RFID BASED PREPAID CARD FOR PETROL STATION

Submitted in partial fulfillment of the requirements

of the degree of

Bachelor of Engineering

in

Electronics and Telecommunication

by

ANSARI ZAIN (15ET17)
MANIAR MAAZ (15ET35)

Under the guidance of

Asst. Prof. Mazhar Malagi

Department of Electronics and Telecommunication Engineering

Anjuman-I-Islam's Kalsekar Technical Campus
Sector 16, New Panvel , Navi Mumbai
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CERTIFICATE

Department of Electronics and Telecommunication Engineering
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University of Mumbai

This is to certify that the project entitled **RFID BASED PREPAID CARD FOR PETROL STATION** is a bonafide work of **Ansari Zain (15ET17), Maniar Maaz (15ET35)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Department of Electronics and Telecommunication Engineering.

Supervisor

Examiner

Head of Department

Director

Project Report Approval for Bachelor of Engineering

This project entitled **"RFID BASED PREPAID CARD FOR PETROL STATION"** by **Ansari Zain and Maniar Maaz** is approved for the degree of **Bachelor of Engineering in Electronics and Telecommunication**.

Examiner

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Supervisor

....

Date;

Place:

Declaration

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

…………………….
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Date:

Acknowledgments

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals. I would like to extend my sincere thanks to all of them.

We am highly indebted to Asst. Prof. Mazhar Malagi for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

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Ansair Zain (15ET17)
Maniar Maaz (15ET35)

ABSTRACT

Radio frequency identification, RFID is a technology that is used in many fields including locks. The unlimited access to the reader and the transponder has resulted in severe security weaknesses and made it possible to apply different attacks. To classify door locks as secure they must at least fulfil two main criteria: the first is the use of a challenge response authentication protocol and the second is to deploy sophisticated and secure algorithms. The main aim of the project is to design a system which is capable of automatically deducting the amount of petrol dispensed from user card based on RFID technology. Liquid dispensing systems are quite commonly found in our daily life in different places like offices, Bus stands, Railway stations, Petrol pumps. Here we are going to present modern era petrol dispensing system which is meant to be operated with prepaid card using RFID technology. The project mainly aims in designing a prepaid card for petrol bunk system and also petrol dispensing system using RFID technology. In current days the petrol stations are operated manually. These petrol pumps are time consuming and require more man power. To place petrol stations in distant area is very costly to provide excellent facility to the consumers. All these problems are sorted out by the use of unmanned power pump which requires less time to operate and it is effective and can be installed anywhere. The customer self-going to avail the service has to done the payment by electronic clearing system.

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Chapter 1

1 Introduction

1.1 Telecommunication 101

Figure 1: telecommunication 101

Telecommunication is the transmission of signs, signals, messages, words, writings, images and sounds or information of any nature by wire, radio, optical or other electromagnetic systems.Telecommunication occurs when the exchange of information between communication participants includes the use of technology. It is transmitted either electrically over physical media, such as cables, or via electromagnetic radiation.Such transmission paths are often divided into communication channels which afford the advantages of multiplexing. Since the Latin term communicatio is considered the social process of information exchange, the term telecommunications is often used in its plural form because it involves many different technologies. A revolution in wireless communication began in the first decade of the 20th century with the pioneering developments in radio communications by Guglielmo Marconi, who won the Nobel Prize in Physics in 1909, and other notable pioneering inventors and developers in the field of electrical and electronic telecommunications. These included Charles Wheatstone and Samuel Morse (inventors of the telegraph), Alexander Graham Bell (inventor of the telephone), Edwin Armstrong and Lee de Forest (inventors of radio), as well as Vladimir K. Zworykin, John Logie Baird and Philo Farnsworth (some of the inventors of television).

1.1.1 History

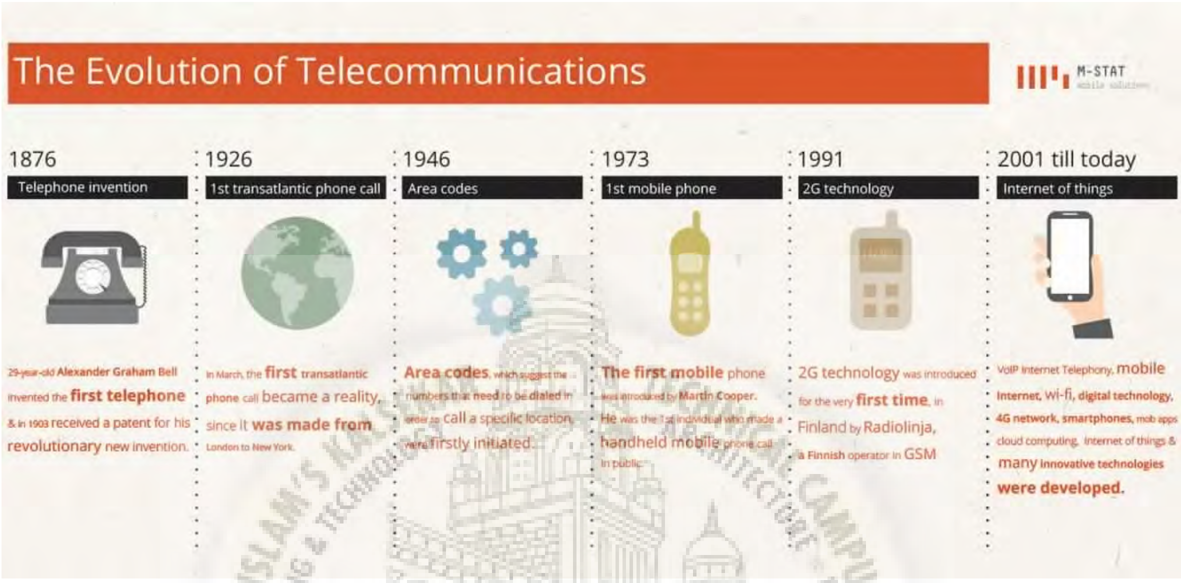

Figure 2: The-Evolution-of-Telecom

Beacons and pigeons: Homing pigeons have occasionally been used throughout history by different cultures. Pigeon post had Persian roots, and was later used by the Romans to aid their military. In the Middle Ages, chains of beacons were commonly used on hilltops as a means of relaying a signal. Beacon chains suffered the drawback that they could only pass a single bit of information, so the meaning of the message such as "the enemy has been sighted" had to be agreed upon in advance. One notable instance of their use was during the Spanish Armada, when a beacon chain relayed a signal from Plymouth to London. In 1792, Claude Chappe, a French engineer, built the first fixed visual telegraphy system (or semaphore line) between Lille and Paris. However semaphore suffered from the need for skilled operators and expensive towers at intervals of ten to thirty kilometres (six to nineteen miles). As a result of competition from the electrical telegraph, the last commercial line was abandoned in 1880.

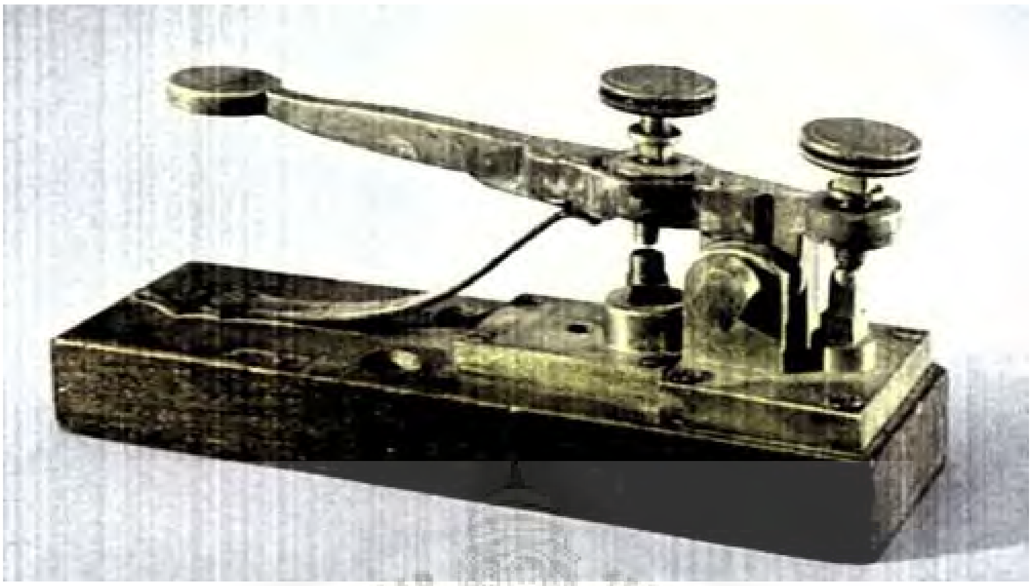

Figure 3: Early-Telecommunication

Telegraph and telephone: On 25 July 1837 the first commercial electrical telegraph was demonstrated by English inventor Sir William Fothergill Cooke, and English scientist Sir Charles Wheatstone. Both inventors viewed their device as "an improvement to the [existing] electromagnetic telegraph" not as a new device. The conventional telephone was invented independently by Alexander Bell and Elisha Gray in 1876. Antonio Meucci invented the first device that allowed the electrical transmission of voice over a line in 1849. However Meucci's device was of little practical value because it relied upon the electrophonic effect and thus required users to place the receiver in their mouth to "hear" what was being said. The first commercial telephone services were set-up in 1878 and 1879 on both sides of the Atlantic in the cities of New Haven and London.

Radio and television: Starting in 1894, Italian inventor Guglielmo Marconi began developing a wireless communication using the then newly discovered phenomenon of radio waves, showing by 1901 that they could be transmitted across the Atlantic Ocean. This was the start of wireless telegraphy by radio. Voice and music were demonstrated in 1900 and 1906, but had little early success.World War I accelerated the development of radio for military communications. After the war, commercial radio AM broadcasting began in the 1920s and became an important mass medium for entertainment and news. World War II again accelerated development of radio for the wartime purposes of aircraft and land communication, radio navigation and radar. Development of stereo FM broadcasting of radio took place from the 1930s on-wards in the United States and displaced AM as the dominant commercial standard by the 1960s, and by the 1970s in the United Kingdom. On 25 March 1925, John Logie Baird was able to demonstrate the transmission of moving pictures at the London department store Selfridges. Baird's device relied upon the Nipkow disk and thus became known as the mechanical television. It formed the basis of experimental broadcasts done by the British Broadcasting Corporation beginning 30 September 1929. However, for most of the twentieth century televisions depended upon the cathode ray tube invented by Karl Braun. The first version of such a television to show promise was produced by Philo Farnsworth and demonstrated to his family on 7 September 1927. After World War II, the experiments in television that had been interrupted were resumed, and it also became an important home entertainment broadcast medium.

Computers and the Internet: On 11 September 1940, George Stibitz transmitted problems for his Complex Number Calculator in New York using a teletype, and received the computed results back at Dartmouth College in New Hampshire. This configuration of a centralized computer (mainframe) with remote dumb terminals remained popular well into the 1970s. However, already in the 1960s, researchers started to investigate packet switching, a technology that sends a message in portions to its destination asynchronously without passing it through a centralized mainframe. A four-node network emerged on 5 December 1969, constituting the beginnings of the ARPANET, which by 1981 had grown to 213 nodes. ARPANET eventually merged with other networks to form the Internet. While Internet development was a focus of the Internet Engineering Task Force (IETF) who published a series of Request for Comment documents, other networking advancement occurred in industrial laboratories, such as the local area network (LAN) developments of Ethernet (1983) and the token ring protocol (1984)

1.1.2 Key concepts

Modern telecommunication is founded on a series of key concepts that experienced progressive development and refinement in a period of well over a century.

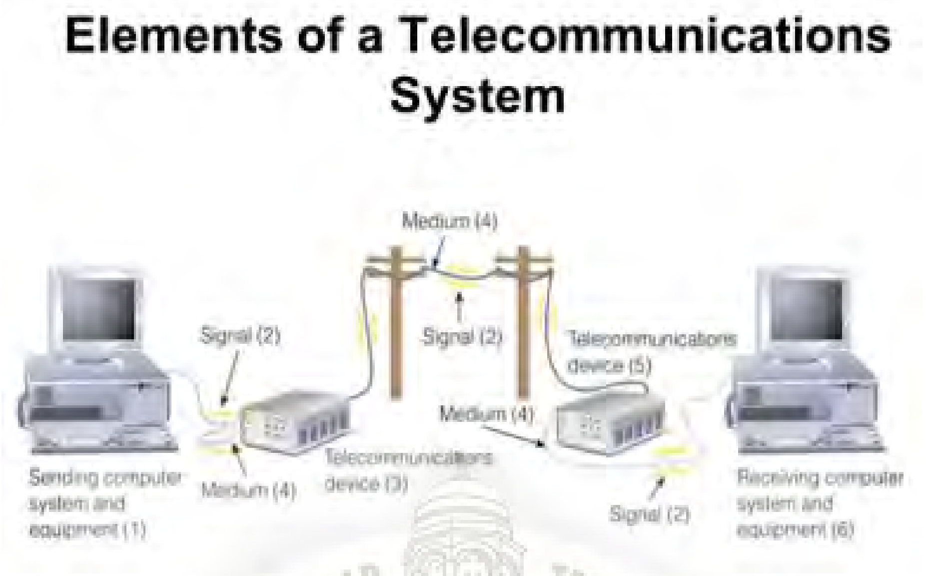

Figure 4: Basic elements

Basic elements: Telecommunication technologies may primarily be divided into wired and wireless methods. Overall though, a basic telecommunication system consists of three main parts that are always present in some form or another:
1) A transmitter that takes information and converts it to a signal.
2) A transmission medium, also called the physical channel that carries the signal. An example of this is the "free space channel".
3) A receiver that takes the signal from the channel and converts it back into usable information for the recipient.

Figure 5: Analog versus digital communications

Analog versus digital communications: Communications signals can be sent either by analog signals or digital signals. There are analog communication systems and digital communication systems. For an analog signal, the signal is varied continuously with respect to the information. In a digital signal, the information is encoded as a set of discrete values (for example, a set of ones and zeros). During the propagation and reception, the information contained in analog signals will inevitably be degraded by undesirable physical noise. (The output of a transmitter is noise-free for all practical purposes.) Commonly, the noise in a communication system can be expressed as adding or subtracting from the desirable signal in a completely random way. This form of noise is called additive noise, with the understanding that the noise can be negative or positive at different instants of time. Noise that is not additive noise is a much more difficult situation to describe or analyze, and these other kinds of noise will be omitted here. On the other hand, unless the additive noise disturbance exceeds a certain threshold, the information contained in digital signals will remain intact. Their resistance to noise represents a key advantage of digital signals over analog signals.

Telecommunication networks: A telecommunications network is a collection of transmitters, receivers, and communications channels that send messages to one another. Some digital communications networks contain one or more routers that work together to transmit information to the correct user. An analog communications network consists of one or more switches that establish a connection between two or more users. For both types of network, repeaters may be necessary to amplify or recreate the signal when it is being transmitted over long distances. This is to combat attenuation that can render the signal indistinguishable from the noise. Another advantage of digital systems over analog is that their output is easier to store in memory, i.e. two voltage states (high and low) are easier to store than a continuous range of states.

Communication channels: The term "channel" has two different meanings. In one meaning, a channel is the physical medium that carries a signal between the transmitter and the receiver. Examples of this include the atmosphere for sound communications, glass optical fibers for some kinds of optical communications, coaxial cables for communications by way of the voltages and electric currents in them, and free space for communications using visible light, infrared waves, ultraviolet light, and radio waves. Coaxial cable types are classified by RG type or "radio guide", terminology derived from World War II. The various RG designations are used to classify the specific signal transmission applications. This last channel is called the "free space channel". The sending of radio waves from one place to another has nothing to do with the presence or absence of an atmosphere between the two. Radio waves travel through a perfect vacuum just as easily as they travel through air, fog, clouds, or any other kind of gas. The other meaning of the term "channel" in telecommunications is seen in the phrase communications channel, which is a subdivision of a transmission medium so that it can be used to send multiple streams of information simultaneously. For example, one radio station can broadcast radio waves into free space at frequencies in the neighborhood of 94.5 MHz (megahertz) while another radio station can simultaneously broadcast radio waves at frequencies in the neighborhood of 96.1 MHz. Each radio station would transmit radio waves over a frequency bandwidth of about 180 kHz (kilohertz), centered at frequencies such as the above, which are called the "carrier frequencies". Each station in this example is separated from its adjacent stations by 200 kHz, and the difference between 200 kHz and 180 kHz (20 kHz) is an engineering allowance for the imperfections in the communication system.

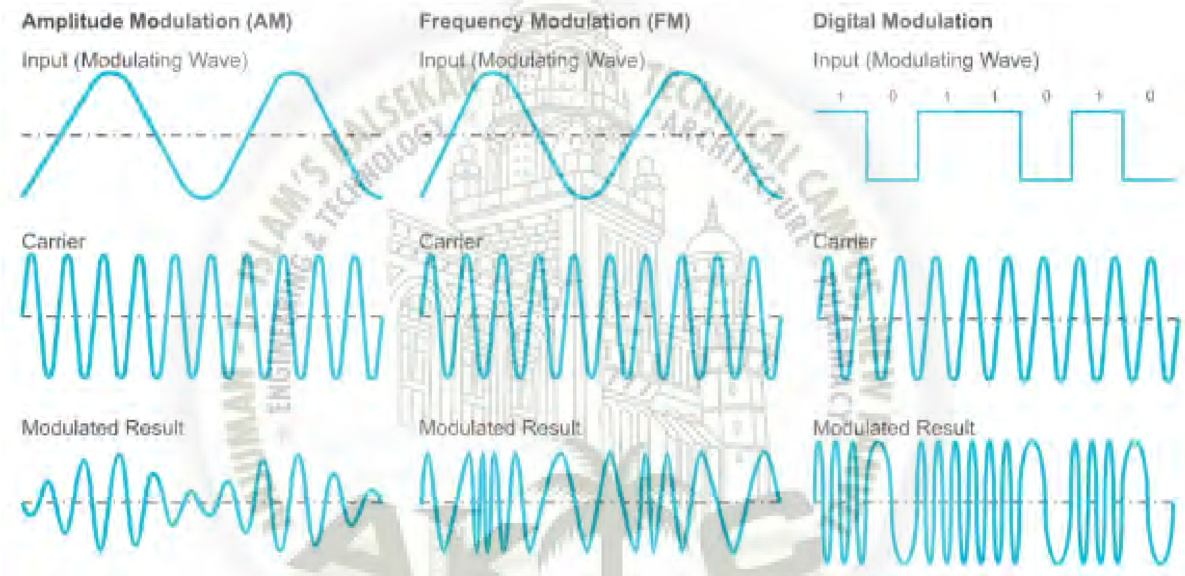

Figure 6: Modulation

Modulation: The shaping of a signal to convey information is known as modulation. Modulation can be used to represent a digital message as an analog waveform. This is commonly called "keying"a term derived from the older use of Morse Code in telecommunicationsand several keying techniques exist (these include phase-shift keying, frequency-shift keying, and amplitude-shift keying). The "Bluetooth" system, for example, uses phase-shift keying to exchange information between various devices. In addition, there are combinations of phase-shift keying and amplitude-shift keying which is called (in the jargon of the field) "quadrature amplitude modulation" (QAM) that are used in high-capacity digital radio communication systems. Modulation can also be used to transmit the information of low-frequency analog signals at higher frequencies. This is helpful because low-frequency analog signals cannot be effectively transmitted over free space. Hence the information from a low-frequency analog signal must be impressed into a higher-frequency signal (known as the "carrier wave") before transmission. There are several different modulation schemes available to achieve this [two of the most basic being amplitude modulation (AM) and frequency modulation (FM)]. An example of this process is a disc jockey's voice being impressed into a 96 MHz carrier wave using frequency modulation (the voice would then be received on a radio as the channel "96 FM"). In addition, modulation has the advantage that it may use frequency division multiplexing (FDM).

1.2 Introduction to Radio

Figure 7: Introduction to Radio

Radio is the technology of signalling or communicating using radio waves. Radio waves are electromagnetic waves of frequency between 30 hertz (Hz) and 300 gigahertz (GHz). They are generated by an electronic device called a transmitter connected to an antenna which radiates the waves, and received by a radio receiver connected to another antenna. Radio is very widely used in modern technology, in radio communication, radar, radio navigation, remote control, remote sensing and other applications. In radio communication, used in radio and television broadcasting, cell phones, two-way radios, wireless networking and satellite communication among numerous other uses, radio waves are used to carry information across space from a transmitter to a receiver, by modulating the radio signal (impressing an information signal on the radio wave by varying some aspect of the wave) in the transmitter. In radar, used to locate and track objects like aircraft, ships, spacecraft and missiles, a beam of radio waves emitted by a radar transmitter reflects off the target object, and the reflected waves reveal the object's location. In radio navigation systems such as GPS and VOR, a mobile receiver receives radio signals from navigational radio beacons whose position is known, and by precisely measuring the arrival time of the radio waves the receiver can calculate its position on Earth. In wireless remote control devices like drones, garage door openers, and keyless entry systems, radio signals transmitted from a controller device control the actions of a remote device. Applications of radio waves which do not involve transmitting the waves significant distances, such as RF heating used in industrial processes and microwave ovens, and medical uses such as diathermy and MRI machines, are not usually called radio. The noun radio is also used to mean a broadcast radio receiver. Radio waves were first identified and studied by German physicist Heinrich Hertz in 1886. The first practical radio transmitters and receivers were developed around 1895-6 by Italian Guglielmo Marconi, and radio began to be used commercially around 1900. To prevent interference between users, the emission of radio waves is strictly regulated by law, coordinated by an international body called the International Telecommunications Union (ITU), which allocates frequency bands in the radio spectrum for different uses.

1.2.1 Radio technology

Radio waves are radiated by electric charges undergoing acceleration. They are generated artificially by time varying electric currents, consisting of electrons flowing back and forth in a metal conductor called an antenna. In transmission, a transmitter generates an alternating current of radio frequency which is applied to an antenna. The antenna radiates the power in the current as radio waves. When the waves strike the antenna of a radio receiver, they push the electrons in the metal back and forth, inducing a tiny alternating current. The radio receiver connected to the receiving antenna detects this oscillating current and amplifies it. As they travel further from the transmitting antenna, radio waves spread out so their signal strength (intensity in watts per square meter) decreases, so radio transmissions can only be received within a limited range of the transmitter, the distance depending on the transmitter power, antenna radiation pattern, receiver sensitivity, noise level, and presence of obstructions between transmitter and receiver. An omnidirectional antenna transmits or receives radio waves in all directions, while a directional antenna or high gain antenna transmits radio waves in a beam in a particular direction, or receives waves from only one direction. Radio waves travel through a vacuum at the speed of light, and in air at very close to the speed of light, so the wavelength of a radio wave, the distance in meters between adjacent crests of the wave, is inversely proportional to its frequency.

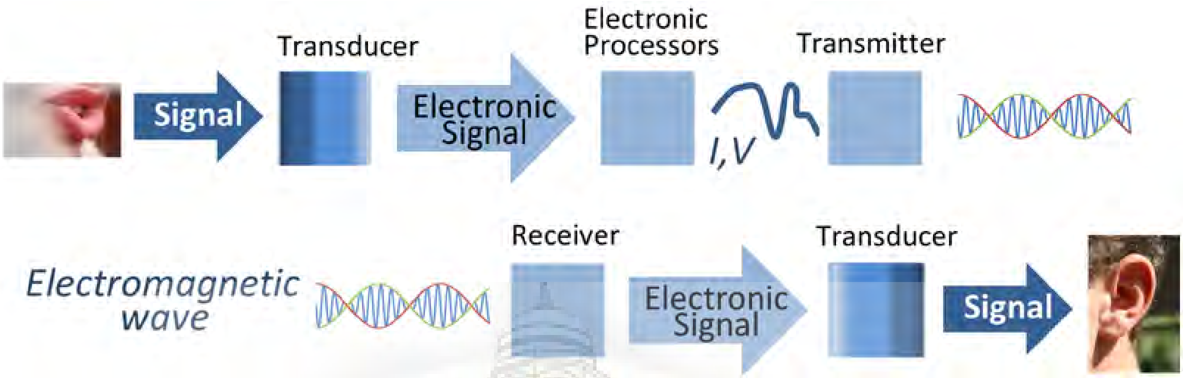

Figure 8: Radio communication

Radio communication: In radio communication systems, information is carried across space using radio waves. At the sending end, the information to be sent is converted by some type of transducer to a time-varying electrical signal called the modulation signal.[6] The modulation signal may be an audio signal representing sound from a microphone, a video signal representing moving images from a video camera, or a digital signal consisting of a sequence of bits representing binary data from a computer. The modulation signal is applied to a radio transmitter. In the transmitter, an electronic oscillator generates an alternating current oscillating at a radio frequency, called the carrier wave because it serves to "carry" the information through the air. The information signal is used to modulate the carrier, varying some aspect of the carrier wave, impressing the information on the carrier. Different radio systems use different modulation methods:
1) AM (amplitude modulation) - in an AM transmitter, the amplitude (strength) of the radio carrier wave is varied by the modulation signal.
2) FM (frequency modulation) - in an FM transmitter, the frequency of the radio carrier wave is varied by the modulation signal.
3) FSK (frequency shift keying) - used in wireless digital devices to transmit digital signals, the frequency of the carrier wave is shifted periodically between two frequencies that represent the two binary digits, 0 and 1, to transmit a sequence of bits.
4) OFDM (orthogonal frequency division multiplexing) - a family of complicated digital modulation methods very widely used in high bandwidth systems such as WiFi networks, cellphones, digital television broadcasting, and digital audio broadcasting (DAB) to transmit digital data using a minimum of radio spectrum

bandwidth. OFDM has higher spectral efficiency and more resistance to fading than AM or FM. Multiple radio carrier waves closely spaced in frequency are transmitted within the radio channel, with each carrier modulated with bits from the incoming bitstream so multiple bits are being sent simultaneously, in parallel. At the receiver the carriers are demodulated and the bits are combined in the proper order into one bitstream.

Many other types of modulation are also used. The modulated carrier is amplified in the transmitter, and applied to a transmitting antenna which radiates the energy as radio waves. The radio waves carry the information to the receiver location. At the receiver, the radio wave induces a tiny oscillating voltage in the receiving antenna which is a weaker replica of the current in the transmitting antenna.[6] This voltage is applied to the radio receiver, which amplifies the weak radio signal so it is stronger, then demodulates it, extracting the original modulation signal from the modulated carrier wave. The modulation signal is converted by a transducer back to a human-usable form: an audio signal is converted to sound waves by a loudspeaker or earphones, a video signal is converted to images by a display, while a digital signal is applied to a computer or microprocessor, which interacts with human users. The radio waves from many transmitters pass through the air simultaneously without interfering with each other. The receiving antenna typically picks up the radio signals of many transmitters. These can be separated in the receiver because each transmitter's radio waves oscillate at a different rate, in other words each transmitter has a different frequency, measured in kilohertz (kHz), megahertz (MHz) or gigahertz (GHz). The receiver uses tuned circuits to select the radio signal desired out of all the signals picked up by the antenna, and reject the others. A tuned circuit (also called resonant circuit or tank circuit) acts like a resonator, similarly to a tuning fork.[6] It has a natural resonant frequency at which it oscillates. The resonant frequency of the receiver's tuned circuit is adjusted by the user to the frequency of the desired radio station; this is called "tuning". The oscillating radio signal from the desired station causes the tuned circuit to resonate, oscillate in sympathy, and it passes the signal on to the rest of the receiver. Radio signals at other frequencies are blocked by the tuned circuit and not passed on.

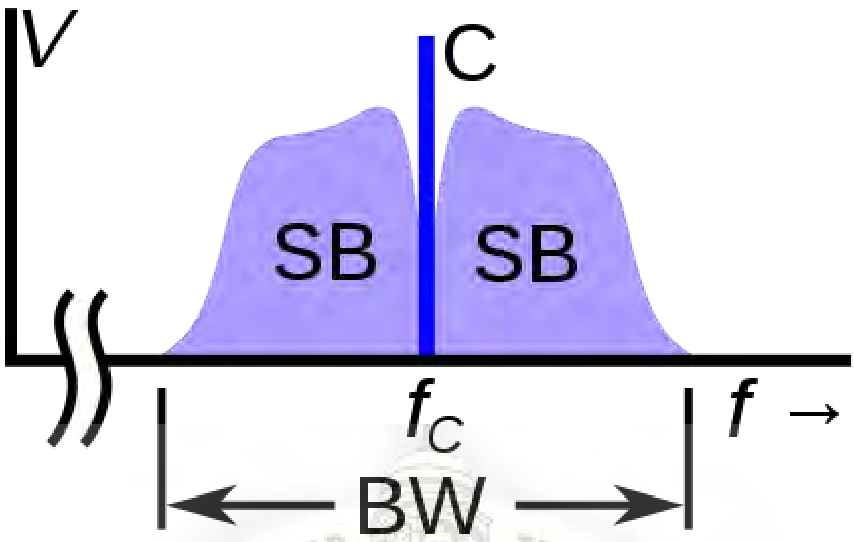

Figure 9: Bandwidth

Bandwidth: A modulated radio wave, carrying an information signal, occupies a range of frequencies. See diagram. The information (modulation) in a radio signal is usually concentrated in narrow frequency bands called sidebands (SB) just above and below the carrier frequency. The width in hertz of the frequency range that the radio signal occupies, the highest frequency minus the lowest frequency, is called its bandwidth (BW). A given amount of bandwidth can carry the same amount of information (data rate in bits per second) regardless of where in the radio frequency spectrum it is located, so bandwidth is a measure of information-carrying capacity. The bandwidth required by a radio transmission depends on the data rate of the information (modulation signal) being sent, and the spectral efficiency of the modulation method used; how much data it can transmit in each kilohertz of bandwidth. Different types of information signals carried by radio have different data rates. For example, a television (video) signal has a greater data rate than an audio signal. The radio spectrum, the total range of radio frequencies that can be used for communication in a given area, is a fixed resource. Each radio transmission occupies a portion of the total bandwidth available. Radio bandwidth is regarded as an economic good which has a monetary cost and is in increasing demand. In some parts of the radio spectrum the right to use a frequency band or even a single radio channel is bought and sold for millions of dollars. So there is an incentive to employ technology to minimize the bandwidth used by radio services. In recent years there has been a transition from analog to digital radio transmission technologies. Part of the reason for this is that digital modulation can often transmit more information (a greater data rate) in a given bandwidth than analog modulation, by using data compression algorithms, which reduce redundancy in the data to be sent, and more efficient modulation. Other reasons for the transition is that digital modulation has greater noise immunity than analog, digital signal processing chips have more power and flexibility than analog circuits, and a wide variety of types of information can be transmitted using the same digital modulation. Because it is a fixed resource which is in demand by an increasing number of users, the radio spectrum has become increasingly congested in recent decades, and the need to use it more effectively is driving many additional radio innovations such as trunked radio systems, spread spectrum (ultra-wideband) transmission, frequency reuse, dynamic spectrum management, frequency pooling, and cognitive radio.

1.2.2 Applications

Below are some of the most important uses of radio, organized by function.

Figure 10: Broadcasting

Broadcasting: Broadcasting is the one-way transmission of information from a radio transmitter to receivers belonging to a public audience. Since the radio waves become weaker with distance, a broadcasting station can only be received within a limited distance of its transmitter. Systems which broadcast from satellites can generally be received over an entire country or continent. Older terrestrial radio and television paid for by commercial advertising or governments. In subscription systems like satellite television and satellite radio the customer pays a monthly fee. In these systems the radio signal is encrypted and can only be decrypted by the receiver, which is controlled by the company and can be deactivated if the customer doesn't pay his bill. Broadcasting uses several parts of the radio spectrum, depending on the type of signals transmitted and the desired target

audience. Long-wave and medium-wave signals can give reliable coverage of areas several hundred kilometres across, but work only with audio signals (speech and music),and are subject to natural and artificial sources of interfering noise. The shortwave bands have greater potential range, but are more subject to interference by distant stations and varying atmospheric conditions that affect reception. At very high frequencies, greater than 30 megahertz, the Earth's atmosphere has less of an effect on the range of signals, and line of sight propagation becomes the principle mode. These higher frequencies permit the great bandwidth required for television broadcasting. Since natural and artificial noise sources are less present at these frequencies, high-quality audio transmission is possible, using frequency modulation. Digital audio broadcasting (DAB) - debuted in some countries in 1998. It transmits audio as a digital signal rather than an analog signal as AM and FM do. DAB has the potential to provide higher quality sound than FM (although many stations do not choose to transmit at such high quality), has greater immunity to radio noise and interference, makes better use of scarce radio spectrum bandwidth, and provides advanced user features such as electronic program guides. Its disadvantage is that it is incompatible with previous radios so that a new DAB receiver must be purchased. Most countries plan an eventual switchover from FM to DAB. The United States and Canada have chosen not to implement DAB. A single DAB station transmits a 1,500 kHz bandwidth signal that carries from 9 to 12 channels of digital audio modulated by OFDM from which the listener can choose. Broadcasters can transmit a channel at a range of different bit rates, so different channels can have different audio quality. In different countries DAB stations broadcast in either Band III (174240 MHz) or L band (1.4521.492 GHz) in the UHF range, so like FM reception is limited by the visual horizon to about 40 miles (64 km). Digital Radio Mondiale (DRM) - is a competing digital terrestrial radio standard developed mainly by broadcasters as a higher spectral efficiency replacement for legacy AM and FM broadcasting. Mondiale means "worldwide" in French and German, and DRM, developed in 2001, is currently supported by 23 countries and has been adopted by some European and Eastern broadcasters beginning in 2003. The DRM30 mode uses the AM broadcast bands below 30 MHz and is intended as a replacement for AM and shortwave broadcasting, and the DRM+ mode uses VHF frequencies centered on the FM broadcast band and is intended as a replacement for FM broadcasting. It is incompatible with existing radio receivers and requires listeners to purchase a new DRM receiver. The modulation used is a form of OFDM called COFDM in which up to 4 carriers are transmitted in a channel formerly occupied by a single AM or FM signal, modulated by quadrature amplitude modulation (QAM). The DRM system is designed to be as compatible as possible with existing AM and FM radio transmitters, so much of the equipment in existing radio stations will not have to be replaced.
1) Satellite radio - a subscription radio service that broadcasts CD quality digital audio direct to subscribers' receivers using a microwave downlink signal from a

direct broadcast communication satellite in geostationary orbit 22,000 miles above the Earth. It is mostly intended for car radios in vehicles. Satellite radio uses the 2.3 GHz S band in North America, in other parts of the world, it uses the 1.4 GHz L band allocated for DAB.
2) Television broadcasting - the transmission of moving images by radio, which consist of sequences of still images, which are displayed on a screen on a television receiver (a "television" or TV) along with a synchronized audio (sound) channel. Television (video) signals occupy a wider bandwidth than broadcast radio (audio) signals. Analog television, the original television technology, required 6 MHz, so the television frequency bands are divided into 6 MHz channels, now called "RF channels". The current television standard, introduced beginning in 2006, is a digital format called HDTV (high definition television), which transmits pictures at higher resolution, typically 1080 pixels high by 1920 pixels wide, at a rate of 25 or 30 frames per second. Digital television (DTV) transmission systems, which replaced older analog television in a transition beginning in 2006, use image compression and high efficiency digital modulation such as OFDM and 8VSB to transmit HDTV video within a smaller bandwidth than the old analog channels, saving scarce radio spectrum space. Therefore each of the 6 MHz analog RF channels now carries up to 7 DTV channels - these are called "virtual channels". Digital television receivers have a different behavior in the presence of poor reception or noise than analog television, called the "digital cliff" effect. Unlike analog television, in which increasingly poor reception causes the picture quality to gradually degrade, in digital television picture quality is not affected by poor reception until, at a certain point, the receiver stops working and the screen goes black.Terrestrial television, over-the-air (OTA) television, or broadcast television - the oldest television technology, is the transmission of television signals from land-based television stations to television receivers (called televisions or TVs) in viewer's homes. Terrestrial television broadcasting uses the bands 41 - 88 MHz (VHF low band or Band I, carrying RF channels 1-6), 174 - 240 MHz, (VHF high band or Band III; carrying RF channels 7-13), and 470 - 614 MHz (UHF Band IV and Band V; carrying RF channels 14 and up). The exact frequency boundaries vary in different countries. Propagation is by line-of-sight, so reception is limited by the visual horizon to 3040 miles (4864 km). In the US effective radiated power (ERP) of television transmitters is limited to 35 kW in the VHF low band, 50 kW in the VHF high band, and 220 kW in UHF band; most TV stations operate below 75 percent of the limit. In most areas viewers use a simple "rabbit ears" dipole antenna on top of the TV, but viewers in fringe reception areas more than 15 miles from a station usually have to use an outdoor antenna mounted on the roof to get adequate reception.Satellite television - a set-top box which receives subscription direct-broadcast satellite television, and displays it on an ordinary television. A direct broadcast satellite in geostationary orbit 22,200 miles (35,700 km) above the Earth's equator transmits many channels (up to 900) modulated on a 12.2 to

12.7 GHz Ku band microwave downlink signal to a rooftop satellite dish antenna on the subscriber's residence. The microwave signal is converted to a lower intermediate frequency at the dish and conducted into the building by a coaxial cable to a set-top box connected to the subscriber's TV, where it is demodulated and displayed. The subscriber pays a monthly fee.

3) Standard time and frequency broadcasts - Governments operate long range radio time stations which continuously broadcast extremely accurate time signals produced by atomic clocks, as a reference to synchronize other clocks. Examples are BPC, DCF77, JJY, MSF, RTZ, TDF, WWV, and YVTO. One use is in radio clocks and watches, which include an automated receiver which periodically (usually weekly) receives and decodes the time signal and resets the watch's internal quartz clock to the correct time, thus allowing a small watch or desk clock to have the same accuracy as an atomic clock. Government time stations are declining in number because GPS satellites and the Internet Network Time Protocol (NTP) provide equally accurate time standards.

4) Radio jamming - Jamming is the deliberate radiation of radio signals designed to interfere with reception of other radio signals. Since radio waves can pass beyond national borders, some totalitarian countries use jamming to prevent their citizens from listening to broadcasts from radio stations in other countries. Jamming is usually accomplished by a powerful transmitter which generates noise on the same frequency as the target transmitter. During wartime, militaries use jamming to interfere with enemies' tactical radio communication.

Figure 11: Two way voice communication

Two way voice communication: A two-way radio is an audio transceiver, a receiver and transmitter in the same device, used for bidirectional person-to-person voice communication. An older term for this mode of communication is radiotelephony. The radio link may be half-duplex, as in a walkie-talkie, using a single radio channel in which only one radio can transmit at a time, so different users take turns talking, pressing a "push to talk" button on their radio which switches off the receiver and switches on the transmitter. Or the radio link may be full duplex, a bidirectional link using two radio channels so both people can talk at the same time, as in a cell phone.
1) Cell phone - a portable wireless telephone that is connected to the telephone network by radio signals exchanged with a local antenna at a cellular base station (cell tower).[7] The service area covered by the provider is divided into small geographical areas called "cells", each served by a separate base station antenna and multichannel transceiver. All the cell phones in a cell communicate with this antenna on separate frequency channels, assigned from a common pool of frequencies. The purpose of cellular organization is to conserve radio bandwidth by frequency reuse. Low power transmitters are used so the radio waves used in a cell do not travel far beyond the cell, allowing the same frequencies to be reused in geographically separated cells. When a user carrying a cellphone crosses from one cell to another, his phone is automatically "handed off" seamlessly to the new antenna and assigned new frequencies. Cellphones have a highly automated full duplex digital transceiver using OFDM modulation working in the UHF or microwave band using two digital radio channels, each carrying one direction of the

bidirectional conversation, as well as a control channel that handles dialing calls and "handing off" the phone to another cell tower. Existing 2G, 3G, and 4G networks use frequencies in the low microwave range, between 700 MHz and 3 GHz. The cell phone transmitter usually has two power levels which it switches between when needed: 0.6 W when near a cell tower, and 3 W when farther away, while cell tower channel transmitter power is 50 W. Current generation phones, called smartphones, have many functions besides making telephone calls, and therefore have several other radio transmitters and receivers that connect them with other networks: usually a WiFi modem, a Bluetooth modem, and a GPS receiver.
2) Satellite phone (satphone) - a portable wireless telephone similar to a cell phone, connected to the telephone network through a radio link to an orbiting communications satellite instead of through cell towers. They are more expensive than cell phones; but their advantage is that, unlike a cell phone which is limited to areas covered by cell towers, satphones can be used over most or all of the geographical area of the Earth. In order for the phone to communicate with a satellite using a small omnidirectional antenna, first generation systems use satellites in low earth orbit, about 400700 miles (6401,100 km) above the surface. With an orbital period of about 100 minutes a satellite can only be in view of a phone for about 7 minutes, so the call is "handed off" to another satellite when one passes beyond the local horizon. Therefore large numbers of satellites, about 66, are required to ensure that at least one satellite is in view continuously from each point on Earth. Other satphone systems use satellites in geostationary orbit in which only a few satellites are needed, but these cannot be used at high latitudes because of terrestrial interference.
3) Cordless phone- a landline telephone in which the handset is portable and communicates with the rest of the phone by a short range full duplex radio link, instead of being attached by a cord. Both the handset and the base station have low power FM radio transceivers operating in the UHF band that handle the short range bidirectional radio link.
4) Land mobile radio system - short range mobile or portable half-duplex radio transceivers operating in the VHF or UHF band that can be used without a license. They are often installed in vehicles, with the mobile units communicating with a dispatcher at a fixed base station. Special systems with reserved frequencies are used by first responder services; police, fire, ambulance, and emergency services and other government services. Other systems are made for use by commercial firms such as taxi and delivery services. VHF systems use channels in the range 3050 MHz and 150172 MHz. UHF systems use the 450470 MHz band and in some areas the 470512 MHz range. In general, VHF systems have longer range than UHF but require longer antennas. AM or FM modulation is mainly used, but digital systems such as DMR are being introduced. Radiated power is typically limited to 4 watts.[7] These systems have a fairly limited range, usually 3 to 20 miles (4.8 to 32 km) depending on terrain. Repeaters installed on tall buildings,

hills or mountain peaks are often used to increase the range, when it is desired to cover a larger area than line-of-sight. Examples of land mobile systems are CB, FRS, GMRS, and MURS. Modern digital systems, called trunked radio systems, have a digital channel management system using a control channel which automatically assigns frequency channels to user groups.
5) Walkie-talkie - a battery powered portable handheld half-duplex two-way radio, used in land mobile radio systems.
6) Airband - radio system used by aircraft pilots to talk to other aircraft and ground-based air traffic controllers. This vital system is the main communication channel for air traffic control. For most communication in overland flights in air corridors a VHF-AM system using channels between 108-137 MHz in the VHF band are used. This system has a typical transmission range of 200 miles (320 km) for aircraft flying at cruising altitude. For flights in more remote areas, such as transoceanic airline flights, aircraft use the HF band or channels on the Inmarsat or Iridium satphone satellites. Military aircraft also use a dedicated UHF-AM band from 225.0399.95 MHz.
7) Marine radio - medium range transceivers on ships, used for ship-to-ship, ship-to-air and ship-to-shore communication with harbormasters They use FM channels between 156 and 174 MHz in the VHF band with up to 25 watts power, giving them a range of about 60 miles (97 km). Some channels are half-duplex and some are full-duplex, to be compatible with the telephone network, to allow users to make telephone calls through a marine operator.
8) Amateur radio - long range half-duplex two way radio used by hobbyists for non-commercial purposes: recreational radio contacts with other amateurs, volunteer emergency communication during disasters, contests, and experimentation. Radio amateurs must hold an amateur radio license and are given a unique callsign that must be used as an identifier in transmissions. Amateur radio is restricted to small frequency bands, the amateur radio bands, spaced throughout the radio spectrum from 136 kHz to 2.4 GHz. Within these bands amateurs are allowed freedom to transmit on any frequency with a wide variety of modulation methods. In addition to radiotelephony, amateurs are the only radio operators still using obsolete Morse code radiotelegraphy.

One way voice communication: One way, unidirectional radio transmission is called simplex.
1) Baby monitor - this is a cribside appliance for mothers of infants that transmits the baby's sounds to a receiver carried by the mother, so she can monitor the baby while she is in other parts of the house. These transmit in FM on 49.300, 49.830, 49.845, 49.860, or 49.875 MHz with low power. Many baby monitors have duplex channels so the mother can talk to the baby, and video cameras to show a picture of the baby, this is called a baby cam.
2) Wireless microphone - a battery powered microphone with a short-range trans-

mitter which is handheld or worn on a person's body which transmits its sound by radio to a nearby receiver unit connected to a sound system. Wireless microphones are used by public speakers, performers, and television personalities so they can move freely without trailing a microphone cord. Analog models transmit in FM on Some models transmit on two frequency channels for diversity reception to prevent nulls from interrupting transmission as the performer moves around. Some models use digital modulation to prevent unauthorized reception by scanner radio receivers; these operate in the 900 MHz, 2.4 GHz or 6 GHz ISM bands.

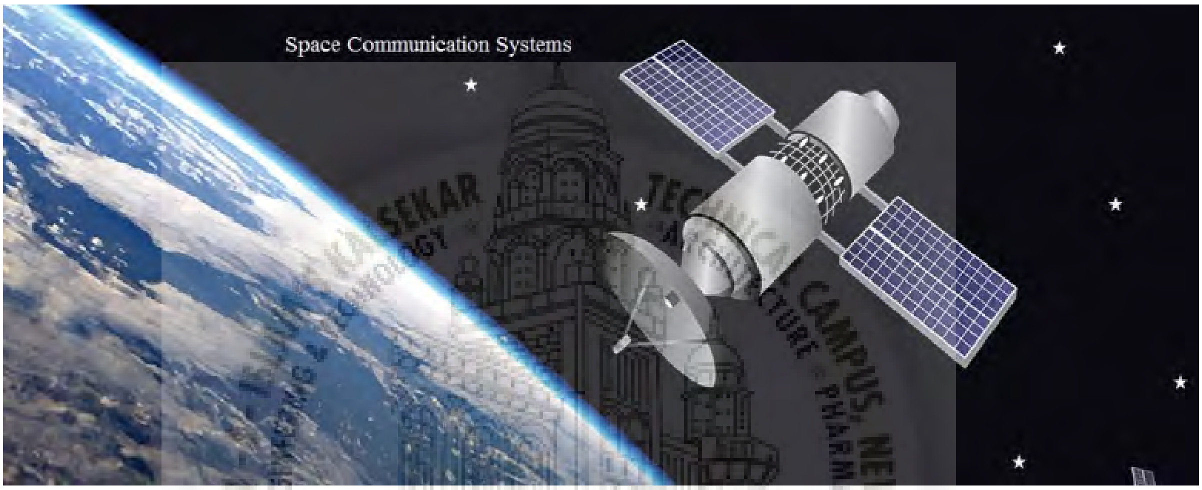

Figure 12: space communication

Space communication: This is radio communication between a spacecraft and an Earth-based ground station, or another spacecraft. Communication with spacecraft involves the longest transmission distances of any radio links, up to billions of kilometers for interplanetary spacecraft. In order to receive the weak signals from distant spacecraft, satellite ground stations use large parabolic "dish" antennas up to 25 metres (82 ft) in diameter and extremely sensitive receivers. High frequencies in the microwave band are used, since microwaves pass through the ionosphere without refraction, and at microwave frequencies the high gain antennas needed to focus the radio energy into a narrow beam pointed at the receiver are small and take up a minimum of space in a satellite. Portions of the UHF, L, C, S, ku and ka band are allocated for space communication. A radio link which transmits data from the Earth's surface to a spacecraft is called an uplink, while a link which transmits data from the spacecraft to the ground is called a downlink.
1) Communication satellite - an artificial satellite used as a telecommunications relay to transmit data between widely separated points on Earth. These are used

because the microwaves used for telecommunications travel by line of sight and so cannot propagate around the curve of the Earth. There are currently over 2000 communication satellites in orbit around the Earth. Most are in geostationary orbit 22,200 miles (35,700 km) above the equator, so that the satellite appears stationary at the same point in the sky, so the satellite dish antennas of ground stations can be aimed permanently at that spot and do not have to move to track it. In a satellite ground station a microwave transmitter and large satellite dish antenna transmits a microwave uplink beam to the satellite. The uplink signal carries many channels of telecommunications traffic, such as long distance telephone calls, television programs, and internet signals, using a technique called frequency-division multiplexing (FDM). On the satellite a transponder receives the signal, translates it to a different downlink frequency to avoid interfering with the uplink signal, and retransmits it down to another ground station, which may be widely separated from the first. There the downlink signal is demodulated and the telecommunications traffic it carries is sent to its local destinations through landlines. Communication satellites typically have several dozen transponders on different frequencies, which are leased by different users.
2) Direct broadcast satellite - a geostationary communication satellite that transmits retail programming directly to receivers in subscriber's homes and vehicles on Earth, in satellite radio and TV systems. It uses a higher transmitter power than other communication satellites, to allow the signal to be received by consumers with a small unobtrusive antenna. For example, satellite television uses downlink frequencies from 12.2 to 12.7 GHz in the ku band transmitted at 100 to 250 watts, which can be received by relatively small 4380 cm (1731 in) satellite dishes mounted on the outside of buildings.

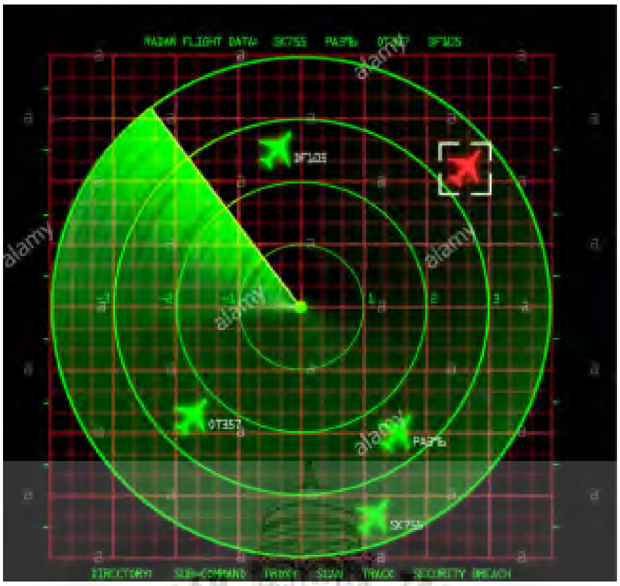

Figure 13: Radar

Radar: Radar is a radiolocation method used to locate and track aircraft, spacecraft, missiles, ships, vehicles, and also to map weather patterns and terrain. A radar set consists of a transmitter and receiver. The transmitter emits a narrow beam of radio waves which is swept around the surrounding space. When the beam strikes a target object, radio waves are reflected back to the receiver. The direction of the beam reveals the object's location. Since radio waves travel at a constant speed close to the speed of light, by measuring the brief time delay between the outgoing pulse and the received "echo", the range to the target can be calculated. The targets are often displayed graphically on a map display called a radar screen. Doppler radar can measure a moving object's velocity, by measuring the change in frequency of the return radio waves due to the Doppler effect. Radar sets mainly use high frequencies in the microwave bands, because these frequencies create strong reflections from objects the size of vehicles and can be focused into narrow beams with compact antennas. Parabolic (dish) antennas are widely used. In most radars the transmitting antenna also serves as the receiving antenna; this is called a monostatic radar. A radar which uses separate transmitting and receiving antennas is called a bistatic radar.

Remote control: Radio remote control is the use of electronic control signals sent by radio waves from a transmitter to control the actions of a device at a remote location. Remote control systems may also include telemetry channels in the other direction, used to transmit real-time information of the state of the device back to the control station. Unmanned spacecraft are an example of remote controlled

machines, controlled by commands transmitted by satellite ground stations. Most handheld remote controls used to control consumer electronics products like televisions or DVD players actually operate by infrared light rather than radio waves, so are not examples of radio remote control. A security concern with remote control systems is spoofing, in which an unauthorized person transmits an imitation of the control signal to take control of the device. Examples of radio remote control:
1) Unmanned aerial vehicle (UAV, drone) - A drone is an aircraft without an onboard pilot, flown by remote control by a pilot in another location, usually in a piloting station on the ground. They are used by the military for reconnaissance and ground attack, and more recently by the civilian world for news reporting and aerial photography. The pilot uses aircraft controls like a joystick or steering wheel, which create control signals which are transmitted to the drone by radio to control the flight surfaces and engine. A telemetry system transmits back a video image from a camera in the drone to allow the pilot to see where he is going, and data from a GPS receiver giving the real-time position of the aircraft.
2) Keyless entry system - a short-range handheld battery powered key fob transmitter, included with most modern cars, which can lock and unlock the doors of a vehicle from outside, eliminating the need to use a key. When a button is pressed, the transmitter sends a coded radio signal to a receiver in the vehicle, operating the locks. The fob must be close to the vehicle, typically within 5 to 20 meters. North America and Japan use a frequency of 315 MHz, while Europe uses 433.92 and 868 MHz. Some models can also remotely start the engine, to warm up the car. A security concern with all keyless entry systems is a replay attack, in which a thief uses a special receiver (”code grabber”) to record the radio signal during opening, which can later be replayed to open the door. To prevent this, keyless systems use a rolling code system in which a pseudorandom number generator in the remote control generates a different random key each time it is used. To prevent thieves from simulating the pseudorandom generator to calculate the next key, the radio signal is also encrypted.
3) Radio-controlled models - a popular hobby is playing with radio-controlled model boats, cars, airplanes, and helicopters (quadcopters) which are controlled by radio signals from a handheld console with a joystick. Most recent transmitters use the 2.4 GHz ISM band with multiple control channels modulated with PWM, PCM or FSK.
4) Wireless doorbell - A residential doorbell that uses wireless technology to eliminate the need to run wires through the building walls. It consists of a doorbell button beside the door containing a small battery powered transmitter. When the doorbell is pressed it sends a signal to a receiver inside the house with a speaker that sounds chimes to indicate someone is at the door. They usually use the 2.4 GHz ISM band. The frequency channel used can usually be changed by the owner in case another nearby doorbell is using the same channel.

Figure 14: Wlan

Data communications:
1) Wireless LAN (wireless local area network or WiFi) - based on the IEEE 802.11 standards, these are the most widely used computer networks, used to implement local area networks without cables, linking computers, laptops, cell phones, video game consoles, smart TVs and printers in a home or office together, and to a wireless router connecting them to the Internet with a wire or cable connection. Wireless routers in public places like libraries, hotels and coffee shops create wireless access points (hotspots) to allow the public to access the Internet with portable devices like smartphones, tablets or laptops. Each device exchanges data using a wireless modem (wireless network interface controller), an automated microwave transmitter and receiver with an omnidirectional antenna that works in the background, exchanging data packets with the router. WiFi uses channels in the 2.4 GHz and 5 GHz ISM bands with OFDM (orthogonal frequency division multiplexing) modulation to transmit data at high rates. The transmitters in Wifi modems are limited to a radiated power of 200 mW to 1 watt, depending on country. They have a maximum indoor range of about 150 ft (50 m) on 2.4 GHz and 50 ft (20 m) on 5 GHz.
2) Wireless WAN (wireless wide area network, WWAN) - a variety of technologies that provide wireless internet access over a wider area than Wifi networks do - from an office building, to a campus, to a neighborhood, to an entire city. The most common technologies used are: cellular modems, that exchange computer data by radio with cell towers; satellite internet access; and lower frequencies in

the UHF band, which have a longer range than WiFi frequencies. Since WWAN networks are much more expensive and complicated to administer than WiFi networks, their use so far has generally been limited to private networks operated by large corporations.

3) Bluetooth - a very short range wireless interface on a portable wireless device used as a substitute for a wire or cable connection, mainly to exchange files between portable devices and connect cellphones and music players with wireless headphones. The transmission power is limited to 1 milliwatt, giving it a very short range of up to 10 m (30 feet). The system uses frequency-hopping spread spectrum transmission, in which successive data packets are transmitted in a pseudorandom order on one of 79 1 MHz Bluetooth channels between 2.4-2.83 GHz in the ISM band. This allows Bluetooth networks to operate in the presence of noise, other wireless devices and other Bluetooth networks using the same frequencies, since the chance of another device attempting to transmit on the same frequency at the same time as the Bluetooth modem is low. In the case of such a "collision" the Bluetooth modem just retransmits the data packet on another frequency.

4) Packet radio - a long-distance peer-to-peer wireless ad-hoc network in which data packets are exchanged between computer controlled radio modems (transmitter/receivers) called nodes, which may be separated by miles, and may be mobile. Each node only communicates with neighboring nodes, so packets of data are passed from node to node until they reach their destination. Uses the X.25 network protocol. Packet radio systems are used to a limited degree by commercial telecommunications companies and by the amateur radio community.

5) Text messaging (texting) - this is a service on cell phones, allowing a user to type a short alphanumeric message and send it to another phone number, and the text is displayed on the recipient's phone screen. It is based on the Short Message Service (SMS) which transmits using spare bandwidth on the control radio channel used by cell phones to handle background functions like dialing and cell handoffs. Due to technical limitations of the channel, text messages are limited to 160 alphanumeric characters.

6) Microwave relay - a long distance high bandwidth point-to-point digital data transmission link consisting of a microwave transmitter connected to a dish antenna that transmits a beam of microwaves to another dish antenna and receiver. Since the antennas must be in line-of-sight, distances are limited by the visual horizon to 3040 miles (4864 km). Microwave links are used for private business data, wide area computer networks (WANs), and by telephone companies to transmit long distance phone calls and television signals between cities.

7) Telemetry - automated one-way (simplex) transmission of measurements and operation data from a remote process or device to a receiver for monitoring. Telemetry is used for in-flight monitoring of missiles, drones, satellites, and weather balloon radiosondes, sending scientific data back to Earth from interplanetary spacecraft, communicating with electronic biomedical devices implanted in the human

body, and well logging. Multiple channels of data are often transmitted using frequency division multiplexing or time division multiplexing.
8) Submarine communication - When submerged, submarines are cut off from all ordinary radio communication with their military command authorities by the conductive seawater. However radio waves of low enough frequencies, in the VLF (30 to 3 kHz) and ELF (below 3 kHz) bands are able to penetrate seawater. Navies operate large shore transmitting stations with power output in the megawatt range to transmit encrypted messages to their submarines in the world's oceans. Due to the small bandwidth, these systems cannot transmit voice, only text messages at a slow data rate. The communication channel is one-way, since the long antennas needed to transmit VLF or ELF waves cannot fit on a submarine. VLF transmitters use miles long wire antennas like umbrella antennas. A few nations use ELF transmitters operating around 80 Hz, which can communicate with submarines at lower depths. These use even larger antennas called ground dipoles, consisting of two ground (Earth) connections 2360 km (1437 mi) apart, linked by overhead transmission lines to a power plant transmitter.
9) Radio Frequency Identification(RFID) - identification tags containing a tiny radio transponder (receiver and transmitter) which are attached to merchandise. When it receives an interrogation pulse of radio waves from a nearby reader unit, the tag transmits back an ID number, which can be used to inventory goods. Passive tags, the most common type, have a chip powered by the radio energy received from the reader, rectified by a diode, and can be as small as a grain of rice. They are incorporated in products, clothes, railroad cars, library books, airline baggage tags and are implanted under the skin in pets and livestock (microchip implant) and even people. Privacy concerns have been addressed with tags that use encrypted signals and authenticate the reader before responding. Passive tags use 125-134 kHz, 13, 900 MHz and 2.4 and 5 GHz ISM bands and have a short range. Active tags, powered by a battery, are larger but can transmit a stronger signal, giving them a range of hundreds of meters.

1.3 Introduction to Radio-frequency Identification (RFID)

Figure 15: Rfid Introduction

Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source (such as a battery) and may operate hundreds of meters from the RFID reader. Unlike a barcode, the tag need not be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method of automatic identification and data capture (AIDC). RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; RFID-tagged pharmaceuticals can be tracked through warehouses; and implanting RFID microchips in livestock and pets enables positive identification of animals. Since RFID tags can be attached to cash, clothing, and possessions, or implanted in animals and people, the possibility of reading personally-linked information without consent has raised serious privacy concerns. These concerns resulted in standard specifications development addressing privacy and security issues. ISO/IEC 18000 and ISO/IEC 29167 use on-chip cryptography methods for untraceability, tag and reader authentication, and over-the-air privacy. ISO/IEC 20248 specifies a digital signature data structure for RFID and barcodes providing data, source and read method authenticity. This work is done within ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques. Tags can also be used in shops to expedite checkout, and to prevent theft by customers and employees. In 2014, the world RFID market was worth USD 8.89 billion, up from USD 7.77 billion in 2013 and USD 6.96 billion in 2012. This figure includes tags, readers, and software/services for RFID cards, labels, fobs, and all other form factors. The market value is expected to rise to USD 18.68 billion by 2026.

1.3.1 History

Figure 16: RFID History

In 1945, Lon Theremin invented a listening device for the Soviet Union which re-transmitted incident radio waves with the added audio information. Sound waves vibrated a diaphragm which slightly altered the shape of the resonator, which modulated the reflected radio frequency. Even though this device was a covert listening device, rather than an identification tag, it is considered to be a predecessor of RFID because it was passive, being energized and activated by waves from an outside source. Similar technology, such as the IFF transponder, was routinely used by the allies and Germany in World War II to identify aircraft as friend or foe. Transponders are still used by most powered aircraft. Another early work exploring RFID is the landmark 1948 paper by Harry Stockman, who predicted 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." Mario Cardullo's device, patented on January 23, 1973, was the first true ancestor of modern RFID, as it was a passive radio transponder with memory. The initial device was passive, powered by the interrogating signal, and was demonstrated in 1971 to the New York Port Authority and other potential users. It consisted of a transponder with 16 bit memory for use as a toll device. The basic Cardullo patent covers the use of RF, sound and light as transmission media. The original business plan presented to investors in 1969 showed uses in transportation (automotive vehicle identification, automatic toll system, electronic license plate, electronic manifest, vehicle routing, vehicle performance monitoring), banking (electronic checkbook, electronic credit card), security (personnel identification, automatic gates, surveillance) and medical (identification, patient history). An early demonstration of reflected power (modulated backscatter) RFID tags, both passive and semi-passive, was performed by Steven Depp, Alfred Koelle, and Robert Frayman at the Los Alamos National Laboratory in 1973. The portable system operated at 915 MHz and used 12-bit tags. This technique is used by the majority of today's UHFID and microwave RFID tags. The first patent to be associated with the abbreviation RFID was granted to Charles Walton in 1983.

1.3.2 Design

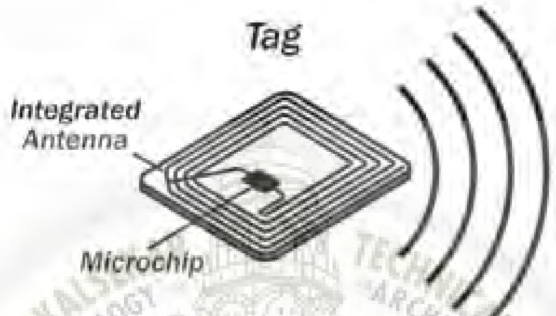

Figure 17: TAGS

Tags: A radio-frequency identification system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response. RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive (BAP) has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than for signal transmission. That makes a difference in interference and in exposure to radiation. Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user. RFID tags contain at least three parts: an integrated circuit that stores and processes information and that modulates and demodulates radio-frequency (RF) signals; a means of collecting DC power from the incident reader signal; and an antenna for receiving and transmitting the signal. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively. An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

Figure 18: reader

Readers: RFID systems can be classified by the type of tag and reader. A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 12,000 feet (0600 m)[citation needed], allowing flexibility in applications such as asset protection and supervision. An Active Reader Passive Tag (ARPT) system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags. An Active Reader Active Tag (ARAT) system uses active tags awoken with an interrogator signal from the active reader. A variation of this system could also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal. Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles.

Signaling: Signaling between the reader and the tag is done in several different incompatible ways, depending on the frequency band used by the tag. Tags operating on LF and HF bands are, in terms of radio wavelength, very close to the reader antenna because they are only a small percentage of a wavelength away. In this near field region, the tag is closely coupled electrically with the transmitter in the reader. The tag can modulate the field produced by the reader by changing the electrical loading the tag represents. By switching between lower and higher relative loads, the tag produces a change that the reader can detect. At UHF and higher frequencies, the tag is more than one radio wavelength away from the reader, requiring a different approach. The tag can backscatter a signal. Active tags may contain functionally separated transmitters and receivers, and the tag need not respond on a frequency related to the reader's interrogation signal. An Electronic Product Code (EPC) is one common type of data stored in a tag. When written into the tag by an RFID printer, the tag contains a 96-bit string of data. The first eight bits are a header which identifies the version of the protocol. The next 28 bits identify the organization that manages the data for this tag; the organization number is assigned by the EPCGlobal consortium. The next 24 bits are an object class, identifying the kind of product; the last 36 bits are a unique serial number for a particular tag. These last two fields are set by the organization that issued the tag. Rather like a URL, the total electronic product code number can be used as a key into a global database to uniquely identify a particular product. Often more than one tag will respond to a tag reader, for example, many individual products with tags may be shipped in a common box or on a common pallet. Collision detection is important to allow reading of data. Two different types of protocols are used to "singulate" a particular tag, allowing its data to be read in the midst of many similar tags. In a slotted Aloha system, the reader broadcasts an initialization command and a parameter that the tags individually use to pseudo-randomly delay their responses. When using an "adaptive binary tree" protocol, the reader sends an initialization symbol and then transmits one bit of ID data at a time; only tags with matching bits respond, and eventually only one tag matches the complete ID string.

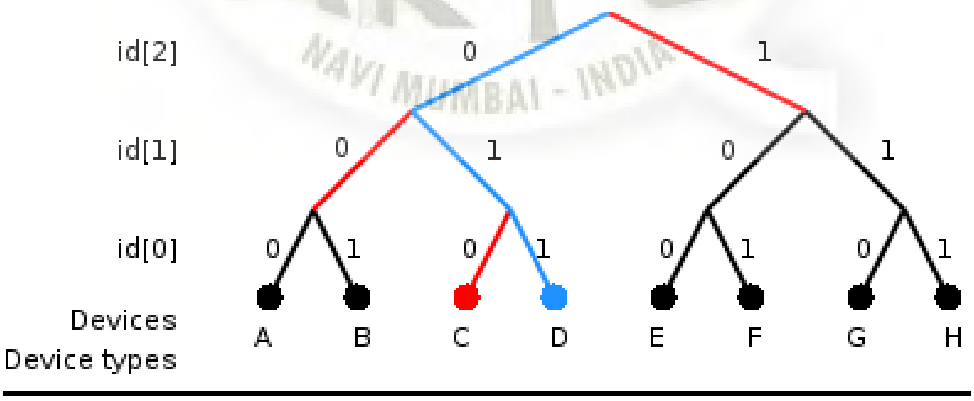

Figure 19: Bulk reading

Bulk reading: "Bulk reading" is a strategy for interrogating multiple tags at the same time, but lacks sufficient precision for inventory control. A group of objects, all of them RFID tagged, are read completely from one single reader position at one time. Bulk reading is a possible use of HF (ISO 18000-3), UHF (ISO 18000-6) and SHF (ISO 18000-4) RFID tags. However, as tags respond strictly sequentially, the time needed for bulk reading grows linearly with the number of labels to be read. This means it takes at least twice as long to read twice as many labels. Due to collision effects, the time required is greater. A group of tags has to be illuminated by the interrogating signal just like a single tag. This is not a challenge concerning energy, but with respect to visibility; if any of the tags are shielded by other tags, they might not be sufficiently illuminated to return a sufficient response. The response conditions for inductively coupled HF RFID tags and coil antennas in magnetic fields appear better than for UHF or SHF dipole fields, but then distance limits apply and may prevent success. Under operational conditions, bulk reading is not reliable. Bulk reading can be a rough guide for logistics decisions, but due to a high proportion of reading failures, it is not (yet) suitable for inventory management. However, when a single RFID tag might be seen as not guaranteeing a proper read, a bunch of RFID tags, where at least one will respond, may be a safer approach for detecting a known grouping of objects. In this respect, bulk reading is a fuzzy method for process support. From the perspective of cost and effect, bulk reading is not reported as an economical approach to secure process control in logistics

Miniaturization: RFIDs are easy to conceal or incorporate in other items. For example, in 2009 researchers at Bristol University successfully glued RFID micro-transponders to live ants in order to study their behavior. This trend towards increasingly miniaturized RFIDs is likely to continue as technology advances. Hitachi holds the record for the smallest RFID chip, at 0.05 mm 0.05 mm. This is 1/64th the size of the previous record holder, the mu-chip. Manufacture is enabled by using the silicon-on-insulator (SOI) process. These dust-sized chips can store 38-digit numbers using 128-bit Read Only Memory (ROM). A major challenge is the attachment of antennas, thus limiting read range to only millimeters.

1.3.3 Uses

The RFID tag can be affixed to an object and used to track and manage inventory, assets, people, etc. For example, it can be affixed to cars, computer equipment, books, mobile phones, etc. RFID offers advantages over manual systems or use of bar codes. The tag can be read if passed near a reader, even if it is covered by the object or not visible. The tag can be read inside a case, carton, box or other container, and unlike barcodes, RFID tags can be read hundreds at a time. Bar codes can only be read one at a time using current devices. In 2011, the

cost of passive tags started at USD 0.09 each; special tags, meant to be mounted on metal or withstand gamma sterilization, can go up to USD 5. Active tags for tracking containers, medical assets, or monitoring environmental conditions in data centers start at USD 50 and can go up over USD 100 each. Battery-Assisted Passive (BAP) tags are in the USD 310 range and also have sensor capability like temperature and humidity. RFID can be used in a variety of applications, such as:
Access management
Tracking of goods
Tracking of persons and animals
Toll collection and contactless payment
Machine readable travel documents
Smartdust (for massively distributed sensor networks)
Airport baggage tracking logistics
Timing sporting events
Tracking and billing processes
In 2010 three factors drove a significant increase in RFID usage: decreased cost of equipment and tags, increased performance to a reliability of 99.9 percent and a stable international standard around UHF passive RFID. The adoption of these standards were driven by EPCglobal, a joint venture between GS1 and GS1 US, which were responsible for driving global adoption of the barcode in the 1970s and 1980s. The EPCglobal Network was developed by the Auto-ID Center.

Figure 20: Commerce/Retail

1) Commerce/Retail: RFID provides a way for organizations to identify and manage stock, tools and equipment (asset tracking), etc. without manual data entry. Manufactured products such as automobiles or garments can be tracked through the factory and through shipping to the customer. Automatic identifica-

tion with RFID can be used for inventory systems. Many organisations require that their vendors place RFID tags on all shipments to improve supply chain management. RFID is used for item level tagging in retail stores. In addition to inventory control, this provides both protection against theft by customers (shoplifting) and employees ("shrinkage") by using electronic article surveillance (EAS), and a self checkout process for customers. Tags of different type can be physically removed with a special tool or deactivated electronically once items have been paid for. On leaving the shop customers have to pass near an RFID detector; if they have items with active RFID tags, an alarm sounds, both indicating an unpaid-for item, and identifying what it is.

2) Access control: RFID tags are widely used in identification badges, replacing earlier magnetic stripe cards. These badges need only be held within a certain distance of the reader to authenticate the holder. Tags can also be placed on vehicles, which can be read at a distance, to allow entrance to controlled areas without having to stop the vehicle and present a card or enter an access code.

3) Advertising: n 2010 Vail Resorts began using UHF Passive RFID tags in ski passes. Facebook is using RFID cards at most of their live events to allow guests to automatically capture and post photos. The automotive brands have adopted RFID for social media product placement more quickly than other industries. Mercedes was an early adopter in 2011 at the PGA Golf Championships, and by the 2013 Geneva Motor Show many of the larger brands were using RFID for social media marketing.

4) Transportation and logistics: Yard management, shipping and freight and distribution centers use RFID tracking. In the railroad industry, RFID tags mounted on locomotives and rolling stock identify the owner, identification number and type of equipment and its characteristics. This can be used with a database to identify the lading, origin, destination, etc. of the commodities being carried. In commercial aviation, RFID is used to support maintenance on commercial aircraft. RFID tags are used to identify baggage and cargo at several airports and airlines. Some countries are using RFID for vehicle registration and enforcement. RFID can help detect and retrieve stolen cars. RFID E-ZPass reader attached to the pole and mast arm (right) used in traffic monitoring in New York City RFID is used in intelligent transportation systems. In New York City, RFID readers are deployed at intersections to track E-ZPass tags as a means for monitoring the traffic flow. The data are fed through the broadband wireless infrastructure to the traffic management center to be used in adaptive traffic control of the traffic lights.

5) Hose stations and conveyance of fluids: The RFID antenna in a permanently installed coupling half (fixed part) unmistakably identifies the RFID transpon-

der placed in the other coupling half (free part) after completed coupling. When connected the transponder of the free part transmits all important information contactless to the fixed part. The coupling's location can be clearly identified by the RFID transponder coding. The control is enabled to automatically start subsequent process steps.

6) Infrastructure management and protection: At least one company has introduced RFID to identify and locate underground infrastructure assets such as gas pipelines, sewer lines, electrical cables, communication cables, etc.

7) Passports: The first RFID passports ("E-passport") were issued by Malaysia in 1998. In addition to information also contained on the visual data page of the passport, Malaysian e-passports record the travel history (time, date, and place) of entries and exits from the country. Other countries that insert RFID in passports include Norway (2005),[39] Japan (March 1, 2006), most EU countries (around 2006), Australia, Hong Kong, the United States (2007), India (June 2008), Serbia (July 2008), Republic of Korea (August 2008), Taiwan (December 2008), Albania (January 2009), The Philippines (August 2009), Republic of Macedonia (2010), Canada (2013) and Israel (2017). Standards for RFID passports are determined by the International Civil Aviation Organization (ICAO), and are contained in ICAO Document 9303, Part 1, Volumes 1 and 2 (6th edition, 2006). ICAO refers to the ISO/IEC 14443 RFID chips in e-passports as "contactless integrated circuits". ICAO standards provide for e-passports to be identifiable by a standard e-passport logo on the front cover.

8) Transportation payments: In many countries, RFID tags can be used to pay for mass transit fares on bus, trains, or subways, or to collect tolls on highways. Some bike lockers are operated with RFID cards assigned to individual users. A prepaid card is required to open or enter a facility or locker and is used to track and charge based on how long the bike is parked. The Zipcar car-sharing service uses RFID cards for locking and unlocking cars and for member identification. In Singapore, RFID replaces paper Season Parking Ticket (SPT).

9) Animal identification: RFID tags for animals represent one of the oldest uses of RFID. 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 RFID tag or transponder can also be used for animal identification. The transponders are better known as PIT (Passive Integrated Transponder) tags, passive RFID, or "chips" on animals. The Canadian Cattle Identification Agency began using RFID tags as a replacement for barcode tags. Currently CCIA tags are used in Wisconsin and by United States farmers on a voluntary basis. The USDA is currently developing its own program. RFID tags are required for all

cattle sold in Australia and in some states, sheep and goats as well.

10) Human implantation: Biocompatible microchip implants that utilize RFID technology are being routinely implanted in humans. The first reported experiment with RFID implants was conducted by British professor of cybernetics Kevin Warwick who had an RFID chip implanted in his arm by his general practitioner George Boulos in 1998. In 2004 the 'Baja Beach Clubs' operated by Conrad Chase in Barcelona[49] and Rotterdam offered implanted chips to identify their VIP customers, who could in turn use it to pay for service. In 2009 British scientist Mark Gasson had an advanced glass capsule RFID device surgically implanted into his left hand and subsequently demonstrated how a computer virus could wirelessly infect his implant and then be transmitted on to other systems. The Food and Drug Administration in the United States approved the use of RFID chips in humans in 2004. There is controversy regarding human applications of implantable RFID technology including concerns that individuals could potentially be tracked by carrying an identifier unique to them. Privacy advocates have protested against implantable RFID chips, warning of potential abuse. Some are concerned this could lead to abuse by an authoritarian government, to removal of freedoms, and to the emergence of an "ultimate panopticon", a society where all citizens behave in a socially accepted manner because others might be watching. On July 22, 2006, Reuters reported that two hackers, Newitz and Westhues, at a conference in New York City demonstrated that they could clone the RFID signal from a human implanted RFID chip, indicating that the device was not as secure as was previously claimed.

Chapter 2

2 Literature Review

2.1 A brief survey on current RFID applications

Tejal Deshpande, Nitin Ahire

Proc. International Conference on Machine Learning and Cybernatics, Baoding, July 12-15, 2009, pp. 2330-2334.

Radio Frequency Identification (RFID) is the next generation wireless communication technology applicable to a wide range of application areas. There are an increasing number of retailers, banks, traffic managements, exhibitions and logistic providers practicing this new technology to their products and services. RFID technology has a lot of advantages, such as simultaneous collection of large quantities of data with high accuracy, contactless, etc. RFID technology has an increasing influence to our lives and gradually replaces barcode in supermarket and logistic management. Most of current RFID applications are for access control and goods location tracking. In fact, RFID provides the function of individual goods identification and online changeable data storage. We should make a better utility to these additional functions. Therefore, we expect that the next generation of RFID applications should incorporate intelligent. Intelligent RFID applications could bring in new research and commercial opportunities. Moreover, it helps to further reduce costs, enhance customer services and could provide insight for updating business models. With the growing maturity of RFID technology and the drop in price of RFID tags, RFID attracts increasing interests from both industry and academic. By attaching RFID tags on objects, one could keep track on and manage those objects. This technology gradually replaces current widely adopted barcode systems.

2.2 Design of spot ticket management system based on RFID

B. Yan and D. Y. Lee
International Conference on Networks Security, Wireless Communications and Trusted Computing, 2009, pp. 496-499.

Making use of advanced RFID technology, the paper proposes a comprehensive and functional solution for sight spots in areas of design of electronic tickets, RFID data integration, hardware architecture, software design, process control, data encryption.This paper applies RFID technology to a sight spot ticket management system, and proposes a comple solution including design of electronic tickets, RFID data integration, hardware architecture, software design, data process and data security, to achieve the authentication of a large number of people, and enhance the efficiency of ticket checking. In addition, many detail technologies and arrangement related to this system are needed to be further researched. RFID has many technical advantages, including unique identification, identification from a distance, reading multi-tags at the same time, writing new data into tags and perfect anti-counterfeiting. Using RFID technology in ticket management, we can effectively put an end to economic loss, save operating costs, improve efficiency, and realize security management. Compared with traditional ticket, e-ticket can be recognized without artificial validation. RFID ticket also has a greater amount of information of the holder. Only the legitimate holders are to enter the sight spot. Because each chip has the only UID, it can not be modified or copied. Algorithm can be used to achieve information security management. So e-ticket is more privacy, more security, and effectively solves the ticket-detected problems and stops the appearance of counterfeit ticket.

2.3 Implementation of RFID technology in parking lot access control system

S. Stankovski, and M. Lazarevic

Annual RFID Eurasia Conference, 2007, pp. 1-5.

Parking plays an important role in the traffic system since all vehicles require a storage location when they are not being used to transport passengers. Whether it is a parking lot or on-street parking there is a problem of parking revenue convenience. Implementation of the RFID technology could be a good solution for this problem. Whether it is a parking lot or on-street parking there is a problem of parking revenue convenience. Implementation of the RFID technology could be a good solution for this problem. Implementation of the RFID technology, in an existing parking lot access control system, has given benefits to all interest parts (the Parking Operator, parking place users and parking collectors). Parking Operator has gain robust system, easy to operate, easy for maintenance, with the reliable RFID tag-ticket check for the prevention of malversation. Also, RFID reader is placed in a way that it doesn't violate exterior. Till now collection of the parking service tariff has been increased for 1700. People using parking place are spending much less time in waiting in line to buy the tickets for the on-street parking and much less time waiting at the entry and exit barriers of a parking lot or garage. Parking collectors that are working at parking lots and garages are much less involved in collecting tariff. They are only active when dealing with parking place users who don't have correct RFID tag-ticket and, of course, when they have to charge for the parking place users who don't have RFID tag-ticket.Future research will be directed towards the designing a parking system so that a parking place user will be able just to drive thru and enter/exit parking lot or garage. Also we will try to automate the in and out privileges of the subscriber and then transfer this data to the enterprise software for the traffic analysis that will allow optimization of the human resources needed for traffic flow in and out. For customer payment, the RFID tag could be read to debit a pre-pay system or charge the parking services against a credit card. All of this will facilitate customers entering and leaving and this improves service levels and increases capacity in the parking lot. These benefits will drive higher revenues.

2.4 RFID based monitoring and access control system

F. Lourenco and C. Almeida
INFORUM, 2009.

Nowadays, an access monitoring system becomes a popular topic and research field. Access control systems using Zigbee are developed for many applications such as industrial and commercial, consumer electronics, home automation, and HVAClighting closures. These systems use wireless technologies to transmit vital signs for access. This paper describes the wireless sensor network based on ZigBee technology and is mainly used for that clients are authorized or not at each senor node. Wireless sensor networks application for access control system has many technologies e.g., Bluetooth and Wi-Fi modules etc. Wi-Fi is available for wider range than Zigbee but it is more expensive than ZigBee. And even though Bluetooth is better than ZigBee for transmission rate, but ZigBee has lower power consumption. Hence, ZigBee is generally used for 24 hours monitor of communication transmission systems. Compared to Bluetooth, ZigBee provides a larger number of nodes, and a better transmission range with low power consumption. Large number of nodes enables the expansion of such kinds of system. Recently, ZigBee-based wireless networks were tested in various applications. In this paper, the system is a wireless monitoring and access control system, which is used at the Parliamentary Campus. This system is based upon wireless Zigbee technology IEEE 802.15.4 providing low cost effective solution.Here the cooperative communication also plays animportant role to make sure that Zigbee nodes are always in the range of ZigbeeCoordinator. Thesystem is convenient and efficient innature andthus increases interaction between sensor nodes at each building and coordinator at the Control Room. This system will widely be used in Campus as point-to-multipoint network. This Zigbee supports 255 nodes in a single network. The database can be stored more than two sensor nodes data in GUI. For further extend, the Zigbee can connect more than 2 nodes in the same network. Moreover, gateway module is needed to interconnect for different network. Adding more sensing device will get a lot of benefit either to the security system. Therefore, the access control monitoring system will be more convenient in Parliamentary Campus.

Chapter 3

3 Our Project

3.1 Statement of Project

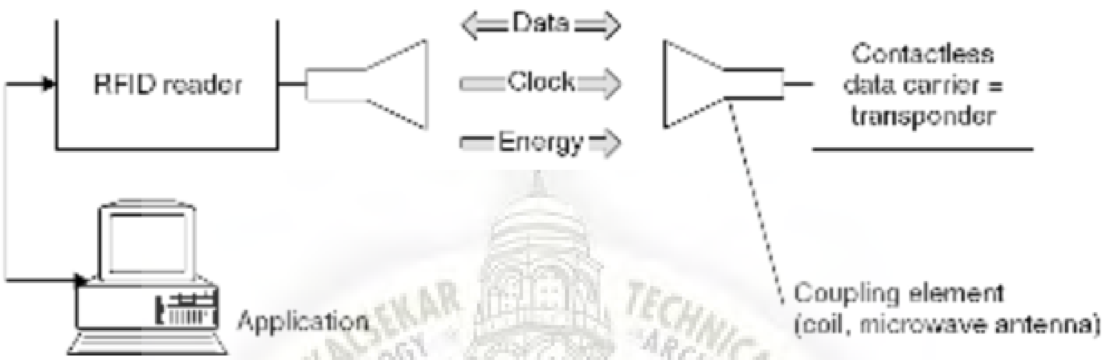

Figure 21: statement

RFID technology is getting very popular, it is used in many areas such as public transport, ticketing, animal identification, electronic immobilisation, industrial automation, access control and many more. The increase in the number of vehicles in India in recent years has led to the congestions and traffic jams in almost all cities of India. The dispensing of the fuel to this huge number of vehicles at the fuel stations has caused many complication in India. The vehicle driver has to pay for fuel with cash money and may have to pay more than the amount of dispensed fuel due to the lack of small money change available with station operator. RFID Based Automated Petrol Pump, is to reduce human work and develop an auto-guided mechanism and to implement the task sequentially by using RFID technology. These systems are highly reliable and less time-consuming devices. The components used in this project are 8051 Microcontroller, RFID tags, Power supply, an LCD display, a Motor driver and an RFID reader. Petroleum products are one of the valuable and rare creations of the nature. The proper use and distribution is an important task to survive these products [1]. A fuel station is a facility which sells fuel and lubricants via fuel dispensers or otherwise called browers which themselves are used to pump gasoline, Diesel, kerosene, etc. into vehicles and to calculate the financial cost of the product thus dispensed [1]. Enterprises engaged in urban and suburban public transport as well as other transport enterprises big fuel consumers, need control of fuel delivery to prevent or at least minimize the misuse of the fuel [2]. The emergency of radio frequency technology has changed the traditional methods of data collection. Compared to the traditional bar code, magnetic card and IC cards, RFID tags have the features of non-contact, reading speed, no wear, long life, user friendly and the security function [7]. The use of RFID for vehicle identification, toll collection, traffic management have already been experimented with extensively [8]. This paper proposes the implementation of RFID technology in controlling fuel dispensing for an Indian cities.

3.2 Project Architecture

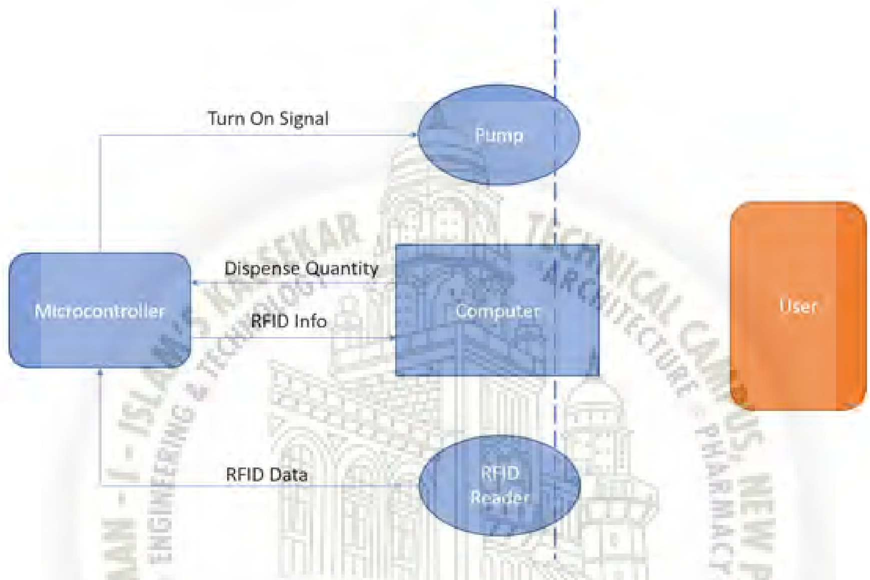

Figure 22: Architecture

RFID system consists of three components namely transponder (tag), interrogator (reader) and computer containing the database, as shown in Fig. 5. The interrogator reads the tag data and transmits it to the computer for authentication. The information is processed and upon verification, access is granted. The system offers diverse frequency band ranging from low frequencies to microwave frequencies [5]:

Low Frequency: 125-134 KHz
High Frequency: 13.56 MHz
Ultra High Frequency: 902-928 MHz
Microwave Frequency: 2.4 GHz

Depending upon the source of electrical energy, RFID tags are classified as either active or passive. The active tags use a battery for powering the circuit on the tag and transmit the tag information upon the reader request. However, these tags are very expensive and seldom used. On the other hands, passive tags get energy from the reader to power their circuit. These tags are very cost-effective and hence most of the applications use them.

Chapter 4

4 Technical Details

4.1 Methodology

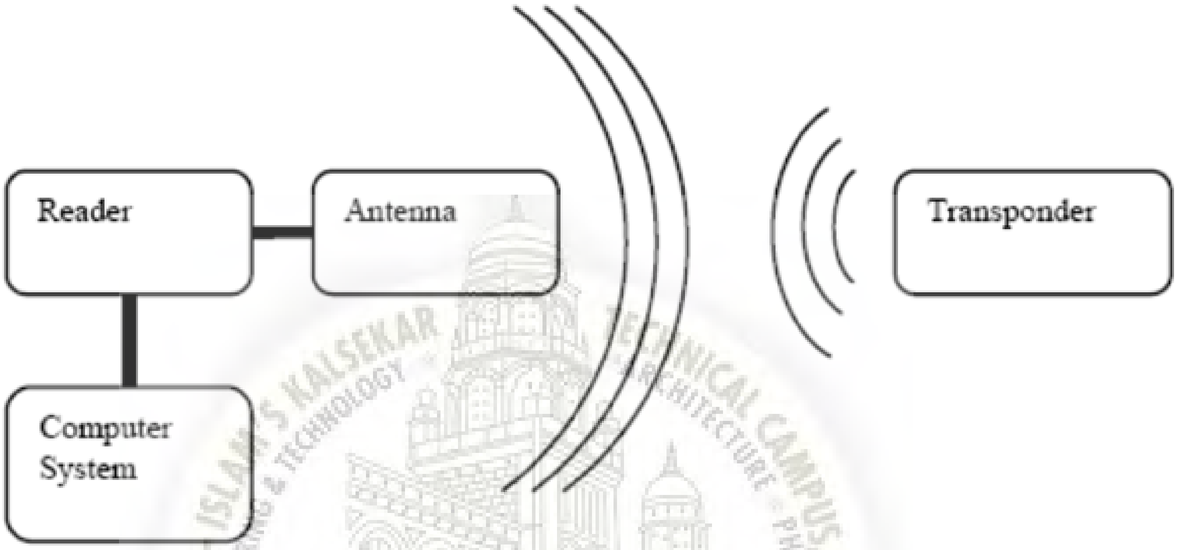

Figure 23: methodology

In the present work, passive RFID tags have been used. A passive RFID tag transmits information to the reader when it comes in the vicinity of electromagnetic field generated by the reader. The phenomenon is based on Faradays law of electromagnetic induction. The current flowing through the coil of interrogator produces a magnetic field which links to the transponder coil thereby producing a current in the transponder coil. The transponder coil then varies this current by changing the load on its antenna. This variation is actually the modulated signal (scheme is known as load modulation) which is received by the interrogator coil through mutual induction between the coils. The interrogator coil decodes this signal and passes to the computer for further processing.

4.2 Project Requirements

To best implement the proposed system, there are a lot of options regarding the different technologies that can be used to obtain the desired result. In this research we opt for the most stable and easily implementable approach for our system which has the following apparatus:

4.2.1 Hardware Requirements

Following are the components required in this solar power system:

Figure 24: RFID Reader Module, EM-18

RFID Reader Module, EM-18: EM-18 RFID reader module uses a RFID reader that can read 125 KHz tags. So, it can be called as a low frequency RFID reader. It gives out a serial output and has a range of about 8-12 cm. There is a built-in antenna and it can be connected to the PC with the help of RS232.The EM-18 RFID Reader module operating at 125kHz is an inexpensive solution for your RFID based application. The Reader module comes with an on-chip antenna and can be powered up with a 5V power supply. Power up the module and connect the transmit pin of the module to recieve pin of your microcontroller. Show your card within the reading distance and the card number is thrown at the output. Optionally the module can be configured for also a weigand output.

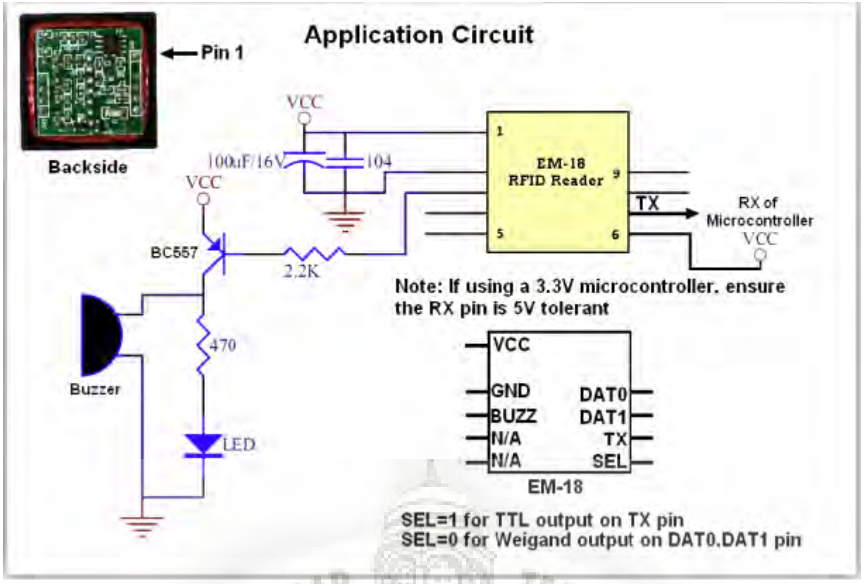

Figure 25: EM-18 application Circuit

Figure 26: RFID Tag

RFID Tag: RFID tags are a type of tracking system that uses smart barcodes in order to identify items. RFID is short for radio frequency identification, and as such, RFID tags utilize radio frequency technology. These radio waves transmit data from the tag to a reader, which then transmits the information to an

RFID computer program. RFID tags are frequently used for merchandise, but they can also be used to track vehicles, pets, and even patients with Alzheimers disease. An RFID tag may also be called an RFID chip. An RFID tag works by transmitting and receiving information via an antenna and a microchip also sometimes called an integrated circuit or IC. The microchip on an RFID reader is written with whatever information the user wants. There are two main types of RFID tags: battery-operated and passive. As the name suggests, battery-operated RFID tags contain an onboard battery as a power supply, whereas a passive RFID tag does not, instead working by using electromagnetic energy transmitted from an RFID reader. Battery-operated RFID tags might also be called active RFID tags. Passive RFID tags use three main frequencies to transmit information: 125 134 KHz, also known as Low Frequency (LF), 13.56 MHz, also known as High Frequency (HF) and Near-Field Communication (NFC), and 865 960 MHz, also known as Ultra High Frequency (UHF). The frequency used affects the tags range. When a passive RFID tag is scanned by a reader, the reader transmits energy to the tag which powers it enough for the chip and antenna to relay information back to the reader. The reader then transmits this information back to an RFID computer program for interpretation. There are two main types of passive RFID tags: inlays and hard tags. Inlays are typically quite thin and can be stuck on various materials, whereas hard tags are just as the name suggests, made of a hard, durable material such as plastic or metal. Active RFID tags use one of two main frequencies either 433 MHz or 915 MHz to transmit information. They contain three main parts, including a tag, antenna, and interrogator. The battery in an active RFID tag should supply enough power to last for 3-5 years. When it dies, the unit will need replaced, as the batteries are not currently replaceable. There are two main kinds of active RFID tags: beacons and transponders. Beacons send out an information ping every few seconds, and their signal is readable from several hundreds of feet away. Because they are sending out data so frequently, their battery tends to deplete quicker. Like passive RFID tags, transponders require the use of a reader to transmit information. When within range of one another, a reader first sends out a signal to the transponder, which then pings back with the relevant information. Because they only activate when near a reader, transponders are much more battery-efficient than beacons.

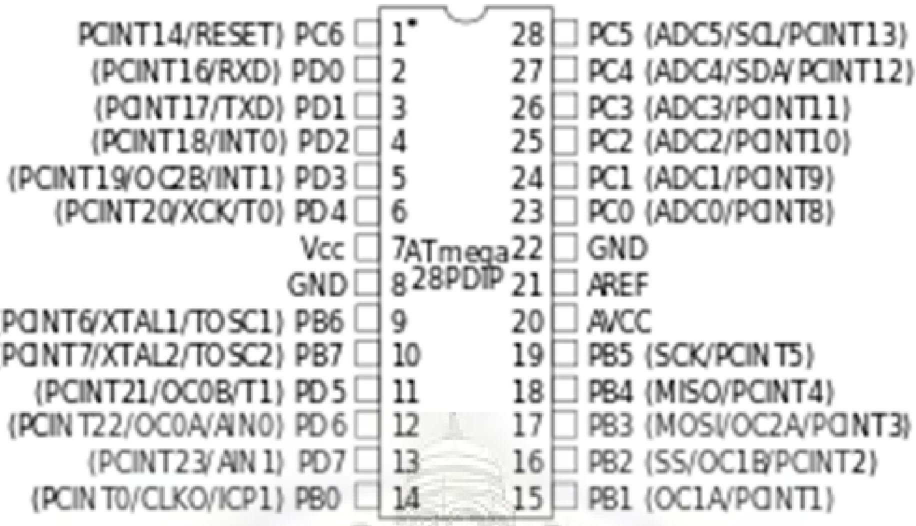

Figure 27: atm

Atmega 328: The ATmega328 is a single-chip microcontroller created by Atmel in the megaAVR family. The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.[1]. As of 2013 the ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed[citation needed]. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno and Arduino Nano models. Reliability qualification shows that the projected data retention failure rate is much less than 1 PPM over 20 years at 85 C or 100 years at 25 C.[4].

Figure 28: arduino

ARDUINO: Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

4.2.2 Software Requirements

Arduino IDE : An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of a source code editor, build automation tools, and a debugger. Most modern IDEs have intelligent code completion. Some IDEs, such as NetBeans and Eclipse, contain a compiler, interpreter, or both; others, such as SharpDevelop and Lazarus, do not. The boundary between an integrated development environment and other parts of the broader software development environment is not well-defined. Sometimes a version control system, or various tools to simplify the construction of a Graphical User Interface (GUI), are integrated. Many modern IDEs also have a class browser, an object browser, and a class hierarchy diagram, for use in object-oriented software development.

Figure 29: ide

Figure 30: Python

PYTHON (programming language) : Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. Van Rossum led the language community until stepping down as leader in July 2018. Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural. It also has a comprehensive standard library. Python interpreters are available for many operating systems. CPython, the reference implementation of Python, is open source software and has a community-based development model, as do nearly all of Python's other implementations. Python and CPython are managed by the non-profit Python Software Foundation.

PySimpleGUI: PySimpleGUI is a wrapper to the Tkinter Python API that allows the programmer to utilize all the same UI elements as with Tkinter but with a more intuitive interface. PySimpleGUI was established in an effort to create a more user-friendly Python GUI development process. PySimpleGUI combines the most effective elements of packages like EasyGUI and WxSimpleGUI, and adds the ability to define custom layouts. Launched in July, 2018, PySimpleGUI sought a solution to streamline the Python GUI development efforts and move users from the command line to a windowed / GUI experience. The PySimpleGUI package is focused on the developer, allowing them to create a custom GUI with as concise code as possible. The PySimpleGUI functions can be split into High Level calls that enable the caller to perform input/output operations in a single function call, and Custom GUI capabilities. The high-level calls usually start with Popup. The most basic of these is Popup which displays a variable number of items in a pop-up window. They resemble the built-in print statement, taking any number of variables in any format and displaying them in a window. The Popup calls that gather user input include PopupGetText, PopupGetFile and PopupGetFolder. Custom GUIs are achieved by first creating a GUI layout that is used to create and display a Window. The GUI layout is composed of Elements, PySimpleGUIs term for a GUI Widget. Simplifying and compacting the code can be achieved by leveraging two of PySimpleGUIs shortcuts. Element names can be written in a short-form format. It reduces the amount of text in the code without losing meaning.

PySerial: PySerial is a library which provides support for serial connections ("RS-232") over a variety of different devices: old-style serial ports, Bluetooth dongles, infra-red ports, and so on. It also supports remote serial ports via RFC 2217 (since V2.5). This module encapsulates the access for the serial port. It provides backends for Python running on Windows, OSX, Linux, BSD (possibly any POSIX compliant system) and IronPython. The module named serial automatically selects the appropriate backend.
Same class based interface on all supported platforms.

Access to the port settings through Python properties.
Support for different byte sizes, stop bits, parity and flow control with RTS/CTS and/or Xon/Xoff.
Working with or without receive timeout.
File like API with read and write (readline etc. also supported).
The files in this package are 100 percent pure Python.
The port is set up for binary transmission. No NULL byte stripping, CR-LF translation etc. (which are many times enabled for POSIX.) This makes this module universally useful.
Compatible with io library
RFC 2217 client (experimental), server provided in the examples.

Chapter 5

5 Implementation

5.1 Hardware Implementation

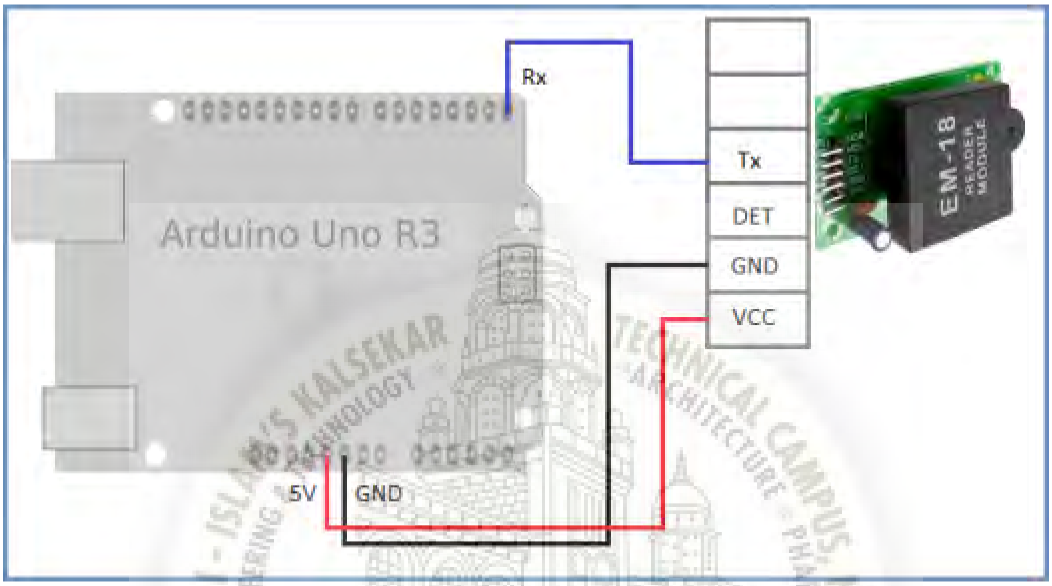

Figure 31: Interfacing Arduino and EM18

5.2 Software Implementation

5.2.1 Arduino Code

```
// RFID Settings
#include <SoftwareSerial.h>
int pinUnused = 12;
int pinRfidSerialIn = 10;
int baudRateRfid = 9600;
SoftwareSerial rfidSerial(pinRfidSerialIn, pinUnused);


// These are used for serial communication
int val = 0;
int ser = 0;
char rfid[10];
int bytesRead = 0;


void setup() {
    // Serial to computer
    Serial.begin(9600);

```

```
    // Set up RFID Reader
    rfidSerial.begin(baudRateRfid);

    pinMode(LED_BUILTIN, OUTPUT);
}

void loop() {
    // Read serial from RFID reader
    if(rfidSerial.available() > 0) {
        val = rfidSerial.read();
        Serial.write(val);
    }

    // Read serial from computer
    if(Serial.available() > 0) {
        ser = Serial.read();
        if(ser == 'Z') {
            // Access Granted
            digitalWrite(LED_BUILTIN, HIGH);
        } else if(ser == 'X') {
            // Access Denied
            digitalWrite(LED_BUILTIN, LOW);
        }

    }

}
```

5.2.2 Python Code

1) Engineer's Application:

```
import sys
import os
import sqlite3
import serial
import subprocess
import time   #for delay functions
layout = [[sg.Text('Fuel Dispensing System - Backend')],
          [sg.Input(size=(20, 1), key='input1')],
          [sg.Button('Enable'), sg.Button('Disable')],
          [sg.Button('Find'), sg.Button('List'), sg.Button('Clear')],
          [sg.Button('Scan',size=(20, 2))],
          ]

layout2 = [[sg.Text('Fuel Dispensing System')],
         #[sg.Text('', size=(10, 1), font=('Helvetica', 18), text_color='red',
    key='out2')],
          [sg.Input(size=(20, 1), do_not_clear=True, justification='right', key='
    input2')],
          [sg.Button('1'), sg.Button('2'), sg.Button('3')],
          [sg.Button('4'), sg.Button('5'), sg.Button('6')],
          [sg.Button('7'), sg.Button('8'), sg.Button('9')],
          [sg.Button('0'), sg.Button('Clear')],
          [sg.Button('Add'), sg.Button('Subtract')],
           ]

window = sg.Window('Kalsekar - BE.EXTC', default_button_element_size=(5, 2),
    auto_size_buttons=False, grab_anywhere=False).Layout(layout)
#window2 = sg.Window('Kalsekar - BE.EXTC', default_button_element_size=(5, 2),
    auto_size_buttons=False, grab_anywhere=False).Layout(layout2)

```

```python
NoneType = type(None)
serial_port = 'COM10'
baud_rate = 9600
amt = 0

# Define the db path to ./rfids.db, relative to this file
#sql_file = os.path.join(os.path.dirname(__file__), 'tags.db')
sql_file = os.path.join('C:\\py', 'tags.db')
needs_creation = not os.path.exists(sql_file)
db_connection = sqlite3.connect(sql_file)
db_connection.row_factory = sqlite3.Row

if needs_creation:
    db_connection = sqlite3.connect(sql_file)
    db_connection.row_factory = sqlite3.Row
    cursor = db_connection.cursor()
    cursor.execute("CREATE TABLE rfid_tags (tag_id text, is_enabled integer, value integer)")
    db_connection.commit()

# ------------------------------------------------------------------------------------------

def run_server():
  print ('Starting serial server...')
  tag_id = ''
  try:
    com = serial.Serial(serial_port, baud_rate)
    print ('Connected to arduino. Awaiting RFID scans.')
    chars = []
    #start_time= time.time()
    #print('Start Time = ', start_time)
    time_out = 5
    while len(chars) <= 12:
      char = com.read().decode("utf-8")
      if char != '\r' and char != '\n' and len(chars) <= 12:
        chars.append(char)
        if len(chars) >= 12:
          tag_id = ''.join(chars[:12])
          print ('Checking tag:', tag_id)
          break
      else:
        chars = []
  except serial.SerialException:
    print ('*ERROR*')
    print ('Could not open serial port.')
  return tag_id

def list():
  print ('All Tags:')
  cursor.execute('SELECT * FROM rfid_tags')
  for row in cursor:
    print ('\t', row['tag_id'], 'ENABLED' if row['is_enabled'] else 'disabled', row['value'])
  return True

def find():
  print ('Tag Details:')
  cursor.execute('SELECT * FROM rfid_tags WHERE tag_id = ?', (tag_id,))
  record = cursor.fetchone()
  if record:
    cursor.execute('SELECT * FROM rfid_tags WHERE tag_id = ?', (tag_id,))
```

```
    for row in cursor:
      print ('\t', row['tag_id'], 'ENABLED' if row['is_enabled'] else 'disabled', row['value'])
    find2(tag_id)
    return True
  else:
    print ('*ERROR* Record not found')

def find2(tag_id):
  window.Hide()
  keys_entered2 = ''
  window2 = sg.Window('Kalsekar - BE.EXTC', default_button_element_size=(5, 2), auto_size_buttons=False, grab_anywhere=False).Layout(layout2)
  while True:
    event2, values2 = window2.Read()  # read the window
    if event2 is None:
      #window2.Close()
      window.UnHide()
      break
    if event2 == 'Clear':
      keys_entered2 = ''
      #window2.FindElement('out2').Update(keys_entered2)
    elif event2 in '1234567890':
      keys_entered2 = values2['input2']
      keys_entered2 += event2
    elif event2 == 'Add':
      keys_entered2 = values2['input2']
      if not keys_entered2 == '':
        amt = int(keys_entered2)
        update(amt, tag_id, event2)
      #window2.FindElement('out2').Update(keys_entered2)  # output the final string
    elif event2 == 'Subtract':
      keys_entered2 = values2['input2']
      if not keys_entered2 == '':
        amt = int(keys_entered2)
        update(amt, tag_id, event2)
    window2.FindElement('input2').Update(keys_entered2)
  return True

def access():
  if len(tag_id) != 12:
    print ('tag id length:', len(tag_id))
    print ('*ERROR* Tag must be 12 character long.')
    return True
  cursor.execute('SELECT * FROM rfid_tags WHERE tag_id = ?', (tag_id,))
  record = cursor.fetchone()
  enabled = event1 == 'Enable'
  if record:
    cursor.execute('UPDATE rfid_tags SET is_enabled = ? WHERE tag_id = ?', (enabled, tag_id))
    db_connection.commit()
    print ('%s access for tag' % ('ENABLED' if enabled else 'disabled'))
  else:
    print ('Added tag with access %s' % ('ENABLED' if enabled else 'disabled'))
    cursor.execute('INSERT INTO rfid_tags (tag_id, is_enabled, value) VALUES (?, ?, ?)', (tag_id, enabled, '0'))
    db_connection.commit()
  return True

def update(amt, tag_id, sign):
  print (amt, tag_id, sign)
```

```
    if len(tag_id) != 12:
        print ('tag id length:', len(tag_id))
        print ('*ERROR* Tag must be 12 character long.')
    cursor.execute('SELECT * FROM rfid_tags WHERE tag_id = ?', (tag_id,))
    record = cursor.fetchone()
    enabled = True
    if record:
        balance = record['value']
    else:
        balance = 0
    if (sign == 'Add'):
        newval = balance + amt
        if record:
            cursor.execute('UPDATE rfid_tags SET is_enabled = ?, value = ? WHERE tag_id = ?', (enabled, newval, tag_id))
            db_connection.commit()
            print ('Data for tag updated. New Balance:', newval)
        else:
            print ('Added tag with access %s' % ('ENABLED' if enabled else 'disabled'))
            cursor.execute('INSERT INTO rfid_tags (tag_id, is_enabled, value) VALUES (?, ?, ?)', (tag_id, enabled, newval))
            db_connection.commit()
    elif (sign == 'Subtract'):
        if record:
            if (amt > balance):
                print ('Remaining: ', balance)
                print ('*ERROR* Not enough Balance.')
            else:
                newval = balance - amt
                cursor.execute('UPDATE rfid_tags SET is_enabled = ?, value = ? WHERE tag_id = ?', (enabled, newval, tag_id))
                db_connection.commit()
                print ('Data for tag updated. New Balance:', newval)
        else:
            print ('Tag does not exist, Please add')
    return True
# ------------------------------------------------------------------------------------------

# Loop forever reading the window's values, updating the Input field
keys_entered = ''
cursor = db_connection.cursor()
while True:
    event1, values1 = window.Read()  # read the window
    if event1 is None:  # if the X button clicked, just exit
        break
    if event1 == 'Clear':  # clear keys if clear button
        keys_entered = ''
    elif event1 == 'Find':
        keys_entered = values1['input1']
        tag_id = keys_entered
        find()
        #find2()
    elif event1 == 'Enable':
        keys_entered = values1['input1']
        tag_id = keys_entered
        access()
    elif event1 == 'Disable':
        keys_entered = values1['input1']
        tag_id = keys_entered
        access()
```

```
    elif event1 == 'List':
      list()
    elif event1 == 'Scan':
      #run_server()
      keys_entered = run_server()

    window.FindElement('input1').Update(keys_entered)  # change the window to reflect current key string
```

OUTPUT:

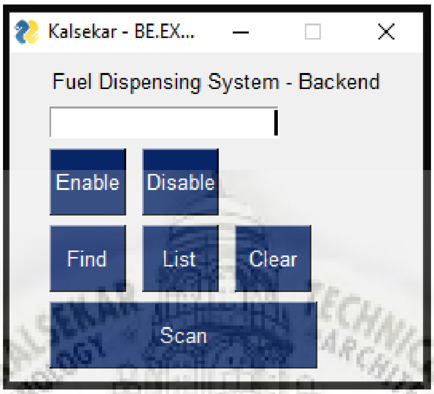

Figure 32: Engineer's Application: Screen - 1

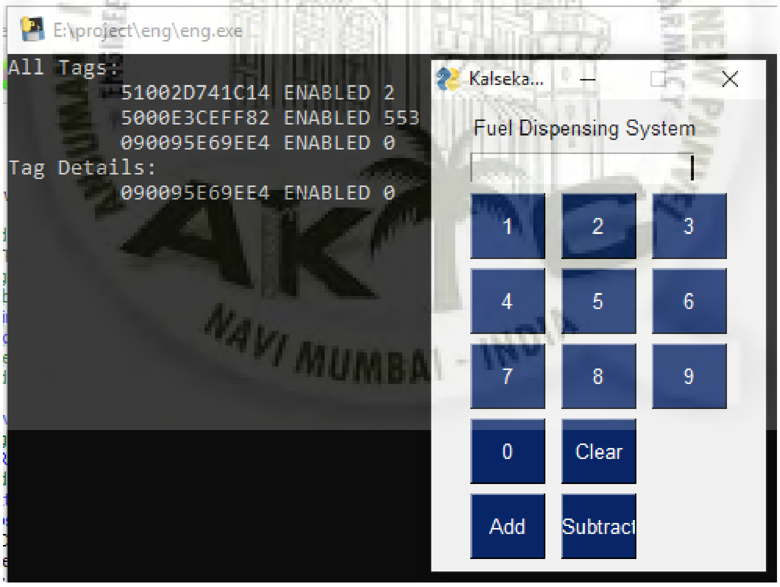

Figure 33: Engineer's Application: Screen - 2

2) User's Application:

```python
import PySimpleGUI as sg

import sys
import os
import sqlite3
import serial
import subprocess
import time   #for delay functions

layout = [[sg.Text('Fuel Dispensing System')],
          [sg.Text('', size=(30, 1), font=('Helvetica', 10), text_color='red', key='out')],
         #[sg.Input(size=(25, 1), do_not_clear=True, justification='right', key='input')],
          [sg.Button('Scan',size=(30, 3))],
         #[sg.Button('Submit'), sg.Button('Clear')],
          ]

layout2 = [[sg.Text('Fuel Dispensing System')],
         #[sg.Text('', size=(10, 1), font=('Helvetica', 18), text_color='red', key='out2')],
          [sg.Input(size=(25, 1), do_not_clear=True, justification='right', key='input2')],
          [sg.Button('1'), sg.Button('2'), sg.Button('3')],
          [sg.Button('4'), sg.Button('5'), sg.Button('6')],
          [sg.Button('7'), sg.Button('8'), sg.Button('9')],
          [sg.Button('Submit'), sg.Button('0'), sg.Button('Clear')],
           ]

window = sg.Window('Kalsekar - BE.EXTC', default_button_element_size=(5, 2), auto_size_buttons=False, grab_anywhere=False).Layout(layout)
window2 = sg.Window('Kalsekar - BE.EXTC', default_button_element_size=(5, 2), auto_size_buttons=False, grab_anywhere=False).Layout(layout2)

NoneType = type(None)

# Change this to the port displayed in your Arduino IDE
# It will be com3 or something for Windows...
serial_port = 'COM10'
baud_rate = 9600
amt = 0

# Define the db path to ./rfids.db, relative to this file
#sql_file = os.path.join(os.path.dirname(__file__), 'tags.db')
sql_file = os.path.join('C:\\py', 'tags.db')
needs_creation = not os.path.exists(sql_file)
db_connection = sqlite3.connect(sql_file)
db_connection.row_factory = sqlite3.Row

if needs_creation:
    db_connection = sqlite3.connect(sql_file)
    db_connection.row_factory = sqlite3.Row
    cursor = db_connection.cursor()
    cursor.execute("CREATE TABLE rfid_tags (tag_id text, is_enabled integer, value integer)")
    db_connection.commit()

# ________________________________________________________________________________

def screen():
    window.Hide()
```

```
    keys_entered2 = ''
    while True:
        event2, values2 = window2.Read()  # read the window
        if event2 is None:
            #window2.Close()
            window.UnHide()
            break
        if event2 == 'Clear':
            keys_entered2 = ''
            #window2.FindElement('out2').Update(keys_entered2)
        elif event2 in '1234567890':
          keys_entered2 = values2['input2']  # get what's been entered so far
          keys_entered2 += event2  # add the new digit
        elif event2 == 'Submit':
            keys_entered2 = values2['input2']
            if not keys_entered2 == '':
              print (int(keys_entered2))
            #window2.FindElement('out2').Update(keys_entered2)  # output the final string
        window2.FindElement('input2').Update(keys_entered2)
def run_server():
    print ('Starting serial server...')
    window.FindElement('out').Update('Starting serial server.')
    window.Read(timeout=10)
    time.sleep(1)
    try:
        com = serial.Serial(serial_port, baud_rate)
        print ('Connected to arduino. Awaiting RFID scans.')
        window.FindElement('out').Update('Connected to arduino. Awaiting RFID scans.')  # output the final string
        window.Read(timeout=10)
        time.sleep(1)
        chars = []
        while len(chars) <= 12:
            char = com.read().decode("utf-8")
            #char = char.decode("utf-8")
            #print (char)
            #tag = com.readline()
            # Read characters from serial until we hit line endings
            if char != '\r' and char != '\n' and len(chars) <= 12:
                chars.append(char)
                #print (chars)
                # If we have 10 characters, then we have an RFID tag
                if len(chars) >= 12:
                    tag_id = ''.join(chars[:12])
                    print ('Checking tag:', tag_id)
                    window.FindElement('out').Update('Tag ID: ' + str(tag_id))  # output the final string
                    window.Read(timeout=10)
                    time.sleep(2)
                    #if tag_id == "090095E69EE4":
                    #   sys.exit('*WELCOME* Opening Engineers Terminal.')
                    cursor = db_connection.cursor()
                    cursor.execute('SELECT * FROM rfid_tags WHERE tag_id = ?', (tag_id,))
                    record = cursor.fetchone()
                    if record and record['is_enabled']:
                        balance = record['value']
                        window.FindElement('out').Update('Balance:' + str(balance))
                        window.Read(timeout=10)
                        time.sleep(2)
```

```
                window.Hide()
                window2 = sg.Window('Keypad2', default_button_element_size=(5, 2), auto_size_buttons=False, grab_anywhere=False).Layout(layout2)
                while True:
                    event2, values2 = window2.Read()  # read the window
                    if event2 is None:
                      window.UnHide()
                      amt = 0
                      break
                    if event2 == 'Clear':
                        keys_entered2 = ''
                        #window2.FindElement('out2').Update(keys_entered2)
                    elif event2 in '1234567890':
                        keys_entered2 = values2['input2']  # get what's been entered so far
                        keys_entered2 += event2  # add the new digit
                    elif event2 == 'Submit':
                        keys_entered2 = values2['input2']
                        if not keys_entered2 == '':
                          amt = int(keys_entered2)
                        else:
                          amt = 0
                        window2.Close()
                        window.UnHide()
                        break
                    window2.FindElement('input2').Update(keys_entered2)  # change the window to reflect current key string
                #amt = keys_entered2 #int(input("Enter Amount:"))
                if (amt > balance):
                    print ('Remaining: ', balance)
                    print ('*ERROR* Not enough Balance.')
                    window.Read(timeout=10)
                    window.FindElement('out').Update('*ERROR* Not enough Balance.' + str(balance))
                    window.Read(timeout=10)
                    time.sleep(2)
                    amt = 0
                else:
                    newval = balance - amt
                    cursor.execute('UPDATE rfid_tags SET value = ? WHERE tag_id = ?', (newval, tag_id))
                    db_connection.commit()
                    print ('Data for tag updated. New Balance:', newval)
                    window.Read(timeout=1)
                    window.FindElement('out').Update('Please Wait')
                    window.Read(timeout=10)
                    time.sleep(2)
                    Z = 'Z'
                    Z = Z.encode("utf-8")
                    X = 'X'
                    X = X.encode("utf-8")
                    com.write(Z)
                    if (amt > 20):
                        amt = 20
                    time.sleep(amt)
                    com.write(X)
                #bamt = amt.encode()
                #com.write(bytes([amt]))
                # Reset buffer
                chars = []
                break
            else:
```

```
                        print ('Tag access denied.')#access_denied(com)
                        window.FindElement('out').Update('Tag access denied.')
                        window.Read(timeout=10)
                        time.sleep(2)
                        # Reset buffer
                        chars = []
                        break
                else:
                    # Reset buffer
                    chars = []
    except serial.SerialException:
        #print ('*ERROR*')
        #print ('Could not open serial port.')
        window.FindElement('out').Update('*ERROR* Could not open serial port.')
        window.Read(timeout=10)
        time.sleep(2)
        #sys.exit('Edit rfid.py and make sure you define serial_port properly.')
# -----------------------------------------------------------------------------

# Loop forever reading the window's values, updating the Input field
keys_entered = ''

while True:
    event1, values1 = window.Read()  # read the window
    if event1 is None:  # if the X button clicked, just exit
        break
    if event1 == 'Clear':  # clear keys if clear button
        keys_entered = ''
    elif event1 == 'Submit':
        screen()
    elif event1 == 'Scan':
      run_server()
      window.FindElement('out').Update('Click Scan.')
      #window.Read(timeout=10)

    #window.FindElement('input').Update(keys_entered)  # change the window to
    reflect current key string
```

OUTPUT:

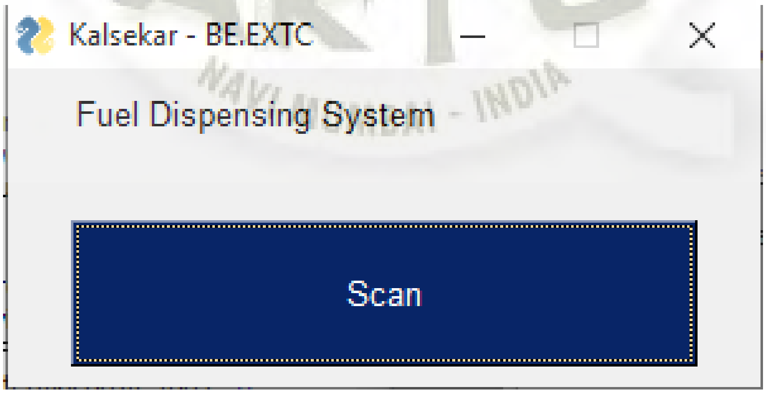

Figure 34: User's Application: Screen - 1

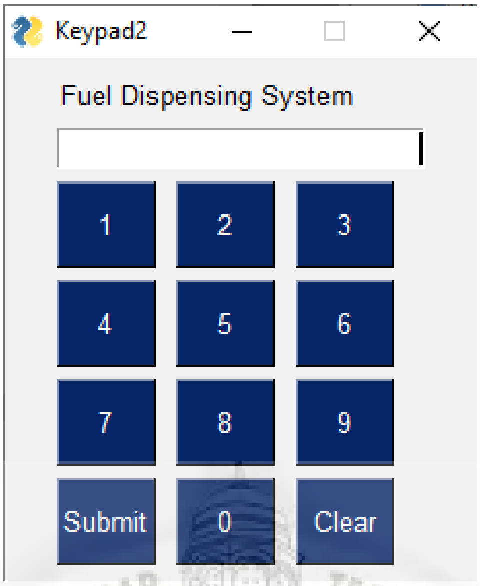

Figure 35: User's Application: Screen - 2

Chapter 6

6 Conclusion and Future Scope

6.1 Conclusion

RFID system is a versatile technology. This system is used in many application and real time application. In our application, RFID system dispenses the accurate amount of fuel which reduces the misuse of the fuel. And it also reduces the man power. And if the customer tries to swipe with the unauthorized card, the RFID system rejects the card. In this way the system is so secured. To obtain best performance the RFID readers and Tags must be in good quality.

6.2 Future Scope

The first addition is strictly a change in the code. As of now, the RFID reader used is linked to the tag and card reader. However, either by adjusting the code or using a different RFID reader, one should be able to read the RFID code of the individual tags and cards. This will allow for more options in terms of how the user wants the security to be set up. By reading the specific RFID codes, you can change the accepted keys and also deny access for certain keys. Another additional addition code is responses to potential brute force.
An example of a physical improvement is adding the ability to run on 9V batteries. This gives albeit a limited amount of security in case of a power outage. Because of the inverting amplifier design, even when disconnected with the Arduino, the door lock has the ability stays locked. But in order for the door to stay locked, it still needs a power supply.

References

[1] D. L. Wu, Wing W. Y. NG, D. S. Yeung, and H. L. Ding, *A brief survey on current RFID applications, . International Conference on Machine Learning and Cybernatics, Baoding, July 12-15, 2009, pp. 2330-2334. .*

[2] B. Yan and D. Y. Lee, *Design of spot ticket management system based on RFID International Conference on Networks Security, Wireless Communications and Trusted Computing, 2009, pp. 496-499. ..*

[3] G. Ostojic, S. Stankovski, and M. Lazarevic, *Implementation of RFID technology in parking lot access control system*, Proc. Annual RFID Eurasia Conference, 2007, pp. 1-5.

[4] N. Ahmad, S. Butler, and U. Ramachandran, *GuardianAngel: An RFID based indoor guidance and monitoring system,*. An RFID based indoor guidance and monitoring system, 2010, pp. 546-551.

[5] K. S. Huang and S. M. Tang, *RFID applications strategy and deployment in bike renting system,*, [*ICACT 2008, pp. 660-663.*],