Goldsmiths, University of London

Software project proposal

iLost

Ahmed, Muhammad
Chowdhury, Thairan
Davies Minta, Dylan
Fakrul, Mahmudul
Farkhani, Hussein
Jheng-Hao, Lin
Pecorella, Mariano

supervised by
Tim Blackwell

December 15, 2017

Contents

1 User Need Overview & Concept Introduction

1.1 Subsection

We began our process of conceptual development by questioning fellow students about some of the everyday issues they encounter to aid us in coming up with an idea capable of mitigating a specific need. During these conversations, the group found that losing personal belongings in both private and public places was a common occurrence. According to research from Mozy, the average value of a lost item is 131.67; the average person irretrievably loses 71.55 of goods each year. As a result of the average person losing over 60 worth of possessions each year; billions are being lost.[1] To satisfy the needs of our users, we focused on finding a way to circumvent the loss of items; we determined that developing an item loss prevention app would be appropriate.

1.2 Concept Introduction

Our app's original intention was to inform the owner that they're about to leave a belonging behind by sending a notification to their phone upon reaching a certain distance away from the item. To facilitate this concept, we needed a means for the app to communicate with the lost possession and concluded that a tracking device of our own would be necessary. We wanted to ensure that the tracking device was discreet; hence our group set its initial focus on Bluetooth stickers. Bluetooth stickers seemed to be a natural choice because theyre lightweight, making them easy to carry around. Additionally, we thought it was the appropriate choice for our project due to how inexpensive these items can be, as well as low power consumption and high accuracy. A Bluetooth tracking device is rendered useless by a dead battery and numerous other potential complications. To counteract this, we adopted a hybrid approach, utilising Bluetooth in conjunction with cellular data, Wi-Fi and a server, enabling logging over greater distances.

2 Data Gathering and Requirements

According to our research, the external stakeholders include the potential users. As the developers of this idea, we are the internal stakeholders. Our project is designed to aid users. Therefore, our aim as internal stakeholders is to address the concerns of the external stakeholders.[1] We carried out a

user investigation using SurveyMonkey, to garner a better understanding of our potential clientele. We gained knowledge that 44% of the interviewees would be very likely to buy the product if its available today. Analysing the data trends of the 54 responses we received informed us that 70% of the interviewees had a positive reaction to the concept. The remaining percentage was concerned about our concepts similarity to other existing products; [2] the concerns that were raised made it a requirement for us to find ways to distinguish our project from others.

Our team gathered data in many ways, helping us meet the stakeholder's requirement of differentiating ourselves. We used the market research, motivated by the survey interviewees concerns, to provide ways in which we can diversify our idea from existing products or solve their shortcomings. Comparing the pros and cons of similar concepts allows us to combine the best of each. Product reviews uncovered a flaw in existing products; users deplore the fact that they arent notified if an item is about to exceed the tracker's range.[3] This improvement users are shown to be longing for[3] is also an integral part of our original idea and this distinguishes us from what exists. This research influenced our decision to utilise GPS triangulation, which is also nonexistent in current products and expands on the general concept.

3 Functional Specification

Our product has the ability to prevent the loss of personal belongings as well as, retrieve lost belongings. How does it do that?

We will accomplish this through a hybrid approach, utilizing small computers and the precision of short range wireless technology as well as long range wireless technology (essentially unlimited range). Given different scenarios, these technologies will alternately adapt according to the users needs. Through the medium of software application, the user will be able to interact with the tracker on the tagged item. Here is how the application works:

1. The application will allow sending requests to the server in order to create a new account, to store a new users data in the database. It will also consent:

    - updating account details
    - retrieve existing users data from the server once the application has acknowledged sign in details.

2. The customer will have to then register item/s of interest that needs to be tracked. This can be done by selecting from an existing items list of items as well as adding a new item label to be tracked.

In a normal scenario:

1. The smartphone will be tracking the users position.
2. The application on the phone will frequently request the labelled items location tagged by tracker utilizing the short range wireless communication technology by default.
3. In the event of the application not detecting signals from short range wireless technology in the tracker. This will trigger the application to send out a notification to the smartphone, warning the user that the item is not in their neighbouring.
4. In this case the item is out of the users range, so the user can head back to the location to recover the item.
5. The customer can also choose to stop the notification temporarily and retrieve the item in a later time.
6. Once the user is back within the range of receiving signals from the tracker to the application, the notification will then permanently stop.
7. The incident will then be recorded and stored on smartphones database as lost history with the marked location.
8. On the other hand, long range wireless technology mounted on the tracker comes in play when an object needs to be recovered or tracked once it is out of the short reading range.

In this case the consumer can utilize the application to interact with the tracker, and switch to the long range wireless technology for it to locate itself displaying the position of the tagged item. At this stage, the location of the item has a vague accuracy range, approximately around 40 metres. However, as the user progresses towards the tagged item the application will notify the long range wireless technology server to switch on the short range wireless technology for greater accuracy of positioning range, roughly of 3 metres distance.

4 Ethical Audits

Ethical audits are a set of rules and regulations that a business is considered to follow. It is a platform in which, priorities different factors and signifies right from wrong. Ethical audits can be both internal and external to the business. The five sectors that are usually looked at under ethical audits are data protection/customer data/privacy, health and safety, labour, environmental ethics and business ethics. Labour however can fall both under environmental or business ethics.

One question that is likely to be asked right off the bat by potential customers is regarding their personal data. As it is a device that not only alerts the user that they have left a product behind, it also allows the user to locate their missing product/s. Our data protection will serve a disclaimer, the application will have a Terms of Use script which tells the user that their data is safe as iLost will only need location data. Now, this might raise further questions, to put any disputes to bed. The data that iLost will use is longitude and latitude just to track the lost property/properties, meaning all other customer data will not be affected. To still have a strong backing, we will make the device as safe to the customers use as possible. Privacy therefore should not be a issue for the user. All the data that we collect, will be stored with ICO (Information Commissioners Office) which is already an established company. iLost will also give the freedom to users to delete any data whenever they want.

5 Design

We have six basic use cases which contain five use case actors. These use cases cover all the services our service could provide for the users, which enable us to develop the use case diagram, sequence diagram and activity diagram.

Name	Description
User	The user who uses our service.
App	The iLost mobile application that User interacts with.
Server	Hologram Cloud APIs, which provides the geolocation of the Tracker.
Tracker	Physical tracker attaching to the user's item(s), a raspberry pi and a GPS module are built-in.
Item	User's personal belonging which is desired to be tracked.

Table 1: Use case actors

Use Case ID	Use Case Name	Primary Actor	Description
1	Log Tracker	User	User logs the Tracker into App.
2	Monitor Tracker	App	App listens to the signal of Tracker.
3	Track Item	User	User uses App to track their item.
4	Send position data	Tracker	Tracker sends position data.
5	Register account	User	User register a new account in App.
6	Login account	User	User login to account in App

Table 2: Use case index

Please find the details of each use case flow in Appendix A.

5.1 Use cases diagram

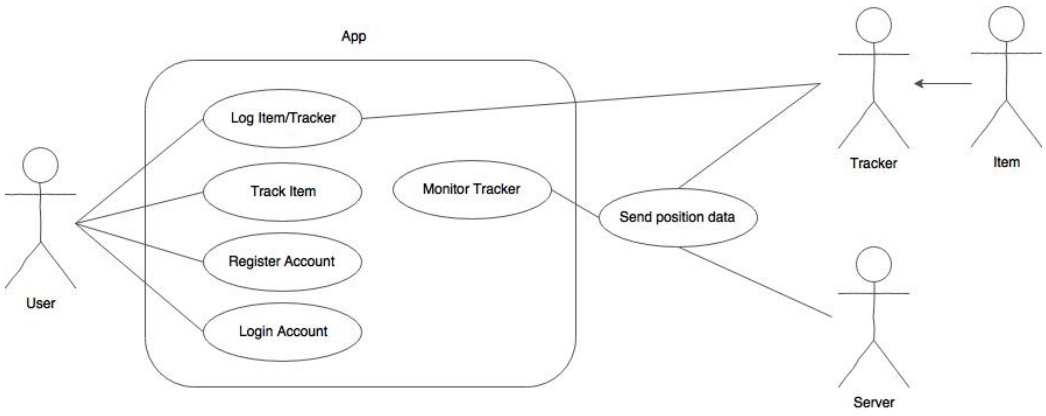


Figure 1: Use case diagram

The use case diagram visualises the relationship between these five actors and the use cases.

5.2 Sequence Diagram

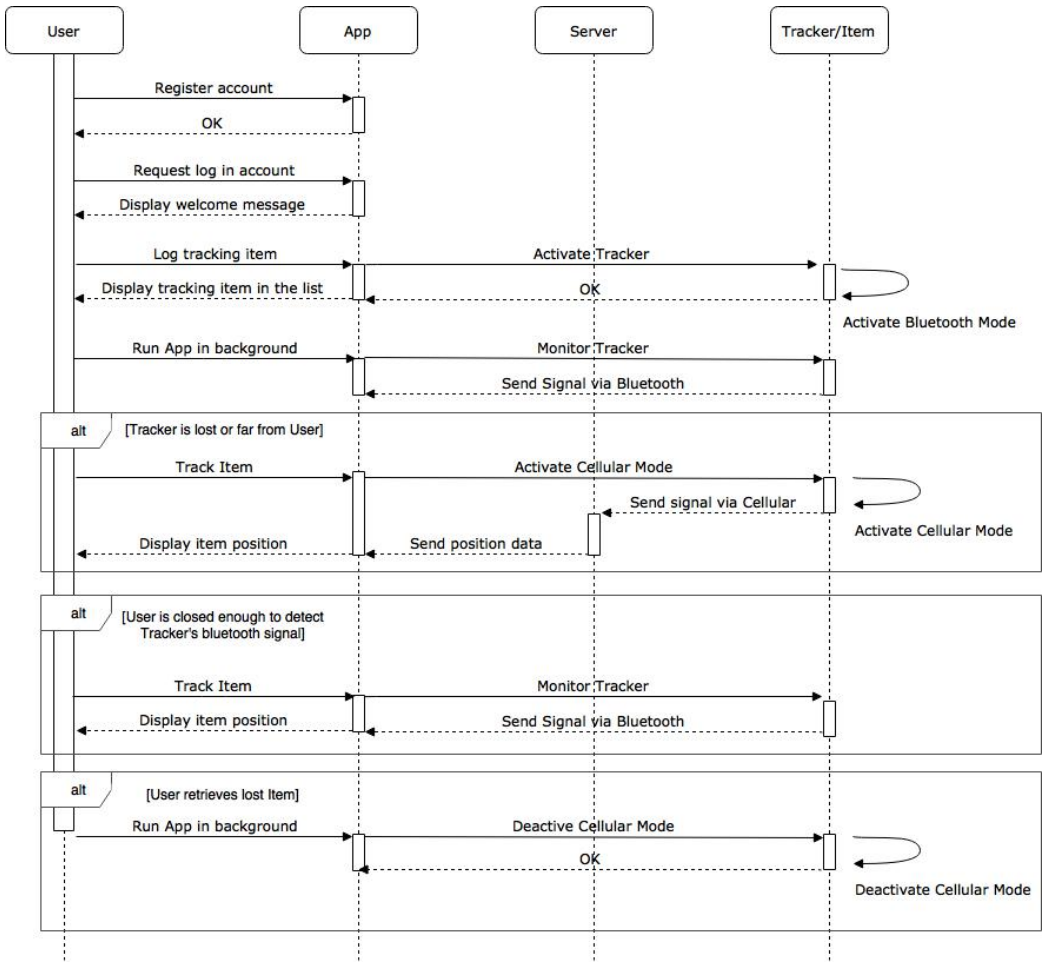


Figure 2: Sequence diagram

The sequence diagram demonstrates the relationship and data flow of each use case.

5.3 Activity Diagram

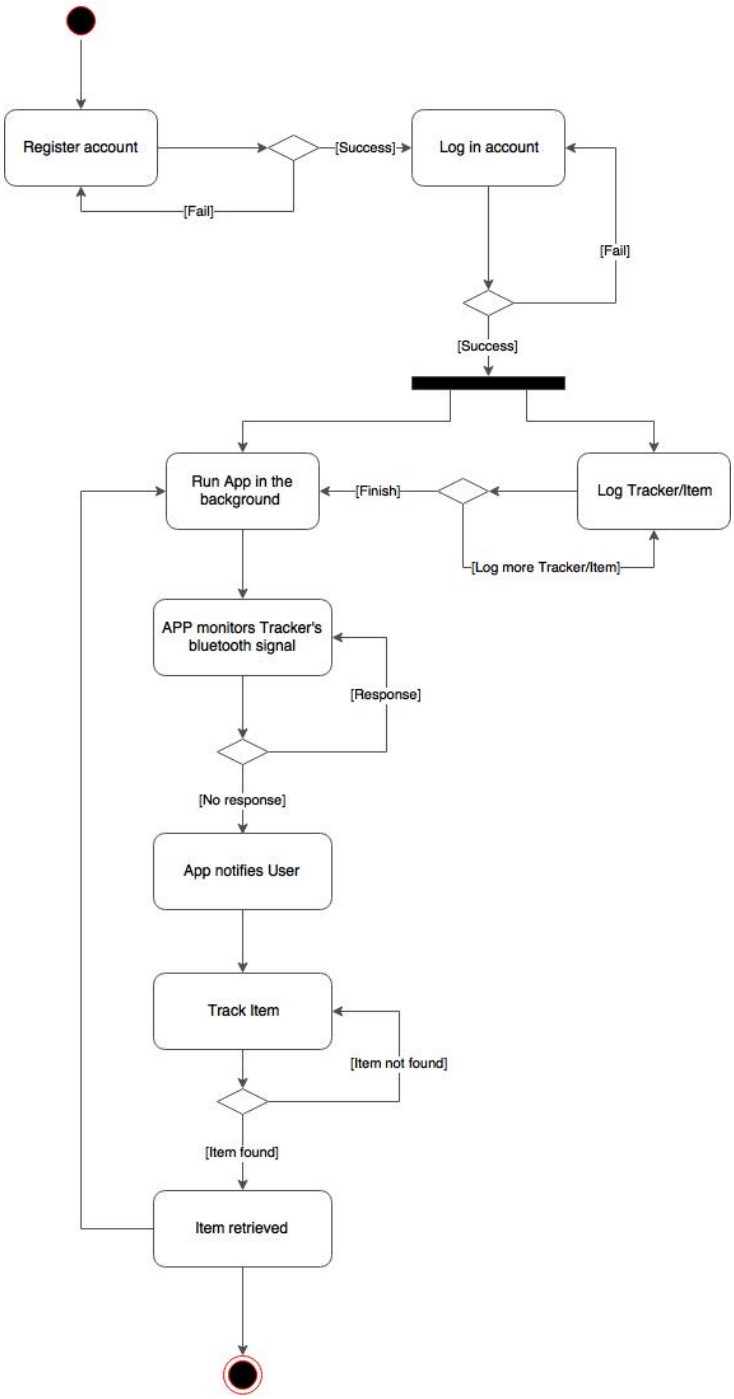


Figure 3: Activity diagram

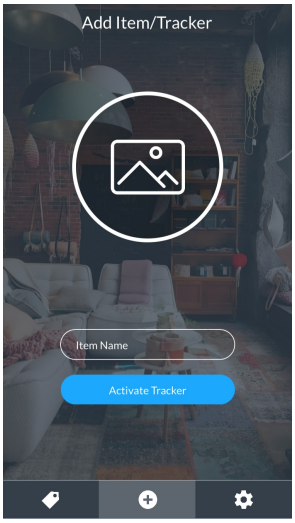
The activity diagram shows the basic usage flow.

5.4 User Interface

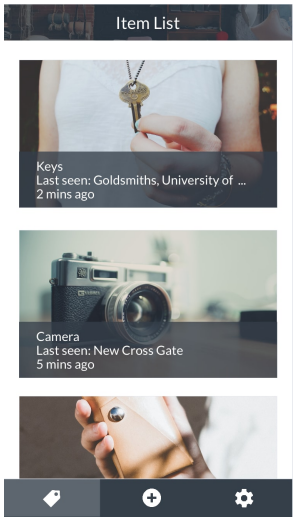
We prototyped the wireframe and user interface base on the use cases with a live prototye(https://marvelapp.com/48da709) to test the usability of our design. In the proposal stage, the application provides the basic functionalities to fulfil the user needs. The user interface is listed below and sorted in usage frequency and importance.

ID	Name	Functionality	For Use Case
1	Log Item	Log new item and Tracker to App.	Log Tracker
2	Item List	Display the list	Track Item
3	Track Item	Show the item's position on the map.	Track Item
4	Notification	App notify User Item is lost	Monitor Tracker
5	Welcome	Introduce our app to the user	Login account.
6	Login account	Allow User to login account.	Login account
7	Register account	User registers a new account.	Register account

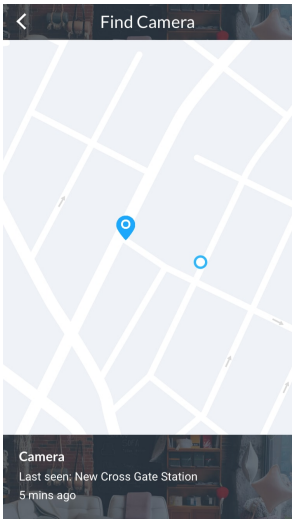
Table 3: Use case index



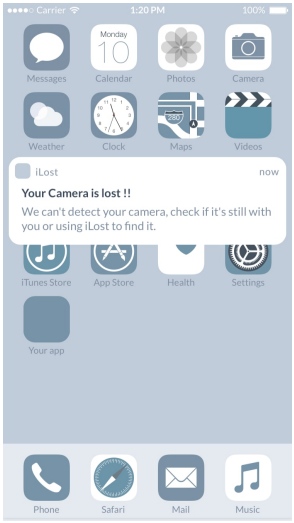
(a) Log Item



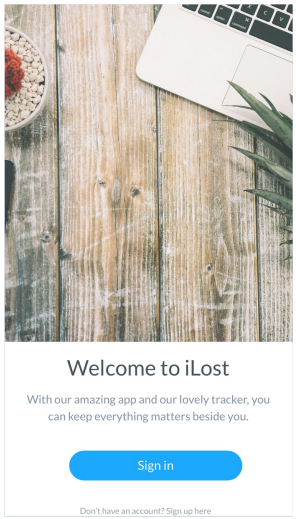
(b) Item List



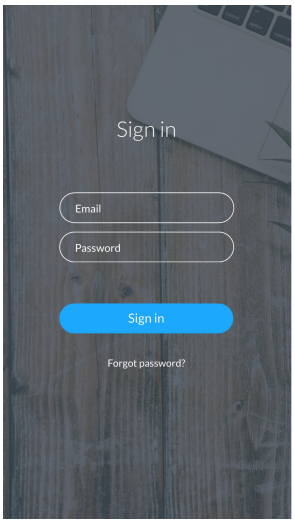
(c) Track Item



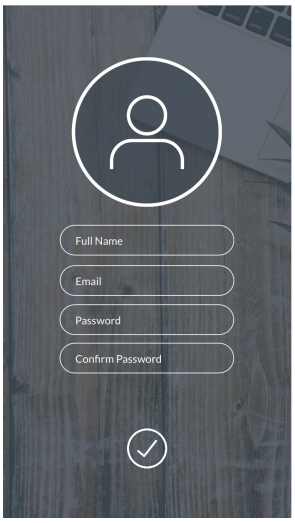
(d) Notification



(e) Welcome



(f) Login account



(g) Register account

Figure 4: User interface design

6 Prototyping

6.1 Singular approach

Initially, our orginal prototype simply consists of a Beetle BLE[2] (with a 3.7v battery) which pings at regular intervals to the users smartphone (if the ping is not detected by the smartphone after a certain time then the item is out of range)

We later replaced the Beetle BLE with an estimote Sticker Beacon[3] which has greater range and battery life as well as being relatively compact in size (also , built in 1 year battery).

This initial prototype did receive positive responses, however a substantial number of users stated that our product was too similar to other competitors on the market such as tile[4] etc.

We needed to prototype a product that was unique, Bluetooth is being overused in the market, however Bluetooth is a reliable technology at short range (0 -30 meters, users expect the tracker to last at least 6 months in the field).

Test prototypes were created with a GPS shield attached to an Arduino, the GPS capability was too inaccurate and power consuming. Another prototype was created using a passive and active RFID reader shield and Arduino. We discovered that either way the range was too short for the product to be feasible and too large for the user. Moreover, active RFID's are far too expensive to implement.

We exhausted other possibilities too. A test using acoustic location (using environmental sound to triangulate the Arduinos location) proved that this was not feasible in the user environment (noisy chaotic urban) and the Arduino did not have the processing capability of handling so many sound sources.

Moreover, we also prototyped an Arduino using wi-fi hotspots to locate itself. This proved to be unreliable as wi-fi hotspots are still not frequent enough and are not guaranteed to be operational at all times, Wi-Fi is also more power consuming than our previous prototypes. Lastly, with a cellular shield and an Arduino- we tried to manually implement cellular triangulation.

This did not work for many reasons, we did not have the ability to negotiate with multiple cellular carriers and data costs would be too expensive, but we recognised that cellular was low power consuming and provided unlimited long range (cell towers cover most of the world more than satellites or Wi-Fi hotspots).

After all of these singular approaches, we decided its best to take a Hybrid approach which allows us to exploit many of the different singular approaches we prototyped earlier.

6.2 Hybrid Approach

Using Skyhook[5] was our first approach to prototyping using many different tracking technologies (Bluetooth, wi-fi hotspot triangulation, GPS etc..) combined. Skyhook is what the apple iPhone uses for location tracking, so it is well supported and we could use our own group member's iPhones for testing accuracy of the location tracking. The Skyhook API can be Installed on a raspberry pi or any smartphone device. It uses whatever sensors on the device to determine its location. For example, it triangulates its location from Wi-Fi hotspots, cell towers and Bluetooth signal strength.

The Hybrid approach does provide better location tracking, so we needed to replace Skyhook. We were inspired by the recent iTrack tracking device (the first device on the market to exclusively use cell tower triangulation). Its seemed best to combine the long range effectiveness of cellular with the excellent short range ability of Bluetooth.

Skyhook was replaced with Hologram Cloud[6], they provide us with a small USB sized cellular modem (Hologram Nova) and a python SDK which can be installed on the raspberry pi, the modem provides cellular location data (it simplifies cell tower triangulation) which can be transmitted via 2G/3G to a Hologram cloud server. The Hologram cloud server then connects to the users smartphone/wearable app, sending the user the location of the tracker.

We tested out the python SDK and read through the documentation thoroughly.

Hologram Cloud does not store user data, so they charge a small amount for data usage. However, they can negotiate with carriers worldwide and provide us with automatic carrier switching.

6.3 Current Prototype

To clarify our tracker consists of a raspberry pi, a Hologram Nova[7] and a lithium poly battery. Bluetooth for short range and cellular triangulation for long range.

We developed a new protocol from this hybrid approach - In a long range situation, when the user gets closer to the tracker, less than 40 meters. The app on the users smartphone sends a request to Hologram cloud server, the server then sends a message to the tracker to turn on the Bluetooth module and look for the users smartphone/wearable thus providing a more precise location, especially in an chaotic urban environment or indoor multi-level environment. We couldnt find any other product that provided this feature. We now need to implement and test this protocol.

7 Technical Architecture

The product contains three parts: a mobile application, a physical tracker and the Hologram Cloud as the server. Hologram Cloud provides various built-in functions which allow us to focus on developing the mobile application and the tracker. Due to the privacy issue, our application doesn't store any data in the cloud server or database but in the user's mobile phone only.

Here we provide three kinds of views in different diagrams. The process view won't be shown here because it is same as the activity diagram in the Design section.

7.1 Logical View

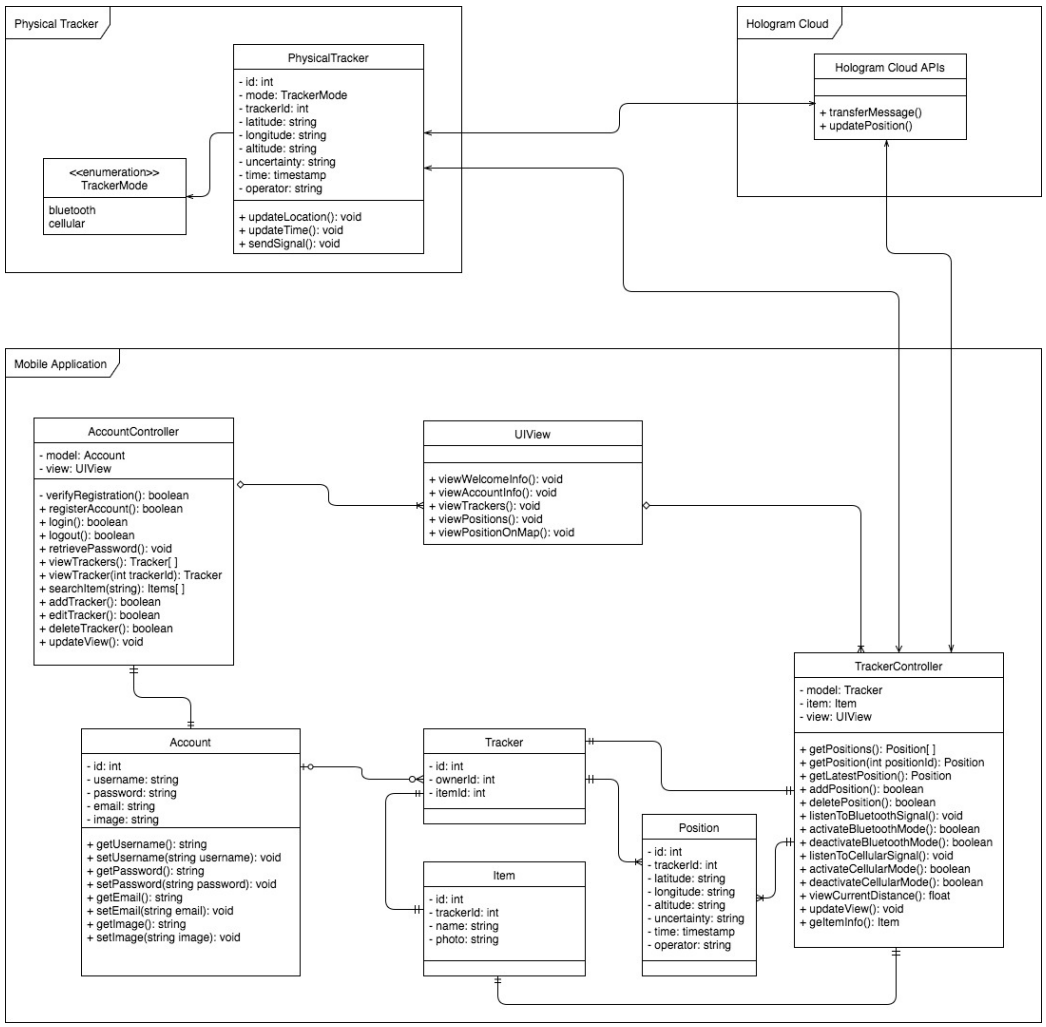


Figure 5: Logical View

The logical View diagram is based on our main architecture split into three parts: Mobile application, Hologram Cloud and Physical Tracker, and mobile application are our main focus. The architecture is based on MVC pattern, one point worth mentioning is that there are three models (Account, Tracker and Position) while two controllers only(AccountController and TrackerController). The reason is that the Position data will be immutable and directly transferred from either Hologram Cloud or Physical Tracker, and binding the data flow with TrackerController simplify the whole routine.

The class of Hologram Cloud is simplified, because it comes with complex APIs and the most important function and the related functions are transferring message and updating position. The getters and setters are omitted due to the readability.

7.2 Development View

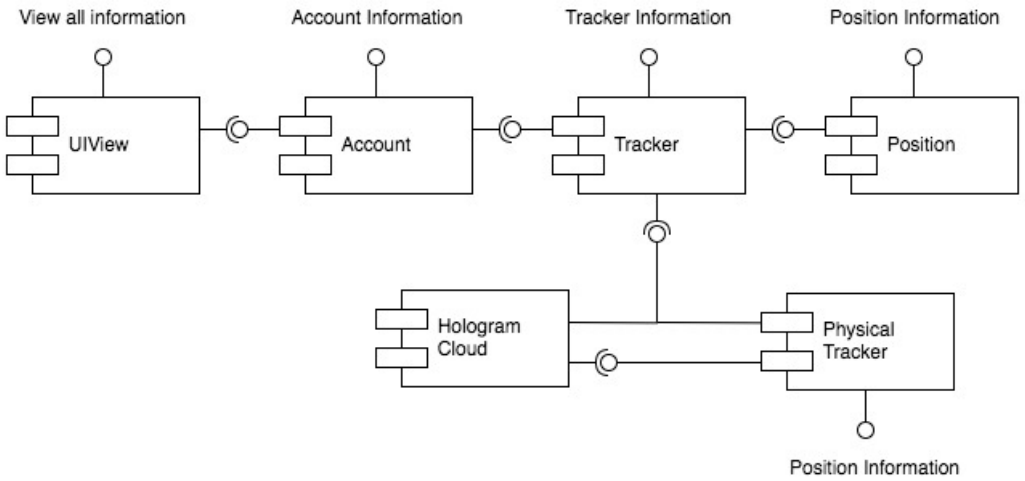


Figure 6: Development View

With development view, we can understand the data flow and what are the data should each component provide from a software engineer's perspective. This helps us to build a more abstract understanding of our project.

7.3 Physical View

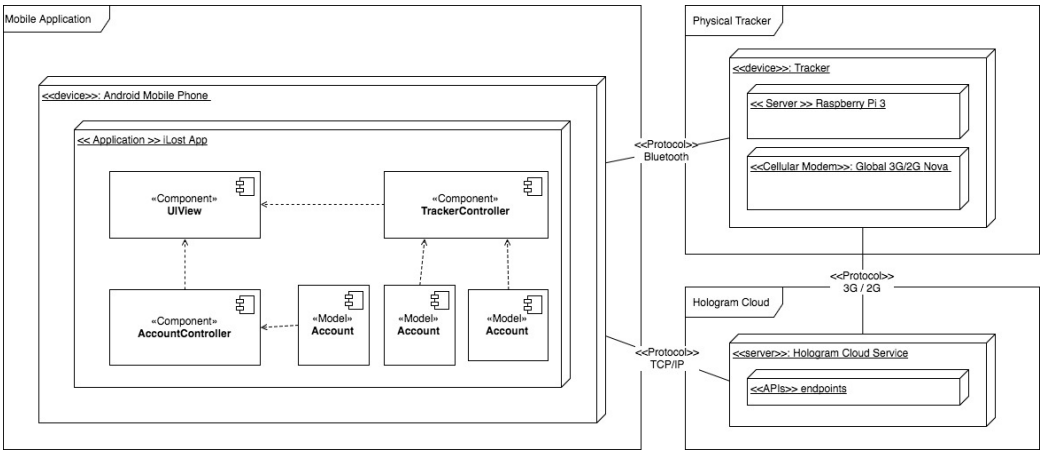


Figure 7: Physical View

The physical view is demonstrated in a deployment diagram and shows the physical structure clearly. With this diagram, we could have a more clearer overview of the whole service.

8 Evaluation Plan

8.1 Hardware

As to the hardware, the main concern was the general size of the tracker and whether it can easily be an extension to the users personal items. The test cases during development are as follows;

1. Give users a mock tracker which match the dimensions of our actual tracker and then survey them as to how they feel about the size.

2. Allow users to use the mock tracker for a week or so to determine whether they could get used to the size.

3. Allow the user to try out different methods of attaching the tracker be it using a key ring, Velcro or adhesives and asses which they find the most convenient.

The test cases post-development could be to redo the above tests and allow the users to see the effectiveness of the software and see whether the extension is worthwhile as previously they didnt have their opinions weighed up against the actual use of the tracker.

8.2 Hardware

As to the software, the main concerns are the effectiveness of the Bluetooth and also the effectiveness of the cellular and whether they can withstand extreme measures. The test cases during development are as follows;

1. The notification a user receives in multiple scenarios such as a loud club, a library and at home and see whether the notification is adequate to grab the users attention.
2. The accuracy of the distance the Bluetooth trackers tells the user by thoroughly testing different locations.
3. The ability of the hologram to triangulate the location in areas with poor cellular signal.
4. Its ability to give a location within a radius of 10m.

The test cases post development will have to be more thorough so we can identify bugs and typical usage problems early in the beta stage before we push the first version and thus assure quality of the product is maintained and optimal.

9 Project Management

9.1 Project Cycle

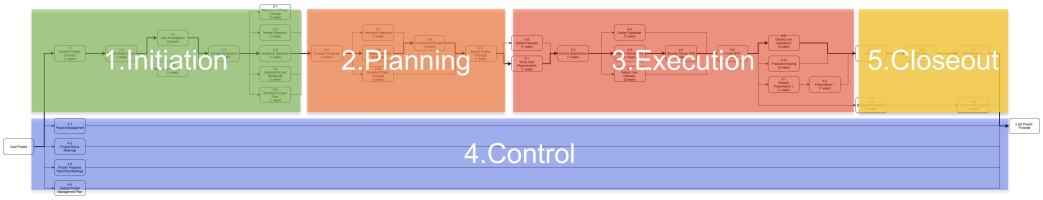


Figure 8: Project Diagram All

Our project cycle contains five process groups[8] and three milestones at the end of some of the developing process. "Initiation" and "planning" two stages are before the proposal submission, "execution" is for developing the actual product, "control" is for project management and "closeout" is the for the final presentation and report.

Stage	Description
Initiation	Confirming the project concept, personas and user needs.
Planning	Researching technology and developing the proposal.
Execution	Developing the minimum viable product and final production.
Control	Project management and the weekly meetings.
Closeout	Developing presentation and final report.

Table 4: Stage Descriptions

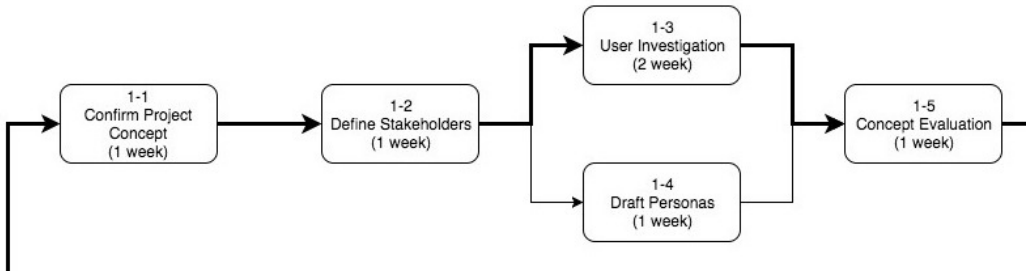


Figure 9: Project Diagram Initiation

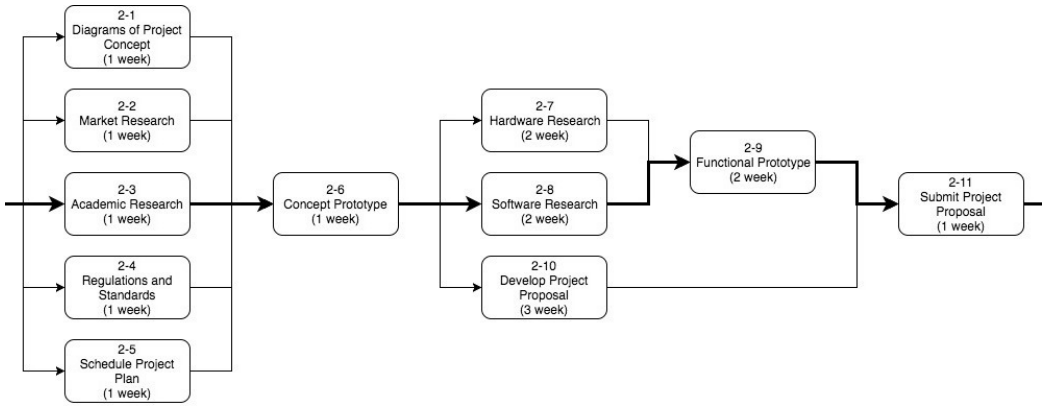


Figure 10: Project Diagram Planning

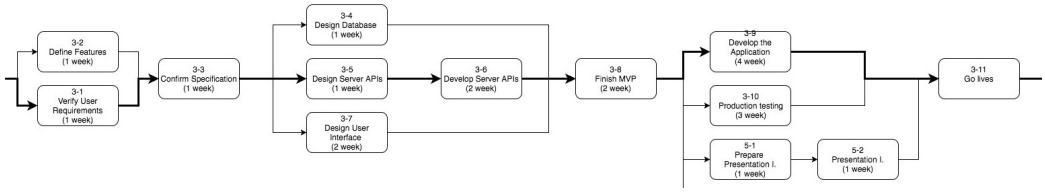


Figure 11: Project Diagram Execution

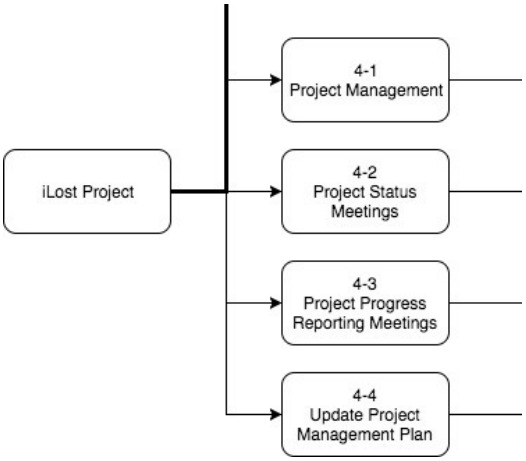


Figure 12: Project Diagram Control

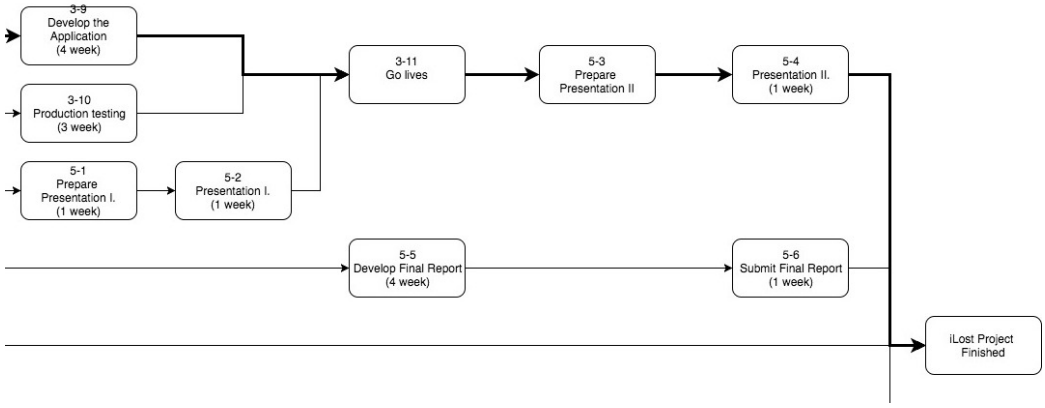


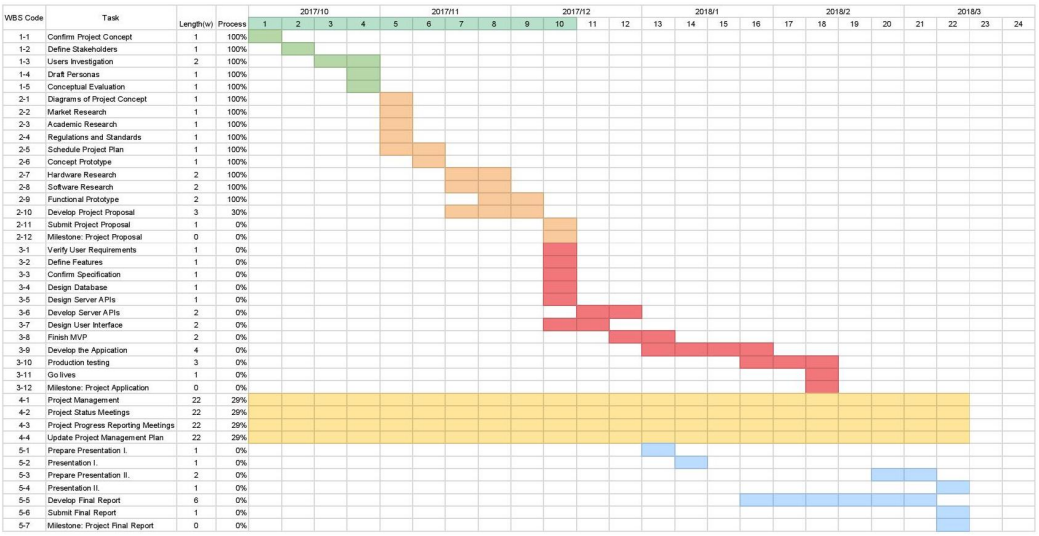
Figure 13: Project Diagram Closeout

Each stage contains multiple tasks which we used to create Gantt chart and record our progress tracking form. More details about the tasks is in Appendix C. The project also contains three main milestones end at different stage.

Milestone Name	Stage
Project Proposal	End of Planning
Project Application	End of Execution
Project Final Proposal	End of Closeout

Table 5: Milestones

9.2 Gantt Chart



WBS Code	Task	Length(w)	Process
1-1	Confirm Project Concept	1	100%
1-2	Define Stakeholders	1	100%
1-3	Users Investigation	2	100%
1-4	Draft Personas	1	100%
1-5	Conceptual Evaluation	1	100%
2-1	Diagrams of Project Concept	1	100%
2-2	Market Research	1	100%
2-3	Academic Research	1	100%
2-4	Regulations and Standards	1	100%
2-5	Schedule Project Plan	1	100%
2-6	Concept Prototype	1	100%
2-7	Hardware Research	2	100%
2-8	Software Research	2	100%
2-9	Functional Prototype	2	100%
2-10	Develop Project Proposal	3	30%
2-11	Submit Project Proposal	1	0%
2-12	Milestone: Project Proposal	0	0%
3-1	Verify User Requirements	1	0%
3-2	Define Features	1	0%
3-3	Confirm Specification	1	0%
3-4	Design Database	1	0%
3-5	Design Server APIs	1	0%
3-6	Develop Server APIs	2	0%
3-7	Design User Interface	2	0%
3-8	Finish MVP	2	0%
3-9	Develop the Application	4	0%
3-10	Production testing	3	0%
3-11	Go lives	1	0%
3-12	Milestone: Project Application	0	0%
4-1	Project Management	22	29%
4-2	Project Status Meetings	22	29%
4-3	Project Progress Reporting Meetings	22	29%
4-4	Update Project Management Plan	22	29%
5-1	Prepare Presentation I.	1	0%
5-2	Presentation I.	1	0%
5-3	Prepare Presentation II.	2	0%
5-4	Presentation II.	1	0%
5-5	Develop Final Report	6	0%
5-6	Submit Final Report	1	0%
5-7	Milestone: Project Final Report	0	0%

Figure 14: Gantt Chart

The Gantt chart was created based on the task list, using a week as a minimum developing unit to measure and schedule the developing process is more feasible than using day and more preciser than using a month.

Our weekly routine and meeting notes are in the Appendix D and E

9.3 Project Management Tools

Slack, Trello, Google Sheets and Github are our main project management tools to fulfil various developing needs. After using Github to record our weekly reports and cooperate on proposal, it's not necessary to use Trello. Github has the features we need from Trello, so we are considering to replace Trello with it completely in the next stage.

Full progress tracking form can found in Appendix F and G. More details about how we utilise all the tools and workflow are in Appendix H, I and J.

9.4 Roles

There are only two types of roles: project manager and project team member. Still it's inevitable for the project manager to do the same duties as the project member.

More details about the roles are in Appendix K.

10 Conclusion

As established by our survey and research by Mozy, we believe the loss of personal belongings in various places is a common, daily life problem for majority of people.

Our solution to this problem is a tracker that works at short and long range, which the user can interact through a mobile application to keep track of an item. Other products on the market, don't provide a short and long range tracker, or a tracker that adapts to the user.

From our survey, we predict a majority of target users will be individuals who are always on the move and active, such as students, office workers who many times need to travel abroad.

Prototyping with different technologies we concluded that only one type of technology wouldnt meet our concept prototype; therefore, we sought a hybrid solution. A combination of Bluetooth at short range and cellular at long range.

We recognise our product may raise privacy concerns. To address this a terms of use script will be ensuring consumers that their data and location will be used for the sole purpose of retrieving items or help them prevent losing them. In order that our product satisfies all our use cases, we will have to experiment and test the UI of our product as well as the underlying physical architecture.

As of now, the lack of resources and expertise are limiting us to build a more portable physical device. We hope to deliver an upgraded version of the device in future after conducting further research on our concept, following the development of the working prototype.

References

[1] Lost & Found Data Loss Research Mozy.uk. [Online]. Available: https://mozy.co.uk/about/news/reports/lost-and-found. [Accessed: 01-Dec-2017].

[2] Bluno Beetle. [Online]. Available: https://www.dfrobot.com/wiki/index.php/Bluno_Beetle_SKU:DFR0339. [Accessed: 15-Nov-2017].

[3] What are Estimote Stickers?, Estimote Community Portal. [Online]. Available: https://community.estimote.com/hc/en-us/articles/203323543-What-are-Estimote-Stickers-. [Accessed: 29-Nov-2017].

[4] Find Your Tile, Waterproof Tile Sport Bluetooth Tracker Helps You Find Your Things — Tile. [Online]. Available: https://www.thetileapp.com/en-gb/products/sport. [Accessed: 30-Oct-2017].

[5] Skyhook Wireless — Location data provider, Skyhook Wireless — Location data provider. [Online]. Available: http://www.skyhookwireless.com/. [Accessed: 27-Oct-2017].

[6] Cloud services, Hologram. [Online]. Available: https://hologram.io/cloud/. [Accessed: 01-Dec-2017].

[7] IoT & M2M Cellular Modem for Raspberry Pi 2G/3G/4G LTE Cat-M1, Hologram. [Online]. Available: https://hologram.io/nova/. [Accessed: 02-Dec-2017].

[8] Kanata and Ont, Project management professional (PMP), 1st ed. Beacon Associates Publications, 2004.

Appendices

A Use Case Flow

A.1 Log trackers

Basic Flow

1. User attachs Tracker to a personal item.
2. App links to Tracker with bluetooth.
3. App activates Tracker.
4. User logs details of the item and Tracker in App.
5. App validates and saves the inputs.

Alternative Flows

- Multiple Trackers: After Step 4, repeat step 1 to 4 for additional Trackers and items.

A.2 Monitor Tracker

Basic Flow

1. App listens for signal at regular intervals.
2. App saves the history of the position of Tracker at regular intervals.

Alternative Flows

- Tracker is with user: If Tracker is within certain distance from User, App listens for bluetooth singal.
- Tracker is lost: Tracker is not within certain distance from User.
    1. App activates Tracker's cellular mode via bluetooth.
    2. App sends a notification to mobile OS to nofity User.
    3. App listens for the geolocation data of Tracker sent from Server.
- Tracker is nearby but not with User after being lost: Tracker is within bluetooth dectable distance after being far away from User.
    1. App activates Tracker's bluetooth mode via Server.
    2. App listens for the geolocation data of Tracker sent from Server and bluetooth singal at the same time.
- Tracker is with User after being lost: App deactivates Tracker's cullular mode via bluetooth, then Resume at Base Flow step 1.

A.3 Track Item

Basic Flow

1. User selects desired tracking item in App.
2. App displays the position data of Tracker.

A.4 Send position data

Basic Flow Tracker sends position data to App.

Alternative Flows

- Activates Cellular mode: Tracker's bluetooth signal is not reaching App after a period of time, then App send message via Server to activates cellular mode.
- Bluetooth mode is activated: Tracker sends position data via bluetooth to App.
- Cellular mode is activated:
  1. Tracker sends position data via cellular to Server.
  2. Server transfer the position data to App.

A.5 Register account

Basic Flow

1. User input account details.
2. App validates the inputs.
3. App creates a new account.

Alternative Flows

- Inputs are validated failed: After step 2, resume at step 1 if the inputs are not validated.

A.6 Login account

Basic Flow

1. User input account details.
2. App validates the inputs.
3. App allows User to login.

Alternative Flows

- Inputs are validated failed: After step 2, resume at step 1 if the inputs are not validated.

B Hardware Research

B.1 Bluetooth Component module

Bluetooth has established itself as the wireless communication standard of choice to connect wearable devices to smartphones, tablets or PCs,

The SESUB-PAN-D14580 module, which is based on TDK's SESUB (semiconductor embedded in substrate) integration technology, features an embedded DA14580 Bluetooth 4.1 chip from Dialog Semiconductor. All terminals of the discrete chip are available, allowing full use of chip functions

The module features an integrated DC-DC converter. With a voltage supply of 3.0 V, its current consumption is only 5.0 mA when transmitting, 5.4 mA when receiving and 0.8 A in standby mode.

The ultra-compact dimensionsTDK SESUB-PAN-D14580 module are just 3.5 mm x 3.5 mm x 1.0 mm.

Main features and benefits

1. Ultra compact module dimensions of 3.5 mm x 3.5 mm x 1.0 mm (typical) drastically reduces the mounting footprint to only about 12 mm2
2. Easy implementation of Bluetooth connectivity
3. Integrated DC-DC converter

B.2 Active RFID tag

Active RFID systems have three essential parts a reader or interrogator, antenna, and a tag. Active RFID tags possess their own power source an internal battery that enables them to have extremely long read ranges as well as large memory banks.

Typically, active RFID tags are powered by a battery that will last between 3 5 years Essentially, two different types of active RFID tags are available transponders and beacons.

Transponders In a system that uses an active transponder tag, the reader (like passive systems) will send a signal first, and then the active transponder will send a signal back with the relevant information. Transponder tags are very efficient because they conserve battery life when the tag is out of range of the reader. Active RFID transponders are commonly used in secure access control and in toll booth payment systems.

Beacons In a system that uses an active beacon tag, the tag will not wait to hear the readers signal. Instead, true to its name, the tag will beacon, or send out its specific information every 3 5 seconds. Beacon tags are very common in the oil and gas industry, as well as mining and cargo tracking applications. Active tags beacons can be read hundreds of meters away, but, in order to conserve battery life, they may be set to a lower transmit power in order to reach around 100 meters read range.

Estimote An Estimote Beacon is a small, wireless device, when placed in a physical space, it broadcasts tiny radio signals to smart devices.

Estimote Beacon is like a small computer. Its 32-bit ARM Cortex M0 CPU is accompanied by accelerometer, temperature sensor, and what is most important2.4 GHz radio using Bluetooth 4.0 Smart, also known as BLE or Bluetooth low energy. This is able to provide mobile devices in range with information about their location and state.

Estimote is an iBeacon-compatible hardware transmitters, using the idea of smart objects that work as transmitter to broadcast digital data using Bluetooth Smart protocols:

1. Eddystone UID
2. Generic Advertiser
3. Nearable
4. Estimote Monitoring
5. iBeacon

iBeacon is a Bluetooth advertising protocol designed by Apple, with native support in iOS, a specification that tells what data, and in what format, a Bluetooth beacon needs to advertise. Estimote Monitoring is the default protocol in both Location and Proximity Beacons and it was built as a mix of Estimote Location and iBeacon, taking the best features of both protocols. It offers various improvements in accuracy and beacon detection and is currently the most reliable protocol

Pros

1. Extremely Long Read Range
2. Increased tag abilities with partnered technologies (GPS, sensors, etc.)
3. Extremely Rugged tag options

B.3 IBeacon Technology (Bluetooth Low Energy Tags)

B.3.1 Accessibility

With smartphones primarily acting as receivers, beacons form a highly accessible indoor location technology.

Pros The capability of beacons to allow smartphones to primarily act as the receivers, makes it a highly accessible location technology

Cons Beacons once installed need to be checked regularly for battery levels, making this less practical.

Range Beacons typically have a wireless range of 1m to 70m

Accuracy Beacons being radio transmitters are not very accurate as they stand the chance of interference, as radio signals can be absorbed by different media, such as water, air, human bodies or even metallic surfaces Cons: Beacons being radio transmitters are prone to suffer from interference

Security

Pros No intrinsic security risks. Since beacons are primarily proximity detection devices that broadcast outbound signals, there is no inherent security risk in the transmission.

Cons The Signals sent out by beacons can be intercepted and used by hackers. Most manufacturers have built in countermeasures that attempt to counter this.

Cost While beacons by themselves are relatively cheap (a typical beacon would cost you anywhere between 5 to 50), the number of beacons required depends on the size of the space and range needed. The cost of beacon system depends on several other factors such as app and integration cost, licensing and data service cost.

B.4 Bluetooth 5

Although We dont believe Bluetooth 5 is currently established. The Bluetooth 5 update will bring:

- 4x the range
- 2x the speed
- 800% more broadcast messaging capacity

B.5 Cellular

A great advantage of cellular is its long range, it comes second to GPS for range. Our product will be used in an unpredictable urban environment. Cell phone towers are everywhere in an urban and even sub-urban environment. Cellular requires less energy than Wi-Fi and does not require a WPA/WEP key (or any other login system) to fully exploit.

However, a tracker using Cellular will require a bigger antenna than what a wi-fi tracker currently uses. During research we discovered whenever a tracking device was using Cellular networks it was in fact using 2G (3G, 4G etc.) to connect to the internet (this is expensive and defeats the purpose of using cellular in this context). What we really want is a Cellular tracker to use triangulation from different cell phone towers to pinpoint its own location.

Government agencies such as intelligence services and emergency services use Cellular triangulation, through our research we found that it would not be possible to implement cellular triangulation in the same way Government/emergency agencies do, we lack expertise knowledge, resources and connections.

But, we have found a middle-man who can, so to speak. SkyHook, the same location provider Apple uses, also provide cell phone triangulation using a map of cell phone towers, they also use the same technique with wi-fi hotspots.

B.6 Acoustic Location

Sound waves travel at an average 343 m/s. By detecting the time taken for the phone (which is what the user interacts with) to detect a sound (which is an inaudible frequency emitted at regular time intervals by the tracker) we can work out the average location of the tracker: distance (m) = speed(m/s) * time (s).

A unique approach, its currently only extensively used by the military and emergency rescue teams. The problem is that the product environment (chaotic Urban) has to much sound interference, this will severely limit the smartphones microphone ability to distinguish the inaudible frequency emitted by the tracker. We also need more than one listening device to make triangulation possible.

In environments were acoustic location is possible, high grade/ large microphones are used and they are normally used in an open or quieter environment than a chaotic urban environment which this product is designed for.

B.7 Hybrid Server Side SkyHook implementation

Whatever device (android, iOS, wearable, any modern operating system) SkyHook can use the device Wi-Fi/cellular/GPS capability and to find the precise location of the device. It does this by mapping wi-fi hotspots, cell phone towers and/or GPS which the device comes across. By using this map, SkyHook can triangulate the location of the device, thus providing a precise location. The iPhone location capability is actually provided by SkyHook.

The device, in this case our product, the SkyHook APK maps nearby WI-FI hotspots and cell phone towers and use this data to triangulate were the location of the device is. It can also add GPS data (but our product may not have GPS capability) SkyHook is only part of the product, a tracker still needs to interact with SkyHooks servers.

SkyHook data is stored in the United States raising privacy concerns, however SkyHook has Skyhook has certified to the EU-U.S. Privacy Shield Framework for the transfer of Personal Information from the EEA to the United States so we can still deploy using SkyHook

B.8 RFID (Radio Frequency Identification) systems

Passive RFID systems use tags with no internal power source and instead are powered by the electromagnetic energy transmitted from an RFID reader.

Made up of two main components the tags antenna and the microchip or integrated circuit.

There are three main frequencies within which passive RFID tags operate:

- 125 - 134 KHz - Low Frequency (LF) range : 1 - 10 centimeters.
- 865 - 960 MHz - Ultra High Frequency (UHF) range: 5 - 6 meters
- 13.56 MHz - High Frequency (HF)
- Near-Field Communication (NFC)range: 1 centimeter up to 1 meter.

Pros Smaller tags Much cheaper tags (starting from 1 - 20+) Thinner/more flexible tags Higher range of tag options Tags can last a lifetime without a battery (depending on the wear and tear)

Cons The tag can be read only at short distances. Passive tags have difficulty sending data through liquids or metal. The orientation of a passive RFID tag must be just right or the reader won't locate it.

Active RFID systems use battery-powered RFID tags that continuously broadcast their own signal (like a cell phone). Made up of three essential parts a reader (or interrogator), antenna, and a tag.There are two main frequencies used by active systems 433 MHz and 915 MHz

Pros Extremely Long Read Range Increased tag abilities with partnered technologies (GPS, sensors, etc.) Extremely Rugged tag options It can have more memory to, store more data. Cons of Passive RFID: Sensitive to harsh environment Costs more (starting from 15/20 a piece) Larger size and weight.

Conclusions Either RFID system has advantages and disadvantages of their own, depending on needs.

Speaking for our purpose an active ultra-wideband (UWB) RFID system, would be able to determine a tagged objects location within few inches. But UWB tags are really expensive.

A passive UHF RFID system can provide about 5 - 10 metres of read range (distance from which a reader can communicate with tag). These can tell the tag is within a read field, but not specifically where within the field.

Passive RFID system uses something called Received Signal Strength Indicator (RSSI) to determine how close the tagged object is to the RFID interrogator. RSSI cant tell if tag is, for example 20 cm away, but it can tell if tagged object is getting closer or further away.

B.9 Arduino GPS

There are many Arduino GPS hardwares out in the market that are buyable. The prices of the GPS Arduino hardwares depends on usually the spec that they have. The hardware will be incorporated with the other features that our initial product will carry. Looking into the market, not one GPS Arduino hardware is perfect, however some excel above all the others. Popular builds so far for the Arduino GPS have been the Copernicus, LS23060, D2523, SUP500F, MN5010 (uMini) and EM-406A. All if not most GPS, are connected via satellites, to get a broad understanding of how each of these look and what they display on a map it is best recommend to configure Google 2D Maps along with a side to side 2D analysis.

The one flaw that these GPS Arduino hardwares have is that inside a structure the signal might not give off an accurate pinpoint location.

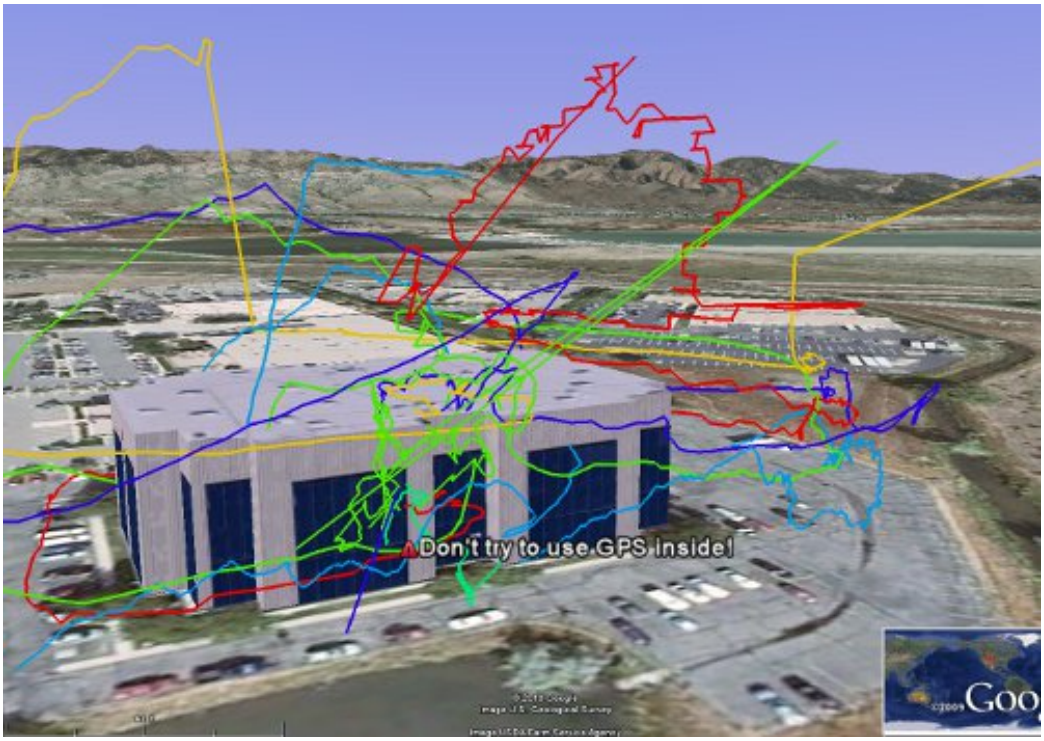


Figure 15: GPS Tracking

This image 15 shows why at first call someone should not use a GPS Arduino hardware inside as signals are distraught. Also why someone should not try to access a area inside a structure even if they are outside. The different colours are the different modules that are mentioned above and how they react to finding a location from inside a structure or a location in the structure. However, there is a likely solution for this. You can attach other elements to the Arduino GPS hardware, a user will have to program a solution on how to make the signals content and not overly responsive. This is only for being able to use the Arduino GPS hardware from inside a structure. Coding something to pinpoint a location within a structure is far more complicated.

Modules	Price	Pros	Cons
Copernicus	56	Basic Understanding of code, at least be able to code serial or TTL. One of the most accurate and reliable modules. It evaluates data in all conditions.	A good understanding of electrical prototyping as user will need to know how much power is required, what each pin does, how to hook up the hardware, etc.
LS23060	45	This requires a good understanding of code, at least be able to code serial or TTL. Tracks longitude and latitude in all conditions. This module also has a good evaluation in all conditions.	A well understanding of electrical prototyping due to users needing to know how much power is r
D2523	60	This requires a well round understanding of code, at least be able to code serial or TTL. Good at places where it is hard to get a signal due to certain conditions such as a high source of dielectric materials. - Excellent latitude and longitude when the sky is clear. Similarly with data ev	
SUP500F	35	The hardware (module) is very small. - Due to its size, it also does not take too much power.	Not having a lot of power can also be an disadvantage.
MN5010 (uMini)	55	This hardware is also very small, therefore it does not take up a lot of space. Allows both hot start and cold start.	Connection is not as accurate as it uses chip antenna.
EM-406A	48	Allows for all 3 start up times.	- Requires and will take up a lot of power. Likely to be interference due to it connecting via chip antenna.

Table 6: Pros & Cons of Modules

C Project Tasks List

Major Task	WBS Code	Task	Length(w)	Definition
Initiation	1-1	Confirm Project Concept	1	Team brainstorms and confirms the concept of the project
Initiation	1-2	Define Stakeholders	1	Consider the stakeholders that might be relevant.
Initiation	1-3	Users Investigation	2	Investivate the prospect users' need and opinions.
Initiation	1-4	Draft Personas	1	Draft personas that might represent a typical user for the ideas.
Initiation	1-5	Conceptual Evaluation	1	Decide wheather to continue the project.
Planning	2-1	Diagrams of Project Concept	1	Produce use case diagrams, use scenarios, sequence diagrams and activity diagrams.
Planning	2-2	Market Research	1	Search for competing products directly and from reviews, trade sites, press reviews and customer reviews.
Planning	2-3	Academic Research	1	Find any academic works describe theory or emerging research that is relevant to the concept.
Planning	2-4	Regulations and Standards	1	Investigate in regulation and standards which may constraint the project.
Planning	2-5	Schedule Project Plan	1	Schedule the project tasks including major tasks, subtasks and milestone.
Planning	2-6	Concept Prototype	1	Develop functional prototypes to validate the project with users and stakeholders and test the project feasibility.
Planning	2-7	Hardware Research	2	Research on possible hardwares meet the project functionalities required.

Planning	2-8	Software Research	2	Research on possible software meet the project functionalities required.
Planning	2-9	Functional Prototype	2	Develop functional prototypes to validate the project with users and stakeholders and test technical feasibility.
Planning	2-10	Develop Project Proposal	3	Under the direction of the Project Manager, the team develops the project plan.
Planning	2-11	Submit Project Proposal	1	Submit the project proposal.
Planning	2-12	Milestone: Project Proposal	0	The project plan is completed.
Execution	3-1	Verify User Requirements	1	Review and validate the requirements with the users and stakeholders.
Execution	3-2	Define Features	1	Define necessary features and functionality of the services based on the user requirements.
Execution	3-3	Confirm Specification	1	Confirm the specifications of hardwares and softwares for the projects, includes the programming languages andframeworks.
Execution	3-4	Design Database	1	Design the schema based on the data flow.
Execution	3-5	Design Server APIs	1	Design and document the server APIs.
Execution	3-6	Develop Server APIs	2	Develop the server APIs based on the documentations
Execution	3-7	Design User Interface	2	Design the user interface of the software.
Execution	3-8	Finish MVP	2	Develop the minimum viable product for the presentation I.
Execution	3-9	Develop the Appication	4	Develop the mobile application based on the server APIs and user interfaces.

Execution	3-10	Production testing	3	Test the production and improve it.
Execution	3-11	Go lives	1	Application go lives with all users.
Execution	3-12	Milestone: Project Application	0	The project application is completed.
Control	4-1	Project Management	22	Overall project management for the project.
Control	4-2	Project Status Meetings	22	Weekly lab session meetings.
Control	4-3	Project Progress Reporting Meetings	22	Weekly progress reporting meetings with the supervisor.
Control	4-4	Update Project Management Plan	22	Project manager and the team update the progress tracking form.
Closeout	5-1	Prepare Presentation I.	1	Prepare the presentation for the prospect employers.
Closeout	5-2	Presentation I.	1	Deliver the presentation to the prospective employers.
Closeout	5-3	Prepare Presentation II.	2	Prepare the presentation slides for the final presentation.
Closeout	5-4	Presentation II.	1	Deliver the presentation in the course.
Closeout	5-5	Develop Final Report	4	The team work on the final report.
Closeout	5-6	Submit Final Report	1	Submit the project final report.
Closeout	5-7	Milestone: Project Final Report	0	The project final report is completed.

Table 7: Use case actors

D Weekly Routine

Time	Task	Task Description	Total Duration
Tuesday Morning	Lab Meeting	Report everyone's previous working status and plan for the Individual Working Slot 1.	1 hour
Tuesday to Thursday	Individual Working Slot 1	Working on the plan discussed in Lab Meeting.	4 hours
Friday Noon	Supervised Meeting	Report the working result and consult with the supervisor.	0.5 hour
Friday to Monday	Individual Working Slot 2	Improve one the working result based on the Supervised Meeting.	4 hours

Table 8: Use case actors

E Meeting Notes

Supervised Meeting 7/12/201

- Walked through the proposal requirements.
- Tim suggested us to
- Build a wood made tracker as a physical usage prototype to test the usage of our tracker.
- Add extreme tests in the evalutaion section

Lab Meeting 5/12/17

- Have asked hatchlab about purchasing hologram.
- Need to buy hologram on our own.
- Discuss what to do during the Christmas break on 12/12.

Supervised Meeting 30/11/201

- Grilled over the technical diagrams.
- We need to catch up on hours.
- Tim likes our project.

Supervised Meeting 24/11/201

- The meeting time has now changed to Thursday 12:00.
- Suggestion:
  - Separate the process diagram into different part to fit them in the proposal.

Lab Meeting 21/11/201

- How to integrate Skyhoot: @hussein159 works on that.
- Platform: Android
- Functional Prototype: @hussein159 works on that.
- To put data privacy issue in proposal while using the skyhook or any cloud service.

Supervised Meeting 17/11/201

- Updated progress tracking form with milestone / tasks.
- People who commit more will have more marks, please record your effort on the progress tracking form and proactively pick the tasks if you need more marks.
- Changing time of the meeting may be quite difficult.
- Tim suggested to host another meeting time during the week apart from the lab.

Supervised Meeting 03/11/201

- What we've done:
  - Meeting with Pete.
  - Hardware research.
  - About to attend the hatch lab induction.
- What we have not done:
  - Improve the previous report.
  - Estimote testing report.

Meeting with Pete 31/10/201

- To discuss:
  - Anyway to improve on our idea?
  - Any suggestion on the hardware?
  - How to compete with competing products?

Supervised Meeting 27/10/201

- Try to build a prototype before next meeting.
- Search what's the techniques the existing products use.
- Search what can we use to provide the service.
- Because of age-related memory loss, the elders or middle age people could be our target customers.

Supervised Meeting 20/10/201

- Progress suggestions
  - Before next week: potential user (Draft personas?)
  - Setup a questionnaire to ask who are our users?
- Preparing for next time:
  - Bring the lab doc / track form (hard copy of the progress sheet).
  - Sketch Functional Architecture
  - Make sure the requirements are met before next week.
  - Use case senario.
  - Completed resource form.
  - Do the questionnaire in: Cafeteria, Costa, Family.
  - Think about project names?

Extra Meeting 19/10/201

- Topic decided: Lost item tracker
- Product name
  - findME
  - BlueJ
  - locate.
  - Lost.
  - LocationRanger

F Progress Tracking Form

WBS Code	Date	Status	Resource Name (Hours)						
			Chin	Dylan	Marian	Mifuad	Hussein	Thairan	Jheng-Hao
1-1	19/10/2017	Brainstormed and decided the subject topic.	1	1	1	1	1		1
1-2	22/10/2017	Planned and scheduled tasks and redesigned progress tracking form							3.5
1-3	23/10/2017	Built online survey - refined and ready to deploy		3	0.5		4		
1-3	23/10/2017	Deployed online survey, collecting data		3	3	1	1		
1-2	23/10/2017	Read references and drafted first persona							1.5
1-2	24/10/2017	Drafted the second and third of personas							0.5
4-2	24/10/2017	Lab session	1			1			1
2-1	24/10/2017	Drafted the user scenarios							0.75
2-2	24/10/2017	Competing Products (Market Research)				3			
2-1	25/10/2017	Improved the user scenarios and drew the use case diagram.							1.5
2-1	25/10/2017	Drew the diagrams.							2.75
2-4	26/10/2017	Regulation and Standards							2
2-3	26/10/2017	Academic Research							1.5
2-10	26/10/2017	Integrate all the reports together							1.5
1-2	26/10/2017	Stakeholders Report						2.5	
4-3	27/10/2017	Meeting with supervisor		0.5	0.5	0.5	0.5	0.5	0.5
4-4	29/10/2017	Recorded meeting notes							0.25
2-7	29/10/2017	Emailed Pete to ask for a meetup							0.5
2-7	29/10/2017	Research on Hardware to use for the sensors		2	1				
2-7	29/10/2017	RFID and NFC research							1
2-7	30/10/2017	Schedule a meeting with Pete							0.25
4-2	31/10/2017	Lab session	1	1	1	1	1		1
2-7	31/10/2017	Meeting with Pete			1	1			1
2-7	31/10/2017	Estimote research					3		
2-10	31/10/2017	Product name survey					1		
4-1	31/10/2017	Divided and assigned the tasks			0.5	0.5			0.5
4-1	01/11/2017	Tracking tasks progress.							0.5
4-1	02/11/2017	Tracking tasks progress.							0.5
2-10	02/11/2017	Integrate all the reports together							0.5
2-5	02/11/2017	Search and select project management tool							1
4-3	03/11/2017	Meeting with supervisor		0.5		0.5	0.5	0.5	0.5
2-7	03/11/2017	Physical lab induction							2
2-6	09/11/2017	Conceptual Prototype Interviews							4
2-6	09/11/2017	Conceptual Prototype Report							1
4-1	09/11/2017	Set up Github Repository							0.5
4-1	10/11/2017	Move reports to Github Repository							2
4-2	14/11/2017	Lab session	1	1		1	1	1	1
2-7	14/11/2017	Prepare Arduino tutorial kits					2.5		
4-1	14/11/2017	Updated repository and readme							1
2-5	15/11/2017	Planning the project (Sub tasks, Major tasks and Milestones)						3.75	
4-3	17/11/2017	Meeting with supervisor			0.5	0.5	0.5		0.5
2-5	19/11/2017	Drew gantt chart and improved the project plan							3
2-7	20/11/2017	Required Training Project 0 and 1.		2	2.5	1			
2-9	20/11/2017	Project Prototype		2			12		
2-5	20/11/2017	Project Sequence Diagram							2
4-2	21/11/2017	Lab session	1	1	0.5		1	1	1
2-9	23/11/2017	Project Prototype Report			3		7		
2-1	23/11/2017	Technical Architecture Research							1
4-3	24/11/2017	Meeting with supervisor		0.5			0.3		0.5
4-2	28/11/2017	Lab session	1	1		1		1	1
2-10	28/11/2017	User Need Overview & Concept Introduction Draft		9.5					
2-7	29/11/2017	Arduino GPS						2.25	
2-1	29/11/2017	Architecture Diagrams							3
4-3	24/11/2017	Meeting with supervisor		0.5		0.5	0.5	0.5	0.5
4-1	02/12/2017	Updated github work flow & convention							1.25
2-7	03/12/2017	Arduino - RFID				3			
2-10	03/12/2017	Prepare presentation					0.4		1

Figure 16: Progress Tracking Form-1

WBS Code	Date	Status	Resource Name (Hours)						
			Chin	Dylan	Marian	Mifuad	Hussein	Thairan	Jheng-Hao
4-2	05/12/2017	Lab session	1	1		1	1	1	1
-	05/12/2017	Resource request meeting		1.5		1.5	1.5	1.5	
2-10	05/12/2017	(Ongoing) Final Proposal				1			2.5
4-3	08/12/2017	Meeting with supervisor		0.5		0.5	0.5		0.5
2-1	08/12/2017	Update use cases					3		3
2-10	09/12/2017	Evaluation Plan - Proposal	3.5						
2-10	09/12/2017	Proposal structural research		2					
2-10	09/12/2017	(Ongoing) Final Proposal							4.5
2-7	09/12/2017	Estimote research			3				
2-10	10/12/2017	(Ongoing) Final Proposal	3						6.5
2-10	10/12/2017	(Ongoing) Final Proposal				6			
2-10	11/12/2017	Proposal reviews	1	1					
2-10	12/12/2017	(Ongoing) Final Proposal		2	2			2	
4-2	12/12/2017	Lab session	1	1	1	1	1	1	
2-10	13/12/2017	(Ongoing) Final Proposal	5	5	4	5		1.5	5
2-10	14/12/2017	(Ongoing) Final Proposal	4			3	3		6

Figure 17: Progress Tracking Form-2

Label Name	Description
WBS Code	Work break down code, which indicates the category of the work for.
Date	The working date.
Status	The detail of the work.
Resource Name(hour)	Usage of the resource(s) in hours.

Table 9: Progress Tracking Form Label

G Progress Tracking Charts

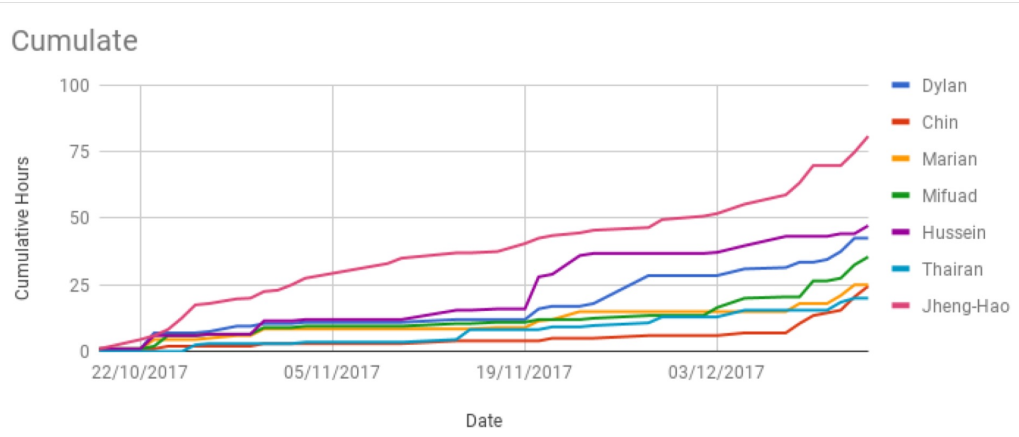


Figure 18: Cumulate Line Chart

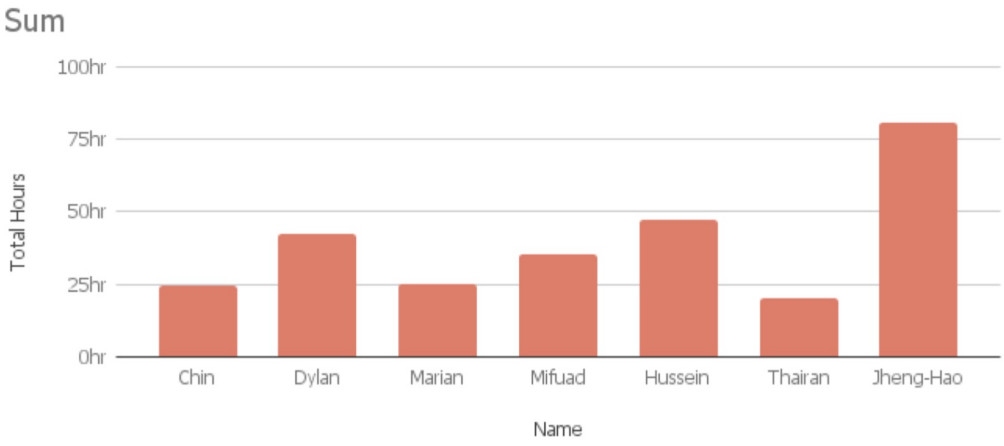


Figure 19: Sum Line Chart

H Project Management Tools Details

Platform	Usage
Slask	Inner communication.
Trello	Divides and assigns weekly tasks. (depreciated) Records weekly meeting notes.
Google Sheets	Progress tracking form. Gantt Chart. Project Tasks List.
Github	Manage source code and report with fixed workflow. Use issue feature to track developing progress. Record weekly reports.

Table 10: Project Management Tools Details

I Github Directories

```
Write('Pascal keywords.');
```

- `/documents`

  The reports for each week progress.

- `/proposal`

  Paragraphs for each section of our first report

- `/src`

  Software/hardwares source code.

- `/presentations`

  Slides for the presentation in March.

- `/final-report`

  Paragraphs for the final report.

J Github Workflow

If you want to update any document or source code in the repository, please follow the **workflow** and the **naming convention** to maintain the consistency.

tl:dr

1. Issue
2. Branch
3. Work
4. Commit
5. Push & pull request

1. Issue Before you start to work on either document or source code, make sure you browse the issue section to see if there is already an existing issue related to what you're going to work on. If you found one, than go to step 2-1.

If there is no such issue you're looking for, create a new one then. Condense the title and add more details in the description. Add the correct label to it and assignees as well.

2-1. Check out the branch Check out the corresponding branch on your local working space. If the issue you found is #13, then the branch name should be like issue#13xxxx. xxxx can be **fix** or **update**.

2-2. Create a new branch based on that issue If you can't find the issue about what you need to work on, create a new one on your own. Here is the naming convention:

issue#[ISSUE NUMBER]-[ACTION]

- NUMBER: the number of the corresponding issue.
- ACTION:
  - update: for report updating or feature updating, mainly for something continuously updating.
  - fix: for fixing a bug or typo, mainly for something happen one time only.

3. Work As title, work on your branch and make sure you're on the right branch already. You can check it with

```
git branch
```

4. Commit To commit, here is the commit message:

```
[TYPE]: [SUBJECT LINE]
[DESCRIPTION]
[ACTION] #[ISSUE NUMBER]
```

- TYPE: Update or Fix. same as the ACTION on the branch name
  - Update: for report updating or feature updating, mainly for something continuously updating.
  - Fix: for fixing a bug or typo, mainly for something happen one time only.
- SUBJECT LINE: briefly describe your changes.
- DESCRIPTION: describe the change in more details.
- ACTION:
  - Close: to close of the branch and the issue forever (theoretically).
  - Update: there should be future updating continuously.
- ISSUE NUMBER: the issue number.

e.g. Update the report

```
Update: Rewrite the project concept.
Condense the project concept and add two new diagrams.
Closes #1234
```

e.g. Fix a bug

```
Fix: Added missing header
The app header was deleted accidently, added it back.
Closes #12345
```

Please review your change before every commit, which will massively reduce the possibility of finding bugs or typos after push the commit.

5 Push & pull request After you push your commit, make a pull request on Github. Everyone can review your change and add comment. After reviewing I will either merge it to the master or ask you to do some change.

J.1 Issue labels

Here are the categories of the issue labels, one issue can be assigned one or more labels.

Label Name	Description
final report	related to final report
enhancement	software functionality enhancement.
bug	software bugs.
hardware	hardware related.
presentation	related to the presenation.
project management	anything related to the project magement.
proposal	related to the proposal content.
weekly documents	weekly unsorted records.
report	anything related to text, including final report, proposal and weekly documents.

Table 11: Issue labels

K Roles

Project Manager

1. Members:

(a) Jheng-Hao

(b) Hussein

2. Tasks:

(a) Lead the discussion lab meeting and supervised meeting.

(b) Divide tasks.

(c) Monitor developing progress.

(d) Maintain workflow and Github repository.

Project Members

1. Members:

(a) Muhammad

(b) Thairan

(c) Dylan

(d) Mahmudul

(e) Hussein

(f) Mariano

2. Tasks:

(a) Contribute to overall project objectives.

(b) Complete individual task.