

Uppsala University
School of Computer Science

Mobile Network Assisted Driving

Project CS 2015

Student Feedback

Submitted in partial fulfillment of the requirements for the project CS course 2015 as requested by Uppsala University and Ericsson Research

1 Feedback from the Whole Team

First and foremost, we as a team would like to thank Uppsala Universitet and Ericsson AB for providing us with this opportunity to research a topic as interesting as this. It was a fascinating experience and everybody who participated learned a lot of new things, for example programming languages, how to design a system, the Scrum framework or just how to work on a project with a team of 20 members. Another very important and positive factor was the good work environment. Part of this was not just the coffee and tea which were provided by the university, but also the many social events we organized or participated in. To mention here are, among others, the many fikas we had, our barbecue in October, our Christmas dinner and of course the Go-kart event at Kista. Additionally the project rooms were very nice to work in. They provided big space for our large group to gather for the bigger events like the daily scrum, but also contained a conference room where smaller teams could meet and discuss without disturbing those not participating in this individual meeting.

We did have problems with the cloud architecture provided by Ericsson. As a result of the troubles connecting to it we were not able to deploy the system into the cloud. However, the communication with our coordinator Edith, the Teaching Assistants and Ericsson were always constructive. Especially the hardware in form of a phone and a tablet we received from Ericsson was very important for testing our system.

Furthermore, we had several workshops and lectures that really helped to give us new insights into our problems and led us towards possible solutions.

Concluding it is to say that we will take very positive memories from the project and the cooperation with Ericsson away.

1.1 Scrum Framework

In the beginning of the project we decided to use the Scrum framework to organize the development of our system. In Scrum the work is divided into so-called sprints of one to four weeks. In the planning meeting in the beginning of the sprint a goal and a number of tasks which are to be completed are set. The team also determines how to demonstrate the completed parts in the end of the sprint. Every team member will work on some part of the system during

the sprint. At the end of the work segment each task will be shown in a presentation for the other members of the team so that the entire group is up-to-date on the progress of the project. During the sprint there is a daily short meeting in which each team member says what they are working on and whether they see any possible problems with reaching the goal set for their part.

An important feature of the Scrum framework is that every team member can work on different modules of the system. This is of course not possible at the same time, but since during every sprint the tasks get re-evaluated and re-assigned it is no problem switching to another part of the system. Thanks to this key detail of the Scrum it is easily achievable for all team members to get a good grasp of the entire application. Another vital element of the framework is the self-adjustment ability. After each sprint there is a retrospective meeting where all members can say what they thought went well during the sprint and what can be improved. As the other team members hear these opinions, they will adjust their behavior (if it is in their power).

One slight concern that came up while applying the Scrum framework is the relatively large administrative overhead with the planning, demonstration and retrospective meeting. Another issue we encountered was that the daily scrum in the morning did not provide as much information about the progress of other modules as we had hoped. This was very likely caused by the size of the team, as there is not that much time to go into details with a group of 20 people without loosing too much time for everybody.

Looking back at our decision to use Scrum we can say it was a good one. Especially during the beginning of our project it was very helpful to have a framework we could base our progress on. Since the specifications were in some points not strictly defined and left room for interpretation we could gather questions without loosing time and ask for clarifications. It was very helpful that our project partners at Ericsson often joined our discussions and helped us resolve many open issues. Additionally, using Scrum forced us to deliver results early and often. Due to this we could detect upcoming problems and make good decisions on the design.

1.2 Advice to Staff

We would like to thank the staff handling the administrative side of the project in the university, our course director Edith Ngai and our TAs, Stephan Brandauer and Amendra Shrestha. We

received a lot of positive feedback during the course of the project.

However, at times we felt that we did not get enough input from the TAs. The TAs are in a unique position to point out risks and see common issues that have happened in previous years. While it is understandable that the TAs are not supposed to tell us in detail what to do, some more opinions and comments would have been welcome at times. One suggestion to improve the work of the TAs would be to communicate suggestions to the whole team and not just to a few selected members.

1.3 Advice to Students

This course is a great preparation for working on a thesis later. It not only trains you to work in a team, but also for a customer. There are many important social skills besides the obvious technical ones to be gained by participating in this project. It also gives you contact to at least one company, in our case Ericsson, and those usually have offers for Master theses. Having a company already know your work makes a significant difference in the hiring process.

Despite this it has to be mentioned that this course takes a lot of work since the office hours are from nine in the morning to five in the afternoon. Even though there are no exams it still requires much effort to get up-to-date on technologies and maybe learn about new ones you have not heard about before. Furthermore we would also like to stress the importance of not taking additional courses during this semester. Taking extra courses will most likely lead to putting effort in the other courses and taking it out of the projectCS. This leads to not only staying behind in your level of technical knowledge in the project but also it shows a lack of commitment which effects the other team members in a negative way. ProjectCS is a 9 to 5 full time course and it requires 100% commitment from its participants in order to really benefit from it. Concluding it is to say that we enjoyed this project very much and had a lot of fun doing it. We can highly recommend taking this course to anybody wondering about whether to take it or choose “normal” courses.

2 Individual contribution to the project

Mohammad Al Haj Ali

During this project I worked mainly on System design, Look Ahead module and Dynamic routes. In sprint 1 I was in system design we discussed and wrote the required components for the system and how they should interact with each other. In sprint 2 I worked on analyzing LookAhead module to understand in depth how should it works and which tools and technologies we should use. We chose Genetic Algorithm and DEAP framework. In sprint 3 I was with LookAhead team I reviewed some papers related to our problem in order to understand how we can encode our problem into genetics algorithm genes and translate them back to timetable. Also, I read about DEAP framework. During this sprint we had long discussions about the module designing and what we should implement (scheduling trip first or generating dynamic routes). In sprint 4-5, I worked with other LookAhead team members on database class and fitness class. We had a lot of discussions to find a good way to group users requests and to find the most fitted solution. Sprint 6: At the first, I worked on some enhancement for lookAhead module , then I did some research on Dynamic routes problem. Sprint 7 - :Programming, testing dynamic routes and report writing.

Eleftherios Anagnostopoulos

During the first weeks of the project I was member of the Component Communication Analysis and Technologies Research groups. More precisely, I was responsible for analyzing the components of the system and their interaction with each other, as well as deciding on the most suitable technologies for each one of them.

From the third sprint, I started working on the implementation of the Authentication Module and the User Database. Furthermore, I joined the Client Application group by generating the functions which established communication between the application and the aforementioned modules.

For the fourth sprint, I implemented the server functionality of the Route Generator. In this way, every component of the system could make requests to this module regarding locations,

routes, or bus stops, and utilize the features of OpenStreetMap. Apart from this, I continued working on the Client Application by introducing asynchronous tasks for the interaction with the Authentication Module. In addition, I contributed to the Notification System by establishing communication between the the Client Application, the Authentication Module, and the Google Cloud Messaging Service.

In the fifth sprint, I joined the Route Administrator team so as to create a server for handling requests from the Vehicle Application. Apart from implementing the corresponding functionality of the Vehicle Application and working on the Vehicle Database, I also participated in the redesigning process of the System Database.

Finally, during the last weeks of the project I offered my support to the designing of the Background Monitoring System and dealt with testing, debugging, and code cleanup tasks.

Chao Cai

I started the project with working on use cases, I have designed the use cases in different scenarios, and we have finalised the use cases with stakeholder. After that I was working on the design group of vehicle App, I was involved in designing the vehicle App's functions according to the use cases, and designed the interfaces.

From the third sprint, I was working on the Android team, which is for the coding part of the Client App. I have implemented several interfaces and their functions such as registration, trip booking, Google log in. Then I was in the vehicle App team, and I have integrated the Uppsala's Map on the vehicle App.

On the fourth sprint, I started working on the simulator, I have written the codes for data generation, designed the data distribution and vehicle visualisation. On the meantime, I was involved in the LookAhead team, and worked on the balancing of number of trips and average waiting time.

From the sixth sprint, I was also involved in the climate information. I was working on retrieving climate information from the internet, and makes them available for the vehicle App.

Ilyass Garara

Having been elected as the substitute Scrum master, I acted as such for several weeks midway through the semester. Since my tenure as the Scrum master coincided with the mid-semester presentation at Ericsson, my main task was to ensure that we had a fully-working prototype for the Client Application, which we later presented to the attendance for hands-on experience. I was also chosen as one of the three presenters and collected some feedback from those who tested the application.

As for the project itself, the objective behind the first two sprints were to design a strong and reliable system that could be exploited by two Android applications. I was responsible for designing the Android applications, but I also actively contributed to the design of several other modules at the back-end (e.g. Databases, Route Generator, Travel Planner) later on. My first objective for the Android applications was to prepare an interactive user interface prototype that contains all of the designed activities and animations. The next step was to implement the functionalities that are used for user interaction and data display. For example, I implemented the RecyclerView classes in the Client Application, and the live updates that display the name of the next bus stop on the map, as well as the distance and time left to reach it.

Later during the project, I also worked in pair on a case study to use Background Monitoring on the project, which allowed us to proceed with the Geofencing approach. I finally spent the last days cleaning the code of the Android applications and fixing most of the compatibility issues and warnings that came up when building the applications.

Charalampos Georgiadis

Throughout the whole semester, working on the MoNAD project and following the Scrum methodology, I was involved in many different modules and parts of the system. I was responsible for researching and deciding about potential choices for database technologies, I was highly involved in the design of the databases and often created scripts for populating them. I was also involved (to a more limited extent though), with researching on the functionality of the LookAhead function and potential technologies and possible use of background monitoring for our system's functionality.

The task I was mostly involved, however, was the implementation of a recommender system. There I was responsible for developing an algorithm that would retrieve information from the database, regarding past requests for every user and the current timetable, then properly process and prepare the data for the use of a clustering algorithm that groups the users' past requests into habits and can suggest back future trips based on each user's past behavior.

Nicholas Got

During the initial phase of the project, I was tasked with coming up with a Git workflow for pushing code changes to the project repository on GitHub. Two approaches were suggested, with most team members preferring to push directly to the Development branch of the repository as opposed to using pull requests as a means of enforcing code reviews.

In the successive sprints, I worked exclusively on the LookAhead module - starting with research into which of Particle Swarm Optimisation, Genetic Algorithms and other optimisation techniques would be most suitable in solving the bus scheduling problem. As it enabled rapid prototyping, the team chose Genetic Algorithms approach and I was consequently involved in the formulation of an encoding for candidate solutions (individuals in the population) and implementing the fitness function using DEAP framework.

The rest of my work consisted of iteratively testing the system after enhancements/changes to determine how good the resulting timetables were.

Christopher Hollmann

During the first 2.5 months of the project I served as the teams Scrum-Master. My tasks here were to conduct the Scrum meetings and keep the Scrum board up-to-date. Furthermore, I was asked to keep the teams work coherent to the Scrum framework. Especially during the design phase of the project the team had many necessary discussions which I was allowed to moderate. I also helped to represent our project to different sides, for example in a presentation for Bachelor students and to the administrative side of the university.

On the technical side of the project I was early on involved in the research and decision on what technologies to use. After the design phase was over I chose to get involved with the backend.

The component I spent most of my time working on was the Travel Planner. The first task was to design the module. Afterwards I implemented and tested this part of the system, trying to get the best possible performance out of it. Another part related to the Travel Planner which I helped execute was the integration with the RequestHandler. Furthermore, I helped designing both the Notification and Feedback System.

Tingwei Huang

In this project I worked mainly on the Database design, Simulator and Look Ahead modules. At the beginning of the project, we discussed with other members and wrote the project's use cases. In sprint 2, I was in Database design group and tasked with designing the database which is used to store all the information except the customers. I read through the project specification and system design, considered features of this project and designed the draft of the database in MongoDB. Having discussed with the whole team and tested the first version of the database, we settled on a design which used for the whole life cycle of the project. From sprint 3 and on, I devoted half of my time on the Simulator module. Firstly I did some research on the simulator platform. Then I designed the architecture of the simulator and the interface between the simulator and the Request Handler. I implemented the framework of the simulator and improved that by adding support for new requests from the other modules like Request Handler and Look Ahead. The data generated by the simulator have started to serve for Look Ahead from sprint 5. Meanwhile, I was in the Look Ahead group, and one of my tasks in this group was to make the simulator's data work correctly with the Look Ahead module. And I also implemented functions to improve the fitness function in order to consider both the user's waiting time and the bus company's cost. After that I worked on translating the output of the Genetic Algorithm into timetables and bus trips and write that into database. Finally, I introduced graph theory to make the Uppsala city's route directed graph for the dynamic routes which is the last part of the application that we researched.

Charalampos Gavriil Kominos

In our first meeting I was elected spokesperson and I remained for the duration of the project. That meant that I had to organize the communication between Ericsson, the supervisors

and the team. My tasks were, to make sure that all the teams needs are met and that all the requests from the team and from Ericsson are forwarded to the right people. I also created slides and presented our project to the Bachelor Students with the help of Christopher Hollmann. On the technical side, in the first sprints I was mostly involved with SysAdmin tasks. I setup and maintained the Jenkins-CI server of our application and also set up the VPN with Ericsson. For the next sprint I helped the database team in their first attempts at designing and building the database. Then for the next sprints I worked on the GCM-Notification System for the Vehicle-app, the Client-app and their integration with the request handler system.

Jasmin Laroche

Throughout the project, I have been involved in various tasks of the project. For the first two sprints I worked use cases of the project and in addition to this I worked with the designing of the vehicle app. I also worked with user interface team group to design the look of the pages. I also worked in designing of interactive prototype of client app for which I went to understand the concept of material design and then I also wrote the coding conventions for programming during 1st sprint.

In the 3rd sprint I also worked with the feedback module which is about receiving feedback from client about his journey and storing it into database. In this module of feedback I went through the python and also used pymongo database. It is used to connect python and store the feedbacks given by user.

From the fourth sprint I was part of look ahead module and I learnt some machine learning concepts and went through the Genetic algorithm as well to implement dynamic timetables. From the fifth sprint I started working on the notification module in the client app that is implemented using GCM technology. Then I also worked in implementing the notification system in the vehicle app. I also implemented the functionalities in the vehicle app. I also coded the interface design of the vehicle app showing the list of bus stops, Emergency notification which was first hardcoded i.e static and then done it dynamically as to fetch the data directly from the database.

Malin Lindvall

In the first sprint, I contributed to the design of the Client Application. The pages I designed include: the Route Activity, Trip Confirmation Pop-up, Trips Activity, and Trip Cancellation Pop-up. I also designed the Trip Confirmation Activity, which has since been removed. In order to design the application, I learned about Material Design, the latest style used when designing applications. During the second sprint, I joined the Look Ahead team in order to define the initial requirements and responsibilities of the Look Ahead module.

During the third and fourth sprints, I was a member of the Client Application team. First, I coded the interface of the application. The activities I mainly worked on included the Trips Activity, Trip Cancel Pop-up, Route Success, Route-Confirm Pop up, Route Activity, Notifications Activity. Next, we focused on making the application dynamic. Previously, all the information being displayed was hard-coded. Programmatically changing the information required many alterations. Part of this sprint was dedicated to learning about the RecyclerView, a view used in order to allow flexibility. The RecyclerView is now used throughout the Client Application in order to create dynamic lists with items that can easily be added and deleted.

In fifth sprint, I joined the Route Administrator team. During this time, I learned Erlang and Python concepts in order to allow communication between the System Database and the applications. Allowing communication between the database and applications presented many opportunities for improving the application, such as creating and sending notifications when the user has booked a trip. The connection also presented some problems with the original MongoDB design, so I contributed to a different design of the System Database. Changing the design of the database was time-consuming but allowed for flexibility within the system. I also worked on Background Monitoring, where we worked on specification, design, and implementation of geofences in order to determine which users are travelling via bus without making a request.

Daniel Llatas Spiers

My contribution on this project started setting up test server and working on the component communication analysis. The first task consisted mainly on installation of mongoDB and

MySQL on the test server, and made them available for everybody on the office. This also included to write a tutorial on how to install a mongoDB client. This task turned out to be very important on the long run since the access to the cloud was not provided by Ericsson on the time it was originally expected. The component communication analysis was more aimed to create a document that can be referred as the guideline during MoNAD'S implementation on how each module should talk to each other.

Finally, I enrolled into Look Ahead team. First weeks were spent into really long discussions about designing the experiment. During this stage, problem overlapping give us more than a headache. However, at some point, it was decided to tackle the scheduling problem first (leaving for later generation of dinamyc routes and bus allocation). After that, the team started to work on implementation. During this stage, I focused mainly on generating initial population and implementing the fitness function. A main challenge was to integrate fitness function with mongoDB database. After first results were obtained, we moved into optimizing the code. On - memory indexing is an idea I had in order to avoid linear search over daily requests. I was really happy when it was implemented and it reduced the experiment execution time. Also, I was chosen by my class mates to present the Look Ahead module during Ericsson interview, which was a big joy for me. I devoted the last sprint working on including the effect of weather conditions on the time table. Integration with a weather service allowed us to modify the trip frequency for particular hours on the time table.

Mavrakis Stavros

During the first part of the project I wrote the general Coding Conventions document and presented it to everyone; for some of the controversial coding standards I suggested a couple of options and we all decided together on one format. Additionally, I worked on the Component Communication Diagram that helped the team members understand how each module communicates with the others and clarify any questions. Harrys and I also set up and configured Jenkins CI to meet the continuous integration and testing needs of the system.

Then, I was responsible for setting up, configuring, implementing and testing the Request Handler. I did research on various server frameworks compatible with our choice of database and singled out the best one considering factors such as performance, scalability, security, and

ability to handle many requests at the same time. I configured the servers according to our needs and ran extensive tests after implementing a prototype to determine whether they were performing in line with our expectations.

I was also part of the Client Application team; I worked on many of the functions, including all communication with the Request Handler, location and background monitoring service, user permission handling, trip searching, booking, canceling bookings and feedback. I wrote the functions connecting the Client Application to the servers over HTTP POST requests and parsing the replies sent in return. I implemented the logic behind most of the main features of the application (e.g. advanced search, quick search, etc.) and the GPS location service as well.

Madhuri Pullambaku

First Sprint: I worked on designing Client Application. I design the pages Log In Activity, Search and Advance Search Activity, Registration Activity, Menu Activity, And i also designed forgot passwords with few steps. Second Sprint: I joined the Component Communication Analysis and designed communication between the components. Third Sprint: I contributed to the interactive prototype of the Client App and vehicle app, i coded the interface of the client application. The Activities i implemented like Login, Notifications, Registration, Forgot password with pop-up. Next we want to make application dynamic for this we learned RecyclerView,a view used in order to allow flexibility. In this sprint I also participated in coding Vehicle app interface. Fourth Sprint: I joined the Look ahead team and discussed and learned about the genetic algorithm how it works and some concepts in machine learning inorder to implement dynamic timetables. And i worked with sequence diagram to make easy to know how the process works. And also in this sprint i worked with feedback module design and implementation. For the implementation of feedback module i learned about mongodb how to connect to python and store the data, and python language to implement the feedback module. Fifth Sprint: In this Sprint i worked with android functionality of buttons like google log in,differnt menu when user login with google+, implemented home button for each activity.And worked with notification activity to display on toolbar and navigate to the particular notification. And also worked with storing and updating the notifications. Sixth Sprint: I participated in vehicle app simulator, And also connect feedback module to Notification System to Notify the user about feedback 30sec of destination time.

Mohamed-Redha Redjimi

During the project's development, I have been involved in different areas. The first sprint I was in the use cases group. I had to imagine all possible scenarios to list as accurately as possible the project's requirements.

The second sprint I was in the LookAhead team. Our goal was to understand the LookAhead module, how it works. It was very hard to get a final idea of this module, especially because the requirements about this module were not very clear. It took actually two or three sprint to finally have a common understanding among the team and with Ericsson.

The third sprint, I was in the Database Prototype team. Our goal was to design a prototype of the different databases. After having decided about the technologies for the databases that is MySQL for the user database and MongoDB for saving routes, requests and recommendations; I designed each database.

The last sprints, I was member of the Travel Recommendation team. I was charged with designing the Travel Recommendation module that is reflecting on how to propose recommendations. We have chosen a specific approach. To create the recommendations we analyze the users' requests with Spark. We use the Kmeans algorithm to create clusters, and we compare the results with the timetables to send accurate recommendations to users.

At the end, but I have not finished this part because of a lack of time, I tried to use feedback in order to improve the accuracy of the recommendations, by using Regression to try to deduce a relation between the feedback and some parameters of our recommendation algorithm.

Jens Rosén

During the project I have mostly worked on the backend with the Look Ahead Module and the Route Generator. Thought, during the first sprint, I spent most of my time with the design of the prototype for the android application, and understanding the specification and requirements of the project as a whole. For the design I mainly worked on the Notification page and the Bookings page, using the Google material design principles.

The second sprint was spent on researching, designing, and discussing the functionality of the

Look Ahead module. Throughout the third sprint, I spent my time researching how we could use the data from OpenStreetMap, regarding pathfinding, bus stops, and other tasks considering geodata. I also looked into search algorithms that could be used.

During the fourth sprint I continued to work with the OpenStreetMap data and I joined the Look Ahead team again. For the Route Generator module, I wrote a python program to parse the OpenStreetMap xml data, implemented a first version of the A* search algorithm, and started to implement other basic functionality. I also read up on DEAP and looked into how to generate the initial population for the Look Ahead.

For the rest of the sprints I worked with both the Route Generator and Look Ahead module in parallel. Some time when into updating the missing values in the map, e.g. missing bus stop names. But, the main effort when into the Route Generator, that was implemented as a server that could receive HTTP requests from the other modules. The A* search algorithm was improved to be more accurate. I also implemented an algorithm to link all the bus stops together to form the bus network.

Yonatan Kebede Serbessa

Throughout the project, I have participated in different tasks in the sprints that we have had. Initially for the first three sprints, I was involved in designing different use cases and their descriptions which were later used in the design prototype of the client and vehicle applications. And then I was part of component communication analysis team whose task was to design as to how the different modules of the application communicate with each other. Then I have participated in Android interactive prototype implementation where my tasks start with designing part of class diagrams for the application. Then I studied about android implementation and material design and start coding the graphical interface for different activities such as the Trips Activity and Trips Confirmation Popup which later were updated in more dynamic way in next sprints. And I also coded for the Profile and the About Us activity.

In sprint 4, I continued in the android team for short while where I coded the alert fragment interface. Apart from this, I joined the Travel Recommendation team in which the first tasks were researching on different kinds of recommender systems. And for the next sprint, I continued in the same team, studied and start using Apache Spark. I worked in pair programming

with other team members. I also researched on to use mongoDB Hadoop Connector, which allows using mongoDB with spark.

During last sprints, I joined vehicle application team and coded a function to calculate the remaining distance from the current location to the next bus stop location for the vehicle. I also pair programmed and debug for the time calculation function.

Huijie Shen

Throughout the project, I have participated in different tasks and modules. In the first sprint, I looked into, as well as presented different platforms for data streaming and batch processing, which will possibly be used in later sprint. I also looked at data serialization technologies. This might be useful in communication between modules written in different languages, but eventually it was not used in the project. In the second sprint, I researched more deeply in data streaming and batch processing, and discussed with my teammates about how they can be used in the project and the interface for other modules. In the third sprint, I investigated the difficulty of applying OpenStreetMap in the Vehicle application. More specifically, I investigated which third-party library meets the requirement of map rendering and has enough instructions and samples to follow. Mapforge was selected at the end. In the fourth sprint, I worked on the Vehicle application with my teammates. My main contribution was integrating OpenStreetMap into the Vehicle application, and finding a way to generate the Uppsala map file with small size.

From the fifth sprint, I were mainly devoted to the development of both the Client application and the Vehicle application. I worked on many functions in the Client application, including user login, registration, profile update, password resetting and update, activity lifecycle management, activity back stack management, profile cleanup after logout, Chinese translation, notification for upcoming recommendations, etc. Also, I worked tightly with teammates in other modules, for example, Authentication Module, Request Handler, Travel Recommendation, etc. After the midterm presentation, I also spared some effort to the Vehicle application, and my main contribution was manual simulation of bus move on the interface of the Vehicle application.

Fatemeh Shirazi Nasab

In this project, I contributed to different parts of project. At the beginning, I worked with user interface group and in a small team we designed the Login and Register pages.

The next sprint, I worked on communication analysis part in a small team. I have used UMLstar to illustrate communication between different modules in sequence diagrams both for Vehicle Application and Client Application. Besides analyzing part, I was also working on design and basic implementation of Feedback module as well. For basic implementation I learned Pymongo, MongoDB and Python. During this sprint I have also participate in Look Ahead group's meeting to learn more about the functionality of this module and know how they use APIs to implement Genetic Algorithm.

After that, I joined the Simulator group. I studied existed documentation about Gama Platform and gml programming and then started to implement Client application Simulator with my teammates. I used MYSQL to save information about bus stops and giving weight to them to implement Hot_Bus_Stops. I also worked on simulating weekend requests and visualization the graphs and movement bus on the road as well. Java programming to communicate between Simulatore and Request Handler was another task that I involved in.

During the last sprints, I learned about how to get online traffic data in order to show them on the vehicle application and implementing this part by using Python.

Ziring Tawifque

Starting with the first sprint, I was in charge of creating a shared folder that was to be used through out the project. I created a Google Drive shared folder as well as an local area network shared folder in the server. The LAN shared folder was to only contain confidential information such as database password. I was also working in the system analysis and design team to create several use cases and use case descriptions. At the same time I was working parallel with the prototype design team in order to include the appropriate use cases when design the paper prototype for the Android applications.

In sprint 2, I spent most of my time doing a component communication analysis of the entire

system. Each module of the system was carefully analyzed and the input and output of each was determined and documented.

For sprint 3, I joined the Look Ahead team to design the genetic algorithm for finding the optimized timetable. I read several research papers that tried to tackle similar problems. I was part of designing the first version of the encoding of the individual. I also spent some time looking at python tutorials and how to use DEAP, the machine learning library for evolutionary algorithms.

By sprint 4, I was still working on the Look Ahead module and a first design of the genetic algorithm was completed. The initial population was created using DEAP and python. I was involved in designing and implementing the first version of the fitness function, cross over and mutation operations.

In sprint 5, the Look Ahead module was extend and redesigned to consider multiple lines because initially we started to only work with a single line. We noticed that this would make the length of the encoding of the individual very long which in turn would slow down the genetic algorithm. We came up with a new format of the individuals which restricted the length of the encoding to the number of time slices and number of bus lines. I was part of implementing this new approach and adjusting the fitness function to the new individuals. For the next two sprints I spent most of the time trying to improve the Look Ahead module by improving the fitness function to be more intelligent when calculating the average waiting time of a timetable. I also spend some time working with the background monitoring team on the input data and writing the final report.