AEE Project Work course 2020

Master's Programme in Automation and Electrical Engineering

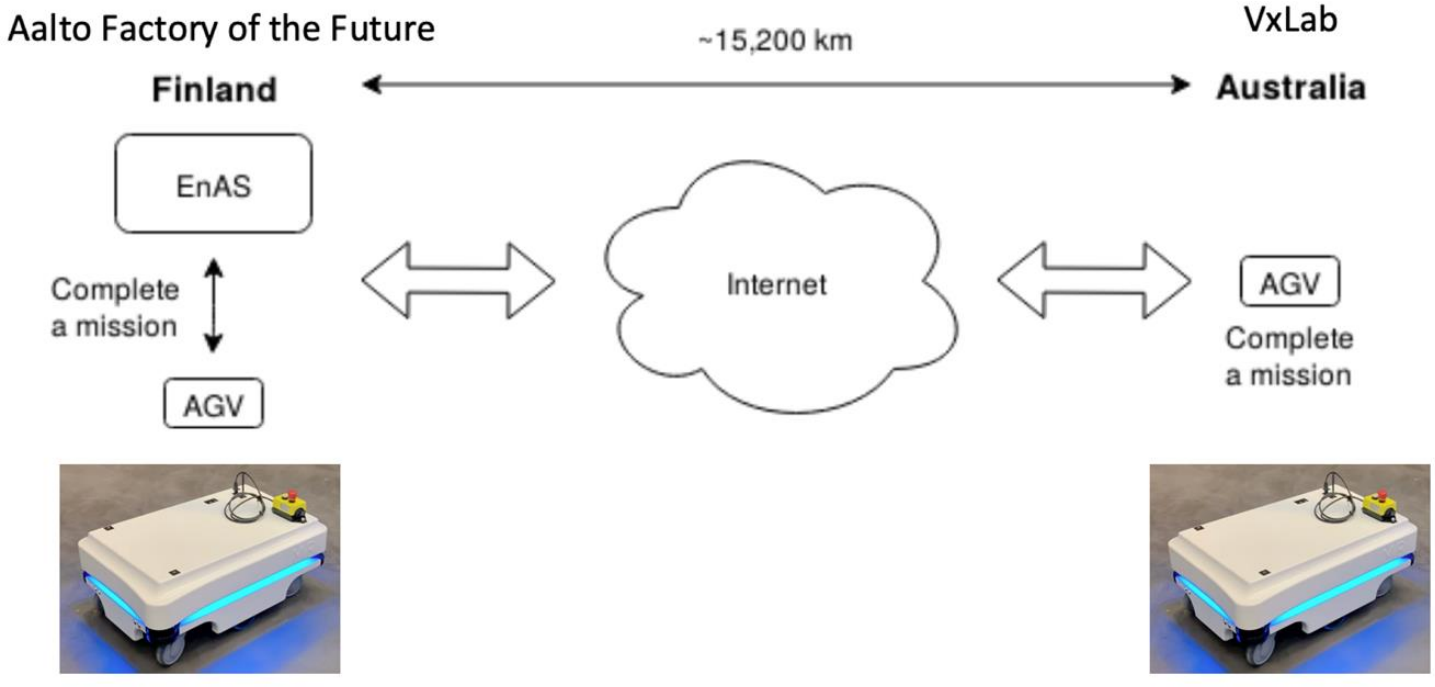
Aalto University
School of Electrical
Engineering

Distributed Intelligent Production Involving Remote Actors

Project group members, group 13: *Panu Salo, Niko Karhula, Juhani Lähde, Minh Duc Pham, Paavo Kajola*

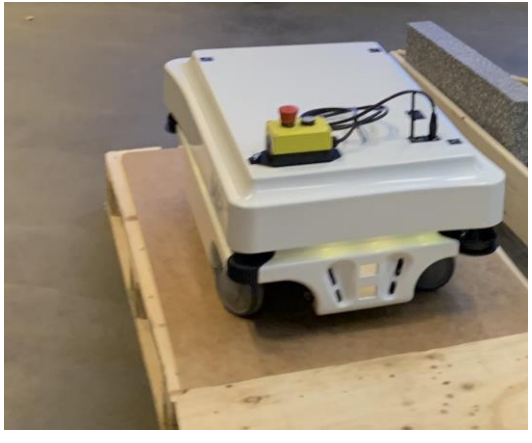
Objectives in the beginning

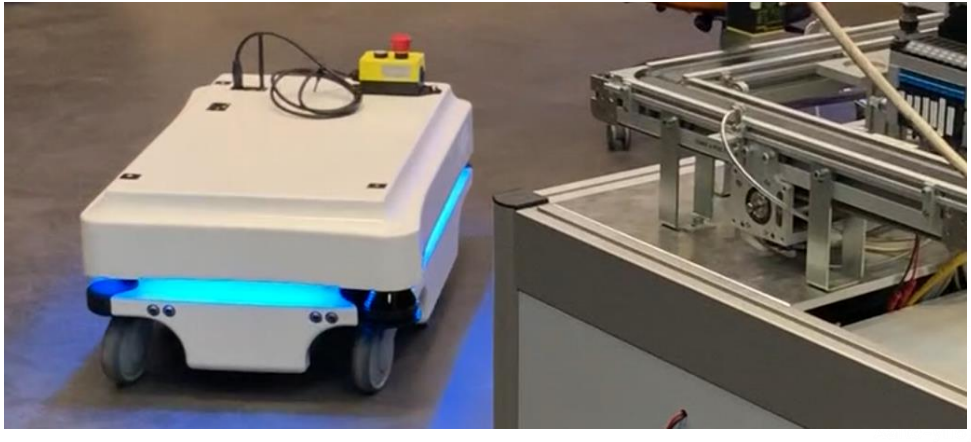
- Setup a secure IP-based connection between AFoF and RMIT VxLab
- Integration with EnAS at the lab (Aalto Factory of the future)
- Demonstrate remote control of MiR100 AGV located in Australia from Finland



REST API

- MIR100 has a ready commercial webpage interface for mapping and programming missions
- Aim was to control MIR100 with REST API commands
  - Executing python scripts from laptop with wireless connection to the MIR100
- Success in python code tests triggering missions through REST API





Changes to the objectives due to campus closure

- Starting from week 12: no more access to the lab because of coronavirus

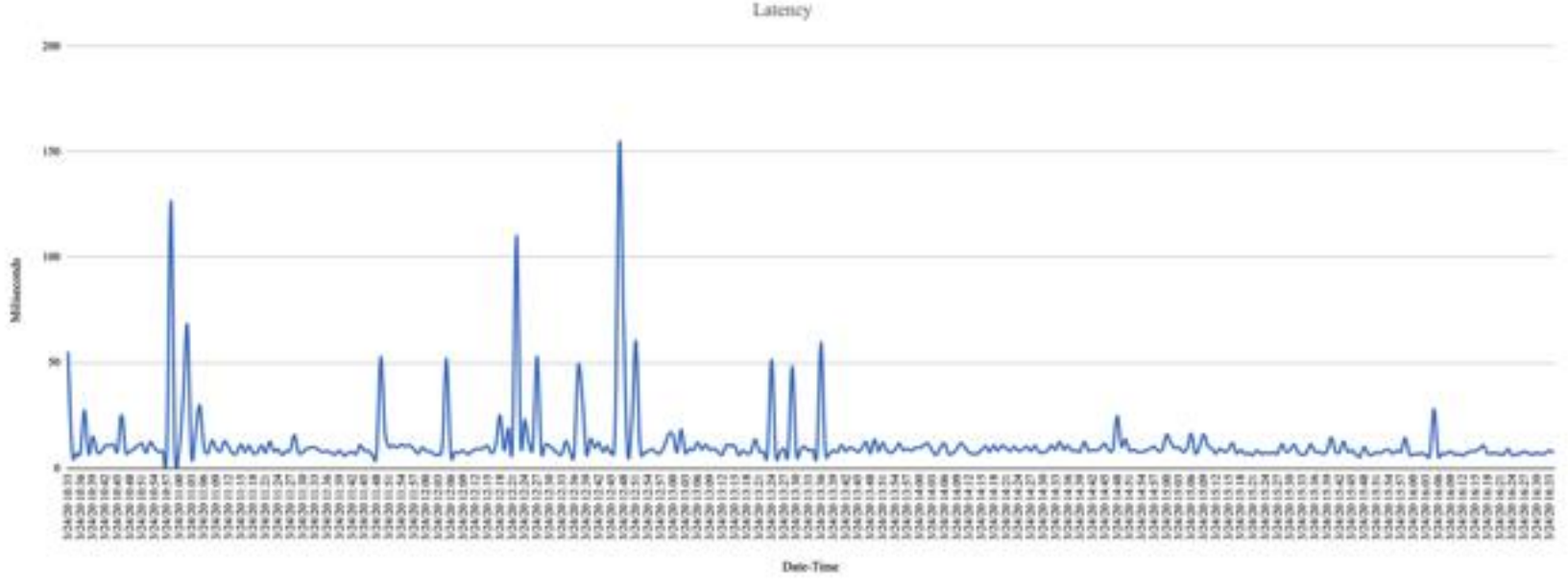
- Activities cancelled due to this:
  - Further moving and control of MIR 100 AGV at AFoF in Otaniemi, Finland
  - Integration of MIR 100 with EnAS 61499 NxtStudio distributed automation system at AFoF in Otaniemi, Finland
  - Remote moving and control of Australian MIR 100 AGV with networking: because campus closed also in Australia

- Objectives: replace the MIR100 component by a simulation environment based on ROS, Gazebo, made by DFKI

Networking latency tests with Raspberry Pi's PiVPN

- Latency of PiVPN connection was measured in Helsinki area with connected Raspberry Pis: average latency was 11.9 ms

	AVG	Max	Min	Std Dev			Test duration (min)	362
Latency	11,89024	154,232	5,33	14,209536			Availability	100,00 %
Throughput	538,40182	1324,71	1,28	173,33115				



Networking latency tests with Raspberry Pi's PiVPN

•average throughput in Helsinki area: 538,4 kB/s

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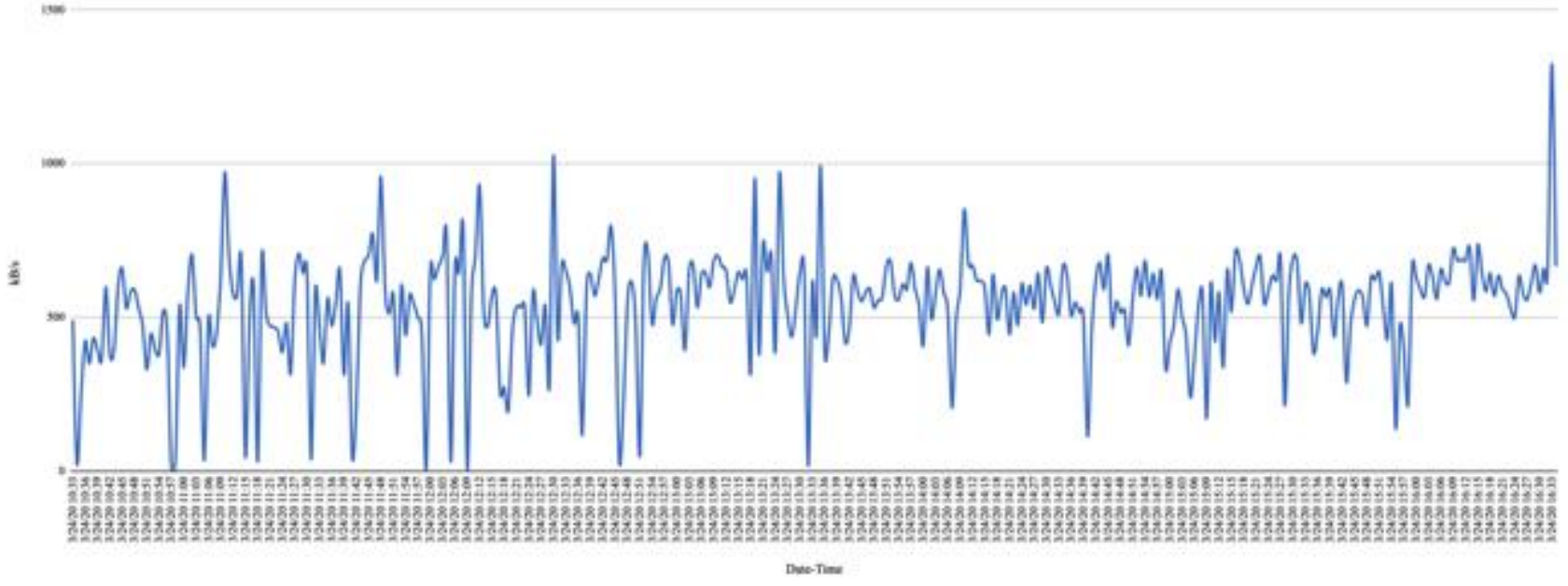
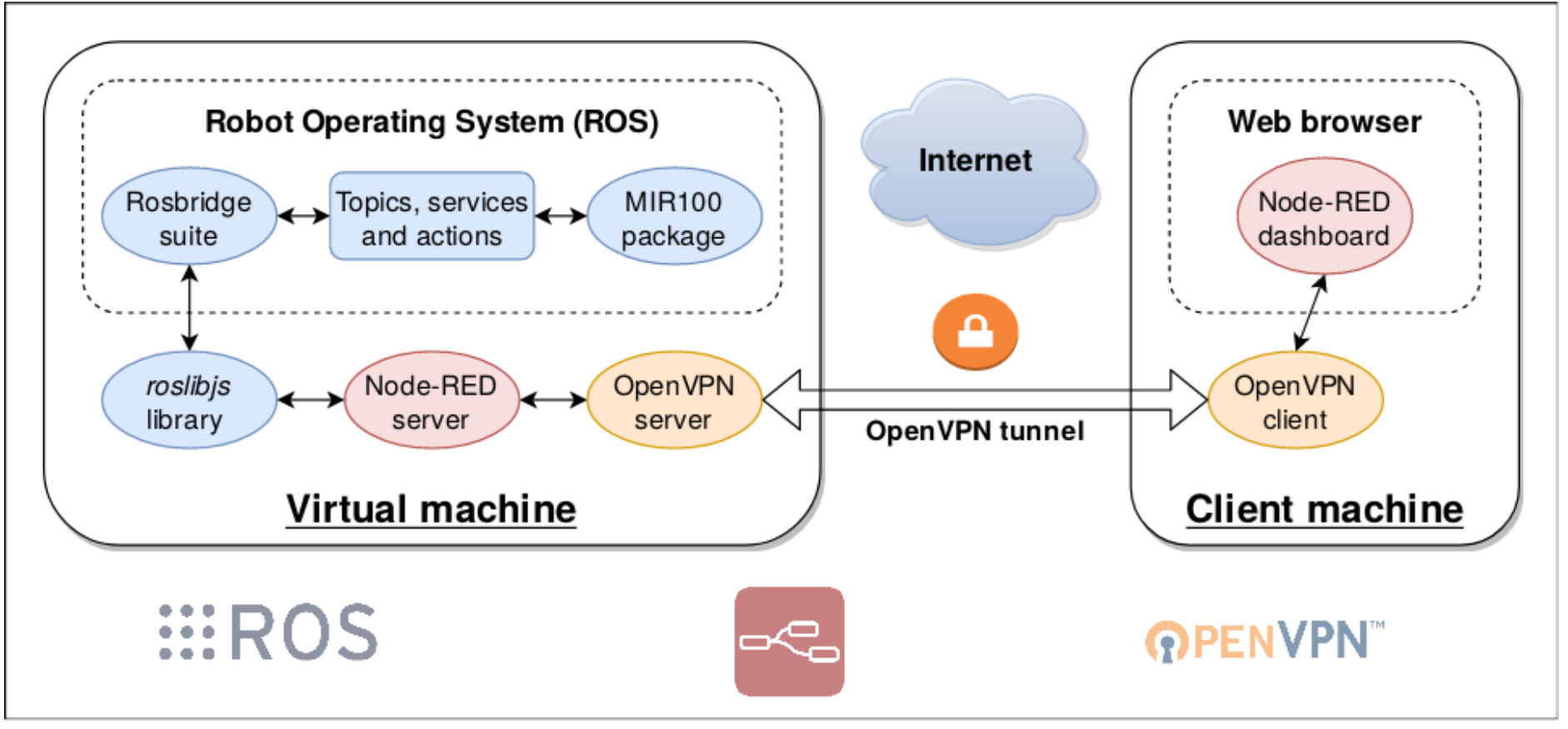


Architecture of the objectives: new goals



Controlling DFKI's ROS Gazebo simulation

- New goal to remotely control DFKI's ROS Gazebo simulation of MIR100
- Success in making OpenVPN connection from another computer to the computer running the simulation
- Also success in how to publish information from website with Node-RED, integration with ROS

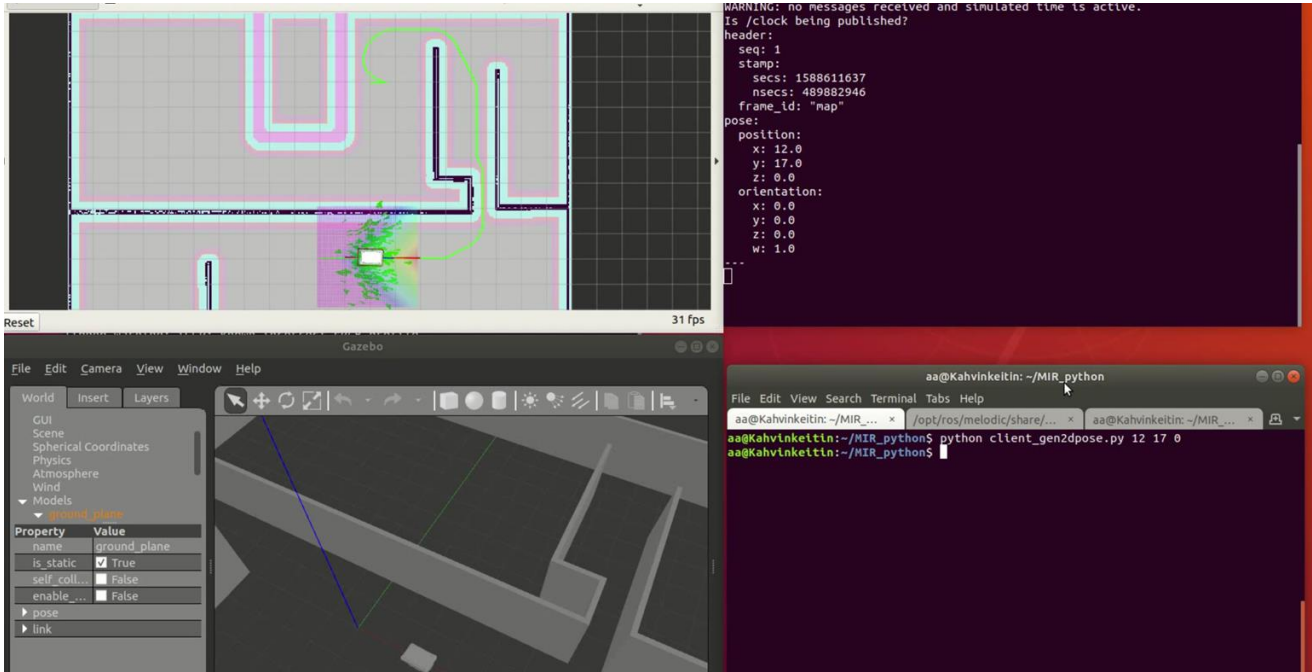
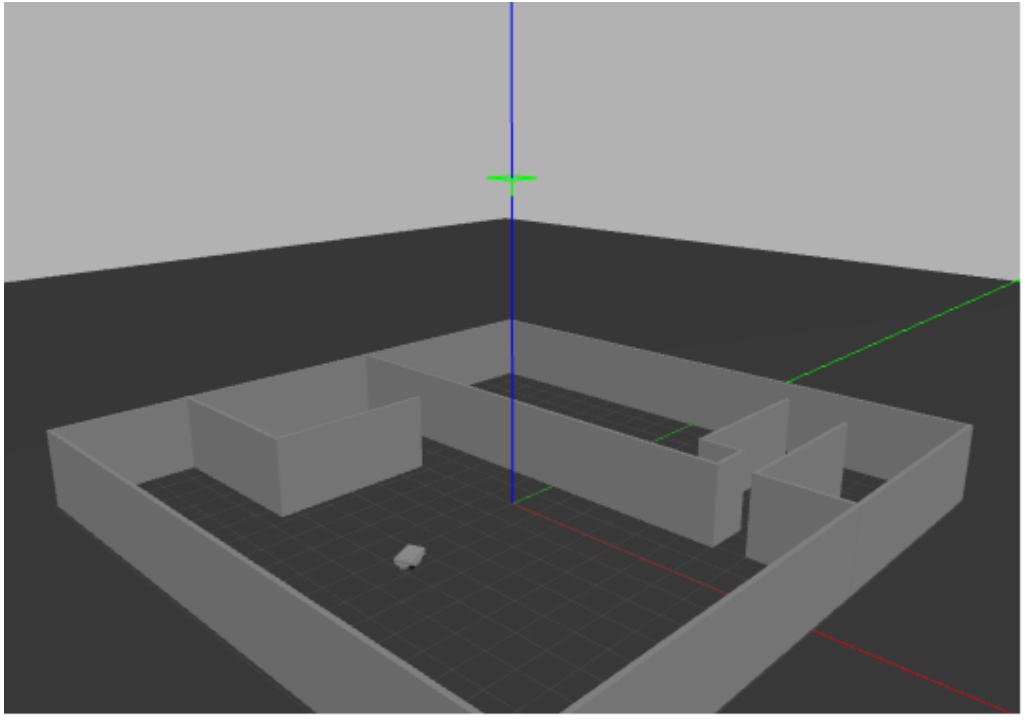


Figure.
Basic publishing example with ROS Gazebo simulation

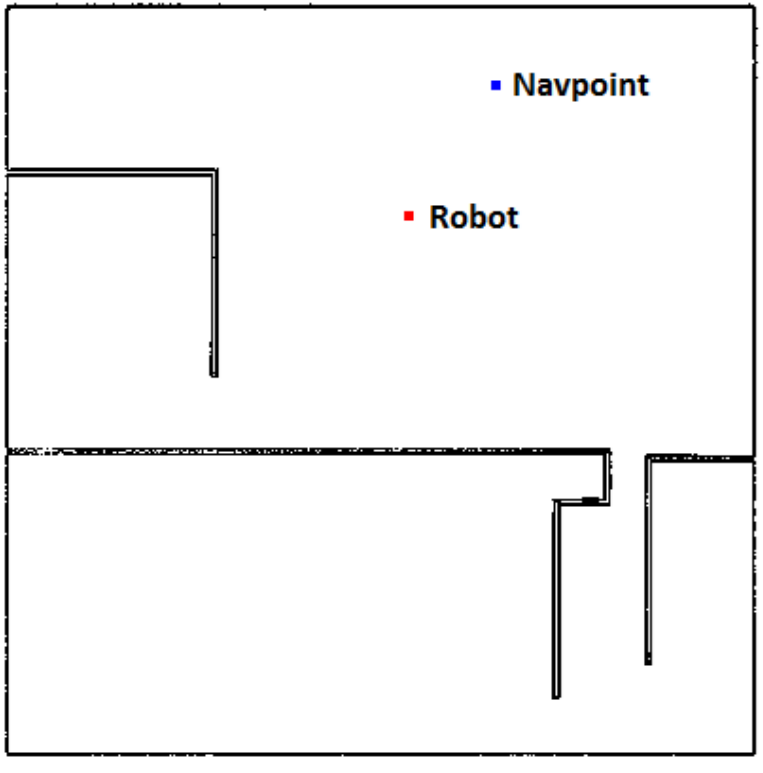
Results

- Remote control of the MIR100 robot was achieved
  - Simple graphical user interface using javascript
  - Intuitive control by clicking to set navigation points
- Successful data transfer with ROS environment
  - Subscribing to critical topics: /map, /amcl_pose
  - Publishing to topics: /move_base_simple/goal, (/move_base/goal)
- Robot position and map are updated when changes occur
  - UI updates are triggered by newly published messages



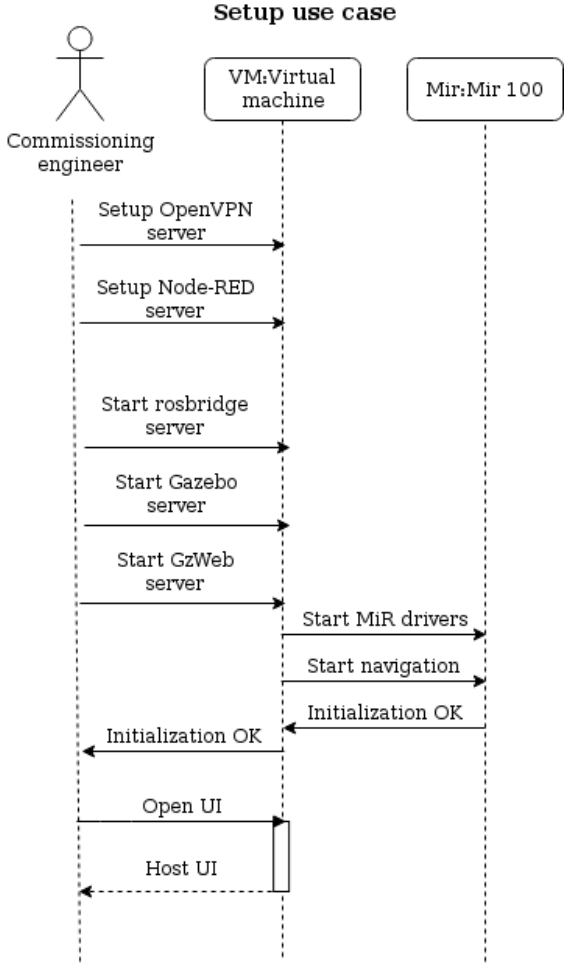
"Reality"/Simulation

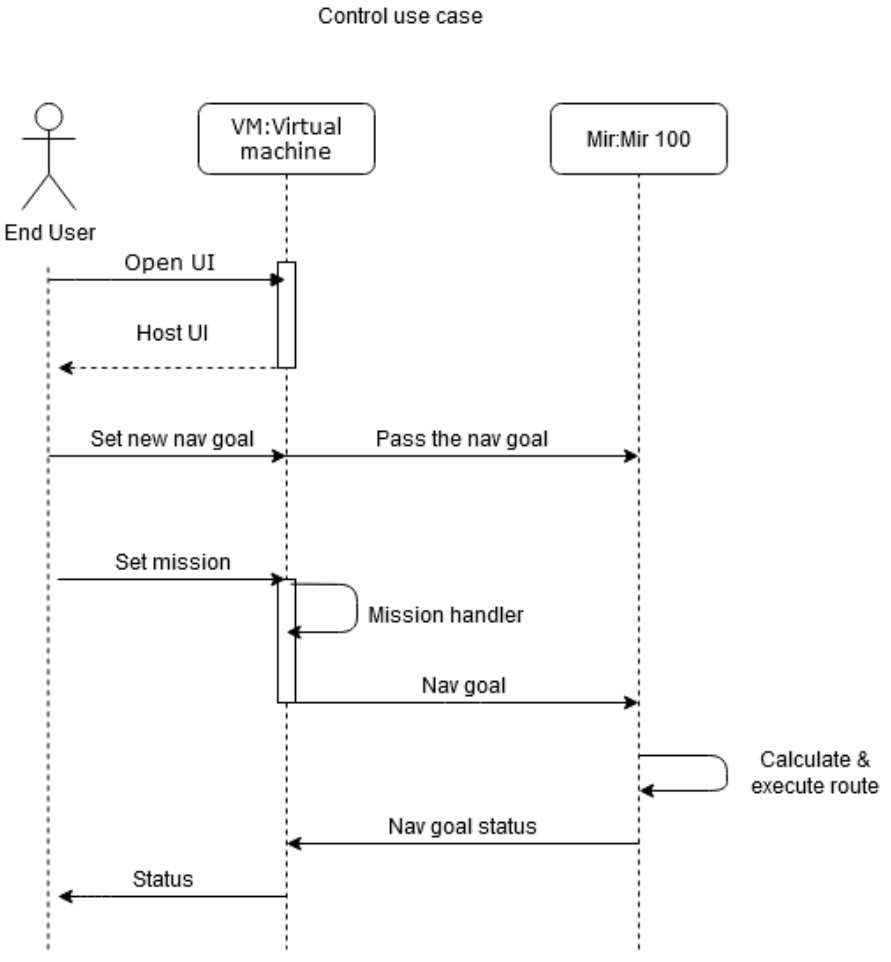
Mir100 control UI



2D Representation

Setup and control





ROS

- Systems consist of nodes
- Communication between nodes follows a publish/subscribe model
- A node publishes/subscribes to a **topic** and sends/receives **messages**
- Communication is anonymous
    - A publisher does not know who is subscribed to the topic
    - A subscriber does not know who is publishing the message