Next Generation Resource Tracking Using RFID Technology

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CERTIFICATE

It is certified that the contents and form of thesis entitled **"Next Generation Resource Tracking Using RFID Technology"** submitted by **Usman Umer, Wasim Ahmad and Muhammad Hamid** have been found satisfactory for the requirement of the degree.

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DEDICATION

To Allah the Almighty

&

To my Parents and Faculty

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First of all, we would like to thank Almighty Allah, who helped us and gave us the capabilities and strengths to successfully complete this final year project. Then, we would like to offer deepest gratitude to our supervisor, Mr. Muhammad Bilal for his kind supervision and support, guidance and help at every step. Finally we would like to give recognition to our parents without their financial and moral support this project would not have been possible.

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1 INTRODUCTION

1.1 Abstract

Identifying different kind of objects based on radio frequency is the primary objective of RFID technology. It is one of the most exciting and promising technology in the field of automated identification. Controlling and tracking the movement of resources will helpful to avoid illegal access or any loss/theft while maintaining the efficiency of the overall system and creating the tracking reports of the resources for any time is a major issue now a days. In an organization it is the biggest issue to track the movement of its inventory, employees and any other assets. The use of RFID technology and placement of RFID devices at different locations of any organization will dramatically improve the efficiency of the tracking system. It will continue to increasingly outweigh the organizations costs in controlling many applications and soon it will be adopted by all sorts of organizations and businesses for controlling the movement of their resources such as employees and assets or inventory items.

Developing a middleware will control all RFID devices and handle all tags information coming from multiple RFID devices and matching tags data with the database will enhance the RFID security. Then it will make movement track of resources. The major issues for such a development are in the design of a robust and flexible database design and software system to handle information coming from multiple devices simultaneously and making the movement reports in real time. We propose the multiple devices placement at different locations to make clear and accurate tracks and avoiding any loss/theft or any illegal access.

1.2 Overview

XRT is an abbreviation for Next Generation Resource Tracking using RFID technology. RFID technology for resource tracking is easy to use and time saving than other similar technologies in the market as the Barcode technology. RFID readers located at different points will identify the tagged asset and corresponding tag ID will be sent to database. ID of the tag will be sent to the database. A report will be generated at the admin point for the corresponding resource movement and the report will be viewed by resource name, by location and also between two different dates for the overall movement in the organization.

Industry or organization professionals around the world often ask themselves "how can we better make track of the movement of our employees and assets and prevent resources theft or the illegal movement of the resources". For most of the organizations unnecessary movement of the resources or the employees may lead to their huge financial lose or any theft of the resources and assets. These managers are striving their best to stop their losses due to its impact on overall company's financial standing. In the efforts of preventing resources theft and reducing shrinkage, most of the organizations should bring in a loss prevention consultant for specific recommendations. These consultants often recommend loss prevention software developed to immediately track the movement of employees and resources in real time. Radio Frequency Identification (RFID) is an automated identification technology that is making it easy for the organizations and the businesses to use this technology and make their jobs easy.

Since automated assets control systems are now mostly preferred by the organizations to enhance security and safety of their assets and resources. This also helps them to save time, make their business fast, quick in working and safe. By the use of RFID tags attached to each of the resource, it makes easy to track and make secure the assets movement. RFID readers located at the entry and exit points and each of the corridor and the labs and offices will detect the resource tag. Tag ID will be sent to the

database along with the date, time and the corresponding RFID device information. At the end, a report will be generated providing information about the movement of the resource at specific locations between specific dates with full information of the timing of the resource movement.

RFID system consists mainly of three components; the transponder/tag, RFID reader and middleware. It is a method of remotely storing and receiving data using devices called RFID or UHF reader. This technology is bringing many real business benefits to today world's organizations. It exerts a major influence in different life areas like inventory tracking and management, modern supply chain management, automated manufacturing, healthcare, library, attendance management and assets tracking. Tagging of products under different organizational areas such as manufacturing or assembling (smart factory), Warehousing, With suitable RFID tags integrated into inventory items is making easy to keep track of the resources movement in real time.

Our solution will provide the tracking of resources which includes the assets, employees and inventory i.e., entry and exit of the resources from an organization or lab etc. It will track the location of the asset, when and at which time the asset was moved; either the movement of the asset was authorized or unauthorized. The movement of the asset will be tracked also, by putting different readers at different points. Once an asset will be moved from one point, corresponding report will be generated providing information about the location and the movement time of the asset. Our system will also provide the location information and groups of assets when and where moved.

1.3 Problem Statement

"Identify and monitor the movement of the resources in real time using RFID technology to avoid any sort of theft / loss or illegal access and maintain the efficiency of the overall system by a robust software/middleware"

The goal of this project is to use RFID technology to keep track of the movement of the resources at any time, at any location and between any two dates. We will further enhance the system for bulk of resources movement by placing multiple devices at different locations of an organization. Since all of the devices will be connected to the central system so when any resource will make movement the RFID device will detect the tag and corresponding tag id, date, time and location from where the tag was detected will be sent to the central database. Since the database will be collection of all of the tags, so for and tag id a report can be generated for its movement at specific locations and between any two specific dates.

1.4 Motivation

Each organization wants to enhance the efficiency and security to its resources against any loss/theft or illegal and unnecessary access and movement. The placement of RFID devices at different locations of an organization will help to solve these problems and makes it all true and provides the security and tracking to the resources movement. This all becomes real scenario by the middleware providing the facility of handling the multiple RFID devices and their records coming into the central database correctly. Since the record in the database contains each tag id along with its movement into the specific locations and timing so it becomes easy now to make and show the report of each of the resource for its entire movement. This report will help in figuring out if there occurred some loss or theft then we can track the resources those who have made their movements in the specific locations and timings.

So this is the reason that an alternative to the barcode; the use of RFID is becoming more and more popular in industry, logistics, retail and other fields as well. It is expected that RFID tags are replacing the conventional barcode labels due to their major benefits that it have over barcode readers as: high data storage capacity, read write capability, read-speed rate, multiple entity identification, information updating, no line-of-sight scanning, durability, and environmental resistance.

We see that Barcode scanners require a line-of-sight to the bar codes, and they usually have to be close to the objects being identified. Moreover, its usage is somehow limited. In case of the inventory items each time we have to scan a single item at once this takes a lot of time if we are moving large amount of inventory / business objects then it requires a lot of time. So then the RFID technology come solution to it which does not require any line of sight. It saves a lot of time as well as it provides the security against theft / loss to products. Since organizations have a large amount of resources and business objects so RFID multi-tag reading capability makes much easier to these organizations to get all the records of their resources movement. RFID readers can read tags without requiring line-of-sight, thus allowing the easy automation of the reading process and making RFID-based identification very appealing commercially. This strategy of tags reading and handling with middleware will continue to increasingly outweigh their costs for security purposes and security person so it is a strong and less costly solution and soon will be adopted by organizations and businesses to control their resources movement.

1.5 Summary

The present technology smart world make us feel that "how can we better make track of the movement of our employees and assets and prevent resources theft or the illegal movement of the resources". Solving this issue, there is a need of such a system which can identify and trace the resources. XRT (Next Generation Resource Tracking System) using RFID technology is developed for fulfilling this need. RFID technology for resource tracking is easy to use and time saving than other similar technologies in the market as the Barcode technology. All the assets need to be tagged in order to be identified by RFID reader; employees will carry RFID cards so that their presence and movement is recognized by the reader. RFID readers located at different points will identify the tagged asset. The corresponding tag ID is stored in the buffer and sent to database for keeping its record. A report generated at the admin side shows the corresponding resource movement. Reports can be generated from

different aspects like resource name, location of the reader and also between two different dates for the overall movement in the reader's proximity.

For most of the organizations unnecessary movement of the resources or the employees may lead to their huge financial lose or any theft of the resources and assets. Radio Frequency Identification (RFID) is an automated identification technology that is making it easy for the organizations and the businesses to use this technology and make their jobs easy.

RFID system consists mainly of three components; the transponder/tag, RFID reader and middleware. It is a method of remotely storing and receiving data using devices called RFID or UHF reader. Developing a middleware will control all RFID devices and handle all tags information coming from multiple RFID devices and matching tags data with the database will enhance the RFID security. Then it will make movement track of resources. This technology is bringing many real business benefits to today world's organizations. It exerts a major influence in different life areas like inventory tracking and management, modern supply chain management, automated manufacturing, healthcare, library, attendance management and assets tracking.

Chapter 2

2 LITERATURE REVIEW

The goal of the project is to help the industries, institutions and the organizations for managing their assets and keeping track of the movement of the resources. It also aims to avoid any theft or loss by the use of RFID tags upon each and every product by making a tracking system. Most of the organizations still depend upon a still good technology but it is time consuming and cannot make security of our assets to much that extent as the RFID. So here is given a brief introduction of this technology [1].

2.1 Barcode Technology

Barcode technology works in the form that it determines the mapping and interpretation of the encoded information or data in the form of lines or some other complex symbols. These lines or symbols represent the digit or the character, when it starts or when it stops as similar to binary encoding. We recognize barcodes as an array of parallel lines alternating between white and black lines. It provides a simple way to encode our information for different products and assets or any type of thing.

There are some different types of barcode technology such as the line or linear barcode technology is usually referred as 1D encoding. There are some complex forms also that use the matrixes and achieve a more complex encoding process that can store and identify the information. And these are referred as 2D technology barcodes. They are not limited to only lines or the matrixes but these also include the circular shape and may be using some image for storing information. Most of the organizations are using the barcode tags to automate the process of identifying their assets and the inventory items. Today, it can be seen everywhere each and every product has a barcode tag. When the barcodes are implemented in business processes, most of the processes can be automated and the errors also reduced. Usually it is used when there is a need to make a record easily and track all products.

2.2 Barcode Reader

A barcode reader or scanner is an electronic device which is used effectively for reading printed barcodes. Barcode reader comprises a light source, a lens and light sensor translating optical impulses into electrical ones. The circuitry included in the decoder analyzes the barcode image data provided by the sensor and then it sends the barcode contents to the scanner output port.

2.3 Barcode Scanners Types

Barcode readers can be divided into the following types. Pen-type readers, Laser scanners, CCD readers, Camera-based readers, Video camera readers, Large field-of-view readers, Omni-directional barcode scanners, Housing types, Handheld scanner, Pen scanner and Stationary scanner, Fixed-position scanner and PDA scanner or Auto-ID PDA.

2.4 Barcode Technology in Industries

Barcodes exist everywhere in the modern world as it is adopted by each store around the world such as almost every item other than fresh produce from a grocery store, departmental store and mass merchandiser. The barcode helps track items and also reduces instances of shoplifting involving price tag swapping, although shoplifters can now print their own barcodes. Barcodes are widely used in the healthcare department and hospital settings and can handling the large amount of the organization data.

It is also used for the medication management and the patient identification such as to access patient data; including medical history, drug allergies etc. It is also used in airline luggage, nuclear waste registered mail express mail and parcels such as we see used by TCS Service. Another big usage of barcode is in library management .These are the some of the organizations that mostly use barcode tags for their products tracking and sales.

2.5 Introduction to RFID technology

Radio frequency identification system uses tags, or labels attached to the objects to be identified. It uses two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response. The readers generally transmit their information and observations that is based on tags collections to a computer system running RFID software or RFID middleware [4].

RFID is a wireless technology that uses radio-frequency usually it is electromagnetic field to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. There are different types of tags. Some tags which require no battery and are powered by the electromagnetic fields used to read them. Some use a local power source and emit electromagnetic field radio waves [4]. The tag contains data in the embedded circuit that is electronically stored information which can be read from up to several meters even up to 100 meters away. Unlike barcode technology, the tag does not need to be within line of sight of the reader, it may be embedded in the tracking object and resource.

The tags contain information as for our scenario is tag ID, date, time and the device information. It may contain some other product related information but overall information is stored electronically in a non-volatile memory. The RFID tag includes a small Radio Frequency transmitter and receiver embedded in a small and thick circuit. An RFID reader transmits an encoded radio signal to interrogate the tag for all of its information. The tag receives the message and responds with its identification information. This may be only a unique tag serial number, or may be product-related information such as a company information, production date, expiry date or other specific information or a resource tag detection date and time.

2.6 Advantages of RFID

Unlike bar code-based tracking systems, an RFID system can read the information on a tag without requiring line of sight and without the need for a particular orientation which makes it more strong and real to track any resource and asset. That means RFID systems can be largely automated, reducing the need for manual scanning.

Moreover, RFID tags hold much more data than Universal Product Code (UPC) labels of the barcode. The tag can be programmed to hold information such as an item's serial number, company information, and color of the product, size, manufacture date and current price, as well as a list of all distribution points the item touched before arriving at a store. Some RFID systems allow companies to write information to the tag and store it there; the RFID tag then essentially acts as a portable, dynamic database. Other systems allow the information contained on the tag to be edited, added and deleted or to be locked. These are the capabilities that are particularly valuable when dealing with high-end resources and assets or inventory tracking and other applications when complete, up to date information is of particular benefit.

2.7 Item level tracking

The ultimate goal of RFID systems is to provide the benefits of technology at a cost that supports items-level resource tracking. Such item-level resource tracking would provide each unit of resource, assets and inventory with a unique ID.

When RFID technology is used for the tracking purpose, the resources and accuracy of the inventory items, goods tracking rise exponentially. Physical assets and inventories and product re-ordering will be done in a fraction of time. It will help the retailers and the organizations to take inventory much more frequently. Truly automated checkout will become viable as RF interrogators list the contents of a shopping cart without moving any of the items. And truly accurate and timely reconciliation of shipments will cut down on shrinkage. New manufacturing

technologies already promise automated, high-speed RFID tag production that will reduce tag costs, a major step in making these benefits possible. It has been predicted by the industry professionals that the new tags information will be as low as five cents per tag and it will occur soon in the next year. As item-level RFID systems move from resource tracking to item manufacturing, perhaps spurred by large organization and retailer demands for tagged resources and merchandise, companies will begin to experience more of the efficiencies of a well-integrated RFID technology system.

2.8 Historical background

In 1945 Leon Theremin invented an espionage tool for the Russia which retransmitted incident radio waves with audio information. Sound waves vibrated a diaphragm which slightly altered the shape of the resonator, which modulated the reflected radio frequency. Even not an identification tag but being this device was a covert listening device, it is considered to be a predecessor of RFID technology, because it was likewise passive, being energized and activated by waves from an outside source.

Similar technology, such as the IFF transponder developed in the United Kingdom, was routinely used by the allies in World War II to identify aircraft as friend or foe. Transponders are still used by most powered aircraft to this day. Another early work exploring RFID is the landmark 1948 paper by Harry Stockman, titled "Communication by Means of Reflected Power" (Proceedings of the IRE, p 1196–1204, October 1948). Stockman 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."

The first very true ancestor of modern RFID technology was a passive radio transponder with memory developed by Mario Cardullo's, patented on January 23, 1973. The initial device was passive, powered by the interrogating signal transponder

with 16 bit of memory for use as a toll device, and was demonstrated in 1971 to the New York Port Authority and other potential users. The basic Cardullo's patent covers the use of RF, sound and light as transmission media. The original business plan that was presented to investors in 1969 showed them the uses in transportation in different industries such as automotive vehicle identification, automatic toll system, electronic license plate, electronic manifest, vehicle routing, vehicle performance monitoring. Its use in banking comprises electronic check book, electronic credit card. In security it has the applications as personnel identification, automatic gates, and surveillance and for medical sector it can be used in identification and patient history.

In 1973 Steven Depp, Alfred Koelle, and Robert Freyman performed the early demonstration of reflected power (modulated backscatter) RFID tags, both passive and semi-passive, at Los Alamos National Laboratory. This system was using a 12 bit tag at 915 MHZ. The same technique is now adopted by the majority of today's Ultra High Frequency Identification Detection (UHFID) and microwave RFID tags. In 1983 the first patent to be associated with the abbreviation RFID was granted to Charles Walton.

The largest deployment of active RFID is the US Department of Defense. It uses the semi active tags on every one of its more than a million shipping containers that travel outside of the continental United States. The largest passive RFID deployment is the enterprise-wide deployment performed by Wal-Mart which instrumented over 2800 retail stores with over 25,000 reader systems, however the exact number is considered 'corporate confidential'.

2.9 RFID System

RFID System comprises of three things

(i) Reader or Interrogator

(ii) Tags

(iii) Middleware

2.9.1 Reader or Interrogator

A transmitter/receiver that reads the contents of RFID tags in the vicinity is also called an RFID interrogator." The maximum distance between the reader's antenna and the tag vary depending on the range that the reader is covering and also the tag used. Usually credit cards and ID badges have to be brought fairly close to the readers, somewhat like bar codes because of protecting the confidential information. For other applications like resource tracking and inventory and assets control system, passive RFID tags can be read up to approximately 10 feet away, while active tags with batteries can be several hundred feet from the reader [4].

The antenna types such as linear polarized antennas transmit in a straight line, and their orientation to the RFID tags is critical otherwise reader is not able to detect RFID tag. But still readers of this type are required in applications such as readers used for conveyer belts where tags can be adhered to the cartons in a consistent manner. There are other reads with circular polarized antennas that radiate in a 90 degree pattern and are less sensitive to the tag's orientation on the package. The radio waves also move around obstructions better than linear antennas.

Depending on the functionality and the distance range that UHF readers cover, have prices in the range of $500 to $3, 000. Dumb readers are readers with limited computing power. They tend to be cheaper than intelligent readers, which typically have on-board computing power and can filter data, store information and execute commands. Agile readers can communicate with tags using a variety of protocols, and multi-frequency readers can read tags using different frequencies. Agile and multi-frequency readers may also have on-board computing power for filtering data and running applications [5].

2.9.2 RFID Tag

The electronic chips that are contactless and can be used for the same purpose as that the barcode technology. But in this technology the tag can be read at a distance ranges from 1 meter to 100 meters depending upon the power of the transponder. This

electronic chip or circuit is called an RFID tag. It is a microchip combined with an antenna within a compact package. This structure or packaging of the tag makes it easy for the tag to be attached with any object to be tracked. The tags antenna communicates with the transponder by picking a signal and then returns the signal that contains the necessary information comprising of ID or the serial number, lock status of the tag and may be some stored customization information.

The sizes of the tags may be different depending upon our requirement. Their size ranges from a rice grain to a few inches. There are two implementations of the RFID technology comprising of Active and Passive RFID. Let's have an introduction to active and passive technology [2].

For reusable applications, it is typically embedded in a plastic housing, and for tracking shipments, it is usually part of a "smart" packaging label. For RFID applications such as toll collection and vehicle and container tracking, the tags are used over and over for many years. Such tags are built into a plastic housing like handheld calculators and other electronic devices. An RFID tag is often confused with an RFID label. A tag is a transponder mounted on a substrate. It can be embedded in packaging or stuck on with adhesive. An RFID label is a transponder sandwiched between a layer with adhesive and paper that can be printed on.

There are different tag types as passive tags, active tags and semi-passive tags. There is no battery power available in the passive RFID tag, and the power is supplied by the reader when it wants to communicate with the tag. Usually the passive tags transmit the signal upon receiving RF energy emitted from a reader nearer to the tag. When the radio waves are in contact with the passive tag, the antenna within the tags makes a magnetic field. The tag draws a power from it and energizes the whole circuit. Once the tag got energy then it sends the information encoded in it to the transponder. The operating range is often up to 30 to 40 feet [2].

Since there is no power source so these tags are usually used for inventorying purposes using the handheld RFID readers, but these can also be used for the movement tracking of the assets as long as there is no security risk.

The minute electrical current induced in the antenna by the incoming radio frequency signal provides just enough power for the integrated circuit (IC) in the tag to power up and transmit a response. The carrier signal form the reader is usually backscattered by most of the passive tags signal. This means that the aerial (antenna) has to be designed to both collect powers from the incoming signal and also to transmit the outbound backscatter signal. The response given by a passive RFID tag is not just to return an ID number; it gives information stored in tags memory about the concerned asset or resource and the date, time and the device information. The tags can have even at a very small size due to lack of an onboard power supply. So there are commercially available products exist that can be embedded under the skin like in poultry and dairy forms for the animals protection. Usually these types of tags are even of small size as a rice grain to be embedded into the skin. Due to their simplicity in design they are also suitable for manufacture with a printing process for the antennae. A development target is polycarbonate semiconductor tags to become entirely printed. Passive RFID tags do not require batteries, and can be much smaller and have an unlimited life span. Passive tags are cheaper than active tags.

But pinning down tag costs is not easy. The frequency at which the tag works i.e., high or ultrahigh frequency, the amount of copper used in the antenna also increases if the antenna is to operate at high frequency, the amount of memory in the tag and design of the antenna all things combine to make the cost high or low for a passive tag. Passive tags generally range from 20 cents for the simplest license plate tag purchased in high volume to several dollars for a transponder embedded in a key fob or plastic housing, to protect the tag from heat, cold or chemicals.
Unlike Passive RFID tags, Semi-passive RFID tags have a built in small battery. The remaining features are almost the same as in Passive RFID tags .The built in battery allows the tag IC to be constantly powered. This removes the need for the aerial to be

designed to collect power from the incoming signal. Semi-passive RFID tags are faster in response and therefore stronger in reading ratio compared to passive tags.

An active RFID tag, the tags are powered by a battery and these tags automatically broadcast their signal to the RFID reader or transponder device. The tag life usually ranges from 3-8 years depending upon their distance at which they are operating. Their costs is usually 15-50$ which depends upon the quantity and the options for which the operation is to be performed such as motion sensor, tamper detection and the temperature measurement. These are usually used to perform the real time monitoring for some specific areas. And these can also provide better security than passive tags [2].

Since active tags have their own internal power source which is used to power any ICs and generate the outgoing signal. They may have longer range and larger memories than passive tags, as well as the ability to store additional information sent by the transceiver. At present, the smallest active tags are about the size of a coin. Many active tags have practical ranges of tens to hundred meters, and a battery life of up to 10 years. Like passive tags the cost of active tags also depends on the size of the battery included, the amount of memory on the microchip and the packaging around the transponder. Active tags are not mass-produced in high volume and don't have problems with antennas detaching from the microchip because they are usually housed in protective plastic.

2.9.3 RFID Middleware

In its most general sense, middleware is computer software that provides services to software applications beyond those available from the operating system. Thus middleware is a customized application that makes it easier for the user and the developer to communicate with the device for input and output operations so they can focus on the specific purpose of their application. Like as we are providing solution that will provide the facility to track the movement of resources such as inventory,

assets and employees i.e., entry and exit of the resource from an organization or lab etc. It will track the location of the resource, when and at which time the resource made movement; either the movement of the resource was authorized or unauthorized. The movement of the resource will be tracked also, by putting different readers at different points. Once a resource will move from one point, corresponding report will be generated providing information about the location movement of the resource. Our system will also provide the location information and groups of resources when and where moved.

2.10 Technological Advancements

Technological advancements in the field of RFID technology are increasing the acceptance and growth of the RFID technology to be accepted at wide industrial range. These advancements can provide the following advantages:

- Make existing applications easier to use
- Offer more functionality
- Drive deployment costs down

Technological advancements open the door for new applications that were not imaginable or possible before. In the following section, we explore some of the more significant technological advancements that are under development today. Innovation around the design and manufacture of RFID tags is an ongoing process. Some of the most promising new designs are covered in the following sections.

2.11 New and Improved Tags

Physical size and environment are the factors, affecting the readable range and accuracy of tags. Some examples are detection near metal or liquid and extreme weather conditions such as low temperature or high humidity. Besides simply improving on existing technology to overcome these limitations, alternative physics are being employed that can sidestep or leapfrog these limitations.

The majority of the work in the alternative physics area includes developments around chip less tags, "Components of RFID Systems." Due to the absence of integrated circuitry chip less tags promise to improve upon the physical limitations of radio frequency detection while potentially offering reduced costs. There are different areas where chip less tags can be more easily applied near metal and liquid or embedded in items like paper. Due to it's this capability it offers greater flexibility and functionality with their use in different areas described earlier. Surface Acoustic Wave (SAW) technology involves the propagation of radio frequency acoustic waves on the surface of polished crystals. Other technologies that are revolutionizing the RFID technology are using nanotechnology, genomics, or even chemistry to achieve chip less tagging and unique identification of objects such as paper currency and product labels. A smart active label (SAL) tag is essentially a semi-active smart label with its power source in the form of a thin, flexible battery. Using SAL tags, tagging and detecting cans of soda and bottles containing liquid can become more practical and economical.

2.12 Tag Packaging

The new tag packaging technology that is using a different approach to tag packaging that is very promising. It prints the electronics circuits. This involves the process of "printing" antennae, transistors, or even integrated circuits using conductive ink and standard printing processes. There is a lot of potential to inexpensively print a tag onto a box or the packaging of an item that is unlocking a new set of possibilities for the widespread application of RFID in everyday items. Advancement by some of the companies made, they have designed smart label antennae that use conductive ink instead of copper.

2.13 Sensory Tags

Some types of tags even react to all sorts of environmental conditions whose packaging integrates them with sensors and they can monitor and record the conditions that's why they are known as sensory tags. These tag types promote an

entirely new set of applications. The major advancements here will be around the coupling or combining of RFID tag technology with sensor technology in very small form factors. Smart Dust is one such combination that offers the functionality of tiny environmental sensors known as Micro Electro Mechanical Sensors (MEMS) with active RFID tag-like capabilities. The size of each such device is expected to be one cubic millimeter in size that is much small. The potential applications of this technology have a wide area, from monitoring battlefield activities in a military operation to tracking the facial movements of the disabled to control their wheelchairs.

Chapter 3

3 SYSTEM DESIGN

3.1 USE CASES

This part of the documentation discusses all the identified use cases in our system. A use case describes the system's behavior as it responds to a series of related requests from an actor. There are eight use cases identified in our system. Details of these use cases are also given

Table 3.1: Use Case for Registering Assets

Use Case	**Registering Resources**
Actors	Administrator
Type	Primary
Purpose	To register all the resources and save their respective information in the database
Description	All the new resources are registered for the sake of security and convenience(identification, tracking)

Table 3.2: Assets/Resource Authentication Use Case

Use Case	**Resources Authentication and movement**
Actors	Administrator
Type	Primary
Purpose	To ensure the proper movement of resource
Description	Identifying the tagged resources and matching the result in the database to ensure that the resources movement is legal

Table 3.3: Device Connect and Disconnect Use Case

Use Case	**RFID Reader Connection & Disconnection**
Actors	Administrator
Type	Primary
Purpose	To connect the reader with the server & disconnect it from the server when operation is completed
Description	For identifying or tracking the assets we should first connect the RFID reader with the server and after completion of the process disconnect it

Table 3.4: Device Setting Use Case

Use Case	**RFID Reader control settings**
Actors	Administrator
Type	Primary
Purpose	To set baud rate and communication port through which the communication between Reader and Server take place
Description	Setting a high baud rate will result in high data transfer and will give a real time response, set com port according to the connection you made with the system

Table 3.5: Use Case for Downloading Resource Information

Use Case	**Downloading data**
Actors	Common user
Type	Primary
Purpose	Downloading the data stored in the RFID devices for monitoring the resources movement
Description	Receiving information from the tags memory (name, price, position, location, model etc.) and making reports on that data for each of the individual resources and on location bases.

Table 3.6: Generating Reports Use Case

Use Case	**Generating Reports**
Actors	Common user
Type	Primary
Purpose	To report the resources movement, make attendance of the students, checking is there any thefts/loss for a specific location
Description	The downloaded data is stored in the database and generate the reports for each of the individual resource movement and the movement at the specific location or the movement between any two dates

Table 3.7: Use Case for Assets/Resource group management

Use Case	**Resource Group Management**
Actors	Common user
Type	Primary
Purpose	To categorize all the available resources for the sake of convenience
Description	Group of resources are made which are related, which help in reporting movement of the resources and overall resources for any organization

Table 3.8: Use Case for Displaying Information log

Use Case	**Displaying information**
Actors	Common user
Type	Primary
Purpose	To know about name, price , location of the resource and also finding out the movement of resources
description	Getting information from the memory of a tag attached to a resource and displaying them on the forms and figuring out the movement of resources

3.2 SEQUENCE DIAGRAMS

Sequence diagram is a kind of interaction diagram in Unified Modeling Language. It shows how processes operate with one another and in what order. It also shows object interaction arranged in time sequence.

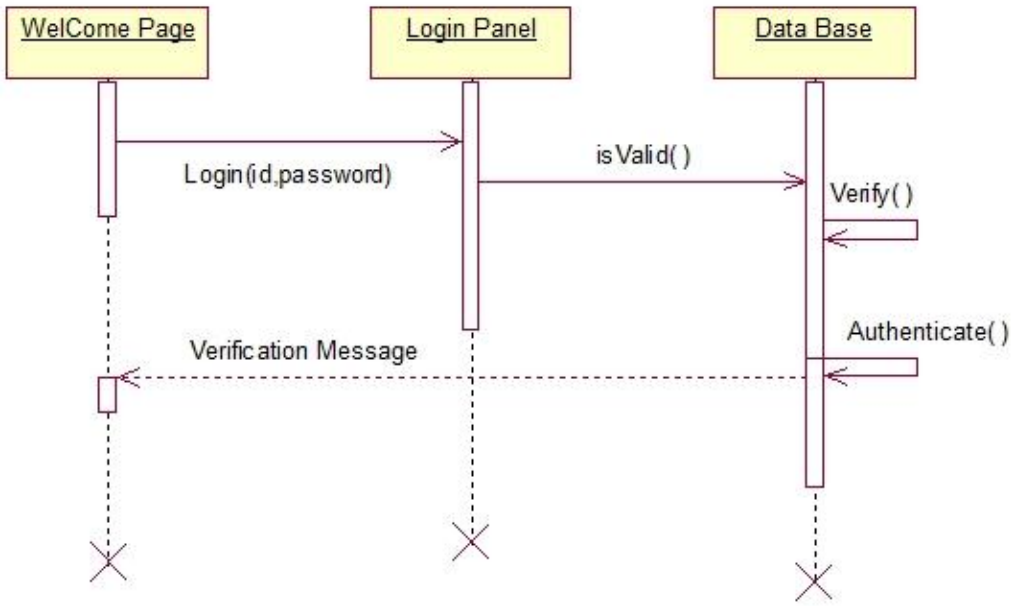

Figure 3-1: Login process Sequence diagram

Figure 3.1 of the sequence diagram is showing the working of login process. The user will interact by providing its credentials through the login panel of our application. And user's data will be verified and authenticated at the same time from database and showing the user message of success or failure.

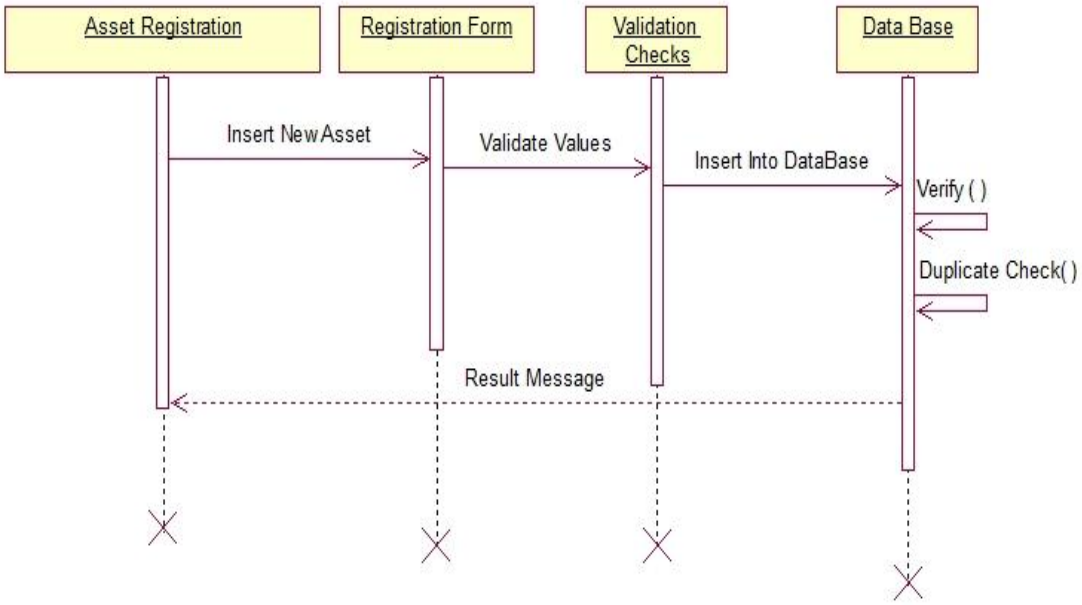

Figure 3-2: Sequence diagram for resource/asset Registration

To insert new asset, figure 3.2 of the sequence diagram is showing when we have to insert values into the registration form, a validation check will be performed whether the required information is included or not and then finally it will be checked in database to avoid any duplicates. Finally the success or failure message will be shown to the user.

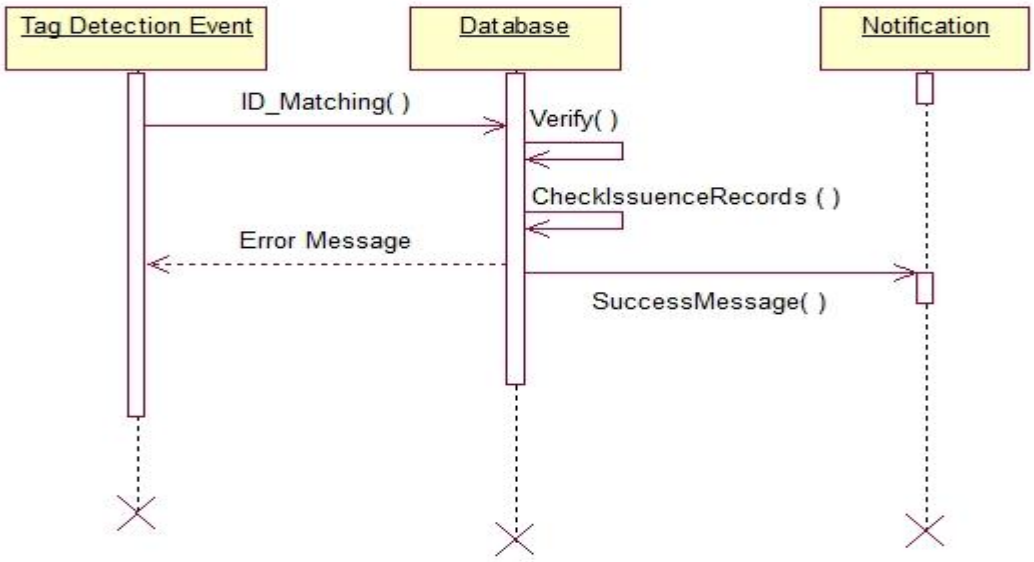

Figure 3-3: Sequence Diagram for resource/asset Authentication

In figure 3.3 of sequence diagram it is shown that once the tag will be detected by the RFID reader, it will match and verify in the database whether the tag record exists or not. If the tag record is found a correspondence success message will be shown to the user about the asset movement. Otherwise error message will be sent if the tag record not found, so then we have to register that asset.

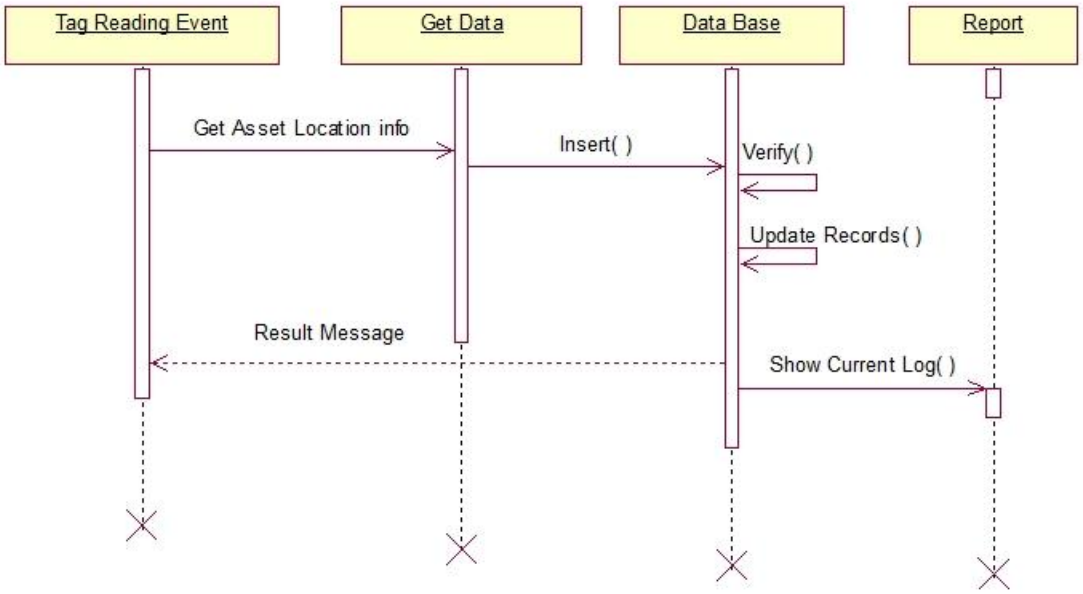

Figure 3-4: Downloading Assets/resources Information

According to this sequence diagram 3.4 to download the tags data on central PC an automatic or manual way is set to collect the data from the RFID devices located at different places. After retrieving data from readers it will be sent to central database where it is verified and updated. Once we have completely retrieved all of the devices records for a specific timing so finally reports will be generated showing the records movement according to places, assets and location wise.

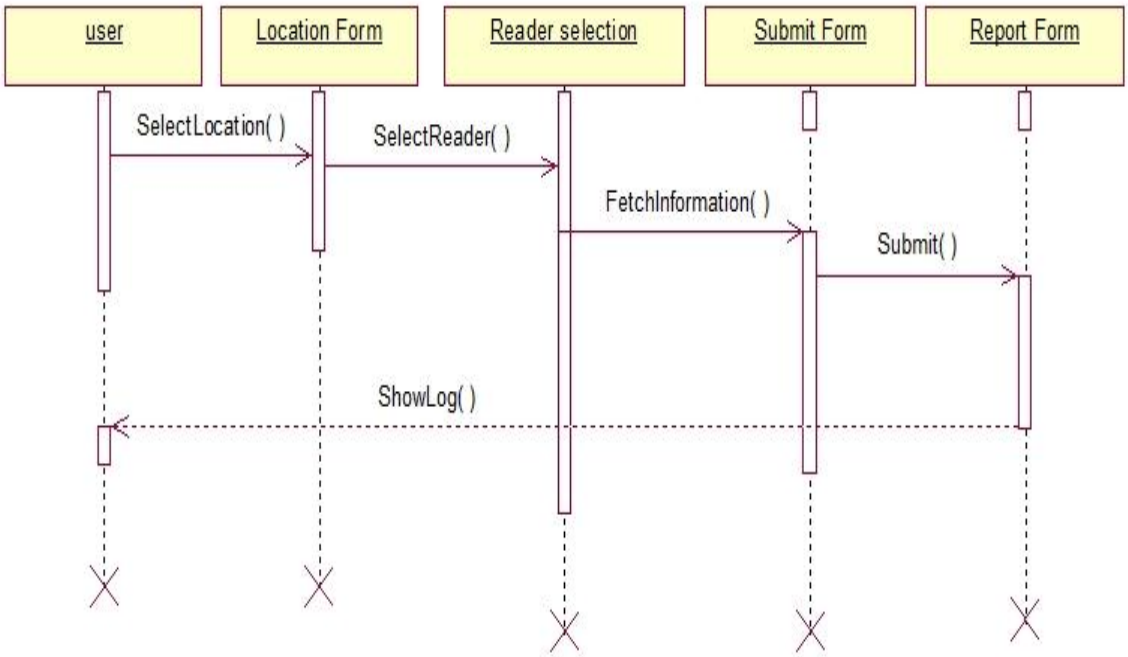

Figure 3-5: Report Generation Sequence diagram

The reports are generated to track the movement of resources and assets. So in this case according to sequence diagram 3.5 if we want to see the movement at specific location so we will select the RFID reader from our application at that location and we will fetch information and records from that reader. Once the records are fetched, after manipulating records our report will show the movement of a specific person, asset or any resource at any time and location.

3.3 ERD of the XRT Database

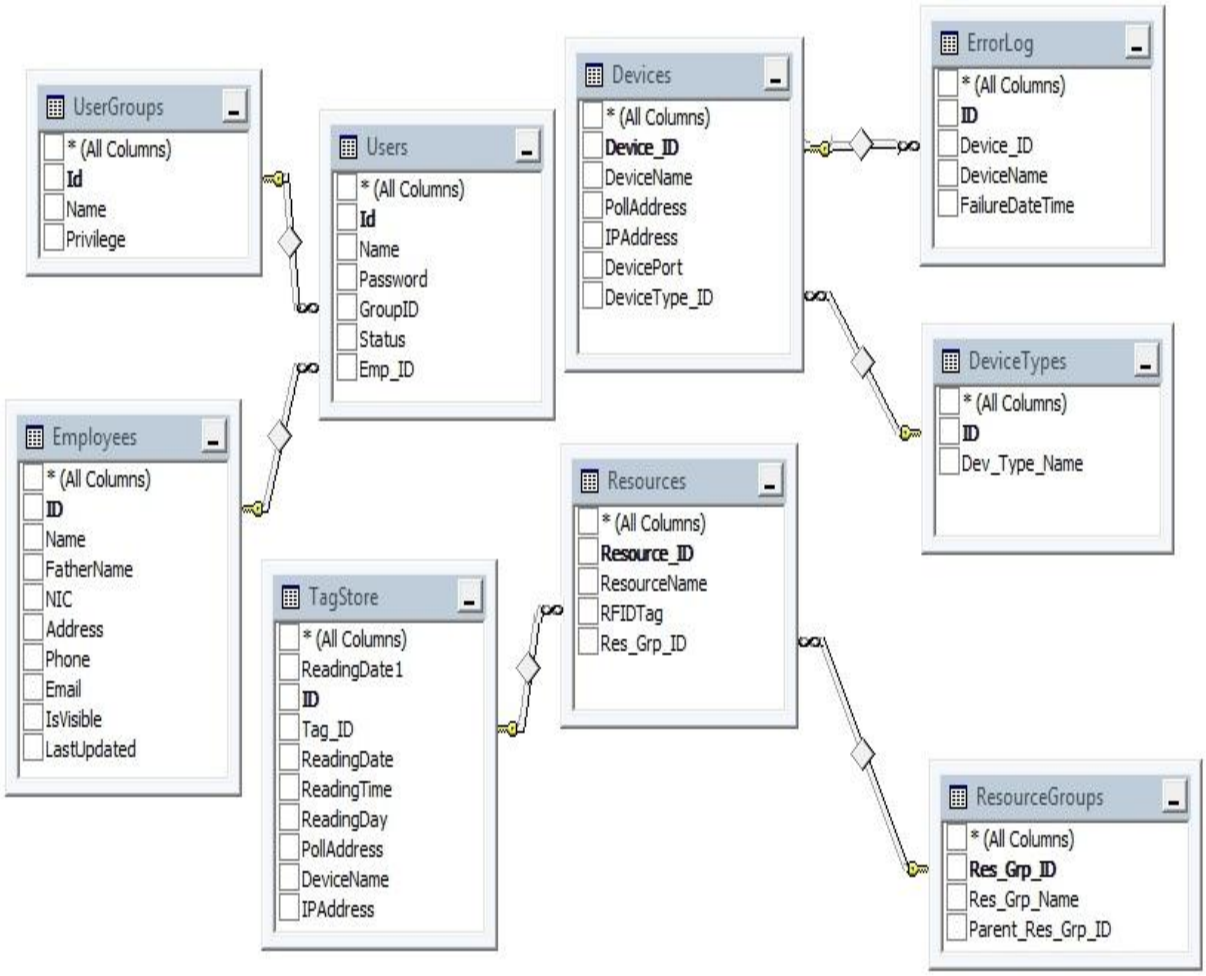

Figure 3-6: ERD of the XRT database

3.4 User Interface of the Software

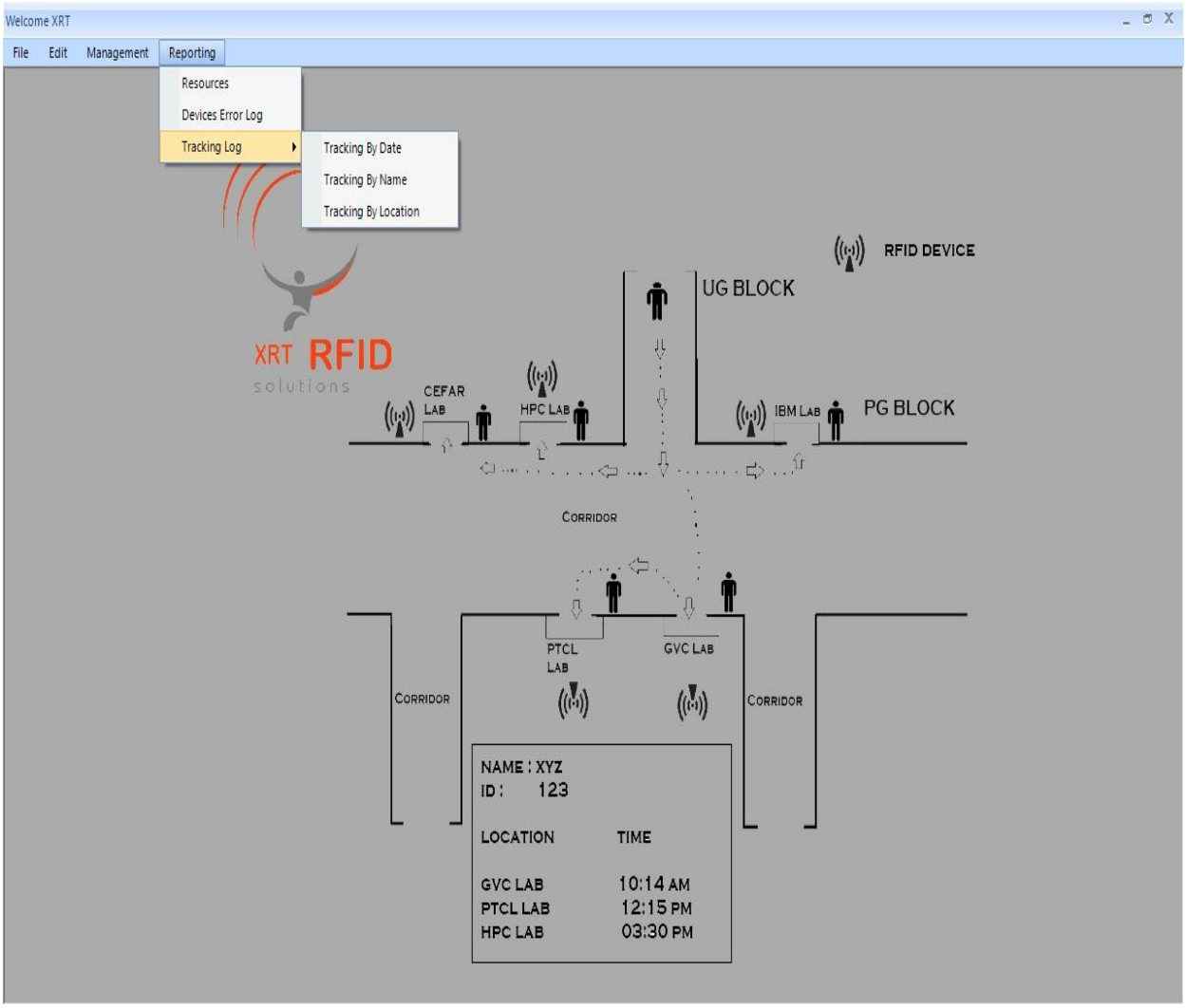

Figure 3-7: XRT Main Layout

Figure 3.7 is showing the main page of the software XRT. It is having three main options available to the user as edit, management and reporting. Edit includes resources and devices registration and update options for resources and devices information. The management tab includes devices configuration, data downloading functionality and the reporting finally includes the reports of the assets movements.

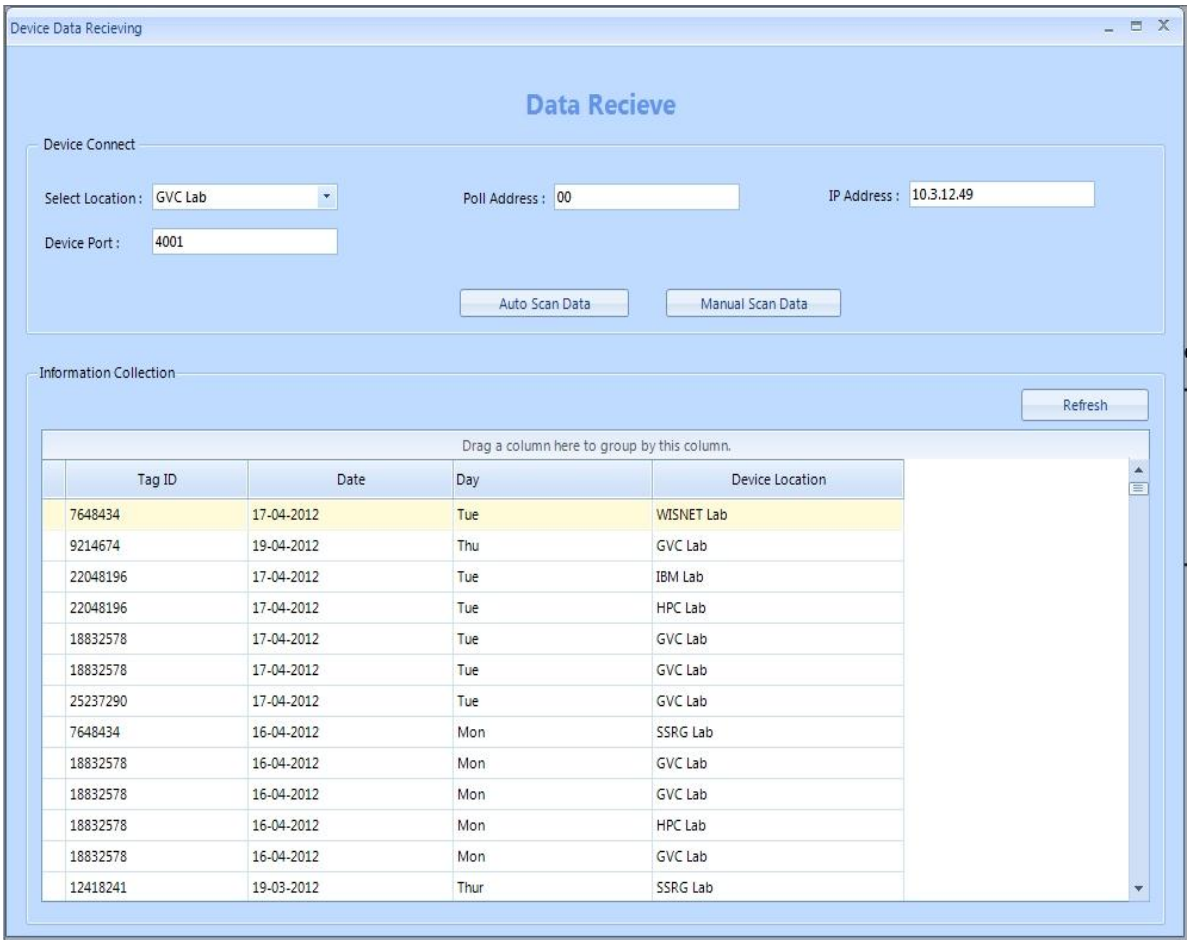

Figure 3-8: XRT Data downloading form

Figure 3.8 is showing data receive or data downloading form. In this form we are connecting to the device by selecting our device and setting its poll address, IP address and the device port. Once our connection is established, data filtration is applied at the background and then finally data is downloading. Once data downloading from a single device is complete automatically our software is disconnects the device and closes the device port. Since here are two options available to us one is manual data download and the other one is auto scan data. In manually we select device of our own option and get download its data. Where as in case of auto scan, at a specific time interval set by our self, all of the devices registered in the software will be automatically connected and correspondingly there IP address, poll address and port number will be set. And data will be downloaded and the disconnection will take place

after data download and the next device or RFID reader will be connected and in this manner the whole readers data will be download and after that time interval this will take place again.

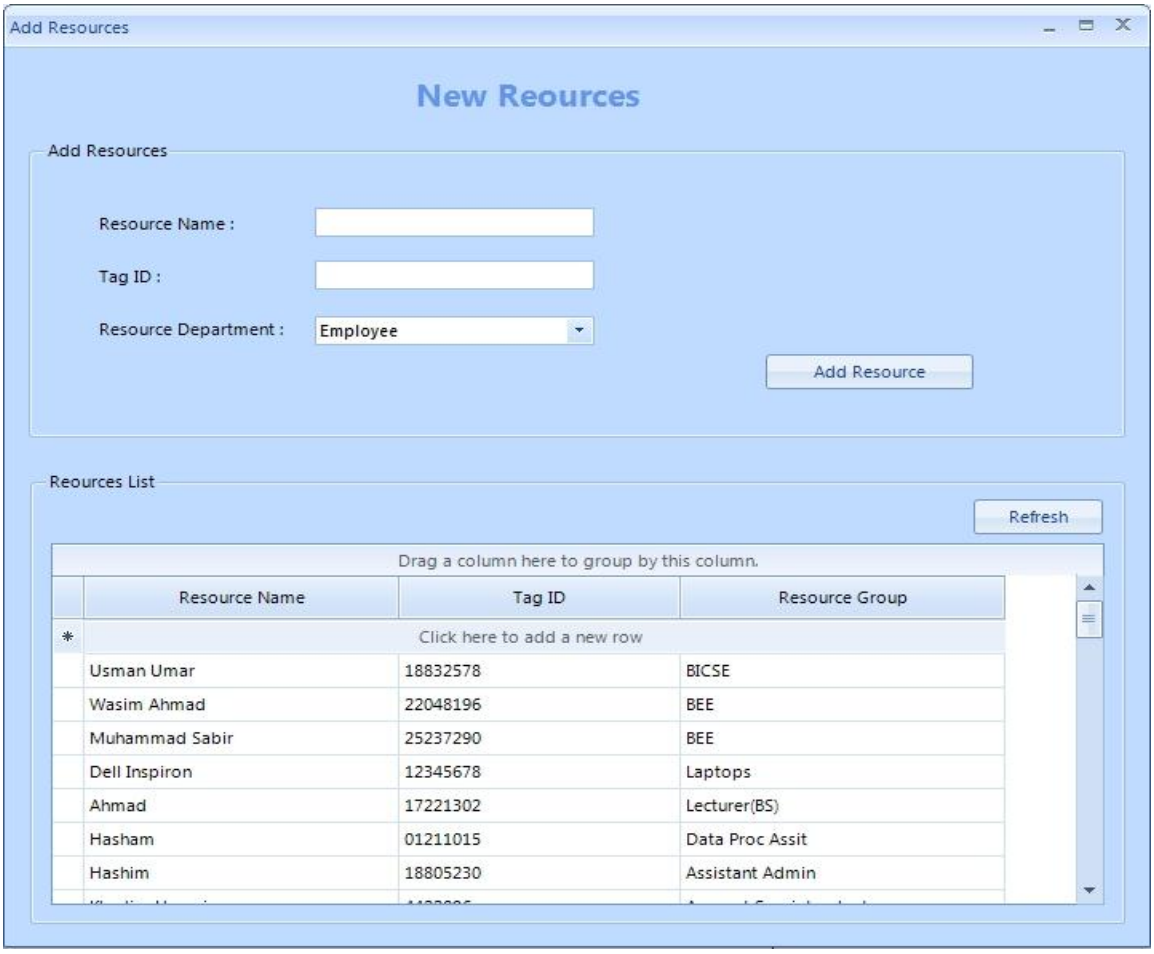

Figure 3-9: XRT New resource Registration form

Figure 3.9 is showing the resource registration form. In this form we are registering our resources whether it is employee, student or any other thing such as laptop or machine. Resource name along with the tag ID is inserted and the resource department or resource category is selected to make a resource group. Once the resource is registered so now it becomes easy for us to track the resource at any place where we

have installed the RFID readers, because once the reader identified the tag id, we can track which resource made a movement at which specific location and at what time.

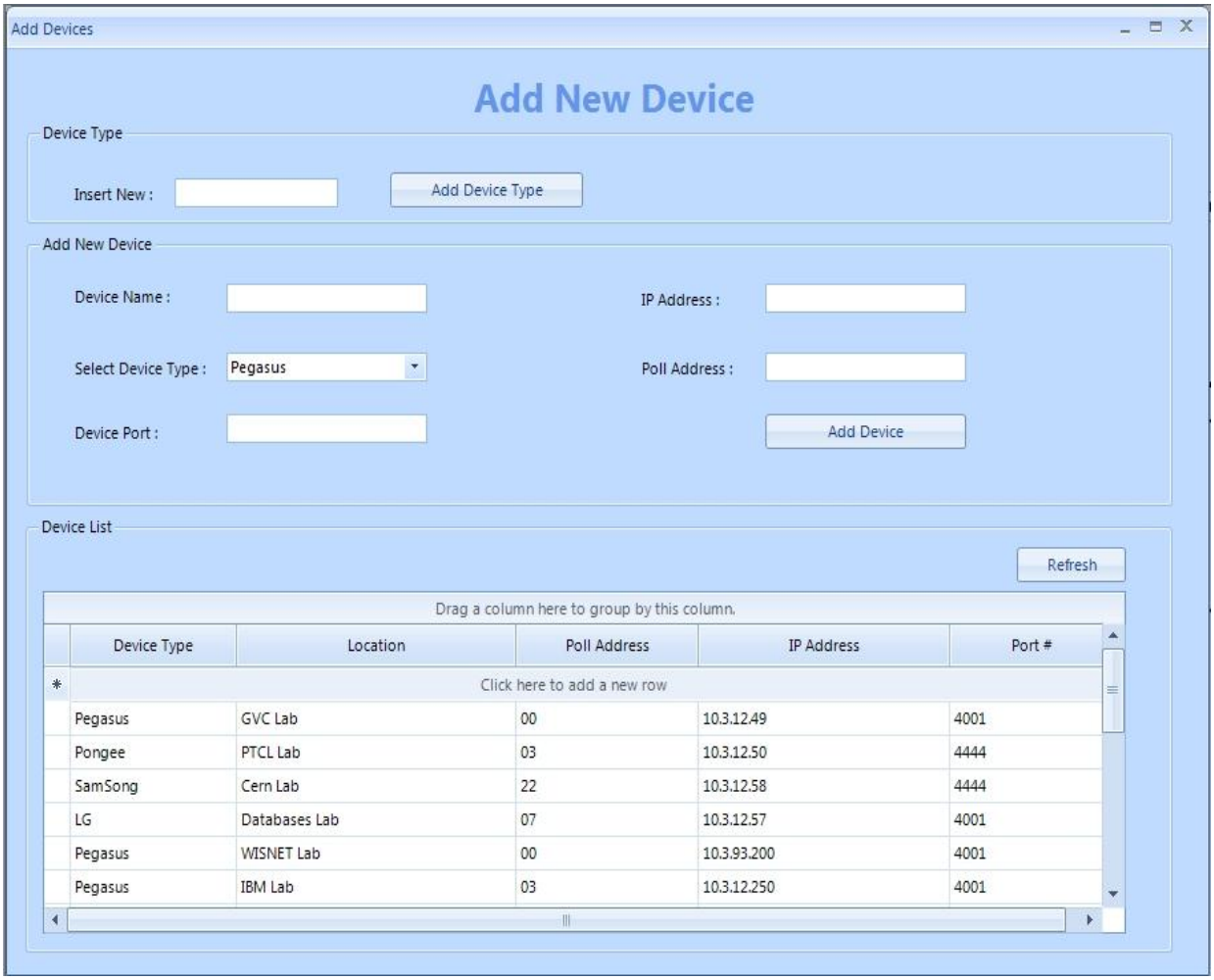

Figure 3-10: XRT New Device Registration form

Figure 3.10 is showing the device registration form. In this form we are registering the new device installed somewhere while connected to the central system. The device information includes its manufacturing company, the device itself name, IP address, Poll address and the device port. In this form we are having information of all of the devices installed and configured with our application. And since location is given, if connection fails we can easily find the location of the device in case of devices installed in a large industry.

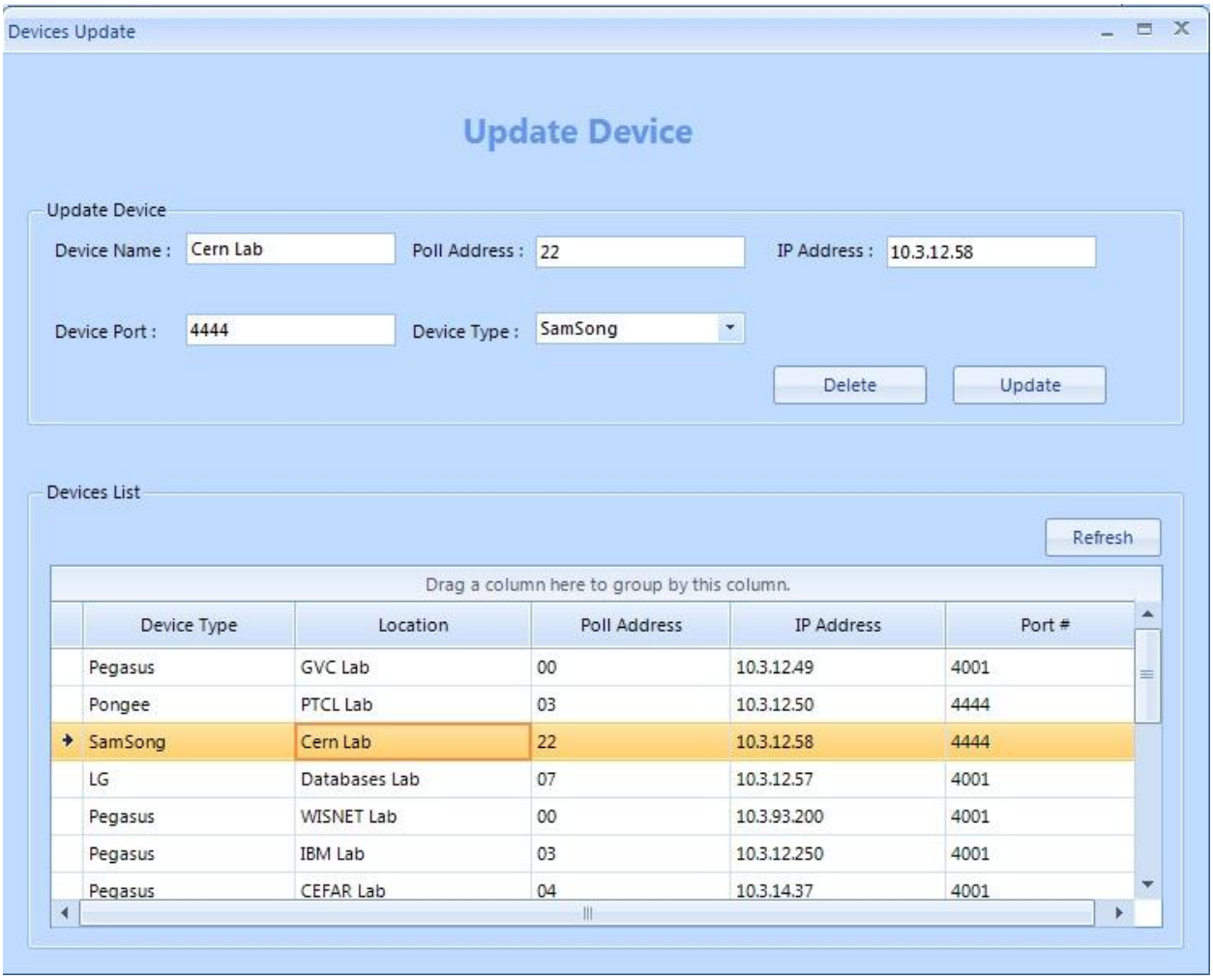

Figure 3-11: XRT Update Device information form

Figure 3.11 is showing devices information update form. Actually this form is designed so that if the device location is changed from Cern lab to Database lab, and we will be having updated information about the device location. And if a device has some fault, in that case we will replace that with some new device by updating the IP address, Poll address and the device port.

Chapter 4

4 SOFTWARE ARCHITECHTURE

4.1 Fundamental tasks of the architecture

The functions performed by the XRT will be as follows as shown by the picture below

4.1.1 RFID Device Configuration

Device configuration includes registering dynamic link library of the RFID device and accessing its functionality along with windows communication control and windows socket library. Once device configured correctly then it is easy to fetch its data and filter the string coming from the device and inserting into database along with the location of the device

4.1.2 RFID Device Registration

The first step is to register the RFID device along with their type, poll address, IP address, port number and the location where device is installed.

4.1.3 RFID Device Connection

The basic functionality is to establish the connection of the XRT middleware with the multiple devices placed at different locations of an organization. This would be done by manually or once activating the automatic function which will make automatic connection with the RFID devices at specific time interval. If the connection of the device fails then corresponding entry will be made for that device with its location and timing.

4.1.4 Resources Data Collection

Once the connection with the device is established then the next and important task is to fetch the data in the device. Since when a resource will make a movement and passing from an RFID reader range the tag id of the resource will be read by the reader and stored. Then it will be sent to the XRT main server. Since the string returned by the reader contains some unuseful information so it will be then filtered.

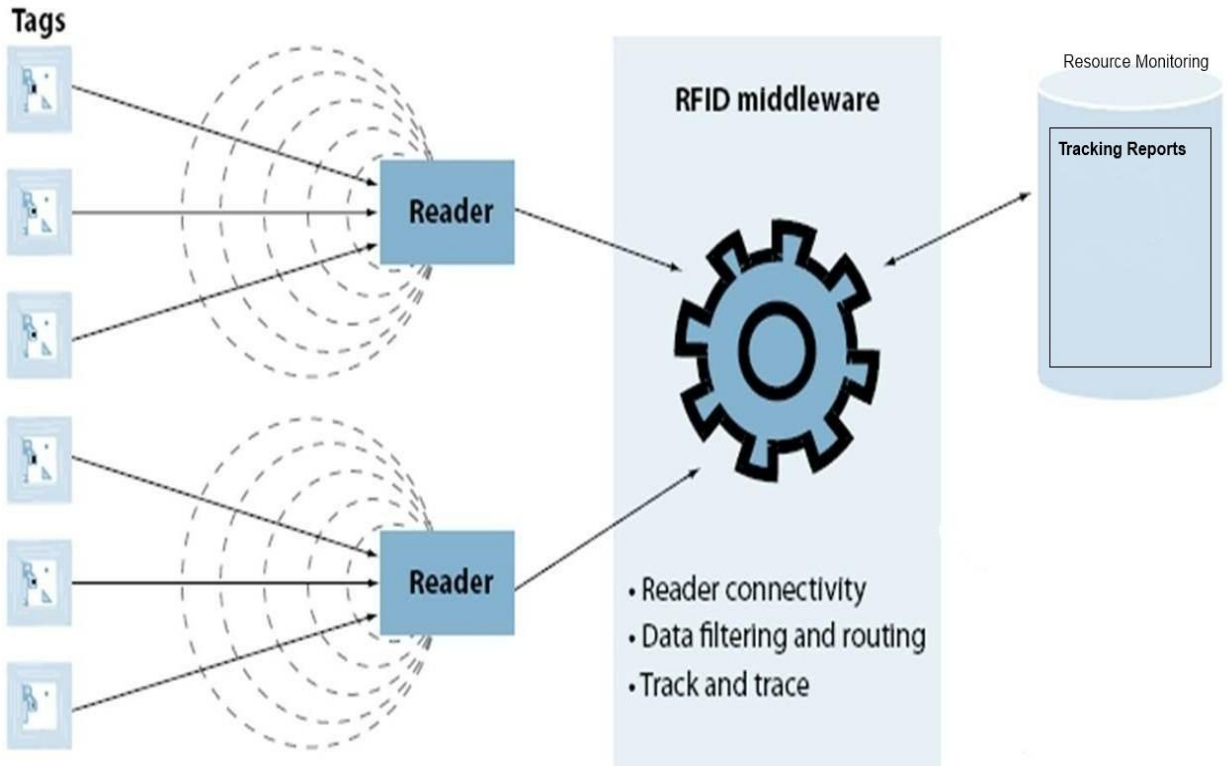

Figure 4-1: Multiple devices and central middleware architecture

4.1.5 Data Filtration

The data coming from the RFID devices may be of different structure for different devices. Usually it is a string, 41 bytes long containing the tag id, date, time and the poll address of the data sending device. After getting id one by one from the device it is the first process that is done on the tag string.

4.1.6 Data Storing

After splitting the string coming from the device is inserted into the database along with the location of the device. It helps to keep track of the movement of the resource against its tag id. The date and time makes it more perfect showing a real time movement of the resource in the organization.

4.2 Major System Components

4.2.1 Devices Management

Devices Management includes new device registration, update and delete functions for any device information such as poll address, IP address and the port number. We are also including the location of the device in data base so it is also contained with other device information

4.2.2 Resources Management

Resource management includes new resource registration by assigning it a specific tag id and resource group. Resources include employees, assets and inventory items etc. Each of the resource is assigned a specific resource group to which it belongs for example if we insert a resource like Dell Inspiron 1525, so the resource group head will be IT Equipment and then Laptop.

4.2.3 Reporting

Reporting helps us to show the information on users need. Like in our case if someone is interested in getting information of all resources those who have made movements at specific location. So then typing a specific location will show him/her all of the resources those who made movements along each resource with a time a specific location. Similarly the reporting also includes asking the system to tell the movements between two specific dates. It also provides the facility to know about a single name and checking its movement for specific date and location.

Chapter 5

5 RESULTS AND DISCUSSION

XRT is customized and generic software with generic database that can be used for resources whether the resources are employees, assets or some tagged inventory items by allocating them some groups and group head.

The system has been completed in three layers as shown in figure 5.1 i.e. Database management, business logic layer, data access layer and presentation layer. Database management layer is having all the records and data but this data is pure because filtration is done before inserting data into the database. The second layer is Business logic layer where we have handled the logic as no empty field insertion while registering a resource and asset. Whereas the Data access layer communicates with the database and all of the data flow is done via data access layer.

And the last one is presentation layer. It is user interface of the software that includes the devices management, update panel for devices and assets information and data downloading form. For the implementation of RFID based resource tracking we have used the RFID device with CPTCP6750.dll which is for .Net and we used its certain functions as follows

- OpenWinsock() :

  It is used for the connection with the RFID device.

- CloseWinsock()

  It is used for the closing of connection with RFID device.

- ReceiveData();

  It is used to receive the information of resources those who made movements under specific locations.

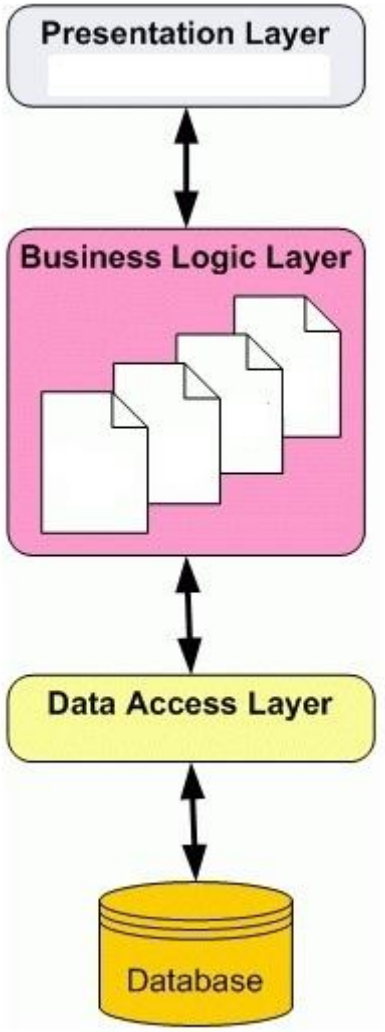

Figure 5-1 : System implementation structure

Chapter 6

6 CONCLUSION

After the successful completion of this project, a fully automated system is now able to identify and track the movement of resources in real time. XRT is now a product that can help organizations to keep records of no go areas movement. This product should be used by organizations having a lot of security measures, although there is a need of improvements in this product. It should be practically implemented then it will be open to us how the improvements can be made to this product and make the real time tracking more robust. Improvement in this product with time will make maximum benefits to the organizations. We should practically implement this project and should keep on improving it with time so that organizations can take maximum benefits out of this product. The movement of resources can be tracked by resources at specific location, movement information of resources by name and movement of all resources at all location points in an organization between two dates. Somehow there may be some security risks but it will reduce the effort to check ID's for employees and check each and every inventory item. We can collect information from multiple devices manual and by automatic function. This information collected from devices is managed in a manner to generate reports for different resources based on their names, location and by date. Thus it will handle the resource movement information and any sort of theft or illegal movement will be marked and tracked.

Although every software cannot be 100% complete it has some bugs and in our case XRT is also lacking some functionality due to limited resources available to us. But we have put our sincere efforts to this project to make a real scenario if we use the devices and readers with UHF frequency, tracking and the movement of resources will be clearer at real time. As RFID devices were used for this project, so in future we want to use UHF devices to improve the functionality and real time performance of this project.

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