Dependable Edge Computing Project Plan EH2760 Management of Projects

Zekun Du, Yulan Shen, Rui Chen, and Tian Xu

1 Background

The development of artificial intelligence(AI) brings autonomous vehicle into reality. However, recently review on automated vehicles [4] pointed out that navigation in urban dynamic environments is still a challenging task. This task is referred as motion planning, which need to introduce information provided from other vehicles as well as global information of urban area. Because of the needing of those information, it is reasonable that centralizing vehicles' planning into cloud sever and managing from urban aspect (i.e. urban traffic management [5]).

However, for autonomous vehicle, a rigid real-time restrict of data processing need to be satisfied. Generally one Gigabyte data has to be processed in one seconds so that a reliable decision can be made [2]. A planning service running on cloud sever with un-predicted round-trip time(RTT) is not feasible. Thus, a computing service provided between data-source and cloud data center, i.e. edge computing [7], need to be introduced in that it can minimize latency [6]. In autonomous vehicle scenario, edge computing service could provided as a cloudlet [3].

Comparing with other mobile applications based on edge computing, planning or traffic management of vehicle need to be more dependable. Thus a secure and dependable frame(e.g. SCOTT [1]) need to be introduced. Combination of dependable edge computing frame and autonomous vehicles motivates this project.

2 Goals

Project Goal: The goal of this project is constructing a basic framework of autonomous vehicles which can be controlled by centralized traffic management and has real-time reaction of accident based on dependable edge computing architecture SCOTT [1], as well as a demonstration which could represent basic functions of the framework. The goal can be decomposed as following sub-goals:

- Two model vehicles with sensors which can provide sufficient information (i.e. RGBD image of surrounding environment, current position and speed) for traffic management and real-time reaction. Deadline: 2018-10-15.

- An edge server constructed as a docker image which can make correct decision for accident within real-time constrain by given information from vehicle. A minimized test cases include simulated road environment with and without unexpected barricade should also be provided. Function is provided as application program interface (API). Deadline: 2018-10-26

- A planner based on SCOTT and Planning Domain Definition Language (PDDL), which can provide correct plan(i.e. a path between two points) by given a problem file. It is constructed as a docker image. Test cases that include navigation problems between two locations should also be provided. Function is provided as API. Deadline: 2018-10-15

- A dashboard constructed as a docker image which can indicate planned path. Test cases that include arbitrary planned path formed as text file should also be provided. Communication provided by interface based on IP/TCP. Deadline: 2018-11-08

- A use case which include roads, two vehicles and accidents which can represent the function of planner, model vehicles, and edge server respectively. Deadline: 2018-11-11

Business Goal Because physical resource(model vehicles) are borrowed from ITRL Lab, only working hours are counted.

- Budget: Project should not exceed 34,000 SEK (calculated as 8,500 SEK/person).

- Expect Outcome: 4.5 CETS obtained from prototype and final presentation section in MF2063 Embedded Systems Design Project.

3 Organization

3.1 Zekun Du <zekund@kth.se>

He is responsible for researches on edge computing and basic algorithms that is used in this project. He is also responsible for part of software part, like building the visual dashboard to monitor the situation. He checks documentation work, mostly its quality and if it is on schedule.

3.2 Yulan Shen <yulans@kth.se>

She is responsible for part of communication between our team and other professionals. She is also responsible for getting collected data from ITRL. She is also responsible for communication system building between vehicles and edges.

3.3 Rui Chen <ruich@kth.se>

He is responsible for platform adaption, like getting familiar with Docker of the given sample project. He is responsible for part of software like learning ROS and adapt it into our project.

3.4 Tian Xu <tianxu@kth.se>

He is responsible for part of communication between our team and other professionals. He is also responsible for getting to know the feature of our hardware (the vehicle) and the components on it.

4 Project Model

The project is departed into several parts with their responsible persons and their acceptance responsible persons. Details are included in the table 1.

Table 1: Project model

Project Phase	**Milestone**	**Tollgate**	**Ready date**	**Responsible**
Project structure	Meeting planned		2018-09-13	Zekun Du
		Meeting, project structure determined	2018-09-17	Fredrik Asplund
Meeting with ITRL	Meeting planned		2018-09-18	Tian Xu
		Vehicle sensing data promised	2018-09-24	Frank Jiang
Project detail	Meeting planned		2018-09-19	Yulan Shen
		Structure and detail determined	2018-09-27	Andrii Berezovskyi
Wishlist delivery	Wishlist submitted		2018-09-25	Zekun Du
		Wishlist talked on design review #1	2018-10-04	Fredrik Asplund
Planning	Project plan submitted		2018-10-10	Zekun Du
		Project plan approved	2018-10-14	Fredrik Asplund
Hardware platform	Meeting		2018-10-10	Yulan Shen
		Hardware selected and tested	2018-10-15	Yulan Shen
Autonomous system	Meeting and discussion		2018-10-10	Rui Chen
		Planner made	2018-10-15	Tian Xu
		Edge built	2018-10-26	Rui Chen
		Visualization achieved	2018-11-08	Zekun Du
Demonstration	Testing a use case		2018-11-11	Rui Chen
		Demo accepted	2018-12-01	Fredrik Asplund
Documentation	report submitted		2018-12-11	Zekun Du
		Accepted	2018-12-15	Fredrik Asplund

5 Commentary on Time and Resource Plan

The project is built within the general limits of Course EH2760. Each students plan to work 160h in total during the project. The planned cost is 400 SEK/(h * person). We will charge our client at the price of 500 SEK/(h * person). We assume we have sold our project at the price of SEK 340,000. Therefore, our project can stay within the budget.

We evenly distribute our working hour so that we can have reasonable workload. At the preparation stage, the first month, we have relatively low workload. More time will be planned for the project as the project goes further.

There are some uncertain things in the plan. Rui Chen will have an exam on 24th Oct. Then he would probably not dedicate to the program during the week before the exam. Tian Xu may have an exam sometime in December. The exact date haven't been decided yet. Yulan Shen may have a vocation during 20th to 23th Oct.

6 Risk Analysis

Possible risks are listed in Table 2. These risks are evaluated using criteria of P, C, and R. P refers to probability, ranging from 1 to 4, where 1 means least likely to happen and 4 means most likely to happen. C refers to consequence, ranging from 1 to 4, where 1 means minor consequence and 4 means severe consequence. R refers to risk value. It is the product of P and C.

In the risk table, risk Nr.1-5 are project management risks. Risk Nr.6 and Nr.7 are external tasks. The other risks are technical risks.

Actions to take are list in Table 3. These actions correspond to the risks listed in Table 2. The responsible staff and starting date are defined. The team is divided into two groups. Zekun Du and Yulan Shen are G1. Rui Chen and Tian Xu are G2.

Table 2: Risk definition and evaluation

Nr	**Risk**	**P**	**C**	**R**
1	Lack of communication between project members leading to inefficiency and wrong decision making.	3	2	6
2	The project requires too much work but we only have four people.	2	2	4
3	Cooperation on the same task leads to unexpected modification on documents/codes	3	2	6
4	High coupling between tasks leads to long critical path, and finally increase project duration.	3	3	9
5	The ITRL lab cannot provide the data that we needs or the data is not the same as what we expected.	2	3	6
6	The hardware that we purchase takes too long time to ship.	1	3	3
7	The Edge Device we select is not eligible to execute the fleet management and give a correct result as a control strategy.	1	4	4
8	The versions of Linux, docker, ROS and other software that we will use conflict with each other.	2	3	6
9	Conflicts and misoperations may happen when transferring the data generated by the device.	3	4	12
10	Information transmission latency among gateways because it depends on 4G or Wi-Fi connection. This will limit the quality of our project.	2	2	8

Table 3: Action list

Nr	Action	Expected outcome	Respon-sible	Ready date
1	Plan meetings regularly, preferably twice a week. [Proactive]	The group members communicate with each other on the meeting. The whole group is working in a cooperative environment.	G1,G2	October
2	Prioritize the tasks and focus on the tasks with highest priority. [Proactive]	We set proper goals so that everyone has reasonable workload.	G1,G2	October
3	Use version control tools (e.g. git) and merge modifications when all participants agree. [Proactive]	Documents and codes would be modified in controlled environment, and can be rolled back when necessary.	G1,G2	October
4	Define unified documents and stimulation environment and/or data for tasks as the first task. [Proactive]	Each task could be executed with simulation environment and data independently.	G1	October
5	Prepare backup plan of the vehicle from other groups(Prof Dejiu Chen's car). Get in contact with them if failure of ITRL's car happens. [Reactive]	If the vehicle is not capable to run planned function and we can not get expected data from ITRL lab, we can turn to our backup plan of the vehicle to make sure the edge and cloud system work properly.	G1,G2	October
6	Order the hardware right after we have decided which one to use or purchase it locally.[Proactive]	We try all of provided alternative vehicles and select the best ones.	G1,G2	October
7	Do precious research and make a clear requirement list and write them into document so that we can choose the proper edge device according to our requirement. [Proactive]	The edge device can carry out the tasks as we wish.	G1,G2	October
8	Read the tutorials of the softwares and learn successful cases to solve version conflicts. [Reactive]	The tools will be friendly and helpful to us.	G1	November
9	Backup the data every time after generating them and every time before transferring them. [Proactive]	Even if the data loss happened, we still have the data.	G2	November
10	Use as good network solution e.g purchase better router or use wired connection and put important jobs on the node (the car) not the cloud. [Proactive]	Important jobs can be strictly realtime.	G2	November

7 Document

Good communication management is at the core of every successful project. In this project, we regard team members as Internal, and our project manager and sponsors as External. For internal communication, which is horizontal, we use slack to share and review the reference and outcome online, and regularly have group meetings.

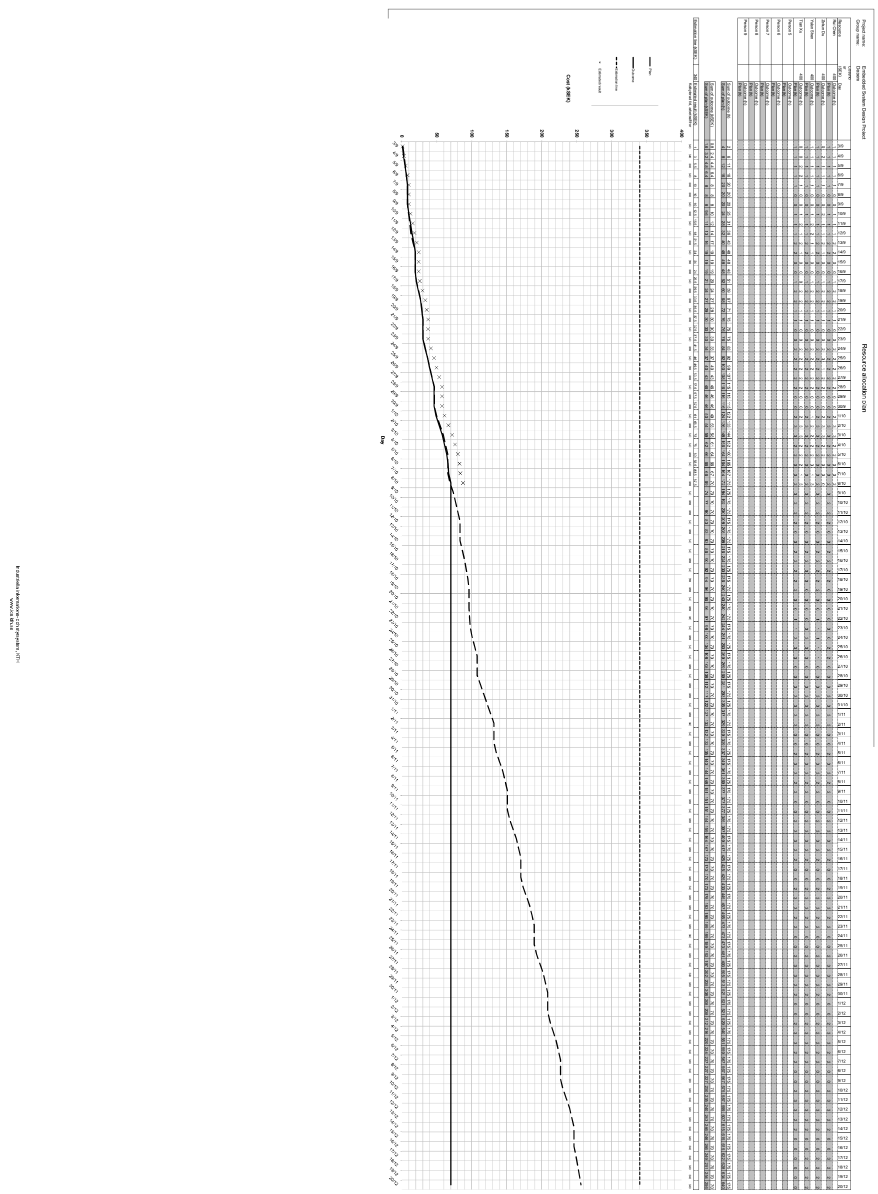
For external communication, which is vertical, we will formally document the encountered problems and discuss with our manager once a week at least. We also have different sponsors related to different stages (hardware or network), and at that time we tend to discuss with them more frequently so as to save time resource for both. Email and skype may be used for external communication.

In our project, "EdgeComputing_title_time_version" is used for report document naming. Engineering document is named as "functionFor_whichPart_time_version". Everyone is responsible for the backup, and all the files generated in the process will be uploaded to git hub.

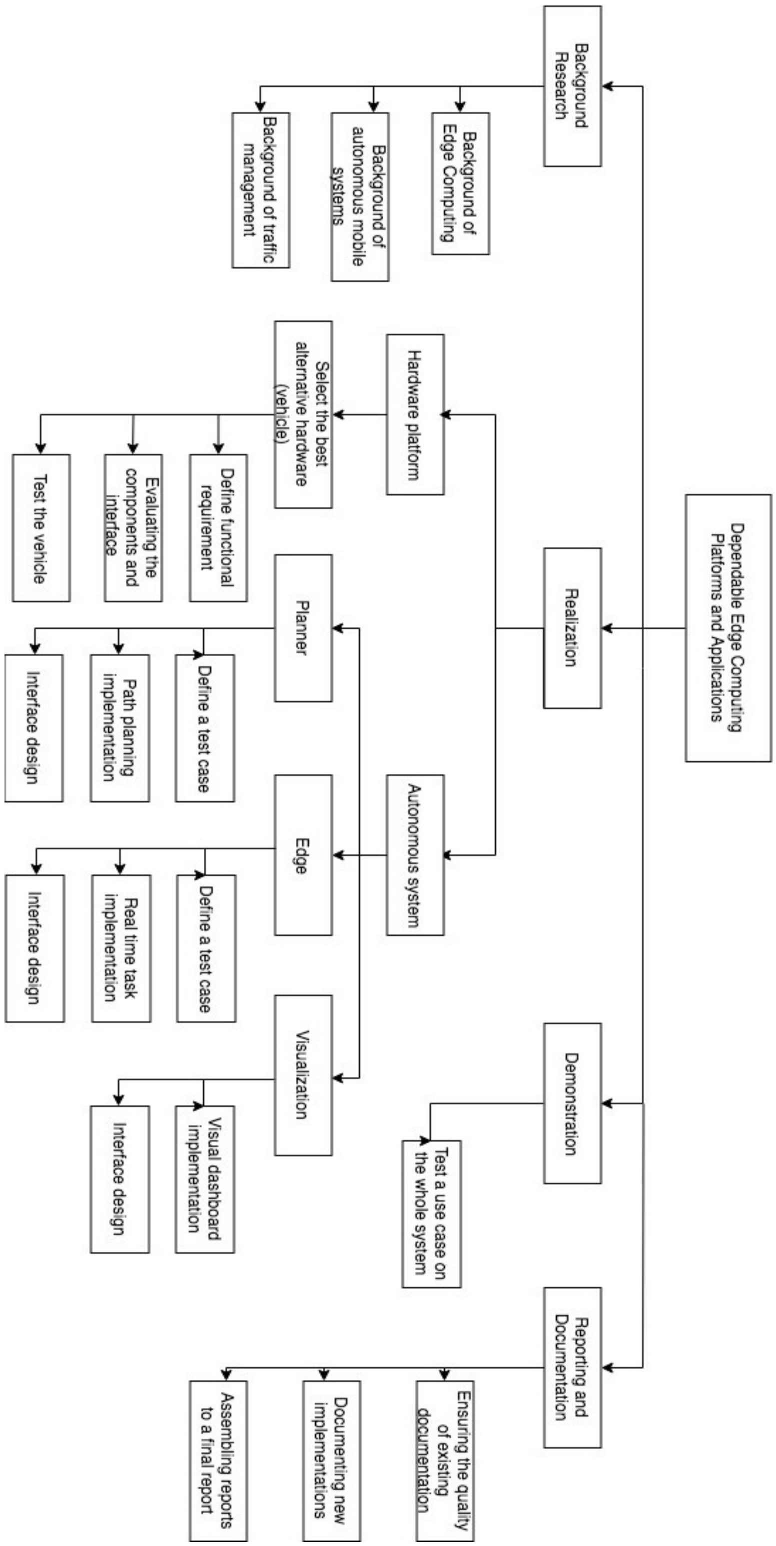
8 Appendix

8.1 Resource Allocation

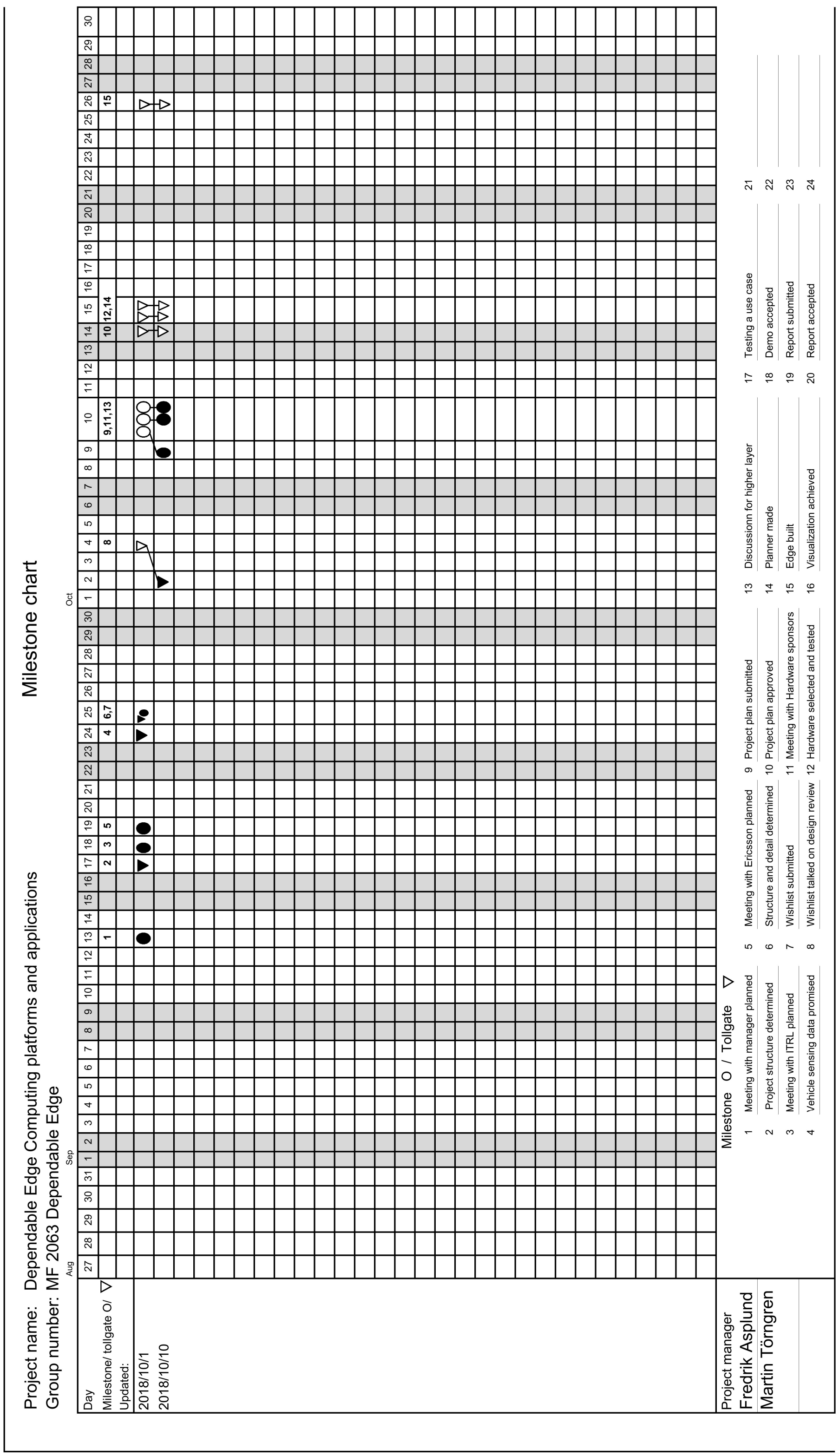
allocation.pdf



8.2 Work Breakdown Structure



8.3 Milestone Chart



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