

# Literature Review

mah60

July 2019

# Contents

<b>1</b>	<b>Introduction</b>	<b>3</b>
<b>2</b>	<b>Similar Projects</b>	<b>3</b>
2.1	Smart Bins . . . . .	4
2.2	Wifi Tracking Using Arduino Wifi Shield . . . . .	4
2.3	TFL Wifi Tracking in the London Underground . . . . .	4
<b>3</b>	<b>Product Development Research</b>	<b>5</b>
3.1	Microcontroller Research . . . . .	5
3.2	Database Design . . . . .	5
3.3	Network Structure . . . . .	6
<b>4</b>	<b>Version</b>	<b>6</b>

# 1 Introduction

The research being completed in the project is to answer, “Investigating the use of individuals mobile devices as a mechanism to enhance locational information within a geographic setting”. The project will require research into multiple different area about networking and electronics. The literature review is here to analyse different websites, project and articles that may support the development of the devices to answer the statement given for the project.

The main tasks that will be researched throughout this project is to create a device that will provide solutions towards the use cases that were given within the Project Outline. These use cases are;

1. Small Event Visit Counter
2. Medium Event Counter
3. Path Tracking Application
4. Rerouting Application

The design of the product that is being has been based around key factors that will be discussed later in this document. However, the key components that define how the product will work are defined by;

- Microcontroller’s - used for wifi tracking and data processing.
- Data Storage - the database that is used to store the selected data and how it will be stored.
- Data processing - what method will be used to process the data to analyse the gathered information.

The components that are selected to complete the product will determine how efficiently the tasks are done and will affect the overall effectiveness of the results. The key variables that will need to be collected to achieve the use cases given are;

- Mac Address - is a unique identifier for each device that is connected to the internet. The variable will look like ‘0c:cb:85:25:d1:f1’. The mac address cannot be used to trace any data back to the owner of the device and can only provide information about the vendor of the device. This data will be used to uniquely identify the device and record data about when it seen and the RSSI at that given time. It is key to counting the footfall in a given area and not counting the same person twice.
- RSSI – Resource Strength Indicator – the signal strength between the two devices, the strength values range between 0 to -100. The stronger the signal the higher the number. The RSSI will give the possibility to determine the range for readings inside the event and will be the primary resource to determine the location of a device.
- Timestamp – this variable will be used to give a time of when each individual signal was received. The variable will look like ‘2019-08-01 20:59:02’ and will be used to calculate dwelling time and help compare individual signals and see if they are related or not.

From these variables select information can be gathered to create the use cases and produce appropriate results that can be given to the user of the product.

## 2 Similar Projects

The initial part of the research for the project is to look towards similar ideas that may indicate different solutions and their limitations or flaws. Therefore, providing a guide to help create a path in which the project should take and show the possible problems that could occur throughout the project.

## 2.1 Smart Bins

The project that was first found to help support the new report around the project of ‘Smart Bins’ that were placed around London by Renew. The BBC news explain the problem areas around the project and Quartz go into further details about the development of the project. The main issue that was found during these reports is that the Renew company had developed these bins to count Footfall data around the area of the bins and provide advertising at the same time, however, the company collected more data than required and started providing select advertising based on paths the device took. This was a breach of personal data was shut down due to this cause. They had further plans to expand to other cities and use the location tracking to gather other personal data, such as the gender of the device holder.

The ‘Smart Bins’ were useful for displaying that it is possible to create a Footfall counter and to demonstrate the ethical and legal issues that lay around a project of this design. As the data collected could be abused to collect personal data on a device holder without them even know, this is due if the device is in promiscuous mode the device will pick out packets and leave no trace that the packets being sent was read.

## 2.2 Wifi Tracking Using Arduino Wifi Shield

The next report that was useful towards the project was about position tracking using an Arduino with a wifi shield by Nathan Conrad at Western Michigan University. The device that was being developed was a network of devices that would help indicate where an employee or object is within the workplace. Each employee would hold a device that would have a tracker connected to it, that only worked within the company building. This device would allow for a button to be pressed to indicate an emergency inside a building and could provide a map the location of the device throughout the building. The main issue that was found during the development of this project was that depending on the amount of access points that are inside a building, the signals may be interrupted or become confused due to noise. Therefore, meaning the reading could contain error within the RSSI, this would cause problems with location tracking as it is the main method of determining the location of a device. The wifi shield was changed from a CC 3000 to a Arduino Wifi Shield that would provide a more efficient solution as the device was less confused by noise within the building.

The report displays the possibility of location tracking through wifi tracking and a clear position of a device can be indicated if a network of device work together to collect appropriate results. However, there can be issues with accurate recordings that depend on the environment that the network is being used within. Meaning during the testing of this project different environments should be experimented with to gather information about the possible flaws of the design, such as too many access points could generate a lot of noise within the network.

## 2.3 TFL Wifi Tracking in the London Underground

The next report discusses possible data that could be collected from the use of wifi tracking. The report discusses the testing that the TFL did to research whether wifi tracking could give accurate information about the whereabouts of users in the London underground and the routes they take. The reasoning behind this research is due to the oyster card only being able to give information about where a user enters the underground and leaves. The collection of this data provides information about the most used routes and peak hours of when people are travelling through the underground. However, it does not provide the actual route they take. This is where wifi tracking helps, as throughout the testing process wifi tracking through people's mobile phones provided additional information, such as which tube lines users went on and how people got from A to B in the underground.

From the data gathered TFL was about to produce results that demonstrated the most used routes between stations. This allowed TFL to search for routes taken between two stations, such as King Cross to Water Loo, and discover the most used ones. Therefor allowing for a journey planner to be developed and supply users of alternative routes to take to avoid traffic. However, this demonstrates a problem of a feed-back loop, due to if you tell everyone to go one way to avoid crowded routes then that route will become crowded. They have to find a solution to this however, this does bring the problem forward when developed the Routing Application for use case 4. The report demonstrates the need and power for wifi tracking to be used in London Underground and other places. This is due to the information being collected could help to support travel between two locations, when development can be done on the train line, e.g. construction or repairs, or rerouting users if something goes wrong.

..... read over this ..... need to references how this is useful towards the project more often, maybe simplify the summary.

### 3 Product Development Research

The core part of the project is to build a product that can track mobile devices and record the data from those devices. There are three core structures that will provide a resource to conduct research into the usefulness of wifi tracking. The core parts of the product are the microcontrollers that will be used to track mobiles and a microcontroller to store and process data on. Then a what structure the database and the network will take. These core parts will be used to gather data and perform processing techniques later on in the development of the product.

#### 3.1 Microcontroller Research

The microcontrollers are a core part to the project as this is where the devices will collect and process the data to achieve the use cases. There were two microcontrollers selected to do the job because the microcontrollers were easy to obtain as there were spare around the department. These microcontrollers were;

- ESP8266 - is a low cost wifi microcontroller that will be programmed using the Arduino IDE. The application for the microcontroller is to be used as a tracker to gather information about the mobile devices in the vicinity. If possible the device will also be used to store and process the data to get the appropriate output.
- Raspberri Pi Model B Revision 2 - this is a computer that can run Linux. This device will be able to run python, which is a language that is very powerful for processing and analysing data. This device will be used for processing the data collected by the individual trackers.

These microcontroller will be used to build the product and create a network of devices that will be able to track mobile devices to retrieve select information. Then once the data is collected it will be stored and processed on these microcontrollers.

#### 3.2 Database Design

The database is where all data will be stored and analysed. Therefor it is essential to think about the data being collected and a sufficient way on how to store the information. The first task is to look at the variables that will need to be stored. Taking into account that there will be multiple trackers and one database, these are the variables that will be collected for each recording.

- Mac Address - the mac address of the device being recorded. A one-way hash will be required to apply against the mac address.
- RSSI - signal strength for the connection between the tracker and the mobile device.

- Timestamp - time and date of when the reading was taken.
- Tracker Mac Address - tracker mac address as each device recording the data will need to be uniquely identified.

There are multiple database management systems (DBMS) that could be used to store this data, such as a document orientated DBMS or relational DBMS. The relational DBMS would be the most ideal choice for this type of data collection as the recordings will always hold fixed variables and information. There should be no missing values or additional variables in the data collected. Therefor a document orientated DBMS is not required.

This reduces the amount of DBMS down to one category of research and mean that there are select database languages that could be used for the task. These languages will be required to be used in either Arduino or Python. The languages chosen are;

- SQLite -
- SQL -
- NoSQL -

### 3.3 Network Structure

## 4 Version

Version	Description	Date
0.1.0	Created the initial design for the document and created the introduction chapter.	01/07/2019
0.2.1	Literature reviews chapters that have been joined up are; RSSI, Mac Address, tomographic reconstruction. Relatable Projects; smart bins, position tracking using arduino wifi shields.	02/07/2019
0.2.2	proofread created chapters	06/07/2019
0.2.3	Completed reading on Position Tracking Using Arduino Wifi Shield, added access points	13/07/2019
0.3.0	Redesign of document to make it more narrative and in clude a bibliography	03/08/2019

## References

- [1] EnGenius; RSSI; 30/06/2019;  
<https://helpcenter.engeniustech.com/hc/en-us/articles/234761008-What-is-RSSI-and-its-acceptable-signal-strength->