Contents

1. Introduction

Pune is the ninth most populated city in India, with a staggering population of 3.99 million people that were part of the 2017 census [1]. A survey conducted by the NSSO (National Sample Survey Organization) revealed that spending on transportation accounts for a large share of the expenditure on services in Indian cities [2]. The case of Pune is no different, where an average of 17074 bus trips are made every day, and these buses carry an average of over 0.9 million people daily [3][4].

1.1 The Problem

The movement of local buses in Pune is affected by various uncertain conditions every day, such as traffic congestion, unexpected delays, randomness in passenger demand, irregular vehicle-dispatching times and many more incidents. Commuters are often late for college and work because they decide to wait for the bus instead of using an alternate transportation [5]. Public transport systems, especially buses, are not able to adhere to predefined timetables due to reasons like traffic jams, breakdowns, etc. Due to lack of information, bus commuters in Pune are unable to make informed decisions regarding whether to take a bus, and which bus to take if they do decide on taking one. Passengers also face anxiety because of not knowing whether a bus is on time or whether it will show up at all. Not only do the increased waiting time and the uncertainty in bus arrival make public transport system unattractive for passengers, but these factors also end up in the wastage of considerable amounts of the passengers' resources, such as time, money and effort.

1.1.1 Problem Statement:

To design a mobile application for the users who want authentic and valid information about the estimated time of arrival (ETA) of local buses in Pune, using a centralized server to share the calculated ETA to bus passenger through the application using GPS (Global Positioning System) technology to fetch data.

1.2 The Solution

Our project aims to propose a solution to the aforementioned problem by the implementation of a Real-Time Bus Tracking System, by installing GPS (Global Positioning System)-module devices on buses which will transmit the current location of the bus from the GPS receiver. The GPS receiver will be interfaced with a computer and an interface driver will send data onto a server that would monitor the live location of buses. From here the control room application will retrieve data and store it in web server from where the system will calculate and transmit ETAs and the location information of the bus. The real-time bus tracking system will be a system designed to display the real-time locations of the buses managed by the Pune Municipal Corporation.

1.2.1 Explanation

To reduce inconvenience of passengers due to misinformation and the lack of information of the local bus travel, we wish to develop a mobile application that will provide the real-time information about the bus showing its arrival time which could reduce the anxiety of passengers waiting for the bus. With the advent of GPS and fast cellular network, live vehicle tracking for better transport management has become possible.

The variable waiting time and the uncertainty in bus arrival make public transport system impractical for passengers to manage their daily transportation. The RTBTS uses GPS technology to fetch data and displays the data using our mobile application allowing the passengers to monitor a bus on a route to determine its ETA. When this information is presented to the passenger on their mobile application, they can manage their time efficiently and reach the bus stop just before the bus arrives, or take an alternate means of transport if the bus is delayed. They can even plan their journeys before they initiate them. This would help the passengers take more informed decisions regarding their mode of transport.

2. LITERATURE REVIEW

Paper 1: "Real Time Bus Position and Time Monitoring System" IJSTE-International Journal of Science Technology Engineering, Volume 1, Issue 10, April 2015.

This paper focuses on the implementation of a Real Time Bus Tracking (RTBT) system, by installing GPS devices on city buses which will transmit the current location on GPS Receiver. The GPS Receiver would be interfaced with computer and interface driver will auto save data in dot text (.txt) file which will continue till GPS module is working. The application would retrieve data and store it in web server from where it will display real time information of bus. The real-time bus position and time monitoring system is designed to display the real-time location(s) of the buses in city.

Paper 2: M. B. M. Kamel, "Real-time GPS/GPRS based vehicle tracking system," International Journal of Engineering and Computer Science, Aug. 2015

In this paper, vehicle-tracking is established by installing a hardware positioning sensor inside the vehicles and a tracking server to receive and decode the incoming signals from the vehicles. It focuses on vehicle systems that were in use at the time and suggests that they used some form of AVL that is a concept for determining the geographic location of a vehicle and transmitting this information to a remotely located server. The location was determined using GPS and transmission mechanism could be a satellite, terrestrial radio or cellular connection from the vehicle to a radio receiver, satellite or nearby cell tower.

Paper 3: "Real Time Availability System" International Journal of Advanced Research in Computer Engineering Technology (IJARCET) Volume 4 Issue 3, March 2015

This project has described the design and architecture of a college bus tracking system. The system is composed of smart phones and a server. The system can demonstrate its performance to track college bus from any area. And for students and parents it is a very helpful application to access their activity Furthermore, the system is low-cost. The display at the user's end acts as a time

saver. Due to this, they established an ideal system of bus transport for college purposes. By implementing the system, a student can plan their journey more efficiently before time as the waiting time at the bus stops is reduced. They have shown that transit information collected in real time can be shown on the server for tracking and monitoring. Internet-enabled mobile phones can receive real-time transit information and will help the passenger to monitor their time more effectively.

2.1 CONCLUSION

Having studied these papers, we have gathered the functional requirements and the technical solution that is required to implement the project. The studied literature suggests that the project is theoretically feasible. To get a better idea of the practical workability of the system, market analysis and business analysis had to be conducted.

3. Similar working systems

Transit app for Android: Transit is an urban travel companion. It helps the user navigate their city's public transit system with accurate real-time predictions, simple trip planning, step-by-step navigation, service disruption notifications, and departure and stop reminders. All presented in a clear, bold interface. If public transport is not cooperating, it helps the user to easily request an Uber, reserve a car2go, or grab the closest bike share.

Moovit: Moovit is a global mobile application that is used in over 1800 cities, 79 countries, and over 100 million users. Moovit has unique features such as:

Detailed Itineraries with GPS support for transit.

Get off Alerts.

Favourite Locations.

Real time status of the local buses.

Nearby Stations and the transit routes.

4. METHODOLOGY

4.1 Telephonic interviews

We had telephonic conversations with some citizens of Pune that use the local buses regularly, and asked them about some of the problems that they face while attempting to travel via local buses in Pune.

Following are some of the responses along with the respective questions that we have gathered.

Q: *Is there any way of knowing about the bus routes throughout the city?*

A: *Yes, the bus numbers and their routes are available online, on the PMPML website. There is also a mobile application called P- indicator that displays the said bus time table of the local buses.*

Q: *Are these sources reliable? How often do these buses arrive, according to the timetable?*

A:*Not very often. Everyday commuters are aware of the fluctuations of these buses, and they know a time interval between which a bus may arrive, but nobody can guarantee the timely arrival of local buses.*

Q:*Are passengers intimated if their buses are delayed, or cancelled?*

A:*No, there no warnings or intimations given to the*

passengers regarding cancellation of any buses.

Q: *Is the lack of information about the latest working bus routes, and the timely statuses of working buses a problem to the commuters?*

A: *Yes, I feel bus transport would be a lot easier if the information regarding latest working bus routes was accessible; it would also be more convenient and time saving if there was some way by which I could know how long it would take for a bus to get to my stop, and if my bus was cancelled or delayed. I feel like a lot of time is wasted because of this lack of information*.

Q: *Would you prefer having information pertaining to real time location of buses and their estimated times of arrival?*

A: *If I could have real time location of the buses so that I could know the approximated time it would take for the bus to get to my stop, that would be a significant positive change in the existing paradigm and make my experience better.*

4.2 Online Research

We read the following papers, as mentioned in the literature review.

Paper 1: "Real Time Bus Position and Time Monitoring System" IJSTE-International Journal of Science Technology Engineering, Volume 1, Issue 10, April 2015.

Paper 2: M. B. M. Kamel, "Real-time GPS/GPRS based vehicle tracking system," International Journal of Engineering and Computer Science, Aug. 2015

Paper 3: "Real Time Availability System" International Journal of Advanced Research in Computer Engineering Technology (IJARCET) Volume 4 Issue 3, March 2015

Articles provided by various newspapers such as the Times of India and The Hindu explained the poor conditions of bus travel in Pune City, and we gauged that some of these problems such as the lack of information could be solved by providing authentic real-time information to the users.

4.3 Which SDLC model?

Prototyping model:

Since this is not a report for a complete implementation of a project, but only a theoretical imagining of the system that we aim to create to solve the selected problem, we have incorporated the first two stages of prototyping model.

In this model, a prototype is developed based on the project requirements. With the prototype, users can have an actual feel of the system and have better understanding about the final system. With this, users may give clearer requirements of the final system, thus the final system will be developed based on the acceptances of the prototypes from users. By this process, we may be able to develop a system that is perfectly optimized for its users.

Why?

In development processes of bus tracking system, there are many uncertainties. In the bus tracking process, there could be errors, and this could affect the accuracy of estimated bus arrival time for users. From the user's perspective, the accuracy of estimated arrival time will determine the success of the system. Therefore, prototyping approach is suitable to test on acceptation of final system from users. According to this methodology, if user rejects a prototype, a new prototype is developed based on new requirements from user feedback and test on user again. Once the prototype is accepted by user, it would be the model for final system. With high user involvement in prototyping process, the quality of final system will be increased.

For the development of this report, the final implementation of the system has not been done, but the first two stages of planning and analysis have been completed.

STAGE 1 - PLANNING: Planning had been done in first stage. We confirmed the project title, and studies on existing bus tracking system were performed. We realised that this system has been implemented successfully in some countries. Based on studies performed on existing system, some common problems were found, and the problem statement was generated. The accurate estimated bus arrival time is very important to determine the performance of bus service. Bus users must know the time at which the bus will arrive. Furthermore, the existing systems provided real time bus tracking in map view instead of just showing timetable to user. Based on the studies and telephonic interviews, we figured that showing the location of the bus on a map view is crucial to improving the user experience. By showing bus position on a map, the user can know where a bus is, and how long it would take for the bus to get to them.

STAGE 2 – ANALYSIS: In the analysis stage, we have gathered functional and non-functional requirements, and analysed both the market and the technological stack that is required to make the system functional. A SWOT analysis has been performed to better gauge the way ahead. Technical analysis has been performed, where we studied the necessary system architecture.

5. Requirement Specifications

5.1 USER REQUIREMENTS:

There are two main target users for the proposed system, passenger, and bus management team. The requirement from different user is stated below.

Bus user (Passenger)

The passenger is the main user of the proposed system because the main objective of bus tracking system is to provide estimated bus arrival time. The passenger must able to retrieve real time estimated bus arrival time for every bus stop. While waiting at the bus stop, they should be able to access bus tracking system with mobile device instead of using computers. This is the main purpose of bus tracking system in mobile application. Instead of just showing timetable to the user, theyshould be able to know where a bus is located. The system provides real time bus tracking with mapping features, which means that students would be able to view the bus position with a map.

Bus Driver

The Bus driver is the second important user of this system. Bus driver is the one who updates the information while bus driver is on bus operating hours. Bus driver should be able to update bus status accordingly, to inform bus users about immediate situation.

5.2 FUNCTIONAL REQUIREMENTS:

Functional requirement refers to the functionalities that must be applied to a system. The functional requirements of bus tracking system are stated below.

1. The system must be able to show bus routes and locations to the users.

2. The system must be able to process the position data received from bus positioning module and calculate the estimated time to user.

3. The system must be able to show estimated arrival time for every bus in every bus stop.

4. The system must be able to allow user retrieve information from mobile device and computer.

5.3 NON-FUNCTIONAL REQUIREMENTS

1. The system should provide the accurate estimated bus arrival time to user.

2. The system should reduce the paper work done by bus management team.

3. The system should be able to increase the efficiency and performance of bus service.

4. The system should reduce work done by bus management team by automated calculation of estimated bus arrival time and showing real time bus position to user.

5. The system should allow user to access information in anywhere with anytime.

5.4 Moscow Analysis:

The system

Must have:	Databases with authentic route data
	GPS capabilities
	Decent internet connection
Should have:	Intuitive and easy interface
	Lightweight size and minimal RAM consumption
	Customised and personalised ads
Could have:	Ticket booking functionality
Would have:	Timetables of other modes of transport
	Booking of other modes of transport

6. Technical Analysis

6.1 Working:

The proposed RTBTS consists of a tracking server to monitor and control the system, web interface to check the location of the buses and in-vehicle units with embedded GPS receivers that have been installed inside each bus. The in-vehicle unit is responsible for capturing the location data continuously. This data is then sent to the tracking server periodically. The time interval of data transmission depends on the preferred operation cost and the in-vehicle unit reliability.

Why Real Time? Why GPS?

An active GPS tracking system is also known as a real-time system as this method automatically sends the information on the GPS system to a central tracking portal or system in real-time as it happens. This kind of system is usually a better option for commercial purposes such as fleet tracking or monitoring of people, such as children or elderly, as it allows a caregiver to know exactly where loved ones are, whether they are on time and whether they are where they are supposed to be during a journey. This is also a useful way of monitoring the behaviour of employees as they carry out their work and of streamlining internal processes and procedures for delivery fleets. [6]

The architecture: It consists of five blocks

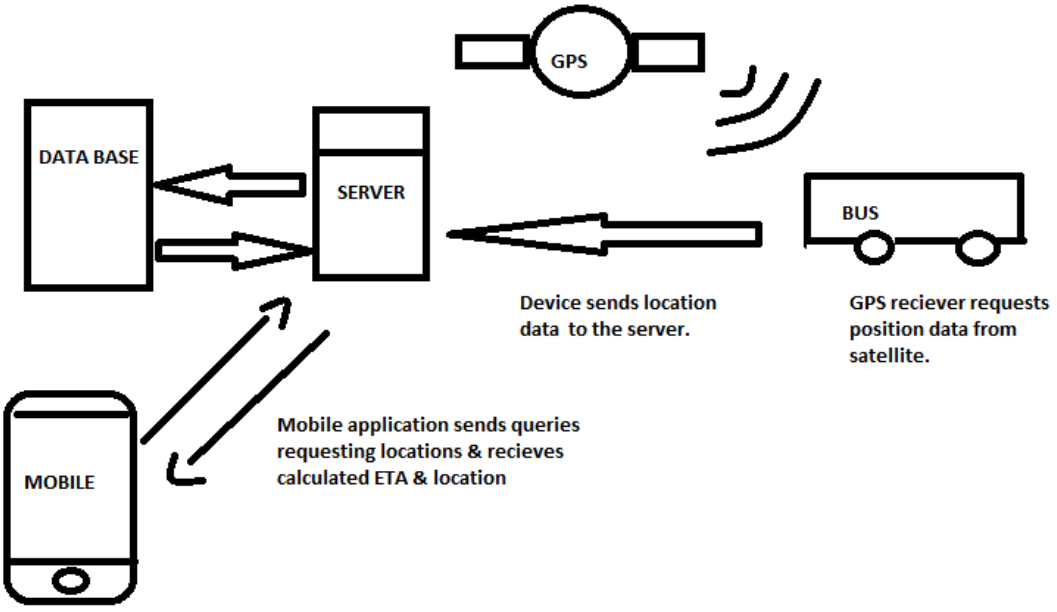
The first block is GPS to Satellite communication, where the satellite sends the information about the position of the GPS through the communication port interface.

The next block is the Bus which consists of the GPS module installed into it and the module is kept active by giving power to it.

The satellite sends the required position information to the module and the module sends it to the Server which is the next block.

The server consists of the current location information in the form of tables along with the time table information i.e. route information. The server calculates the information required by the user and replies using the software and end user interface.

The last block is the user interface. These are the mobile devices through which the user can send their query and get a response on it.



In case of a delay in the bus routine, where the bus cannot reach the user in the estimated time, the driver would have to press a button on the GPS module which would automatically help in intimating the PMPML that a delay or a breakdown has occurred, after which they can interrogate into the matter and arrange for quick recovery. Meanwhile, the bus would not be shown in the mobile application, and users tracking it would get an intimation informing them that the bus cannot arrive on time.

6.2 Scenarios

Without the app:

1. The bus user walks onto the bus stop, unaware that the bus that they want is cancelled. The user realises that their bus is not coming after having wasted a lot of their time.
2. The bus user walks onto the bus stop, unaware of a delay in the bus schedule. The user waits at the stop for some time and leaves because they have to be somewhere fast, but it shows up right after they leave.

With the app:

The bus user walks onto the bus stop, opens the app, inputs their current location and preferred destination, sees that the bus is late, and decides to take another mode of transport if they are in a hurry, or waits for the bus while tracking its location if they are not in a rush.

Visual Representation:

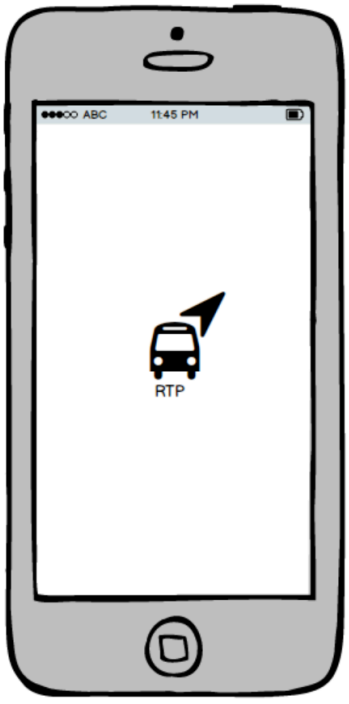


Figure 1 User selects the app

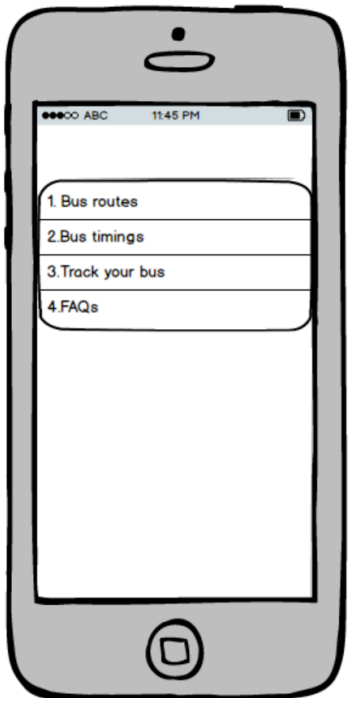


Figure 2 Prototype Menu

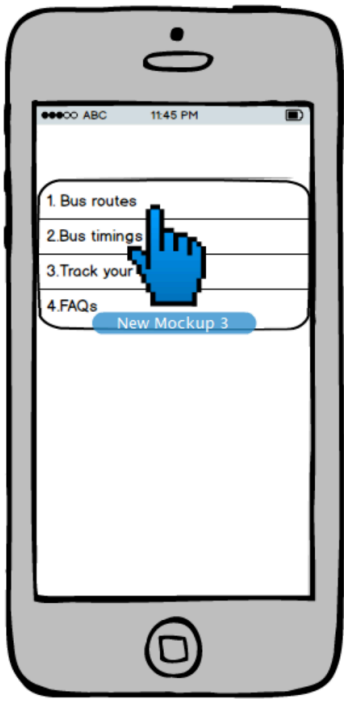


Figure 3 User selects option bus routes

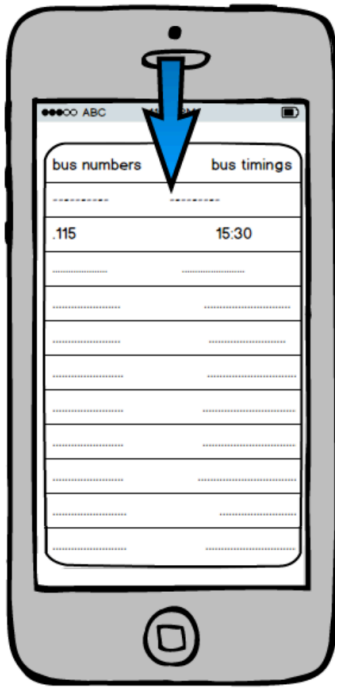


Figure 4 Available buses near user and timings are displayed

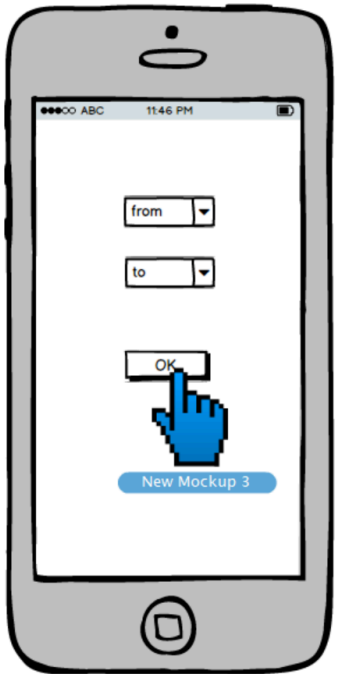


Figure 5 User's location and destination are asked

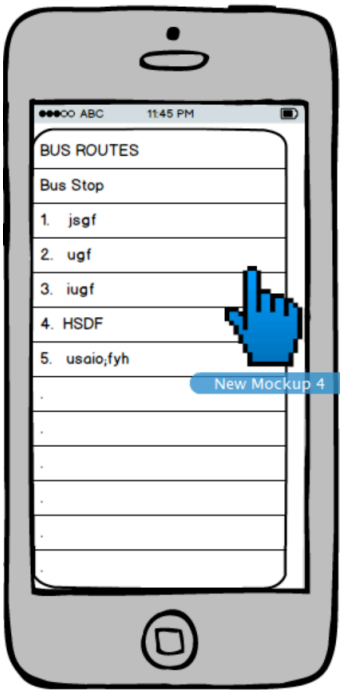


Figure 6 All buses that the user can choose

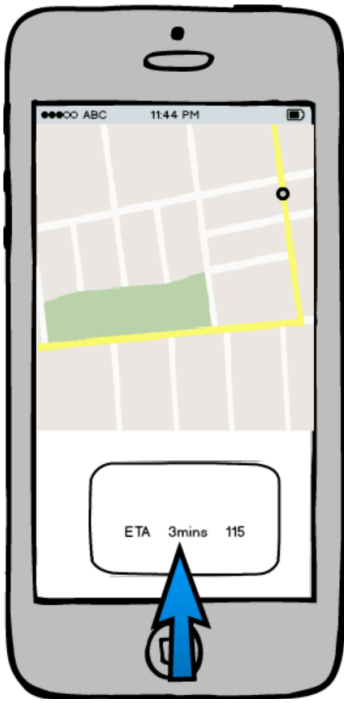


Figure 7 Bus location and ETA are displayed

7. MARKET ANALYSIS

7.1 SWOT

Strengths:

The strength of the application is that it would provide the passengers with the real-time bus locations i.e. it gives the bus timings including the delay and in worst case gives intimations if the buses are cancelled.

It also provides the bus routes and the bus numbers which would take one to their desired destination.

Weakness:

The following are the possible weakness

Replacements for cancelled buses cannot be provided as it is not feasible with population.

The places with weak GPS can lead to less accurate RTS.

Places with no internet connection

Opportunities:

The following are the opportunities.

the passengers could make a tentative plan of travelling and make necessary changes if required.

The people travelling to a new place for the first time and the information needed for travelling could be provided thus avoiding misleading and wrong information.

Threats:

The possible threats can be on two sides.

User side:

Threats for users can be,1 delay in providing the status of the required buses as it is done manually, and human error can occur.

Weak internet could be a problem for the user.

Service provider:

We as the provider can have security threats as there could be tracking of the buses as the terrorist events could take place.

There could be a problem by providing locations of the buses as there could be weak GPS connections.

8. BUSINESS MODEL

Customer segments

Effective customer segmentation is critical for any company. Our customer base is divided into a group of individuals which include the government employees, office staff, college kids who use the bus, and the PMPML. The PMPML will be our primary customer with whom we'll be collaborating, since it is the agency that is responsible for the management of bus routes in Pune.

Value Propositions

To better understand the customer needs so that we can design the system that they want, our value proposition is simple and efficient provision of accurate information. We'll be providing the customers with real-time location of the buses along with the route information (bus numbers, bus stops and timings).

We aim to lower the risk of missing buses and saving time of the passengers by providing them with accurate GPS locations of respective buses. Usage of public bus transport reduces the number of cars in street, and thus helps improve air quality, lead to lesser utilization of fuel, alleviate traffic congestion, and noise.

Channels

We're going to try to reach our customers through our portable mobile application, billboards marketing by PMPML and referral through other users.

Customer relationship

We aim to forge a sustainable relationship with our customers through FAQs, reviews, ratings, feedback systems, and tech support.

Revenue Streams

The main revenue source for our app is through customized location-based ads and partial revenue through PMPML.

Key Resources

Our most important assets are our customers, most of whom are estimated to be existing users of modes of public transportation in Pune. Since we are aiming to create an information providing platform, the other key resource would be accurate data pertaining to the buses in use, like their routes and timetables.

Key Activities

Developing the application platform, setting up scalable databases and secure communication channels for the efficient working of the system are some of the activities that are required to set up the system. Providing active technical support and addressing the concerns of the PMPML are also critical to the sustainable operation of the system.

Key Partners

The most important partner for our work is the PMPML with whom we're going to collaborate.

COST STRUCTURE

Setting up the necessary infrastructure for the server-side implementation of the system is one of the primary costs that we would have to incur. Application and system development costs that must be paid to partner developers and security analysts need to be considered into the cost structure.

9. Security

A GPS tracking system uses the Global Navigation Satellite System (GNSS) network. This network incorporates a range of satellites that use microwave signals that are transmitted to GPS devices to give information on location, vehicle speed, time and direction. So, a GPS tracking system can potentially give both real-time and historic navigation data on any kind of journey. With GPS technology now more commonplace in many new smartphones, this means that the location of anyone carrying a GPS enabled smartphone can be accurately tracked at any time.

From a security point of view, this could be dangerous as anyone who can gain access to the server that can monitor these buses can also monitor the location of the people that use those buses. This makes it a threat to the common public and precautions must be taken to ensure a high level of security against malicious threats such as hackers.

Using location data combined with knowledge of specific location—such as addresses of the homes or offices of politicians, athletes, or movie stars—Synack, which is a penetration testing firm, was even able to determine the exact identities of many mobile device users. Synack researchers were able to track and pinpoint the locations of tens of thousands of users. They were able to detect location in real-time, as well as uncover patterns and schedules and, in some cases, even determine the exact identity of the user.

Flaws like the ones Synack plans to demonstrate can potentially put lives at risk. If Synack researchers can track people using insecure location tracking data, then so can potential attackers. [7]

In addition to providing data isolation, supporting full-filesystem encryption, and providing secure communications channels, Android provides a wide array of algorithms for protecting data using cryptography. For sending and receiving critical data, we need a secure tunnel, for which we may consider using HttpsURLConnection or SSLSocket libraries in the Android framework. Various cryptographic algorithms like AES could be used for security purposes.

It is thus critical that the application must be developed such that it conforms to sophisticated security protocols, so that it is near impossible for

anyone to track passengers or have any access to their current or past location data.

10. Conclusion

After the in-depth selection of the problem, the preparation of an accurate problem statement, technical and market analyses, research on security, and the drafting of a suitable business model, we believe that it is feasible to build a system which would greatly facilitate the distribution of information regarding local buses, which would greatly help the users make better and more informed decisions when it comes to deciding which bus or mode of transport they should take.

Since the efficient usage of public transport leads to lesser private vehicles on the road, thus helping to reduce pollution, and leading to lesser utilization of fuel, it is also an environmentally friendly solution.

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