HALMSTAD UNIVERSITY

Tollgate 1
System
Modeling

Design of Embedded and Intelligent Systems

Decision & Control in Pandemic Rescue using Semi-autonomous Platooning System

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INTRODUCTION

- Here, we will discuss about autonomous robots travelling a platoon in year 2040 in scenario of pandemic.
- We will discuss about the way the robots in platoon navigate and arrange themselves in platoon.
- The way, the regular vehicles in platoon react during intersections or in case of an emergency vehicle.

SENSORS AND ACTUATORS

ENCODERS:

- We use encoders to measure speed and distance travelled by the robot.

IR LIGHT SENSOR:

- To follow black tracks and detect intersections.
- It works by emitting a beam of Infrared lights down below surface and measure reflected signal.

CAMERA:

- We use it in platooning to follow a vehicle or detect obstacles or to detect the traffic lights.

ACCELEROMETER:

- It measures the acceleration of the robot. To tell whether the robot is on incline.

ULTRSONIC SENSOR:

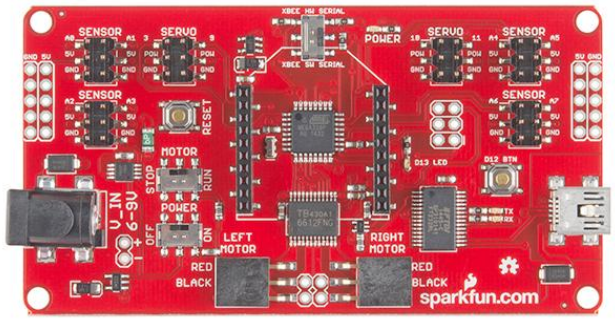
- To measure the distance to the object.

DC MOTOR:

- To rotate the wheels. It is important actuator in terrestrial robots.

CONTROLLER BOARDS

REDBOT MAINBOARD



RASPBERRY PI 4 MODEL-B

Types of vehicles:

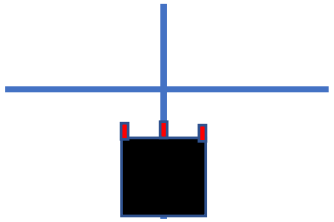
emergency (have a higher priority), regular (regular vehicles can assemble in platoons)

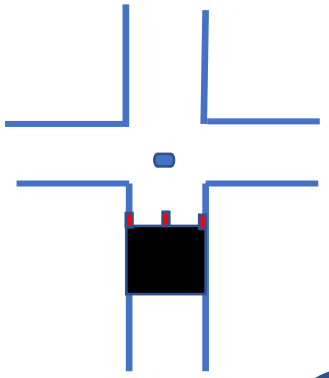
Types of markers:

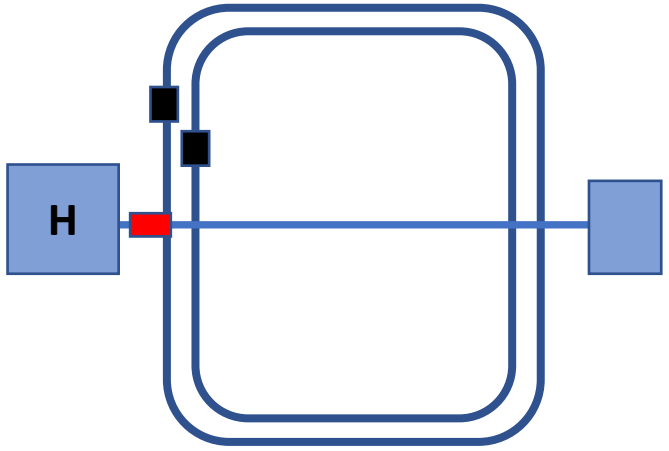
up – for central camera; backside – for platooning.

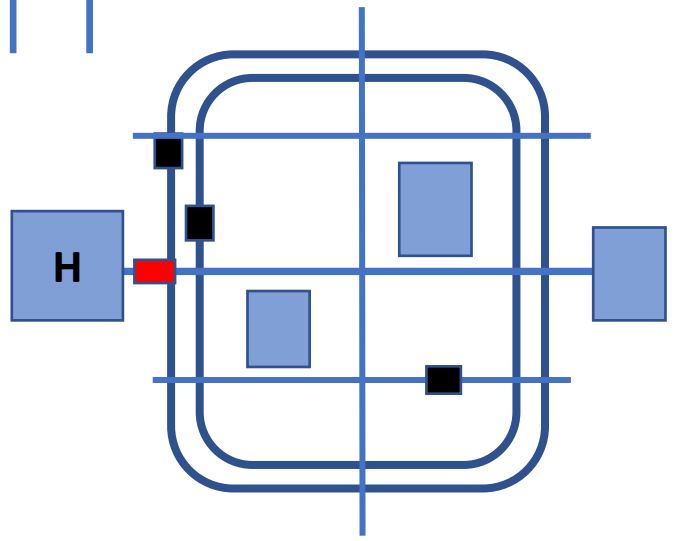
Types of obstacles: static; moving (vehicle in front, vehicle passing intersection)

Types of tracks:



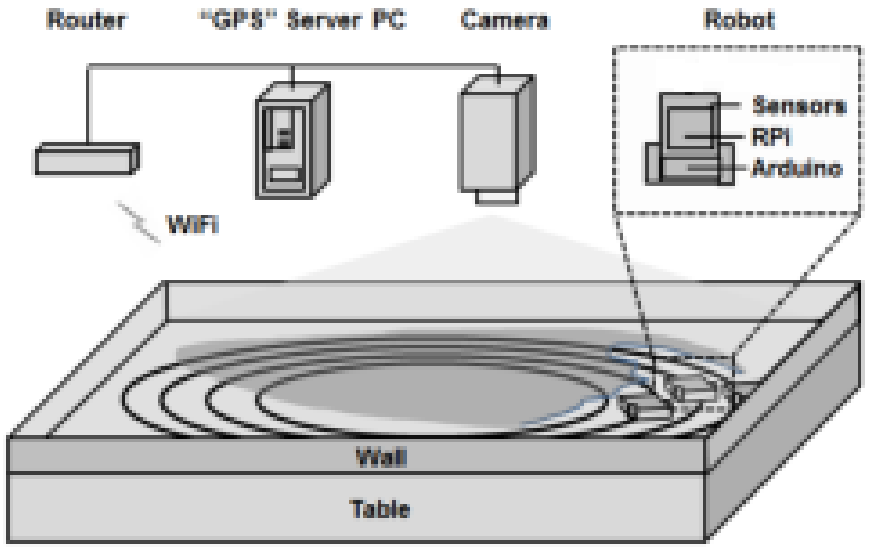




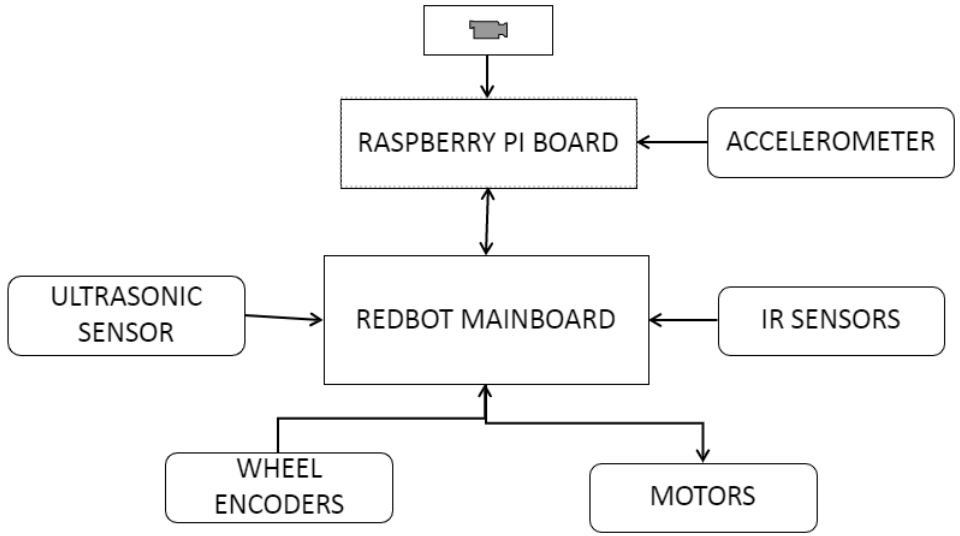


System Design and Architecture

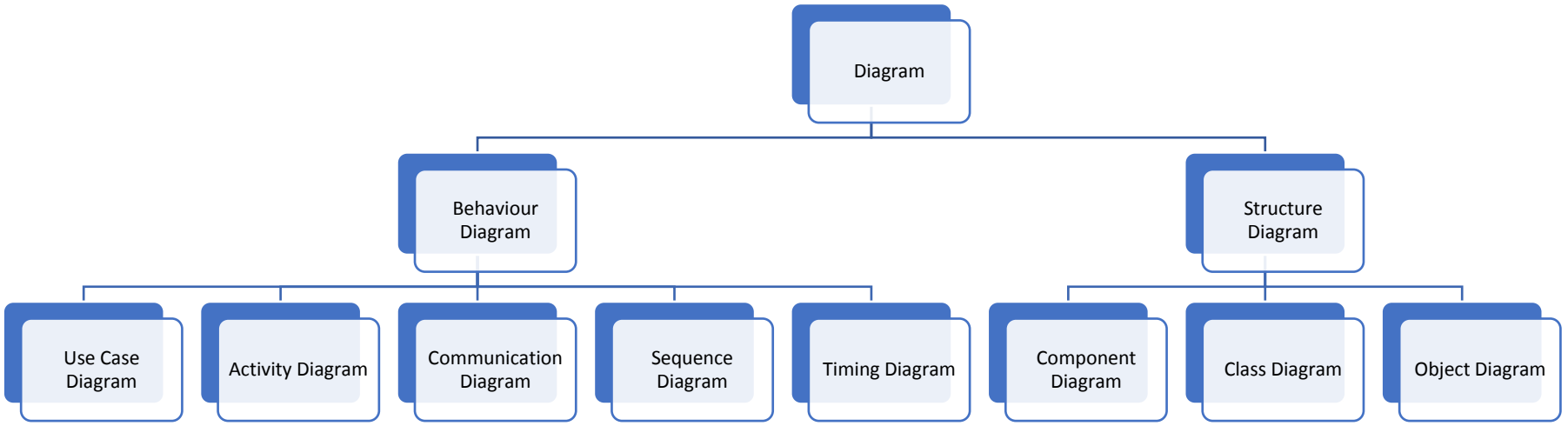
Basic Environmental Set-up



Robot Architecture



System UML Diagram



Avoiding collisions:

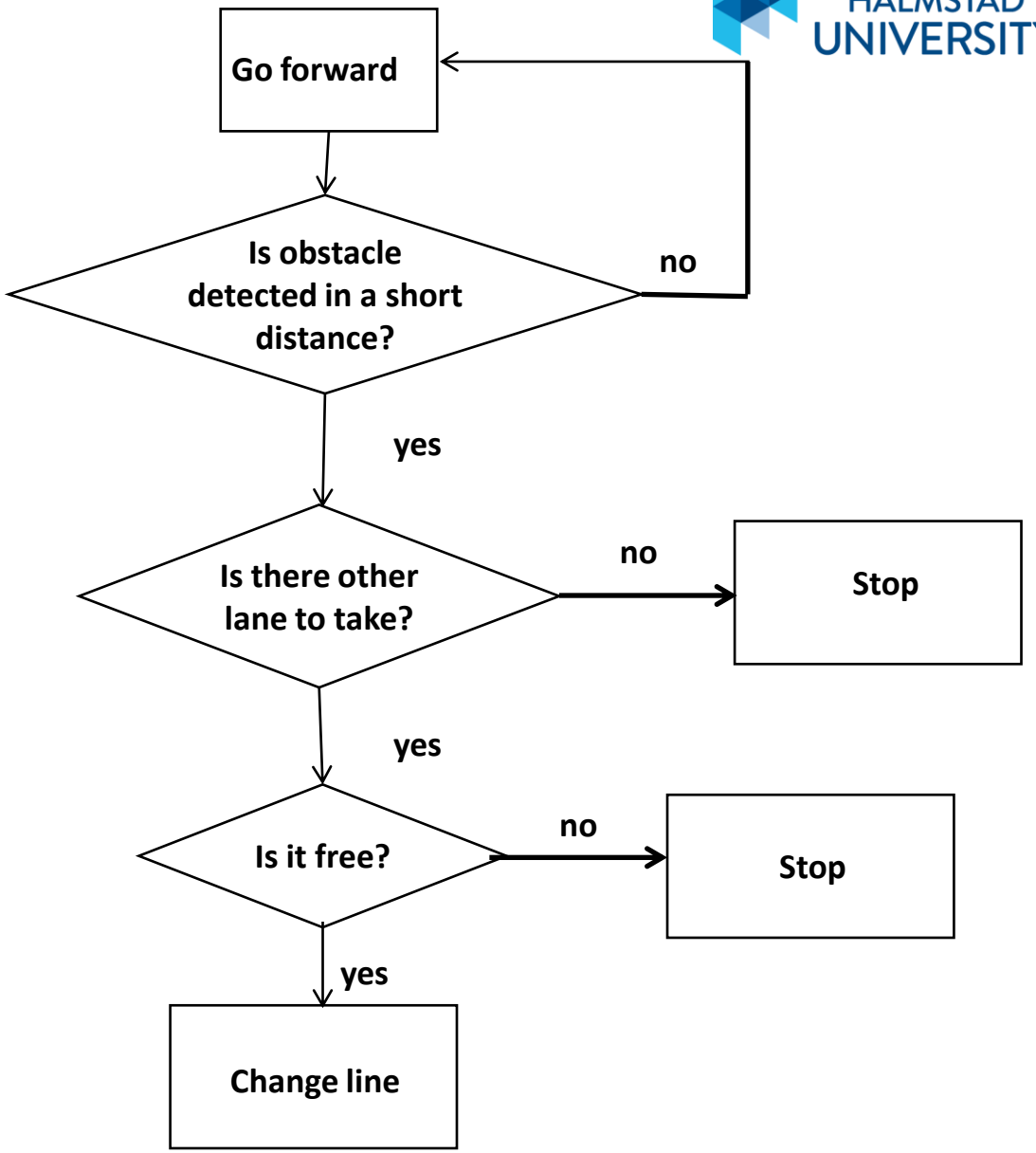
Avoid static obstacles – stop or change the line if possible (permission from the server/using side sensors)

Avoid moving obstacles –

accelerate or decelerate, stop, change lines or go to the side of the road (permission from the server) to avoid crash or give way to priority vehicle which is coming from behind or in an intersection;

react to traffic lights – green: maintain current speed;

red: stop, decelerate (adjust the speed).



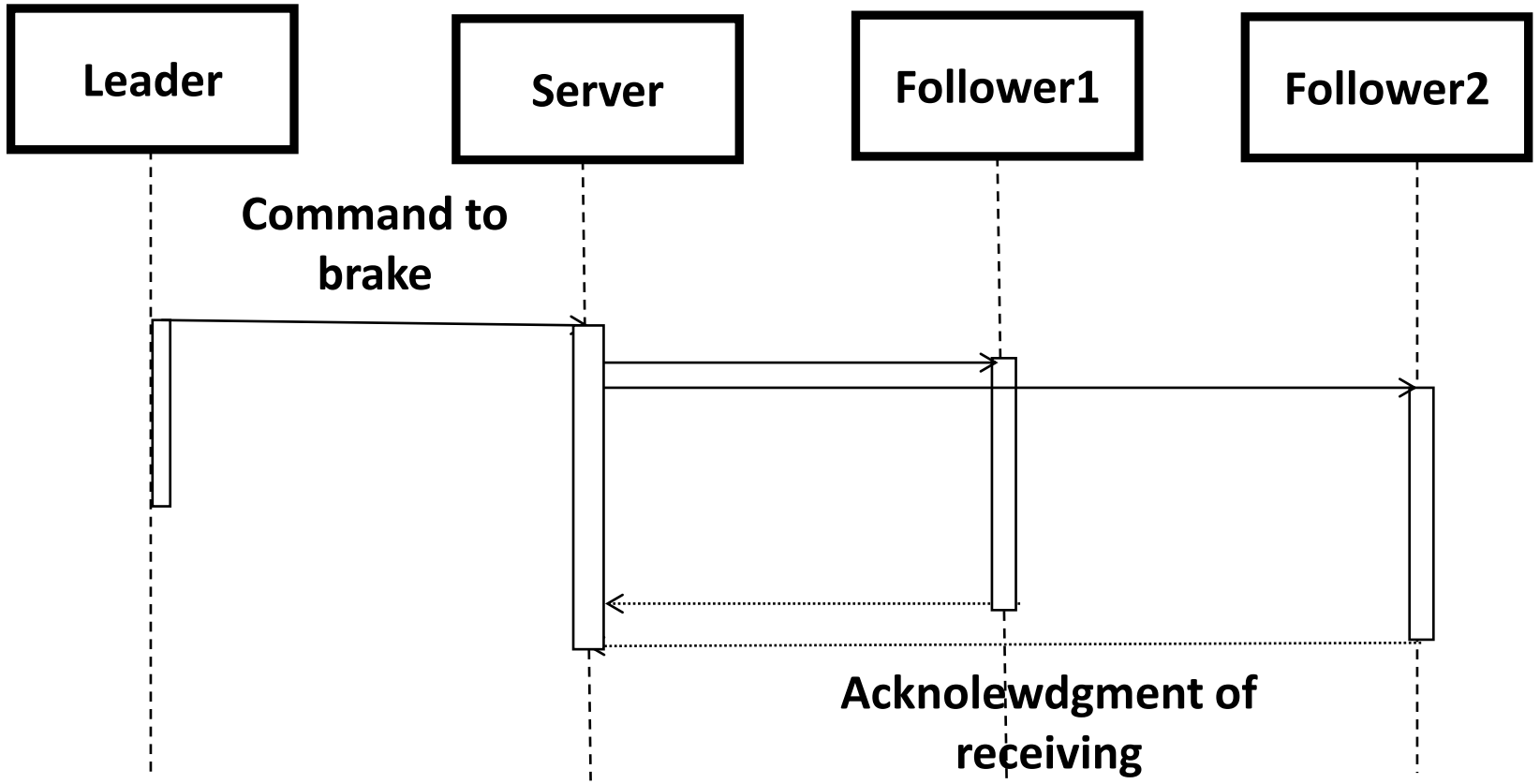
Static obstacle avoidance

Platooning:

Assemble into platoon – leader and followers are decided by the server.

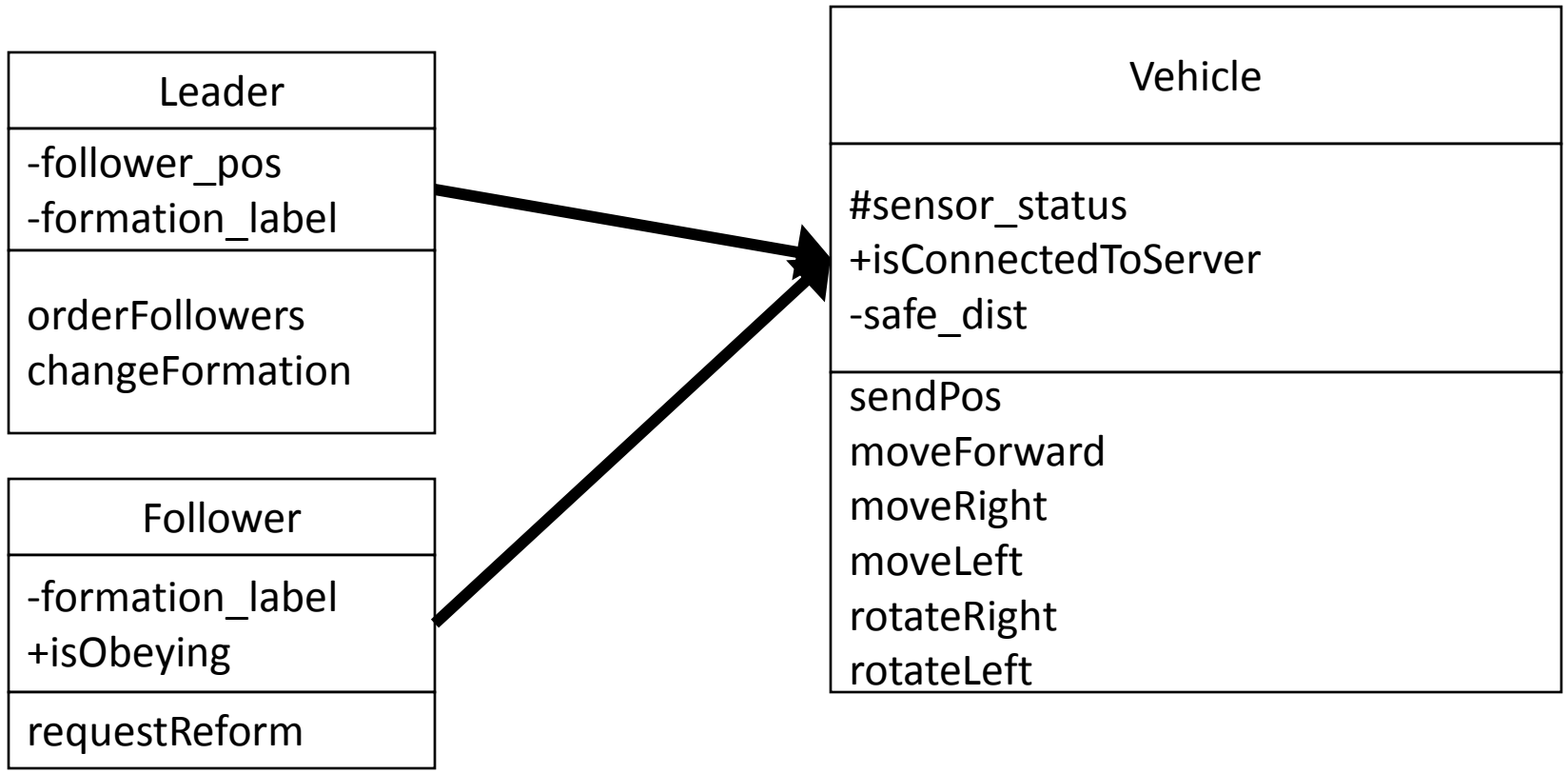
Following in the platoon – maintain safe distances.

Braking in platoon – leader informs followers through the server to brake; braking by stop/ gradually by decreasing rotating of motors/ changing the line for some platoon members.



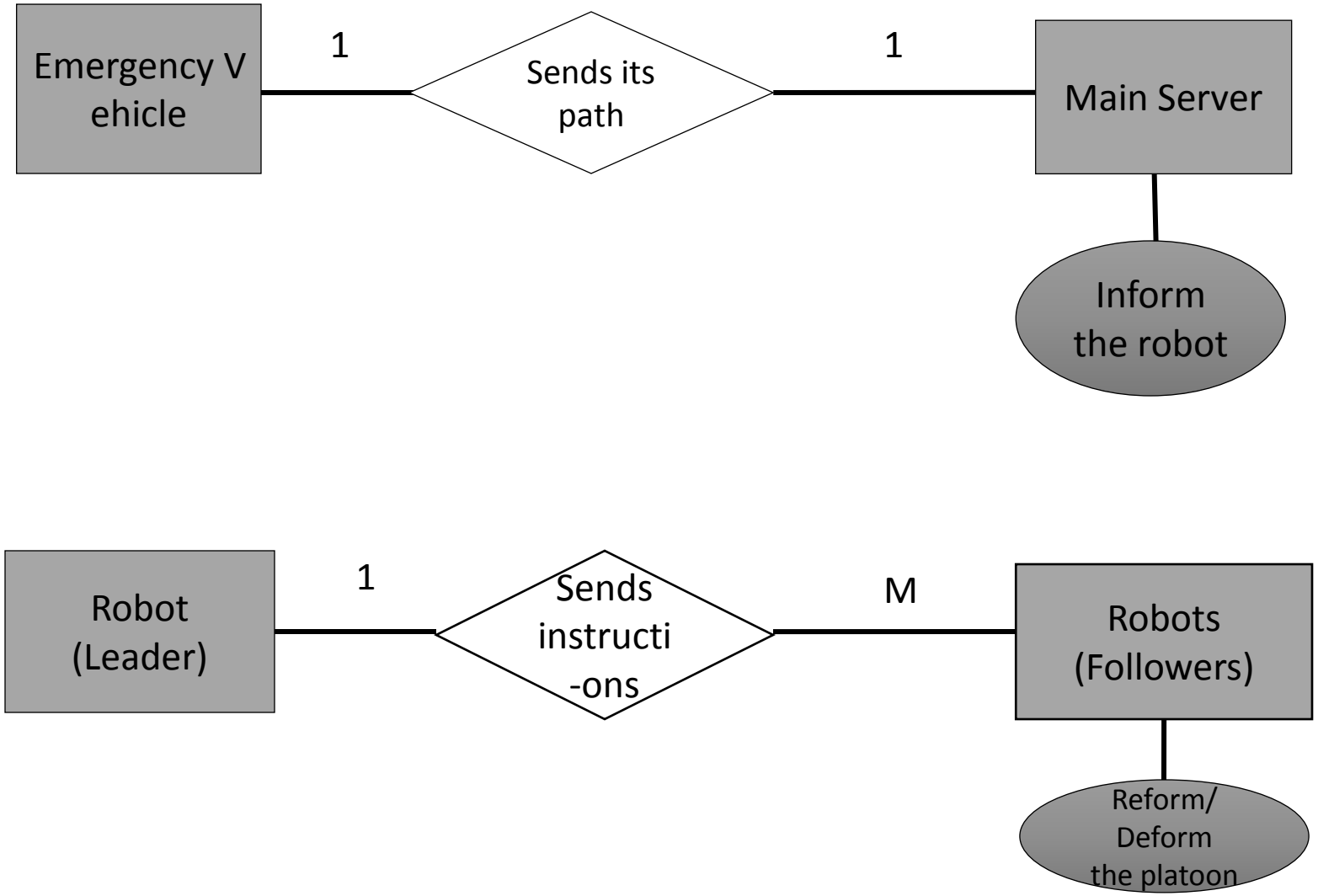
Abstract model implementation

- Class diagram for Leader and Followers in platoon



Entity Relationship Diagram

Entity relationship diagram for client-server model.



NONFUNCTIONAL REQUIREMENTS

1. **Usability -** Our system can help the EVs to reach the destination by breaking the platooning using different break strategies.

2. **Portability -** The system can be modifiable to the different operating systems.

3. **Scalability -** As the number of robots and EVs increase, the system can be capable enough to increase its performance.

4. **Reliability -** Our system can perform efficiently throughout its lifetime under controlled environments.

5. **Availability -** The availability of the system is directly proportional to the battery life.

NONFUNCTIONAL REQUIREMENTS

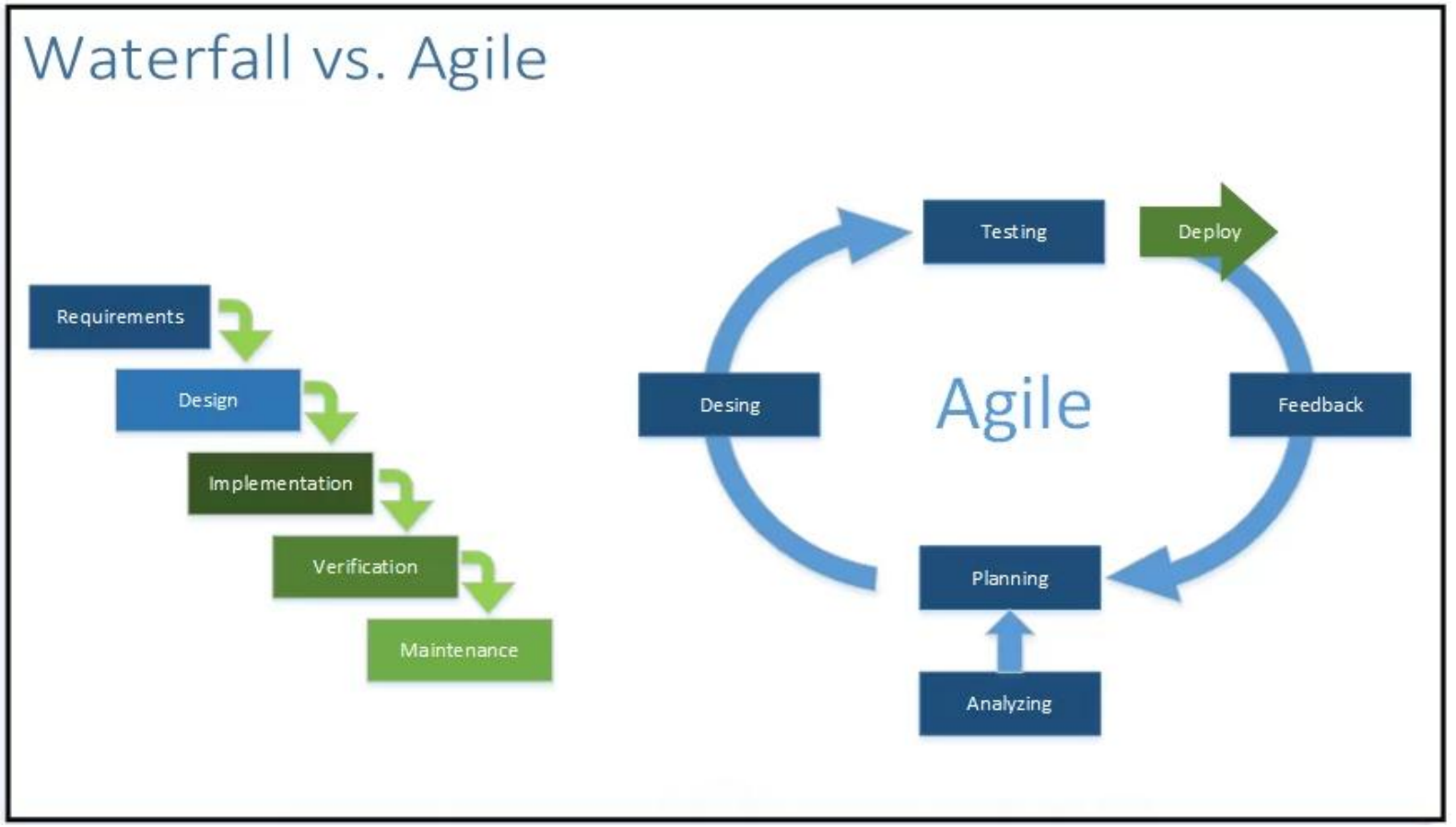
6. **Maintainability -** When maintenance is needed the system maintenance can be done in the garage and testing can be done where the system is restored.

7. **Interoperability -** The system can work correctly in the presence of other robots.

8. **Data Integrity -** The system can hold accuracy and consistency of data over execution cycle.

9. **Security -** The system will be designed in such a way that it should maintained safe distance between vehicles and avoid the collision with other comminuting devices .

Agile vs Waterfall



Research questions

- Robot's deceleration {by Renu}

- Control of followers in the platoon to mimic the behavior of the leader (i.e. change the platoon structure)
  - ✓ rely on onboard sensors (like cruise control): camera and ultrasound sensor {by Vinay}
  - ✓ receive commands from the leader (via Server) {by Akhil}

- Braking in platooning: what distances are safe?*{by Galina}

* Vehicle-to-Vehicle Communication for Safe and Fuel-Efficient Platooning//Galina Sidorenko, Johan Thunberg, Katrin Sjöbergy, Alexey Vinel. IEEE IV 2020

Thank you!