Abstract

The main aim of this project was to design and build a GPS-based asset tracking system with an integrated android mobile application for easy identification and tracking of our assets.

GPS was chosen as the main technology for this project because of its availability 24hrs a day and most especially the worldwide range coverage of the device.

In this project, an Arduino board communicates with a GPS receiver and transmits its received coordinates into a certain database and developed mobile software picks the coordinates from there and plots it against a google map.

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1. INTRODUCTION

1.1. BACKGROUND OF THE STUDY

The Global Positioning System (GPS), also known as Navstar GPS, is a global navigation satellite system (GNSS) that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

The GPS system operates independently of any telephonic or internet reception, though these technologies can enhance the usefulness of the GPS positioning information. The GPS system provides critical positioning capabilities to military, civil, and commercial users around the world.

The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver. The GPS project was launched in the United States in 1973 to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s.

The U.S. Department of Defense (DoD) developed the system, which originally used 24 satellites. It became fully operational in 1995. Roger L. Easton, Ivan A. Getting and Bradford Parkinson of the Applied Physics Laboratory are credited with inventing it.

A GPS tracking system is a device, normally carried by a moving vehicle or person, that uses the Global Positioning System to determine and track its precise location, and hence that of its carrier, at intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or Internet-connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real time or when analyzing the track later, using GPS tracking software. Data tracking software is available for smartphones with GPS capability.

Locating assets is a critical task for many people and businesses. Basically, using a tracking device and a software helps you identify what you have, monitor the changes in physical location, and account for cost and changes in book value over time.

Typically, individuals and company-owned resources are stored and then shared throughout an office or spread out to multiple locations. Assets that

are moved when needed by individuals and the challenge is keeping track of all the movement and changes of possession over time.

With an asset tracking system, you can log onto your mobile and quickly find out where each asset is located and to some extent see who the assigned custodian is.

Asset tracking refers to the method of tracking physical assets. Over the years, a lot of technological advancements have been made towards this problem of finding items locations and below are a couple of previously used technologies used in tracking devices;

- Barcodes

  Assets can be tracked via manually scanning barcodes such as QR codes. QR codes can be scanned using smartphones with cameras and dedicated apps, as well as with barcode readers.

- Wi-fi, IR, and Bluetooth

  For indoor asset tracking Wi-fi combined with another technology like IR has been used. Bluetooth technology has also been used, and may provide more accuracy even if Bluetooth technology wasn't primarily developed for localization.

- NFC

  Latest trend in asset tracking is using NFC. NFC technology simplifies tracking of assets by tapping the assets and getting the details. This is an advantage for tracking critical assets where user needs to see the condition of the asset to be tracked.

- RFID

  'Passive' RFID tags broadcast their location but have limited transmission range (typically a few meters). Longer-range "smart tags" use 'active' RFID -where a radio transmitter is powered by a battery and can transmit up to 2000 meters (6,600 feet) in optimum conditions. RFID-based Asset Tracking requires an infrastructure to be put in place before the whereabouts of tags may be ascertained. An asset tracking system can record the location and usage of the assets and generate various reports.

- GPS asset tracking

Assets may also be tracked globally using devices which combine the GPS system and mobile phone and/or satellite phone technology. Such devices are known as GPS asset trackers and are different from other GPS tracking units in that they rely on an internal battery for power rather than being hard-wired to a vehicle's battery. The frequency with which the position of the device must be known or available dictates the quality, size or type of GPS asset tracker required. It is common for asset tracking devices to fail due to Faraday cage effects as a huge proportion of the world's assets are moved via intermodal containers. However modern tracking technology has now seen advances in signal transmission that allows enough signal strength reception from the GPS satellite system which can then be reported via GPRS to terrestrial networks.

1.2. STATEMENT OF PROBLEM

This project targets to solve the problem of finding and providing the status of objects of an inventory or mobile stock/assets.

The business justification to invest in asset tracking capability is usually the risk of loss. This can be loss of the asset directly, or loss of the ability to render service to customers that is enabled by the asset. For example, the business may have a few critical tools, and the loss of just one of these tools would significantly degrade the ability to perform necessary work.

Thus, the assets being tracked may

a) have specific quantifiable capital value or

b) have general aggregate operational

value. Examples for such assets include

- Laptops, smartphones, tablets
- Hardware & machinery
- Computer accessories
- Vehicles
- Construction tools
- Medical equipment
- Patients etc.

1.3. JUSTIFICATION OF THE PROJECT

According to 'Missingx.com', which happens to be the world's largest online lost and found platform helping people to recover their lost items at airport, railway stations or at any other places; thousands of items are lost in the airports all around the world every day.

A total of 1,381,537 items were reported missing and found since the beginning of the year till the publication of this article in October, 2016.

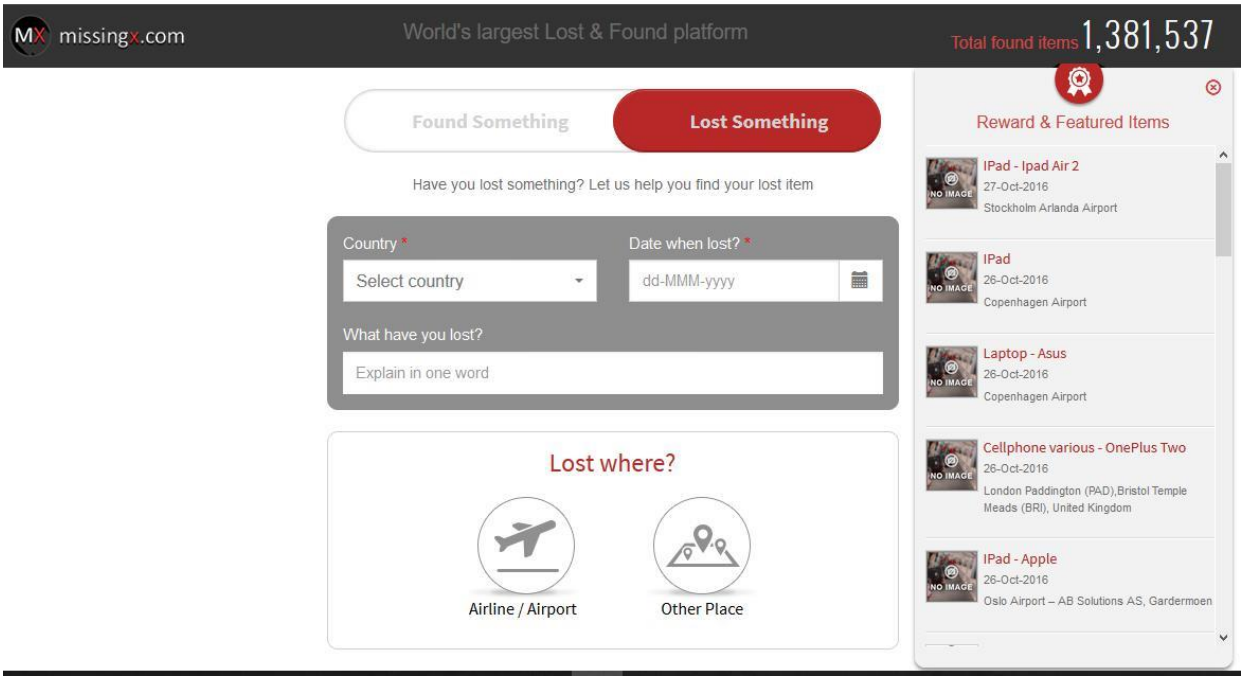

Figure 1 - shots from missing.com showing how much people are losing their items

While most of the airports have, a lost and found terminal to help people reclaim their lost items, still it is a tedious process. The passengers have to go to the airport to complain about their missing or lost items and also to collect it since most of the airports do not offer services where your item is sent to your address. It might take days and sometimes months to get back the lost items.

On average, businesses spend 5% of annual revenue on logistics assets, and almost one-fifth of respondents spend more than 10%. The annual costs include the replacement of lost or damaged special containers, where typically up to 30% of the containers are surplus in circulation just because nobody

knows when and where according to statistics made by "Aberdeen Group; An RFID-Enabled Logistics Asset Management that aims at Improving Capital Utilization, Increasing Availability, and Lowering Total Operational Costs, captured on 15 September 2006."

The installing of a GPS asset tracking units may also provide the following benefits:

- improved workplace efficiency
- reduced fuel costs due to improved routing systems
- reduced overhead costs
- improved employee accountability
- quick location of your vehicles in the event of theft or accident

1.4. OBJECTIVES OF THE PROJECT

At the end of this project, we should be able

- To review long range tracking technologies
- To design and construct a GPS tracker
- To develop a mobile app
- To test the GPS tracker and mobile app to see its workability

1.5. SCOPE AND LIMITATIONS THE PROJECT

This project is able to get the latitude and longitude coordinates of the asset being tracked and transmit this to a database, position these coordinates on a google map, show the location and from which we can access on a mobile application.

The accuracy of this project could sometimes be disturbed since the GPS technology we are using has an accuracy level of +/- 15m and also when the asset being tracked is inside a room since the room cannot be shown on the map. The project can't always give accurate results especially when the object being tracked is in a crowded environment and the line-of-sight of at least 3 satellites are blocked

The tracking unit that will be designed will bulky as it may not be easily attached to any device being tracked. Nanotechnology has made it possible to design tracking units which are very small to be easily attached to anything.

The working principle of our tracking unit is the same as that of the nanotechnology.

Lastly, the physical protection of this device cannot be 100 percent secured in that, it could easily be detached from an item and thrown away especially in the case of theft.

1.6. METHODOLOGY

The project targets using a GPS based tracker to locate these easily misplaced mobile assets by attaching a GPS receiver to the appropriate asset of interest. GPS receiver detects the latitude and longitude of any location on the Earth with exact UTC time (Universal time coordinated).

The GPS system is the main module in our tracking system. This device receives the coordinates from the satellite for each and every second, with time and date.

The GPS module sends the data related to tracking position, we exact the coordinates and transmit it to a mobile app interface where the user can determine to exact location of the item.

The whole process is as summarized in the flow chat as shown in figure 2.

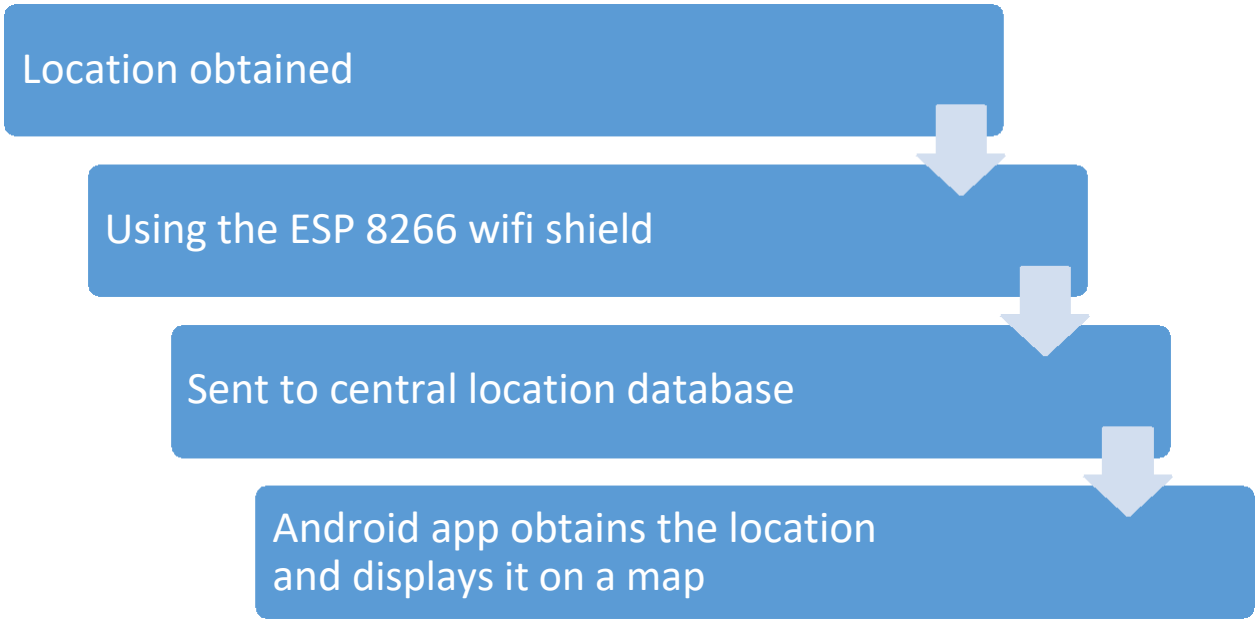

Figure 2 - flow chart of methodology-

1.7. CONCLUSION

By the end of this project, we hope to have solved the problem of losing a greater number of asset by attaching our GPS based device to whatever deemed as an asset to any individual or business society.

GPS was chosen because of its greater advantage over all other tracking technologies currently available in our world by covering the whole planet and around.

2. LITERATURE

REVIEWS 2.1. INTRODUCTION

Many people have developed numerous devices using numerous technologies to try solve this problem of finding missing items. Most common amongst them all is the RFID-based asset tracking system. In this system,

An RFID tracking system has a reader and a tag that communicates with each other using radio frequencies. In a basic RFID system, tags are attached to all items that are to be tracked

An RFID reader with an antenna sends power as well as data and commands to the tags. It acts like an access point for the tagged items so that the tags' data can be made available to the consumer.

RFID tags are so small and require so little power that they don't even need a battery to store information and exchange data with readers.

Although RFID has many advantages, its ability to locate items is limited to a particular area. That is to say, albeit that RFID is ideal for locating items within a specific property, RFID is unable to track items that are further than 300 feet away.

Even the longest range active RFID systems can identify objects from no more than few yard or meters away according to RFID-journals.com which is a forum where expects are questioned of RFID technologies

GPS-based asset tracking system has been a field where many researchers have been actively involved. Various enhancements have developed in this field.

2.2. RELATED WORKS

2.2.1. Personnel tracking system using a Bluetooth-based epidemic protocol

[1] In the personnel tracking system using a Bluetooth-based epidemic protocol, author present a tracking system that uses a Bluetooth technology based on epidemic protocol. The idea is to get information automatically by a person's previous contact with other people using Bluetooth-enabled device that communicates wirelessly when they are in close contact. A record which includes the identification number of both and the current time is created when

a peer discovers another. Both users will then exchange records of previous contacts with other peers and the acquired data is stored in memory. The process repeats until the user comes in contact with a Bluetooth access point and all the data in memory is uploaded to the server. The main idea is that a record originated in a certain member of the network will eventually arrive to the server through other peers due to the widespread of the infectious message. The system uses two programs: Bluetrack which performs the tracking and runs on PDAs only and Blueserver which runs on the access point.

Figure 3 - Personnel tracking system using a Bluetooth-based epidemic protocol

2.2.2. GPS and Bluetooth based object tracking system

[2] In the GPS and Bluetooth based object tracking system the paper presents a Global Positioning System (GPS) and Bluetooth based Object Tracking System that finds belongings misplaced in a short period of time without much effort. The system consists of Global Positioning System GPS for long range and Bluetooth module for short range. Each target object will have a tag that has both GPS and Bluetooth module. A mobile application is created that can be used only on smart phones, as an interface between the wireless sensors and the user. The transmitter end sends a signal to the receiver sensor, which after being traced will start ringing if the object is in a short range from the user, to notify the user as to where the lost item is. A GPS system is used to

locate the lost item if it is out of a specified range. The system allows a user to view the present position of the target object on Google Map through an android application

Figure 4 - A GPS and Bluetooth based object tracking system

2.2.3. RFID tracking system

[3] RFID asset tracking system focuses on how to locate an item using RFID in real time indoor tracking mechanism. The purpose of using RFID is to minimize the searching time, effort, and cost. Electronic tag is attached for each asset, where its information is pre-inserted into the system through user interface. The tag reader is composed of RFID sensor, microcontroller, and serial-to-Ethernet chip. The RFID sensor reads the serial number of the tag, within the given range, through radio waves then it passes the data serially to the MCU, which will transmit it through serial peripheral interface (SPI) to the serial-to-Ethernet chip. The Ethernet chip will convert the data to be transmitted through Ethernet network to remote server. When a tag number for any asset reaches the server, its associated information will be displayed through user interface and updated accordingly.

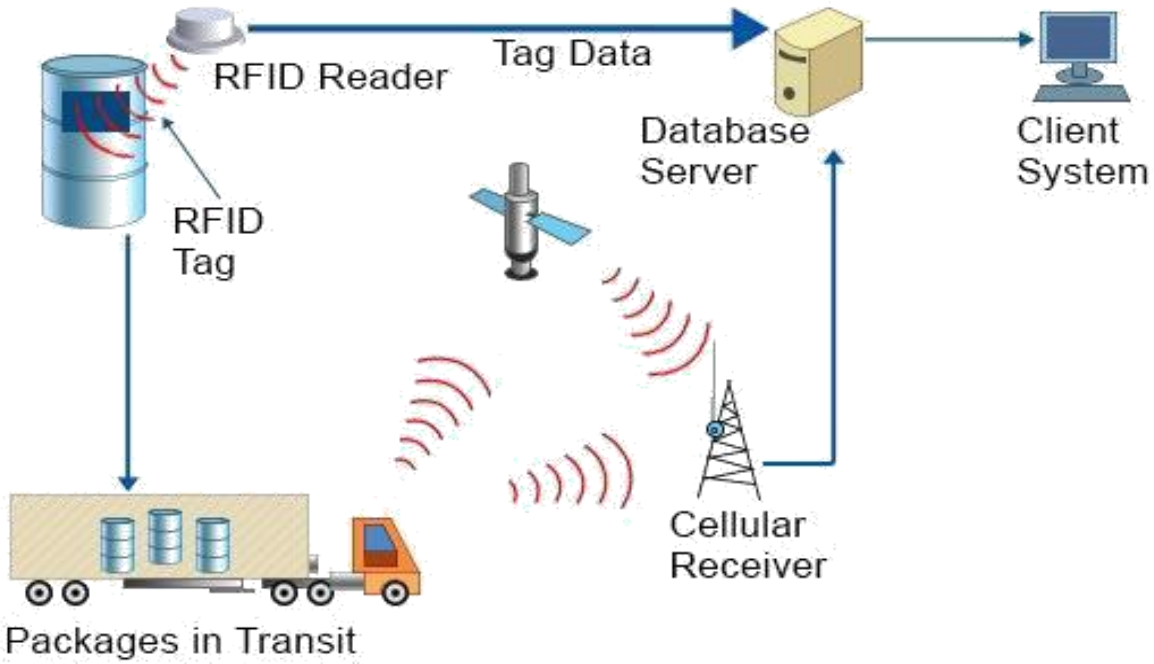

Figure 5 - An RFID tracking system

2.2.4. Design and development of GPS-GSM based tracking system with Google map

[4] Another project in which the GPS technology was implemented is in the design and development of GPS-GSM based tracking system with Google map based monitoring project by Pankaj Verma and J.S Bhatia .The aim was to control vehicle theft .The system consisted of the transmitting and monitoring side. The transmitting side has the GPS which receives the location values and GSM which transmits the location values. The GPS/GSM module is controlled by an 8 bit CMOS microcontroller. The location co-ordinates are then typed in WAMP server application and then displayed on the Google map incorporated in the WAMP server. The project made it possible to monitor vehicles and also know where vehicles are in the case of theft.

Figure 6 - A GPS-GSM based tracking system with Google map integration

2.2.5. GPS/GSM Enabled Person Tracking System

[5] The authors presented a tracking system using open GTS which is an open source GPS tracking system for tracking person's position which requires the internet access. A GSM modem is used and is a modem which accepts a SIM card, and operates over a subscription to a mobile operator. The person to be tracked must have GSM model with SIM GPRS enabled for a constant relay of digital data and can be tracked on Google map Live. GPS Receiver receives the human longitude and latitude from satellite through GPS Antenna. GPS receiver is interfaced with the ARM 7 through RS232 converter. RS232 converter is used to convert RS232 logic to TTL logic vice versa because GPS receiver is the RS232 logic and ARM-7 is the TTL logic. The disadvantage is the system cannot work without internet.

The advantages of the system are

- cost-effective, Reliable and has the function of accurate tracking.

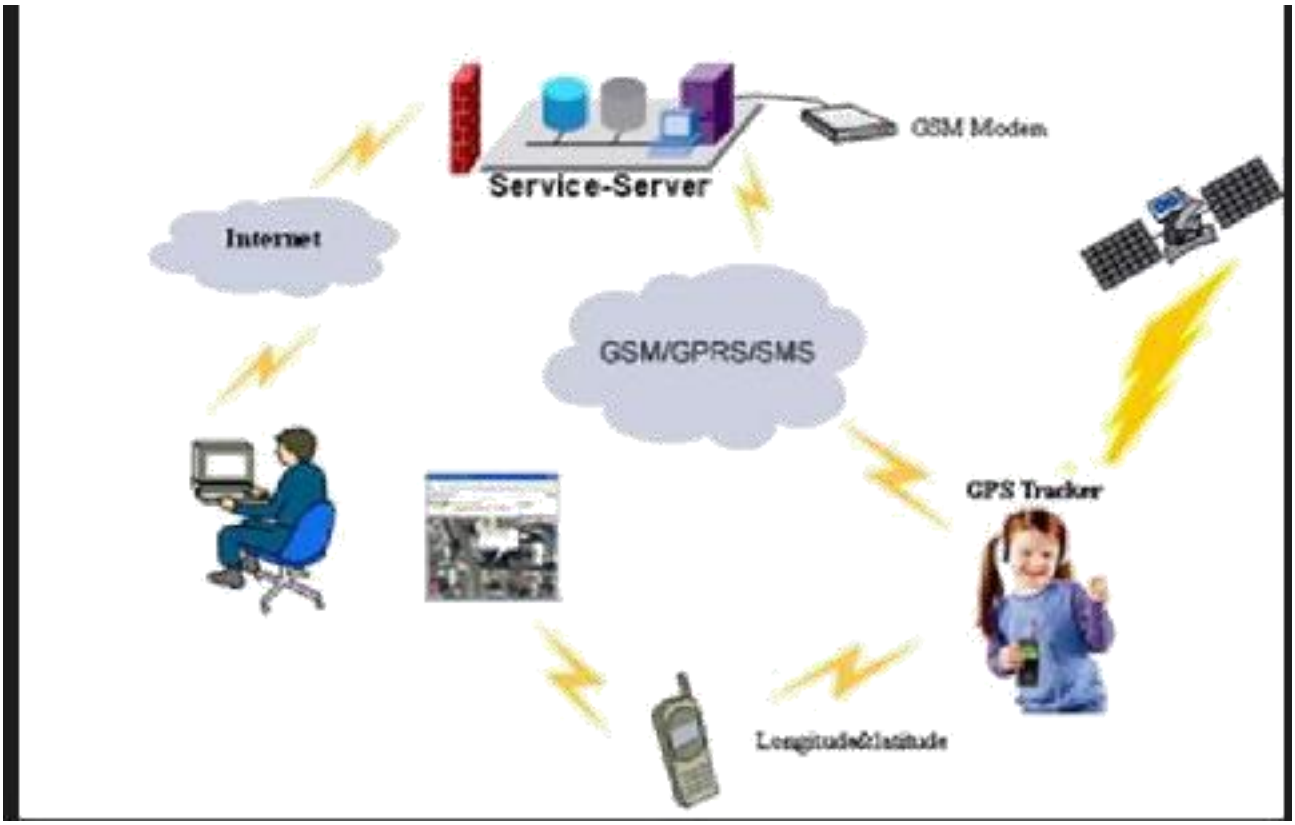

Figure 7 - GPS/GSM Enabled Person Tracking System

2.2.6. Tracking Animal Location and Activity with an Automated Radio Telemetry

[6] The authors presented a high resolution automated radio telemetry system that uses standard VHF radio tracking technology to monitor the movements of radio-tagged study animals automatically, continuously and simultaneously. The system uses a standard radio transmitters, six Automated Receiving Units (ARU) mounted on a tower having a pulse rate of 9 seconds per frequency space equally across 360^0 for the receival of signals.

Advantages are; because it relies on VHF technology, it can be used to track animals that are too small to be fitted with GPS transmitters. Additionally, ARTS are better able to track animals through the dense vegetation of a tropical rainforest than satellite-based tracking systems, which rely on UHF signals. Smaller tags as small as 0.2 grams. It is cost effective

Disadvantages are; It has a slightly lower accuracy (~50 m) compared to GPS. Tracking smaller animals like rats is challenging since the animals are fitted with lower power (battery) transmitters hence transmission is low. Power management in a real-world deployment is a challenging issue. Detecting the faint signal of a radio-tagged animal can be impossible if there is strong

interference from other radio transmitters on or near the same frequency. The maximum extent of practical tracking areas varies between 50 and 300 km^2

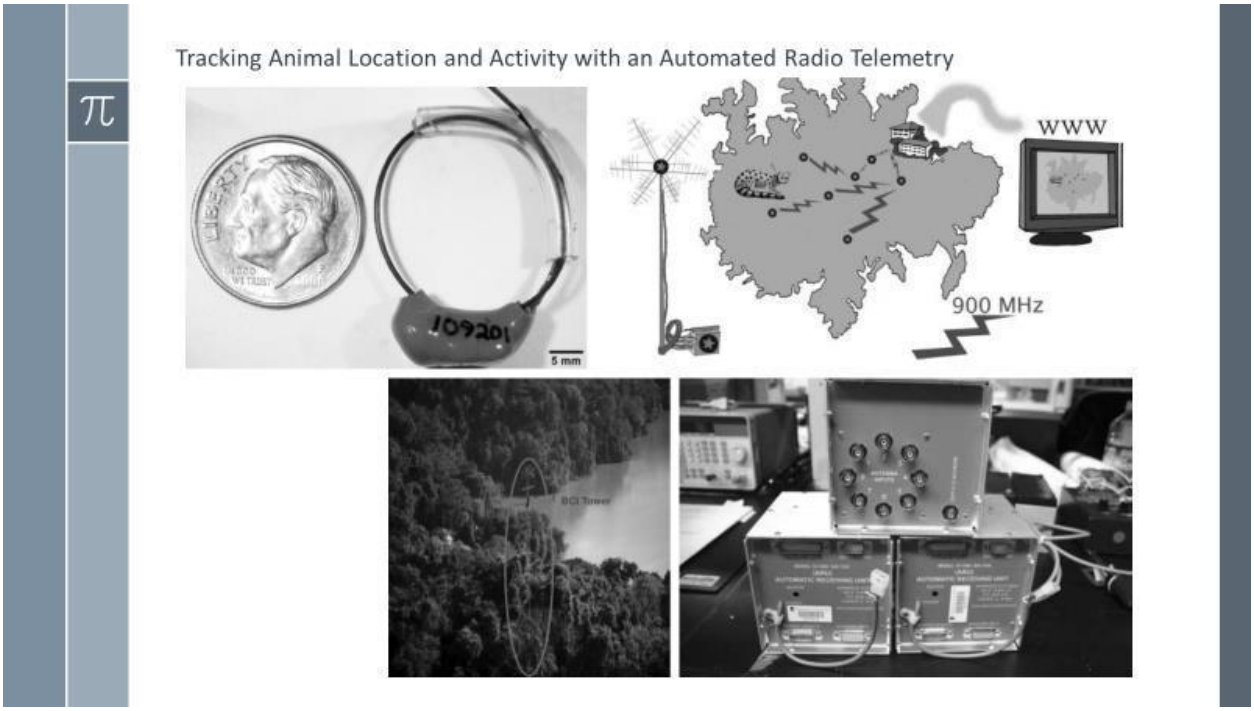

Figure 8 - An Automated Radio Telemetry for Tracking Animal Location

2.2.7. Mobile Phone Location Tracking by the Combination of GPS, Wi-Fi and Cell Location Technology

[7] The authors used a mobile phone location technology Wi-Fi and cell location together with GPS due to the limitation of the usage of GPS in tunnels and building. In the research, in the case where GPS signal is blocked, the researcher would identify the closest wireless access point with the strongest signal shown on researcher's Wi-Fi equipped mobile phone. The data obtained by the data collection application will be used to calculate the position of the mobile phone. The authors used the Pythagoras theorem to calculate the lost point of signal assuming the point of lost was between two points. The Haversine formula for the shortest possible distance between the two points on a sphere from their latitudes and longitudes. The values from the two formulas are compared to the actual GPS coordinates to know the location of the mobile phone. In the case of cell location, when the mobile phone is turned on and left as standby, the mobile phone will link or connect itself to the base station with the best quality signal using Control Channel and remind connected at all time. The calculated values give the best approximate position

than the cell location only. Disadvantages is a number of Wi-Fi hotspots are placed along a predetermined path and that is costly.

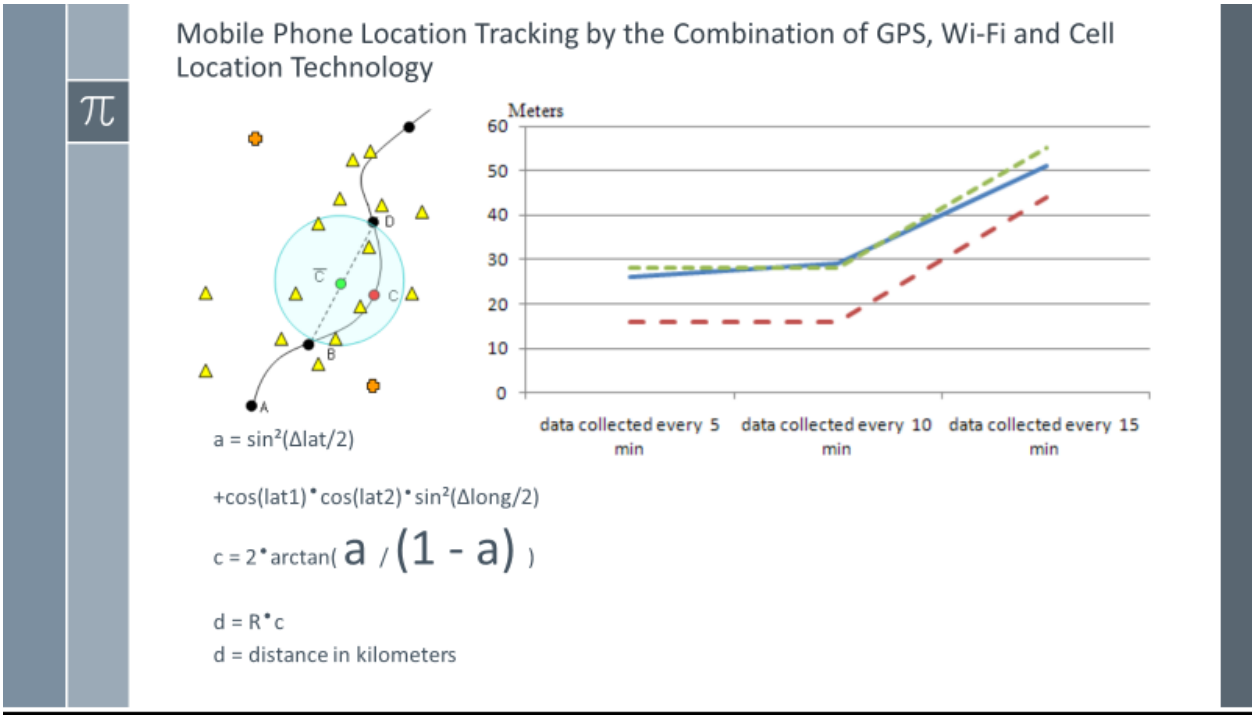

Figure 9 - Mobile Phone Location Tracking using GPS and cell stations

2.2.8. iSECUREtrac GPS Tracking for Parolees

[8] GPSs are even being used to track gang members in U.S. cities, strapped to parolees. The U.S. law specifies that a court can issue a warrant for the installation of a mobile "tracking device" if a person is suspected of committing a crime.

The "iSECUREtrac" company designed GPS monitoring systems to track parolees and sex offenders ensuring they do not commit any crimes, alert authorities if they enter certain locations, (e.g. schools, parks), and prevent them from leaving their homes, if that is prohibited. Today many parolees are fitted with a small tamperproof GPS tracker worn as a bracelet or anklet. The ankle device is in the shape of a rigid plastic ring, accompanied by a small tracking box that can fit in a pocket. Parolee and pedophile tracking is widespread in the United States with an estimated 120,000 tracked parolees in 28 states.

In 2000, Jackson was found guilty of murdering his daughter after the GPS device placed on his truck found that he had returned to his daughter's crime scene.

Figure 10 - GPS Tracking for Parolees

2.2.9. Barcode Tracking system

[9] The Barcode tracking system is a project developed mainly for shops and supermarket employees to perform accurate and quick cost of items calculations. This project, like the RFID technology used a tag and a reader communication process where the tags are stacked on the various items and contains information of the product such us the name, cost, expiry date etc. The reader, whether stationary or mobile communicates with the tag and gets the product’s information from it for receipt and cost calculations.

The advantage of this project is that it’s very fast and accurate and has the disadvantage of having a very limited or smaller communication range.

Figure 11 - Barcode Tracking system

2.2.10. MTN Protect Service

[10] The MTN Protect Service allows subscribers to locate their cellphones and other smart devices which are sim enabled when misplaced, lost or stolen. It available to all MTN Prepaid and Postpaid subscribers.
It takes the following phone permissions from the user:
Lock screen, GPS, take thief's picture, Message to finder, Play alert; and uses it to perform its tracking operations
The web self-care provides direct access to

- locate phone, Lock phone, Play siren, Wipe content.

It also shows within the app the phone's model that the service is attached.
Access to the guide (for people who feel lost and finally prepare to be guided)
View of latest events that can be extended to the all timeline events big map indicating the latest location
Limitations

- For IPhone Operating System (iOs), only phone location and alarm will be available.

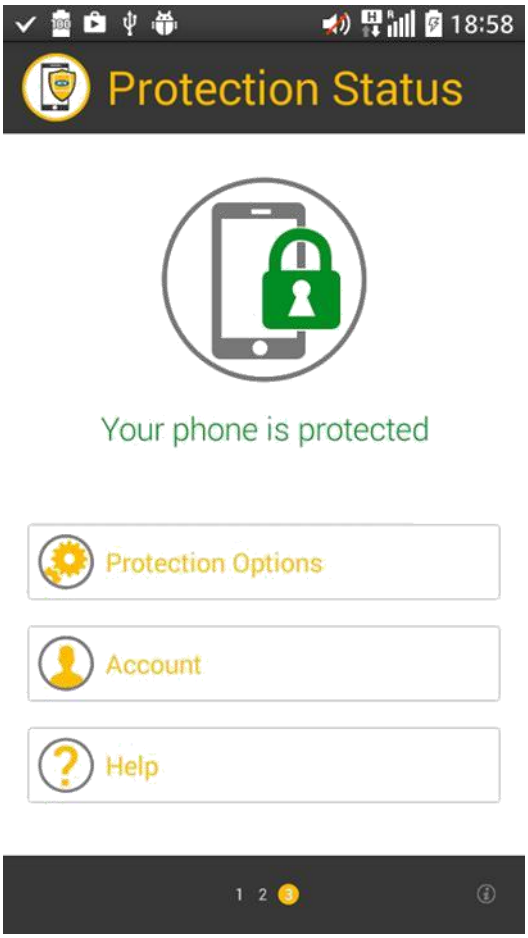

Figure 12 - MTN Protect Service

3. DESIGN METHODOLOGY

3.1. GPS TRACKING SYSTEM

The operation of this system could be represented in diagrammatically as in figure 13.

First, an item is tagged with our tracking device, the device gets its current coordinates/location from the GPS satellites in space and updates it in its 'location database' every 120 seconds. All databases are located on a server. Then lastly a user who seeks to know the where about of his/her asset is provided with a visualized form of a map.

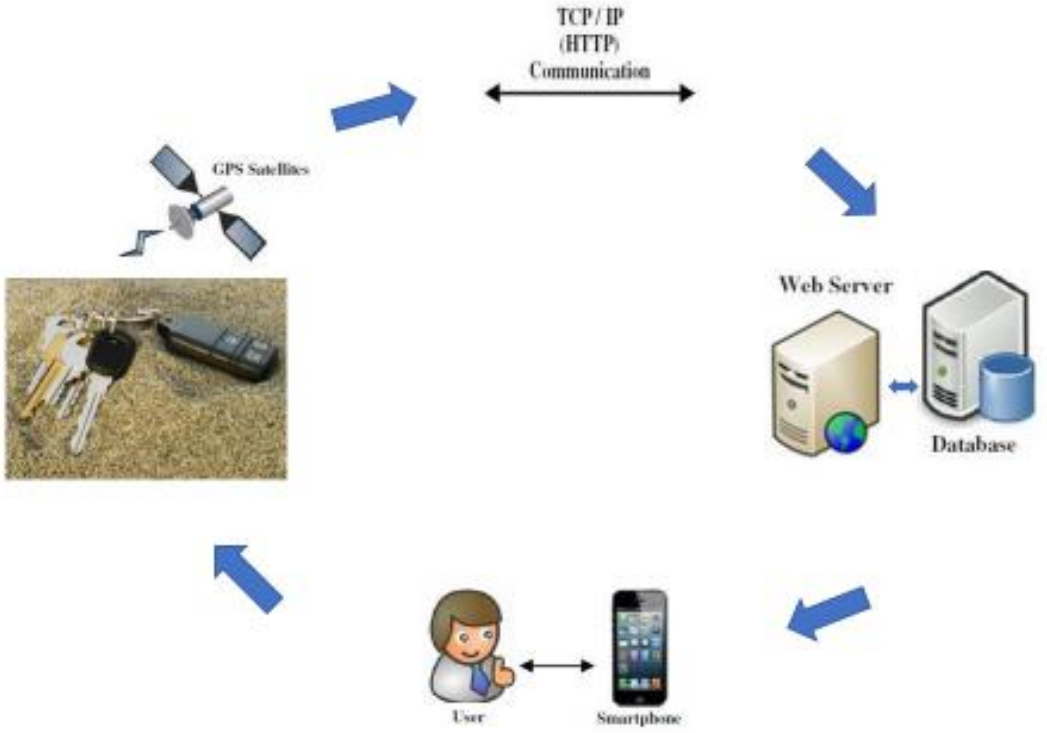

Figure 13 - design methodology

3.2. DESIGN TOOLS

3.2.1. MAIN HARDWARE COMPONENTS

3.2.1.1. A7 AI THINKER GPS MODULE

Figure 14 - Ai thinker (GPS module)

This is an A7 GPRS/GSM/GPS Shield, which is use the newest A7 GSM/GPRS/GPS module, A7 module is a GSM/GPRS/GPS function module. It supports GSM/GPRS Quad-Band（850/900/1800/1900） network. Also, it supports voice calls, SMS messages, GPRS data service and GPS function. We can use it make a simple phone.
The module is controlled by AT command via UART and supports 3.3V and 4.2V logical level.

Features

- Operating temperature -30 ℃ to + 80 ℃;
- 1KG peak suction
- Low standby current
- Operating Voltage 3.3V-4.2V;
- Power voltage> 3.4V;
- Standby average current 3ma less;
- Support the GSM / GPRS four bands, including 850,900,1800,1900MHZ;
- Support China Mobile and China Unicom's 2G GSM network worldwide;
- GPRS Class 10;
- Sensitivity <-105;
- Support voice calls;
- Support SMS text messaging;
- Support GPRS data traffic, the maximum data rate, download 85.6Kbps, upload 42.8Kbps;
- Supports standard GSM07.07,07.05 AT commands and extended commands Ai-Thinker;
- Supports two serial ports, a serial port to download an AT command port;

- AT command supports the standard AT and TCP / IP command interface;
- Support digital audio and analog audio support for HR, FR, EFR, AMR speech coding;
- Support ROHS, FCC, CE, CTA certification;
- SMT 42PIN

3.2.1.2. ESP 8266 WIFI SHIELD

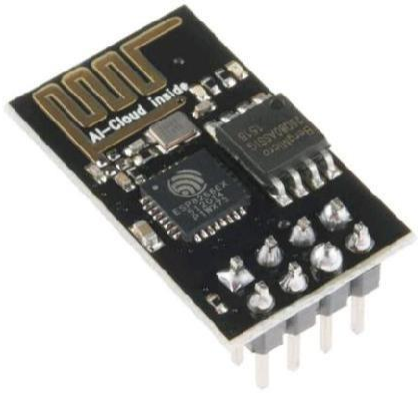

Figure 15 - ESP 8266 WiFi Module

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box). The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support. In the documents section, you will find many resources to aid you in using the ESP8266, even instructions on how to transforming this module into an IoT (Internet of Things) solution!

Note: The ESP8266 Module is not capable of 5-3V logic shifting and will require an external Logic Level Converter. Please do not power it directly from your 5V dev board.

Note: This new version of the ESP8266 WiFi Module has increased the flash disk size from 512k to 1MB.

Features:

- 802.11 b/g/n
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- +19.5dBm output power in 802.11b mode
- Power down leakage current of <10uA
- 1MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

3.2.1.3. ARDUINO PRO MINI MODULE

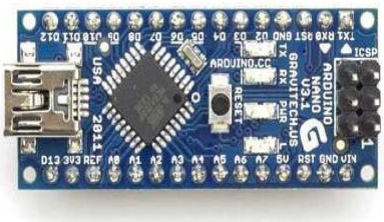

Figure 16 – Arduino Pro Mini

The Arduino Pro Mini is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six-pin header can be connected to an FTDI cable or Sparkfun breakout board to provide USB power and communication to the board.
The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions. The board comes without pre-mounted headers, allowing the use of various types of connectors or direct soldering of wires. The pin layout is compatible with the Arduino Mini.
There are two versions of the Pro Mini. One runs at 3.3V and 8 MHz, the other at 5V and 16 MHz
The Arduino Pro Mini was designed and is manufactured by SparkFun Electronics.

3.2.2. SOFTWARE TOOLS

3.2.2.1. XAMPP SQL DATABASE SERVER

XAMPP is a free and open source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, MariaDB database, and interpreters for scripts written in the PHP and Perl programming languages. XAMPP stands for Cross-Platform (X), Apache (A), MariaDB (M), PHP (P) and Perl (P). It is a simple, lightweight Apache distribution that makes it extremely easy for developers to create a local web server for testing and deployment purposes. Everything needed to set up a web server – server application (Apache), database (MariaDB), and scripting language (PHP) – is included in an extractable file. XAMPP is also cross-platform, which means it works equally well on Linux, Mac and Windows. Since most actual web server deployments use the same components as XAMPP, it makes transitioning from a local test server to a live server extremely easy as well.

3.2.2.2. ECLIPSE ANDROID IDE

Eclipse is famous for our Java Integrated Development Environment (IDE), but our C/C++ IDE, PHP and android IDEs are pretty cool too. You can easily combine language support and other features into any of our default packages, and the Eclipse Marketplace allows for virtually unlimited customization and extension.

3.2.2.3. ARDUINO IDE

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.

3.2.3. CIRCUIT DIAGRAM

The circuit diagram for the design phase of our project is as shown in figure 17 and 18 below. The diagram was drawn using the 'Eagle software' and the desired circuit was printed and etched on a PBC (Printed Circuit Board) before all the components were fixed and finally soldered on it. The circuit diagram has been divided into two for visibility reasons.

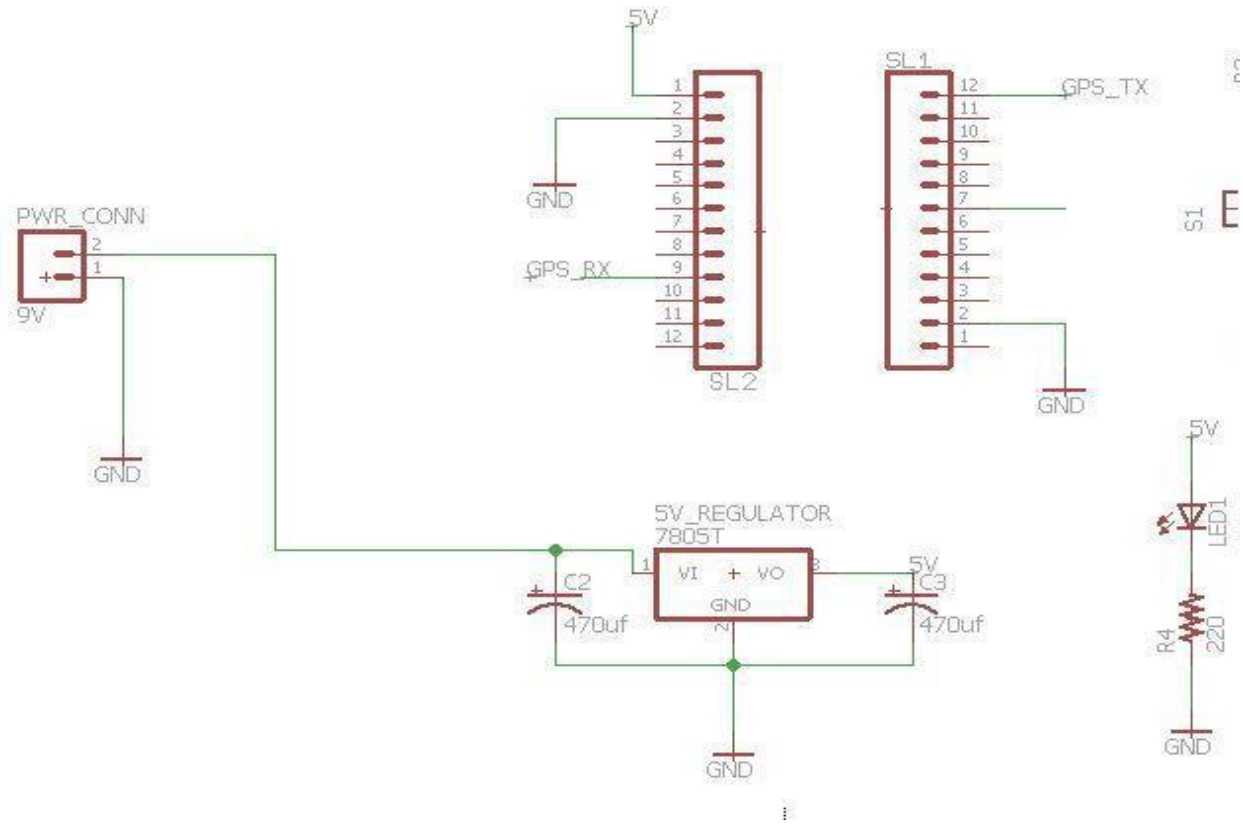

Figure 17 – Circuit Diagram (a)

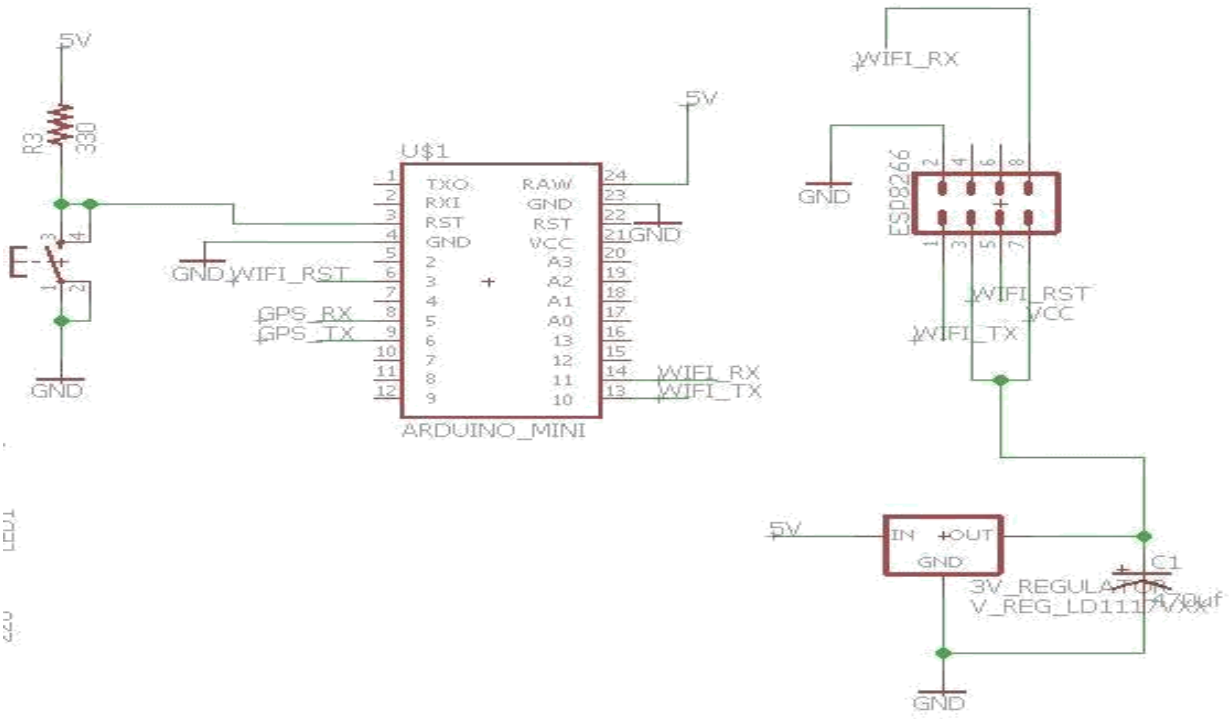

Figure 18 – Circuit Diagram (b)

A picture of the whole design with all the components fixed on it is shown in figure 19 and the system was powered by a 9V battery.

Figure 19 – Final work design

4. RESULTS

4.1. BACK-END WORK

The back end works of the system is represented by the flow chart below:

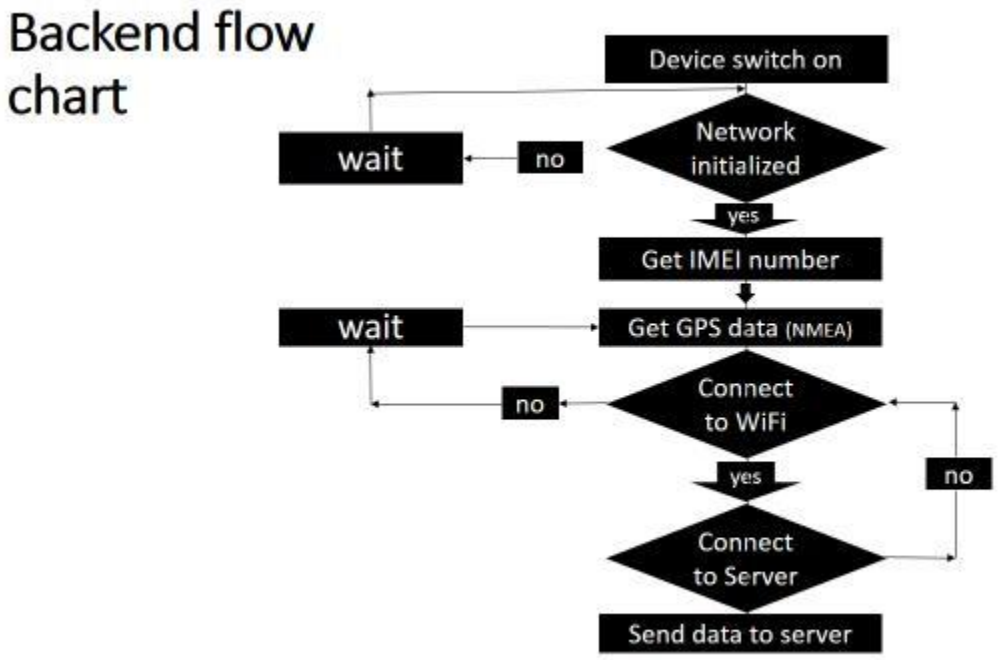

Figure 20 – Backend flow chat

First the device is switched on, it takes a couple of seconds (roughfully 30 seconds) to initialize and bring up all the connected components. Then it gets the IMEI number of the of the device and confirms if from our IMEI database (which for demonstrative purposes we manually inputted '1234' for the device we built and then we begin getting our GPS coordinates from the satellite and be pushing them into our location database from which our android application software will be getting them later for its front-end activities.

4.1.1. SECURITY

Our back end works also takes care massively of security issues. The projects seeks to target tracking of assets which are usually sensitive and expensive items hence we wouldn't want a situation where someone has

your mobile device and the person has access to all your sensitive items hence, a login credentials has to be provided at the front end of our android mobile application and these credentials are saved in a 'user database' on our server and the password chosen by a particular user is hardly encrypted with SHA encryption technology such that, even if some gets access to our servers, the person wouldn't have the opportunity to see in plain text your login credentials and hence attach your sensitive items.

Below is a truncated picture of what happens inside our user database found on our servers:

Figure 21 – Encrypted User Database

The location database is as shown in figure 22. It was created using google cloud database software known as 'Firebase' and its updated every 120 seconds taking its inputs from our tracking device. The frontend of the application gets its coordinates from here and before plotting them on the google map desired by the user.

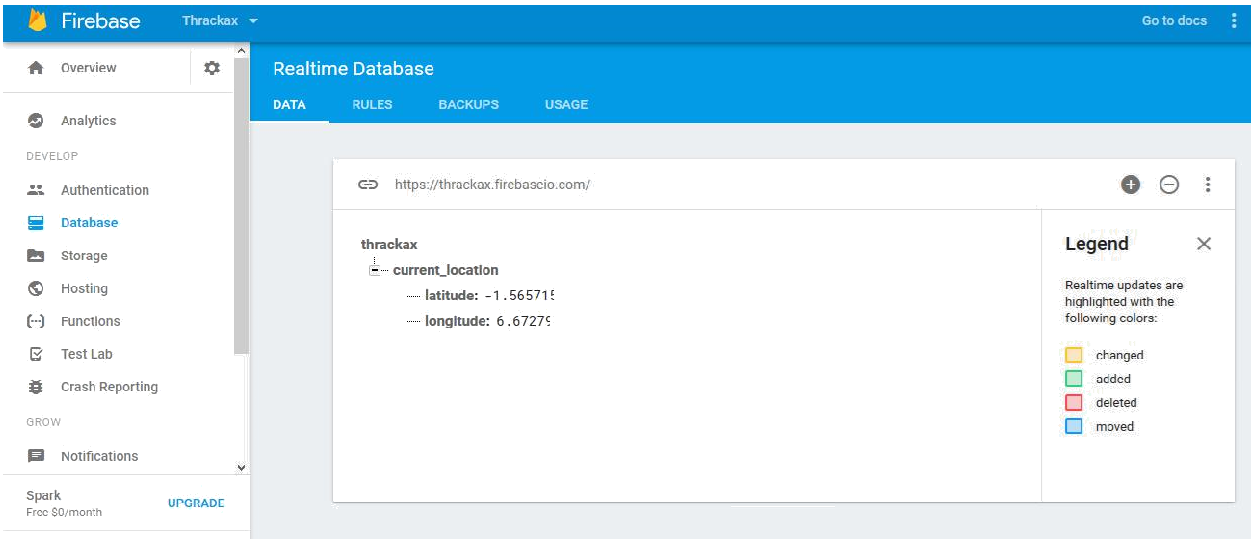

Figure 22 – Location Database

4.2. FRONT-END WORK

The front-end works of our project consists of an android mobile application that assists an individual to easily track our devices and hence your tagged assets successfully:

The application has a login interface for existing users or a register option for new users upon opening. The general picture of what the application does is as shown in figure 23:

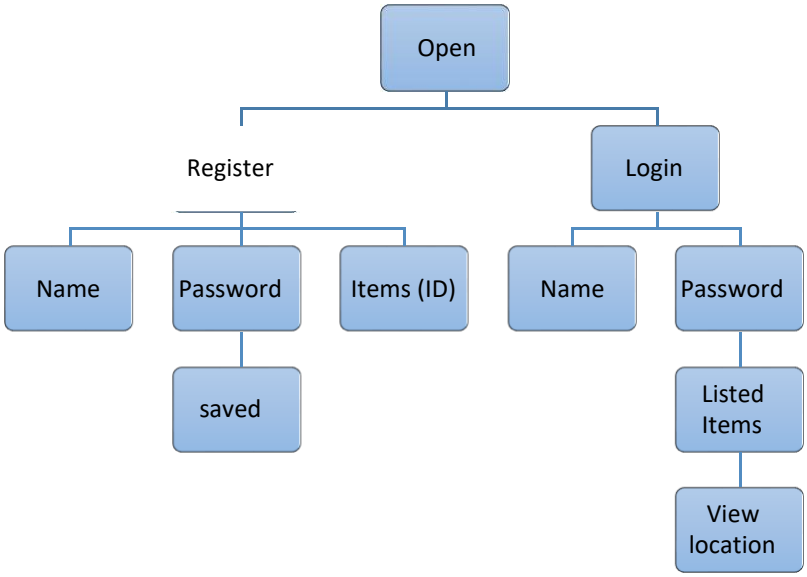

Figure 23 – UI structure

The application called “My Asset Finder” takes your full name, E-mail and a password to successfully register a user (as shown on the left of figure 24) and only the users e-mail and password to login if the person has already registered (as shown on the right of figure 24).

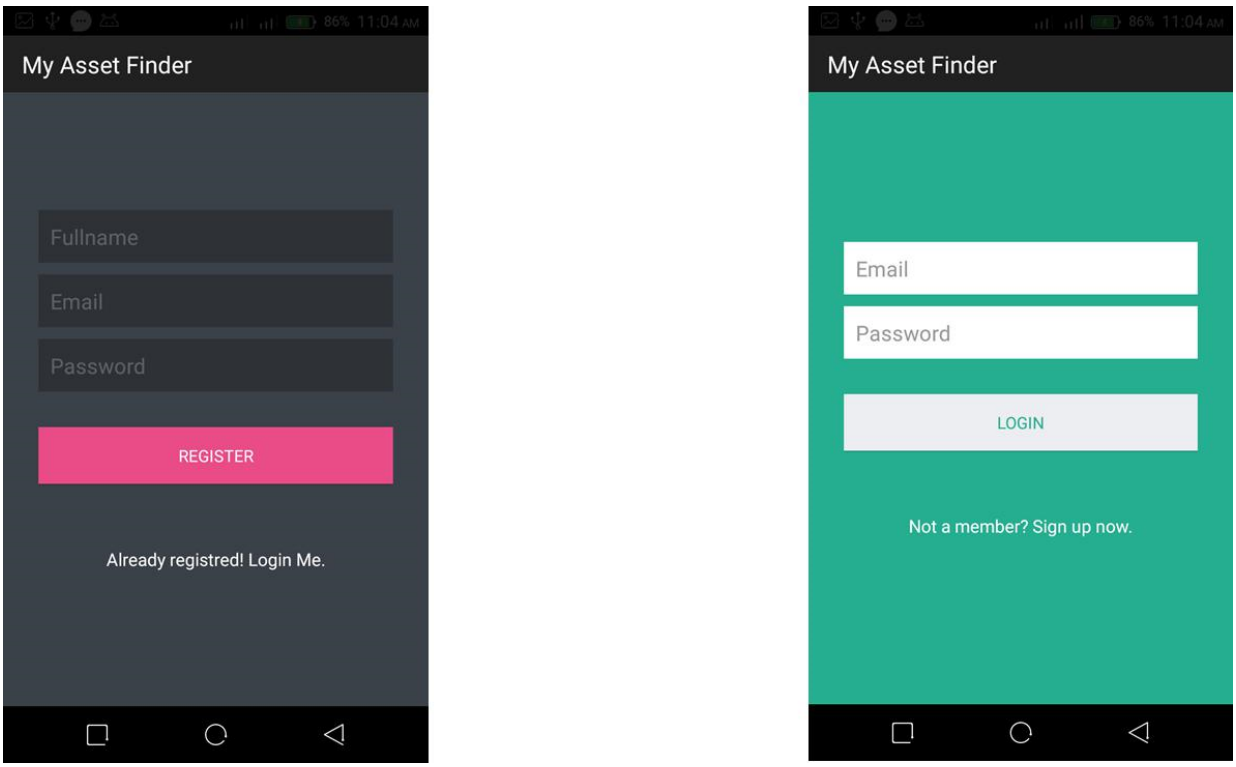

Figure 24 – Registration Page (Left); Login Page (Right)

The next step after a successful login is a welcome page that displays your full name and your e-mail address and also some options buttons to choose from (Register asset, view assets and logout) as shown on the left of figure 24 and the first option (Register asset) upon selection takes you to a page that allows you to input an asset name and a tagged ID to help the system differentiate between different assets. That can also be seen on the right of figure 24:

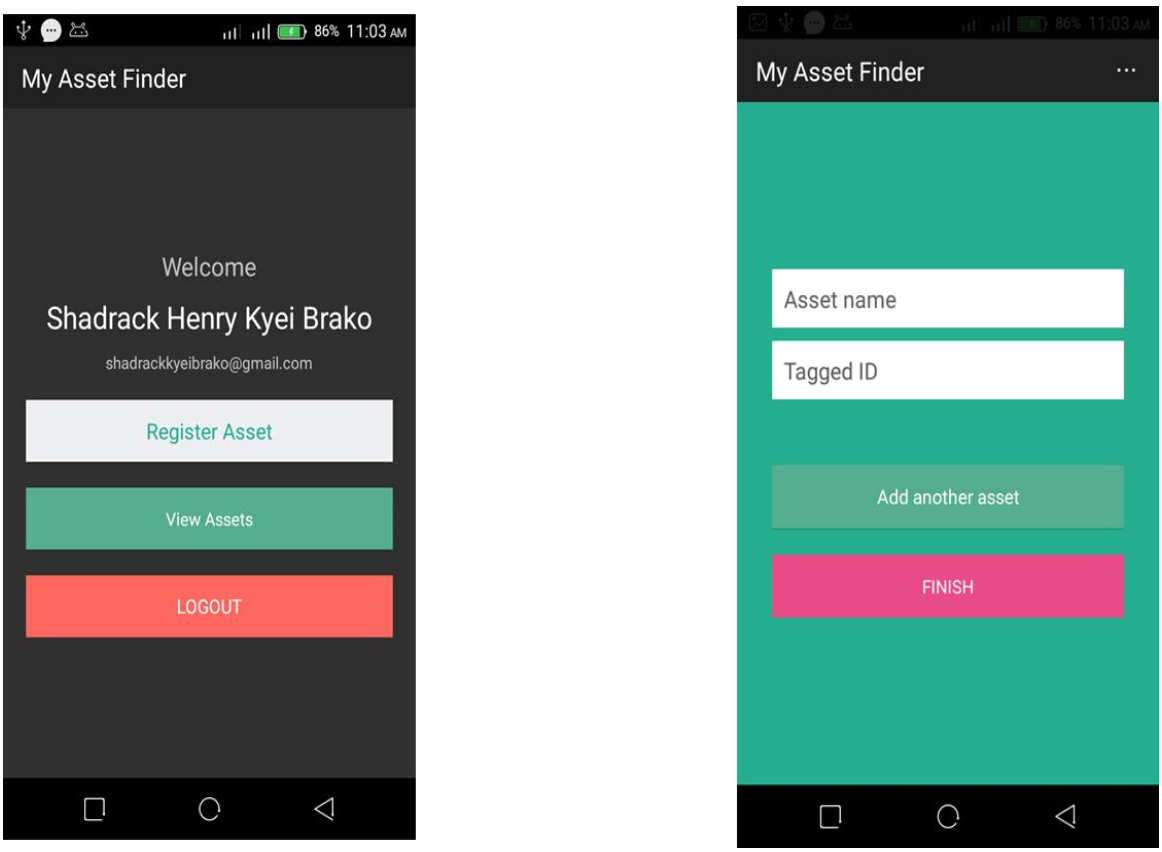

Figure 25 – Welcome Page (Left); Asset Registration Page (Right)

The second option (view assets button) displays a list of all registered assets from the previous menu in a search view format. A sample view of

our first trial is as shown on the left of figure 26; and by the click of any particular item, the application gets the most recent coordinates from the ‘location database and plots it on a google map for your perusal. This can be shown on the right of figure 26.

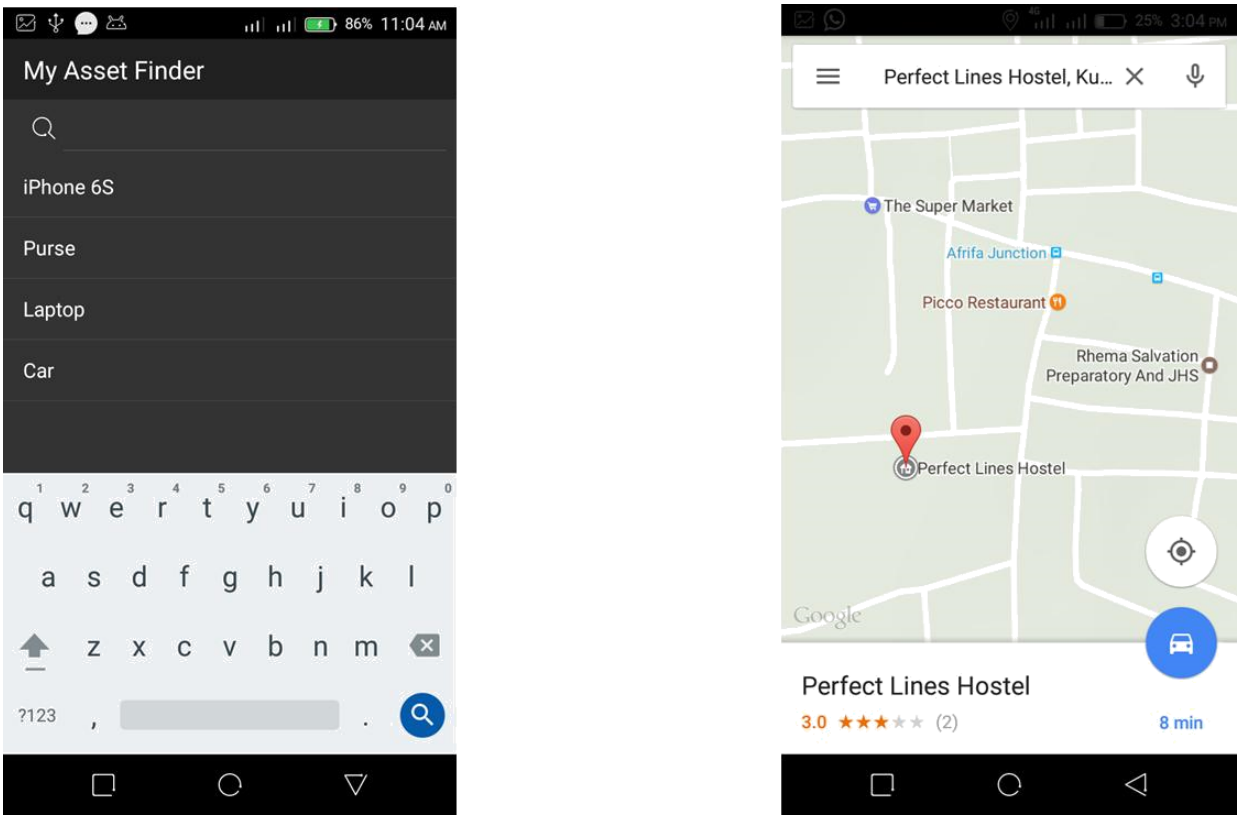

Figure 26 – Asset Listing Page (Left); Map Display Page (Right)

5. CONCLUSION

5.1. SUMMARY OF CHAPTER

By the end of this project, we were able to achieve all objectives and we successfully solved the problem of losing a greater number of asset by attaching our GPS based device to whatever is deemed as an asset to any individual or business society.

GPS was chosen because of its greater advantage over all other tracking technologies currently available because it covers the whole planet and even beyond.

We gave our product a not so obvious packaging as shown in the image below just to offer some form of physical protection to the asset and the device in the cases of theft.

Figure 27 – Final design with package

5.2. RECOMMENDATION

We recommend the following technologies for anyone interested in advancing this project to correct our limitations:

- Use of Nano technology: to miniaturize the final circuit
- Small size power source: to miniaturize the design and also keep the device running for a long time without running out
- Street View Navigation: to improve the accuracy of the device and to reduce the difficulty in finding exactly where on the street the asset is located.

5.3. REFERENCES

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APPENDIX

5.4. ARDUINO CODING

```
#include <SoftwareSerial.h>

byte RX = 10; // This is your RX-Pin on Arduino UNO byte
TX = 11; // This is your TX-Pin on Arduino UNO
SoftwareSerial *A7board = new SoftwareSerial(RX, TX);

void print_result()
{
  Serial.print("A7 board info: ");
  while( A7board->available() != 0)
    Serial.write( A7board->read());
  Serial.println();
}
//----------------------------------------------------------------
void setup() {
  Serial.begin(9600);
  A7board->begin(9600);
  delay(200);

  Serial.println("Send AT command");
  A7board->println("AT");
  delay(15000);
  print_result();

  Serial.println("AT+GPS turn on");
  A7board->println("AT+GPS=1");
  delay(5000);
  print_result();
}
//----------------------------------------------------------------
void loop() {
  print_result();
  delay(2000);
}
//----------------------------------------------------------------
```

5.5. ANDROID CODES

5.5.1. REGISTRATION SECTION

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/android"
   xmlns:tools="http://schemas.android.com/tools"
   android:layout_width="fill_parent"
   android:layout_height="fill_parent"
   android:background="@color/bg_register"
   android:gravity="center"
   android:orientation="vertical"
   android:padding="10dp" >

   <LinearLayout
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:layout_gravity="center"
      android:orientation="vertical"
      android:paddingLeft="20dp"
      android:paddingRight="20dp"
      tools:ignore="UselessParent" >

      <EditText
         android:id="@+id/name"
         android:layout_width="fill_parent"
         android:layout_height="wrap_content"
         android:layout_marginBottom="10dp"
         android:background="@color/input_register_bg"
         android:hint="@string/hint_name"
         android:inputType="textCapWords"
         android:padding="10dp"
         android:singleLine="true"
         android:textColor="@color/input_register"
         android:textColorHint="@color/input_register_hint" />

      <EditText
         android:id="@+id/email"
         android:layout_width="fill_parent"
         android:layout_height="wrap_content"
```

```
    android:layout_marginBottom="10dp"
    android:background="@color/input_register_bg"
    android:hint="@string/hint_email"
    android:inputType="textEmailAddress"
    android:padding="10dp"
    android:singleLine="true"
    android:textColor="@color/input_register"
    android:textColorHint="@color/input_register_hint" />

<EditText
    android:id="@+id/password"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:layout_marginBottom="10dp"
    android:background="@color/input_register_bg"
    android:hint="@string/hint_password"
    android:inputType="textPassword"
    android:padding="10dp"
    android:singleLine="true"
    android:textColor="@color/input_register"
    android:textColorHint="@color/input_register_hint" />

<!-- Login Button -->

<Button
    android:id="@+id/btnRegister"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:layout_marginTop="20dip"
    android:background="#ea4c88"
    android:text="@string/btn_register"
    android:textColor="@color/white" />

<!-- Link to Login Screen -->

<Button
    android:id="@+id/btnLinkToLoginScreen"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:layout_marginTop="40dip"
    android:background="@null"
```

```
            android:text="@string/btn_link_to_login"
            android:textAllCaps="false"
            android:textColor="@color/white"
            android:textSize="15sp" />
    </LinearLayout>

</LinearLayout>
```

5.5.2. LOGIN SECTION

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:background="@color/bg_login"
    android:gravity="center"
    android:orientation="vertical"
    android:padding="10dp" >

    <LinearLayout
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:orientation="vertical"
        android:paddingLeft="20dp"
        android:paddingRight="20dp"
        tools:ignore="UselessParent" >

        <EditText
            android:id="@+id/email"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:layout_marginBottom="10dp"
            android:background="@color/white"
            android:hint="@string/hint_email"
            android:inputType="textEmailAddress"
            android:padding="10dp"
            android:singleLine="true"
            android:textColor="@color/input_login"
```

```
        android:textColorHint="@color/input_login_hint" />

    <EditText
        android:id="@+id/password"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_marginBottom="10dp"
        android:background="@color/white"
        android:hint="@string/hint_password"
        android:inputType="textPassword"
        android:padding="10dp"
        android:singleLine="true"
        android:textColor="@color/input_login"
        android:textColorHint="@color/input_login_hint" />

    <!-- Login Button -->

    <Button
        android:id="@+id/btnLogin"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="20dip"
        android:background="@color/btn_login_bg"
        android:text="@string/btn_login"
        android:textColor="@color/btn_login" />

    <!-- Link to Login Screen -->

    <Button
        android:id="@+id/btnLinkToRegisterScreen"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="40dip"
        android:background="@null"
        android:text="@string/btn_link_to_register"
        android:textAllCaps="false"
        android:textColor="@color/white"
        android:textSize="15sp" />
  </LinearLayout>

</LinearLayout>
```

5.5.3. WELCOME PAGE

```
<RelativeLayout
xmlns:android="http://schemas.android.com/apk/res/android"
   xmlns:tools="http://schemas.android.com/tools"
   android:layout_width="match_parent"
   android:layout_height="match_parent"
   tools:context="${relativePackage}.${activityClass}" >

   <LinearLayout
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:layout_centerInParent="true"
      android:layout_marginLeft="20dp"
      android:layout_marginRight="20dp"
      android:gravity="center"
      android:orientation="vertical"
      tools:ignore="UselessParent" >

      <TextView
         android:layout_width="wrap_content"
         android:layout_height="wrap_content"
         android:text="@string/welcome"
         android:textSize="20sp" />

      <TextView
         android:id="@+id/name"
         android:layout_width="wrap_content"
         android:layout_height="wrap_content"
         android:padding="10dp"
         android:textColor="@color/white"
         android:textSize="24sp" />

      <TextView
         android:id="@+id/email"
         android:layout_width="wrap_content"
         android:layout_height="wrap_content"
         android:textSize="13sp" />

      <Button
```

```
        android:id="@+id/btnRegisterAsset"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="20dip"
        android:background="@color/btn_login_bg"
        android:text="Register Asset"
        android:textAllCaps="false"
        android:textColor="@color/btn_login"
        android:textSize="17sp"
        />

    <Button
        android:id="@+id/btnViewAsset"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="20dip"
        android:background="#56ae90"
        android:text="View Assets"
        android:textColor="@color/white"
        />

    <Button
        android:id="@+id/btnLogout"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="20dip"
        android:background="@color/btn_logut_bg"
        android:text="@string/btn_logout"
        android:textAllCaps="false"
        android:textColor="@color/white"
        android:textSize="15sp" />

  </LinearLayout>

</RelativeLayout>
```

5.5.4. ASSET REGISTRATION

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/android"
```

```
xmlns:tools="http://schemas.android.com/tools"
android:layout_width="fill_parent"
android:layout_height="fill_parent"
android:background="@color/bg_login"
android:gravity="center"
android:orientation="vertical"
android:padding="10dp" >

<LinearLayout
   android:layout_width="fill_parent"
   android:layout_height="wrap_content"
   android:layout_gravity="center"
   android:orientation="vertical"
   android:paddingLeft="20dp"
   android:paddingRight="20dp"
   tools:ignore="UselessParent" >

   <EditText
      android:id="@+id/assetname"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:layout_marginBottom="10dp"
      android:background="@color/white"
      android:hint="Asset name"
      android:inputType="textCapWords"
      android:padding="10dp"
      android:singleLine="true"
      android:textColor="@color/input_register"
      android:textColorHint="@color/input_register_hint" />

   <EditText
      android:id="@+id/taggedid"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:layout_marginBottom="10dp"
      android:background="@color/white"
      android:hint="Tagged ID"
      android:padding="10dp"
      android:singleLine="true"
      android:textColor="@color/input_register"
      android:textColorHint="@color/input_register_hint" />
```

```
        <!-- Link to Another Asset -->

        <Button
            android:id="@+id/btnRegisterAnotherAsset"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:layout_marginTop="40dip"
            android:background="#56ae90"
            android:text="Add another asset"
            android:textAllCaps="false"
            android:textColor="@color/white"
            android:textSize="15sp"
             />

        <!-- Login Button -->
        <Button
            android:id="@+id/btnRegisterAsset"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:layout_marginTop="20dip"
            android:background="#ea4c88"
            android:text="FINISH"
            android:textColor="@color/white" />


    </LinearLayout>

</LinearLayout>
```

5.5.5. ASSET DISPLAY PAGE

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
```

```
    android:background="@color/lbl_name"
    android:gravity="center"
    android:orientation="vertical"
    tools:context=".ListActivity" >

    <SearchView
        android:id="@+id/idsearch"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:iconifiedByDefault="false" >

        <requestFocus />
    </SearchView>

    <ListView
        android:id="@+id/idlistview"
        android:layout_width="match_parent"
        android:layout_height="match_parent" />

</LinearLayout>
```

5.5.6. GOOGLE MAP INTEGRATION

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical" >

    <fragment
        android:id="@+id/map"
        android:name="com.google.android.gms.maps.SupportMapFragment"
        android:layout_width="match_parent"
        android:layout_height="match_parent" />

</LinearLayout>
```