Hochschule
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Software Development Project

Final Presentation

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Introduction

Software Development Project

Basic Navigation Test

- Environment: Workspaces, waypoints and obstacles.
- Task specification: Sequence of poses.

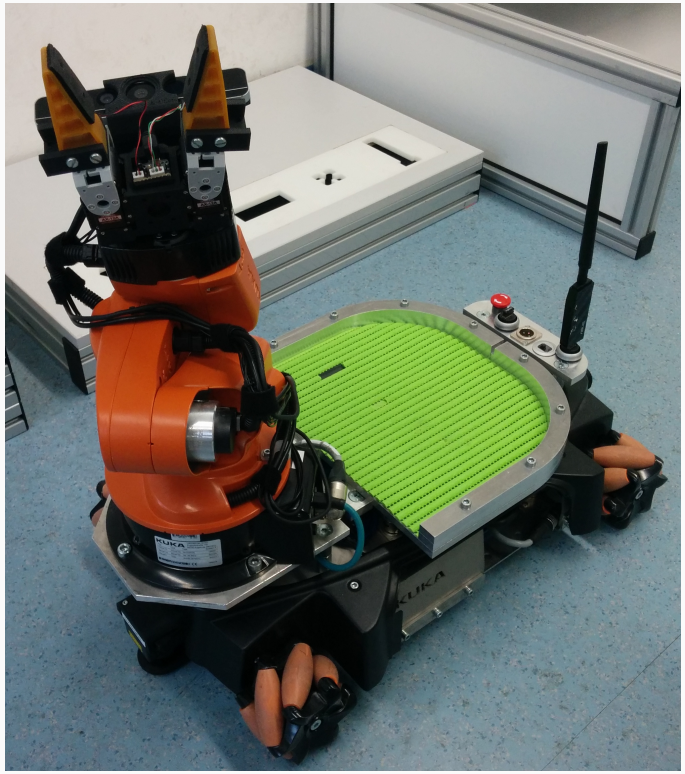
Challenges

- **Perception:** Accessing and processing sensor data.
- **Mapping:** Building map of the environment.
- **Localization:** Pose inside map.
- **Path planning:** Determine sequence of poses between waypoints.
- **Motion control:** Execution of path.

KUKA youBot

The youBot is a mobile manipulator designed for education and research purposes. It comes with fully open interfaces and API.

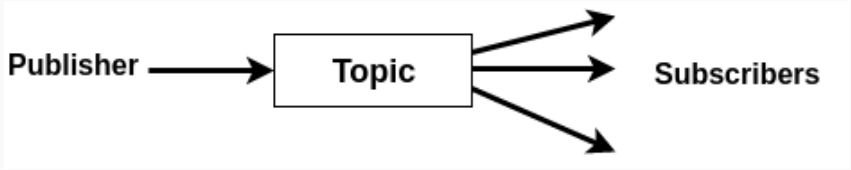
- Omnidirectional, four-wheeled
- 5-DOF manipulator with a two-finger gripper
- On-board PC with CPU, 2GB memory, 32GB SSD drive
- Sensors: vision sensors, rangefinders



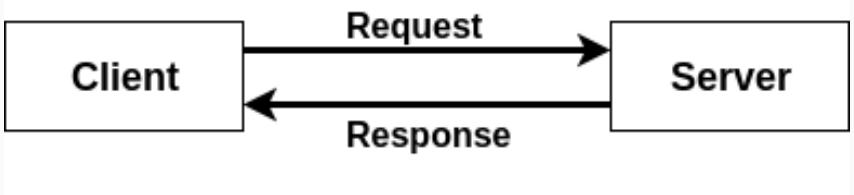
Robot Operating System (ROS)

Set of software and libraries.

- **Node**: A process using ROS.
- **Topic**: Message queue, used for communication between nodes.



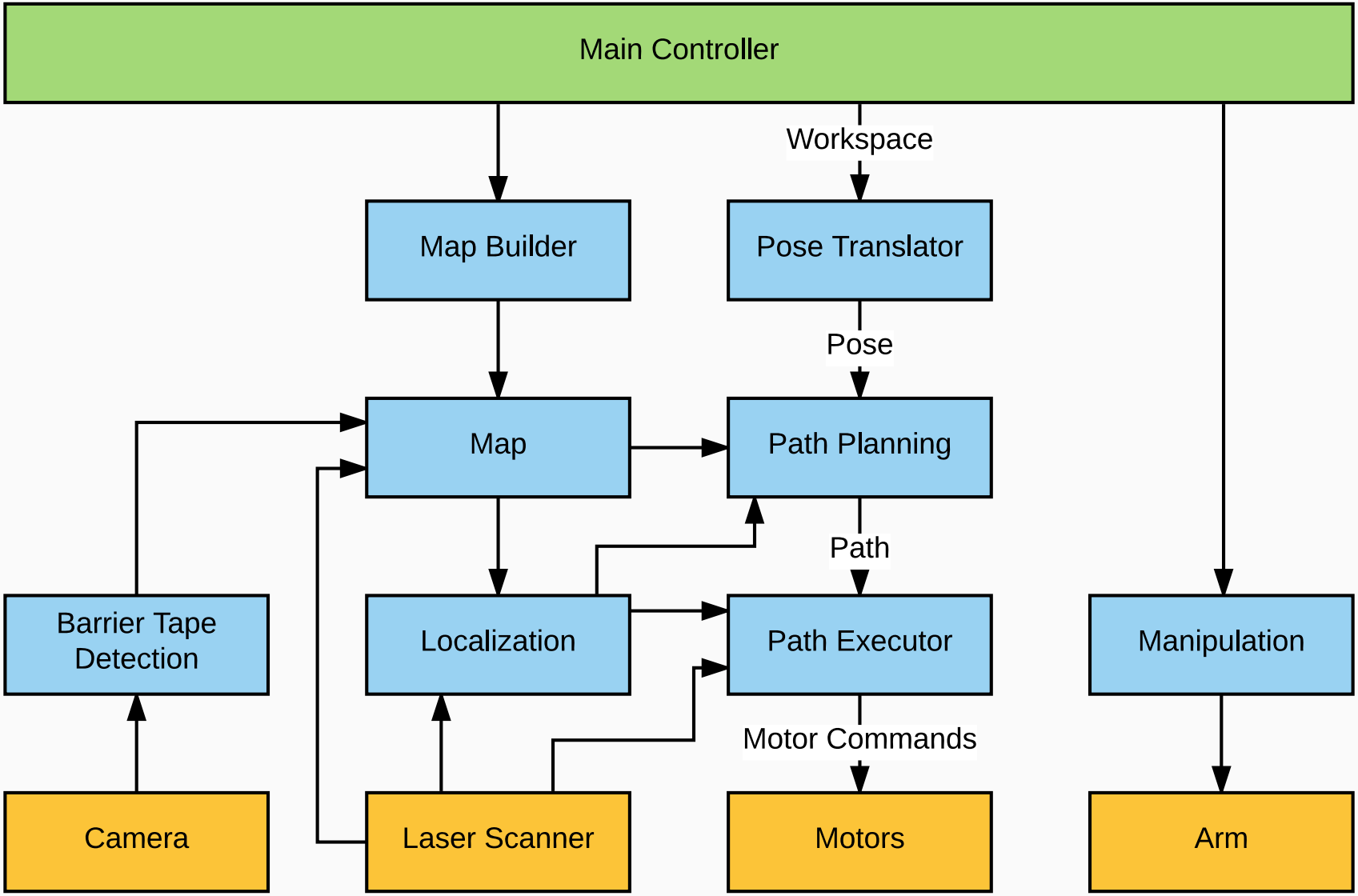
- **Service**: Offers synchronous service calls.



- **Actionlib**
  - Provides client interface to send requests to server
  - Client and server communicate with messages:
    - Goal
    - Feedback
    - Result

Approach

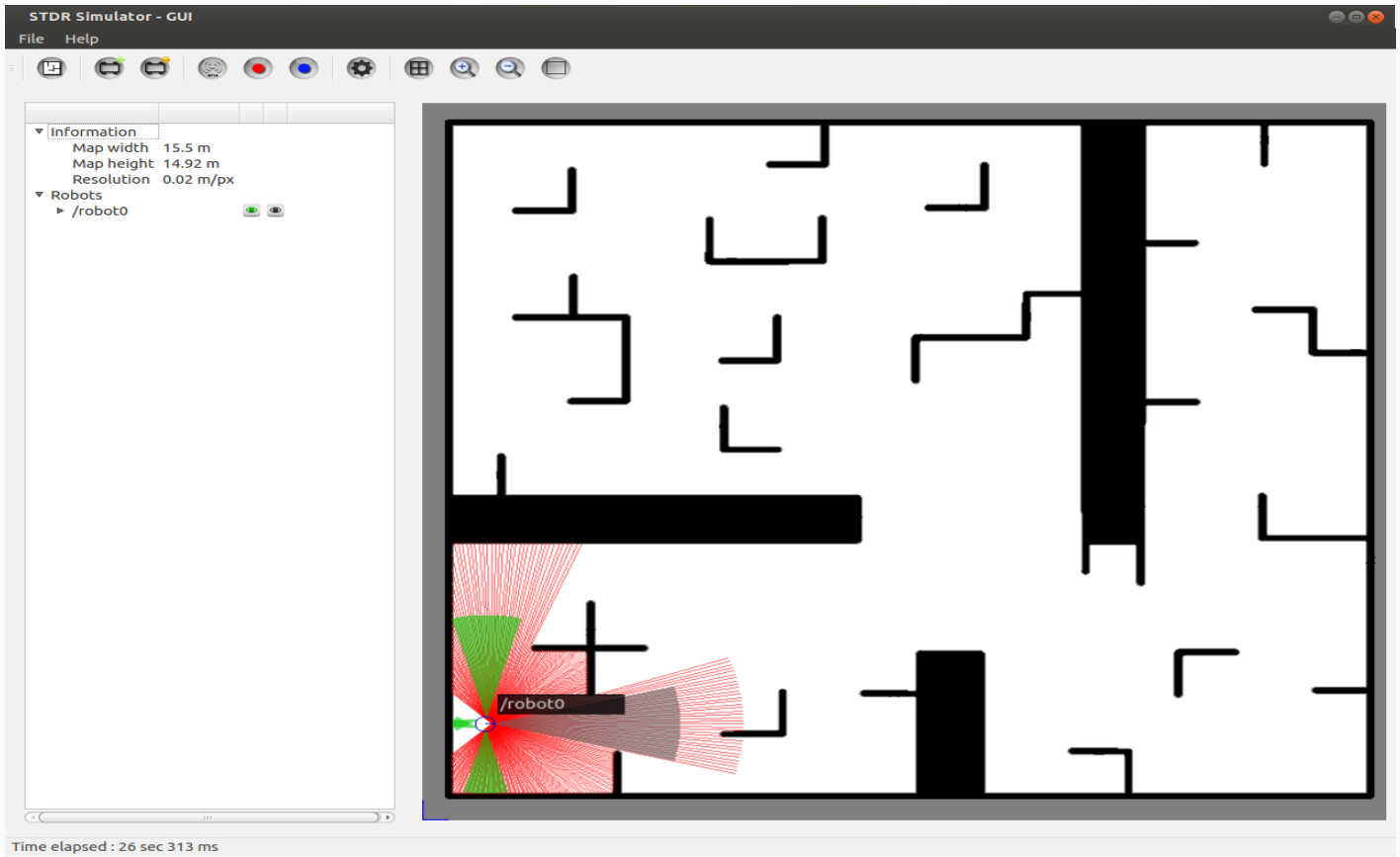
Software Modules



Realization

Simulation

- Simple Two Dimensional Robot (STDR) simulator
- Tasks performed:
  - Map Building
  - Localization



Map building I

- Gmapping is used to build the map
  - Uses laser scanner
- Map Server
  - Provides map saver utility, to save generated map in files(yaml and pgm)
  - Offers map data as a ROS Service

Localization I

- Adaptive Monto Carlo Localization(AMCL) is used to localize the robot
- Uses particle filter to track the pose of robot
- What it needs?
  - Laser scans
  - Initial pose
  - Transforms
  - Map

Localization I

- **Problems**
  - Amcl could not find laser data on /scan topic
  - Amcl node crushes after some time
- **Solutions**
  - Remap /scan_front and /scan_rear to /scan topic
  - Because of incorrect transformations provided by stdr simulator

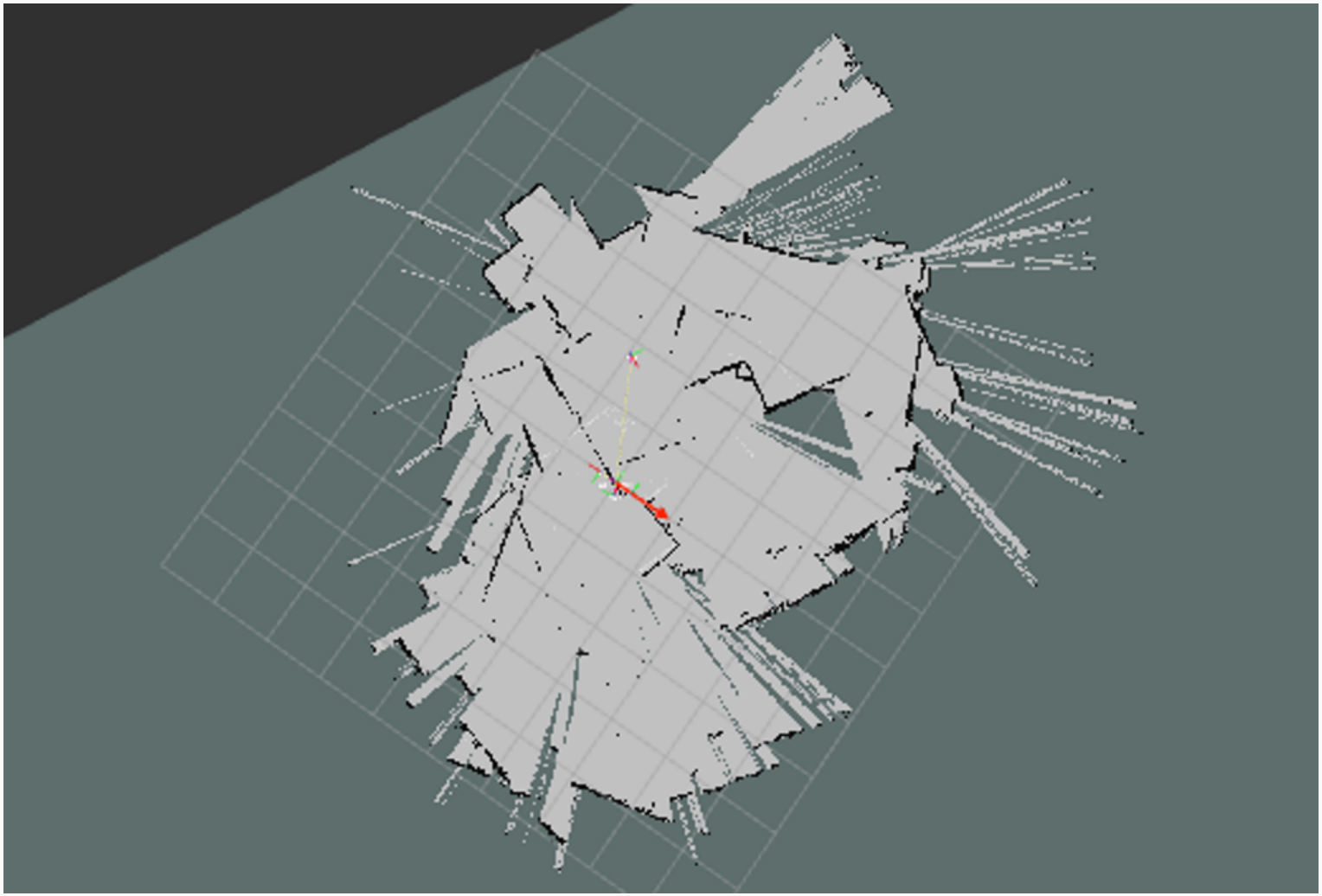
youBot Driver

- **ROS Wrapper**
  - Allows to write ROS programs for controlling youBot
  - Provides an interface between youBot driver and ROS framework
  - Allows to move the base and arm by sending ROS messages
- **List of Drivers**
  - Drive base
  - Laser scanners
  - Arm
  - Joystick
  - Transformations

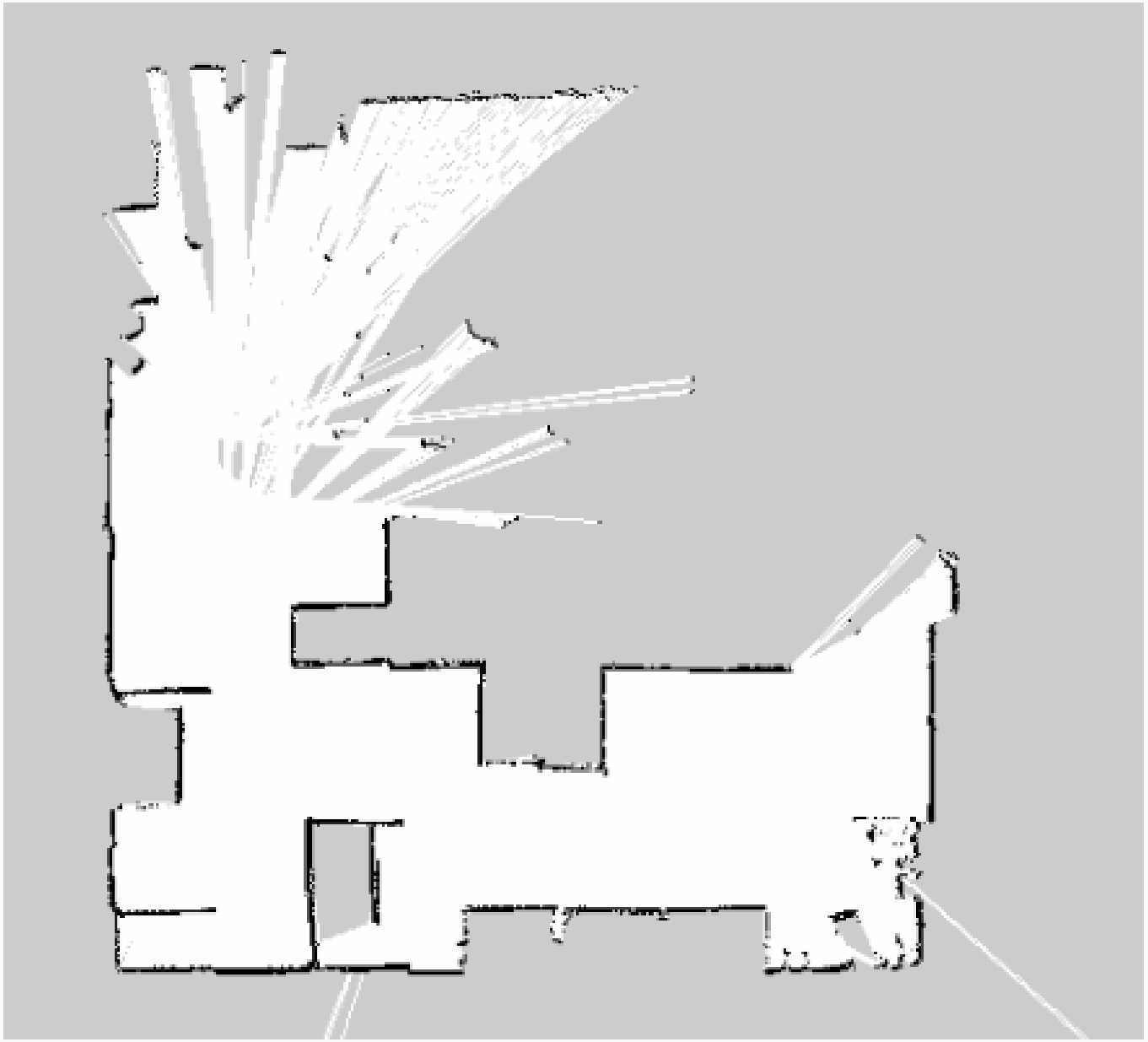
Map building II

- **Problems**
  - Messy Map
- **Solutions**
  - Incorrect transformation between laser frame and base link

Map building III



Map building IV



Localization II

Navigation

- Requirements
  - Map (map_server)
  - Localization (amcl)
  - Odometry source
  - Transforms
  - Sensor sources
  - Goal (move_base)
- Components
  - Planners: global, local
  - Costmaps: global, local
- Output: Velocity command (cmd_vel)

Navigation - Local Planner

- Planner: dwa_local_planner
- Given: plan, costmap, odom
- Generates costs of transversing through map grids
- Output: Velocity command

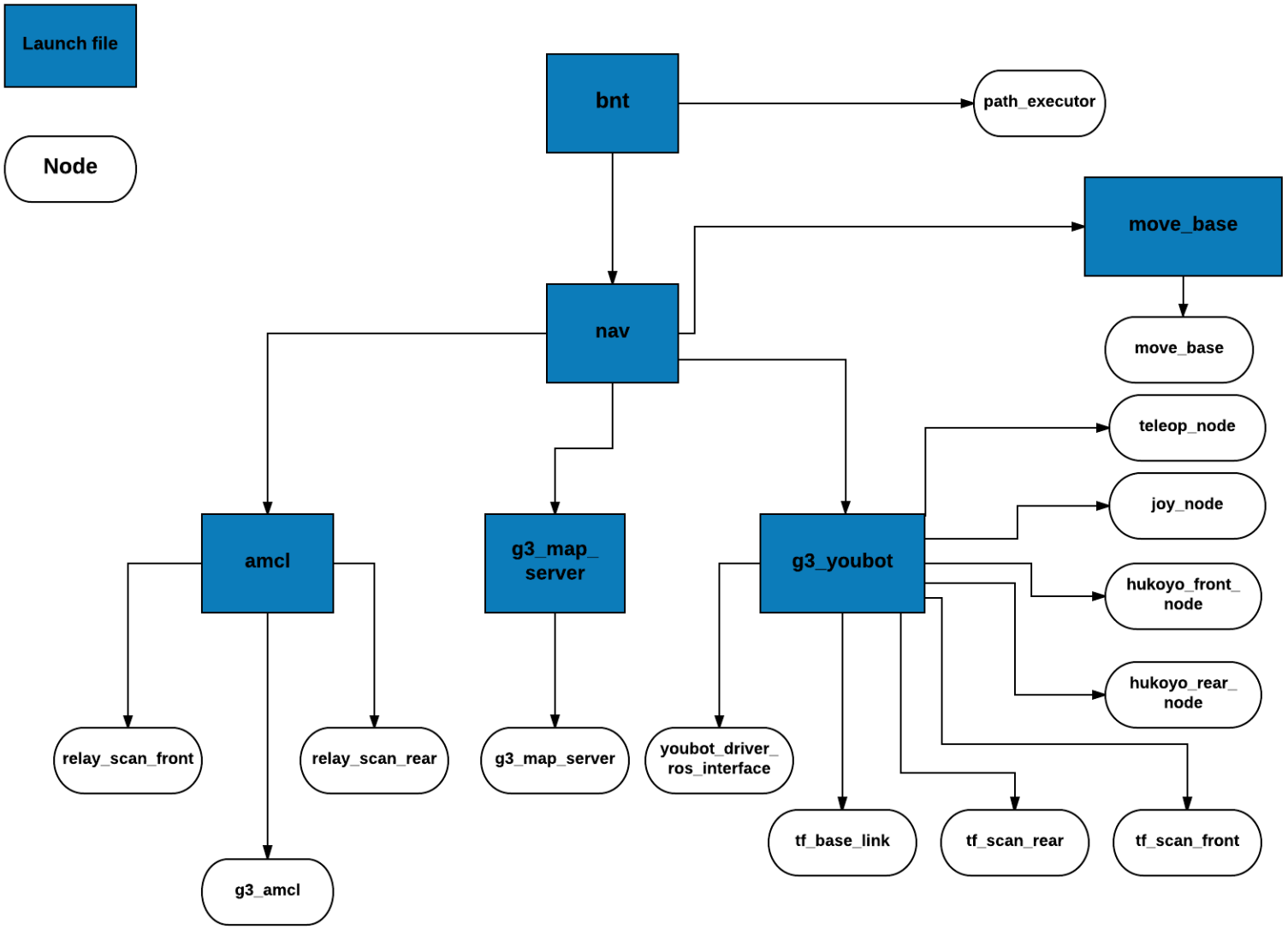
BNT.py

The node acts as path executor that reads a set of user inputs and convert them to move_base_msgs.

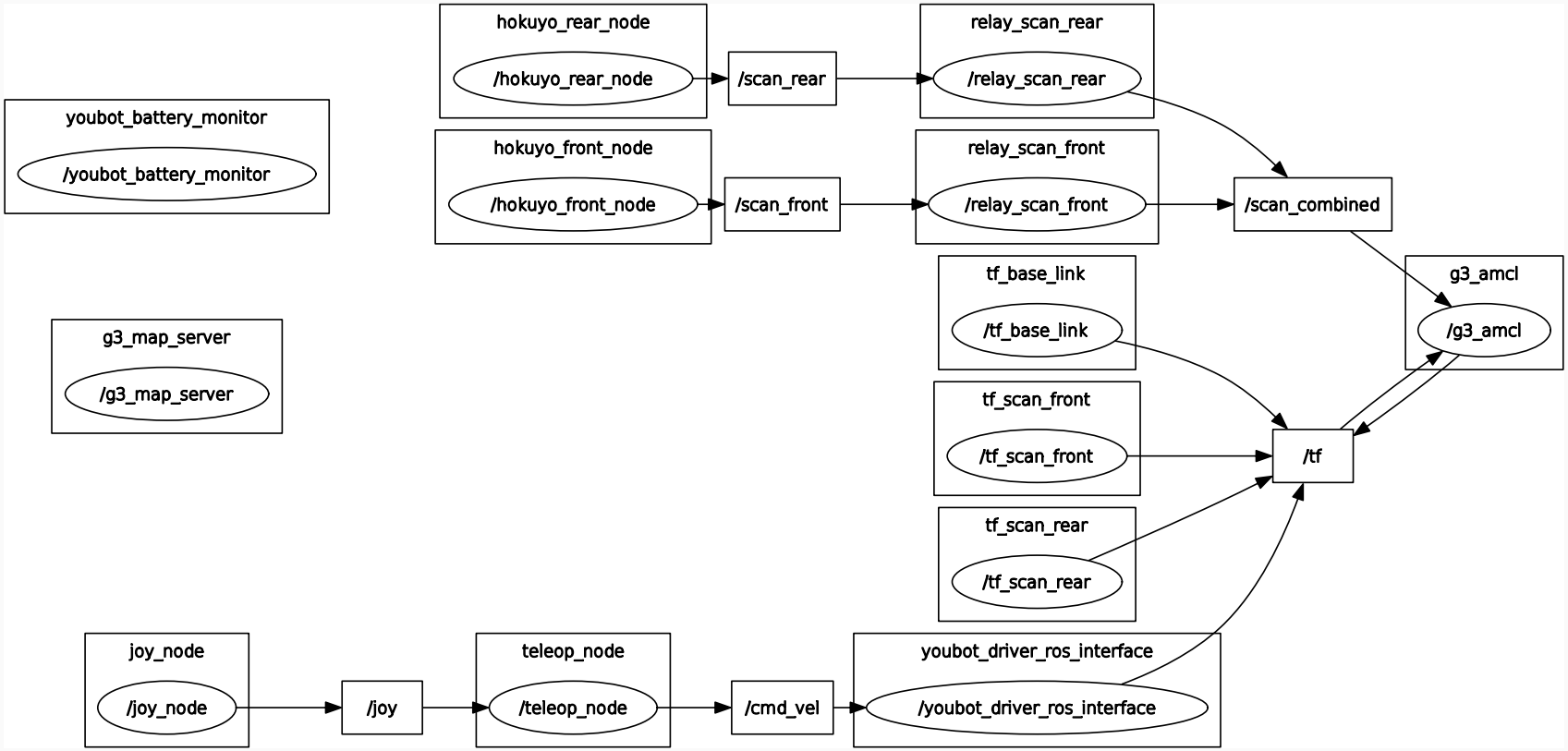
- Class: Position, Pose, Environment, Workspace, PathExecutor
- Functions:
  - Reads user inputs
  - Reads workspace from file
  - Converts workspace to move_base_msgs
  - Clears cost map
  - Sends goal message

Results

Launch Files



RQT Graph


hokuyo_rear_node
/hokuyo_rear_node
/scan_rear
relay_scan_rear
/relay_scan_rear
youbot_battery_monitor
/youbot_battery_monitor
hokuyo_front_node
/hokuyo_front_node
/scan_front
relay_scan_front
/relay_scan_front
/scan_combined
tf_base_link
/tf_base_link
g3_amcl
/g3_amcl
g3_map_server
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tf_scan_front
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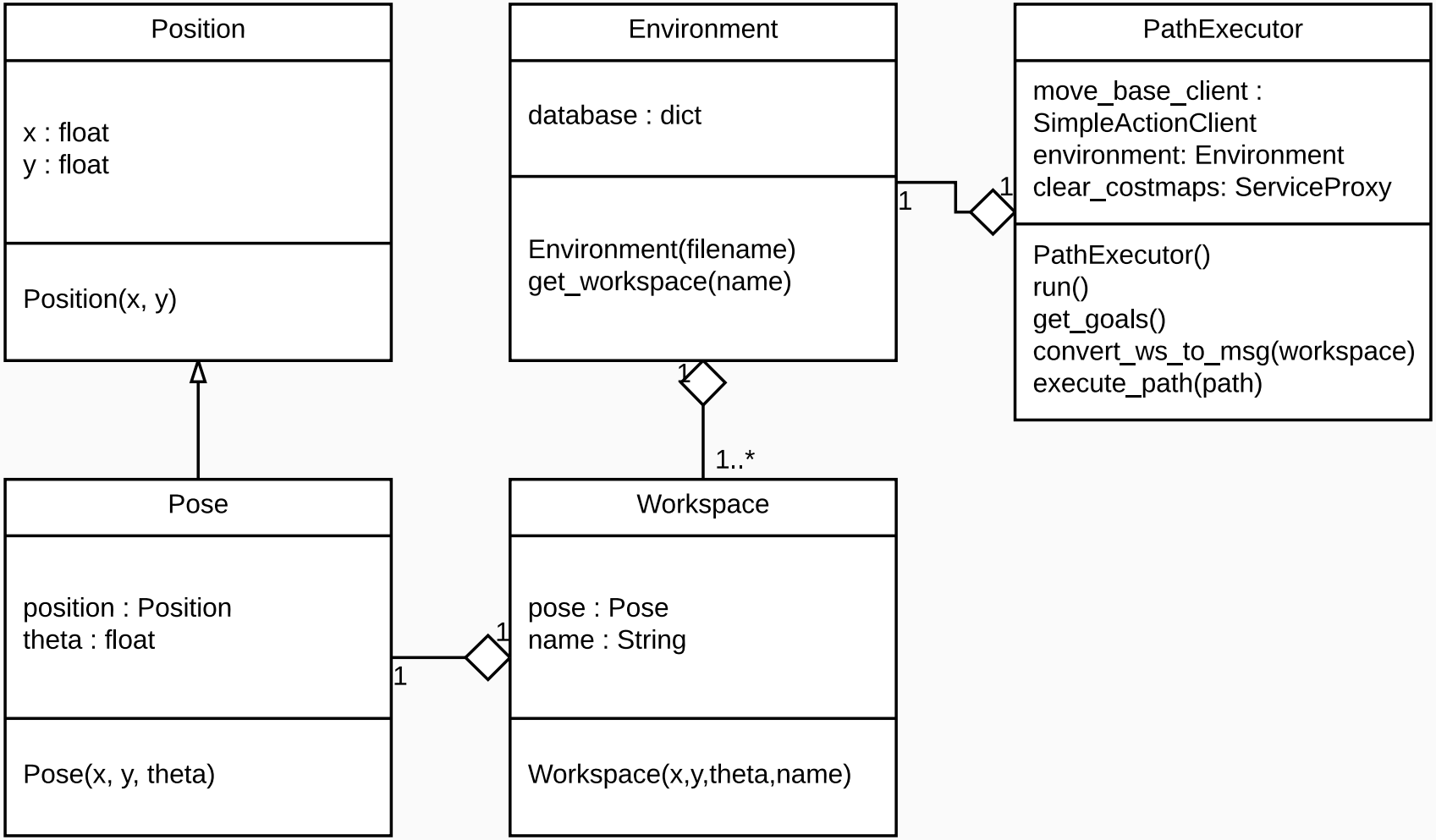
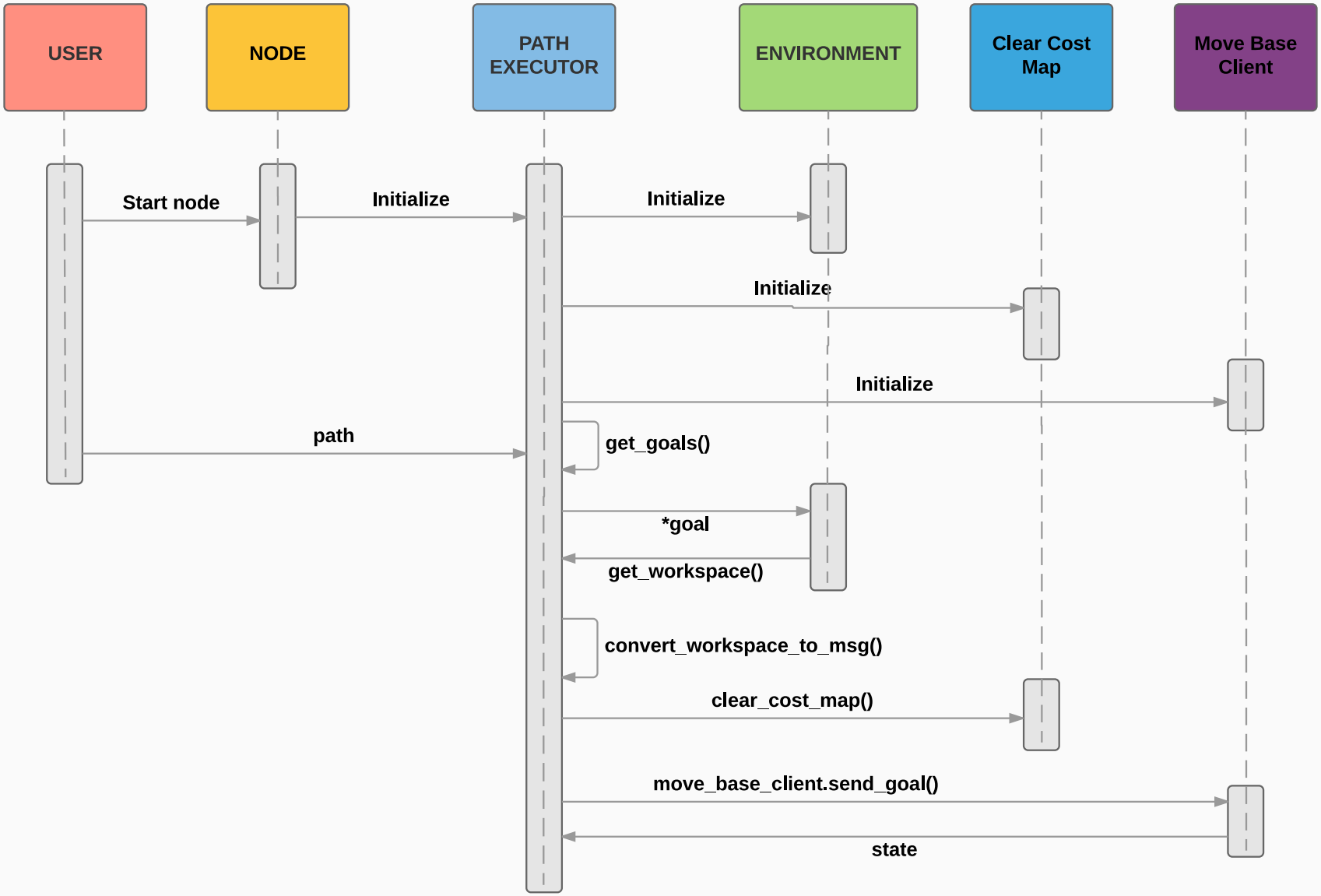
/tf
tf_scan_rear
/tf_scan_rear
joy_node
/joy_node
/joy
teleop_node
/teleop_node
/cmd_vel
youbot_driver_ros_interface
/youbot_driver_ros_interface

Class Diagram



Sequence Diagram



Conclusions

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Future Work