Multipart asynchronous communication, application to mobile robots

CAPSTONE
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Introduction

Capstone project → continuation of the TER project

TER project “Refinement of Communication Protocols by Model Transformation”

- transformation of models for software with remote communications
- creation of a communication overlay to abstract the different types of communications (Bluetooth and WiFi of the Lejos Framework)
- automate a code generation

Objective : abstract a new diffusion protocol, MQTT, for a future model transformation program containing communications

→ case study representing a race

Presentation Plan

1. Case study
2. Communication overlay
3. Encountered problem
4. Project management
5. Conclusion and perspectives

Presentation Plan

1. **Case study**
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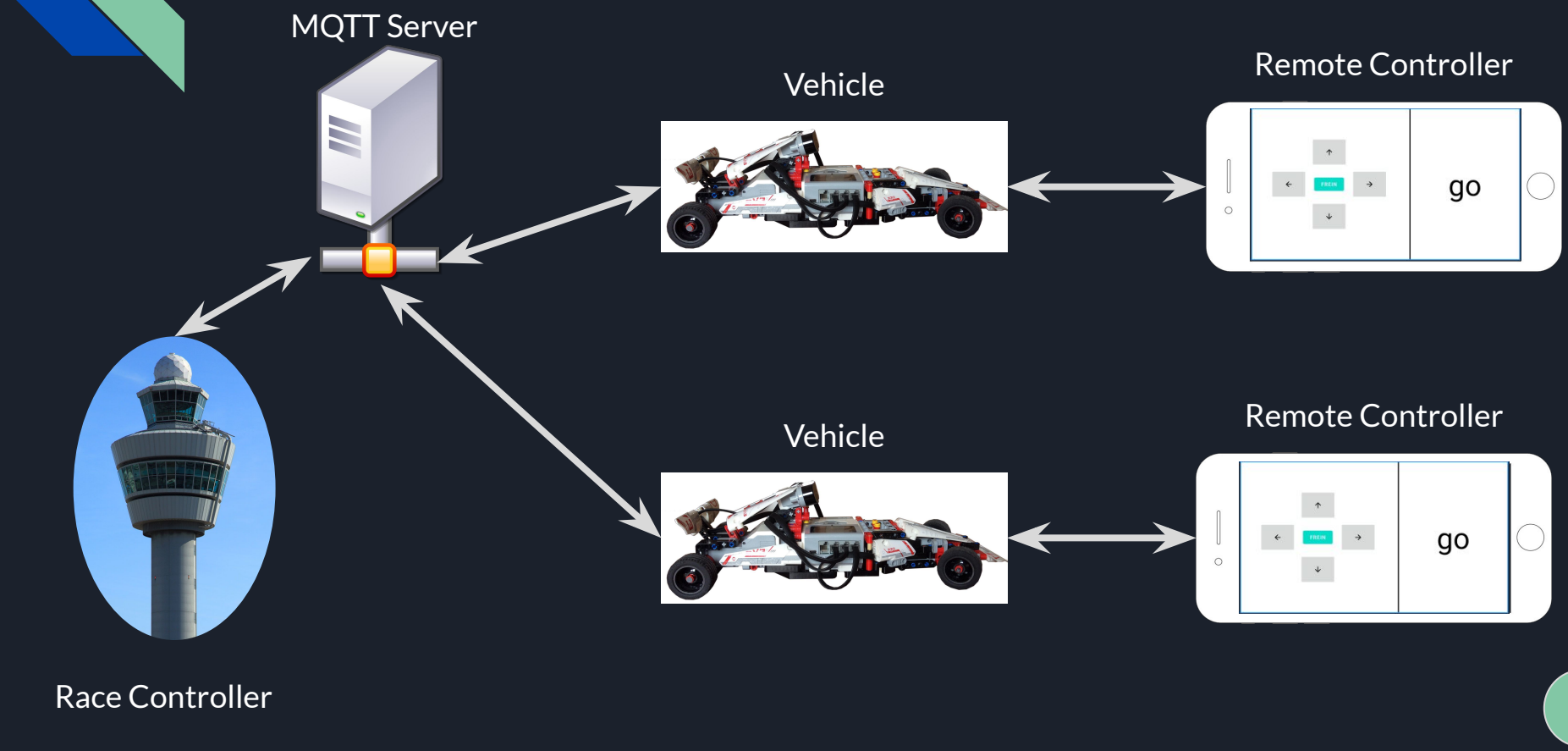
Case Study

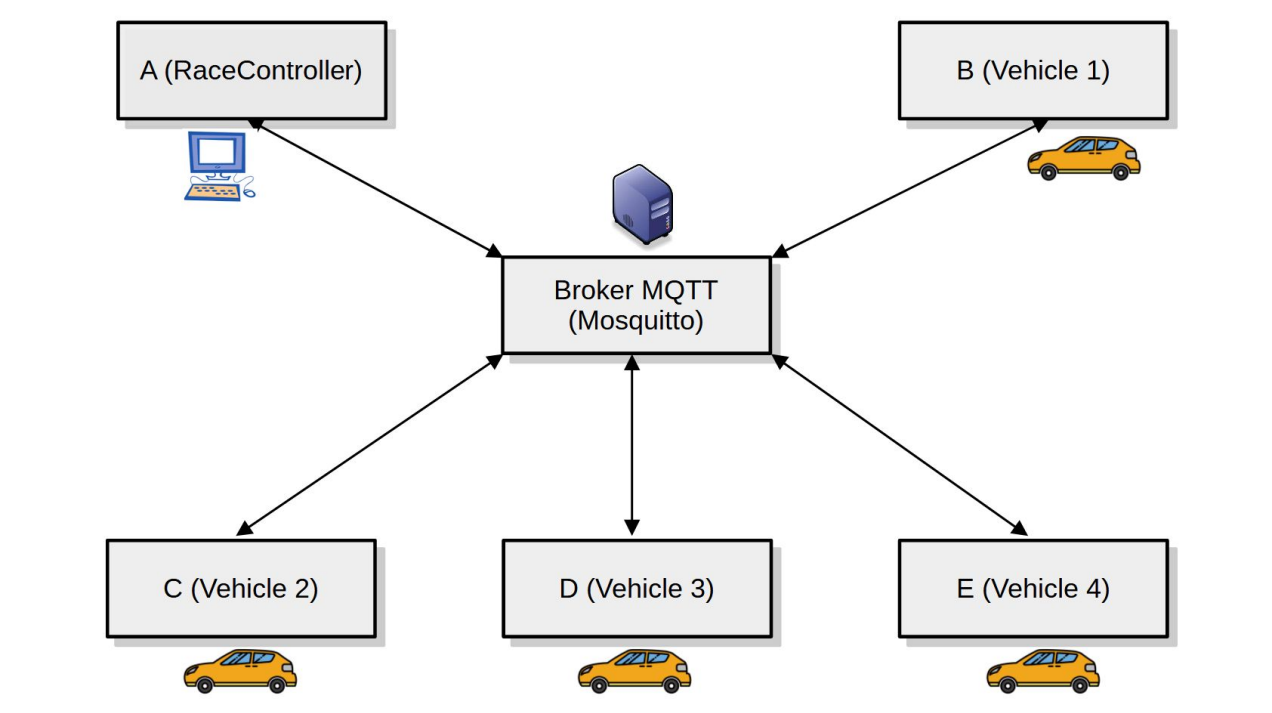
1. Presentation of the case study
2. MQTT Protocol
3. Vehicle
4. Remote Controller
5. Race Controller

Presentation of case study / Alma Kart racer



MQTT protocol

Presentation and mosquitto broker



Paho framework

Client	MQTT 3.1	MQTT 3.1.1	MQTT 5.0	LWT	SSL / TLS	Automatic Reconnect	Offline Buffering	Message Persistence	WebSocket Support	Standard MQTT Support	Blocking API	Non-Blocking API	High Availability
Java	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Python	✔	✔	✔	✔	✔	✔	✔	✖	✔	✔	✔	✔	✖
JavaScript	✔	✔	✖	✔	✔	✔	✔	✔	✔	✖	✖	✔	✔
GoLang	✔	✔	✖	✔	✔	✔	✔	✔	✔	✔	✖	✔	✔
C	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
C++	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Rust	✔	✔	✖	✔	✔	✔	✔	✔	✖	✔	✔	✔	✔
.Net (C#)	✔	✔	✖	✔	✔	✖	✖	✖	✖	✔	✖	✔	✖
Android Service	✔	✔	✖	✔	✔	✔	✔	✔	✔	✔	✖	✔	✔
Embedded C/C++	✔	✔	✖	✔	✔	✖	✖	✖	✖	✔	✔	✔	✖

Advantages

- Light
- Requires minimal resources
- Uses 11 times less energy to send messages than HTTP
- Uses 170 times less to receive than the HTTP protocol
- 93 times faster than HTTP protocol
- Machines can communicate with each other even if they are not programmed on the same languages

Vehicle Part

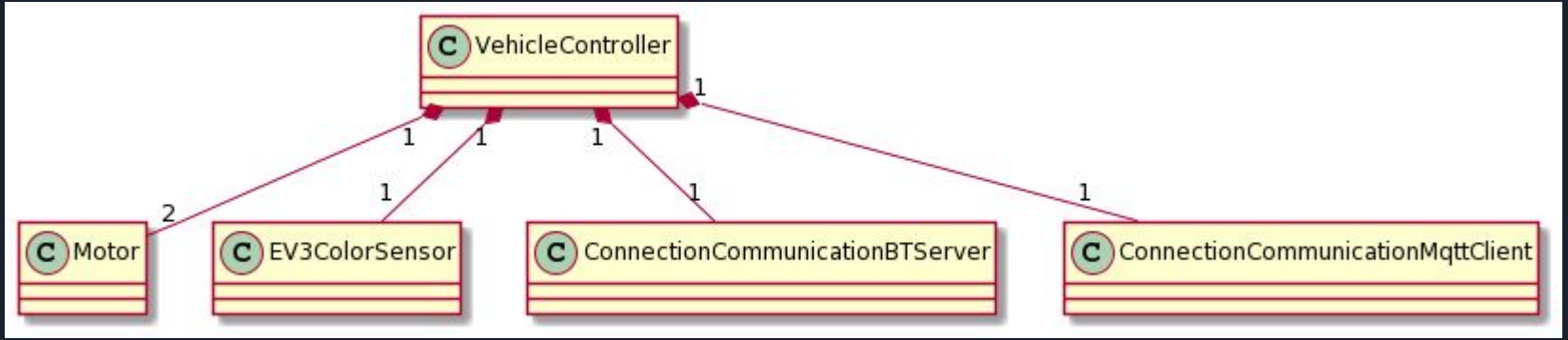
Vehicle Part - Presentation

Vehicle

MQTT Server

Remote Controller

Vehicle Part - Programming



Parallel elements:

- The color sensor
- The BT communication
- The MQTT communication

Vehicle Part - MQTT Communication

MQTT Server

Vehicle

Race Controller

3 differents communication possible:

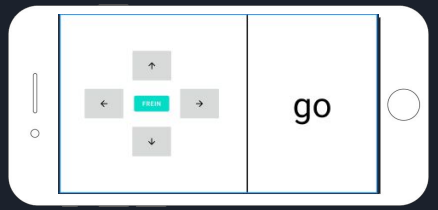
- The launch of the race
- The arrival of the race
- Bonus/penalty management

Remote Controller Part

Remote Controller - Presentation

Vehicle

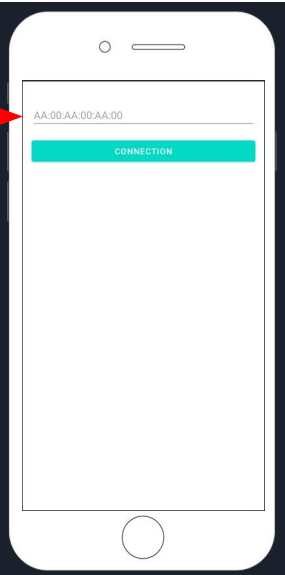
Remote Controller



Remote Controller - Functioning

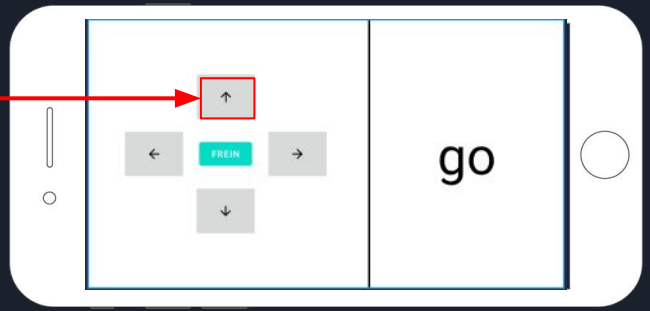
Connection Screen

MAC address



Control Screen

When, pressed, sent byte *1* to the vehicle



vehicle control

information screen

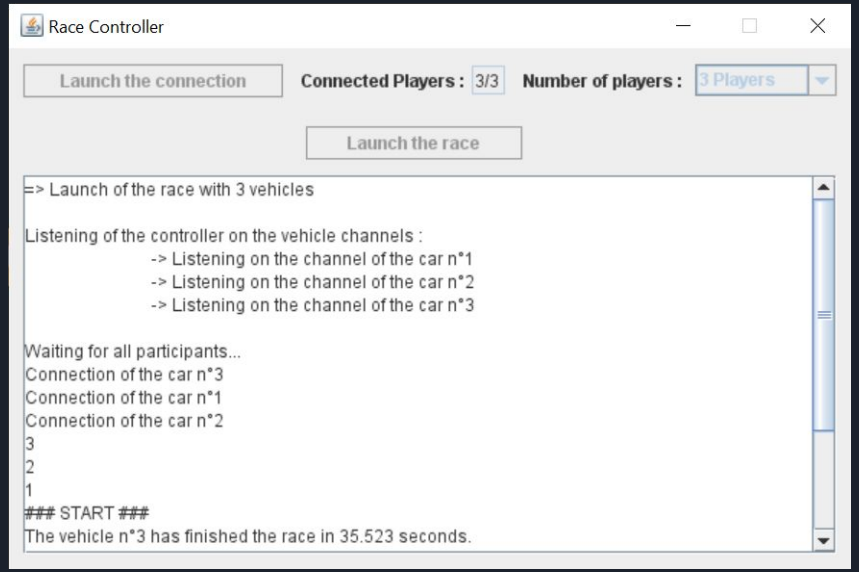
Race Controller Part

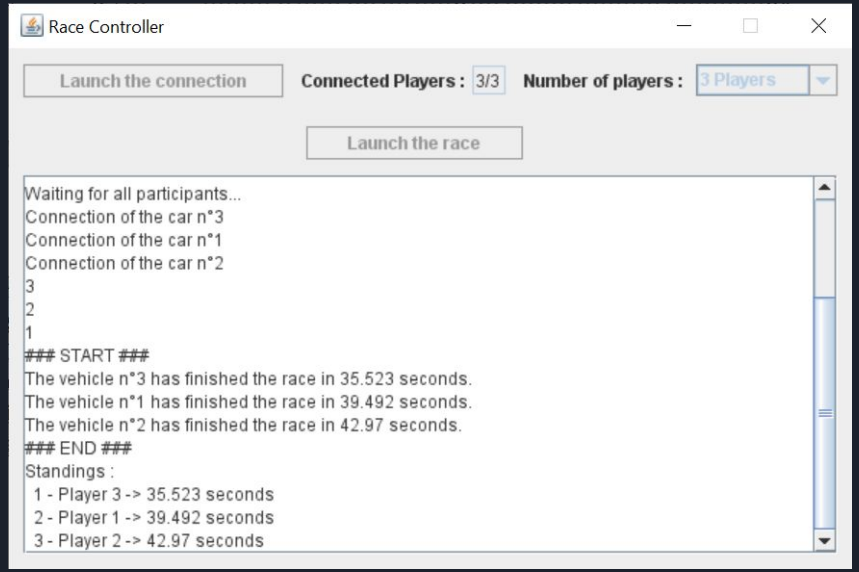
Race Controller - First approach

Race Controller - Technical approach

First Step	Race section	Final Step
Initialisation of the Mqtt Client and of the different attributes of the class. Initialisation of the MQTT Connection Waiting for players to be ready : - Command.READY	Start of the race: - COUNTDOWN - Command.START Waiting for message to treat : - “Command.WANTBONUS” - Command.FINISH	End of the race with the classification and display of the times from the shortest one to the longest one. Send the standing to the vehicles.

Race Controller - Swing window





A little demonstration

Presentation Plan

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2. **Communication overlay**
3. Encountered problem
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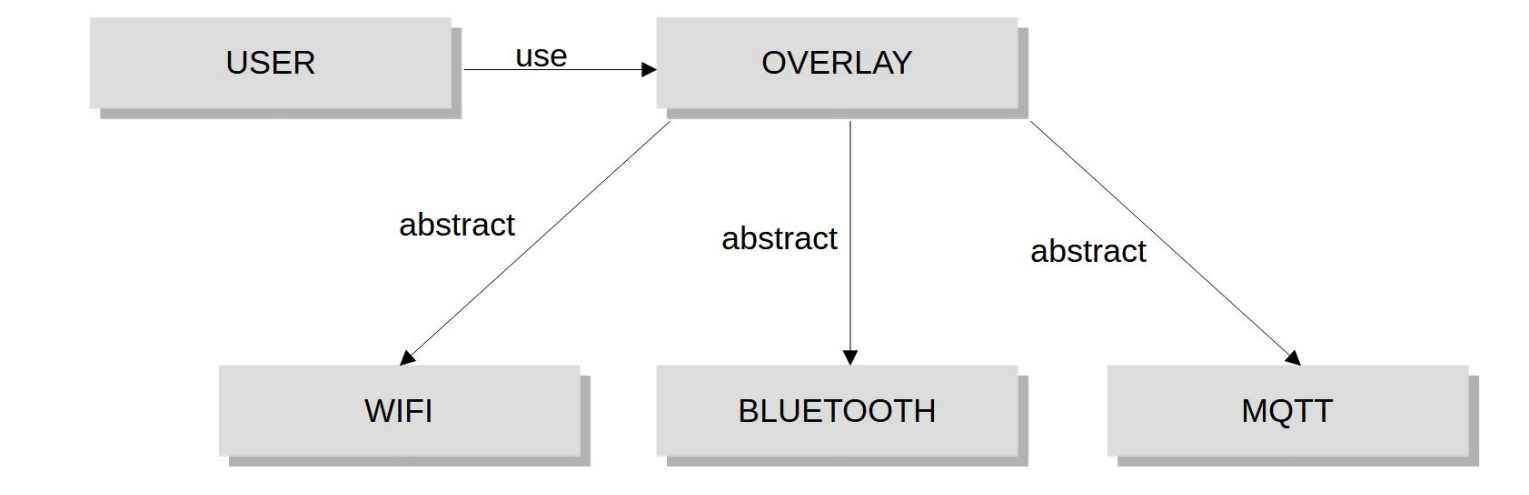
Presentation



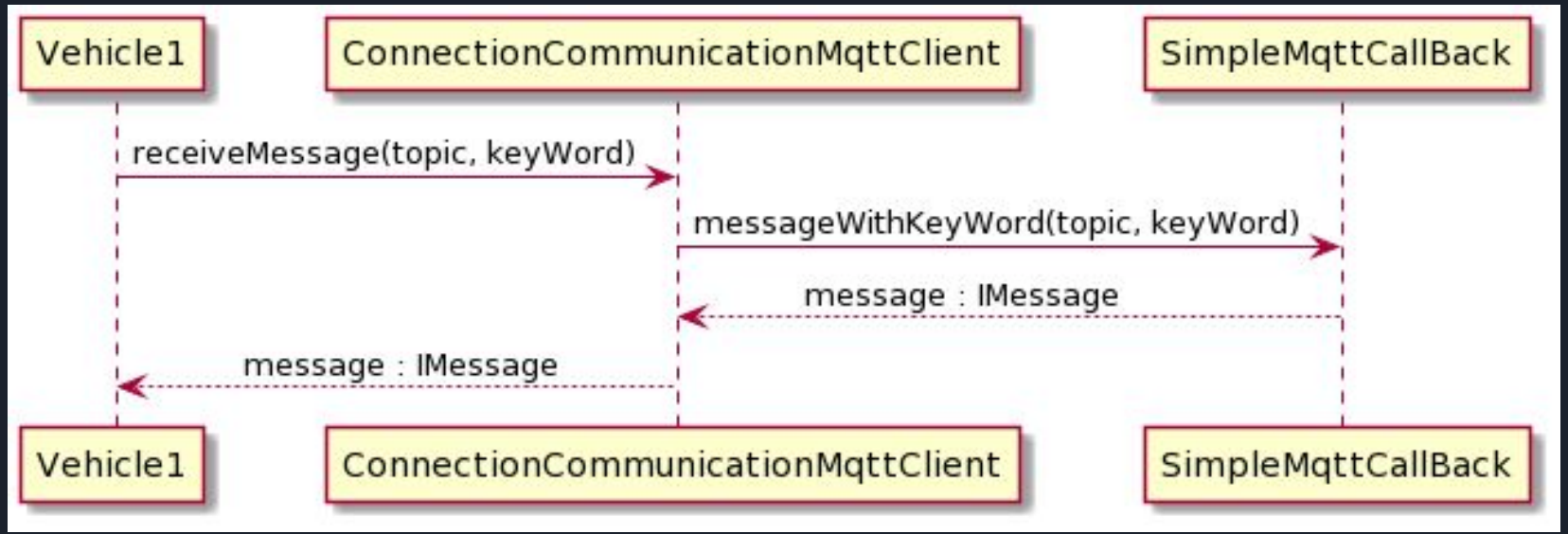
Modification (1/2): Send MQTT message

- Message sending function in WIFI/Bluetooth use write()
- Message sending function with MQTT use publish()

- Avoid big modification
- Avoid redundant rewrite (code overload)

- Generic Message type : type of message which accept all the different types

Modification (2/2): MQTT message reading



SimpleCallBak implementation and MQTT message sending standard

Syntax : keyWord:BodyMessage

Pros : Makes it easier to find the right message

Cons : The user who receives this message must know the keyword

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Encountered problems

- Connection to the MQTT server
- Compatibility between Java Lejos version and Paho version
- Bluetooth using the communication overlay
- Bonuses and penalties during the race

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Project management

- Organisation

- Communication

Presentation Plan

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Conclusion

- The capstone subject
- Interesting support
- Thanks to our supervisors

Perspectives

- **For the global project :**
  - Add new communication protocols (ex : HTTP)

- **For the capstone project :**
  - Operate the bonus feature already implemented
  - Add road borders detection
  - Improve the handling of the vehicle

Do you have questions ?

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