CHAPTER 2

Module II

RFID Technology

Syllabus :

Introduction, Principle of RFID, Components of RFID system : RFID tag, Reader, RFID middleware, Issues etc.

2.1 Introduction

- One of the integral aspect of IOT is the identity. The recognition of true identity of device, user, services etc. makes the IOT system successful.
- There are many ways available to collect the identity of assets, devices and users. For example, MICR, machine readable character, smart cards, bar code, magnetic strips, retina scans, finger print scanners etc.
- These technologies of identity recognition are mostly of two types. They recognize the objects when it physically contacts the object (contact type recognition) or when they come close enough to object to detect the presence in line of single path (proximity based techniques).
- The most popular identification mechanism in IOT today is RFID (Radio Frequency Identification). They overcomes most of the bottlenecks of traditional IOT systems.
- RFID system consists of the RFID tag which is also called the transponder. The transponder remains attached to the object which has to be identified.
- The tags normally has a tiny antenna and an integrated circuit. The reader tries to query the tag on radio frequency. Radio frequency waves are used to get the identity of the tag. Many range of radio frequency bands are used in RFID systems. Mostly they are used in the following band:
  1. Low Frequency: 125 kHz to 134.2 KHz
  2. High Frequency: 13.56 MHz
  3. Ultra High Frequency: 860 to 915 MHz
  4. Microwave Frequency: 2.45 GHz to 5.8 GHz
- Radio Frequency Identification is the wireless identification service which is used as bind device things with unique serial number encoded within a tag.
- RFID tags can be recognized using their readers even without direct line of sight or direct contact.

- The communication between special tag and the reader happens via radio frequency.
- RFIDs are attached physically to the device which needs identification.
- Some additional data can also be stored on the device along with the serial number according to the size limitations.
- RFIDs can work on read only, read-write, read-write-re-write as per the need and encoding.
- RFIDs are frequently used for products where direct line of sight identification like barcodes cannot be used.

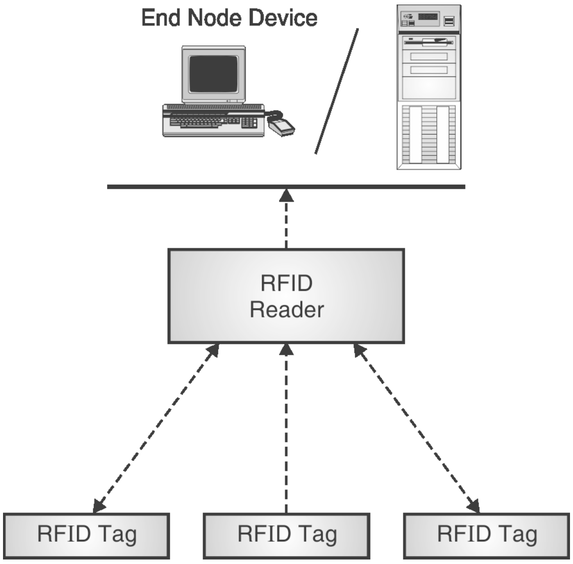

Fig. 2.1.1 : RFID tags and communication

2.2 Principles of RFID

- RFID uses radio frequency to communicate between the tag attached on a device and RFID reader that identifies the unique RFID tag which can be used for identifying and tracking the implanted object.
- Let’s see in details how RFID is works internally and what the applications of IT are.
- RFIDs are attached physically to the device which needs unique identification.
- RFID tags stores a serial number that identifies the object and some additional data can also be stored on the device along with the serial number according to the size limitations.
- RF signals are used by the tag to convey the message to the reader. The logical load represent state 1 and 0 (switching ON and OFF) are used for the purpose.
- With the help of this load modulation, the communication takes place between the tag and the reader. In fact without any transmitter, identity of the tag is transferred using this communication.
- The microchip located at the tag is responsible for storing the identity of the chip.

- The state machine or the processor is responsible for reading the load modulation and operating the switch.
- The clock signal is generated by oscillator which backed up by battery. Some more sophisticated can operate without battery and power is supplied by reader itself. A diode in the tag is used to rectify the RF energy into electric signal.
- RFID provides low cost contact less identification of devices.
- When the device comes in range of the RFID reader equipment, readers read this data on the tag using the radio frequency even without the actual contact.
- As shown in Fig. 2.2.1, RFID systems contains a device implanted with RFID tag, a RFID reader, a middleware which can be used to specify business logic if any to process the data (for example payment of a vehicle on toll plaza) and the device that displays the processed RFID information which can be desktop laptops or an individual system.

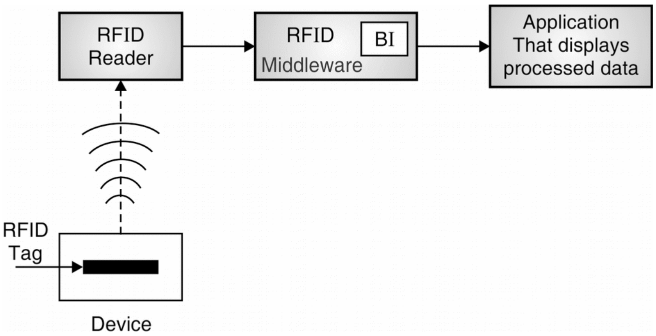

Fig. 2.2.1 : RFID tag communication

- RFID tags are of three types which are active, passive and semi-passive. They are categorized on the basis of battery support.
- An active RFID tag has an on-board battery installed which broadcasts the signal all the time while passive RFID tag doesn’t have a battery support.
- Semi-passive RFID has a small battery installed which is active only when the tag is in presence of an RFID reader.
- RFID is different from other three pillars of IoT in the sense that RFID is generally used with unintelligent objects while M2M, WSN and SCADA are used for communication between intelligent objects.
- RFID technology is frequently used with RFID tags implanted on animals, cloths, cards, books etc.
- Before RFID barcodes and plain text were used for object and article identification.
- Universal Product Code (UPC) was used in USA and Canada for object identification and tracking.
- European Article Number (EAN), which was developed after UPC, was used in Europe and Ubiquitous ID (UID) was used in Japan for the same.
- RFID concept is also used to develop new techniques like :

1. Auto-ID is a mechanism that uses identification technology like RFID and manages automatic data capturing and storage of this information over the internet.
2. Electronic Product Code (EPC) is designed to be stored on RFID tag to provide unique identification for a product.

2.2.1 Examples of RFID Applications with Standardization

1. A low frequency passive RFID is used for animal identification and tracking. (Working Frequency: 125 kHz, Standardization: ISO 18000-2)
2. A high frequency passive RFID is used for identification of books in a library, clothes at shopping malls and other objects.

   (Working Frequency: 13.56 MHz, Standardization: ISO 14443)
3. Remote controlled vehicle lock management system uses 400 MHz working frequency. (Standardization: ISO 18000-7)
4. Vehicle identification and toll collection systems uses long ranged passive and active RFID reading with working frequency of 5.8 GHz and Standardization: ISO 18000-5.

2.2.2 Operating Frequency Bands for RFID

1. Low Frequency: 125 kHz to 134.2 kHz
2. High Frequency: 13.56 MHz
3. Ultra High Frequency: 860 to 915 MHz
4. Microwave Frequency: 2.45 GHz to 5.8 GHz

2.3 Components of RFID System

- Two most important components of the RFID is reader and the tag. Tag stores the identity and have the signal generation mechanism. Reader has the ability of reading identity of multiple tags.
- Identity read by the reader cannot be used for the actual purpose unless the reader is connected to network and the information is gathered at server. So the middle ware also plays an important role in RFID communication.
- So the three important components are :

1. RFID Reader
2. RFID Tag
3. RFID Middleware

2.3.1 RFID Reader

- RF reader modulates the RF carrier as per the information to be transferred to the tag. Antenna is used to amplify and modulate the carrier.
- Reader also has the task of receiving the electromagnetic waves. These waves are backscattered by the RFID tag.

- The internal diagram and working of RFID reader is shown in Fig. 2.3.1.

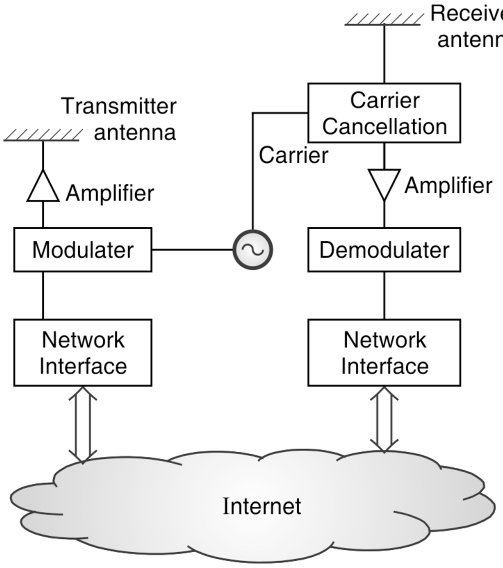

Fig. 2.3.1 : Functional block diagram for RFID reader

- The antenna are the externally visible part of RFID reader system. According to the order of wavelength, the antenna is designed in its size.
- For the purpose of proper isolation the two antennas are kept apart from transmitter and receiver.
- There are some reader with single antenna called the "monostatic" system RFID.

2.3.2 RFID Tag

- The most elementary and basic RFID is made up of capacitor and a parallel inductor.
- These simple RFIDS can designed to operate on HF band.
- In such system resonance of around 13.56 MHz can be achieved with resonant circuitry made up inductance and capacitance.
- In its basic working, whenever the tag is placed close to the reader antenna, it induces back electromagnetic frequency. This is sensed by the readers antenna.
- At many occasions, diodes in the tags are used to reduce the false alarm rate.
- Harmonic frequencies can be generated by the non-linear element such as diode.
- Tag can contain integrated circuit. Circuit make the bit smarter by storing some more information. IC can be attached to tag's antenna.
- IC also contributes at detector stage which rectifies the RF coming from the reader. Capacitor contributes in removing the ripples from the signal.

2.3.3 RFID Middleware

- RFID middleware consists of a software subsystem that separates the top level application and the RFID hardware.
- In a typical IoT application system, there may be several RFID tags and many readers, each contributing in the success of entire IoT application system. Such systems needs some middle level software for intermediate processing of data received from RFID readers.
- The middle ware can have business rule to filter the relevant data to send to level decision making systems.
- Many type of pre-processing of data can also be applied at the middleware level.
- The middleware consists mainly of three things :

1. The device interface,
2. Core processor and
3. Application interface.

- Device interface consists of drivers and device specific software. It provides the data to processing unit for pre-processing.
- Core processor applies the filtering and pre-processing rules. It sends the data to high level application via application interface.
- The application interface acts as a channel between middleware and enterprise application.

2.4 RFID Issues

The following are the problems with RFID

I. Technology related problem.
II. Privacy and ethics related.
III. Security related.

I. Technology Related Problems

1. Problems with the standards of RFID

- RFID built in different ways by companies have designed, international standards are still under development and interoperability, which is working to achieve well. Here, it should be pointed out that some of the RFID devices do not have to leave the network and the RFID cards used for inventory control within the company.
- There are development standards that operate in high frequency and low, but in fact, big companies want to use cards that operate on high frequencies that provide a wide range compared with those working in low frequencies, but in fact Quarry cards that operate in the high frequencies a list price of about $ 1000 or more, large companies need to be thousands of these readers to cover all the required area, and also the need of millions of cards that are inexpensive, but it will be hung on the products be priced a few dollars, which makes the process expensive.

2. The RFID systems can be easily disrupted

- RFID systems that use the electromagnetic spectrum (Wi-Fi networks as well as cell phones), leading to a collision when you are working on the same frequency and to a lot of delays and inconvenience to consumers who want to Pay and get out of the store.
- In addition to the cards that contain the effective battery that will be questioned continuously at a low level of the battery if no answer.

3. RFID reader collision \ interference

Reader collision occurs when the overlap with readers my reference each other, the card is able to respond to the two systems should avoid these situations, so the protocols and found the anti-collision, which enables the card to take the decision to send the information to the reader.

4. RFID tag collision

Occur when there are many of the cards found in a small area, in addition to the reading time is short, so it is easy for vendors to develop systems that ensure a response card and only one by employing the appropriate algorithms.

II. Problems of security and privacy of RFID

The following problems that occur with RFID cards and readers identified as follows :

1. Contents of an RFID tag can be read after the item leaves the supply chain

RFID cards cannot be a different value from the reader to another. Since the RFID reader be mobile and RFID cards can be read from a distance of several inches to several yards, opening the field to see what are the contents of the purse or pocket when you are moving in the street, can also fire the RFID card after leaving the main center.

2. RFID cards is a problem of the movement (RFID tags Are difficult to remove)

Some cards are small (half a millimeter square and can be size and paper), some of the last to be secreted into the product where consumers can see it. New technology has allowed for the RFID cards to be printed on the product and may be subject to scroll.

3. RFID tags can be read without your knowledge

Can also read some of the cards without a pass or clear. Anyone have a RFID reader can read the chip on your clothes or any of the consumer products without your knowledge, for example when you enter a store will be tested if you are pregnant card, RFID and so on. Can be close to the person with the reader so he can read your card and find out how much money in your wallet and carry this problem for privacy and security.

4. RFID tags can be read at greater distances with a high-gain antenna

For a variety of reasons some systems, the reader / card, designed to increase the distance between the reader and the card. Higher profit for the antenna can be used to read cards from a distance, which thus causing a big problem in terms of privacy.

5. RFID Tags with unique serial numbers could be linked to an individual credit card number

Currently, the **Universal Product Code** (UPC) implemented with bar code which allows each product to have its own number known. Has been the development in this area, as it is with the purchase of any commodity is the RFID tag can be associated with the credit card number.

III. Security issues can be classified in several items

1. Data ownership and data-mining techniques

Express roads in the collection of information concerned with privacy and data ownership. For example, the investor personal card information can be used to detect a medical condition, this problem prior to the use of RFID, but the vast information provided through the RFID cards impose on us concern for the security of this information.

2. Data theft

To steal the data requires us to do two things, namely :

1. Login to the computer system

2. To carry out skilled to carry out the theft.

Since the RFID tags that transmit information, allowing the scanners to read the hidden data very easily too. There are many manufacturers of the cards are added several security measures by the addition of encryption systems to protect data.

3. Data corruption

Most anti-RFID cards to write. This feature may be secured (The card write it once and are read by many devices) or to remain effective, depending on the application and by the sensitivity of security. In the library of many of the cards remain unlocked for freedom in the re-use this card to other books or to believe in order to verify the tracking study.

4. Concerns about How RFID will be used

- Advocacy groups, civil liberty has increased concerns about the use of RFID in tracking the movement of persons, for example in the passports will contain RFID and will contain airports Scanners and thus can follow any passport through this card and from the moment they left the car and even stepped up to the plane.
- There is concern about that after the purchase from the store that the card will remain effective, this means that the thief traffic next to you can see what he can count the things that you purchased, thieves can also find out what's in the house before entering the house.
- Military equipment and clothing contain RFID tags are useful for tracking. In terms that there is concern about the elements associated with these cards, for example presence of explosives in a car once the required card passage in front of it will work these explosives. This in itself poses a threat to internal and international security.

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