Number of items that can be scanned	One	Multiple	Very fast inventory scan
Automation & Accuracy	Manual read errors & prone to mis-scanning	Fully automated and highly accurate	Error free inventory count
Identification	Only series or type	Unique item level	Targeted Recall
Data storage	Limited codes	Up to several kB data	Real time data access in any location

Table 1. Barcodes and RFID

The basic components of any RFID system include:

- Tags (or transponders), which can be either active or passive. Active tags have their own means of sending a signal, whereas passive tags rely on power from tag readers
- Data stored on tags, which could be a simple ID number relating to an online catalogue or complex
- Information such as manufacture date, lot number, serial number and so on
- Readers (or interrogators) are used to identify all

tags within the reception coverage area and aggregate and "smooth" the data collected..

- IT infrastructure to support the collection, management and use of key RFID data

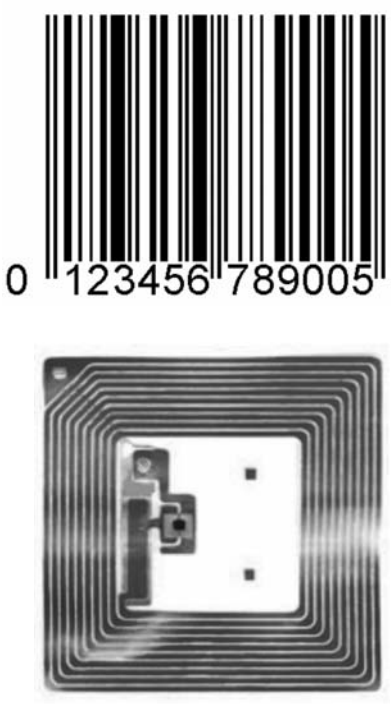

Fig.1 RFID

The distance from which a tag can be read is called its read range. Read range depends on a number of factors, including the frequency of the radio waves used for tag-reader communication, the size of the tag antenna, the power output of the reader, and whether the tags have a battery to broadcast a signal or gather energy from a reader or merely reflect a weak signal back to the reader. Battery-powered tags typically have a read range of 300 feet (100 meters). These are the kinds of tags used in toll collection systems. High-frequency tags, which are often used in smart cards, have a read range of three feet or less. UHF tags - the kind used on pallets and cases of goods in the supply chain - have a read range of 20 to 30 feet under ideal conditions. If the tags are attached to products with water or metal, the read range can be significantly less. If the size of the UHF antenna is reduced, that will also dramatically reduce the read range. Increasing the power output could increase the range, but most governments restrict the output of readers so that they don't interfere with other RF devices, such as cordless phones.

The paper is organized into the following major sections. The II section gives a clear picture of the history of RFID. The III section discusses the challenges faced. The IV section is a debate on 'RFID -a boon or ban'. The applications of RFID in day to day life is briefed in section V. The VI section discusses the prediction of RFID in 2020. The paper concludes with the references.

II. THE HISTORY OF RFID

One can trace the ancestry of RFID back to the beginning of time. Science and religion agree that in the first few moments of creation there was electromagnetic energy. "And God said, 'Let there be light,' and there was light". Before light, everything was formless and empty. Before anything else, there was electromagnetic energy. The first form in the universe was electromagnetic energy. During the first few seconds or so of the universe, protons, neutrons and electrons began formation when photons (the quantum element of electromagnetic energy) collided converting energy into mass. The electromagnetic remnant of the Big Bang survives today as a background microwave hiss.

This energy is the source of RFID [6]. It would take more than 14 billion years or so before we came along, discovered how to harness electromagnetic energy in the radio region, and to apply this knowledge to the development of RFID. RFID is not a new" technology [7]. It is fundamentally based on the study of electromagnetic waves and radio, which was rooted in the 19th century work of Michael Faraday, Guglielmo Marconi and James Clerk Maxwell. The concept of using radio frequencies to reflect waves from objects dates back as far as 1886 to experiments conducted by Frederick Hertz. Radar as we know it was invented in 1922, and its practical applications date back to World War II, when the British used the IFF (Identify Friend or Foe) system to distinguish friendly aircraft returning from missions on mainland Europe from unfriendly aircraft entering British skies.

In 1948, Harry Stockman published a paper titled "Communication by Means of Reflected Power," in which he outlined basic concepts for what would eventually become RFID. In the paper, Stockman suggested that "considerable research and development work has to be done before the remaining basic problems in reflected-power communication are solved, and before the field of useful applications is explored". There was some activity in the 1960's and 1970's in the application of RFiD technology, with a fundamental patent filed in 1973 by Charles Walton, a former IBM researcher who left IBM to form his own company, Proximity Devices, in Sunnyvale, California. Walton's patent was for a radio operated door lock, where a "dormant tag" was sent a small electrical current by a radio transceiver to recognize the key it was attached to. His idea was bought by the lock-making firm

Schlage to make electronic locks that could be opened by a user waving a keycard in front of a reader, the fundamental idea behind the access cards used today. The developments taken over the past decades are tabulated in Table 2

Technology advances in a variety of different fields like computers, radio, radar, supply chain management, transportation, quality management, and engineering which have made RFID technology more useful with applications in asset management, payments, ticketing, livestock tracking and transportation. The US government helped advance the RFID technology during this time, as the Los Alamos National Laboratory in New Mexico performed research and development in radio frequency technology with research in livestock tracking applications, railroad applications and toll road applications. Exxon/Mobil introduced the Speedpass transponder device in 1997 to allow drivers to make credit gasoline purchases by waving a key fob with a tiny transponder in front of the gas pump. The program has an estimated 7 million subscribers.Futher development in the RFID area can be traced to the work of Dr. Sanjay Sarma in the mid-1990s [13]. Sarma, then an engineering professor at the Massachusetts Institute of Technology (MIT), along with a colleague, David Brock, were working on a robotics problem - how to have a machine recognize and respond to items in its environment. Sarma and Brock asked a “what if” question: What if, instead of having a robot attempt to “recognize” objects optically, what if objects, with the use of an electronic marker, could identify themselves to a robot? Using a simplified marker, or tag, a robot could be informed of the presence of an item and then use its identifier to access a database to obtain specific information on the item for refererence.

In 1999, Sarma, Brock, and Kevin Ashton co-founded the Auto-ID Center at MIT, to explore methods by which RFID technology could be used in commercial applications. The Auto-ID Center helped to develop the concept of using RFID as a networked technology during the time when many saw the power of using the internet as a foundation for applications.

Decade	Event
1940 - 1950	Radar refined and used, major World War II development effort. RFID invented in 1948.
1950 - 1960	Early explorations of RFID technology, laboratory experiments.
1960 - 1970	Development of the theory of RFID; Start of applications field trials.
1970 - 1980	Explosion of RFID development; Tests of RFID accelerate; Very early adopter implementations of RFID.
1980 - 1990	Commercial applications of RFID enter mainstream.
1990 - 2000	Emergence of standards; RFID widely deployed; RFID becomes a part of everyday life.

Table 2. History of RFID

III . THE CHALLENGES OF RFID

RFID presents a number of technology challenges. First, organisations must manage vast quantities of data generated by reading tags on individual pallets, cartons or high-value items. In addition, they must implement a fully-integrated software architecture that enables this data to be analysed and made available to internal and external systems in near real time. Additional challenges include:

- **Configuration and management of reader devices**

  Where organisations deploy a large number of readers, the process can be simplified with highly automated tools for set-up, configuration and batch management.

- **Tremendous data volumes**

  Each RFID tag is scanned several times per second and many facilities will be scanning hundreds of products simultaneously.

- **Information maintenance and look-up**

  Each time a tag is scanned its key attributes must be looked up in a corresponding database in near real time.

- **Ownership and partner data integration**

  In complex environments, such as the supply chain, supporting infrastructure must protect data owned by different business partners.

- **Standards and architecture interoperability**

  Systems must be compliant with EPCglobal standards for defining product attributes and exchanging data. To overcome these technical challenges, organizations need to establish clear strategies for RFID deployment. They should also build their solutions on highly scalable systems that are built on open standards such as XML. In this way, they can rapidly create interfaces to enable real-time data exchange between internal and external systems. Typically, today's trials are based on specific areas of the supply chain where immediate returns on investment can be realised with minimum disruption to existing business processes or technology infrastructure.

- **Data privacy**

  Today, most RFID deployments are supply-chain applications such as tagging for shipping containers or pallets. These do not associate personally identifiable information (PII) with tag identification (EPC) numbers. But with 'item - level' tagging, unique identification numbers in EPCglobal tags might become associated with an individual at the

POS when the tagged product, such as an item of clothing, is acquired. The situation is of concern to privacy pressure groups because: RFID can be read through materials, items or packaging, so consumers can never be sure when a tag is present or being scanned . RFID can be read at a small distance with no overt physical action required to scan the tag. Data collected from RFID tags can potentially be held by multiple parties, including Internet-accessible databases, causing security concerns. Tags can potentially remain active outside of the store environment

To ensure that customers' concerns are addressed, retailers and other organisations must undertake initiatives to educate the public on the realities and myths of RFID. Increasingly, such initiatives will demonstrate that RFID is designed to track products and physical assets rather than people.

The kind of passive tags that will be deployed for most retail applications, for example, are only readable from a few metres, ensuring that customers cannot be tracked once they exit the store. Tags can also be disabled as they leave the store, or placed inside labels that customers can remove from products once they have purchased them. In addition, it is imperative that all customer-facing RFID-enabled solutions are optional. That means customers must always give their permission before data about them is used.

IV . RFID - A BOON OR BAN

Is RFID the answer to supply chain woes, or a serious threat to consumer privacy?

The Department of Defense (DoD) is in the process of transforming the Army, Navy, Marines, and Air Force into leaner and lighter warfighters to prepare for a myriad of challenges that may face the United States in the years to come. Along with these changes to its military forces, the DoD is designing, developing, and incorporating the necessary capabilities to enhance its logistics support systems so that it can ensure the timely sustainment of its transforming fighting forces. For logisticians, the requirement to provide timely support to the warfighters means the DoD's logistics supply chain will need to transform the tools it uses to support all the military services.

Radio frequency identification (RFID) is a Logistics Transformation tool the DoD can use to provide valuable insight into the DoD supply chain and ensure the United States that leaner and lighter military forces are combat-ready when required to protect the country's national interest. The valuable insight that RFID technology can provide is termed Total Asset Visibility (TAV). Total Asset Visibility is envisioned in the DoD's Joint Vision JV 2020 plan and Joint Chiefs of Staff (JCS) Focused Logistics concept as a capability that can enable the DoD to transform the military into lighter and leaner force packages for future conflicts. RFID technology provides DoD logisticians the capability to identify, categorize, and locate assets automatically. As users of TAV information, US Transportation Command (TRANSCOM), Air Mobility Command (AMC), and the warfighting combatant commanders can benefit significantly from RFID technology, because RFID can provide insight into the movement of cargo during major theater war and contingency operations. At the same time, the Defense Logistics Agency (DLA), the organization responsible for integrating RFID capabilities within the DoD, can benefit financially by integrating RFID technology to lower the quantity of its sizable inventory.

However, because RFID is a fairly new technology, the current DoD RFID system is obsolete, and RFID industry wide is nonstandard and noninteroperable. To meet the myriad of challenges that may face the United States in the future, today's RFID technology shortfalls must be corrected. Like the DoD, the commercial industry has learned the benefits of using RFID technology and is using it throughout supply chains to automate inventory and for movement of items. So the question is, can the DoD benefit from commercial industry's pursuing RFID technology to correct current RFID technological shortfalls? It is an ongoing process ….

V. RFID AND ITS APPLICATIONS

There are numerous potential applications of RFID [8]. Some are in the planning stages now, some are being prototyped, and others are still a bit blue sky but certainly not impossible. As RFID capabilities expand and mature, there will be an endless array of applications. Those that enhance the quality of life are some of the most exciting and profitable. By addressing the health and safety of the elderly population, other national issues such as the overburdened Medicare and Medicaid systems may be eased. Eventually, this capability could be utilized for all individuals. By monitoring and tracking their health at an early age, serious medical issues could be prevented before they occur. Some of the current applications are listed below

- Providing markings for electronic equipment, automobiles, and other large items with unique serial numbers or codes. By scanning the RFID, the item can be located by it's unique serial number.
- Marking shipping containers, pallets, or cartons.

This application is being implemented in the retail industry by Wal-Mart, Target, and others.

- Attaching patient history to medications, so that the information is readily available in a hospital or clinic with a scanner.
- Attaching medical history to a person so that during an emergency an EMT or other medical personnel could quickly gain access to the patient's history.

RFID in libraries

Libraries began using RFID systems to replace their electro-magnetic and bar code systems in the late 1990s [10,11] Approximately 130 libraries in North America are using RFID systems, but hundreds more are considering it . The primary cost impediment is the price of each individual tag. Today, tags cost approximately seventy-five cents but prices continue to fall.

However, privacy concerns associated with item-level tagging is another significant impediment to library use of RFID tags. The problem with today's library RFID systems is that the tags contain static information that can be relatively easily read by unauthorized tag readers. This allows for privacy issues described as “tracking” and “hotlisting.” Tracking refers to the ability to track the movement of a book by “correlating multiple observations of the book's bar code” [11] or RFID tag. Hotlisting refers to process of building a database of books and their associated tag numbers and then using an unauthorized reader to determine who is checking out items on the hotlist.

Current standards (ISO 15693) apply to container-level tagging used in supply chain applications, and do not address problems of tracking and hotlisting. Next generation tags (ISO 18000) are designed for item-level tagging. The newer tags are capable of resolving many of privacy problems of today's tags and could be adopted for the libraries.

RFID in Vehicle Tracking

RFID could be employed to track movement of vehicles [12] in and out of a parking lot or other site as shown in Figure 2.. Each car is tagged with and RFID tag (windshield, mirror or grill). RFID readers are located at Entry/Exit points . As car passes through the gate, the vehicle ID is read from the car along with car data and updates a central database

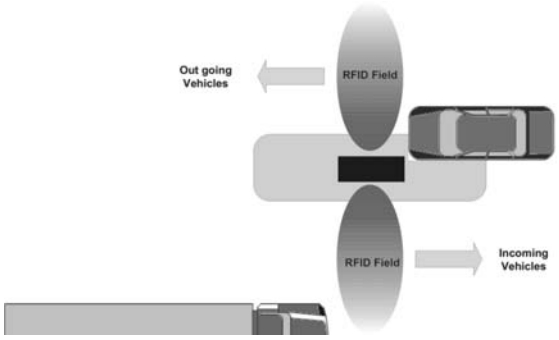

Fig. 2. Vehicle Tracking

This enables effective real-time updates on fleet inventory and activity records. It reduces labor costs and errors on tracking and locating vehicles and related information. There is Rapid check in/check out for reduced turn-around time and client wait. The theft rate is also reduced. The system is very efficient as an accurate information on vehicle use and activity history is available for maintenance and purchasing decisions.

VI. RFID IN 2020

Predicting the future of any technology is never easy, but it doesn't have to be a blind gamble. Researchers constantly engage in clear-eyed futurism to anticipate changes that may lurk over the horizon. The process starts by examining known trends, testing scenarios, and constructing a narrative about where technology is headed.

RFID wireless microchips are already used by large companies to track products in real time. Wal-Mart is requiring its top vendors to employ the technology in the near future. Target is using RFID today to track containers moving from port to port. Microchip tags will give companies the ability to monitor the location and condition of individual products anytime, anywhere in the world.

Highly focused companies are taking advantage of short production cycles and global markets to create new products and new business models. Dell is the best-known example: Its dynamic connection to roughly 60 core suppliers allows the PC maker to cycle inventory through assembly facilities in just six hours.

Chips integrated into commonplace products such as floor tiles, shelf paper, cabinets, appliance, exercise equipment, and grocery and packaged products would allow even our most intimate activities to be monitored.”

People with RFID chips in their clothing, books, bags, or bodies could be targeted by smart projectiles that

will zero in on that particular instant. Imagine being able to bury an explosive in a roadway that would only go off when a particular car drove over it. These bombs could be buried months in advance, in any or every major or minor roadway. The targeting (e.g. via driving a radio-equipped car over it and transmitting new instructions to it) could be changed whenever required. A whole list of cars that it would explode with the dates could be included.

Project these realities a few decades into the future, to the year 2020, RFID chips will become ubiquitous, providing unprecedented information about manufacturing processes and consumer behavior. Meanwhile, as specialization becomes the order of the day, vertically integrated companies may be supplanted by networked constellations of business partners. What does the world of business look like then?

Using a wireless network connection, the 2020 Robo will locate beer by scanning for the product-specific RFID tag attached to each can or bottle in the fridge. This new Robo will be the life of the party as it would serve beer to guests, perform cute tricks, and sweep up the mess afterward.

Warehouses become smaller as inventory needs are met in real time. Companies always know where goods are, and shipments can be rerouted at will.

Driver navigation systems use real-time traffic-density data to determine the quickest routes around town.

VII . CONCLUSION

A detailed overview has been made in this paper on RFID. RFID technology promises to change our world. It has the capability of making our personal lives and our work more convenient. However, every new technology comes at a cost. In order to remediate those costs, efforts must be undertaken to guide its development and implementation.

RFID solution was too expensive for commercial usage though it was a proven technology since a few decades. Lack of standards was another inhibiting factor for widespread use of RFID technology.

An in depth study has been made in this paper about RFID technology and its applications so that the technology could be used in the best possible way.

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