PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

UNIVERSITY OF M'SILA
FACULTY OF MATHEMATICS AND INFORMATICS

MEMORY of end of study

Presented for the MASTER's degree

Domain: Mathematics and Informatics

field of study : Informatics

Specialty : Information and Communication Technology

SUBJECT

Securing & Tracking Homes In Smart Cities

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Promotion : 2017 / 2018

ACKNOWLEDGMENTS

I would like to thank Dr. Azzeddine Attir, the supervisor, for the encouragement and support during my studies. Despite his busy schedule, he was always ready to offer advice, support and guidance throughout my studies.

I would also like to express my gratitude to many who have supported and encouraged me from friends and students and that makes me feel like I am a member of an extended family: Bilal Hamid, Amine Bensalah, Arar Haroun, Boukhalfa Redouane, and the list still long.

I express my gratitude to my family for their love, care and support. I am deeply indebted to my parents for their love and eternal encouragement.

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LIST OF ABRIVIATIONS

RFID	**R**adio **F**requency **Id**entification
IoT	**I**nternet **o**f **T**ings
ICT	**I**nformation and **C**ommunication **T**echnology
M2M	**M**achine-To-**M**achine
WSN	**W**ireless **S**ensor **N**etworks
RDF	**R**esource **D**escription **F**ramework
GSM	**G**lobal **S**ystem for **M**obile
UII	**U**nique **I**tem **I**dentifier
EPC	**E**lectronic **P**roduct **C**ode
WORM	**W**rite **O**nce **R**ead **M**ultiple
UHF	**U**ltra **H**igh **F**requency

GENERAL INTRODUCTION

Since the advent of wireless networks and remote control systems, the world seeks to adapt them to serve humanity and facilitate daily life in all areas of civil life. from the most important fields as security and health, to the least important as recreation and entertainment. and that will done after connecting as many things as possible to each other in the so-called the Internet of Things " IoT ", in order to make the person familiar with all his life's courses and the person’s life who is responsible for them

when we talk about IoT, we talking about smart cities, which are basically made up of smart buildings / houses and smart streets, which allows its residents to track all changes immediately and intervene effectively, and that can be in different fields such as: Health, Environment, Energy, Security, smart Homes / Offices, also the Management, the Industry and the Transportation fields.

After determining Smart Security as a research and studying field, we will consider setting up a tracking system that allows tracking of objects and informing the owner by sending text messages and alerts to his phone about their movements and their whereabouts, using the radio frequency identification "RFID" tags , and the RFID readers.

The objective from this work is realising a securing and tracking system based on the RFID technology, the network of RFID readers detect every tags movement and the control unit process the read data, after that the system will send a messages to the responsible or the owner, using the GSM network (Global System for Mobile), and all of that in real time, with low cost, and more efficiency.

The organization of this thesis is as follows: in the first chapter contains the basics of the structure of smart homes/cities, in the second chapter we will talk about some methods and necessities of security and tracking systems including the selected hardware for this project. The last chapter represent the development environments and the different tools used for the realization of our project.

CHAPTER 1

SMART CITIES / HOMES ARCHITECTURE

1.1. Introduction :

When we talk about smart cities, we need to know the basics of architecture and the environment for each component from the city, as well as those wireless sensor networks (WSN) and the different phases from data collection to the services phase, also we need to know about the communication methods and data transaction between them.

This chapter focuses on the concept of smart cities and almost everything related with WSN, data exchange and the diversity of communication methods, to provide services effectively to facilitate life

1.2. Smart Cities :

1.2.1. Definition :

A smart city is a municipality that uses information and communication technologies to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare.

While the exact definition varies depending on whom you talk to, the overarching mission of a smart city is to optimize city functions and drive economic growth while improving quality of life for its citizens using smart technology and data analysis.[1]

Figure 1. 1 Smart City and IoT [7]

1.2.2. Smart City Components :

When considering the difference between a different environments, from one country to another, and from one climate to another, we find that the smart cities components or sections also differ.

This means that there is no standard division of smart city components, in which case we will mention some of the components that may be fundamental or common to many of the current Smart Cities schemes.

And when we add the term "smart" to all of this components then we are talking about the recruitment of the ICT "information and communication technology", sensor network and big data collecting, analysing and processing in a short “real” time and by effective and inexpensive means.

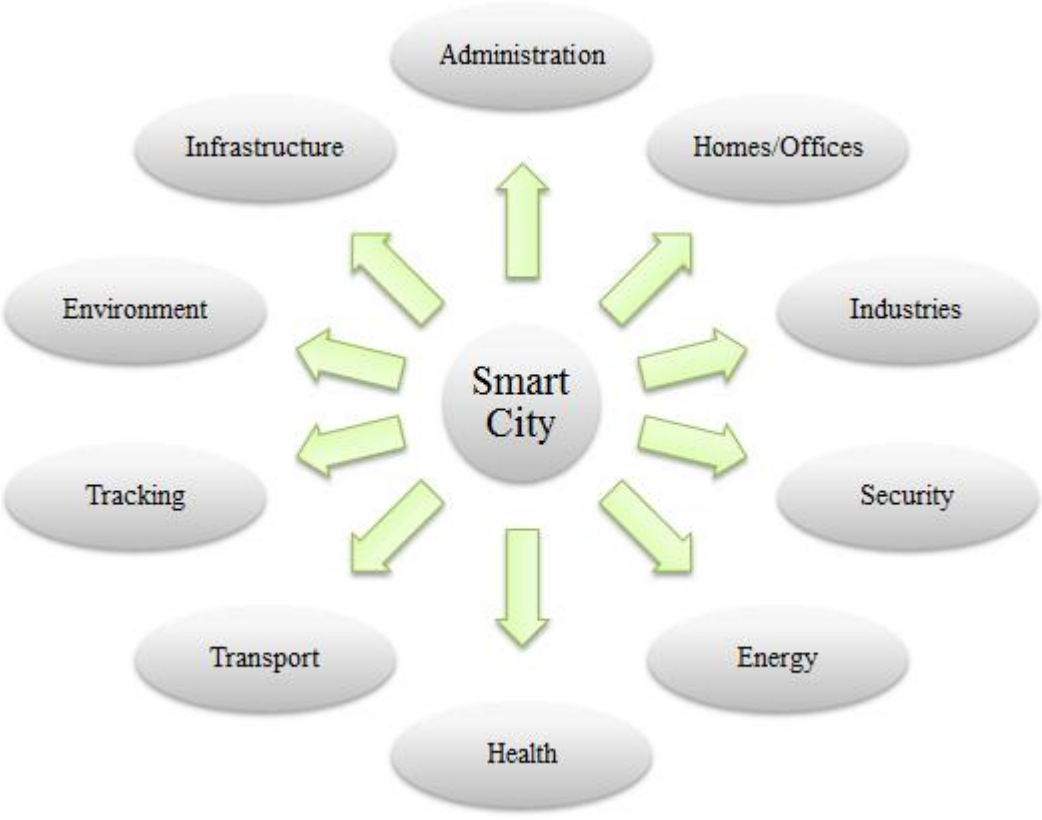


Figure 1. 2 Smart Cities Components

As shown in Fig 1.2, we assumed that the division of smart city components is basically ordered in the following sections.[2]

1.2.2.1. Smart Administration :

Including all aspects of civil life and human resources transactions, as well as data collection, analysis, and processing, also the communication services, notifications, alerts, monitoring and control systems.

1.2.2.2. Smart Homes/Offices :

Smart Homes / Offices In another sense, every place where people spend most of their time. It should be available on the systems of comfort, automation and WSN and the possibility of remote control in energy, lighting, various equipment and machinery and especially security field and tracking systems.

1.2.2.3. Smart Infrastructure :

Including various sewerage networks, connections and supplies related to energy, gas, water distribution or communication lines. It also includes the subways, tunnels, ventilation and lighting systems.

1.2.2.4. Smart Industries :

This area focuses on harnessing all of the above mentioned ICT systems, digitization to improve the industry sector and all its required as transportation, primary sources, refining and recycling processes, saving energy and reducing emissions.

1.2.2.5. Smart Environment :

This component represents everything related to the environment such as weather monitoring and changes in emission levels, reduce pollution and develop agriculture, industry and clean energy fields.

1.2.2.6. Smart Transport :

In this component we find the parking services and the improvement of traffic systems to avoid congestion.

Also assisting systems for drivers, such as navigation, automatic driving, short cuts, and position tracking systems.

1.2.2.7. Smart Energy :

which mean controlling remotely and reducing the energy consuming, and managing the distribution depending on the dynamically statistics.

1.2.2.8. Smart health :

These includes healthcare, follow-up of chronic conditions, measurable things like blood pressure and heart rates, medication times remainder, hospital and medical clinics services data

Also Patient equipment and Early Diagnosis Based on data and statistics from various sensors used in healthcare and medical care, and other sensors for detecting radiation or poisoning cases

1.2.2.9. Smart Security :

When we talk about security, we find it in every component of the above

And in smart cities is one of the most important factors to be achieved

Therefore, for a safe city, all data coming from every sensor in the city must be harnessed, whether from homes, street, office, factories, buildings, infrastructure, transportation and even weather changes are also taken into consideration

After the collecting of data, it will be processed and lead to extract some information which help to permit decision making, acting, send notifications or warnings in case of danger.

1.2.2.10. Smart Tracking :

We considered tracking a separate component in itself

Because it does not fall within the concept of protection and security only, but it's implemented in several areas, such as tracking shipments and customer orders, also searching for some of the most vulnerable things to loss, away from theft. as well as cars and mobile phones to see the location of its owners

And we do not overlook its importance in cases of kidnapping or theft of properties and possibly in other different cases.

1.3. Wireless Sensors network (WSN) and Data Treatment :

1.3.1. Wireless Sensors network :

This is what we find in the system of communication M2M (machine to machine)

The sensors vary according to their characteristics, from pressure sensors, heat, motion, gases, to vibrations, frequencies and magnetic or electromagnetic field sensors, etc.

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. The wireless protocol you select depends on your application requirements. Some of the available standards include 2.4 GHz radios based on either IEEE 802.15.4 or IEEE 802.11 (Wi-Fi) standards or proprietary radios, which are usually 900 MHz .[3]

1.3.2. Data Treatment Architecture :

Sensors form the primary source of information generation. The raw data sensed by the sensor node are transferred to "*data collection centre* " of the Smart City using communication services to perform further "*data processing*" , then "*data integration and reasoning*" after that the obtained data can be used in "*devices control and alerts*". [2]

1.3.2.1. Data collection :

In this level, raw information collected from sensors is stored for further processing. Some of the formats in which heterogeneous data are collected are tweets, database schemas and text messages.

1.3.2.2. Data processing :

Information gathered from the data collection level is summarized prior to transmission, analysis and fusion in the further levels using semantic web technologies. The main objective of this level is to convert the collected heterogeneous information into a common format, e.g. Resource Description Framework (RDF). RDF is the most common way to exchange information over the web and it facilitates heterogeneous data sharing and integration for different Smart City domains. RDF also helps in defining metadata about the resources on the web.

Different software applications can then utilize RDF data for intelligent reasoning operations. Pre-processed RDF data generated at this level will be exploited using semantic knowledge and uncertain reasoning rules in the next level for high-level context-aware information retrieval.

1.3.2.3. Data integration and reasoning :

Semantic web technologies enable exploitation of domain specific data based on the concepts and relationships between those concepts.

Web ontology language (OWL) is used for publishing the ontologies. OWL is an RDF graph that is built using the RDF and ontologies. It allows the classification of the individual/concepts based on the classes. It also provides two different types of properties, which can be used to form relationships between different classes, namely the Data property and Object property. Once data classification is done, knowledge can be further enriched with domain experts and uncertain reasoning.

1.3.2.4. Device control and alerts :

Data obtained from previous phase can be utilized by different web applications for intelligent operating conditions. The inferred data can be utilized in many ways such as input/output, messaging, alerts and warnings [2]

1.4. Communication Services :

The communication medium plays an important role in achieving the Smart City concept. the existing communication services that are utilized in a Smart City infrastructure represented in: 3G (3rd generation), LTE (Long-term evolution), Wi-Fi (Wireless fidelity), WiMAX (worldwide interoperability for microwave access), ZigBee, CATV (cable television) and satellite communication. The main aim is to connect all sorts of things (sensors and IoT's) that can help in making the life of citizens more comfortable and safer. An example is provided by communication services in the home domain for connecting telephone devices and PC through the internet. In the case of the Government sector, cloud and communication services are combined to obtain a better governance system. In the case of the health sector, communication technologies can be used to connect health statistics, medication and location of something tracked from a remote location thus helps to achieve a Smart Health system. Hence, with Smart

City and communication technologies we can provide a more secure and convenient infrastructure for better living. [2]

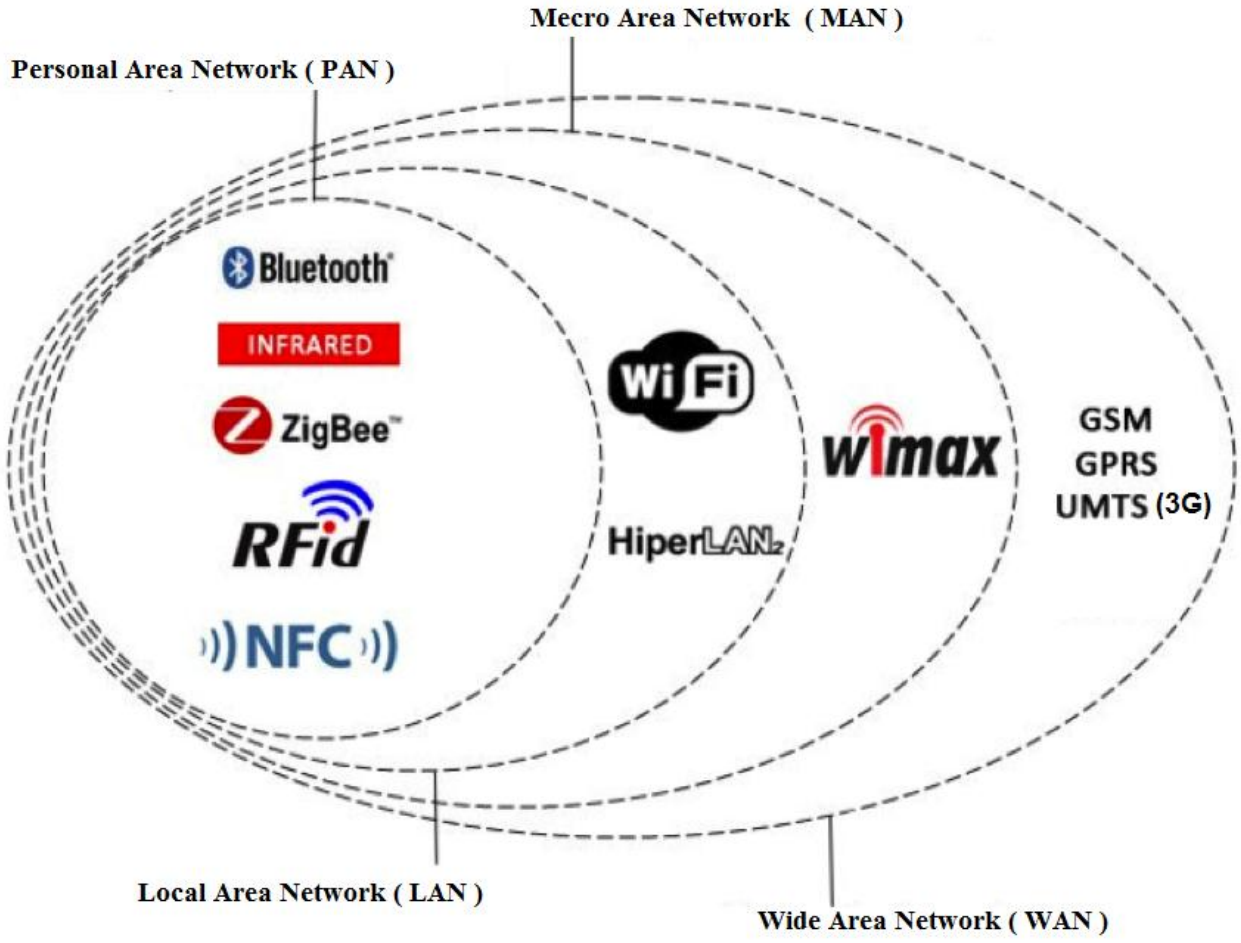


Figure 1. 3 Different wireless Networks in Smart City [8]

1.5. Smart City Network Schemes :

it is possible to use several different kinds of networks for appropriate user applications. The network hierarchy is shown in **Fig 1.3.**

PAN is a wireless communication network scheme with a little bit larger communication range. One of the examples of PAN is Bluetooth, and its communication range is more than 10m at the longest. It needs a small size transceiver, and the power consumption is small. Another popular PAN is ZigBee with very little power consumption. Bluetooth needs a pairing operation to connect to a device, and it is reliable and steady. Therefore, it has been used to connect a

keyboard, a mouse, a printer, some kinds of media devices, mobile phones, and so on in a home network. On the other hand, ZigBee is easy to find target device, and it can connect multiple devices simultaneously to build an ad hoc network. It is suitable to construct sensor networks in a home, connecting several sensors distributed throughout a house. Another short-range wireless communication is electromagnetic field communication . It is usually used in the form of the integrated circuit card, and its communication range is less than 10 cm.

Wireless sensor networks (WSN) are alternative cost effective solutions for connecting sensor nodes in highly meshed networks with very low energy requirements . Integrating sensing, communication, and computation capabilities for monitoring and data processing of variables, such as temperature, pressure, humidity, and light, allows complex data processing based on sensed physical phenomena for smart living purposes.[6]

1.6. Conclusion :

In this chapter we briefly discussed the basics that help to understand each simple step of the Smart Cities system

Although some of the information we mentioned is unclear. But the purpose of this chapter is to learn about the smart city's components and the importance of sensors, as well as the available communication services and how to transfer data from one stage to another.

Knowing that in the next chapter we will talk specifically about a particular type of sensor and how we specifically deal with it in both of security and tracking sectors.

CHAPTER 2

SECURING & TRACKING THINGS WITH « RFID » TECHNOLOGY

2.1. Introduction :

The Security and tracking fields are the most important Among the fields that smart cities aim to increase their efficiency and their quality to the highest levels

which lead us to take an overview about how can "sensors networks" and "communication services", increase and extend the services in those fields.

In this chapter we specified the radio frequency identification RFID as the studied sensor as well as the cellular services like GSM (Global System for Mobile) ,we are going to propose a stricture for a securing and tracking system based on the RFID technology and other components such as a micro-controller like Arduino, and the GSM model to send messages or alerts depending on the positioning reading of different kinds of tags.

2.2. RFID Technology :

2.2.1. RFID definition:

Automatic identification technology which uses radio-frequency electromagnetic fields to identify objects carrying tags when they come close to a reader. [4]

2.2.2. How RFID Works :

An RFID system consists of two main components, a transponder or a tag which is located on the object that we want to be identified, and a transceiver or a reader.

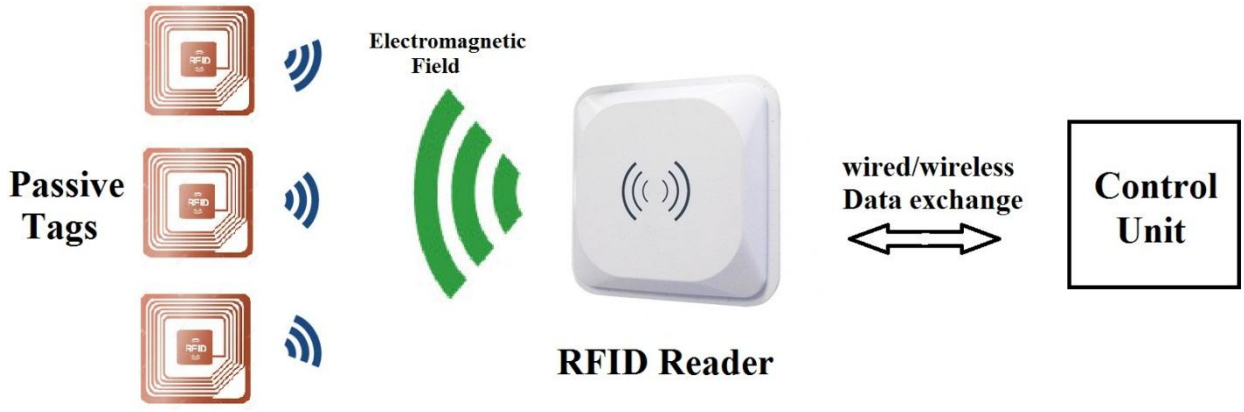


Figure 2. 1 How RFID's system Works

2.2.3. RFID reader :

Data (identification number for instance) included in the electronic chip of the RFID label can be collected by the reader. This reader can also change the content of the label's memory.

However, RFID cannot be reduced to one technology. RFID uses several radio frequencies and many types of tag exist with different communication methods and power supply sources. [4]

2.2.4. RFID tags :

RFID tags generally feature an electronic chip with an antenna in order to pass information onto the interrogator (also known as a base station or more generally, reader). The assembly is called an inlay and is then packaged to be able to withstand the conditions in which it will operate. This finished product is known as a tag, label or transponder.

The information contained within an RFID tag's, electronic chip depends on its application. It may be a unique identifier (UII, Unique Item Identifier or EPC code, Electronic Product Code, etc.). Once this identifier has been written into the electronic circuit, it can no longer be modified, only read. (This principle is called WORM Write Once Read Multiple). Some electronic chips have another memory in which users can write, modify and erase their own data. These memories vary in size from a few bits to tens of kilobits. [4]

Figure 2. 2 Different types of RFID Tags

2.3. History of RFID :

Radio-frequency technology has come far from its roots at the beginning of the twentieth century. Russian physicist Leon Theremin is commonly attributed as having created the first RFID device in 1946. While Theremin may be recognized for the first successful application of the technology, RFID has earlier roots.

RFID is a combination of radar and radio broadcast technology. Radar was developed in the U.S. in the 1920s. Scholars noted the relationship between electricity and magnetism, which is a foundation of radio broadcasting, at the beginning of the nineteenth century. Harry Stockman wrote a seminal paper in 1948, identifying the vast amount of research and development still needed before "reflected-power communications" could be used in applications. [5]

Interest in implementing RFID in libraries is on the rise. RFID technology has been used to raise efficiency in transport, business and theft-monitoring systems.

The evolution of RFID described below suggests that libraries may well benefit from widespread use of this technology.[5]

- **1920s Foundation Established**
  - Radar was developed as a technology in the U.S. in the 1920s.
  - RFID, a combination or radio broadcast technology and radar, was developed soon after.
- **1930s Progress**
  - Britain used a related technology, an IFF transponder, to distinguish enemy aircraft during WWII.
- **1940s RFID Invented**
  - Radar is refined.
  - Harry Stockman publishes "Communication by Means of Reflected Power."
- **1950s Time of Research and Development**
  - Technologies related to RFID were explored in laboratories.
  - Designs developed for long-range transponder systems for aircraft.
- **1960s Applications Abound**
  - During the 1960s inventors began applying radio frequency technology to devices aimed at markets beyond the military.

- Companies Sensormatic, Checkpoint and Knogo develop theft prevention production for public consumption using Electronic Article Surveillance
- EAS is an affordable and relatively simple technology. "1-bit tags" meant that systems could only detect the presence of absence of the tag.
- EAS represents the first and to-date, most popular use of RFID technology

➢ **1970s Hard at Work**

- Academic institutions, government laboratories companies and independent researchers are all working to develop RFID technology.
- Work done at this time was aimed toward electronic toll collection, animal and vehicle tracking, and factory automation.

➢ **1980s Commercial Expansion**

- RFID technology is fully implemented. Europe and the U.S. apply RFID to transportation systems, animal tracking, and business applications.

➢ **1990s RFID Becomes Commonplace**

- RFID uses are so widespread that standards begin to emerge.
- RFID is widely used by consumers and companies globally.

➢ **2000s RFID Enhancements**

- Improved technology leads to miniaturization.
- Cost of RFID continues to fall.
- Private authentication develops as key concern in library implementation. [5]

2.4. RFID and Smart Security :

Smart security is a very broad topic, covering everything from national security to shoplifting. I'll try to touch on the major ways in which RFID can improve security.

2.4.1. Securing E-Passports with RFID :

you don't want people sneaking into your country to do bad things. RFID transponders are being put into passports in order to improve border control. The idea here is not that governments can use the transponder to track you, but rather that the RFID chip can store a biometric image of the passport holder. That way, you can't simply change the picture to one of your own face and sneak into a country.[9]

Figure 2. 3 E-Passport With RFID Technology[10]

2.4.2. RFID Control Access :

RFID has been used for decades to control access to buildings. Companies issue badges or cards with transponders that have serial numbers stored in a database. If your serial number is approved, you can enter a building or its sensitive areas. This has helped to reduce theft of corporate assets. The technology has also been used to decrease ticket counterfeiting, and to control access to large events, such as the Olympics.[9]

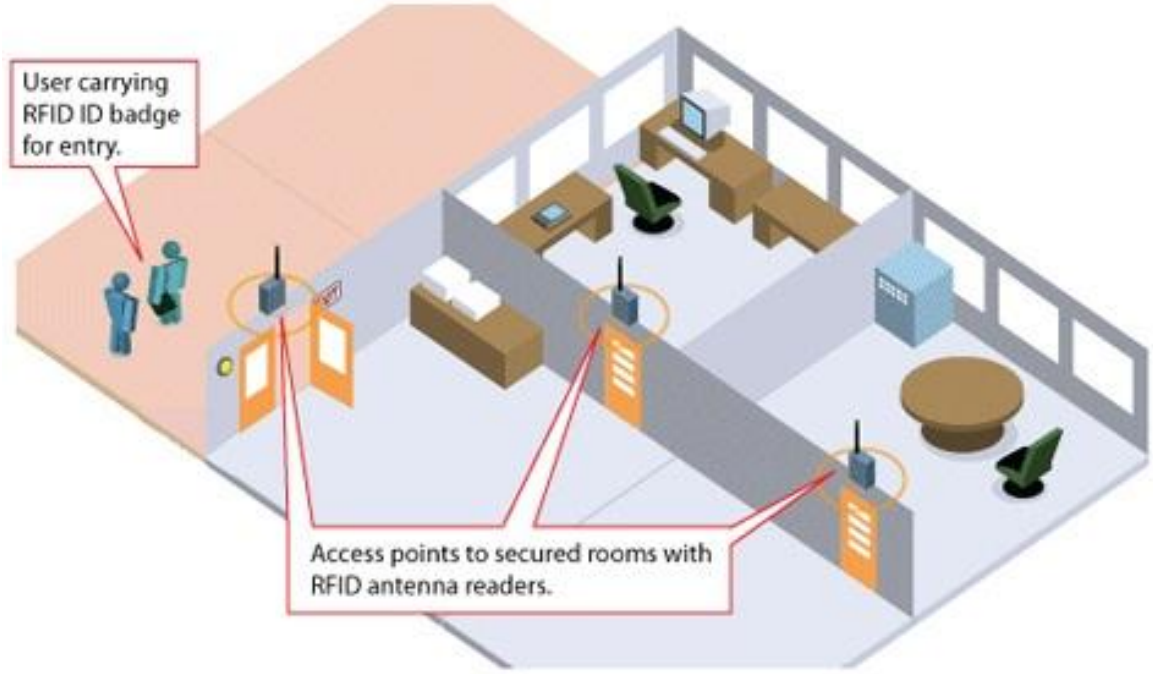


Figure 2. 4 RFID Access Control System[11]

2.4.3. Securing Sensitive Documents with RFID :

In addition, RFID can help to reduce the theft of national or company secrets. One way to accomplish this is to place tamper-resistant RFID transponders on sensitive documents (national defence plans, for instance, or corporate research and development plans). A reader is installed in each photocopy machine, and every time someone attempts to photocopy sensitive documents, that person must first scan his or her ID. The reader also interrogates the tag in the document. If the person lacks permission to scan that document, the photocopier will not work.[9]

Figure 2. 5 Printers with RFID Reader to Control Users[12]

2.4.4. RFID Tags in Stores :

What's more, RFID can be used to reduce store theft. For the few past years, Gerry Weber, a German manufacturer and seller of women's clothing, has sewn RFID tags into garments and used the technology as a form of electronic article surveillance. also jewellery retailers using the RFID to reduce theft of rings and other small items, and there are a retailers selling handbags that utilizes the technology to alert security every time that a bag is removed from a shelf.[9]

Figure 2. 6 RFID Tags Into Garments. [13]

2.4.5. Human Safety with RFID

There are many other applications as well, such as protecting new-born infants from being removed from hospitals by strangers, ensuring that school children are accounted for, protecting the food supply from tampering. [9]

Figure 2. 7 Tags for Matching Mothers with babies [14]

2.5. RFID and Smart Tracking :

Here we will talk about RFID uses in tracking and their effectiveness compared to other systems such as tracking systems using GPS, Bluetooth or even Wi-Fi

RFID is widely used in the field of tracking goods, clothing, food, various industries, storage centres and containers. We mentioned earlier that it was used in the field of smart health too, such as linking mothers with their new-borns, tracking boys in schools and knowing if they accessed or not, and counted their numbers fast easily.

So in this work we will aim tracking important things in the smart home and also in the smart city using RFID readers distributed in many places, which can determine the Tags location quickly and accurately.

2.5.1. Why RFID ?

we choose RFID depending on several characteristics such as :

- RFID readers are rather expensive, Tags are cheap.
- the tags are Passive which mean no need to power supply.
- also the ability of reading a huge number of tags in the same time.
- reading and writing data from tags.
- the tags still function correctly even when they embedded or dirty.
- Long reading distance of several meters/foots depending on Ultra High Frequency (UHF) Readers.[17]

2.5.2. RFID / Bluetooth / WIFI Comparison :

As shown in Fig.2.8 and Fig.2.9, the most complete feature in the RFID tracking system is the semi-complete dispensing of the power supply for the Tags, although the RFID accuracy does not demonstrate the accuracy of Wi-Fi or Bluetooth and also the GPS. However, these systems are completely dependent on the batteries energy. consumption varies from one to another as shown in Fig.2.9, which requires continuous monitoring and maintenance, as well as we have to considerate the possibility of failure in case of low energy levels, and that is not acceptable in threat/dangerous cases.

	Bluetooth	RFID
Possibilities	Extensive tracking – server based and client based	Selective object identification and tracking
Range	Up to 30 meters inside buildings	Passive: up to 4 meters Active: up to 100 meters
Accuracy	Server based tracking: below 5 meters	Tending to be more accurate, but depends on type of RFID tag. No extensive positioning.
Cost	About 9€ each, plus hardware (infsoft Locator Nodes) and software if necessary	Readers are rather expensive, passive RFID tags are cheap
Durability	A few days up to 8 years running on batteries, can be connected to the electrical grid	Passive tags: long durability

Figure 2. 8 Comparison Table, Between RFID and Bluetooth [15]

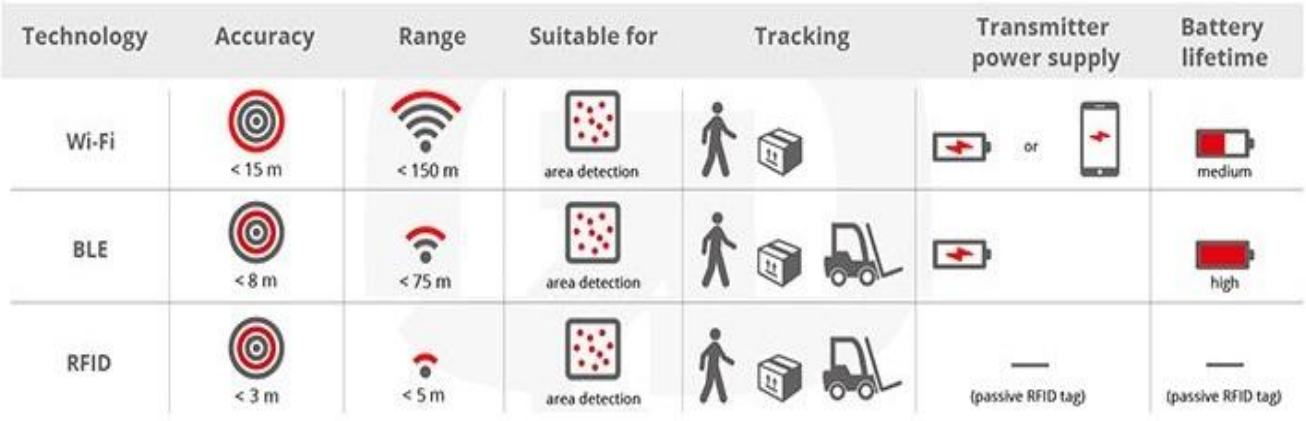


Figure 2. 9 Another Comparing Between (UHF)RFID,WIFI And Bluetooth [16]

2.6. Smart Tracking Architecture Using RFID :

To achieve an RFID tracking system We must checks a certain basic phases

The first phase is distributing "UHF" RFID readers at each access point or to cover a certain area With a view to full coverage of the facility

Then we install the tags on everything we want to know its location (Assets, keys, wallets, devices, goods, pets and even in the identification cards and various vehicles. after that the system will send a messages to the owners or to the units which are responsible, that message includes :(the name of the tag, the last seen position (the reader location), date and time, etc.)

2.6.1. Access point coverage :

The whole area must be covered from inside and from outside to read every tag's move and record its position as shown in the Fig 2.10 the antenna extending the reader covered zone which able to read tags from a distance.

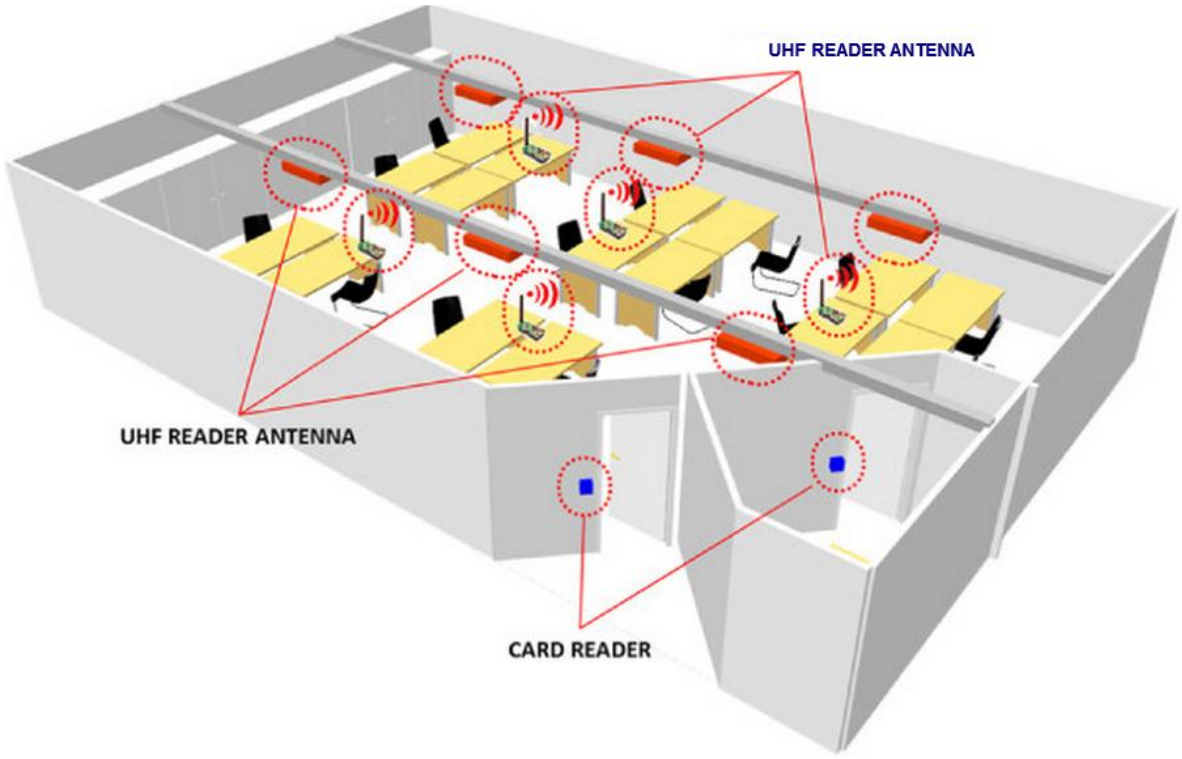


Figure 2. 10 RFID Positioning System Schema [18]

Of course the number of RFID readers and antennas depends on the area surface.(Fig 2.11)

Figure 2. 11 Covering the Access Point and Taging Everything [19]

2.6.2. Reading Tags :

When the tag read from another antenna means that that thing or person or anything holding the tag are moving, the reader will send the information from the detected tag to the unit control, and in turn the owner received a notification message or an alert in threat cases. (Fig 2.13)

The message will send with GSM network which mean there is no problem if the owner be in far places. the unit control relied with GSM model include a cellule.

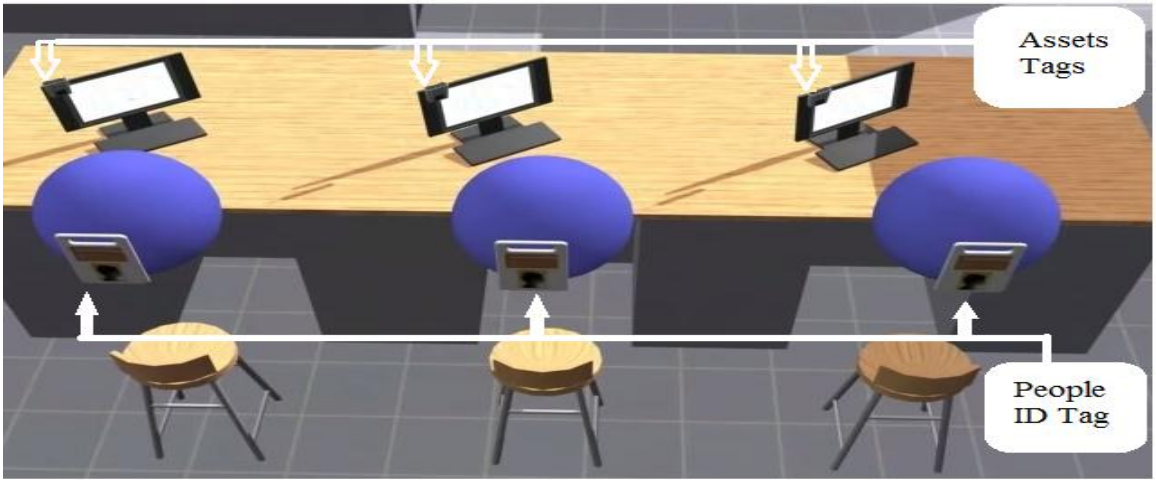


Figure 2. 12 Tags In Almost Everything. [19]

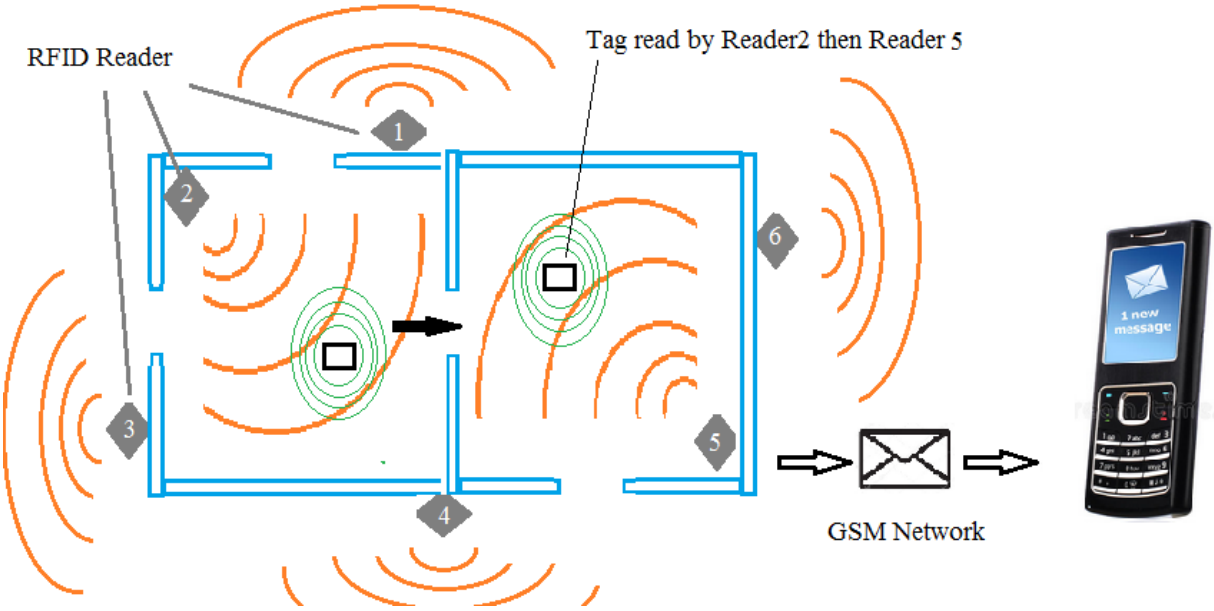


Figure 2. 13 Reading Tags and Sending Messages

2.6.3. Customized Services :

After the data receiving in the unit control there will be a several services such as :

2.6.1.1. Control & Reaction :

For example after reading the identification card the door will open or still closed if the person not allowed to access as shown in Fig 2.15. Also counting/controlling the presence and the truancy as shown in Fig 2.14, etc.

Figure 2. 14 Counting the Presence and Regestrait the Truncy [19]

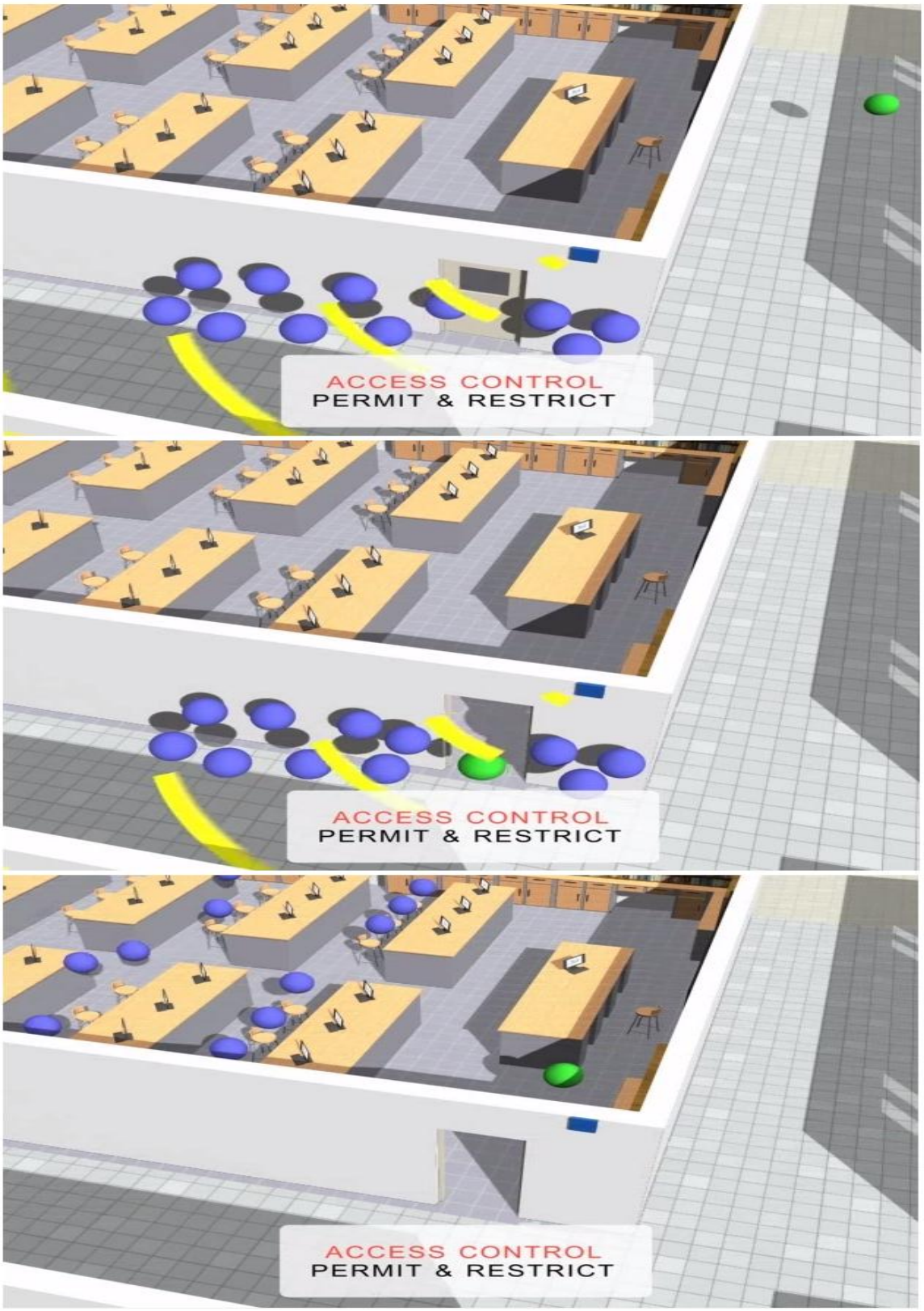


Figure 2. 15 Access Control System [19]

2.6.1.2.Notification system :

The notifications are generally letters containing information to inform the owner and make sure that the owner is aware of the changes, in cases the owners denying the knowing of what is happening the system will send an alerts immediately to the responsible unit.

2.6.1.3. Alerts :

In the absence of owners directly, the system alerts them and sends alerts to the security interests as well as the concerned authorities to intervene quickly, also gives the possibility of tracking anything which prone to theft or loss.

2.6.1.4. Tracking Service :

The tags can be tracked In/Outdoor when the reader send a message after each detecting/reading and the message contains the last position where the tag was read, and all of that in real time.

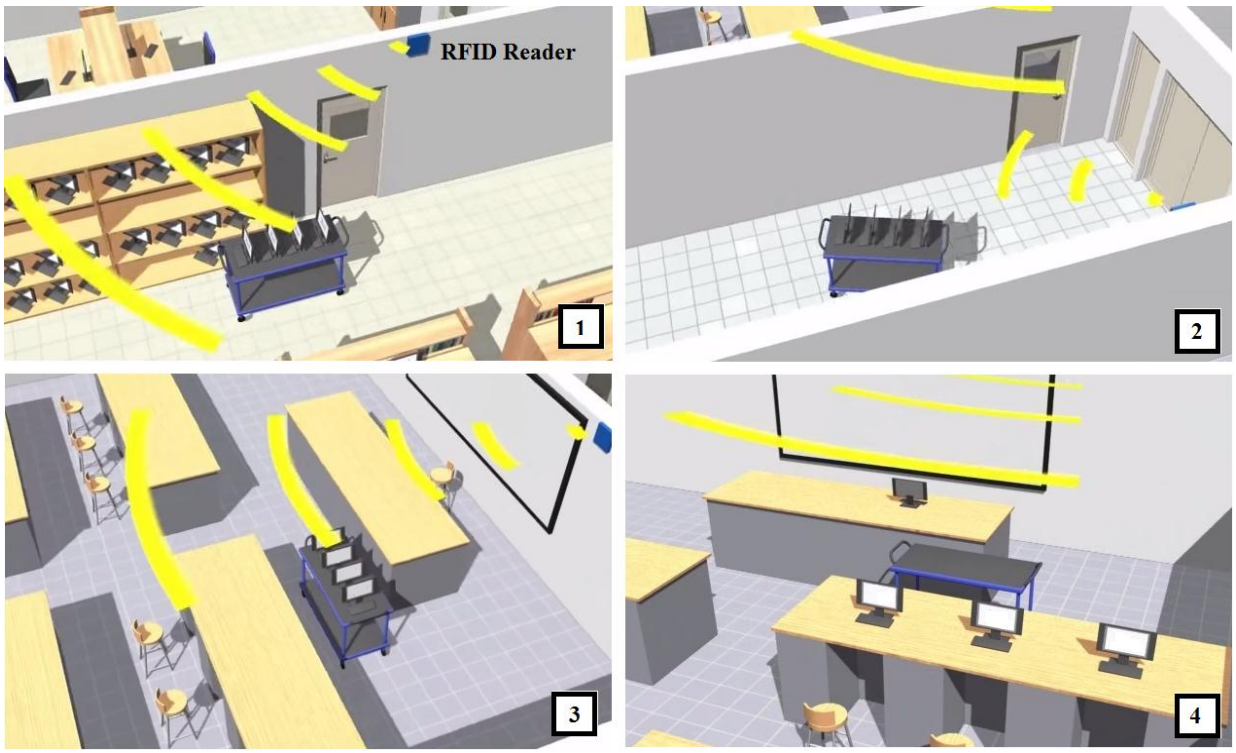


Figure 2. 16 Indoor RFID Tracking System [19]

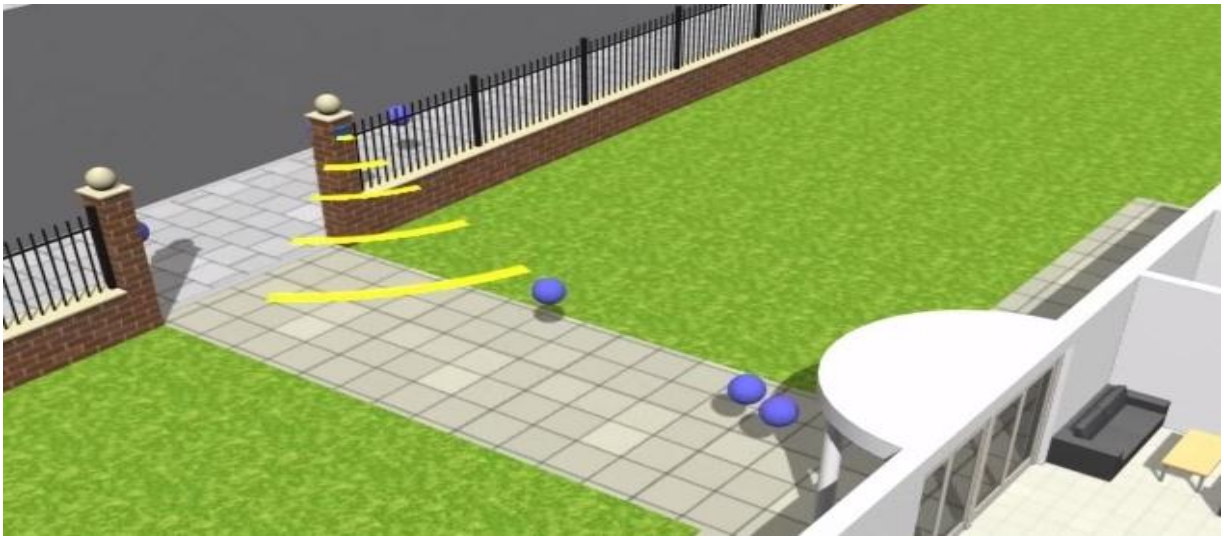


Figure 2. 17 Possibility of Tracking Outdoor [19]

2.7. Conclusion :

In this chapter, we tried to gather as much information as possible about the RFID applications in both of smart security/tracking fields

We also talked about some of the basics for achieving a tracking system based on the RFID technology, mentioning the initially phases we need from install to the services provided by this tracking system.

The next chapter will be an implementation and simulation prototype about the detecting tags with RFID reader and sending messages with GSM model.

CHAPTER 3

IMPLEMENTATION

3.1. Introduction :

In this chapter we are going to implement the RFID securing & tracking system using a small microcontroller unit (Arduini Mega 2560) which receive the data from the RFID readers after every card detecting, of course the range of the used RFID readers (RC522) are very small and covered a small area because there is no antenna.

for now the work will include both of securing and tracking services, the first one will be the securing system represented in a console access function and sending alerts in suspicious or threat cases, the tracking will represented in text message including the name of the tag which moved and the last seen positioning of it, all those messages and alerts will be sent from the control unit using the AT commands through the GSM model.

We are going to introduce each component and the connecting/gathering plans then we talks about the programming languages, interfaces and the different services.

3.2. RFID Securing &Tacking System Components (Hardware) :

3.2.1. Control Unit (ARDUINO MEGA 2560) :

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges,

differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide[20].

The Arduino Mega is a microcontroller board based on the ATmega1280 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila[21].

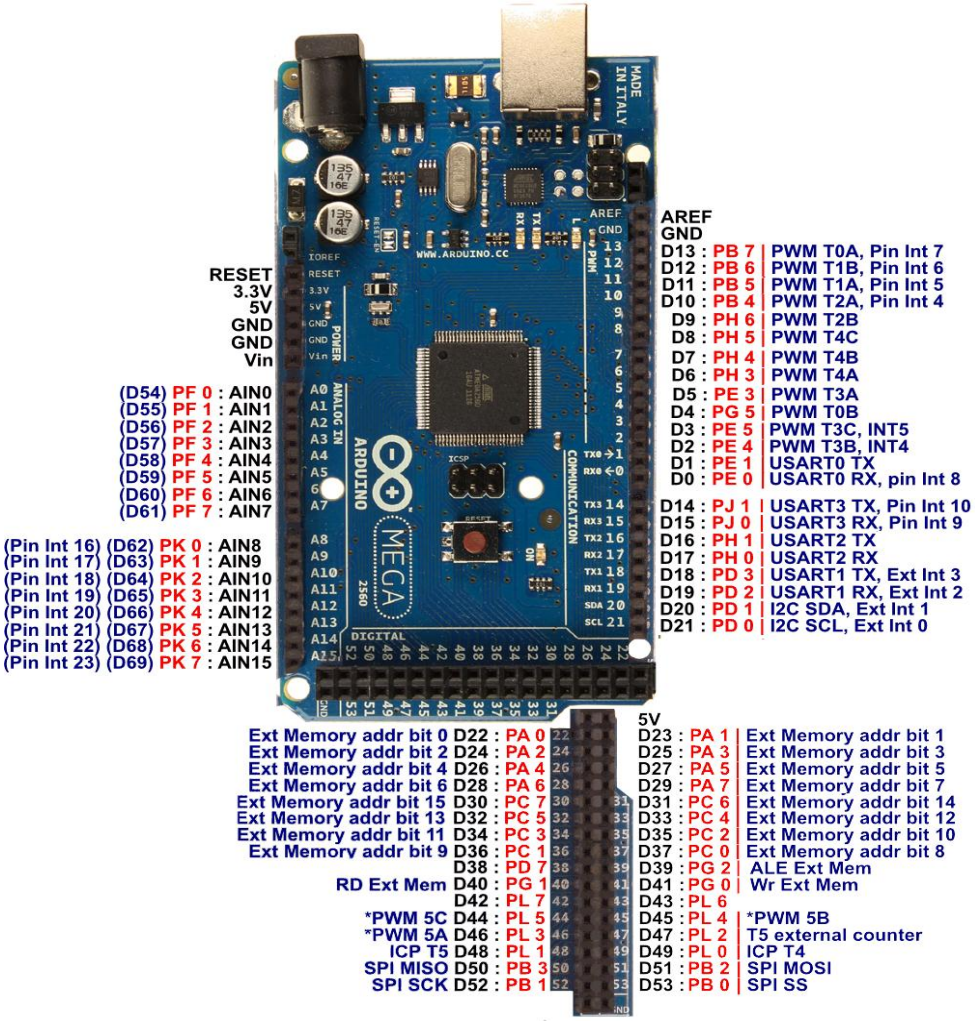


Figure 3. 1 ARDUINO MEGA 2560

3.2.2. RFID Reader (RC522) :

RFID RC522 is used in highly integrated 13.56MHz contactless communication card chip to read and write, of NXP for “three” and the application launched a low voltage, low cost, small size, non-contact card chip to read and write, intelligent instruments and portable handheld devices developed better.[22]

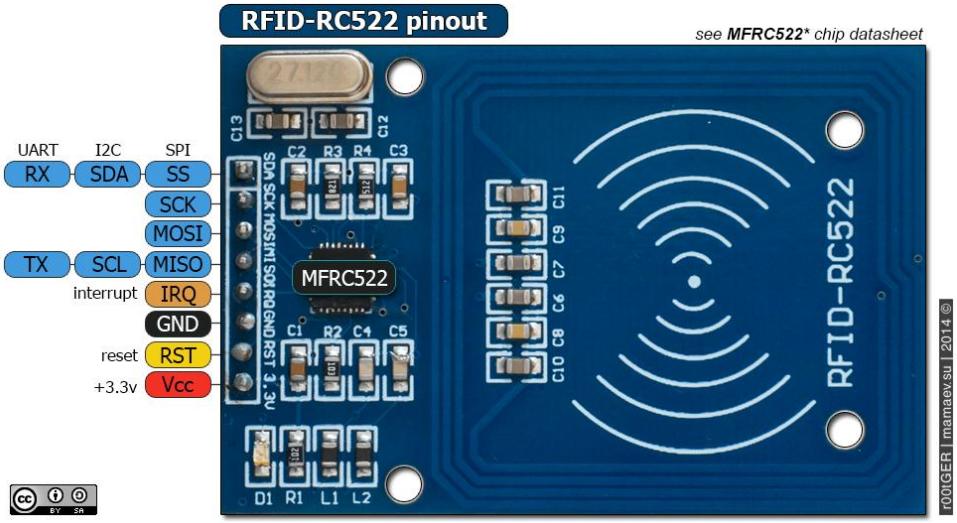


Figure 3. 2 RFID RC522 Reader

3.2.3. RFID Tags :

The tow tags in the Fig 3.3 coming with the RC522 Reader, its available and can be found sold alone and at a low cost.

Figure 3. 3 RFID Tags

3.2.4. GSM model (SIM800L) :

The SIM800L GSM module is one of the smallest GSM modules in the world with a size of 2.2 cm x 1.8 cm. It is a powerful module that starts automatically and automatically searches for the network. It includes Bluetooth 3.0 + EDR and FM radio (receiver only). It will allow you to exchange SMS, to make calls but also, and it is new, to recover data in GPRS 2G +. This way you will be able to transmit data over a very long distance, if for example the FM radio or the Bluetooth is not enough anymore.[23]

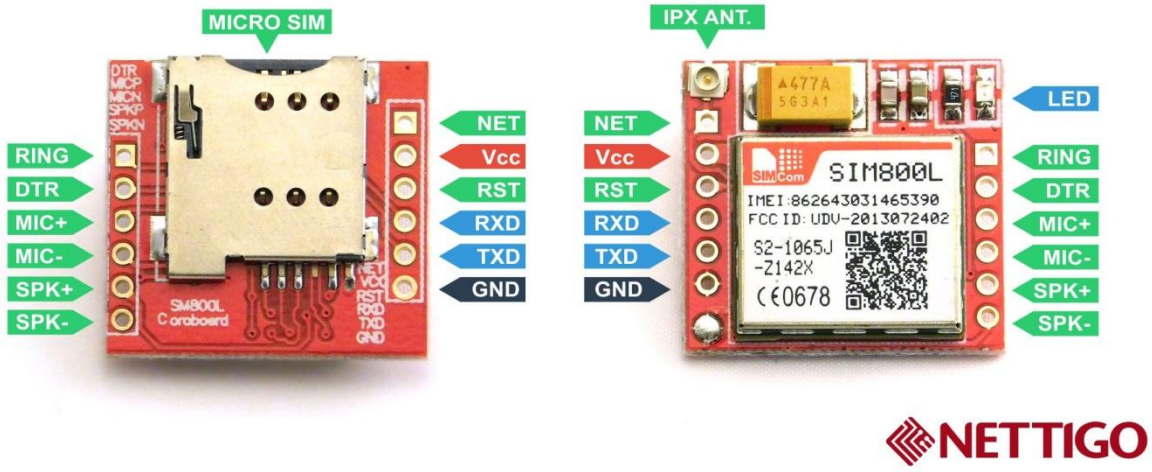


Figure 3. 4 Module GSM SIM800L

3.2.5. Other Component :

3.2.5.1. Mini DC Voltage Step-Down Regulator (D-SUN):

We use it to control the power supply to the GSM SIM800L Model, because it need from (3,4v) to (4,7v) to work.

- Input voltage : 4.5V-28V DC
- Output voltage : 0.8V-20V DC
- Output current : 3A (Max)

In this case we fix the OUT voltage at 4v, and the alimentation from 9v battery.

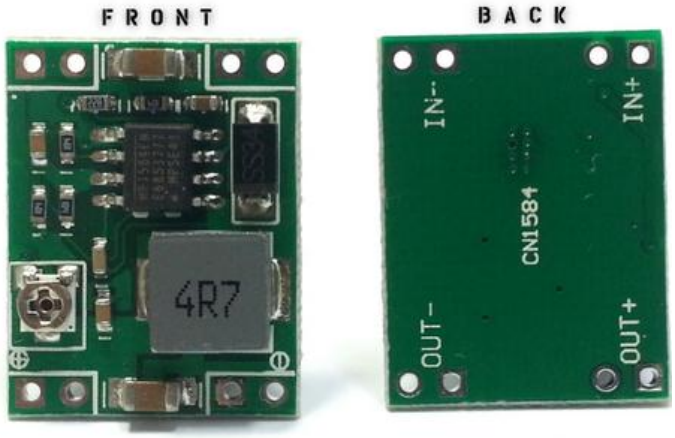


Figure 3. 5 Mini DC Voltage Step-Down Regulator

3.2.5.2. Breadboard :

Its helps to gathering multi RFID readers and minimising the number of connecting wires.

Figure 3. 6 Small Breadboard

3.3. Tracking system circuits Architecture :

In this project we are going to gathering an Arduino (Mega 2560) with two (RC522) RFID readers and a GSM model (SIM800L). we assume that each one from the RC522 readers represent an RFID reader covering a room area, of course we don't have an antenna to extend the covered zone but it will be just a simulation, in the real project the antenna is necessary and the number of the readers will be huge to cover all the access point and the whole area of the smart city.

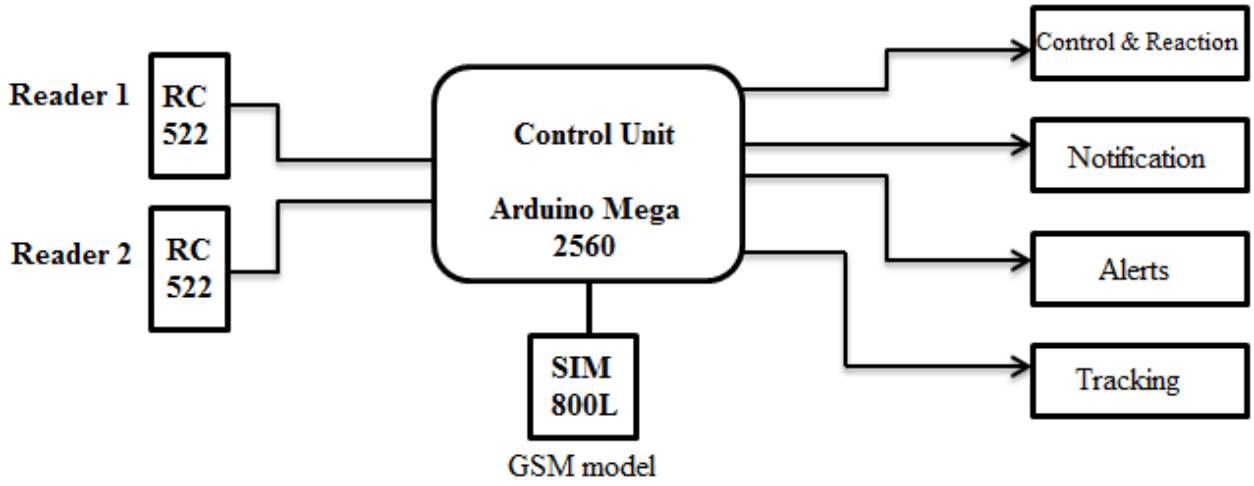


Figure 3. 7 Securing & Tracking System Architecture

3.3.1. Typical pin layout used (Arduino Mega + 2 RC522):

Signal	RC522 Reader/PCD Pin	Arduino Uno Pin	Arduino Mega Pin
RST/Reset	RST	9	5
SPI SS 1	SDA(SS)	10	10
SPI SS 2	SDA(SS)	8	2
SPI MOSI	MOSI	11	51
SPI MISO	MISO	12	50
SPI SCK	SCK	13	52

Table 3. 1 Pin layout used to connect (Arduino Mega + 2 RC522)

3.3.2. Typical pin layout to connect (Arduino Mega + SIM800L) :

SIM 800L Pin	Arduino Mega Pin
GND	GND
TX	RX1 Pin 19
RX	TX1 Pin 18
RST	RESET

Table 3. 2 Typical pin layout to connect (Arduino Mega + SIM 800L)

3.3.3. Circuit and Component :

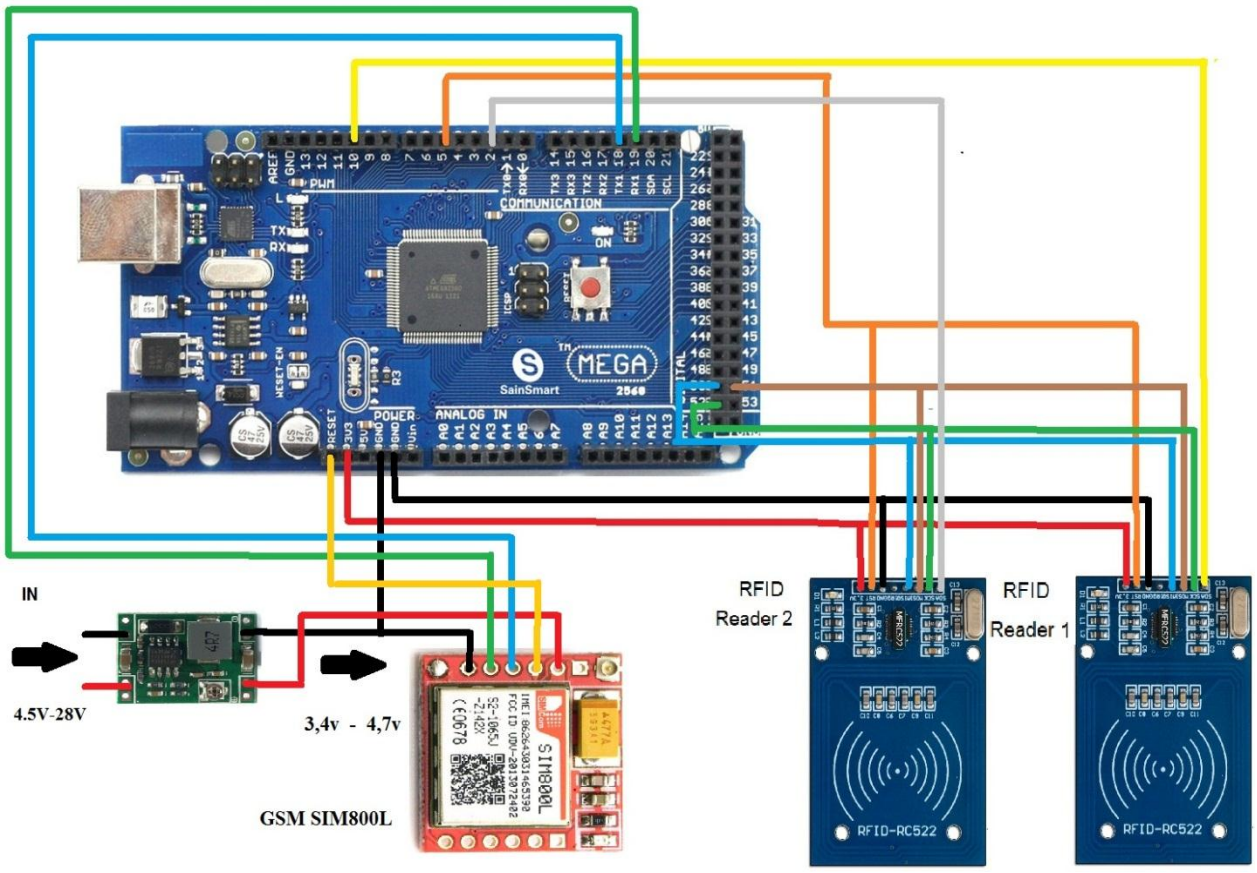


Figure 3. 8 All the component layout scheme

3.4. Tools and Programming Languages :

3.4.1. ARDUINO IDE (1.8.6) :

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

This software can be used with any Arduino board.[24]

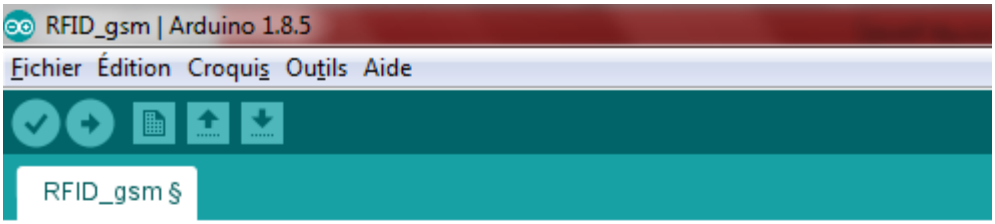
3.4.2. C/C++ Languages :

The Arduino can be programmed with C and C++. the libraries are mostly written in C++.

And when we coding we need two principal functions setup ( ) and loop ( ), and other functions like SENDSMS( ), SENDAT( )

3.4.2.1. Setup ( ) Function :

The setup ( ) function is called when a sketch starts. Use it to initialize variables, pin modes, start using libraries, etc. The setup ( ) function will only run once, after each powerup or reset of the Arduino board.[25]




```
bool x=0, y=0, z=0;

#define GreenLED 12
#define REDLED 13

void setup() {

    pinMode(GreenLED, OUTPUT); digitalWrite(GreenLED, LOW);
    pinMode(REDLED, OUTPUT); digitalWrite(REDLED, LOW);

    Serial.begin(9600);
    while (!Serial) {
    ;
    // wait for serial port to connect.
    }
    Serial.println("Testing GSM Connection!");

    // set the data rate for the SoftwareSerial port
    Serial1.begin(9600);

    SPI.begin();
    rfid.PCD_Init();

    for (uint8_t a=10; a>0;a--) send_AT("AT", 1000, 6, "\r\nOK\r\n");
    send_AT("ATE0", 1000, 6, "\r\nOK\r\n");
    send_AT("AT+CMGF=1", 250, 6, "\r\nOK\r\n");
}
```

Figure 3. 9 Setu( ) Function for the RFID Securing/Tracking Project

3.4.2.2.Loop ( ) Function :

After creating a setup ( ) function, which initializes and sets the initial values, the loop() function does precisely what its name suggests, and loops consecutively, allowing your program to change and respond. Use it to actively control the Arduino board.[26]

```
void loop() {
  if (!rfid.PICC_IsNewCardPresent() || !rfid.PICC_ReadCardSerial())
    return;

  // Serial.print(F("PICC type: "));
  MFRC522::PICC_Type piccType = rfid.PICC_GetType(rfid.uid.sak);
  // Serial.println(rfid.PICC_GetTypeName(piccType));

  String strID = "";
  for (byte i = 0; i < 4; i++) {
    strID +=
    (rfid.uid.uidByte[i] < 0x10 ? "0" : "") +
    String(rfid.uid.uidByte[i], HEX) +
    (i!=3 ? ":" : "");
  }
  strID.toUpperCase();

// When this section is reached, the strID variable stores the UID of the tag.
// can be used to take it to IF to the tube.
// LED on or off
 Serial.print("Tap card key: ");
  Serial.print(strID+ "  ");
if (strID == "F5:E6:56:BE" && x==0) { Serial.println("Tag 1 Acceded"); x=1; }
else if (strID == "F5:E6:56:BE" && x==1) {Serial.println("Tag 1 Leave"); x=0;}

if (strID == "42:4D:62:10" && y==0) { Serial.println("Tag 2 Acceded"); y=1; }
else if (strID == "42:4D:62:10" && y==1) {Serial.println("Tag 2 Leave"); y=0;}

if (strID == "B6:02:66:25" && z==0) { Serial.println("Tag 3 Acceded"); z=1; }
else if (strID == "B6:02:66:25" && z==1) {Serial.println("Tag 3 Leave"); z=0;}

else if (strID != "F5:E6:56:BE" && strID != "42:4D:62:10" && strID != "B6:02:66:25") {
  Serial.println("unauthorised tag");
  Send_SMS("Unauthorised Tag :"+strID);
  digitalWrite(REDLED, HIGH);
  delay(1000);
  digitalWrite(REDLED, LOW);
}
  rfid.PICC_HaltA();
  rfid.PCD_StopCrypto1();
}
```

Figure 3. 10 Loop( ) Function for the RFID Securing/Tracking Project

3.4.2.3. SENDSMS( ) :

```
void Send_SMS(String msg) {
    //send_AT("AT+CMGF=1", 250, 6);
    // use your 10 digit cell no. here
    Serial1.println("AT+CMGS=\"03[illegible]\"");
    delay(1000);

    Serial1.print(msg);
    Serial1.write(0x1A);
}
```

Figure 3. 11 SENDSMS( ) Function

3.4.2.4. AT Commands :

When we upload the program the AT commands will be sent to the GSM model, we wait until we have exactly the response that we are looking for, from the GSM.

These AT Commands are designed according to the ITU-T (International Telecommunication Union, Telecommunication sector) V.25ter document. [27]

AT Command	Response / Request
AT	OK
ATE0	Echo mode off
AT+CMGF=1	Select SMS message format
AT+CMGS=\0000000000\	Send SMS message to this number

Table 3. 3 List of used AT commands[27]

3.5. Interfaces and Project prototype :

3.5.1. Delivered Messages :

The owners receive the messages in real time includes information about the detected Tag, even when read a huge number of tags it still work efficiently.

As shown in the Fig 3.12 below the message contain the entering and leaving tags and the last seen position of the tag in case of tracking.

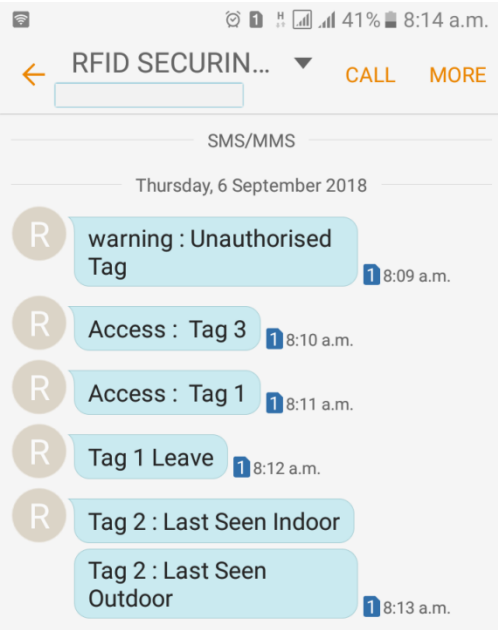


Figure 3. 12 Delivered Messages From The RFID S&T System

3.5.2. Securing & Tracking RFID Prototype :

In this prototype we fixed two RFID readers in different places to cover the access points and simulate the access control system and the reading of tag's positions and use it for tracking

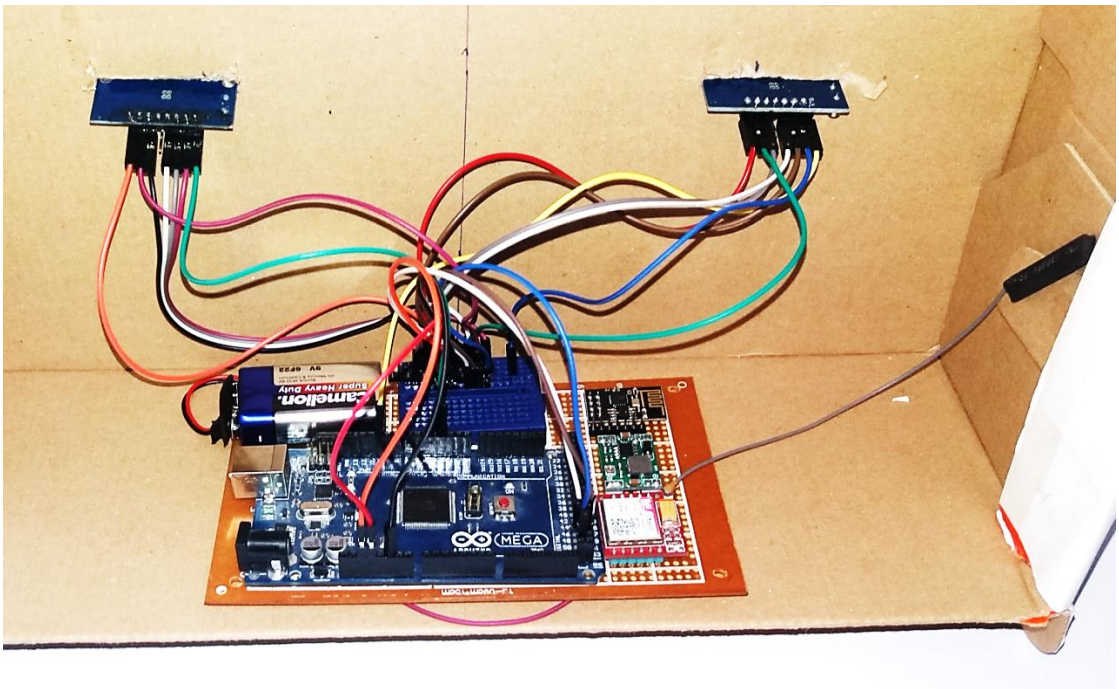


Figure 3. 13 RFID Securing & Tracking System Prototype (Inside)

The prototype from outside (Fig3.14) shown the separated readers, and we assumed that each one of them covering the whole area.

When the tags move through the reader field the SMS will be send immediately.

Figure 3. 14 RFID Securing & Tracking System Prototype (Outside)

GENERAL CONCLUSION

In this thesis, we have been able to almost accomplish the proposal that we have set in the general introduction, we have demonstrated all the processes of developing and designing a smart securing and tracking system that uses the RFID technology as a wireless sensor network and GSM as a communication network, RFID depends on reading electromagnetic field of passive tags and the GSM send the messages to the owners using AT commands, in real time and to far places no matter where, also we have compared and discussed their advantages and downsides with other technologies.

Through the development of the project, we encountered several difficulties, both conceptually and at the level of implementation.

the work with electronic chips is very interesting and It brings to you knowledge and a new experiences away from programming.

One of the most attractive future works that we are planning to accomplish, is that we want to create a fully automated securing and tracking system, that uses different networks and extra range for the RFID readers with possibility of remote controlling such as mobile application, an artificial intelligent and machine learning systems, and why not even printing/reading/writing our own tags and include it in all of smart cities fields.

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Abstract

With the growth of smart cities and the expansion of communication areas between things “IoT”. we are in need of more protection and improved tracking systems.

This thesis discusses the effectiveness of controlling the access points and tracking things and sending alerts in threat cases to the facilities owners, depending on the radio frequency identification "RFID" tags and GSM communication network.

Keywords: Tracking, Smart Cities, Internet of Things IoT, RFID, GSM.

Résumé

Avec la croissance des villes intelligentes et l'expansion des zones de communication entre les choses "IoT". Nous avons besoin de plus de protection et de meilleurs systèmes de suivi.

Cette thèse traite de l’efficacité du contrôler les points d'accès et du suivi des objets et de l’envoi d’alertes dans les cas de menace aux propriétaires d’équipements, en fonction des balises d’identification par radiofréquence "RFID" et le réseau de communication GSM..

Mots-clés: localisation, Villes intelligentes, Internet des objets, RFID, GSM.

ملخص

مع نمو المدن الذكية وتوسيع مجالات الاتصال بين الأشياء. نحن بحاجة إلى مزيد من الحماية وأنظمة التتبع المحسنة.

تناقش هذه الرسالة فعالية مراقبة نقاط الدخول و تتبع الأشياء وإرسال التنبيهات في حالات التهديد إلى مالكي المرافق ، اعتمادًا على علامات "RFID" لتحديد تردد الراديو وشبكة الاتصالات GSM.

كلمات البحث : تعقب الأشياء, المدن الذكية, أنترنت الأشياء IoT , GSM, RFID.