

An Introductory and Elementary Study on RFID & Its Applications

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Abstract - RFID technology has been known as one of the prominent converging technologies of the 21st century. The technology has many applications in military, airline, library, security, healthcare, sports, animal farms and other areas. Industries use RFID for various applications like personal vehicle access control, departmental store security, baggage, equipment tracking, fast food establishments, logistics, etc. Intelligent Transport Systems (ITS) has seen a drastic increase in number of applications with its widespread use in the management of the overall transport sector. Some other applications available in the market are Electronic Toll Collection (ETC), RFID contactless smart card commonly used in buses and LRTs, Smart Parking, Automatic Vehicle Identification (AVI), and congestion zone pricing. However the use of RFID is restricted due to security concerns and delays in standardization. This paper explores RFID technology and its applications in this modern era.

Index terms - RFID technology, RFID components, RFID applications, Electronic Product Codes (EPC), Radio Frequency Identification, RFID tags, Supply Chain Management, Security, Automatic Identification and Data Capture (AIDC)

I. INTRODUCTION

The first Radio Frequency Identification (RFID) application was used by the British in the World War II and they called it "Identification Friend or Foe" system (IFF) in which fighter planes and tanks were fixed with transponders.

In essence, the system facilitates automatic identification through a combination of tags and readers. Barcode technology has been replaced by RFID and has a big benefit as it automatically transmit data to the reader even without a line of sight and tracking the objects from a remote position. RFID also find its application in Automatic Identification and Data Capture (AIDC). It offers tantalizing benefits such as reduced labour levels, increased visibility, and improved inventory management. Second biggest client in the adoption of RFID technology is Wal-Mart [1, 2].

Security problems are still dominant today about RFID technology like people can easily made RFID readers at cheaper costs and can read data from a RFID chip without any knowledge and may be even change the data.

In 2014, the world RFID market is worth \$8.89 billion, up from \$7.77 billion in 2013 and \$6.96 billion in 2012. This includes tags, readers and software/services for RFID cards, labels, fobs and all other form factors. The market value is expected to be increased by \$27.31 billion by 2024.

II. HOW RFID SYSTEM WORKS

It is categorized under automatic identification technologies that have well established protocols. In these electromagnetic fields use wireless techniques to transmit data, for automatic recognition and tags connected to objects for scanning. The tags store and transmit data to readers using radio waves. The readers collect data from the different tags and relay them back to the server for further analysis and processing. The system serves the purposes of identification, monitoring, authentication and alerting through this exchange of data between the tag and the reader.

Each tag acquires "read-only" or "rewrite" internal memory based on the type and application [7]. Memory stores information of product, such as an object's unique ID manufactured date etc. The RFID reader generates magnetic fields that allow the RFID system to track objects (via tags) that are within its range [5]. The high-frequency electromagnetic energy and query signal generated by the reader triggers the tags to reply to the query [4]. Consequently communication between the tags and reader of the system is established [6]. Supply chain industries control this problem by using filters that are routed to the backend information systems. To control this problem Savant software has been developed as it acts as a buffer between the Information Technology and RFID reader [6, 7].

III. COMPONENTS OF A RFID SYSTEM

The RFID system consists of various components which are integrated. This allows the RFID system to decrease the number of tags and can perform multiple operations on it. The RFID system consists of five components (as shown in Fig. 1):

- Tag (transponder).
- Antenna (tag detector, generates magnetic field).
- Reader (manipulator, receiver of tag information).
- Communication infrastructure
- Application software (backend database) [10].

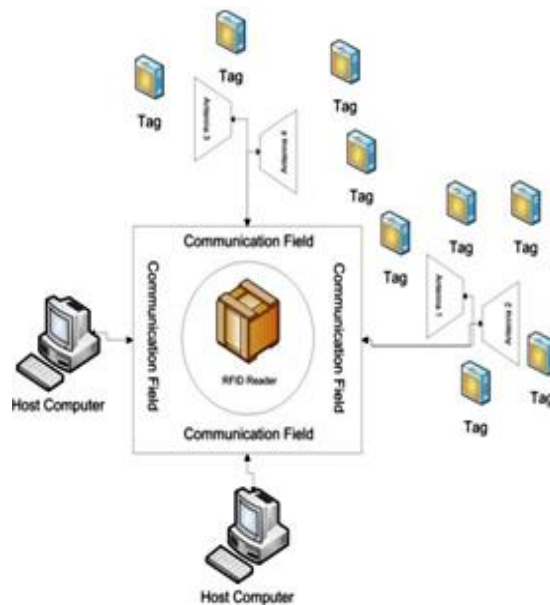


Fig.1 Components of an RFID System

III. A) TAGS

A RFID System uses tags, or labels joined to the objects to be acknowledged. Interrogators or readers (two way radio transmitter-receivers) send a signal to the tag and interpret its response.

RFID tags are basically classified into passive, active or battery assisted passive [7]. An active tag has an onboard battery and transmits its ID signal periodically. A battery assisted passive (BAP) tag consists of a small battery on board which can be triggered in the presence of an RFID reader. A passive tag is inexpensive and smaller as it has no battery; Instead, this tag uses the radio energy transmitted by the reader. But, to operate a passive tag, it must be illuminated with a power level about a thousand times stronger than for signal transmission.

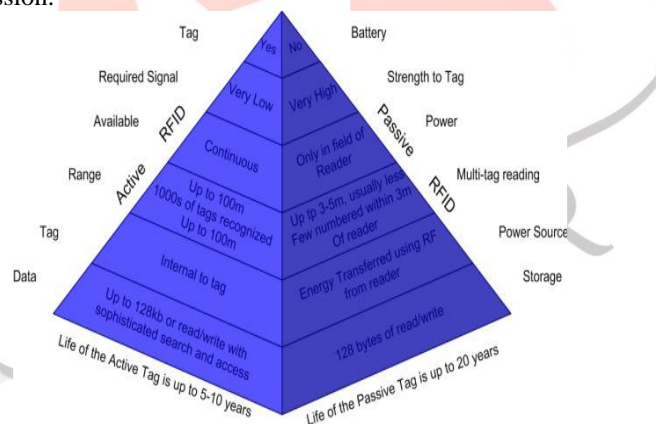


Fig.2 RFID active and passive tags comparison

Tags may either be read-only [5], comprises of a factory assigned serialized number which is utilized to enter in a database, or may be read/write, which can be used to write specific data on the tag by the client. However Field programmable tags can also be used which may be write once, read multiple.

RFID tags contain: an integrated circuit for accumulating and processing information, DC power from the incoming reader signal, an antenna to transmit and receive the signal and modulating and demodulating a radiofrequency (RF) signal. A non-volatile memory piled up all the information received by tags. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively. Figure 3 demonstrates the different sizes and shapes of the RFID tags.

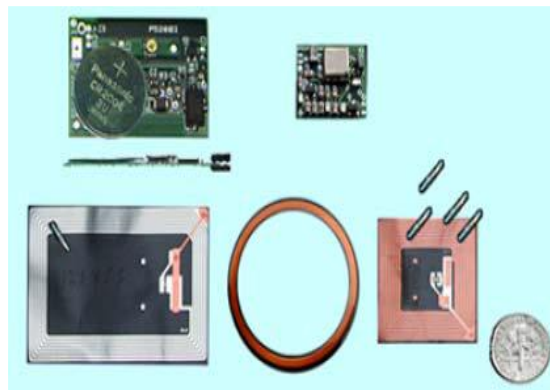


Fig.3 Variety of RFID tags (various shape & sizes) [10]

An RFID reader transmits an encoded radio signal to interrogate the tag. Readers are mostly of 4 types:-

Passive Reader Active Tag (PRAT), Active Reader Passive Tag (ARPT), Active Reader Active Tag (ARAT) and sometimes Battery Assisted Passive (BAP) tag is also used. [7]

The RFID tag obtains the message and responds with its identification and other information. This may be a distinct tag serial number, or may be information linked with product such as a stock number, production date, batch number or other specific information.

IV. RFID FREQUENCY BANDS

RFID tags are classified into several regions with respect to frequency:

TABLE1. FREQUENCY BANDS

Band	Range	Data Speed	Remarks
120-150 kHz (LF)	10cm	Low	Animal identification, factory data collection
13.56MHz (HF)	10cm-1m	Low to moderate	Smart cards, Non fully ISO compatible memory cards, microprocessor ISO compatible Cards
433MHz (UHF)	1-100 m	Moderate	Defence Application
2450-5800 MHz (Microwave)	1-2m	High	802.11 WLAN, Bluetooth standards
3.1-10 GHz (Microwave)	Up to 200m	High	Requires semi-active or active tags

V. ADVANTAGES & DISADVANTAGES OF RFID SYSTEM

TABLE2. COMPARISON OF RFID SYSTEM

Advantages	Disadvantages
High speed	Interference
Multipurpose	Expensive
Reduce man-power	Some materials may create signal problem
High precision	Overloaded reading (fail to read)
Complex replication	
Multiple reading (tags)	

VI. RFID STANDARDS

Several RFID standards cover:-

- Recognition, the coding of distinct item identifier, or other information on the RF tag;
- Data and system protocols, consequently the middleware of an RFID system;
- The air interfaces i.e. the wireless communication between the reader and the tag;
- Application support, which grants advice about how to execute the technology;
- Experimenting, compliance, and health and protection i.e. the protocols that manage RFID actions; and
- Terminology.

The extensive range of feasible applications involves various types of tags, often with conflicting goals (e.g. inexpensive vs. security). That is reproduced by number of standards.

Some of the fundamental standards created by the organization are

- ISO 11784 utilized in the tracking of RFID cattle.
- ISO 11785 for interface protocol.
- ISO 14443 for smart cards in payments and
- ISO 15693 is applied to vicinity cards.

VII. APPLICATIONS

1) Applications in Business

RFID has numerous applications in business purposes. The widely used applications are:-

Supply chain management

RFID tags can be used to track products throughout the supply chain—from supplier delivery, to warehouse stock and point of sale. New applications are designed to track from checkout through customer billing. A central database records movement of product, which manufacturers or retailers can query afterwards for location, delivery authentication, or theft prevention. For this application, RFID mainly serves as a substitute for the bar code scanners to track manufactured goods and consignments in similar manners.

2) Intelligent Transport System

Various associations make use of RFID tags embedded in ID cards, which are examined at a building entrance. RFID tags are also utilized by a few credit cards and other payment devices. Other cards use tags for automatic fare expense in mass-transit systems like subway and bus system (Figure 5 shows samples of such cards). Essentially, these are a replacement for ID cards with magnetic stripes, providing a more reliable technique to store identification information—magnetic stripes tend to wear out and drop information over time. In addition to this, RFID tags also have a higher memory capacity than magnetic stripes.



Fig.5 Common devices that use RFID

A) Mashhad "My Card"

Mashhad municipality initiated the "My Card" contactless Smartcard system in 2010, and has released 2.2 million cards. In Iran, it has become major multi-modal smart card system of its kind that incorporates all modes of transport systems. This system has the ability to hold up to 5 million transactions per day across all means of public transport.

"My Card" holders can experience expedient contactless ticketing while also having the option to use the same device for applications such as payment at vending machines, access management, loyalty or social services. With "My Card" people are able to pay for taxi, bus, subway, parking etc.

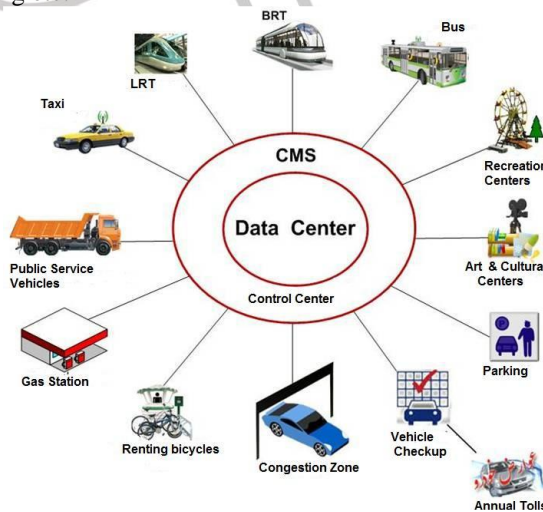


Fig.6 Application architecture for Mashhad "My Card"

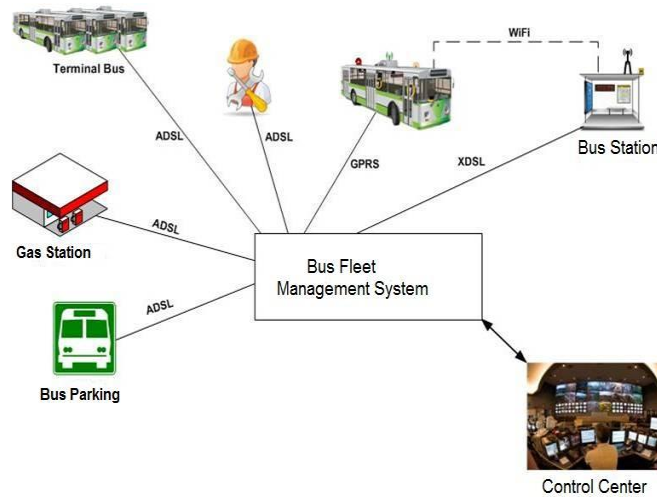


Fig.7 System architecture of Mashhad BUS management system

B) RFID Application in Mashhad Taxi Fleet Management System

The highly developed technology system for taxi fleet management is Automatic Vehicle Identification (AVI) including RFID technology.

AVI systems can be used in a central hub area to computerize entry of identifying information to a central dispatching system, to enforce access limitations, and to monitor vehicle mass in the holding area. AVI technology is able to recognize both a vehicle and its driver.

The operators at airports and terminals can also use the system to predict customer demand and send off taxis. The system uses GPRS wireless communication links. Fig. 8 shows the main architecture of the system in which fare payment using "My Card" is also predictable. The system can also provide important planning and statistics management information. Some important outcomes of the system are:

- Rapid and accurate tracking of Taxi sign out and activity record
- Well-organized real-time updates on fleet directory and activity history
- Quick check in/check out for compact turn-around time and customer stay
- Precise information about vehicle use and activity history for protection and purchasing alternatives
- Present record of vehicle accessibility for efficient management
- Reduction in effort to manually record data and revise system
- Reduced theft and enhanced security

All these advantages could help traffic management authorities to foretell travel times and optimize traffic plans. This is a cost-effective way and eradicates the need to look into vehicles for traffic data gathering.

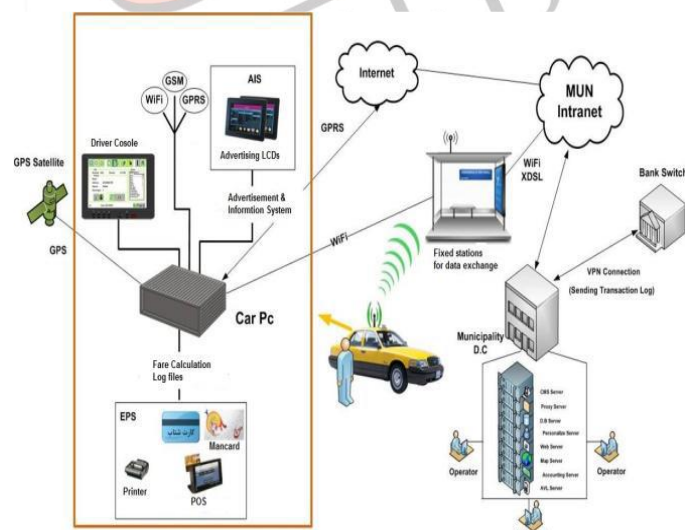


Fig.8 Architecture of Mashhad taxi fleet management system using "MyCard" payment

3) Health Care Industry

RFID sensors have been used to scrutinize through wireless communication the heart-rates of cardiac patients, to identify patients for surgery, to help establish embedded devices, used to store the patient's medical history and to monitor the life of dental retainers. It can also be used as a direction sensing RFID sensor to assist mobile robots in an indoor environment. RFID tag is inspected each time to determine the progress and modifies patient's health condition and medication [4, 5].

VIII. CONCLUSION

This study has acknowledged and clarified the nature of RFID technology advancement with regard to RFID applications. RFID technology will open new doors to make organisations, companies more secure, reliable, and accurate. The first part of this paper has explained the RFID technology and its elements, and the second part has explored the main applications of RFID technology. This paper considers RFID technology as a means to offer new potentials and efficient techniques for numerous applications. RFID technology needs to develop its capability to be used with computing and mobile devices. Although RFID is still in a developing phase but it will surely become ubiquitous in the future. This study facilitates the application of RFID in association with resource optimization and enhancing effectiveness. As prices drop more and hi-tech advancement prolongs to occur, RFID technology is supposed to emerge as efficient and technically more feasible and impact our daily lives as more applications are developed.

IX. FUTURE SCOPE

RFID is rapidly growing technology and technologists build up new and attractive innovations. And as more companies experiments with RFID, more potential use cases are rising how RFID technology can be utilized to resolve real-world business problems. In future, RFID can be used in attendance system, in educational institutes, Bank lockers, Ware houses & other storage places. It can also be used in a Hex keypad can be interfaced with microcontroller board by which user can enter his password then only lock can be opened, this ensures even if someone has card then also without the valid password he can't get access. RFID technology will definitely penetrate other market segments very soon due to lower cost and more functionality.

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