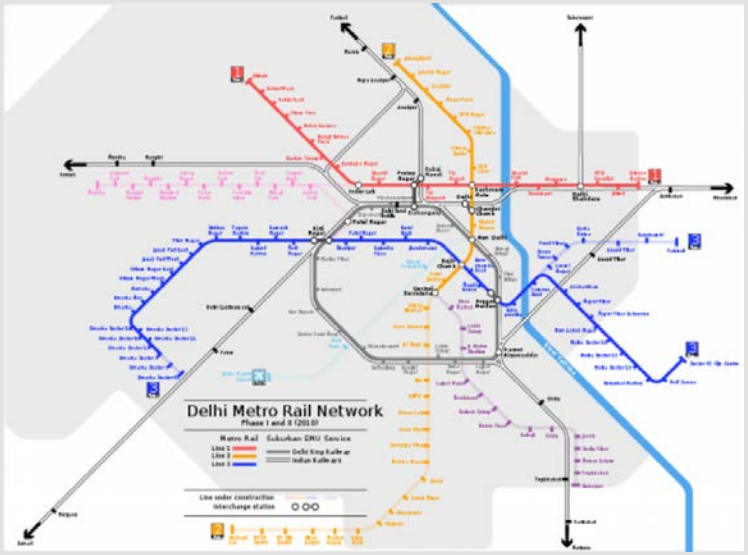
INDOOR NAVIGATION FOR ALL

Proposal submitted by-
LOVEJEET GEHLOT
B.Arch. 2017, MNIT, Jaipur.

Argument

Barrier free communication has been emphasised a lot in the world lately for sustainable development goals, but even after spending tons of money on trying to follow the purpose, it never usually is able to fulfil the goal. For example, tactile paths lets the visually impaired people assist on movement, but provides no hint of orientation or direction.

Which way is it to Seelampur?



Furthermore, public transport systems such as Delhi Metro, have become so enormous and complex that even regular users get lost frequently into the chaotic system of mapping. It is not uncommon that travellers have to ask others for routes to their preferred location.

Intention

With expeditious advancement in technology and affordability, more than 500 million Indians today have access to internet and smartphones. With such rapid increment, many apps have tried to provide special features for regular and disabled travellers to support navigation through indoors and outdoors. Yet they have mostly been inefficient and proven to be impractical due to various reasons discussed later.

We propose adding technological advancements to the environment through developing navigation systems, that can guide people of all kinds who find to traverse across buildings such as airports and metro stations.

Target

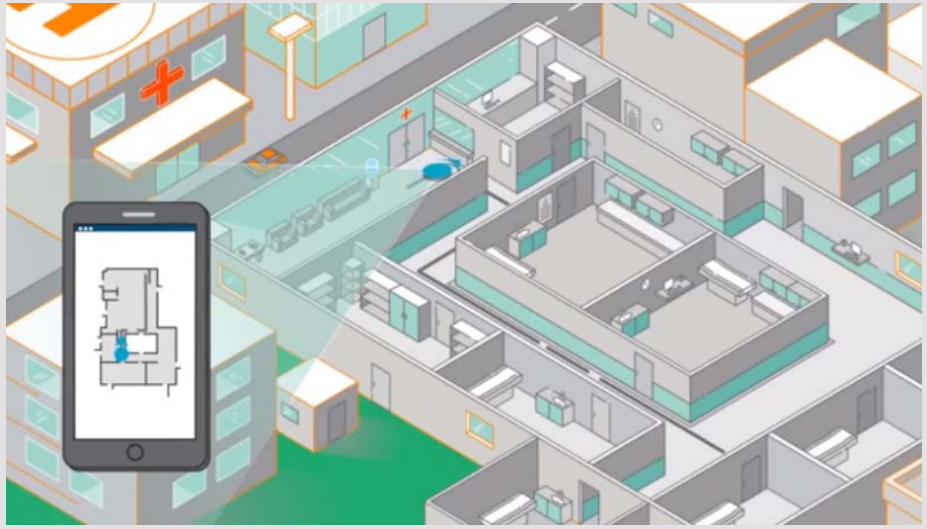
According to 2011 census by government of India, Delhi has more than 30k VI/blind people and more than 24k people with multiple disabilities, which can add up to blind or VI people. (http://www.census2011.co.in/disability.php).
Delhi Metro, a ₹350 billion project, which claims to have 'barrier-free' design by merely providing tactile paths for blind people, never succeeded in serving visually-impaired people. Even when they choose to use the facility, they would always have to rely on others to assist them as it challenges their spatial awareness ability, which also leads up to stress and anxiety. This makes them even more hesitant in using the service in future.

Proposal

We propose the use of Beacon technology, that connects to Smartphones with an app, that solves all the problems of navigation and direction not only for disabled but also for regular users.

The proposed solution makes use of Custom developed app from Estimote SDK# and Google Eddystone Protocol an open-sourced solution for navigation, with a set of Estimote Location and Proximity beacons*.

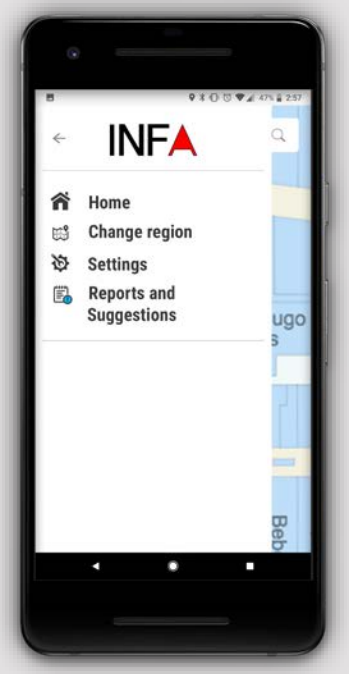
The Estimote SDK is open sourced set of API** to help developers use their technology in whatever way they would like to. Those APIs are Indoor Location, Beacon Monitoring, Beacon Ranging, Telemetry, Sensors, RESTful API, Fleet Management, Cloud, Bulk Update, Mesh networking



*Beacon refers to a radio transmitter whose signal helps to fix the position of any smartphone.
#SDK – Standard development kit
**API – Application Programming Interface is a system of tools and resources in an operating system, enabling developers to create software application.

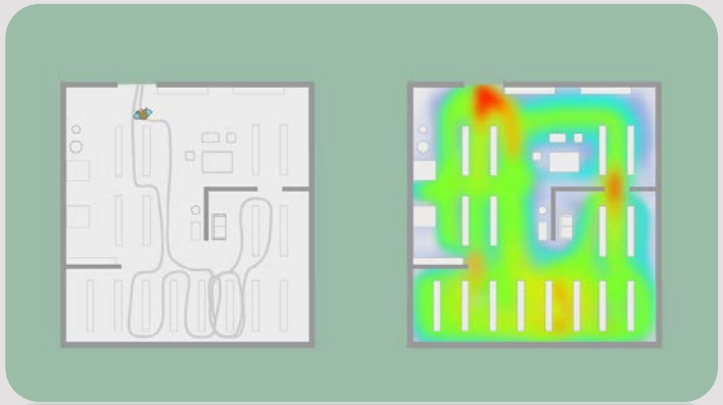
Solutions

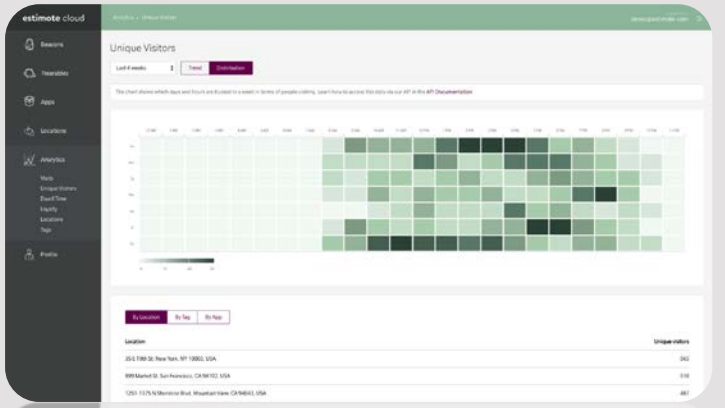
- Precise navigation for pedestrians indoors and outdoors. (Depends upon the requirement and beacon installation).
- Reporting directions to the desired metro-line that will take the user to its desired station.
- Instructing shortest route to the desired location within the metro station without the need of tactile assistance.
- Information of nearby regions such as restrooms, drinking water facilities and resting points within the metro station.

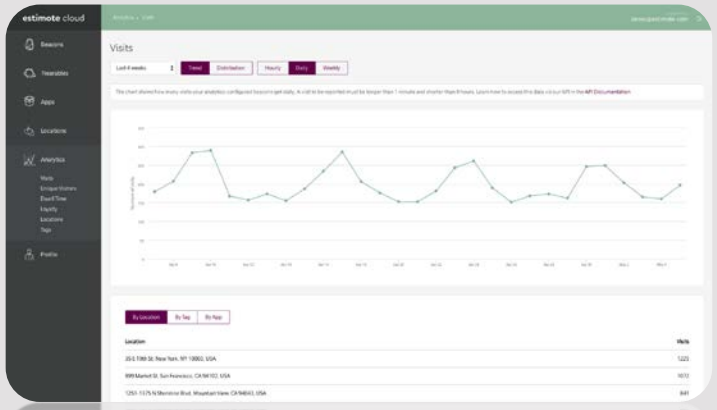


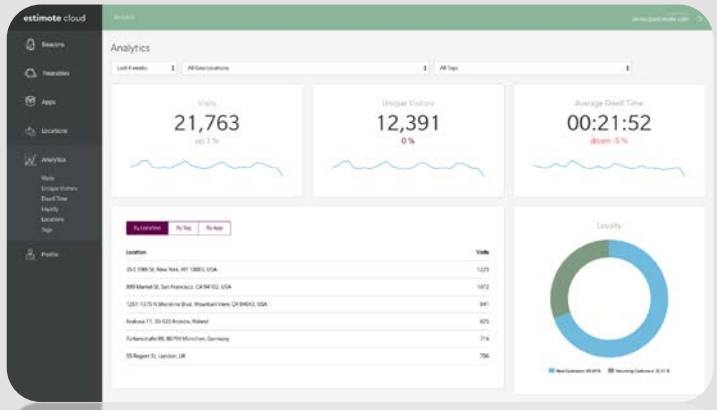
The information or analytics of usage, and beacon info would also be collected on cloud network. This information will be accessible over the internet, helping users and designers to identify crowd intensity of any point at any period of time. These analytics can provide information on the following-

Pathing heat maps- Records movement and crowding pattern, useful for identifying pressure points and make improvements for future planning. Also, helps pedestrians to avoid crowded areas.





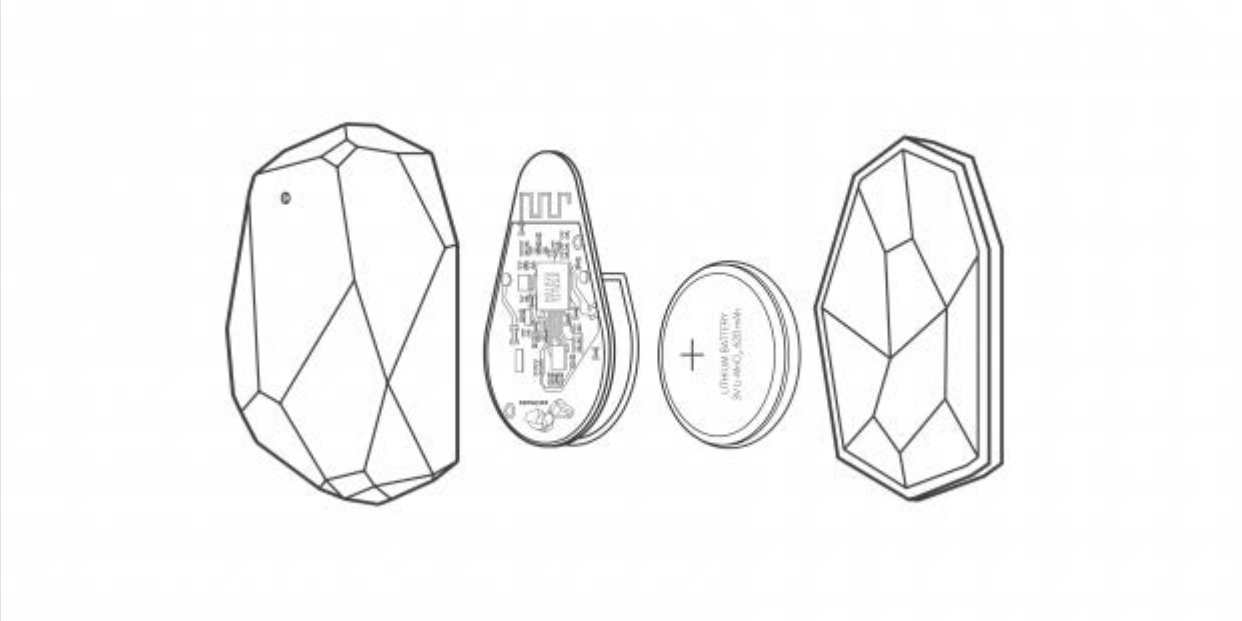




Records number of regular and unique visitors and their dwelling time at any time of day.

How?

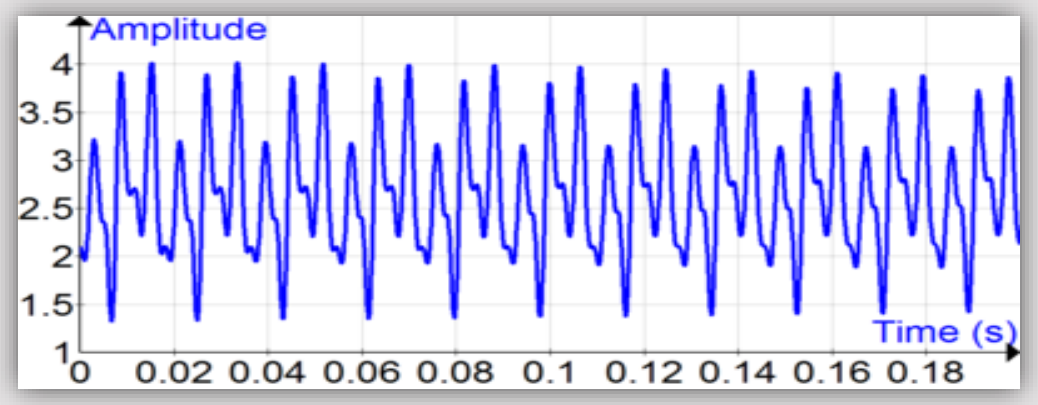
Estimote Beacon is a tiny computer that broadcasts radio signal that can be interpreted by any smartphone. Powered by a coin battery, beacon has an ARM processor, memory, Bluetooth Smart module, and temperature and motion sensors.
When an eligible mobile app enters the signal's region, corresponding actions can be triggered.

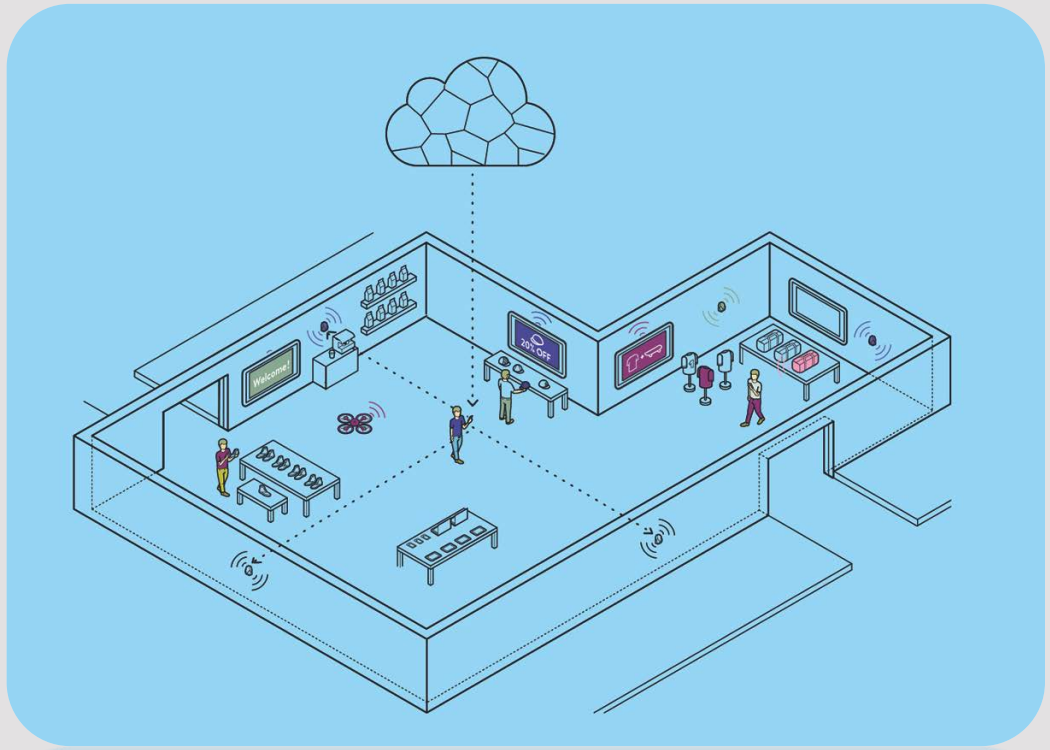


With the generosity of Estimote company, which open-sources the Standard development kit (SDK) which has a number of Application Programming Interface (API) and with the help of Google developers' open sourced beacon format or protocol Eddystone, we can use these devkits at no cost.

Phones detect the beacon's signal which contains basic data such as UUID (Universally Unique ID), Major and Minor. Phones read the RSSI (Received Signal Strength Indicator) value and calculate the distance between each beacon. Since it would not be enough to pin point the precise location, Standard development kit (SDK) and Application Programming Interface (API) uses it's software algorithm such as Trilateration, Particle Filtering, etc. and calculates the precise location.

Estimote's platform standard takes advantage of thousands of lines of code, written to overcome issues with shaky signal readings. The Estimote SDK is built on top of Core Location, so it includes all noise reduction algorithms to smooth the signal readings like doing fast Fourier transformation and applying High/Low pass or filters. And is always updated with further fixes and increased accuracy.

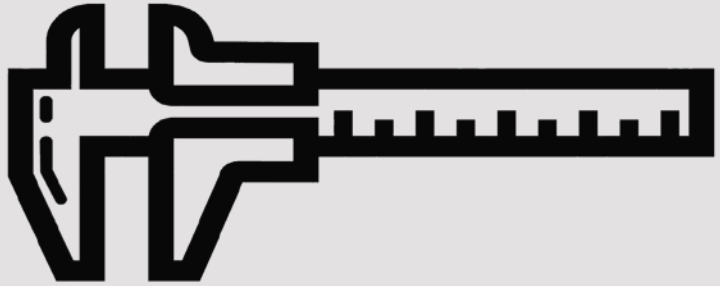




Why Estimote?

Estimote are good for developer kits and Radius Networks, since they open source the Kits. They provide support at development to deployment of the system, have API/SDK for almost all use case of the technology. For large deployments, they can even fly a technician in for support!

What will be the accuracy?



Accuracy heavily depends upon the formula Area/[(Accuracy)^2 * pi] + 15% which determines the number of beacons used, RSSI values, Frequencies, and TXPower, it can be anything from 10cm to 5m. The recommended target would be 1m from us, that too will vary with different zones of a station, like a straight alley can have 1-1.5m accuracy with no problems, and where there’s an open space with Ticket counters, Toilets, Platforms, it can go down to 50cm. Note that noise, Interference, Diffraction, Multipath propagation, Absorption can vary results.

Where are the APIs and SDKs?

The aforementioned APIs and SDKs can be found at following links -

- API Documentation available on - https://cloud.estimote.com/docs/
- Quick starting any of the API services - https://github.com/Estimote/Android-SDK/blob/master/Docs/quick_snippets.md#bulk-updater-quick-start
- Estimote SDK Javadoc - http://estimote.github.io/Android-SDK/JavaDocs/index-all.html
- Estimote indoor SDK JavaDocs - https://estimote.github.io/Android-Indoor-SDK/docs/index.html
- Google tutorial on Eddystone - https://developers.google.com/beacons
- Full tutorials on Estimote - https://forums.estimote.com/t/newbies-guide-to-the-estimote-galaxy/7381
- Estimote Developer documents – https://developer.estimote.com/
- Estimote GitHub – https://github.com/Estimote

Existing Alternatives

There are two major existing companies abroad that are working on similar solutions –

- **Right-Hear company** (https://www.right-hear.com/#services) has provided similar solution in foreign countries but lacks the main portrayed feature that we propose, which is 'navigation technology'. It fails to identify the location of the user and only instructs direction form one point of interest location to other, by which they try to make environment familiar with audio guide. Project done at San Francisco Airport's Terminal two in 2014.

- **Indoors** (https://indoo.rs/) is a an app that lacks navigation features and requires points of interest (POI) to navigate and fails to provide 'text to voice' feature, it just notify when a certain location is reached such as stairs. It does not even support android phones. We on the other hand, would have pre-defined voice commands for every situation, which would be suitable to use by android as well as iPhone users.

How are we different?

Both the above applications lacks ideas that we propose, which is ‘navigation technology’, where we pin-point the location of the user and command in relation, rather than commanding in proximity or points of interest. This makes it more easy and reliable to use. ‘INFA’, would also be capable of taking inputs such as terminal number, restrooms and other facilities that can take you directly the location, without having to ask people or search.
Note- In India, there is no company working on it at such a broad range.

There’s also a Open sourced project NavCog which is a subpart of HULOP (Human Localization Platform) of IBM research lab at Newell-Simon Hall Carnegie Mellon University Robotics Institute Pittsburgh.
Still being an iOS only project, focuses on developing Algorithms to make the indoor location more precise. We can also use their data for our development.
Navcog Docs - https://github.com/hulop/00Readme/blob/master/quick_start/index.md
https://github.com/hulop

Development Timeline

Any app is developed on two aspects:
Content generation and Maintenance(Updates):
Since we're targeting on a single building at a time, three types of data would be needed to develop the program:

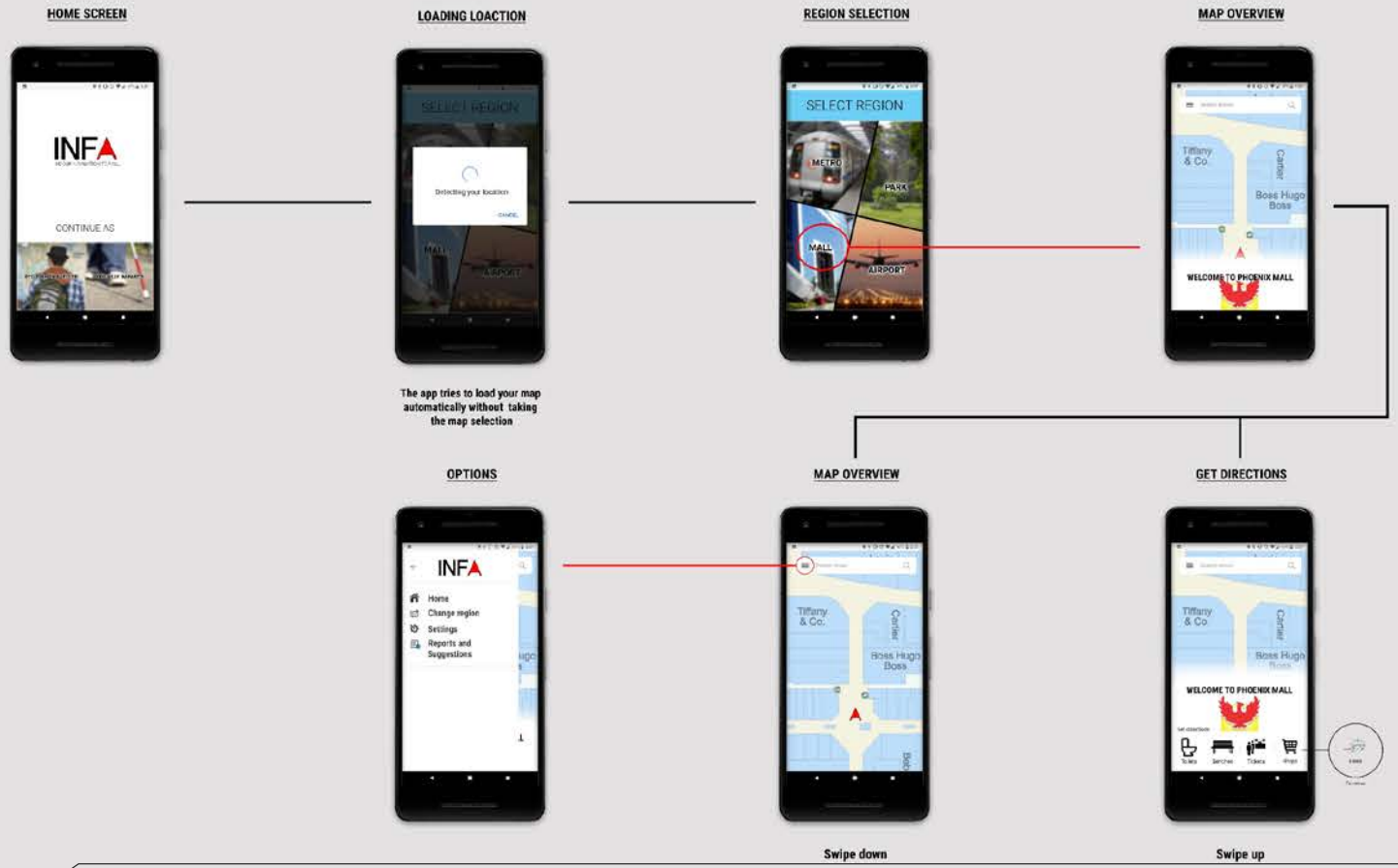
- **Static data**, where no updates would be needed like the map of the building, which stays permanent.
- **Dynamic data**, where a cloud server would be needed and updates would be required, such as new facilities, unavailability / renovation of certain paths or regions of building or change or addition of routes or their timings.
- **User generated data**, which would be our analytics, for the maintained and planning of metro networks to check the public activity.

Since Estimote already provides Telemetry and RESTful API (REpresentational State Transfer, or RESTful, web services provide interoperability between computer systems on the Internet), the main focus would be of building a User Interface and a map and not the Beacon data Interface. Thus developing the app would have mainly Design and Testing processes involved only.

Stage 1 Timeline

Following processes would be needed to develop an app.

- Wireframing the app - In this phase the ideas and features fuse into a clearer picture. Wireframing is the process of creating a mock-up or prototype of our app, which is the foundation of the app on which it will be built. **(0.5 - 1 month)**
- App screen design (Front-end) **(1-1.5 months)**
- App programming (Front-end) – Programming the UI and working of an app. **(2 months)**
- Application / Database Framework and Server-side Application Programming (Back-end/Cloud)– Would not be needed as the server would be used of Estimote's.
- APIs Development – Would not be needed as is already provided.
- Usability QA - Testing the app screens for bugs and fixing any issues. **(1 month)**
- Multi-platforms, Multi-devices, Resolutions QA - Testing the app on Android, and different OS versions of, Different resolutions of different mobile devices (between different devices of smartphones, phablets, and tablets, there are quite a bit resolutions to test for). **(3-4 months)**
- Back-end QA – Not needed.
- Cloud Setup – Not needed.



Wireframe with Screen design

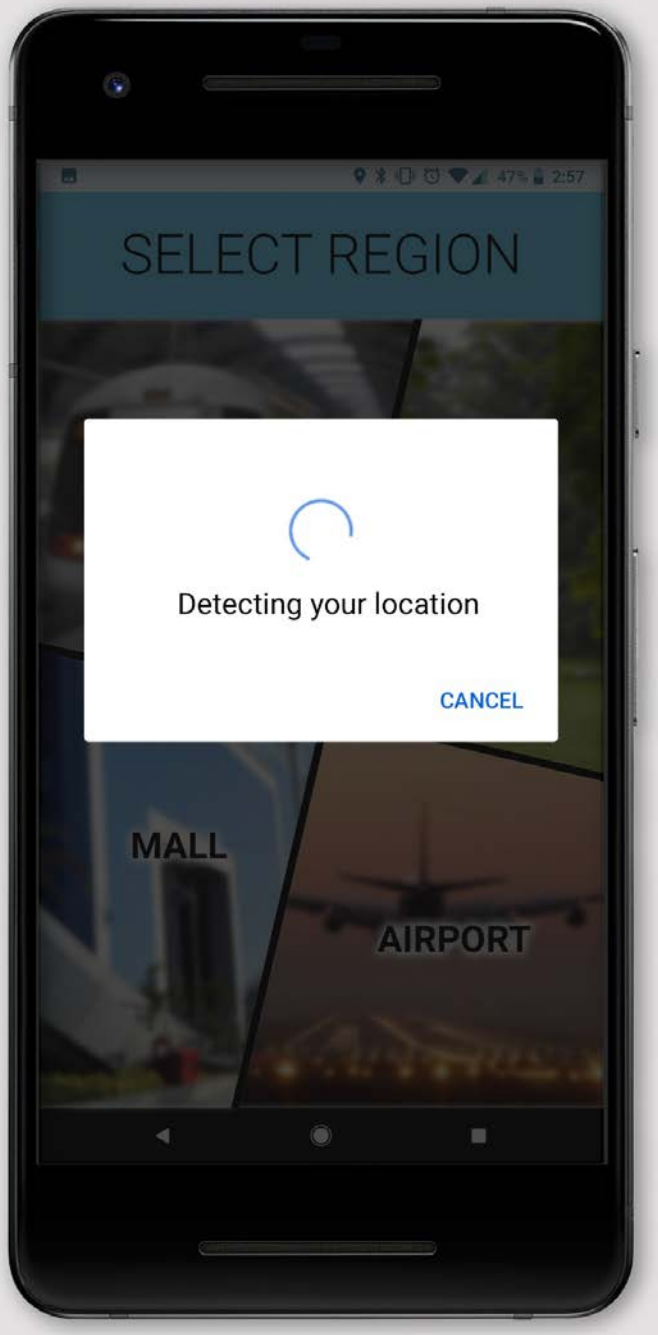
Basic Wireframing with screen design has already been done to make the thought into the picture.

Home Screen


47% 2:57
INFA
INDOOR NAVIGATION FOR ALL
CONTINUE AS
REGULAR TRAVELLER
VISUALLY IMPARED

Location Detection

The app tries to automatically figure out the location you’re in to load the indoor map.



Region Selection

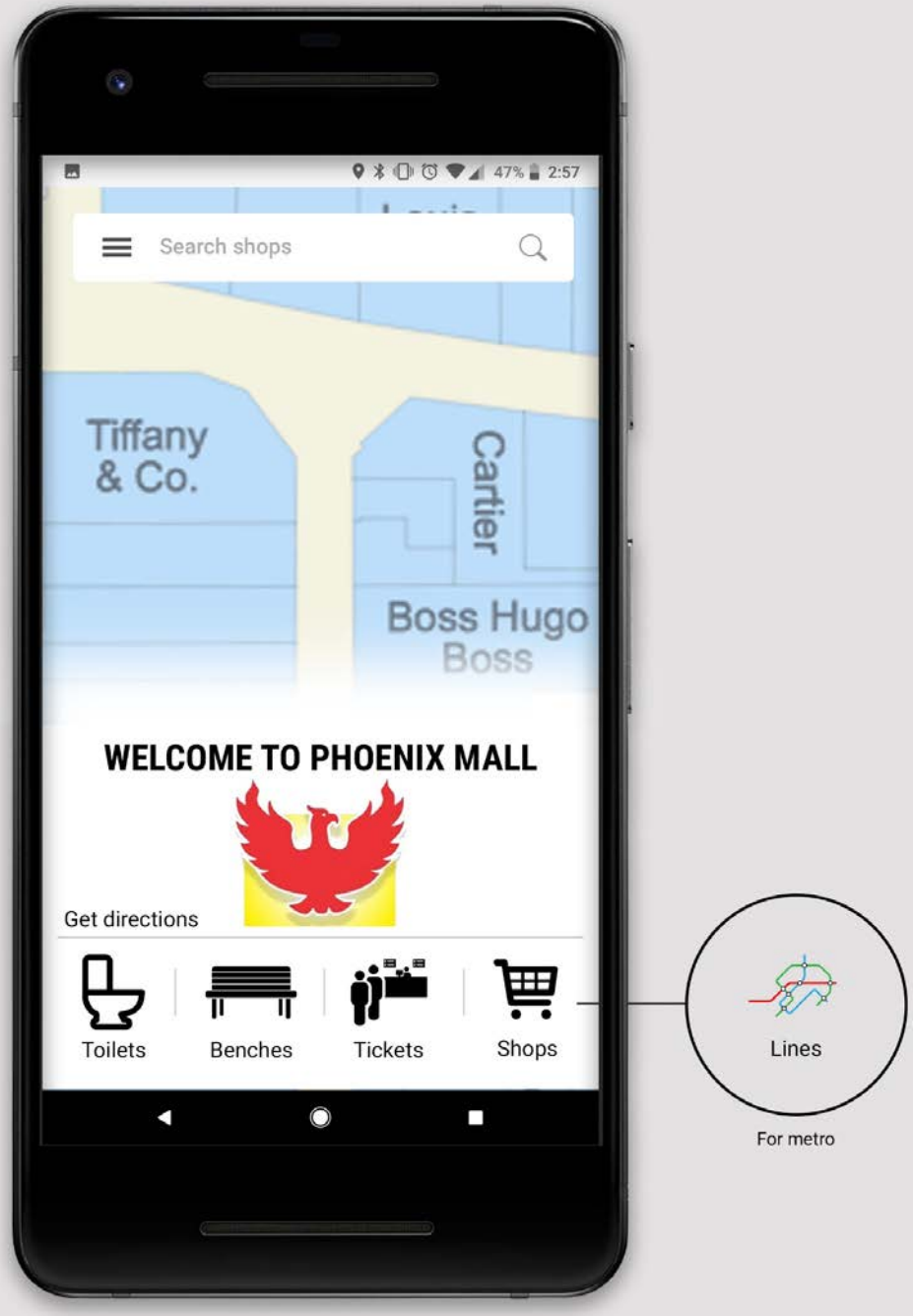
The user selects the facility they’re in if location detection doesn’t works out.

Map overview

As soon as the facility is selected, the screen loads up with a welcome message and map of the facility with a marker location you on it.

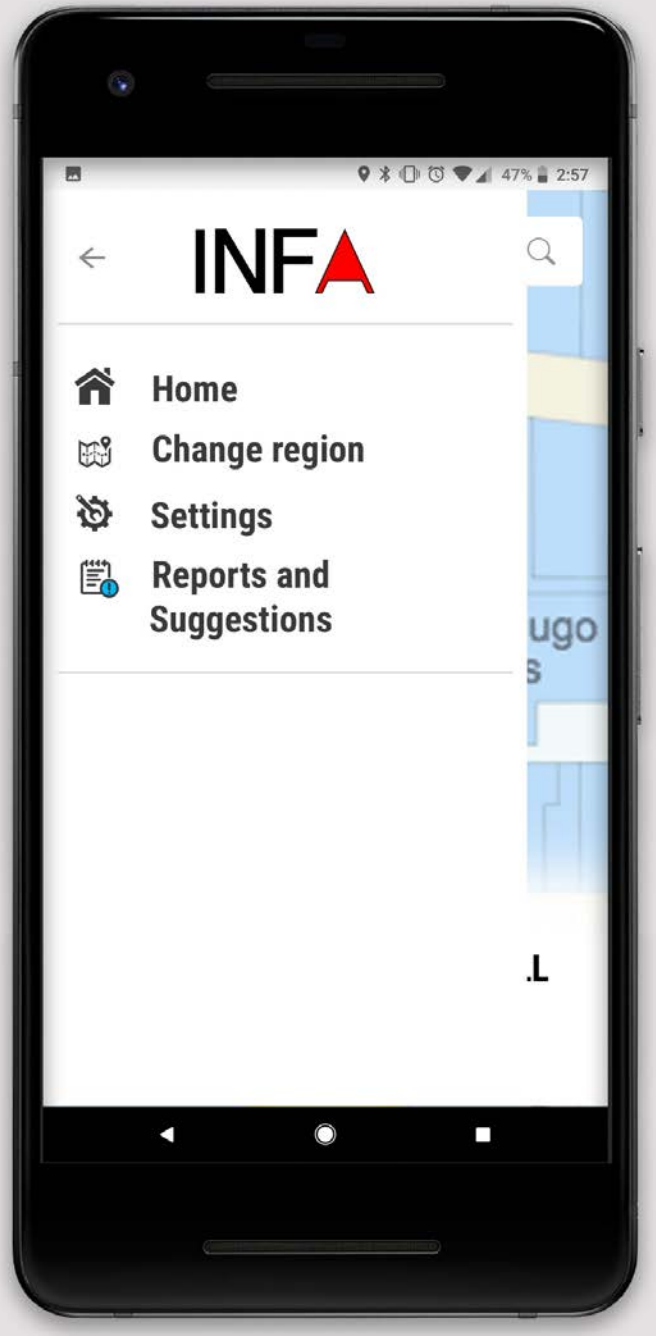
Get directions

Swipe up in the overview, which shows a set of quick access for provisions to select from.



Options

When the Hamburger icon (Three lines) is pressed, the options for the app will open from the right.



Steps in Stage 1

The app will be developed in three main Steps–

•**α (alpha)** – Testing in a controlled environment and tuning the power, RSSI and frequency of beacons to learn its location tracking pattern and latency. Mapping the location precisely.

•**β1 (beta 1)** – Testing and applying the knowledge of α in the proposed site, tuning again the RSSI, Frequency and Power to accommodate with the site.

•**β2 (beta 2)** – Testing the app on test subjects in a controlled way, learning the limitations, taking suggestions and fixings them. Here we would be launching a Beta or Basic version of the app with fewer features according to the available funds, and would closely monitor the user activity, feedback and reported bugs.

Conclusion

Total Duration – 8 to 10 months

Total cost can vary from ₹ 70,000 to ₹1,25,000.

With Monitored activity, feedbacks and reported bugs, development for further content and investment would be looked forward to for the second stage of the application.