RADIO FREQUENCY IDENTIFICATION

APPLICATIONS

This Paper deals about the working of RFID (Radio Frequency Identification), Various components and the numerous applications of the same. Also, we have had an idea about implementing the basic idea of RFID to SMART CARDS in our college. The various sources are: www.google.com and www.wikipedia.com.

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Radio frequency identification (RFID) is a generic term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object or person wirelessly, using radio waves. It’s grouped under the broad category of automatic identification technologies.

Imagine going to the grocery store, filling up your cart and walking right out the door. No longer will you have to wait as someone rings up each item in your cart one at a time. Instead, these RFID tags will communicate with an electronic reader that will detect every item in the cart and ring each up almost instantly. The reader will be connected to a large network that will send information on your products to the retailer and product manufacturers. Your bank will then be notified and the amount of the bill will be deducted from your account. No lines, no waiting.

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. Some auto manufacturers use RFID systems to move cars through an assembly line. At each successive stage of production, the RFID tag tells the computers what the next step of automated assembly is.

Radio frequency

Radio frequency (abbreviated RF, rf, orrf.) is a term that refers to alternating current (AC) having characteristics such that, if the current is input to an antenna, an electromagnetic (EM) field is generated suitable for wireless broadcasting and/or communications. These frequencies cover a significant portion of the electromagnetic radiation spectrum, extending from nine kilohertz (9 kHz), the lowest allocated wireless communications frequency (it's within the range of human hearing), to thousands of gigahertz (GHz).

When an RF current is supplied to an antenna, it gives rise to an electromagnetic field that propagates through space. This field is sometimes called an RF field; in less technical jargon it is a "radiowave." Any RF field has a wavelength that is inversely proportional to the frequency. In the atmosphere or in outer space, if $f$ is the frequency in megahertz and $s$ is the wavelength in meters, then

$$s = \frac{300}{f}$$

The frequency of an RF signal is inversely proportional to the wavelength of the EM field to which it corresponds. At 9 kHz, the free-space wavelength is approximately 33 kilometers (km). At the highest radio frequencies, the EM wavelengths measure approximately one millimeter (1 mm). As the frequency is increased beyond that of the RF spectrum, EM energy takes the form of infrared (IR), visible, ultraviolet (UV), X rays, and gamma rays.

Many types of wireless devices make use of RF fields. Cordless and cellular telephone, radio and television broadcast stations, satellite communications systems, and two-way radio services all operate in the RF spectrum. Some wireless devices operate at IR or visible-light frequencies, whose electromagnetic wavelengths are shorter than those of
RFfields. Examples include most television-set remote-controlboxes, some
cordless computer keyboards and mice, and a few wireless hi-fi stereo headsets.

**RFID History**

First use of RFID device was during the 2nd
dworld war by Britain to Identify Friend or Foe.
Harry Stockman in October 1948 presented a
Paper – Communication by means of reflected
power (The proceedings of the Institute of
interrogating signaladio Engineers).
RMario Cardullo’s device in 1973 was the first
ture ancestor of modern RFID, as it was a
 passive radio transponder with memory.
The initial device was passive, powered by the
interrogating signal. The basic Cardullo patent
covers the use of RF, sound and light as
transmission media.
The first patent to be associated with the
abbreviation RFID was granted to Charles
Walton in 1983.

**Evolution**

The largest deployment of active RFID is the
US Department of Defense use of active tags
on every one of its more than a million
shipping containers that travel outside of the
continent United States. In 2009 researchers
at Bristol University successfully glued RFID
microtransponders to live ants in order to
study their behavior. RFID tags technology
was used to tracking cattle, which wanders
away and are lost sometimes. This technology
has been used in tracking delivery of goods, in
courier services and baggage handling. Other
uses include automatic toll payments, access
in large buildings, security of items and
equipment tracking in engineering firms.

**How RFID system works?**

A Radio-Frequency IDentification system
has three parts:

- A scanning antenna
- A transceiver with a decoder to
  interpret the data
- A transponder - the RFID tag - that
  has been programmed with
  information.

The scanning antenna puts out radio-
frequency signals in a relatively short
range. The RF radiation does two things:

- It provides a means of
  communicating with the
  transponder (the RFID tag) AND
- It provides the RFID tag with the
  energy to communicate

This is an absolutely key part of the
technology; RFID tags do not need to
contain batteries, and can therefore
remain usable for very long periods of
time (maybe decades).
The scanning antennas can be
permanently affixed to a surface;
handheld antennas are also available.
They can take whatever shape you
need.

When an RFID tag passes through
the field of the scanning antenna, it
detects the activation signal from the
antenna. That "wakes up" the RFID
chip, and it transmits the information
on its microchip to be picked up by the
scanning antenna.
Rfid Components

The components of a RFID system are:

1. Tag (Transponder)
   This tag includes a CHIP and an ANTENNA. This tag is attached with the object and is used for unique identification. Tags are analogous to barcode labels, and come in different shapes and sizes. The tag contains an antenna connected to a small microchip containing up to two kilobytes of data.

2. Reader (interrogator)
   This includes a RF module (Transmitter and Receiver), control unit and several interfaces. The reader, or scanner, functions similarly to a barcode scanner; however, while a barcode scanner uses a laser beam to scan the barcode, an RFID scanner uses electromagnetic waves. To transmit these waves, the scanner uses an antenna that transmits a signal, communicating with the tags antenna. The tags antenna receives data from the scanner and transmits its particular chip information to the scanner.

3. A Host Computer
   This computer must have the basic application software. It is also called as middleware. Middleware is the interface needed between the interrogator and the existing company databases and information management software.

Tags

A RFID device that actively transmits to a reader is termed an “active” tag; an RFID device that only reflects or backscatters transmission from a reader is termed “passive.” The tags are programmed with data that identifies the item to which the tag is attached. Tags can be either read - only, volatile read/write, or write one/read many (WORM) and can be either active or passive. In general, active tags use batteries to power the tag transmitter (radio) and receiver. These tags usually contain a greater number of components than do passive tags. Therefore, active tags are usually larger in size and are more expensive than passive tags. In addition, the life of an active tag is directly related to battery life. Passive tags can be either battery or non-battery operated, as determined by the intended applications. Passive tags reflect the RF signal transmitted to them from a reader or transceiver and add information by modulating the reflected signal. A passive tag does not use a battery to boost the energy of the reflected signal. A passive tag may use a battery to maintain memory in the tag or power the electronics.
that enable the tag to modulate the reflected signal.

Active tags

**Powered by an internal battery**
Finite lifetime (because of battery)
Greater range
Better noise immunity
Higher data transmission rates

Passive tags

**Operate without battery**
Derive power from the field generate by the reader
Less expensive
Unlimited life
Subject to noise
Require more powerful readers
Orientation sensitivity

**Antenna**

Each RFID system includes at least one antenna to transmit and receive the RF signals. In some systems, a single antenna transmits and receives the signals; in other systems, one antenna transmits and one antenna receives the signals. The quantity and type of antennas used depend on the application.

The RF transceiver is the source of the RF energy used to activate and power the passive RFID tags. The RF transceiver may be enclosed in the same cabinet as the reader or it may be a separate piece of equipment. When provided as a separate piece of equipment, the transceiver is commonly referred to as an RF module. The RF transceiver controls and modulates the radio frequencies that the antenna transmits and receives. The transceiver filters and amplifies the backscatter signal from a passive RFID tag.
Reader

The RFID reader directs the RF transceiver to transmit RF signals, receives coded signal from the tag through the RF transceiver, decodes the tag’s identification, and transmits the identification with any other data from the tag to the host computer. The reader may also provide other functions. For example, ETC applications include accepting data from other input devices such as a vehicle detector and controlling gate and lights. Firmware in the reader controls reader operations. The user can change or customize the reader’s operations to suit a specific requirement by issuing commands through the host computer or a local terminal.

fig: a hand held Rfid Reader.

Middleware

An RFID system consists of hardware, including RFID readers, and software. The software runs on ordinary PCs or servers and consists of middleware, which contains the logic of the RFID application, and a backend database system (e.g., Oracle, SQL Server, Postgres, MySQL) for storing information about the tags. Typically, the tags contain an identification number and possibly some item-specific information. For a supermarket application, the checkout scanner might simply read the ID number and look it up in the database to see how much the product costs. However, in an airport baggage application the system might write the passenger’s ticket number and the final destination for the bag onto the tag at check-in time (because the next airport the bag visits may not have access to the originating airport’s database). When the bag is later scanned, the middleware could then just ask it where it is supposed to go. So this software depends on where the rfid is use. This host computer has the application software.

fig: a pocket system or a desktop system can be used as Middleware.

Rfid spectrum

The RF spectrum is divided into several ranges or bands. With the exception of the lowest-frequency segment, each band represents an increase of frequency corresponding to an order of magnitude (power of 10). The table depicts the eight bands in the RF spectrum, showing frequency and bandwidth ranges. The SHF and EHF bands are often referred to as the microwave spectrum.
The range from 300Mhz-3Ghz is used for radio frequency identification purposes.

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Characteristics</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW 100-500kHz</td>
<td>Short to medium read range, inexpensive, low reading speed</td>
<td>Access control, Animal/Human identification, Inventory Control</td>
</tr>
<tr>
<td>MEDIUM 10-15MHz</td>
<td>Short to medium read range, Potentially inexpensive, Medium reading range</td>
<td>Access Control, Smart Cards</td>
</tr>
<tr>
<td>HIGH Ultra high: 850-950MHz Micro: 2.4-5.8 GHz</td>
<td>Long read range, High reading speed, Line of sight required, (Microwave) Expensive</td>
<td>Railroad car monitoring, Toll collection systems</td>
</tr>
</tbody>
</table>

### Applications

#### Asset Tracking

Static or in-motion assets tracking or locating, like a healthcare facility, wheelchairs or IV pumps in, laptops in a corporation and servers in a data center, was not so easy task.

User can instantly determine the general location of tagged assets anywhere within the facility with the help of active RFID technology. Control point detection zones at strategic locations throughout the facility allow the user to define logical zones and monitor high traffic areas. Tagged assets moving through these control points provide instant location data.

Asset tracking applications will see an almost vertical growth curve in the coming years and the growth rate in this area will be much higher than the growth rate of general RFID market.

### Rfid Vs Bar codes

<table>
<thead>
<tr>
<th>System</th>
<th>Barcode</th>
<th>RFID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Transmission</td>
<td>Optical</td>
<td>Electromagnetic</td>
</tr>
<tr>
<td>Typical Data Volume</td>
<td>1-100 bytes</td>
<td>18-28 Kbytes</td>
</tr>
<tr>
<td>Data Modification</td>
<td>Not possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Position of Data Carrier for Read/Write</td>
<td>Visual contact</td>
<td>Non line of sight possible</td>
</tr>
<tr>
<td>Reading Distance</td>
<td>Several meters/line of sight</td>
<td>From centimeters to meters (depending on the frequency and tag)</td>
</tr>
<tr>
<td>Access Security</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Environmental Susceptibility</td>
<td>Dirt</td>
<td>Very small</td>
</tr>
<tr>
<td>Anticollision</td>
<td>Not possible</td>
<td>Possible</td>
</tr>
</tbody>
</table>
People tracking system are used just as asset tracking system. Hospitals and jails are most general tracking required places. Hospital uses RFID tags for tracking their special patients. In emergency patient and other essential equipment can easily track. It will be mainly very useful in mental care hospitals where doctors can track each and every activity of the patient. Hospitals also use these RFID tags for locating and tracking all the activities of the newly born babies.

The best use of the people tracking system will be in jails. It becomes an easy tracking system to track their inmates. Many jails of different US states like Michigan, California, and Arizona are already using RFID-tracking systems to keep a close eye on jail inmates.

Many government libraries use barcode and electromagnetic strips to track various assets. RFID technology uses for reading these barcodes unlike the self-barcode reader RFID powered barcode reader can read multiple items simultaneously. This reduces queues and increases the number of customers using self-check, which in turn will reduce the staff necessary at the desks.

Delhi metro has introduced a Travel Card. By using this card, a passenger can travel in the train without actually buying the ticket or paying the money. All you got to do is buy a travel Card, keep recharging it at the counters and show it while entering and leaving the station. The ticket amount will be automatically deducted from the balance value. This travel card actually uses RFID technology. So, no more waiting in lines to buy the ticket.
Easy Shopping

Easy shopping is amongst the latest developed trends in Rfid. Shopping experiences can be tiring when we are made to stand in long lines for billing. So, for this Rfid readers are fixed on the shopping carts and when the shopper produces the card, it checks the balance and as the products are being placed in the cart, the bill is generated and is produced at the end. So no manual assistance needed and a lot of time is saved.

Museums

RFID technologies are now also implemented in end-user applications in museums. An example was the custom-designed temporary research application, “eXspot,” at the Exploratorium, a science museum in San Francisco, California. A visitor entering the museum received an RF Tag that could be carried as a card. The eXspot system enabled the visitor to receive information about specific exhibits. Aside from the exhibit information, the visitor could take photographs of themselves at the exhibit. It was also intended to also allow the visitor to take data for later analysis. The collected information could be retrieved at home from a "personalized" website keyed to the RFID tag.

digitized photograph of the passport holder. They employ a "multilayered approach" to protect privacy and reduce the possibility that passersby can skim data from the books, the agency said.

"The Department of State is confident that the new e-passport, including biometrics and other improvements, will take security and travel facilitation to a new level," the agency said in a statement.

A first wave of U.S. passports implanted with radio tags will soon begin making their way into the hands of American travelers. The new passports, which have been undergoing testing for several months and have already been issued to some U.S. diplomats, will be equipped with radio frequency identification (RFID) chips that can transmit personal information including the name, nationality, gender, date of birth, place of birth and
Animal Identification

RFID tags for animals represent one of the oldest uses of RFID technology. Originally meant for large ranches and rough terrain, since the outbreak of mad-cow disease, RFID has become crucial in animal identification management. An implantable variety of RFID tags or transponders can also be used for animal identification. The transponders are more well-known as passive RFID technology, or simply "chips" on animals.

Race Timings

Many forms of RFID race timing have been in use for timing races of different types since the early 1990s. The practice began with pigeon racing, introduced by a company called deister electronic GmbH of Barsinghausen, Germany. It is used for registering race start and end timings for animals or individuals in large running races or multi-sport races where it is impossible to get accurate stopwatch readings for every entrant.

In the race, the racers wear passive or active tags that are read by antennae placed alongside the track or on mats across the track. UHF based tags instead of low or high frequency last-generation tags provide accurate readings with specially designed antennas. Rush error, lap count errors and accidents at start time are avoided since anyone can start and finish any time without being in a batch mode.

Payment By Mobile

Nokia's 2008 device, the 6212, has RFID capabilities also. Credit card information can be stored, and bank accounts can be directly accessed using the enabled handset. The phone, if used as a vector for mobile payment, has added security in that users would be required to enter a passcode or PIN before payment is authorized.
Food Safety

Retailers and consumer packaged goods firms should use Radio Frequency Identification (RFID) tags to aid product recalls and track health issues. But to put consumers at ease about privacy concerns, retailers need to make clear the advantages of being able to trace food, and provide opt-in choices regarding the storage and analysis of collected data. Firms operating in the grocery supply chain have to be able to identify the origin and destination of food products, and provide immediate information to governments by January 2005, as part of the European Health and Consumer Protection Directorate. RFID tags provide firms with the best way of doing this, as well as a way of saving money from product recalls. By placing RFID tags on containers and pallets, retailers and manufacturers will be able to bring about large cost savings by reducing the number of goods that need to be recalled. Warehouse management systems, which store container and pallet RFID tags, will be able to list individual items stored in them, lowering the extent of recalls across distribution centres, retail stores and in transit.

Waste Management

With costs rising at all points in the waste management process, shrinking landfill space, and growing consumer interest in recycling, RFID is enabling cities and towns across the country to foster recycling while improving the efficiency of their waste operations. Taking advantage of RFID’s ability to reliably identify individual receptacles, municipalities can create incentive-based recycling programs that accurately reward customers for the amount they recycle, while minimizing the amount of trash headed for the landfill. By automating the collection of all waste, RFID can assure that individual bins have been collected, providing verification of service. In addition this information can be used to optimize truck usage and routes.
The rfid technology is widely used in anti-theft devices. To prevent car theft, the heart of a car has a tiny electronic device, called a transponder, which is embedded into the vehicle's ignition key. The transponder contains a unique and unalterable identification code that corresponds to that particular vehicle.

Every time the key is inserted into the ignition, a radio frequency (RF) reader located in the steering column is triggered. The reader is comprised of a small antenna integrated with the ignition switch and the steering lock cylinder, and a transceiver, which is connected to a control module in the engine's central computer. The computer controls vital automotive functions, such as the ignition and fuel supply circuits.

As the ignition is turned, the reader is activated and sends out a wireless signal to the transponder. The signal powers up the transponder's capacitor, allowing it to transmit its unique code back to the reader. The code is then sent to the control module, which compares it to the code stored in its memory. If the two codes match, and the appropriate additional security challenges are passed (depending upon the type of transponder featured in the immobilizer system), the control module enables the engine's computer or the fuel pump relays. If the codes do not match, an alarm indicator will show and the engine will not start, rendering the vehicle impossible to drive until the proper key is inserted for ignition.

Since Rfid is used in almost every sector today, it is also possible to use it any university or educational institute, for instance our college. A smart card is a plastic card about the size of a credit card, with an embedded microprocessor that can be loaded with data.

The microprocessor on the smart card is there for security. The host computer and card reader actually "talk" to the microprocessor. The microprocessor enforces access to the data on the card. If the host computer read and wrote the smart card's random access memory (RAM), it would be no different than a diskette.

The data is usually associated with either value, information, or both and is stored and processed within the card's chip. The card data is transacted via a reader that is part of a computing system.

This smart card uses rfid technology or Radio Frequency Identification Technique.

So if such a SMART CARD is provided to every student, that card will contain information about student profile including details like Name, Branch, Class, Personal information
and many details about the person. A student can avail the following facilities:

1. Students can use the card in library for checking on the books available, last date for return, reissuing books, using the library database and so on.

2. This card will be particularly useful to keep a track on hostel students and their activities. They can also keep a check on their entry and exit time.

3. Students can pay through this card for the coffee day and the canteen, provided they have enough balance and they keep recharging.

4. Even staff can use be provided with such cards, for their attendance.

5. The college management can check if a student has attended classes or not.

6. This card may act as a bus pass also

ADVANTAGES:

1. Establishment of such a system in the college is very economical.

2. Everything becomes easier and simple.

3. No time will be wasted in taking the attendance.

4. College Management can keep an eye on the students and their progress.

5. No need to issue special bus passes.

The above is a picture of how a students card makes their lives easier.