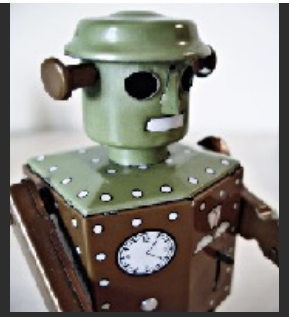
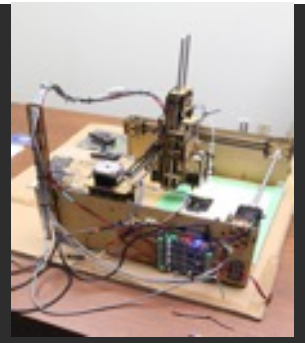
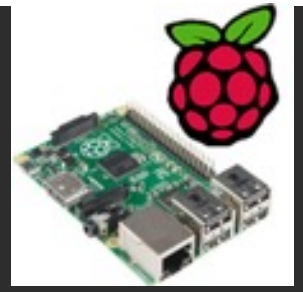



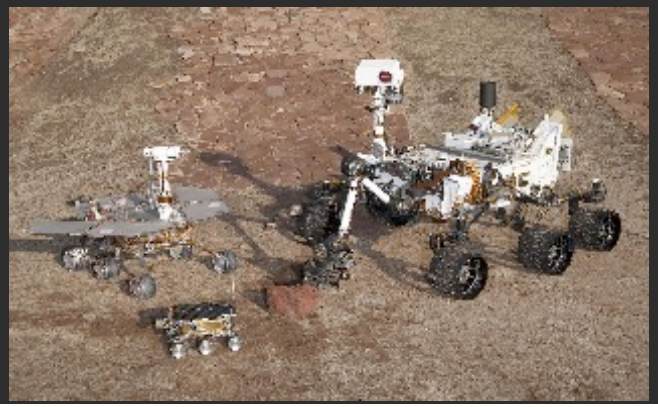
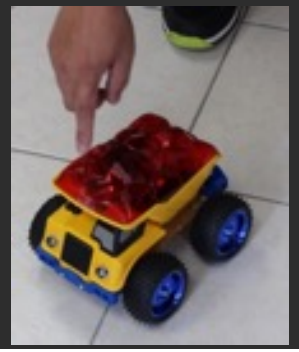




INTRODUCTION TO ROS WITH NEATO TURTLE

ROSS LUNAN

JULY 2, 2023




What is ROS and OS?

- ROS = Robot Operating System, essentially exclusively uses Ubuntu machines. Others, are available but not to the same support extent. Currently Long-Term Support Versions are now the ROS 2 platform

- OSRF = Open Source Robot Foundation, founded in 2012 in Menlo Park, Ca, (https://www.osrfoundation.org/about/). In 2016, OSRF created the for-profit Open Source Robotics Corporation. In Dec/22 Google Intrinsic acquired OSRC. Open Robotics (not-for-profit) holds the ROS, gazebo, and Open-RMF IP , and is their contining support.

  https://discourse.ros.org/t/the-osrc-team-is-joining-intrinsic-and-what-it-means-for-the-ros-community/28764

- Mission: To support the development, distribution, and adoption of open software and hardware for use in robotics research, education, and product development.
- What is ROS: An open-source, meta-operating system for your robot. It provides the services you would expect from an operating system, including hardware abstraction, low-level device control, implementation of commonly-used functionality, message-passing between processes, and package management. It also provides tools and libraries for obtaining, building, writing, and running code across multiple computers.
- Robots: 100's around the world….
- Installations, Tutorials, Blog, Repositories: www.ros.org : ROS currently only runs on Unix-based platforms. Software for ROS is primarily tested on Ubuntu. e.g ROS Humble uses Ubuntu 22.04

Thar be Robots...(a small sample)

http://robots.ros.org/all

Neato Turtle Parts List

- Single Board Computer (SBC): Raspberry Pi3 or Pi4 2 or 4GB
- Power Raspberry Pi with 10,000 MaH or so Battery Bank
- USB-A to Micro USB 12“ cable, USB-A to mini USB (RPi3) or USB-c (RPi4)
- Micro sd Card 16 or 32 GB. Select fast 4K or better
- Neato Robot Vacuum: All models use a similar API from the original 2010 BV 70 & 80 series, newer D-series models D70, D75, D80, D85, and current models D3, D4, D6, D7. Latest D6 & D7 do not.

- Remote Desktop: Ubuntu Machine, such as modest Windows PC (i5) HD reform to “Ubuntu ext” or a 2nd Partition with ext/Ubuntu 22.04 Desktop
- HDMI Monitor, USB Keyboard & Mouse to configure the Pi. Be aware that RPi4 USBC power and micro HDMI connectors
- Optional Teleop: Game Controller, Logitech F710 or Xbox OS4 work great
- Optional Camera: USB Webcam

Installing ROS 2 on Raspberry Pi (or equivalent)

- ROBOT SBC: Format Micro SD card with “RaspberryPi Imager” which enables configuring user name, machine name, WiFi. https://www.raspberrypi.com/software/
- Remote DESKTOP: Download Ubuntu Ub22.05 Desktop Bootable iso Image to your development Workstation and burn to USB Drive. (e.g. belenaEtcher, Win32DiskImager)
- Boot the Pi, and configure the Ubuntu Parameters, including a 4 GB
  - Update packages & add your desired Apps & Utilities (e.g. synapatic, gedit, etc)
  - Open browser & navigate to ROS 2 Install procedure, selecting Desktop

  https://docs.ros.org/en/humble/Installation/Ubuntu-Install-Debians.html
  - Configure the “**Environment Setup**” and “source” from your /Home directory

    :~/ source /opt/ros/humble/setup.bash
  - Follow “**Using colcon to build packages**” https://docs.ros.org/en/humble/Tutorials/Beginner-Client-Libraries/Colcon-Tutorial.html . Select your preferred workspace, e.g. dev_ws. Later, after compiling any code, you must “Source “ every Terminal instance from the colcon root, e.g.

    :~/dev_ws/ source install/setup.bash .

Neato Turtle Installation from Github Repository

- **Install Ubuntu 22.04 (Jammy) Desktop and ROS 2 Humble Desktop (with colcon development) on Desktop Workstation and SBC Raspberry Pi**
- **Prerequisites:**
- sudo apt install build-essential
- sudo apt install ros-humble-xacro sudo apt install python3-rosdep2

Be sure and create a **workspace** and “source” its root directory for your ROS 2 from source builds, on both **Desktop** and **Raspberry Pi Robot**.

- Check ($ sudo clone <repo name>) these following repositories into that **workspace** / source directory as follows:

Workspace , e.g. ros2_ws

- cd <ws>/src
- git clone https://github.com/cpeavy2/botvac_node.git
- git clone https://github.com/cpeavy2/neato_robot.git
- git clone https://github.com/kobuki-base/cmd_vel_mux.git
- git clone https://github.com/kobuki-base/kobuki_velocity_smoother
- git clone https://github.com/stonier/ecl_tools

Install Navigation 2 on Ubuntu PC workstation (not necessary to have on Pi).

- sudo apt install ros-humble-navigation2
- sudo apt install ros-humble-nav2-bringup

Navigation 2 Docs, Github, Tutorials

- NAV 2 https://navigation.ros.org

- Github https://github.com/ros-planning/navigation2

  The required packages can be installed from Binary on your Laptop Desktop. e.g.

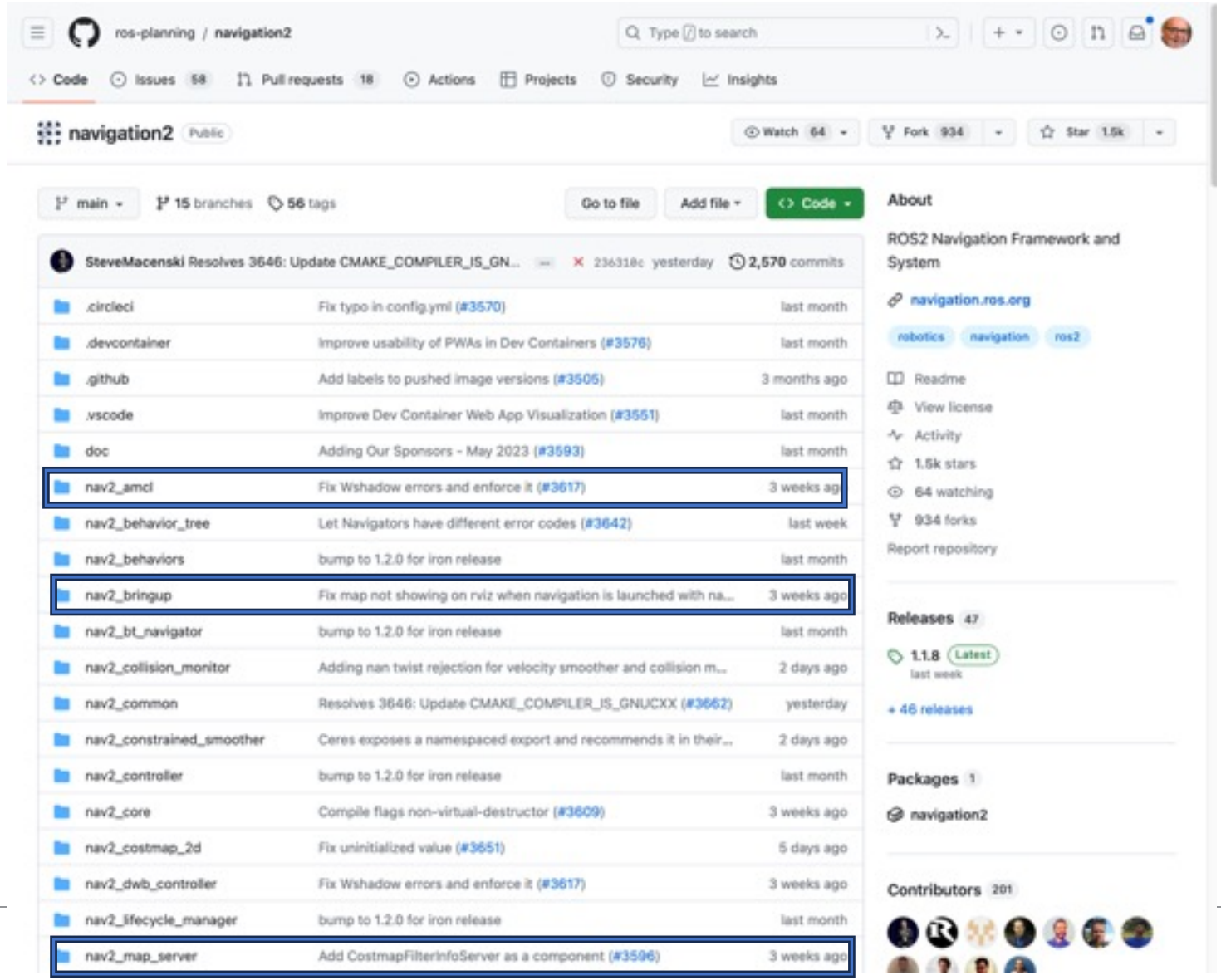
  :$ sudo apt install ros-humble-navigation2

  :$ sudo apt install ros-humble-nav2-bringup

- Getting Started https://navigation.ros.org/getting_started/index.html

  (Don’t necessarily do the Simulation – unless you are curious)

Navigation 2 github.com



N A V 2

ros-planning/navigation2

ROS2 Nodes from Neato Turtle Launch

/amcl

/behavior_server

/bt_navigator

/bt_navigator_navigate_through_poses_rclcpp_node

/bt_navigator_navigate_to_pose_rclcpp_node

/cmd_vel_mux

/controller_server

/global_costmap/global_costmap

/joy_node

/laser_to_base

/launch_ros_4492

/lifecycle_manager_localization

/lifecycle_manager_navigation

/local_costmap/local_costmap

/map_server

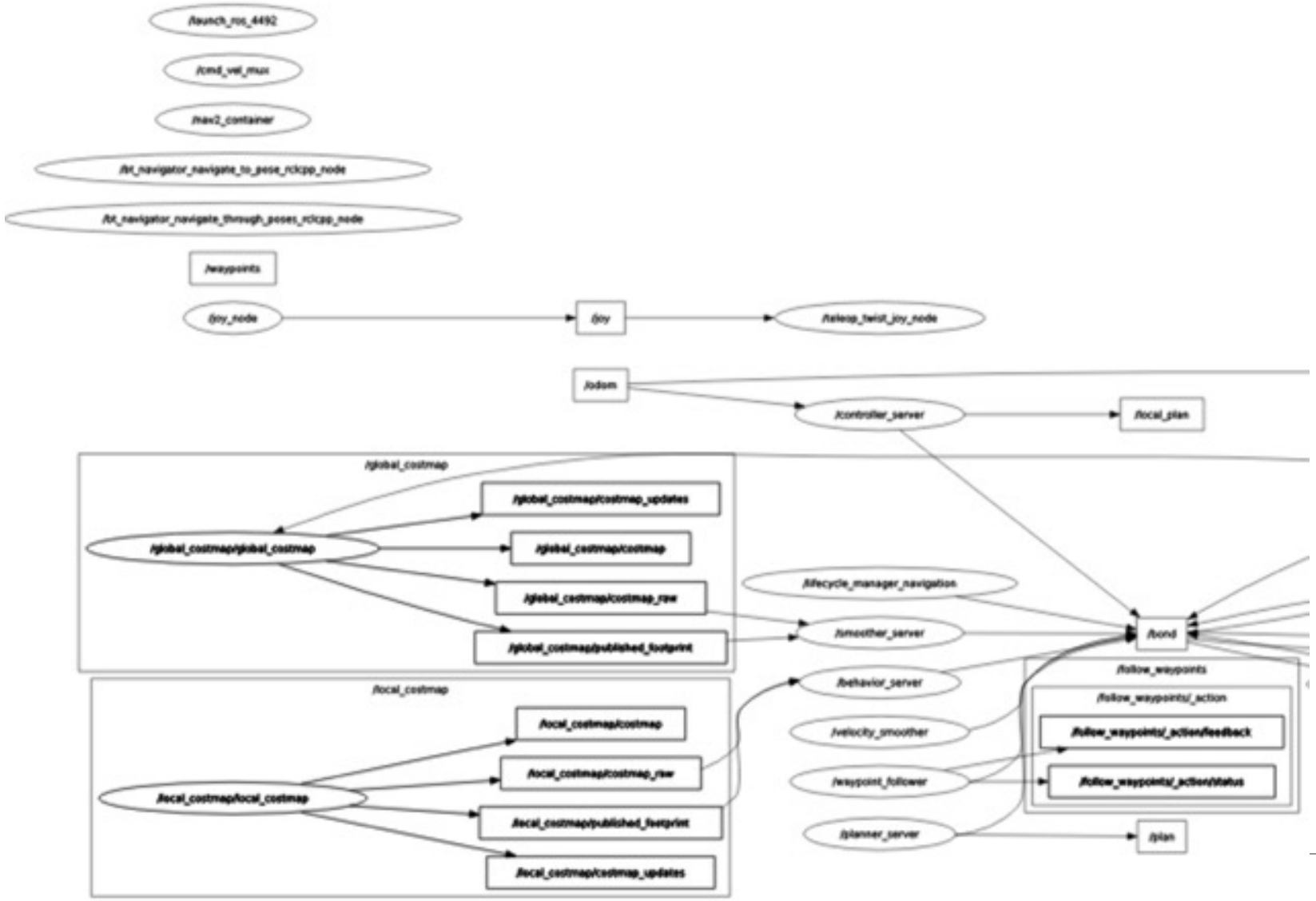
/nav2_container

```
/neato_node
/planner_server
robot_state_publisher
/rqt_gui_cpp_node_4362
/rviz
/smoother_server
/teleop_twist_joy_node
/transform_listener_impl_aaaaffaa0b40
/transform_listener_impl_aaab0f690d90
/transform_listener_impl_aaab0fd05ea0
/transform_listener_impl_ffff4c00c2e0
/transform_listener_impl_ffff54006170
/transform_listener_impl_ffff600024b0
/v4l2_camera
/velocity_smoother
/waypoint_follower
```

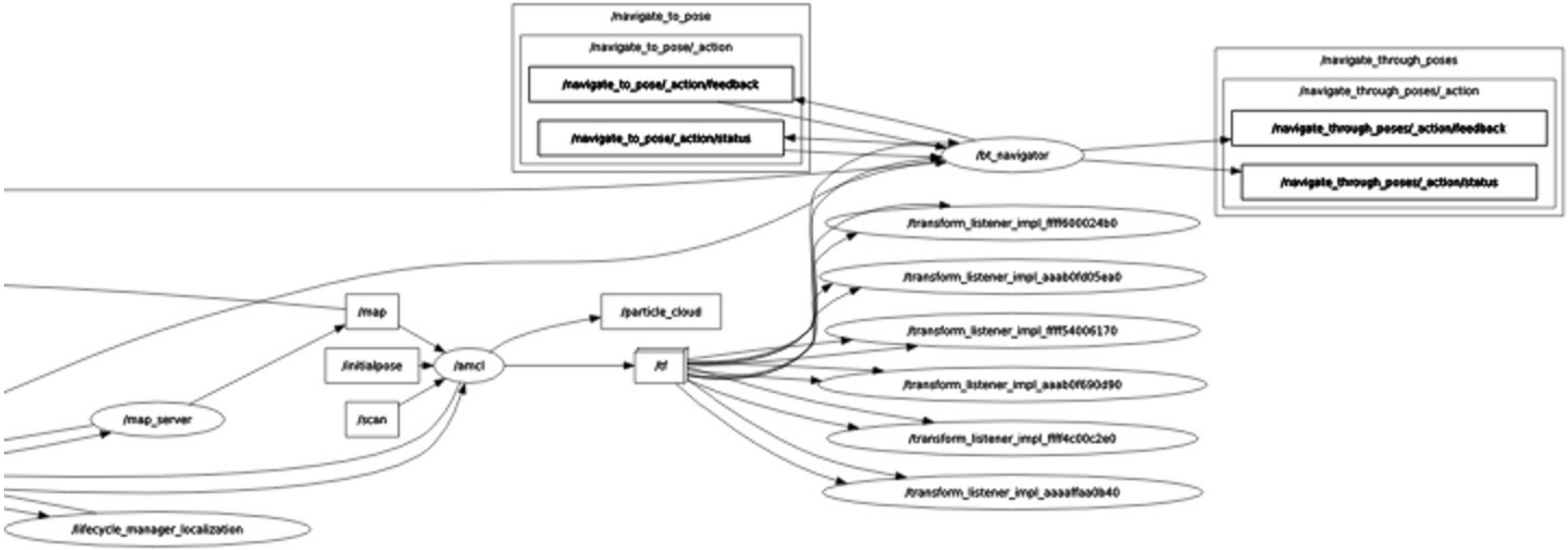
ROS 2 Topics

/active
/amcl/transition_event
/amcl_pose
/behavior_server/transition_event
/behavior_tree_log
/bond
/bt_navigator/transition_event
/button
/camera_info
/clicked_point
/cmd_vel
/cmd_vel_nav
/cmd_vel_teleop
/controller_server/transition_event
/cost_cloud
/diagnostics
/downsampled_costmap
/downsampled_costmap_updates
/evaluation
/global_costmap/costmap
global_costmap/costmap_raw
/global_costmap/costmap_updates
/global_costmap/footprint
/local_costmap/voxel_marked_cloud
/local_plan
/map
/map_server/transition_event
/map_updates
/marker
/mobile_base/sensors/bumper_pointcloud
/odom
/parameter_events
/particle_cloud
/plan
/plan_smoothed
/planner_server/transition_event
/preempt_teleop
/received_global_plan
/robot_description
/rosout
/scan
/sensor
/smoother_server/transition_event
/speed_limit
/map
/map_server/transition_event
/map_updates
/marker
/mobile_base/sensors/bumper_pointcloud
/odom
/parameter_events
/particle_cloud
/plan
/plan_smoothed
/planner_server/transition_event
/preempt_teleop
/received_global_plan
/robot_description
/rosout
/scan
/sensor
/smoother_server/transition_event
/speed_limit
/tf
/tf_static
/transformed_global_plan
/velocity_smoother/transition_event
/waypoint_follower/transition_event
/waypoints

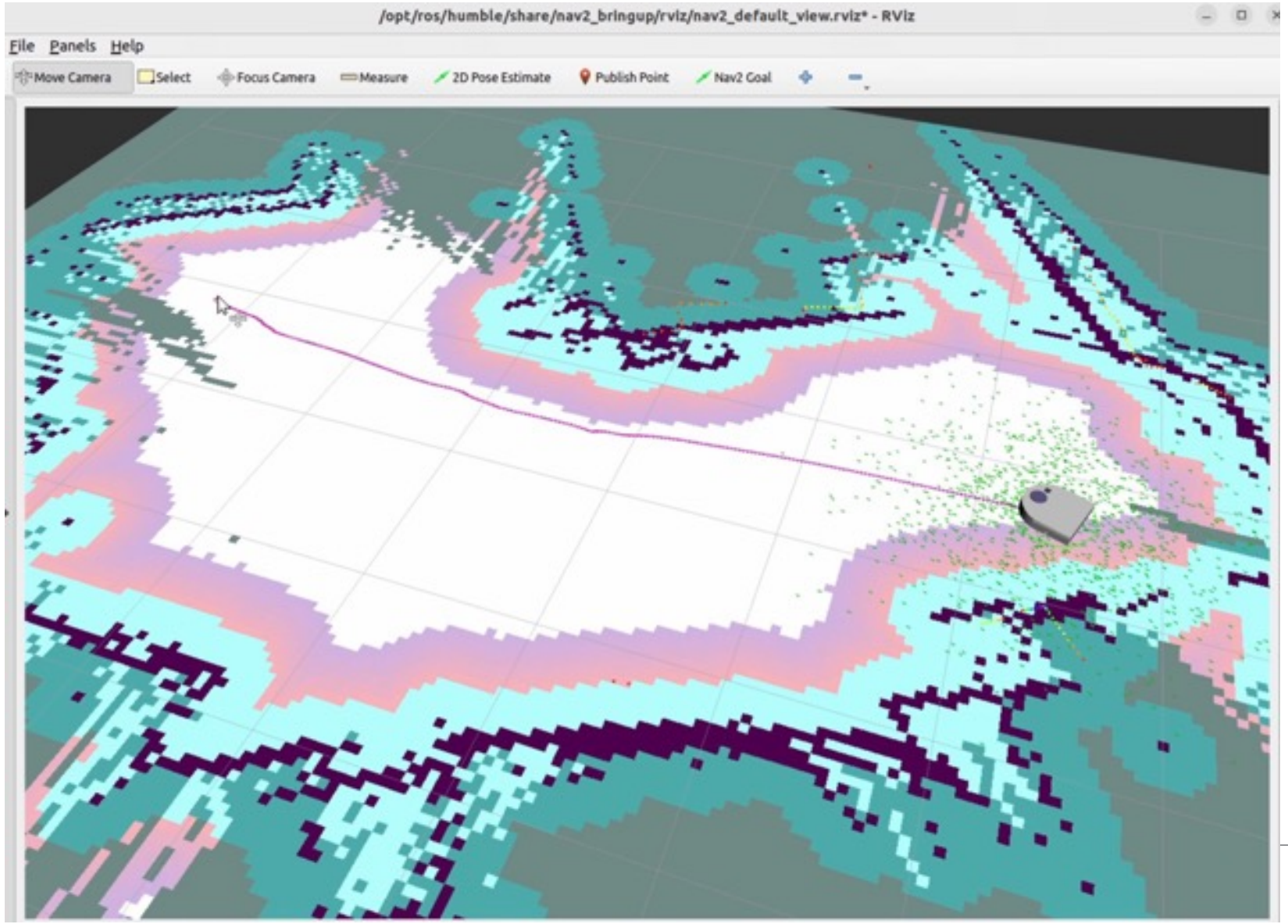
Neato Turtle ros_graph (left part)



Neato Turtle ros_graph (right part)



SLAM & Navigation on map with SLAM Toolbox



ROS 2 Rviz Display

Global Map: Outside Perimeter of the Scan data

Costmap: Grid maps where each cell is assigned a specific value of cost. It represents the cost (difficulty) of traversing different areas of the map. The different colors represent known spaces, unknown space, obstacles , and inflation layers.

AMCL Path Plan from Pose Estimate to Nav2 Goal

ROS References

- "Home Brewed Robots!, by Camp Peavy .Chapter 6 describes configuring and running a Neato Turtle Robot System. (from Amazon)
  https://github.com/cpeavy2/botvac_node
- ROS/Introduction
  http://wiki.ros.org/ROS/Introduction
- ROS Users - for general ROS-related discussions
  https://discourse.ros.org
- ROS Developers - for ROS core development
  https://answers.ros.org
- Neato Turtle (Botvac)S Developers - for ROS core development
  http://wiki.ros.org/ROS/Introduction
- Navigation 2
  https://navigation.ros.org
  https://github.com/ros-planning/navigation2/tree/humble/nav2_bringup/launch