# 2.Multi-vehicle navigation

## 2.1. Program function description

After the virtual machine and Muto-side program are started, after calibrating the positions of Muto1 and Muto2 in the map in the virtual machine rviz, and setting the target points respectively, Muto will automatically navigate to the specified positions respectively.

## 2.2. Program reference path

After entering the docker container, the source code of this function is located at

```
/root/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_multi/launch
```

The virtual machine source code is located at

```
/home/yahboom/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_rviz/launch/displa
y_multi_nav_launch.py
/home/yahboom/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_multi/launch/map_s
erver_launch.py
```

## 2.3. Program startup

Note: Multi-machine communication needs to be set up in advance.
That is to say, the virtual machine and Muto (taking two Muto as an example) need to be on the same LAN and the ROS_DOMAIN_ID must be the same to enable distributed communication.

The virtual machine is running rviz2, visual navigation and loading the navigation map, so you need to first place the navigation map in the following location in the virtual machine

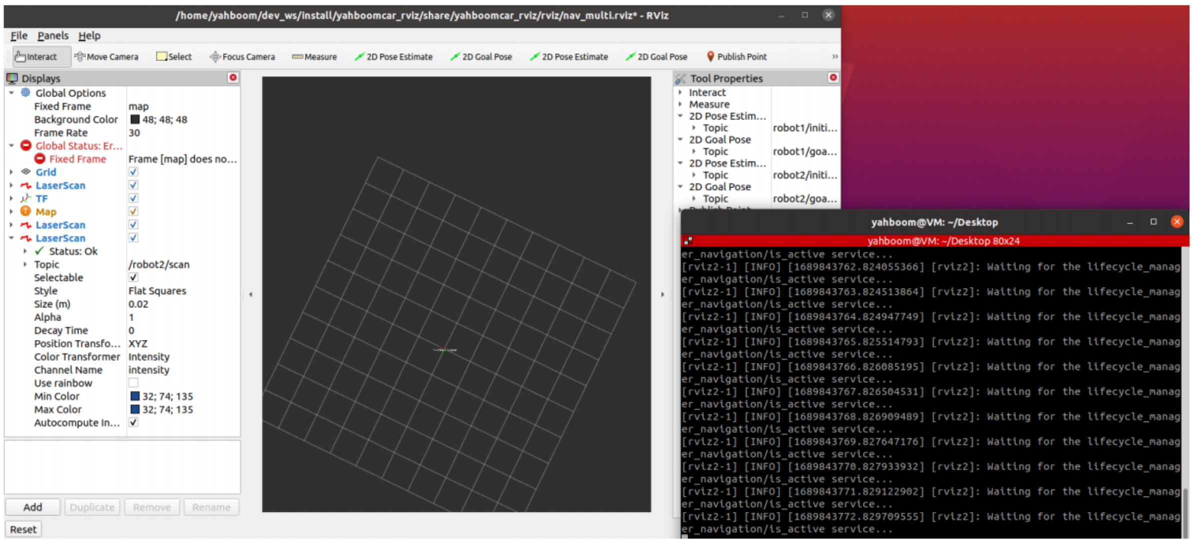
```
/home/yahboom/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_multi/maps
```

yahboom_map.yaml is the startup map parameter file loaded by the program, and yahboom_map.pgm is the map image loaded by the map parameter file.

### 2.3.1. Start RVIZ on the virtual machine

Virtual machine terminal input

```
ros2 launch yahboomcar_rviz display_multi_nav_launch.py
```



/home/yahboom/dev_ws/install/yahboomcar_rviz/share/yahboomcar_rviz/rviz/nav_multi.rviz* - RViz

Displays

```
Global Options
  Fixed Frame          map
  Background Color     48; 48; 48
  Frame Rate           30
Global Status: Er...
  Fixed Frame          Frame [map] does no...
Grid                   ✓
LaserScan              ✓
TF                     ✓
Map                    ✓
LaserScan              ✓
LaserScan              ✓
  Status: Ok
  Topic                /robot2/scan
  Selectable           ✓
  Style                Flat Squares
  Size (m)             0.02
  Alpha                1
  Decay Time           0
  Position Transfo...  XYZ
  Color Transformer    Intensity
  Channel Name         intensity
  Use rainbow
  Min Color            32; 74; 135
  Max Color            32; 74; 135
  Autocompute In...    ✓
```

Tool Properties

```
Interact
Measure
2D Pose Estim...
  Topic                robot1/initi...
2D Goal Pose
  Topic                robot1/goa...
2D Pose Estim...
  Topic                robot2/initi...
2D Goal Pose
  Topic                robot2/goa...
```

yahboom@VM: ~/Desktop

yahboom@VM: ~/Desktop 80x24

```
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843762.824055366] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843763.824513864] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843764.824947749] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843765.825514793] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843766.826085195] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843767.826504531] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843768.826909489] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843769.827647176] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843770.827933932] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843771.829122902] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
[rviz2-1] [INFO] [1689843772.829709555] [rviz2]: Waiting for the lifecycle_manag
er_navigation/is_active service...
```

### 2.3.2. Start two Muto chassis

After entering the docker containers of Muto1 and Muto2 respectively, enter in the terminal according to the actual lidar type

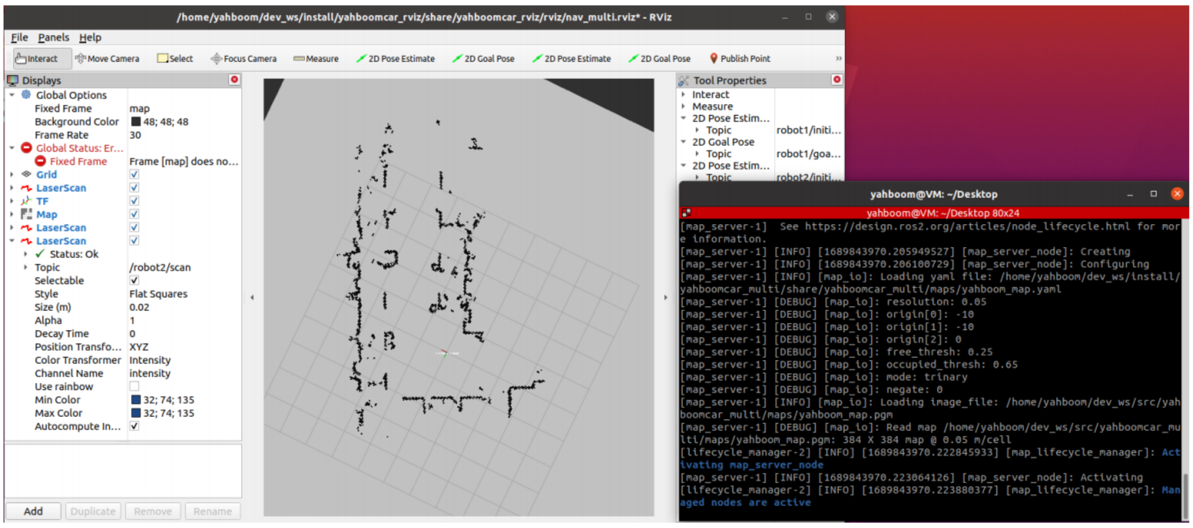
```
#A1 lidar launched
#Muto1
ros2 launch yahboomcar_multi bringup_laser_a1_multi_launch.xml
robot_name:=robot1
#Muto2
ros2 launch yahboomcar_multi bringup_laser_a1_multi_launch.xml
robot_name:=robot2

# -------------------------------Select based on actual lidar type---------------
------------------

#4ROS lidar launched
#Muto1
ros2 launch yahboomcar_multi bringup_laser_4ros_multi_launch.xml
robot_name:=robot1
#Muto2
ros2 launch yahboomcar_multi bringup_laser_4ros_multi_launch.xml
robot_name:=robot2
```

[robot_name] indicates the serial number of Muto to start. Currently, the program can choose to start robot1 and robot2.

### 2.3.3. Load the map on the virtual machine side

```
ros2 launch yahboomcar_multi map_server_launch.py
```

The map loaded here may not be loaded in one go. If rviz does not display the image, then ctrl c closes the node and starts it several times to try.



```
[map_server-1]  See https://design.ros2.org/articles/node_lifecycle.html for mor
e information.
[map_server-1] [INFO] [1689843970.205949527] [map_server_node]: Creating
[map_server-1] [INFO] [1689843970.206100729] [map_server_node]: Configuring
[map_server-1] [INFO] [map_io]: Loading yaml file: /home/yahboom/dev_ws/install/
yahboomcar_multi/share/yahboomcar_multi/maps/yahboom_map.yaml
[map_server-1] [DEBUG] [map_io]: resolution: 0.05
[map_server-1] [DEBUG] [map_io]: origin[0]: -10
[map_server-1] [DEBUG] [map_io]: origin[1]: -10
[map_server-1] [DEBUG] [map_io]: origin[2]: 0
[map_server-1] [DEBUG] [map_io]: free_thresh: 0.25
[map_server-1] [DEBUG] [map_io]: occupied_thresh: 0.65
[map_server-1] [DEBUG] [map_io]: mode: trinary
[map_server-1] [DEBUG] [map_io]: negate: 0
[map_server-1] [INFO] [map_io]: Loading image_file: /home/yahboom/dev_ws/src/yah
boomcar_multi/maps/yahboom_map.pgm
[map_server-1] [DEBUG] [map_io]: Read map /home/yahboom/dev_ws/src/yahboomcar_mu
lti/maps/yahboom_map.pgm: 384 X 384 map @ 0.05 m/cell
[lifecycle_manager-2] [INFO] [1689843970.222845933] [map_lifecycle_manager]: Act
ivating map_server_node
[map_server-1] [INFO] [1689843970.223064126] [map_server_node]: Activating
[lifecycle_manager-2] [INFO] [1689843970.223880377] [map_lifecycle_manager]: Man
aged nodes are active
```

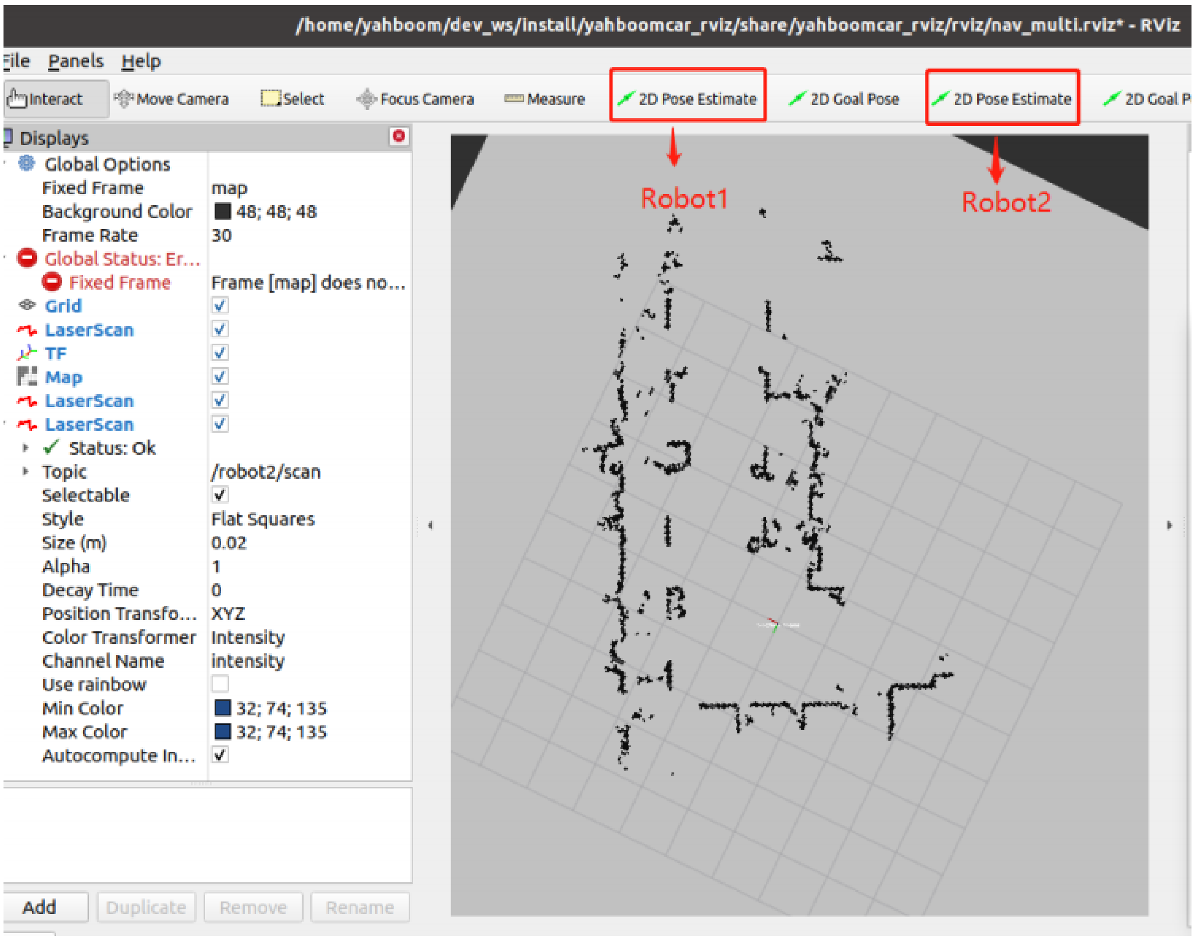
## 2.3.4. Two Muto start AMCL positioning

After entering the docker containers of Muto1 and Muto2 respectively, enter in the terminal

```
#Muto1
ros2 launch yahboomcar_multi amcl_robot1_launch.py
#Muto2
ros2 launch yahboomcar_multi amcl_robot2_launch.py
```

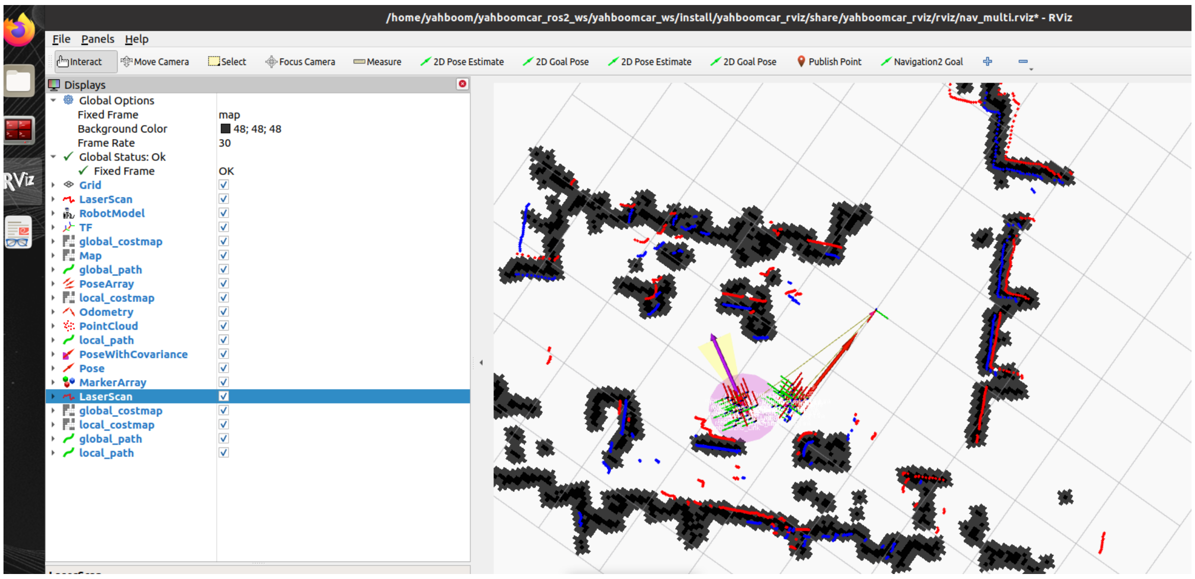
When starting both cars amcl's terminal prints ACML cannot publish a pose or update the transform. Please set the

initial pose..., then use the figure below to mark the positioning of the two cars.



| | |
|---|---|
| Global Options | |
| Fixed Frame | map |
| Background Color | ■ 48; 48; 48 |
| Frame Rate | 30 |
| Global Status: Er... | |
| Fixed Frame | Frame [map] does no... |
| Grid | ✓ |
| LaserScan | ✓ |
| TF | ✓ |
| Map | ✓ |
| LaserScan | ✓ |
| LaserScan | ✓ |
| Status: Ok | |
| Topic | /robot2/scan |
| Selectable | ✓ |
| Style | Flat Squares |
| Size (m) | 0.02 |
| Alpha | 1 |
| Decay Time | 0 |
| Position Transfo... | XYZ |
| Color Transformer | Intensity |
| Channel Name | intensity |
| Use rainbow | |
| Min Color | ■ 32; 74; 135 |
| Max Color | ■ 32; 74; 135 |
| Autocompute In... | ✓ |

After calibration, the robot1 lidar is red and the robot2 lidar is blue.


/home/yahboom/yahboomcar_ros2_ws/yahboomcar_ws/install/yahboomcar_rviz/share/yahboomcar_rviz/rviz/nav_multi.rviz* - RViz
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose 2D Pose Estimate 2D Goal Pose Publish Point Navigation2 Goal
Displays

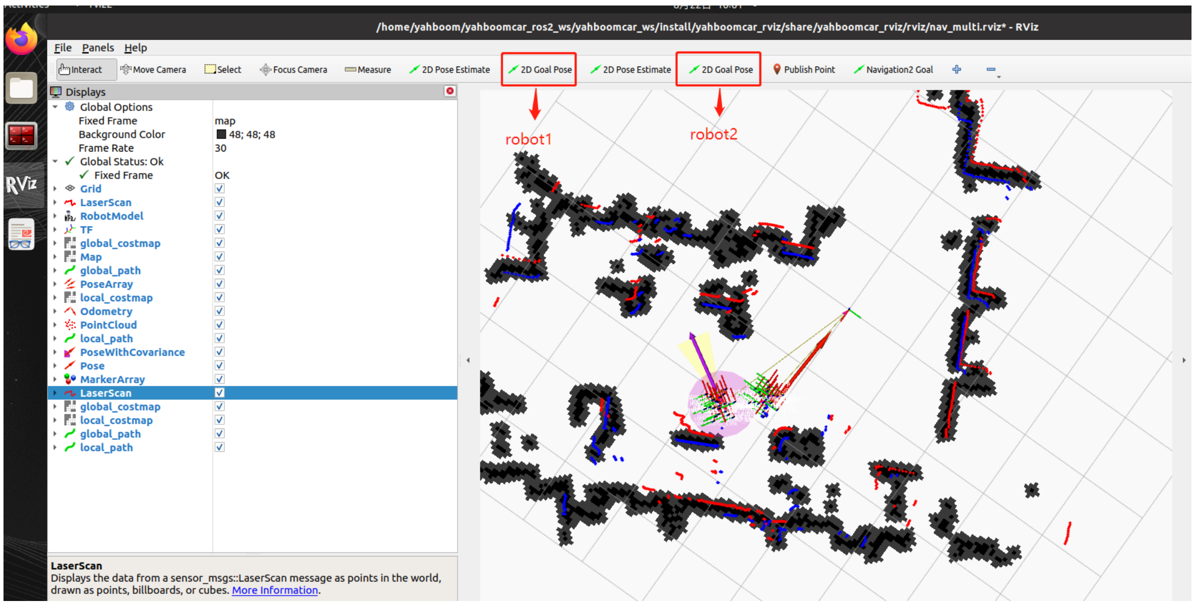
```
Global Options
  Fixed Frame         map
  Background Color    48; 48; 48
  Frame Rate          30
Global Status: Ok
  Fixed Frame         OK
Grid
LaserScan
RobotModel
TF
global_costmap
Map
global_path
PoseArray
local_costmap
Odometry
PointCloud
local_path
PoseWithCovariance
Pose
MarkerArray
LaserScan
global_costmap
local_costmap
global_path
local_path
```

## 2.3.5. Two Mutos start DWB navigation or TEB navigation, choose one.

After entering the docker containers of Muto1 and Muto2 respectively, enter in the terminal

```
#Start DWB Navigation
#Muto1
ros2 launch yahboomcar_multi nav_dwb_robot1_launch.py
#Muto2
ros2 launch yahboomcar_multi nav_dwb_robot2_launch.py

#--------------------Here you can choose one of the two options to run.-----------
---------

#Start TEB Navigation
#Muto1
ros2 launch yahboomcar_multi nav_teb_robot1_launch.py
#Muto2
ros2 launch yahboomcar_multi nav_teb_robot2_launch.py
```

After the program is started, use the tools shown in the figure below to set the target point.


/home/yahboom/yahboomcar_ros2_ws/yahboomcar_ws/install/yahboomcar_rviz/share/yahboomcar_rviz/rviz/nav_multi.rviz* - RViz
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose 2D Pose Estimate 2D Goal Pose Publish Point Navigation2 Goal
Displays
robot1
robot2

```
Global Options
  Fixed Frame         map
  Background Color    48; 48; 48
  Frame Rate          30
Global Status: Ok
  Fixed Frame         OK
Grid
LaserScan
RobotModel
TF
global_costmap
Map
global_path
PoseArray
local_costmap
Odometry
PointCloud
local_path
PoseWithCovariance
Pose
MarkerArray
LaserScan
global_costmap
local_costmap
global_path
local_path
```

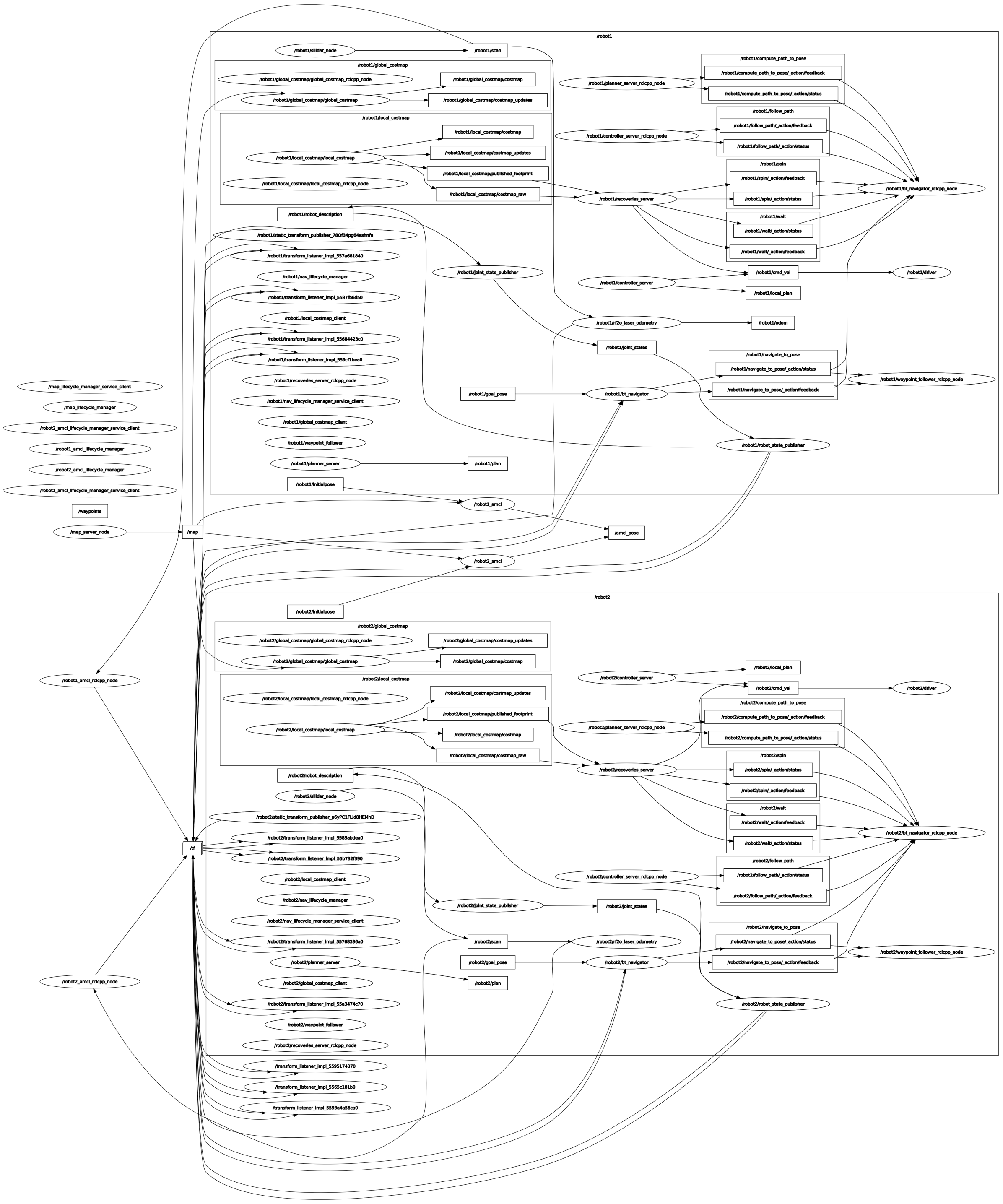
LaserScan
Displays the data from a sensor_msgs::LaserScan message as points in the world, drawn as points, billboards, or cubes. More Information.

After the target point is given, Muto1 will navigate to their respective destinations.

## 2.4. View node communication diagram

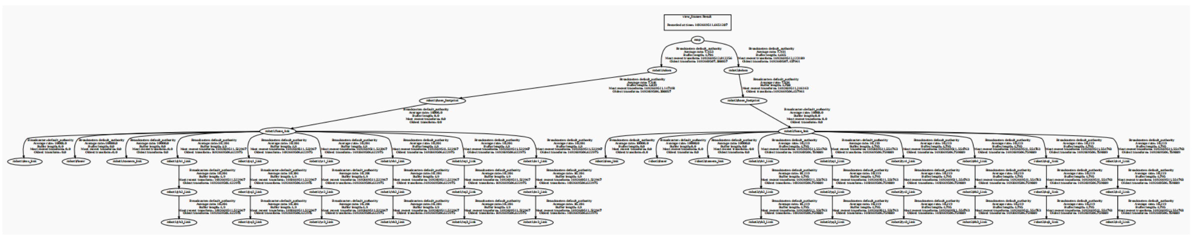
Virtual machine terminal input

```
ros2 run rqt_graph rqt_graph
```



## 2.5. TF transformation

```
ros2 run tf2_tools view_frames.py
```



If you can't see the above picture clearly, you can look at the frames.pdf file in the directory of this course, which contains high-definition TF pictures.