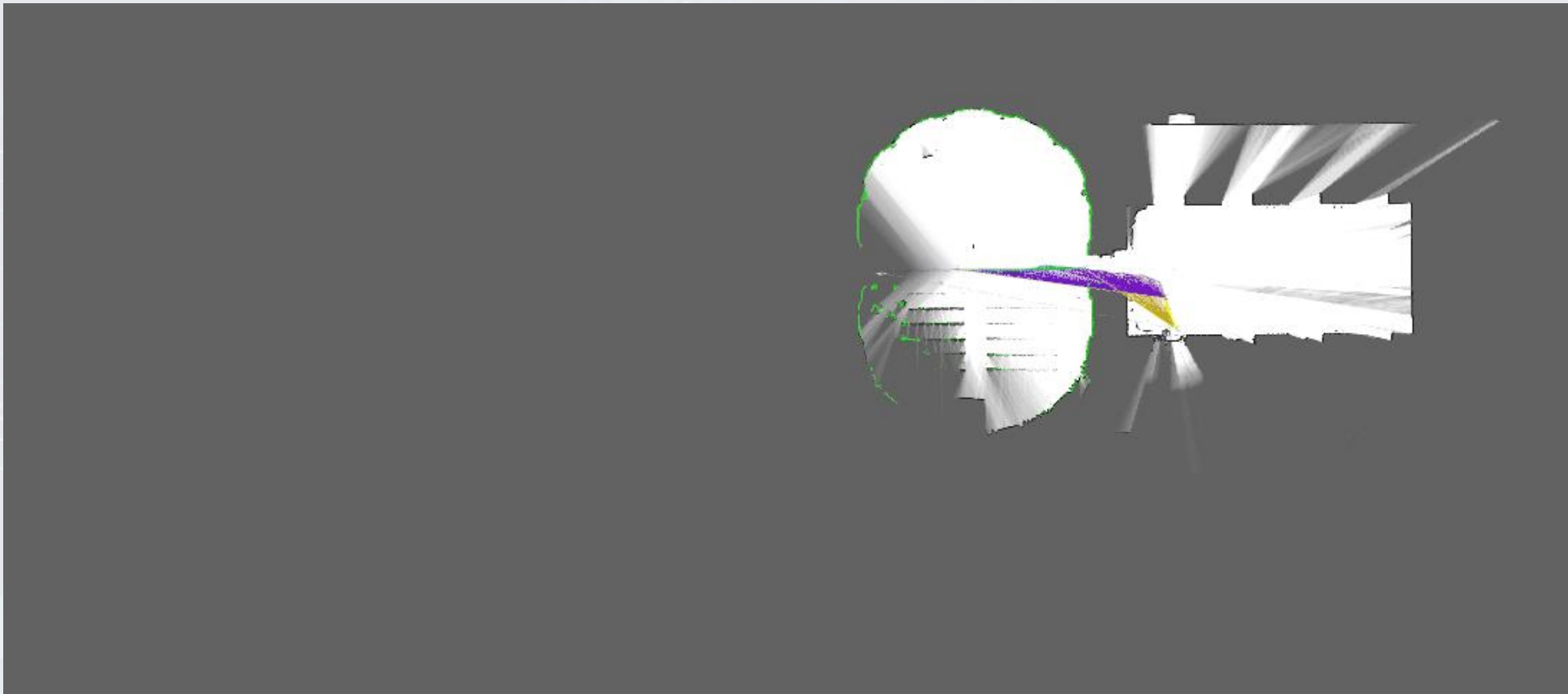


iron-X's SLAM and Navigation **By TESR**

ROS2

iron-X's SLAM Cartographer

- **Cartographer** is a system that provides real-time simultaneous localization and mapping (SLAM) in 2D and 3D across multiple platforms and sensor configurations.



iron-X's SLAM Cartographer

- To run SLAM you must to active the iron-X's bringup by using:

**On the Remote Desktop(NoMachine) or Remote Terminal*

```
ros2 launch ironx_bringup ironx_start.launch.py
```

- And then, launch the iron-X's SLAM Cartographer by using:

**On the PC/Laptop Terminal*

```
ros2 launch ironx_navigation cartographer.launch.py use_sim_time:=false
```

```
pi@ubuntu: ~  
pi@ubuntu:~$ ros2 launch ironx_bringup ironx_start.launch.py  
[INFO] [launch]: All log files can be found below /home/pi/.ros/log/2022-09-06-14-23-07-861668-ubuntu-30298  
[INFO] [launch]: Default logging verbosity is set to INFO  
[WARNING] [launch_ros.actions.node]: Parameter file path is not a file: /home/pi/ros2_ws/install/ironx_driver/share/ironx_driver/ironx_driver/imu_node.py  
urdf_path : /home/pi/ros2_ws/src/ironx_simulation/ironx_description/urdf/ironx_3d_camera.urdf  
[INFO] [rplidar_composition-1]: process started with pid [30375]  
[INFO] [ironx_driver-2]: process started with pid [30377]  
[INFO] [ironx_driver-3]: process started with pid [30378]
```

**On the Remote Desktop(NoMachine) or Remote Terminal*

```
rengy@tesr-9939: ~/ros2_ws  
rengy@tesr-9939:~/ros2_ws$ ros2 launch ironx_navigation cartographer.launch.py use_sim_time:=false  
[INFO] [launch]: All log files can be found below /home/rengy/.ros/log/2022-09-06-14-25-40-296917-tesr-9939-37187  
[INFO] [launch]: Default logging verbosity is set to INFO  
[INFO] [cartographer_node-1]: process started with pid [37189]  
[INFO] [occupancy_grid_node-2]: process started with pid [37191]  
[INFO] [rviz2-3]: process started with pid [37193]  
[cartographer_node-1] [INFO] [1662449140.377145053] [cartographer_ros]: I0906 14:25:40.000000 37189 configuration_file_resolver.cc:41] Found '/home/rengy/ros2_ws/install/ironx_navigation/share/ironx_navigation/config/ironx_lds_2d.lua' for 'ironx_lds_2d.lua'.  
[cartographer_node-1] [INFO] [1662449140.377360196] [cartographer_ros]: I0906 14:25:40.000000 37189 configuration_file_resolver.cc:41] Found '/opt/ros/foxy/share/cartographer/configuration_files/map_builder.lua' for 'map_builder.lua'.
```

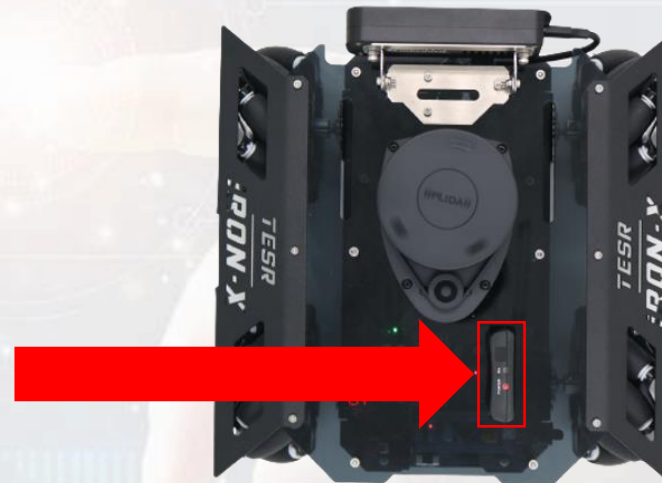
**On the PC/Laptop Terminal*

iron-X's SLAM Cartographer

- And then, you may use the keyboard to control iron-X's by type:

```
ros2 run teleop_twist_keyboard teleop_twist_keyboard
```

- You can also use the joystick that connected on module on iron-X too.



iron-X's SLAM Cartographer

- Using joystick to move around your place to draw a map.

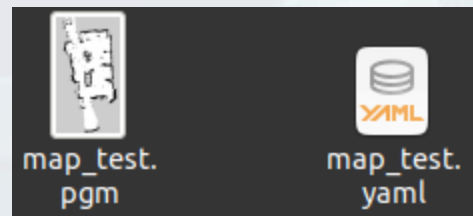


Save a map for Navigation

- And then, you can save a map that you drew using:

```
ros2 run nav2_map_server map_saver_cli -f ~/ros2_ws/src/ironx_navigation/map/map_test
```

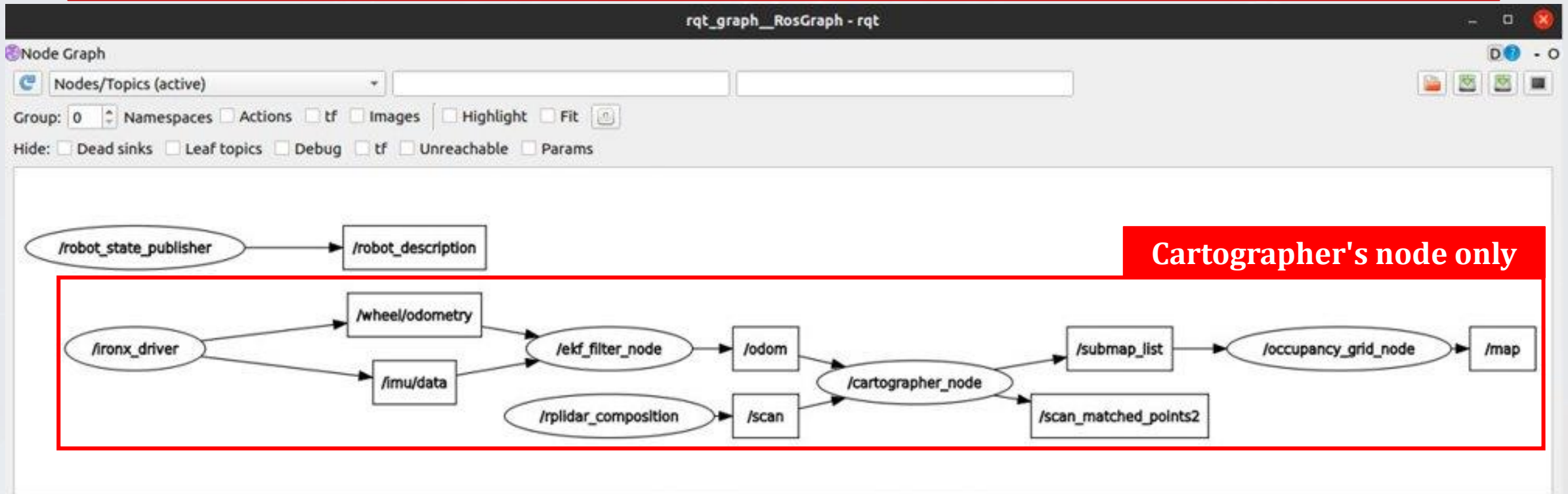
```
rengy@tesr-9939: ~  
rengy@tesr-9939:~$ ros2 run nav2_map_server map_saver_cli -f ~/ros2_ws/src/ironx_navigation/map/map_test  
[INFO] [1662450140.899949523] [map_saver]:  
    map_saver lifecycle node launched.  
    Waiting on external lifecycle transitions to activate  
    See https://design.ros2.org/articles/node_lifecycle.html for more information.  
[INFO] [1662450140.900033273] [map_saver]: Creating  
[INFO] [1662450140.900152330] [map_saver]: Saving map from 'map' topic to '/home/rengy/ros2_ws/src/ironx_navigation/map/map_test' file  
[WARN] [1662450140.900162460] [map_saver]: Free threshold unspecified. Setting it to default value: 0.250000  
[WARN] [1662450140.900171677] [map_saver]: Occupied threshold unspecified. Setting it to default value: 0.650000  
[WARN] [map_io]: Image format unspecified. Setting it to: pgm  
[INFO] [map_io]: Received a 140 X 85 map @ 0.05 m/pix  
[INFO] [map_io]: Writing map occupancy data to /home/rengy/ros2_ws/src/ironx_navigation/map/map_test.pgm  
[INFO] [map_io]: Writing map metadata to /home/rengy/ros2_ws/src/ironx_navigation/map/map_test.yaml  
[INFO] [map_io]: Map saved  
[INFO] [1662450141.425802215] [map_saver]: Map saved successfully  
[INFO] [1662450141.425868321] [map_saver]: Destroying
```



After save the map you will get 2 file are map_test.pgm and map_test.yaml at where you are fill to save it. In this case, path of file is ~/ros2_ws/src/ironx_navigation/map

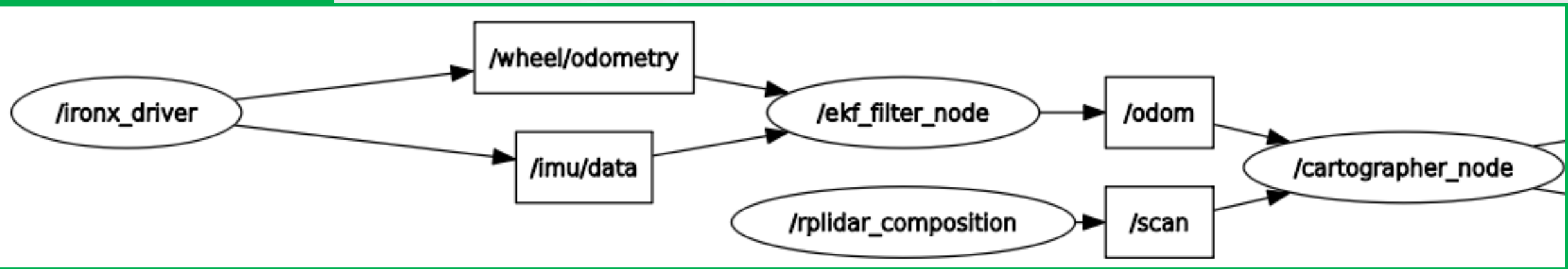
RosGraph of **iron-X's** SLAM Cartographer

- You can see the RosGraph of iron-X's SLAM Cartographer using:
rqt_graph

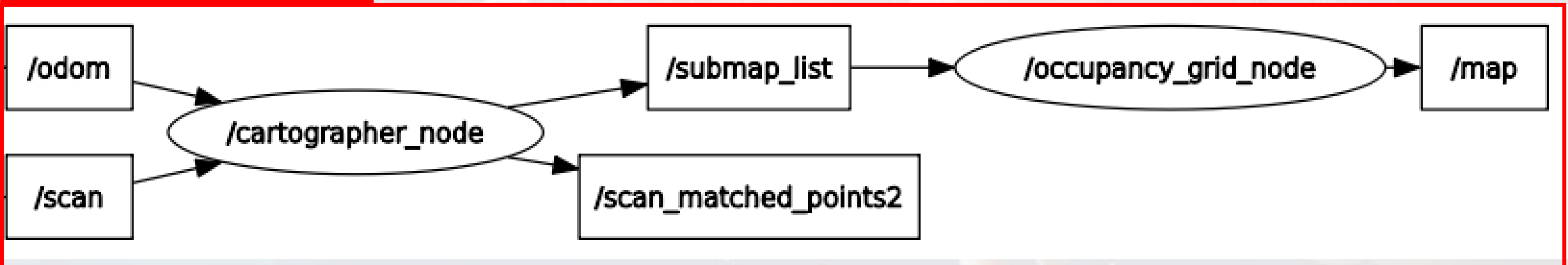


RosGraph of **iron-X's** SLAM Cartographer

Cartographer's Input



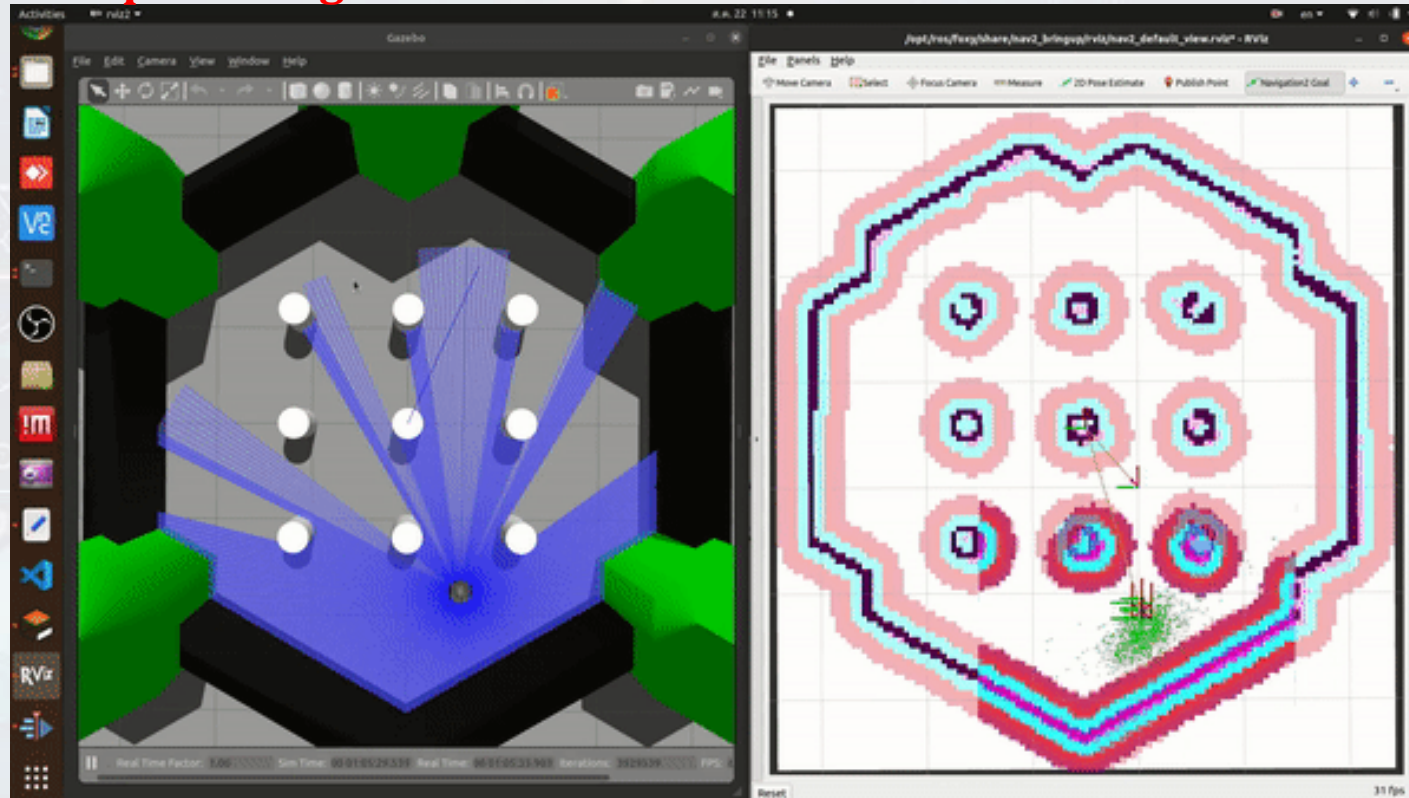
Cartographer's output



iron-X's Navigation

- A 2D navigation stack that takes in information from odometry, sensor streams, and a goal pose and outputs safe velocity commands that are sent to a mobile base

Example from gazebo



Speed x4

Launch the iron-X's Navigation

- Before run the navigation, you need to active iron-X's bringup using:

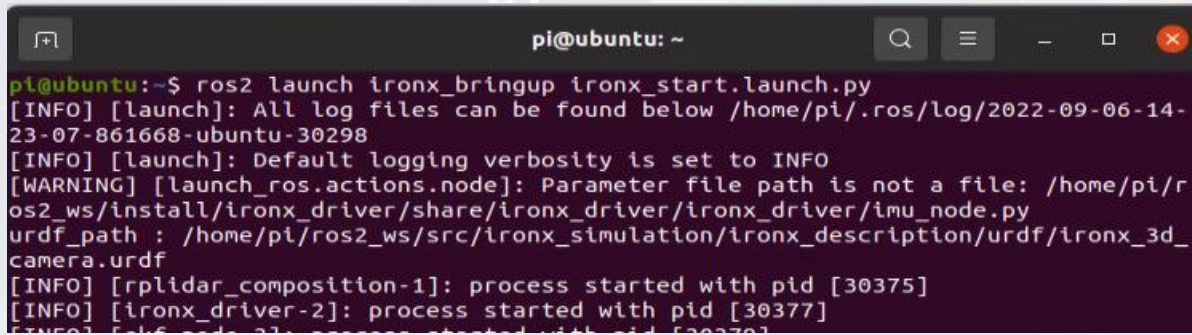
**On the Remote Desktop(NoMachine) or Remote Terminal*

```
ros2 launch ironx_bringup ironx_start.launch.py
```

- You can run the iron-X's navigation by using:

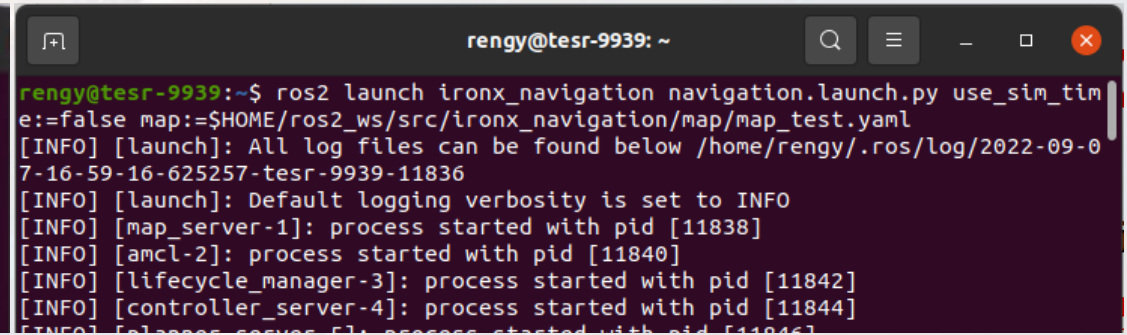
**On the PC/Laptop Terminal*

```
ros2 launch ironx_navigation navigation.launch.py use_sim_time:=false map:=$HOME/ros2_ws/src/ironx_navigation/map/map_test.yaml
```



```
pi@ubuntu: ~  
pi@ubuntu:~$ ros2 launch ironx_bringup ironx_start.launch.py  
[INFO] [launch]: All log files can be found below /home/pi/.ros/log/2022-09-06-14-23-07-861668-ubuntu-30298  
[INFO] [launch]: Default logging verbosity is set to INFO  
[WARNING] [launch_ros.actions.node]: Parameter file path is not a file: /home/pi/ros2_ws/install/ironx_driver/share/ironx_driver/ironx_driver/imu_node.py  
urdf_path : /home/pi/ros2_ws/src/ironx_simulation/ironx_description/urdf/ironx_3d_camera.urdf  
[INFO] [rplidar_composition-1]: process started with pid [30375]  
[INFO] [ironx_driver-2]: process started with pid [30377]  
[INFO] [ironx_driver-3]: process started with pid [30378]
```

**On the Remote Desktop(NoMachine) or Remote Terminal*

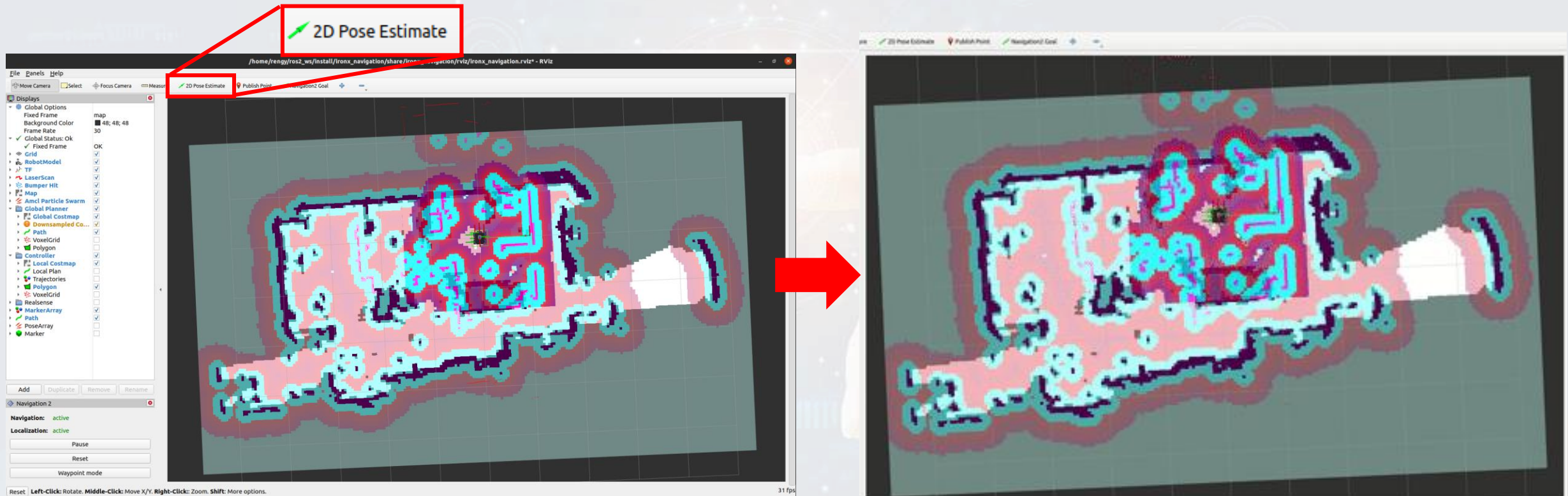


```
rengy@tesr-9939: ~  
rengy@tesr-9939:~$ ros2 launch ironx_navigation navigation.launch.py use_sim_time:=false map:=$HOME/ros2_ws/src/ironx_navigation/map/map_test.yaml  
[INFO] [launch]: All log files can be found below /home/rengy/.ros/log/2022-09-07-16-59-16-625257-tesr-9939-11836  
[INFO] [launch]: Default logging verbosity is set to INFO  
[INFO] [map_server-1]: process started with pid [11838]  
[INFO] [amcl-2]: process started with pid [11840]  
[INFO] [lifecycle_manager-3]: process started with pid [11842]  
[INFO] [controller_server-4]: process started with pid [11844]  
[INFO] [lifecycle_server-5]: process started with pid [11846]
```

**On the PC/Laptop Terminal*

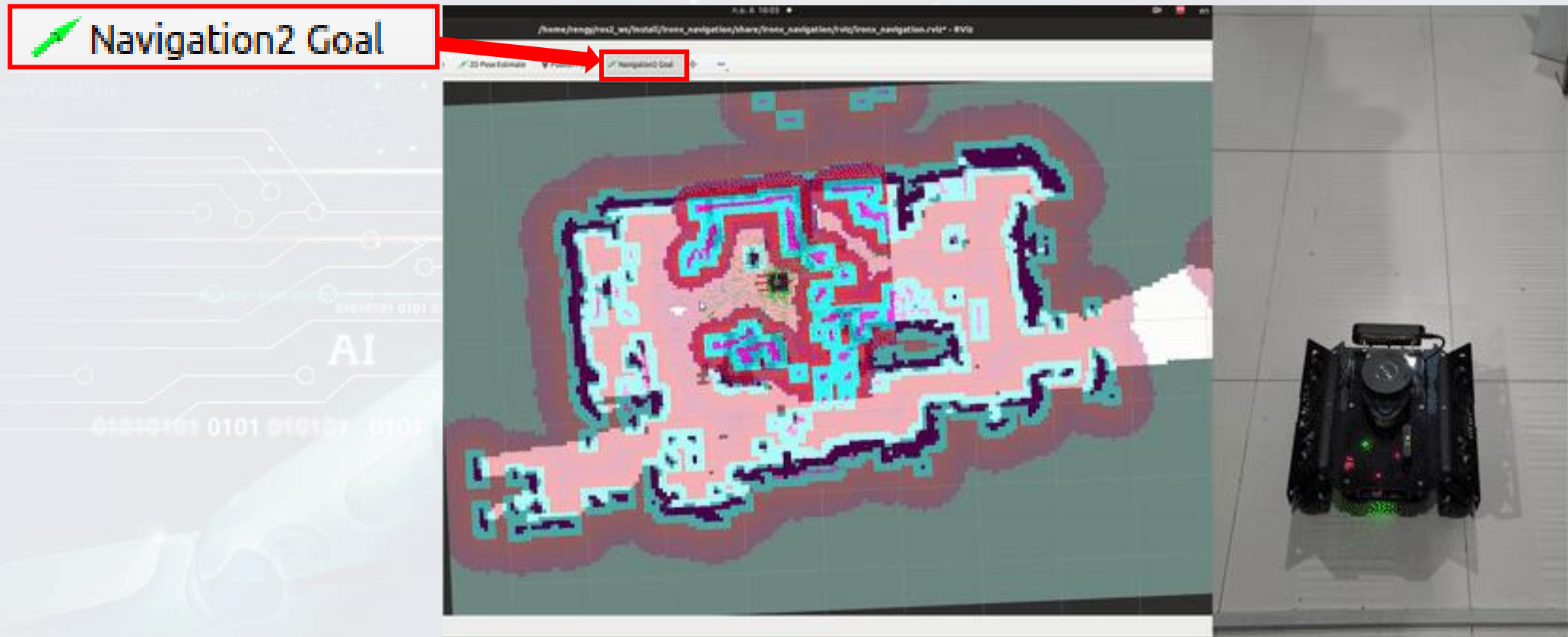
Re-position using 2D Pose Estimate

- You can see on Rviz. If the start position of iron-X's model not the same as the real position. So, you can use **"2D Pose Estimate"** to re-position it:



Navigation2 Goal

- And then, you can publish the goal for the navigation using "**Navigatoin2 Goal**":

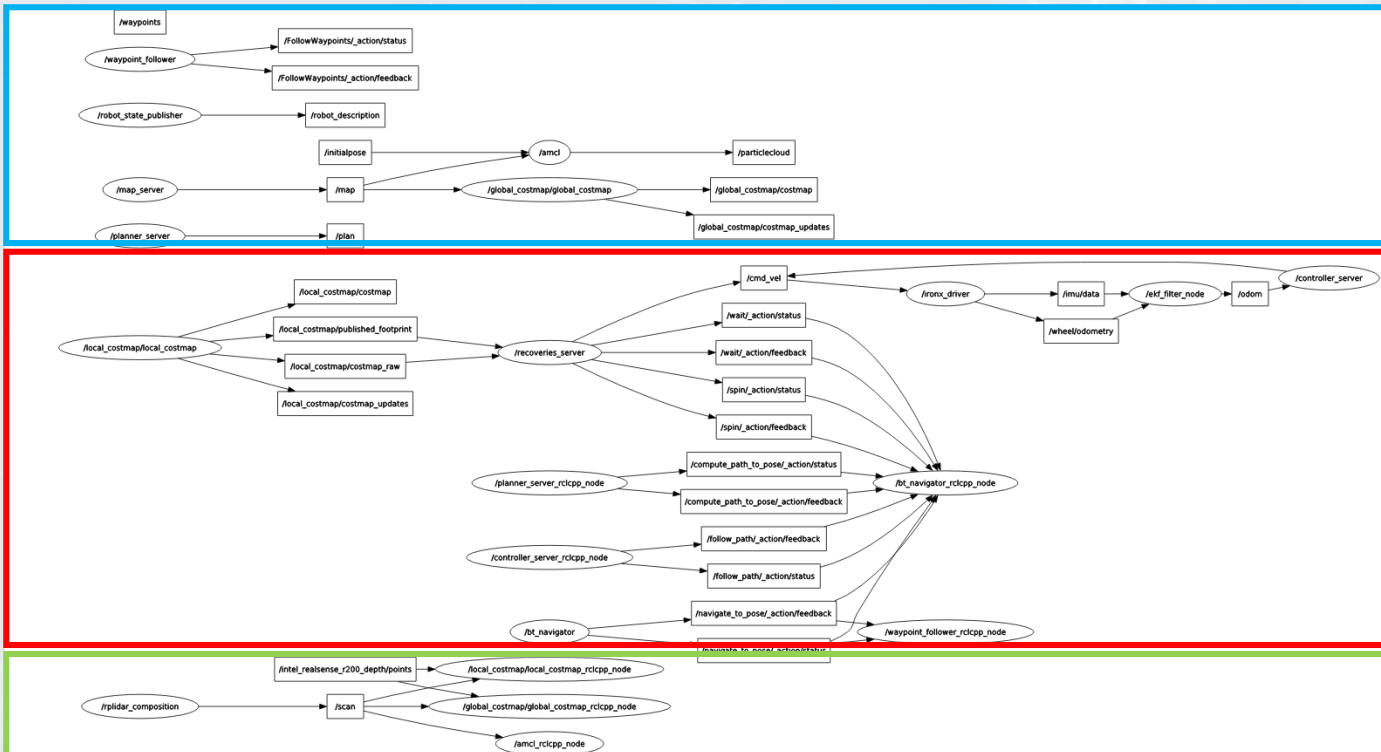


Speed x2

RosGraph of **iron-X's** Navigation

- You can see the RosGraph of iron-X's Navigation using:

rqt_graph



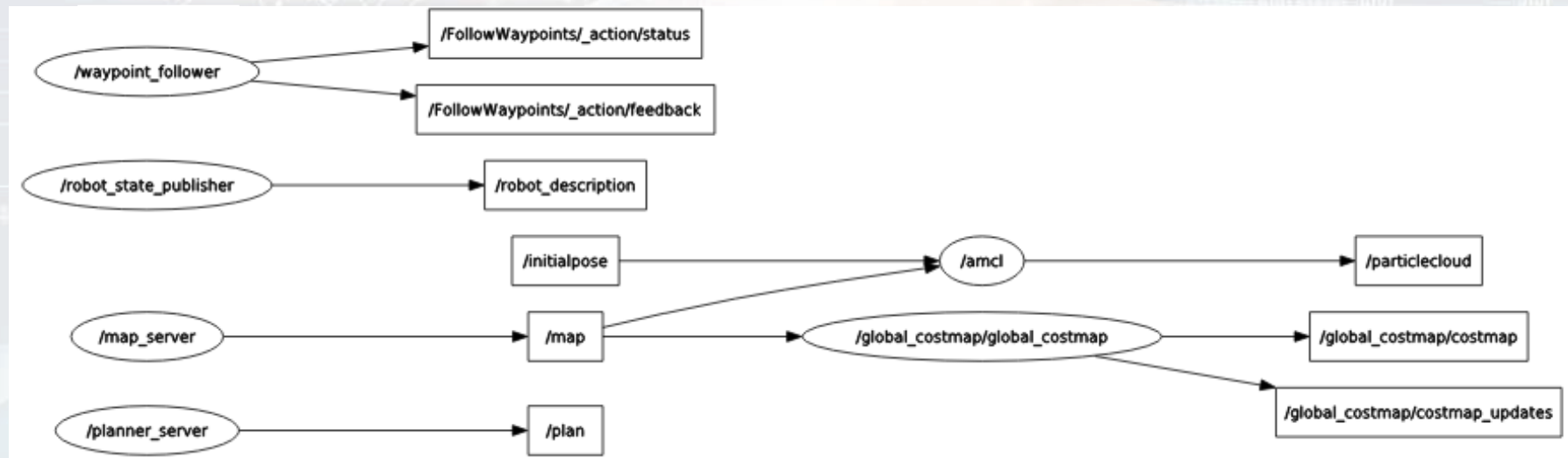
Waypoint_follower, map_server, amcl, global_costmap and planner_server:

Local_costmap, navigation node server and local_plan:

Rplidar_composition node:

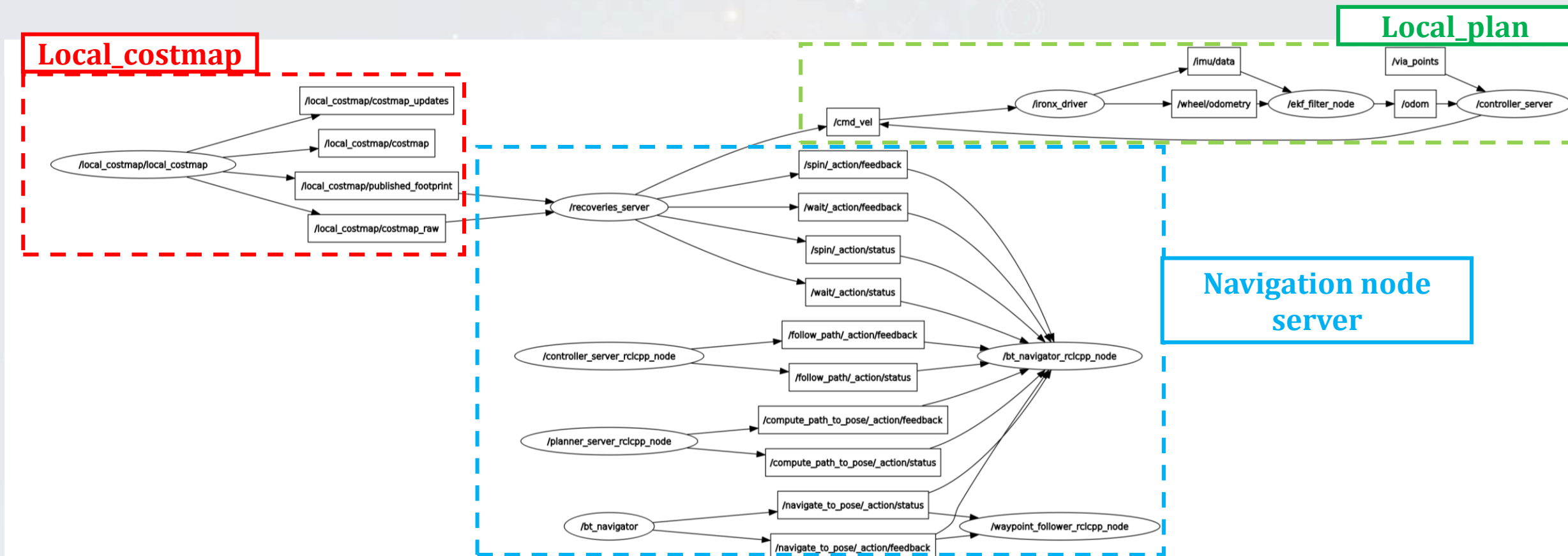
RosGraph of **iron-X's** Navigation

- **Waypoint_follower, map_server, amcl, global_costmap and planner_server:**
 - **Waypoint_follower** - module implement a way of doing waypoint following.
 - **Map_server** - provide the map to the navigation system used in topic and service of nav.
 - **AMCL** - is a probabilistic localization system for a robot moving in 2D.
 - **Global_costmap** - the environment provided from sensor data and 2d static map data.
 - **Planner_server** - handling the plan that requests for the stack and host a map of plugin implementations.



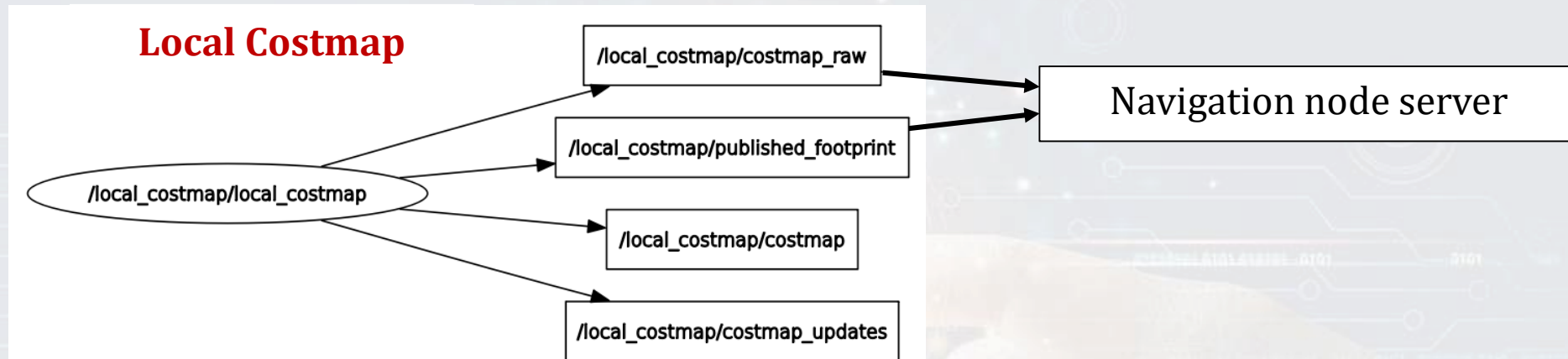
RosGraph of **iron-X's** Navigation

- Local_costmap, navigation node server and local_plan:

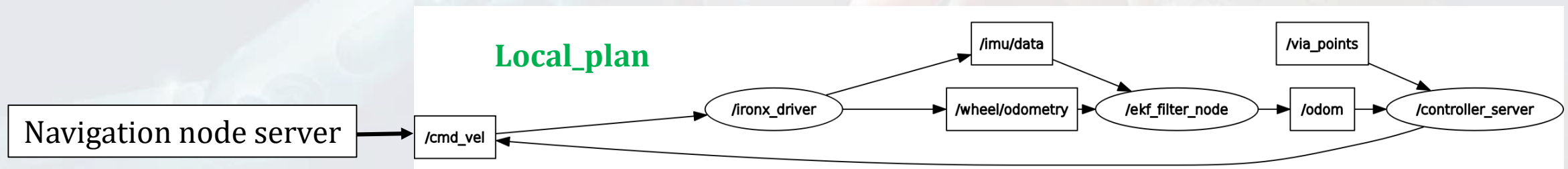


RosGraph of **iron-X's** Navigation

- **Local_costmap and local_plan:**
 - **Local_costmap** – 2d_costmap layer which is the environment provided from sensor data.

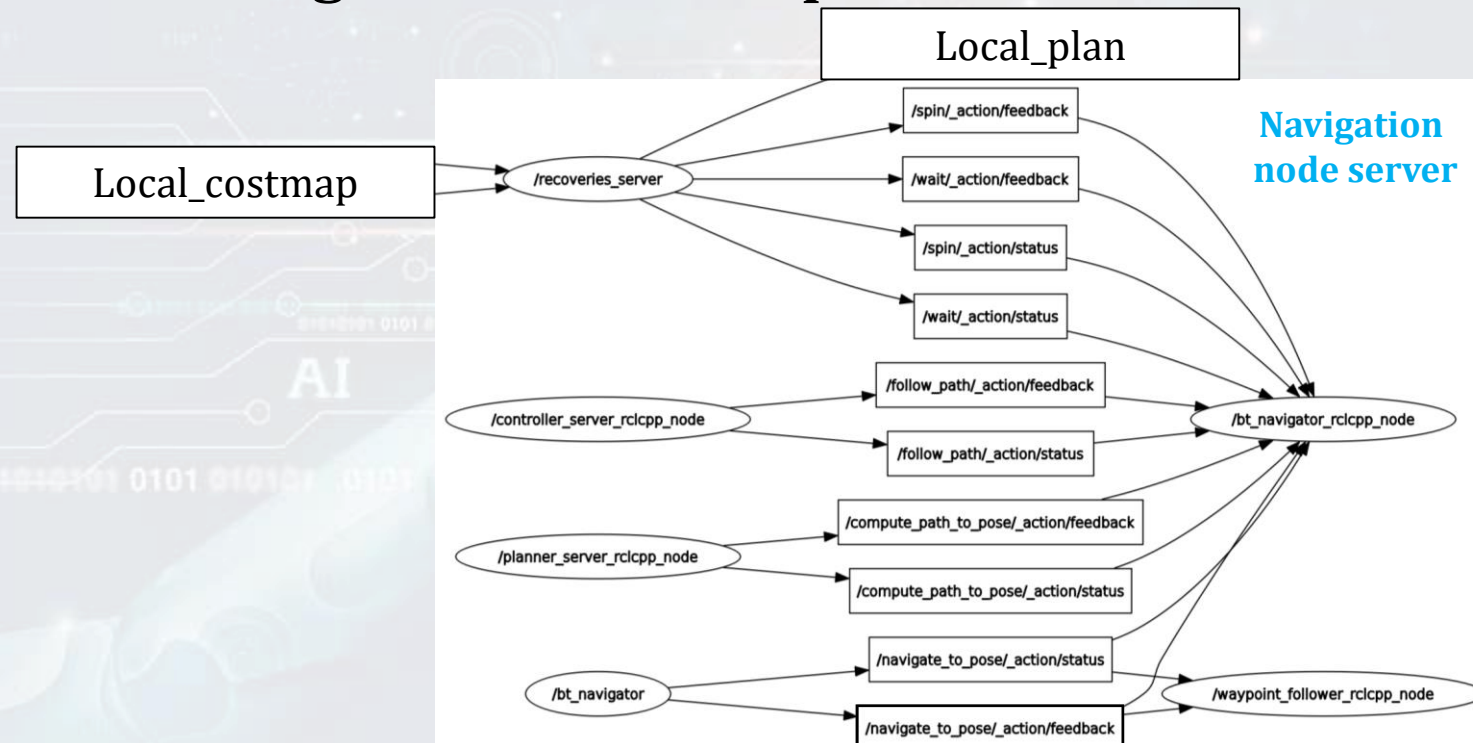


- **Local_plan** - provides implementations of the Trajectory Rollout and Dynamic Window approaches to local robot navigation on a plane.



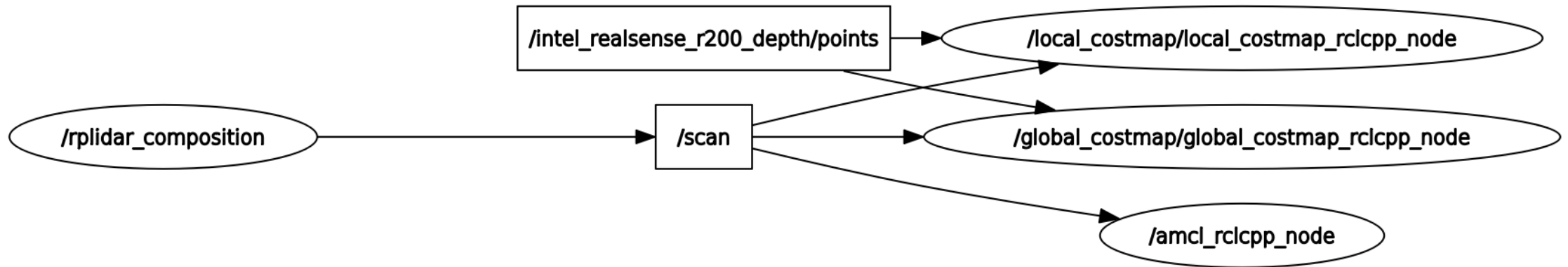
RosGraph of **iron-X's** Navigation

- **Navigation node server** – the part of the navigation stack system that working as a server to provide the action to the iron-X:



RosGraph of **iron-X's** Navigation

- **Rplidar_composition node** – the rplidarNode which is a actuator driver for RPLIDAR that provide scan data from LIDAR sensor. From this graph, it provide scan data to local_costmap, global_costmap and amcl node:



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TESR Co., LTD

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จังหวัดนบุรี 11000