



Navigation

&

Mapping

Mapping

SLAM

อะไรคือ SLAM?

Simultaneous
Localization
And
Mapping

Keeping track of an agent's location

while simultaneously

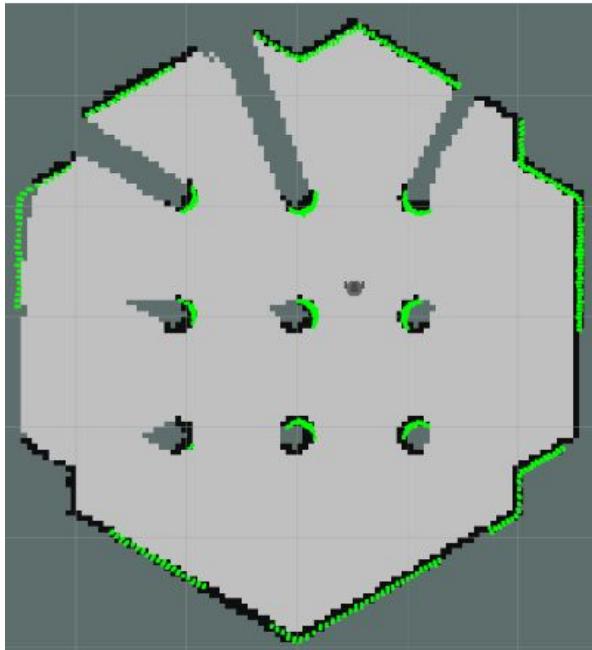
Constructing or updating a map of
an unknown environment.

PDF

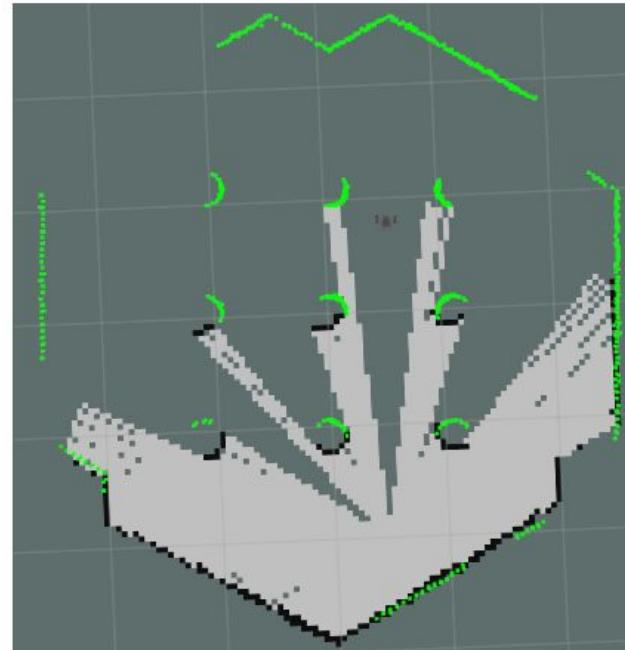
Output จาก SLAM

OccupancyGrid

map update interval = 2.0



map update interval = 20.0



Use SLAM with
TurtleBot3 in
Gazebo

```
$ sudo apt install ros-noetic-turtlebot3-slam \
ros-noetic-gmapping ros-noetic-map-server
```

เปิด terminal

```
$ roscore
```

```
[REDACTED]:~# roscore
... logging to /root/.ros/log/a4938efa-7c5b-11ec-b410-0242ac110002/roslaunch-c0665c07a68b-2984.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:39823/
ros_comm version 1.15.13

SUMMARY
=====
PARAMETERS
* /rosdistro: noetic
* /rosversion: 1.15.13

NODES

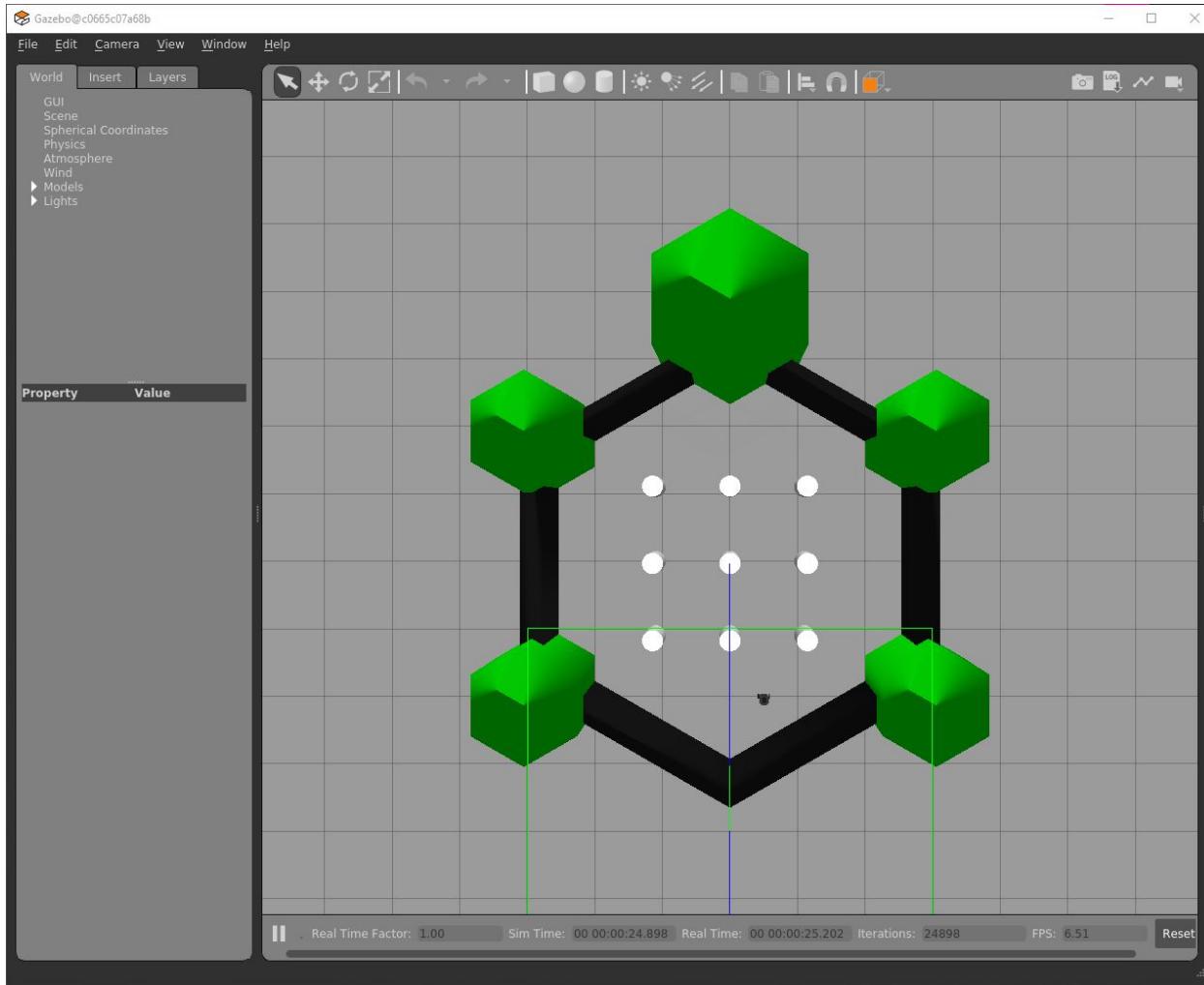
auto-starting new master
process[master]: started with pid [3008]
ROS_MASTER_URI=http://[REDACTED]:11311/

setting /run_id to [REDACTED]
process[rosout-1]: started with pid [3028]
started core service [/rosout]

-
```

เปิดหน้าต่างใหม่

```
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```



เปิดหน้าต่างใหม่

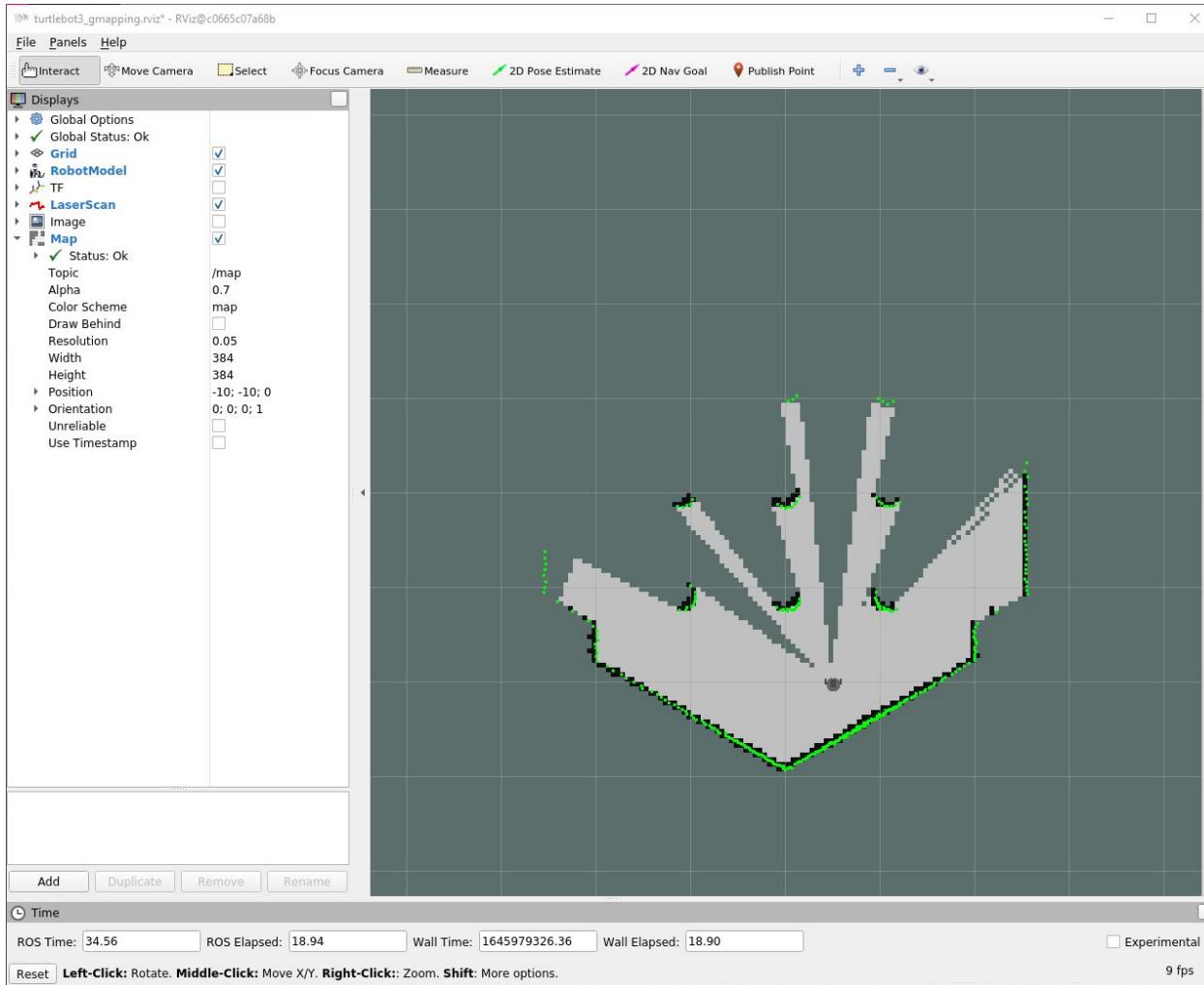
```
$ roslaunch turtlebot3_slam turtlebot3_slam.launch slam_methods:=gmapping
```

```
* /turtlebot3_slam_gmapping/ymin: -10.0
NODES
/
    robot_state_publisher (robot_state_publisher/robot_state_publisher)
    rviz (rviz/rviz)
    turtlebot3_slam_gmapping (gmapping/slam_gmapping)

ROS_MASTER_URI=http://localhost:11311

process[robot_state_publisher-1]: started with pid [18755]
process[turtlebot3_slam_gmapping-2]: started with pid [18756]
process[rviz-3]: started with pid [18757]
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
Warning: TF_REPEATED_DATA ignoring data with redundant timestamp for frame odom at time 101.392000 according to authority unknown_publisher
    at line 278 in /tmp/binarydeb/ros-noetic-tf2-0.7.5/src/buffer_core.cpp
[ INFO] [1645979393.238892563, 101.402000000]: Laser is mounted upwards.
-maxUrange 3 -maxUrange 3.49 -sigma      0.05 -kernelSize 1 -lstep 0.05 -lobsGain 3 -astep 0.05
-srr 0.1 -srt 0.2 -str 0.1 -stt 0.2
-linearUpdate 1 -angularUpdate 0.2 -resampleThreshold 0.5
-xmin -10 -xmax 10 -ymin -10 -ymax 10 -delta 0.05 -particles 100
[ INFO] [1645979393.240577397, 101.404000000]: Initialization complete
update frame 0
update ld=0 ad=0
Laser Pose= -2.03063 -0.499967 -3.14068
m_count 0
Registering First Scan
```

```
Average Scan Matching Score=315.344
neff= 100
Registering Scans:Done
update frame 6
update ld=1.62027e-05 ad=0.000188653
Laser Pose= 1.63914 -0.802675 2.37017
m_count 2
Average Scan Matching Score=315.542
neff= 100
Registering Scans:Done
update frame 9
update ld=1.61115e-05 ad=0.000187629
Laser Pose= 1.63916 -0.802681 2.36998
m_count 3
Average Scan Matching Score=315.761
neff= 100
Registering Scans:Done
update frame 12
update ld=1.60208e-05 ad=0.000186611
Laser Pose= 1.63917 -0.802687 2.36979
m_count 4
Average Scan Matching Score=315.738
neff= 100
Registering Scans:Done
update frame 15
update ld=1.59307e-05 ad=0.000185598
Laser Pose= 1.63919 -0.802694 2.36961
m_count 5
Average Scan Matching Score=315.754
neff= 100
Registering Scans:Done
update frame 18
update ld=1.5841e-05 ad=0.000184592
Laser Pose= 1.6392 -0.8027 2.36942
m_count 6
Average Scan Matching Score=315.784
neff= 100
Registering Scans:Done
```



เปิดหน้าต่างใหม่

```
$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
```

```
:~$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
... logging to /root/.ros/log/3cadf654-97ea-11ec-8c45-0242ac110003/roslaunch-c0665c07a68b-19766.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:46375/

SUMMARY
=====
PARAMETERS
* /model: burger
* /rosdistro: noetic
* /rosversion: 1.15.13

NODES
/
  turtlebot3_teleop_keyboard (turtlebot3_teleop/turtlebot3_teleop_key)

ROS_MASTER_URI=http://localhost:11311

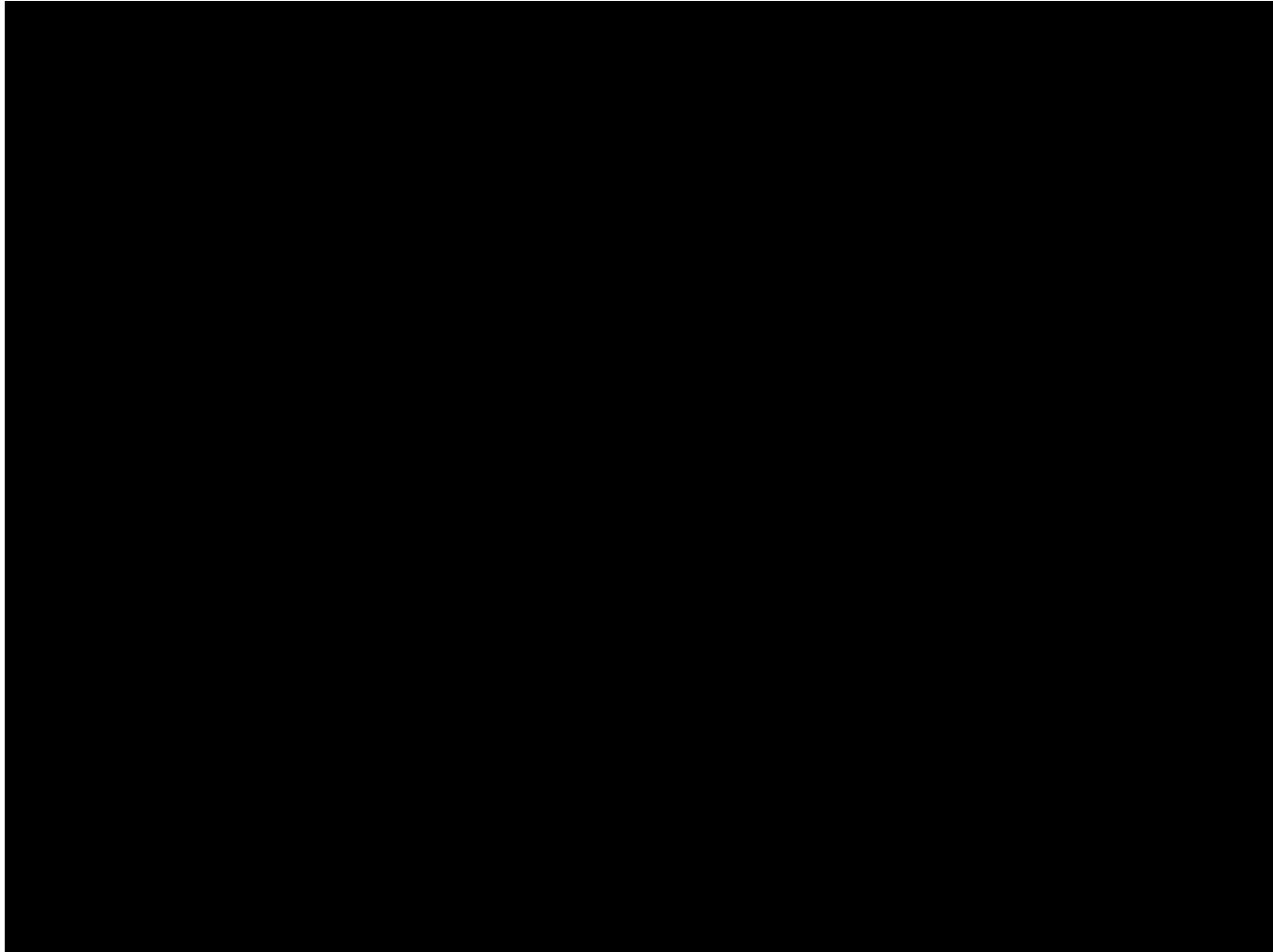
process[turtlebot3_teleop_keyboard-1]: started with pid [19791]

Control Your TurtleBot!
-----
Moving around:
      w
    a   s   d
      x

w/x : increase/decrease linear velocity (Burger : ~ 0.22, Waffle and Waffle Pi : ~ 0.26)
a/d : increase/decrease angular velocity (Burger : ~ 2.84, Waffle and Waffle Pi : ~ 1.82)

space key, s : force stop

CTRL-C to quit
```

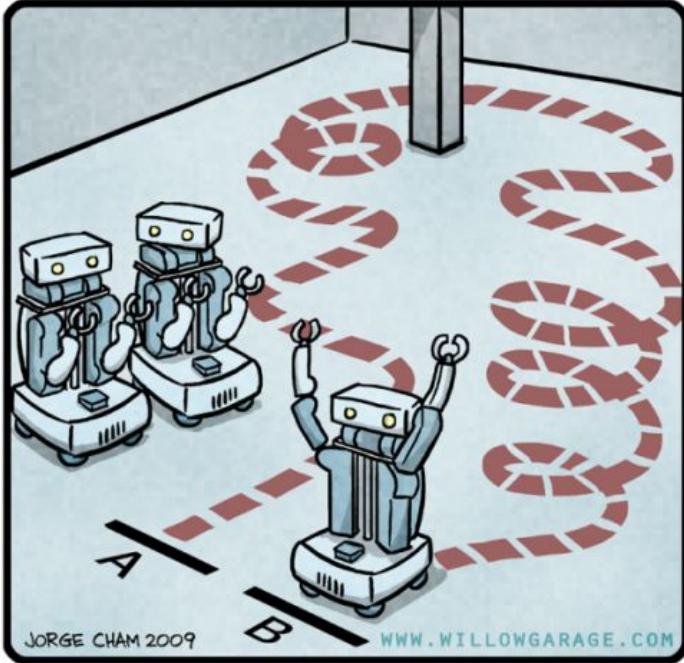


```
$ rosrun map_server map_saver -f ~/map
```

```
:~$ rosrun map_server map_saver -f ~/map
[ INFO] [1645982607.924016646]: Waiting for the map
[ INFO] [1645982608.197519730]: Received a 307 x 307 map @ 0.05 m/pix
[ INFO] [1645982608.197555918]: Writing map occupancy data to /root/map.pgm
[ INFO] [1645982608.199186861, 370.091000000]: Writing map occupancy data to /root/map.yaml
[ INFO] [1645982608.199319520, 370.091000000]: Done
```

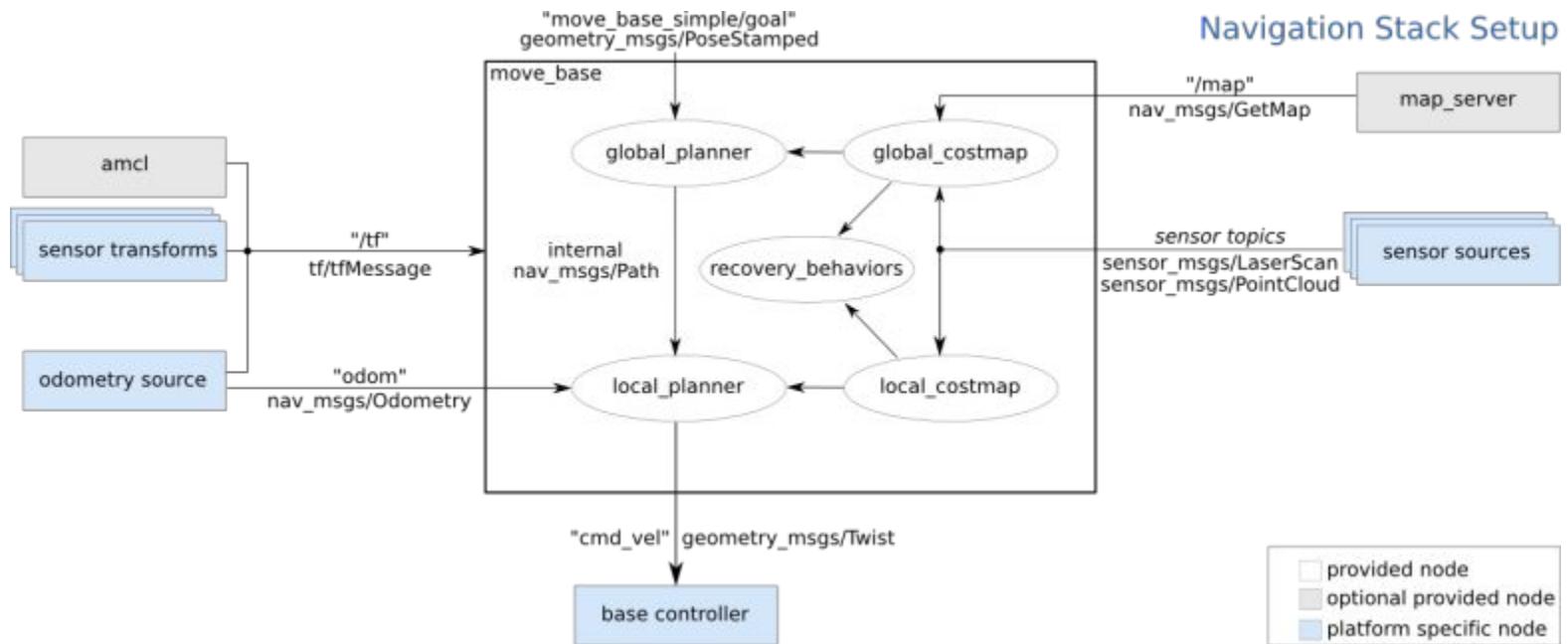
Navigation

R.O.B.O.T. Comics



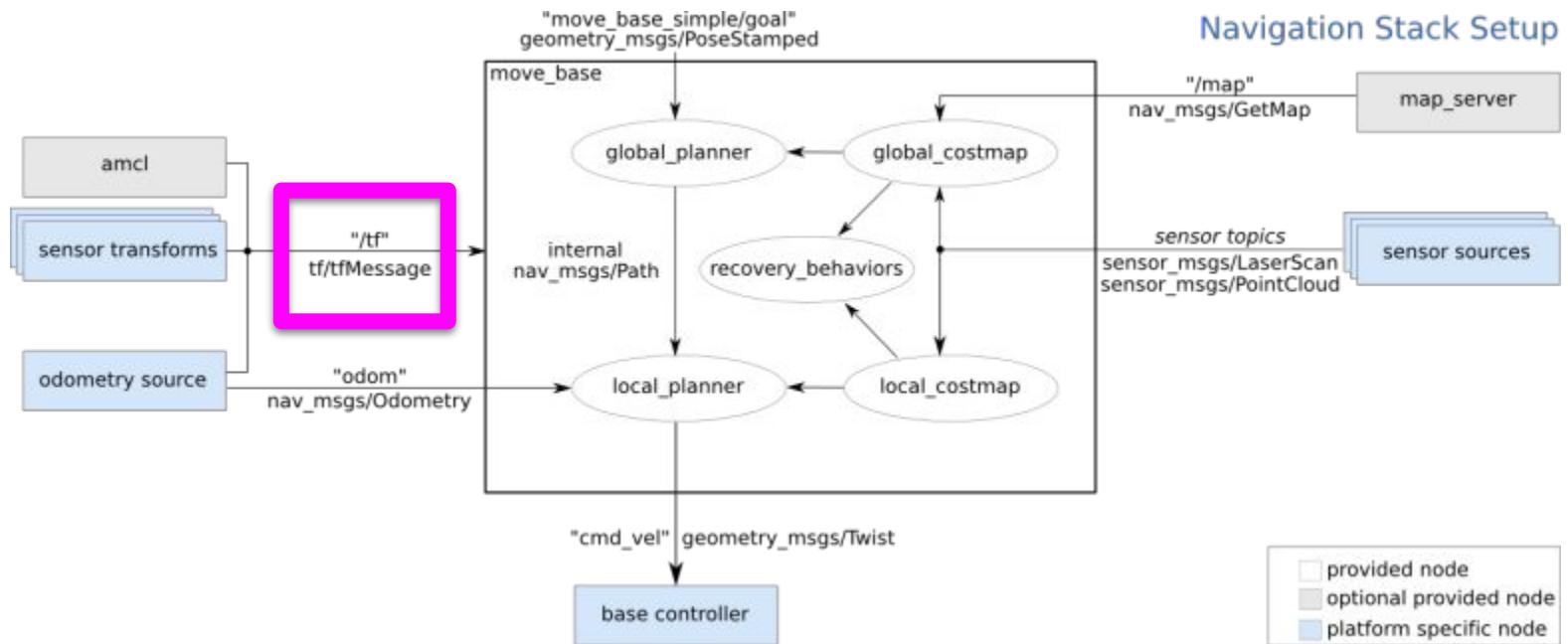
"HIS PATH-PLANNING MAY BE
SUB-OPTIMAL, BUT IT'S GOT FLAIR."

Navigation Stack



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

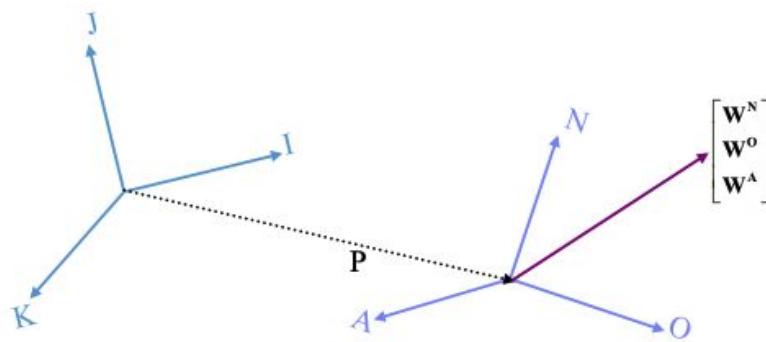
Transform Configuration



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

TF

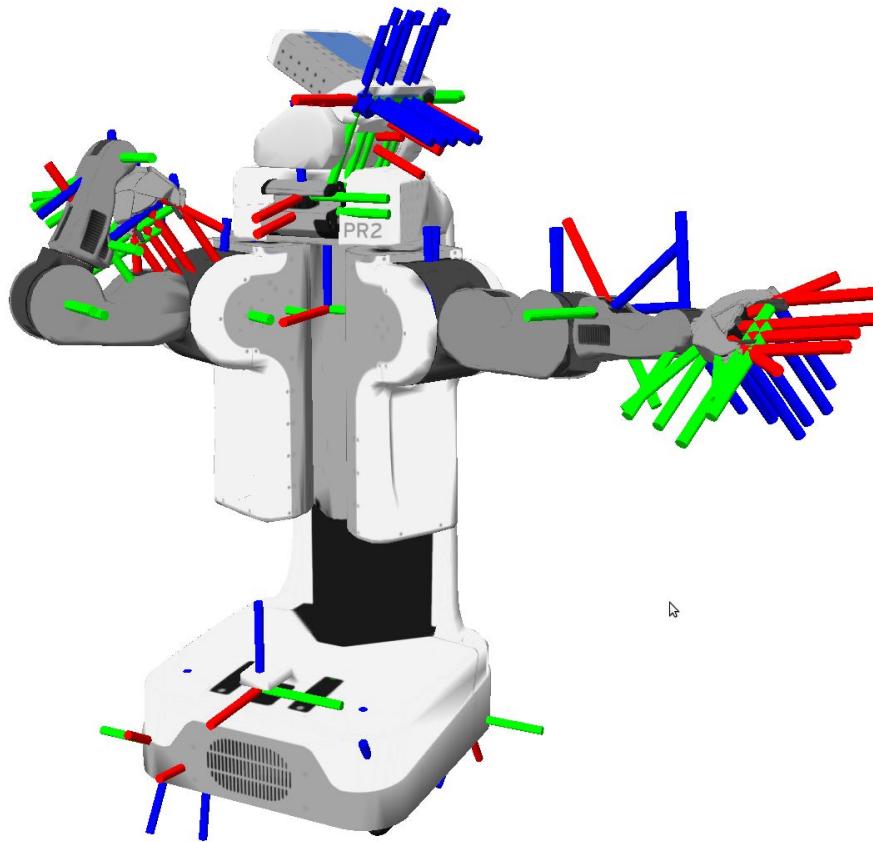
Transformation



$$\begin{bmatrix} \mathbf{W}^I \\ \mathbf{W}^J \\ \mathbf{W}^K \\ 1 \end{bmatrix} = \begin{bmatrix} \mathbf{n}_i & \mathbf{o}_i & \mathbf{a}_i & \mathbf{P}_i \\ \mathbf{n}_j & \mathbf{o}_j & \mathbf{a}_j & \mathbf{P}_j \\ \mathbf{n}_k & \mathbf{o}_k & \mathbf{a}_k & \mathbf{P}_k \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & 1 \end{bmatrix} \begin{bmatrix} \mathbf{W}^N \\ \mathbf{W}^O \\ \mathbf{W}^A \\ 1 \end{bmatrix}$$

TF2

Transform library



REF: <http://wiki.ros.org/tf2>

```
$ sudo apt install ros-noetic-tf2
```

TURTLE_TF

```
$ sudo apt install ros-noetic-turtle-tf2  
ros-noetic-tf2-tools ros-noetic-tf
```

เปิด terminal

```
$ roscore
```

```
[REDACTED]:~# roscore
... logging to /root/.ros/log/a4938efa-7c5b-11ec-b410-0242ac110002/roslaunch-c0665c07a68b-2984.log
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started roslaunch server http://[REDACTED]:39823/
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PARAMETERS
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NODES

auto-starting new master
process[master]: started with pid [3008]
ROS_MASTER_URI=http://[REDACTED]:11311/

setting /run_id to [REDACTED]
process[rosout-1]: started with pid [3028]
started core service [/rosout]

-
```

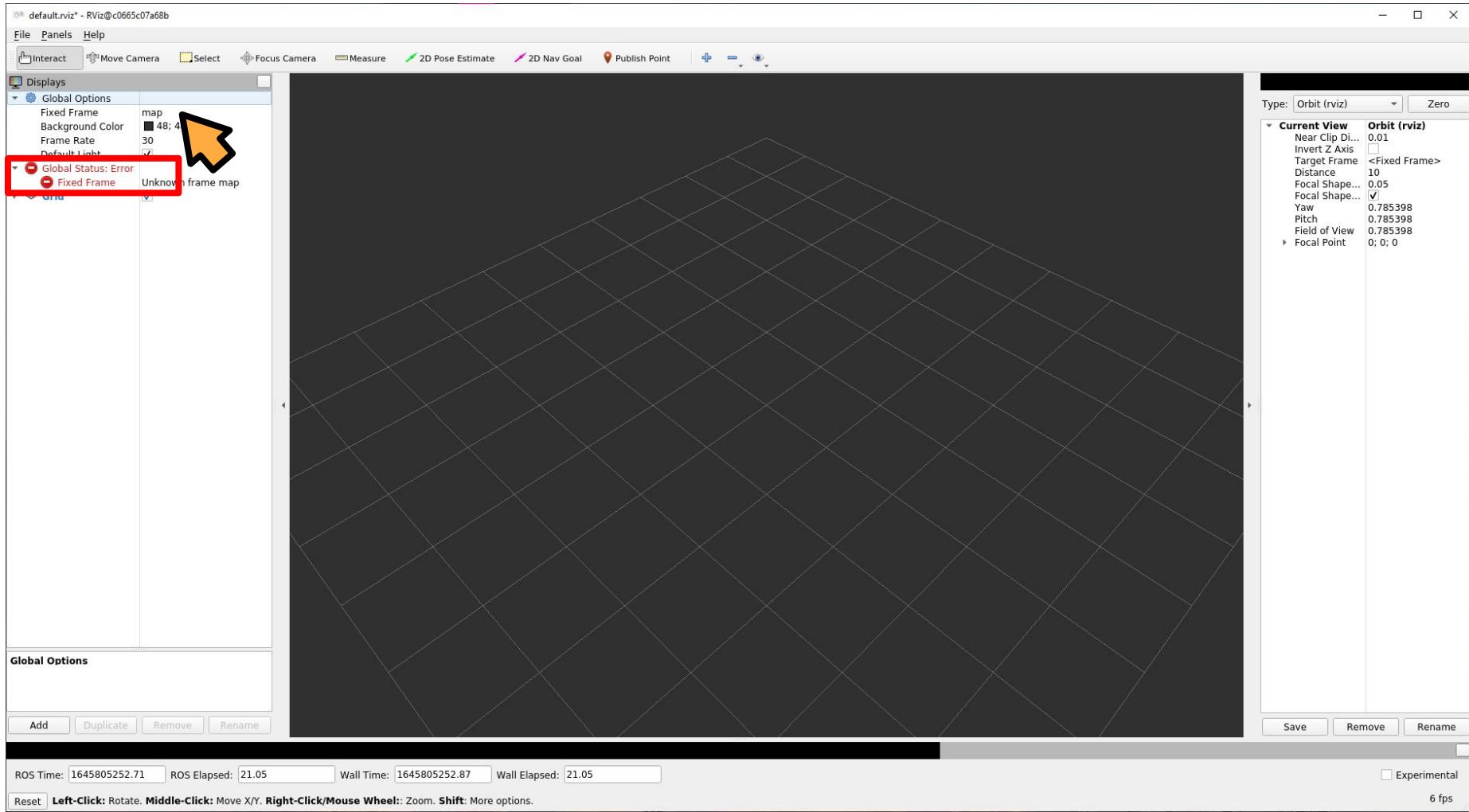
เปิดหน้าต่างใหม่

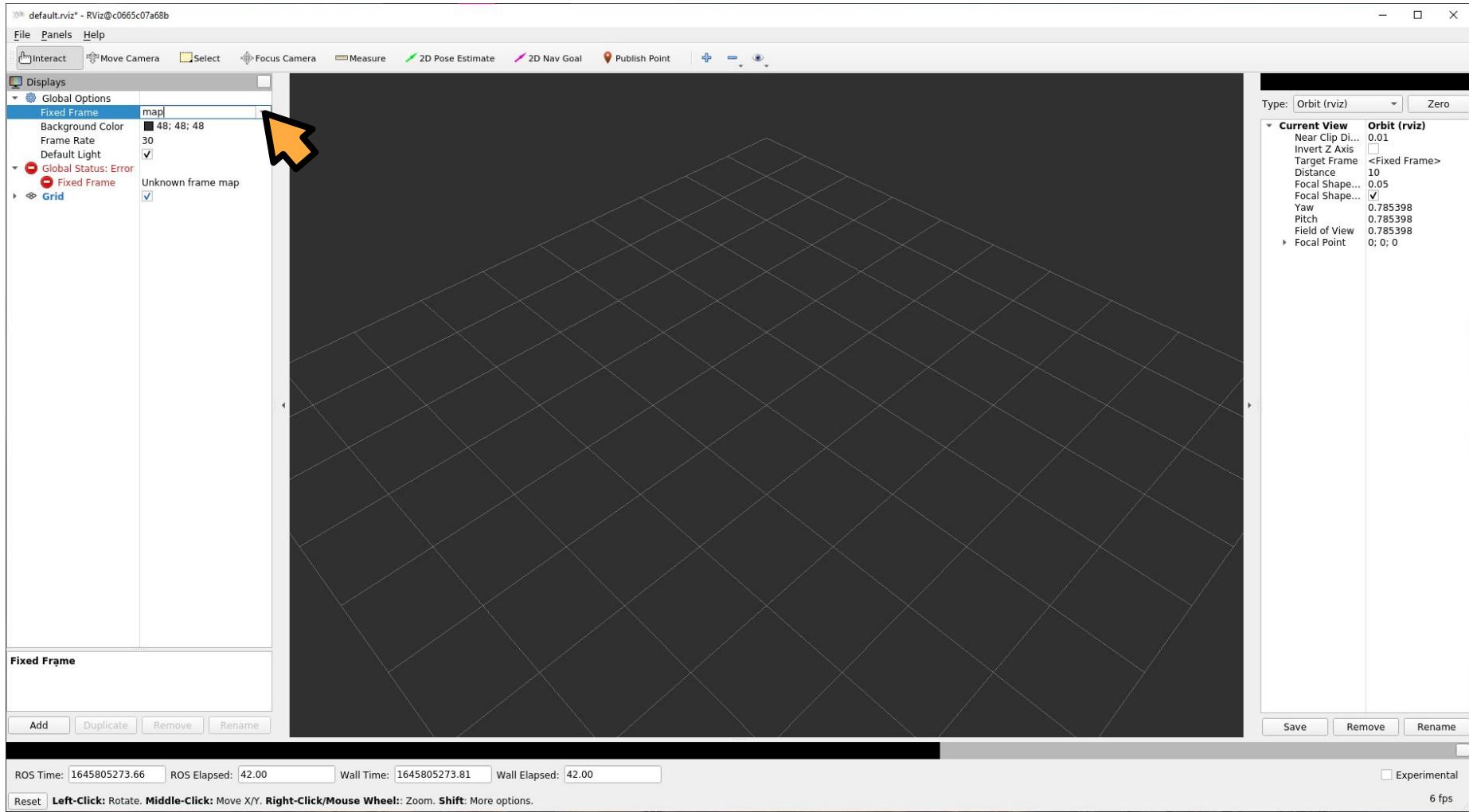
```
$ roslaunch turtle_tf2 turtle_tf2_demo.launch
```



เปิดหน้าใหม่

```
$ rviz
```





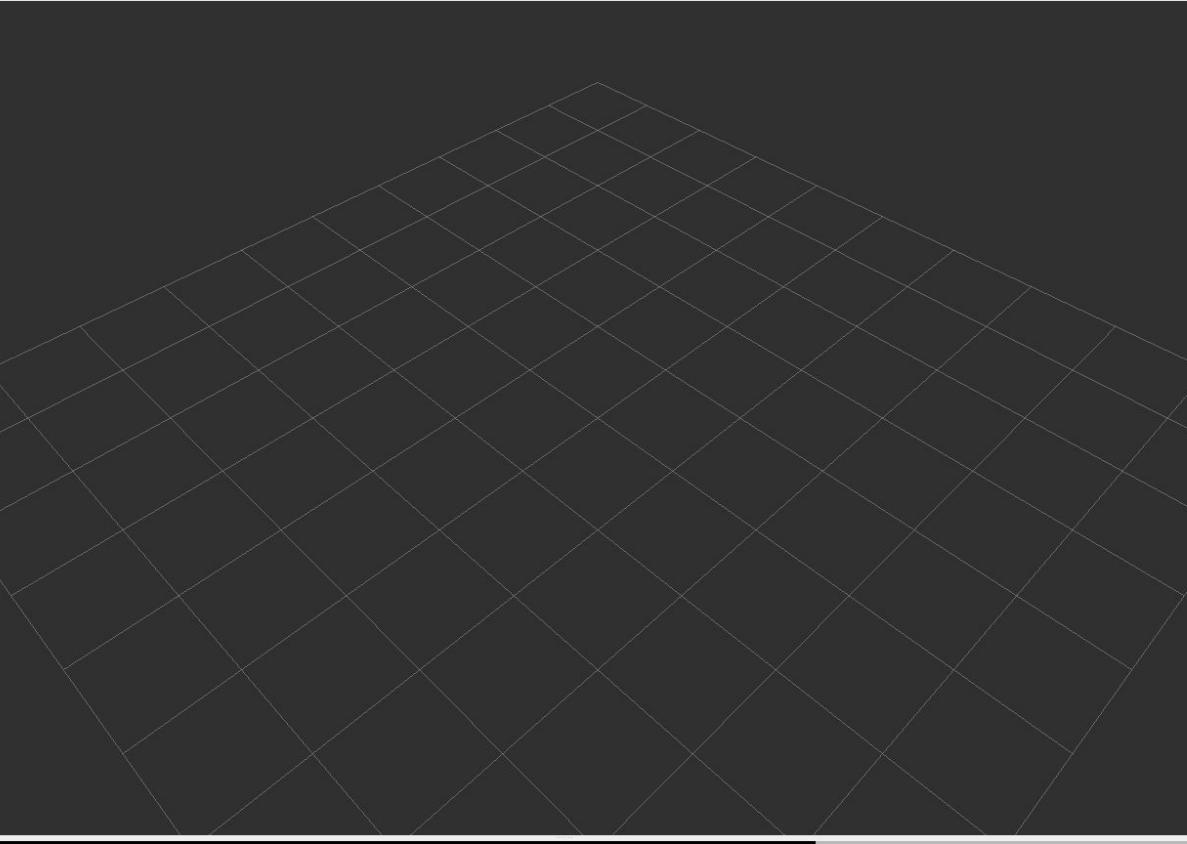
File Panels Help

Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Nav Goal Publish Point

Displays

Global Options

Fixed Frame map
Background Color turtle1
Frame Rate turtle2
Default Light world
▼
Global Status: Error
Fixed Frame Unknown frame map
Grid



Type: Orbit (rviz) ▾ Zero

Current View Orbit (rviz)
Near Clip Di... 0.01
Invert Z Axis
Target Frame <Fixed Frame>
Distance 10
Focal Shape... 0.05
Focal Shape...
Yaw 0.785398
Pitch 0.785398
Field of View 0.785398
Focal Point 0: 0; 0

Fixed Frame

Add Duplicate Remove Rename

ROS Time: 1645805319.30 ROS Elapsed: 87.64 Wall Time: 1645805319.42 Wall Elapsed: 87.64

Experimental

Reset Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel: Zoom. Shift: More options.

10 fps



Displays

▼ Global Options

Fixed Frame

map

Background Color

turtle1

Frame Rate

turtle2

Default Light

world

▼ Global Status: Error

Fixed Frame

Unknown frame map

► Grid



▼	Global Options	
	Fixed Frame	map
	Background Color	turtle1
	Frame Rate	turtle2
	Default Light	world
▼	Global Status: Error	
	- Fixed Frame	Unknown frame map
▶	Grid	<input checked="" type="checkbox"/>

File Panels Help

Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Nav Goal Publish Point

Displays

Global Options

Fixed Frame world

Background Color 48; 48; 48

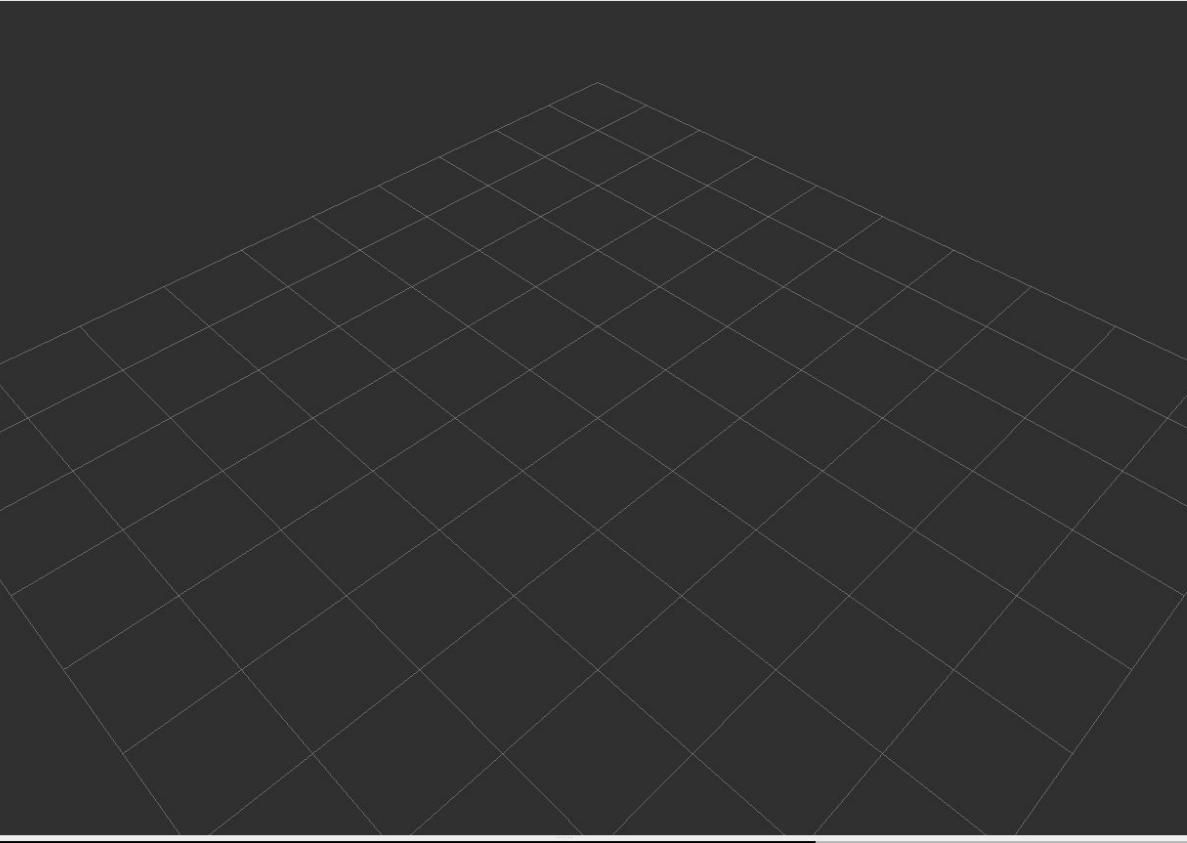
Frame Rate 30

Default Light ✓

Global Status: Ok

✓ Fixed Frame OK

Grid



Type: Orbit (rviz) ▾ Zero

Current View Orbit (rviz)

Near Clip Di... 0.01

Invert Z Axis □

Target Frame <Fixed Frame>

Distance 10

Focal Shape... 0.05

Focal Shape... ✓

Yaw 0.785398

Pitch 0.785398

Field of View 0.785398

Focal Point 0; 0; 0

Fixed Frame

Add Duplicate Remove Rename

ROS Time: 1645805372.11

ROS Elapsed: 140.45

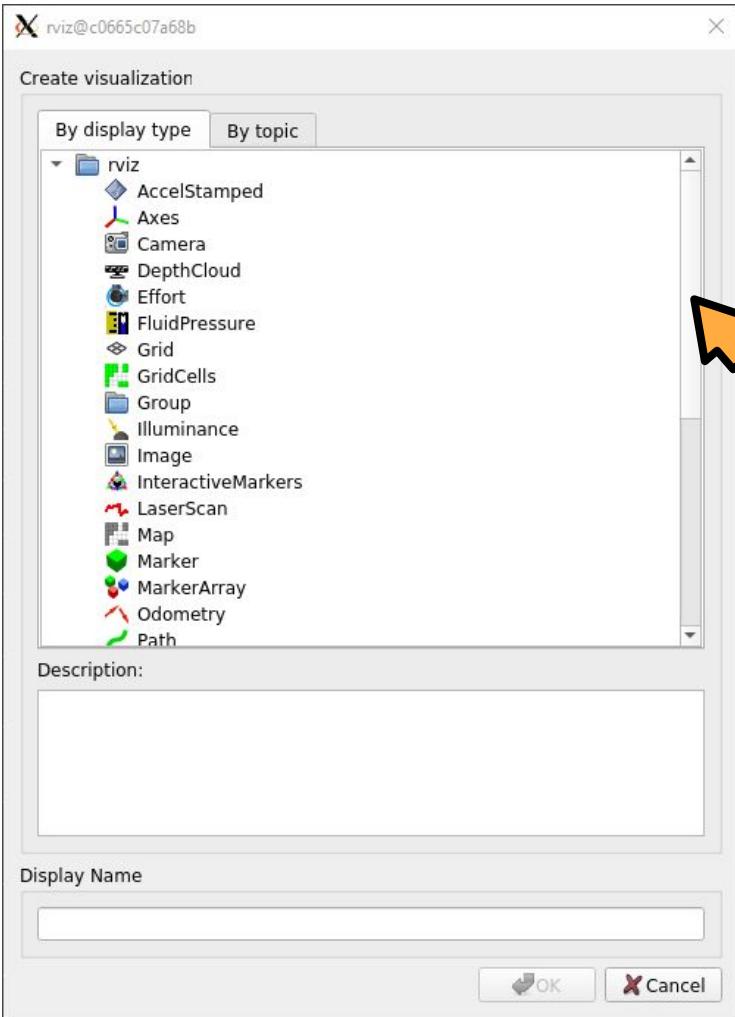
Wall Time: 1645805372.23

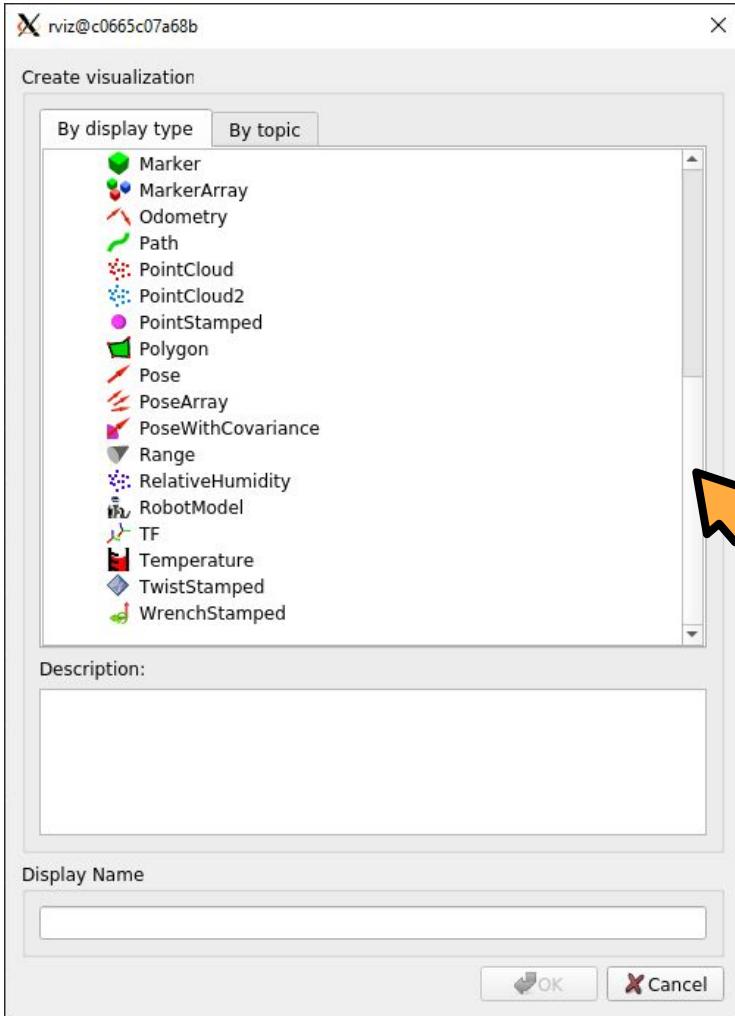
Wall Elapsed: 140.45

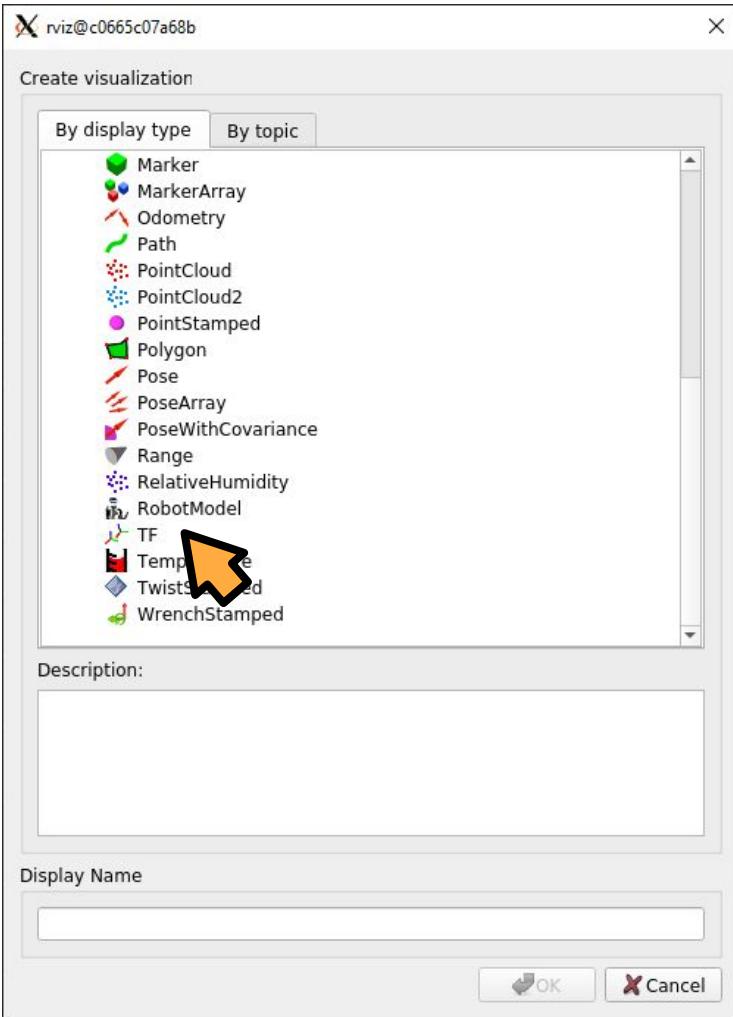
Experimental

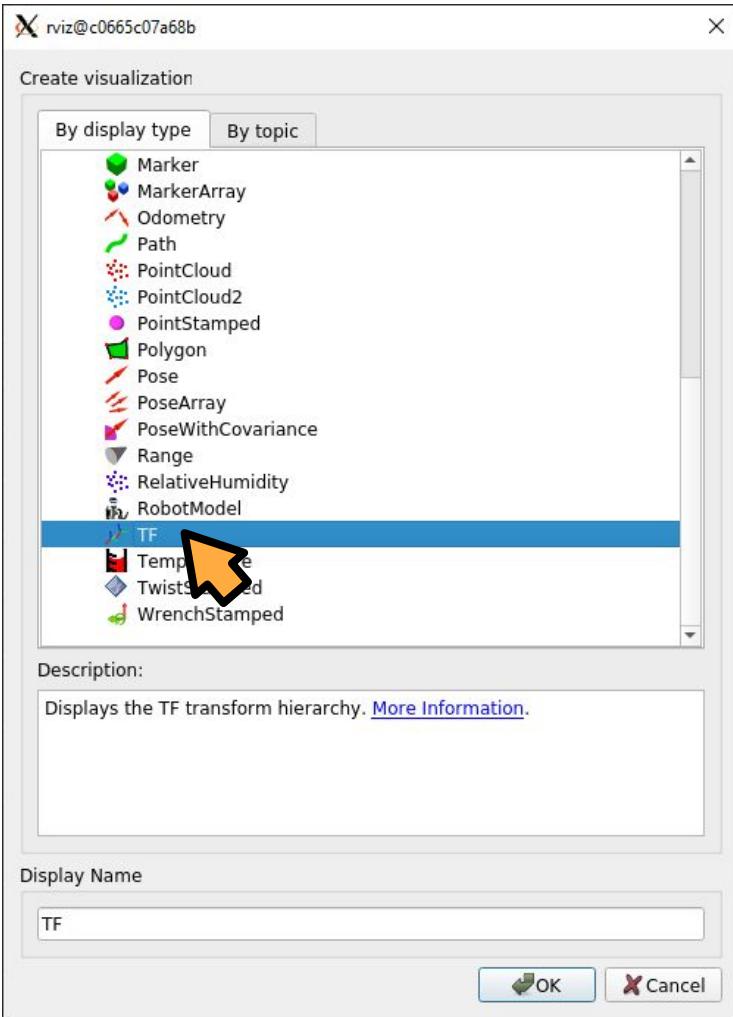
11 fps

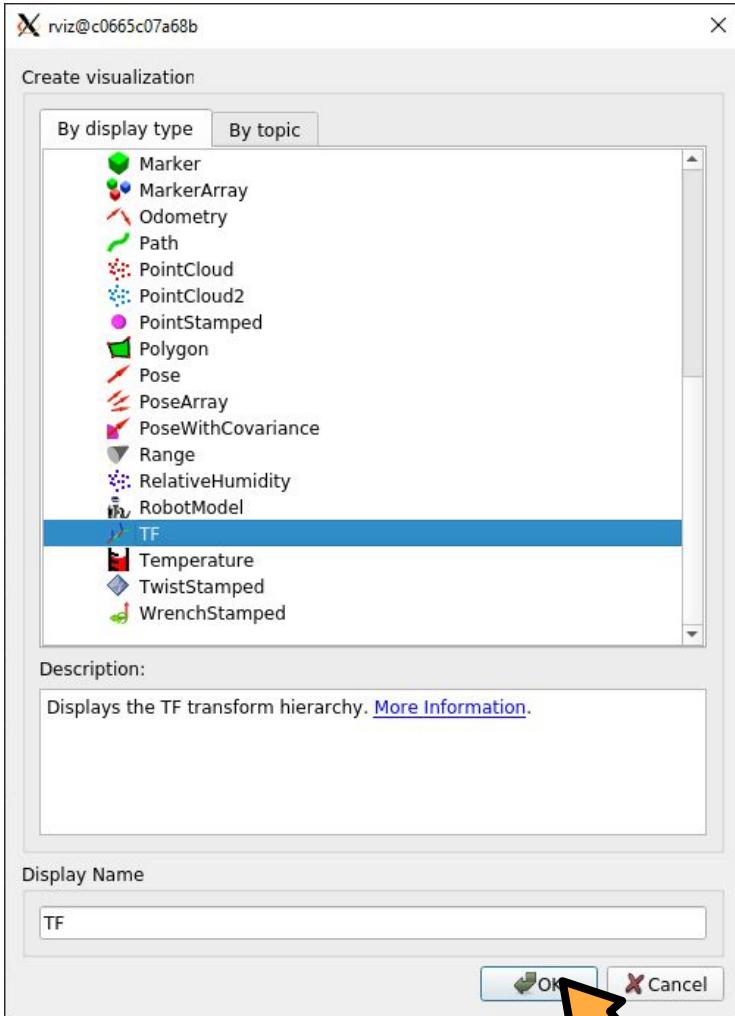
Reset





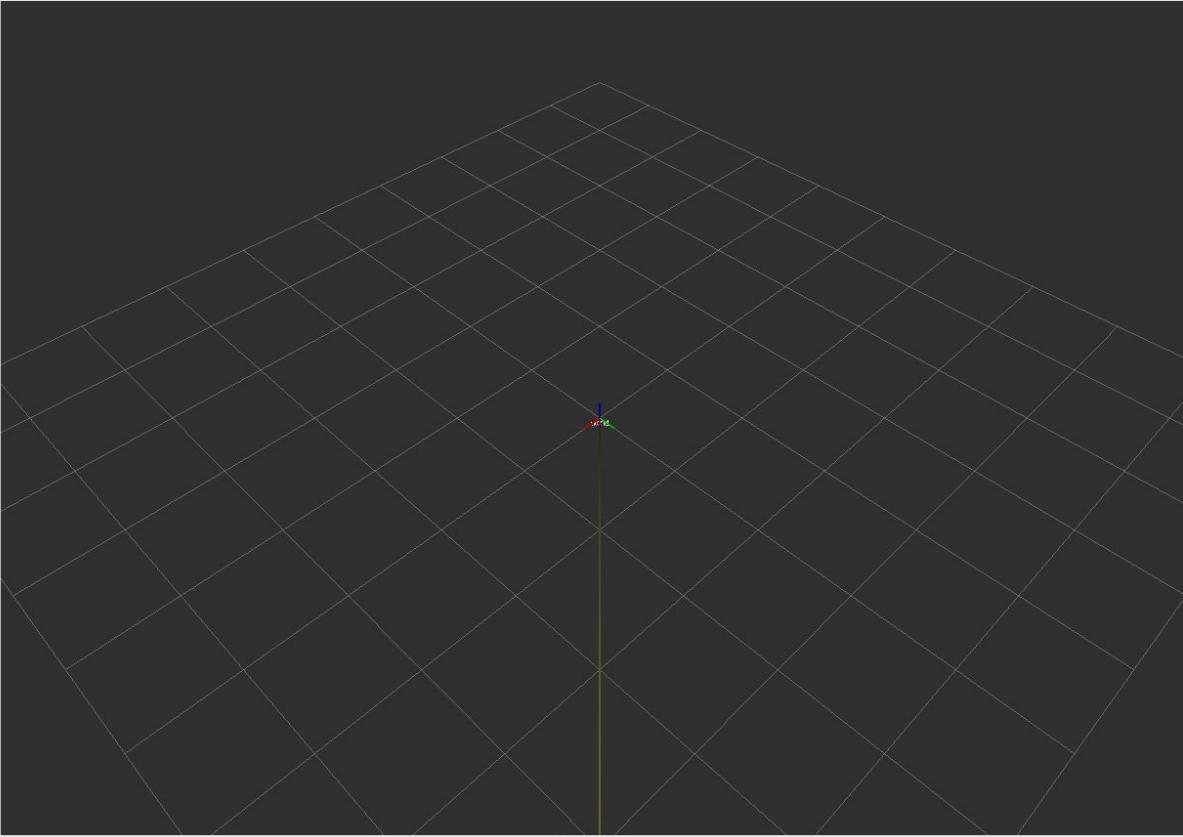






File **Panels** **Help****Interact** **Move Camera** **Select** **Focus Camera** **Measure** **2D Pose Estimate** **2D Nav Goal** **Publish Point****Displays**

- **Global Options**
 - Fixed Frame
 - Background Color
 - Frame Rate 30
 - Default Light
 - ✓ Global Status: Ok
 - ✓ Fixed Frame
 - OK
 - Grid
 - TF

**Fixed Frame****Add** **Duplicate** **Remove** **Rename**

ROS Time: 1645805533.05 ROS Elapsed: 301.39

Wall Time: 1645805533.13

Wall Elapsed: 301.31

Reset Experimental

10 fps

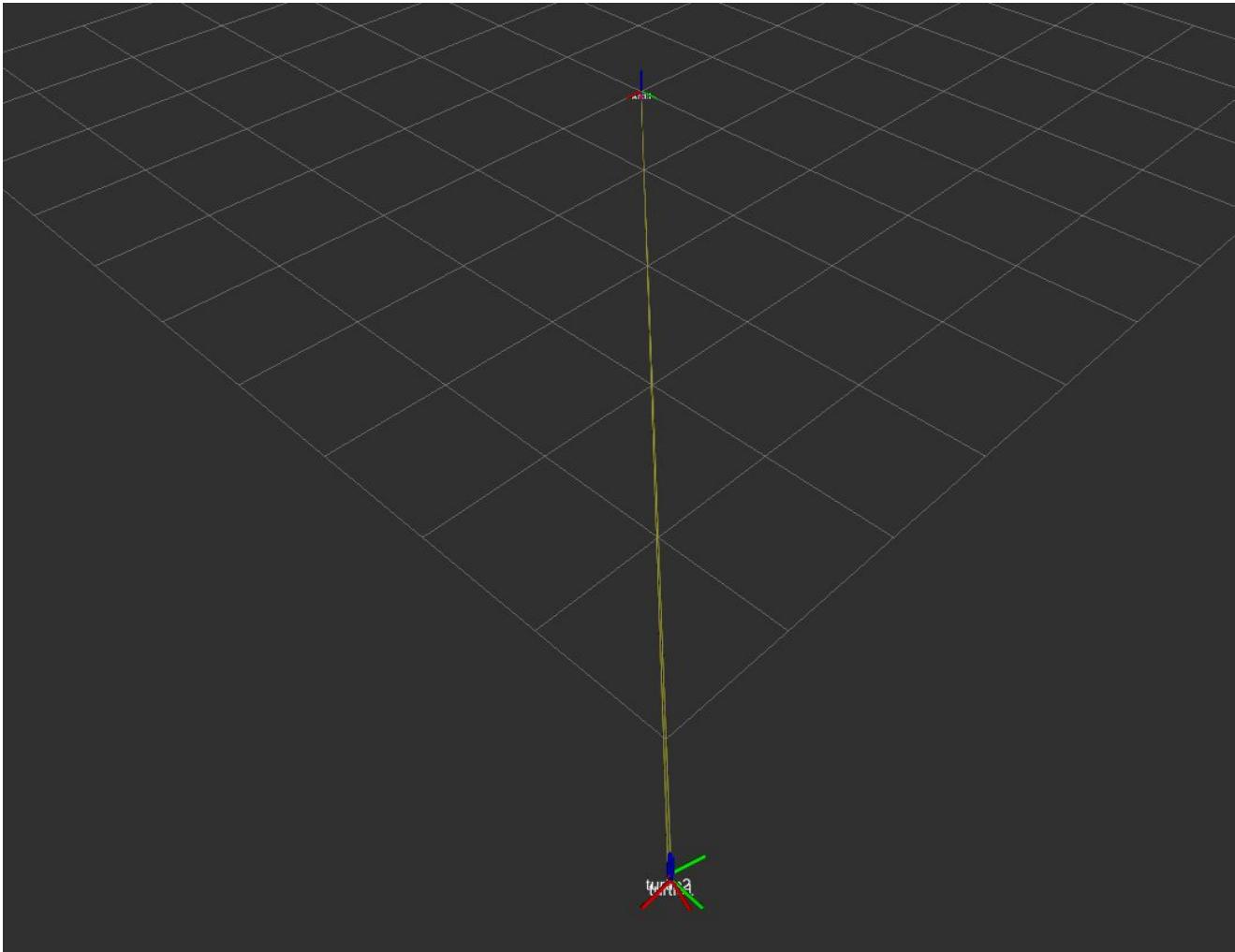
Type: **Orbit (rviz)** **Zero**

- **Current View** **Orbit (rviz)**
 - Near Clip Di...
 - Invert Z Axis
 - Target Frame <Fixed Frame>
 - Distance 10
 - Focal Shape... 0.05
 - Focal Shape...
 - Yaw 0.785398
 - Pitch 0.785398
 - Field of View 0.785398
 - Focal Point

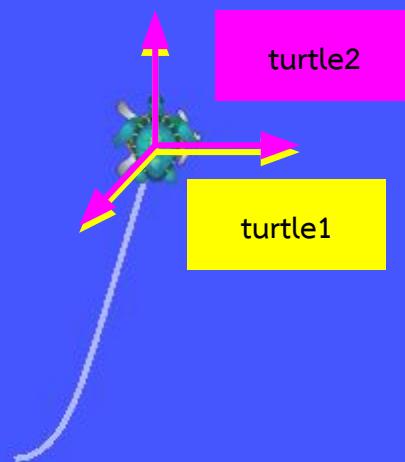
Save **Remove** **Rename**

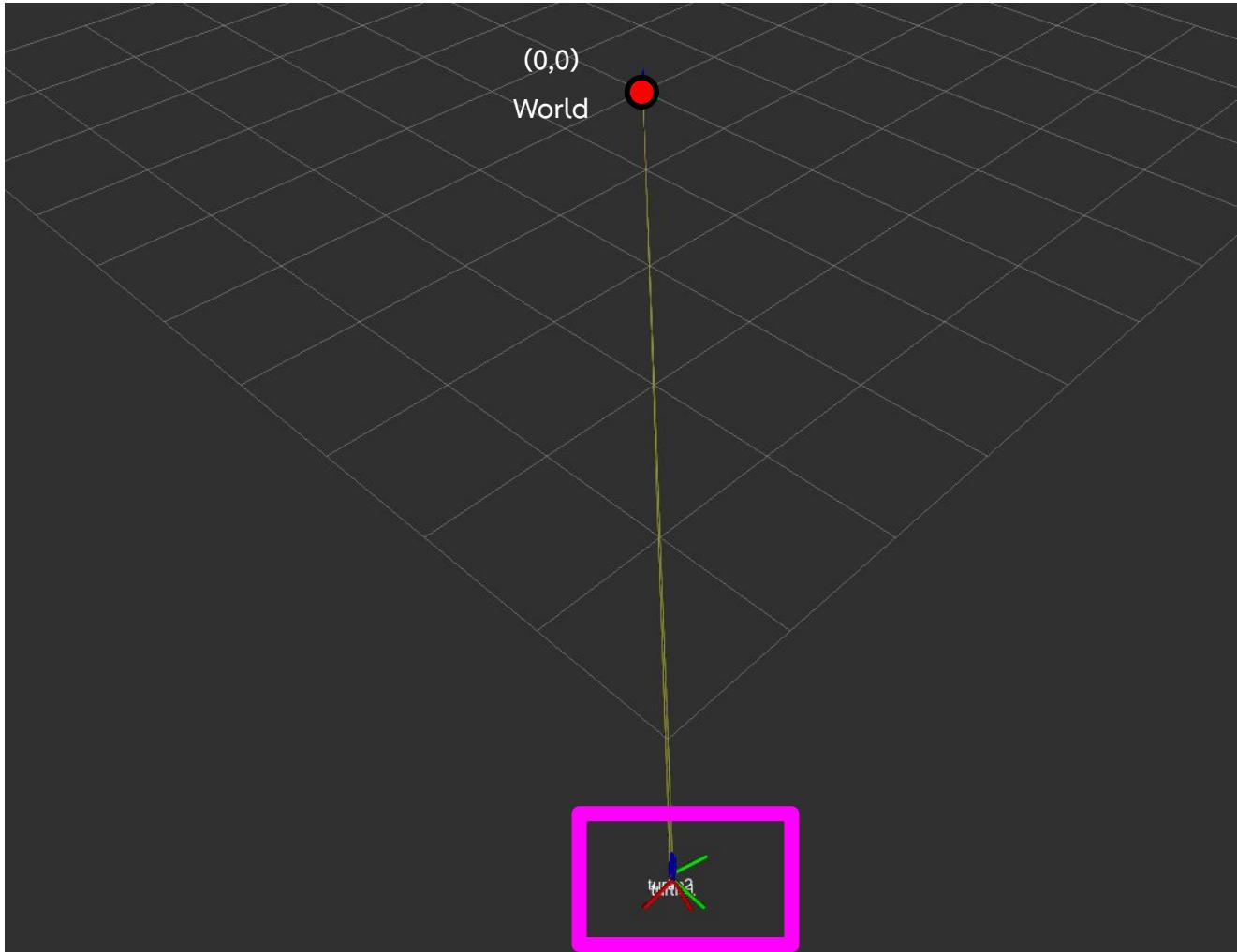
ZOOM OUT





(0,0)
World





ZOOM IN



File Panels Help

 Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Nav Goal Publish Point

+

-

v

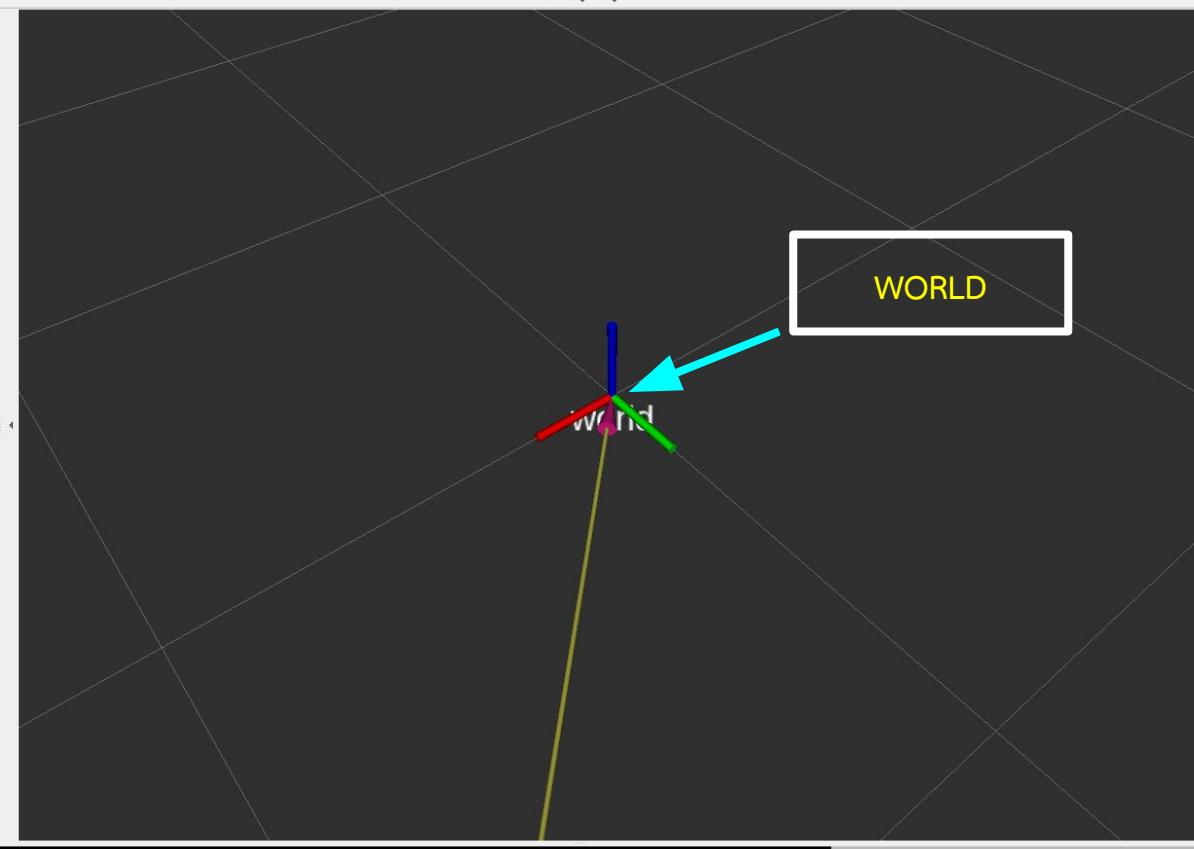
Global Options
Fixed Frame world
Background Color 48; 48; 48
Frame Rate 30
Default Links

Global Status: OK

✓ Fixed Frame OK

Grid

TF



Fixed Frame

 Add Duplicate Remove Rename

ROS Time: 1645806258.44 ROS Elapsed: 1026.77 Wall Time: 1645806258.56 Wall Elapsed: 1026.72

Reset Left-Click: Move X/Y Right-Click: Move Z Mouse Wheel: Zoom.

Type: Orbit (rviz) Zero

Current View Orbit (rviz)

Near Clip Di...	0.01
Invert Z Axis	<input type="checkbox"/>
Target Frame	<Fixed Frame>
Distance	10
Focal Shape...	0.05
Focal Shape...	<input checked="" type="checkbox"/>
Yaw	0.785398
Pitch	0.785398
Field of View	0.785398
Focal Point	0; 0; 0

 Save Remove Rename Experimental

10 fps

▼  Global Options

Fixed Frame

world



Background Color

█ 48; 48; 48

Frame Rate

30

Default Light



File Panels Help



Move Camera



Focus Camera



2D Pose Estimate



Publish Point



Displays

- Global Options
 - Fixed Frame
 - Background Color
 - Frame Rate
 - Default Light
- Global Status: Ok
 - Fixed Frame
- Grid
 - TF

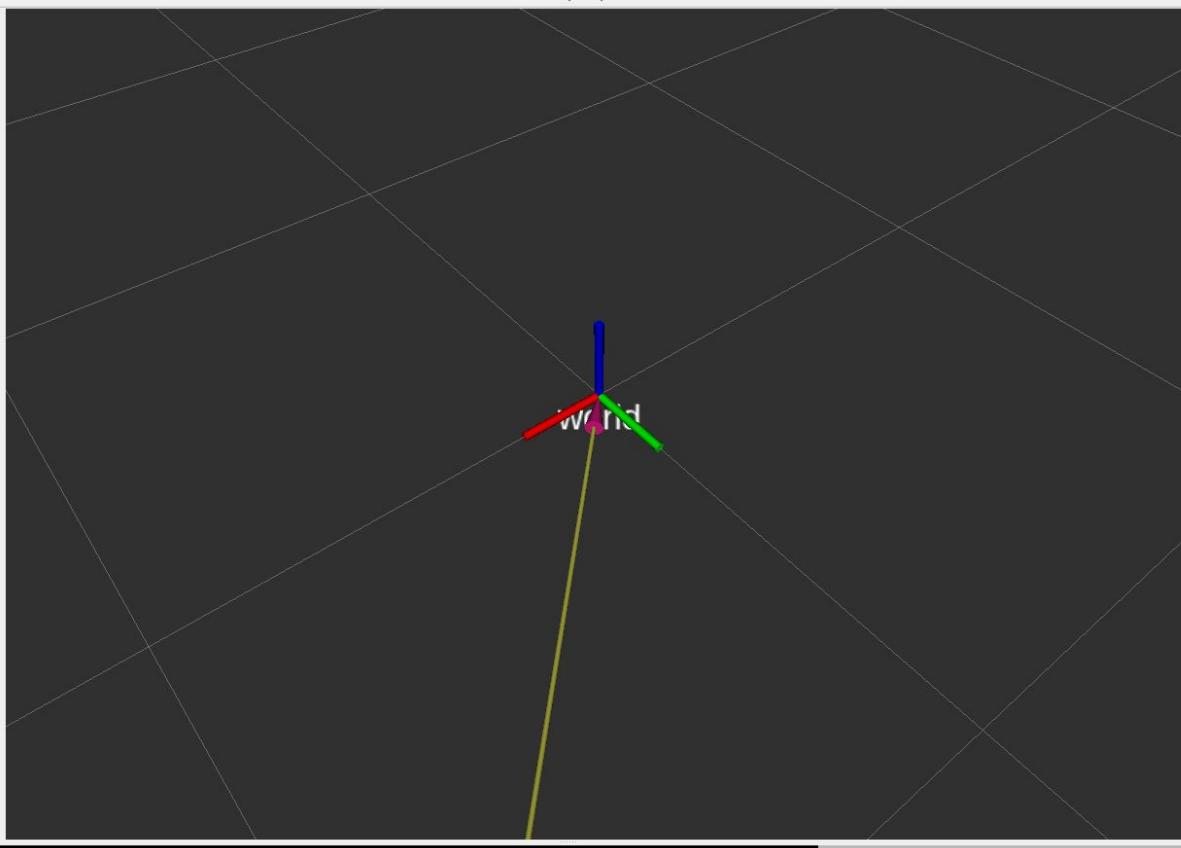
world
48; 48; 48

30

OK

OK

OK



Fixed Frame

 Add Duplicate Remove Rename

ROS Time: 1645806258.44 ROS Elapsed: 1026.77 Wall Time: 1645806258.56 Wall Elapsed: 1026.72

Reset Left-Click: Move X/Y Right-Click: Move Z Mouse Wheel: Zoom.

Type: Orbit (rviz) Zero

Current View

- Orbit (rviz)
 - Near Clip Di... 0.01
 - Invert Z Axis
 - Target Frame <Fixed Frame>
 - Distance 10
 - Focal Shape... 0.05
 - Focal Shape...
 - Yaw 0.785398
 - Pitch 0.785398
 - Field of View 0.785398
 - Focal Point 0; 0; 0

 Save Remove Rename Experimental

10 fps

▼  Global Options

Fixed Frame

Background Color

Frame Rate

Default Light

▼  Global Status: Ok

 Fixed Frame

►  Grid

►  TF

world

 48; 48; 48

30

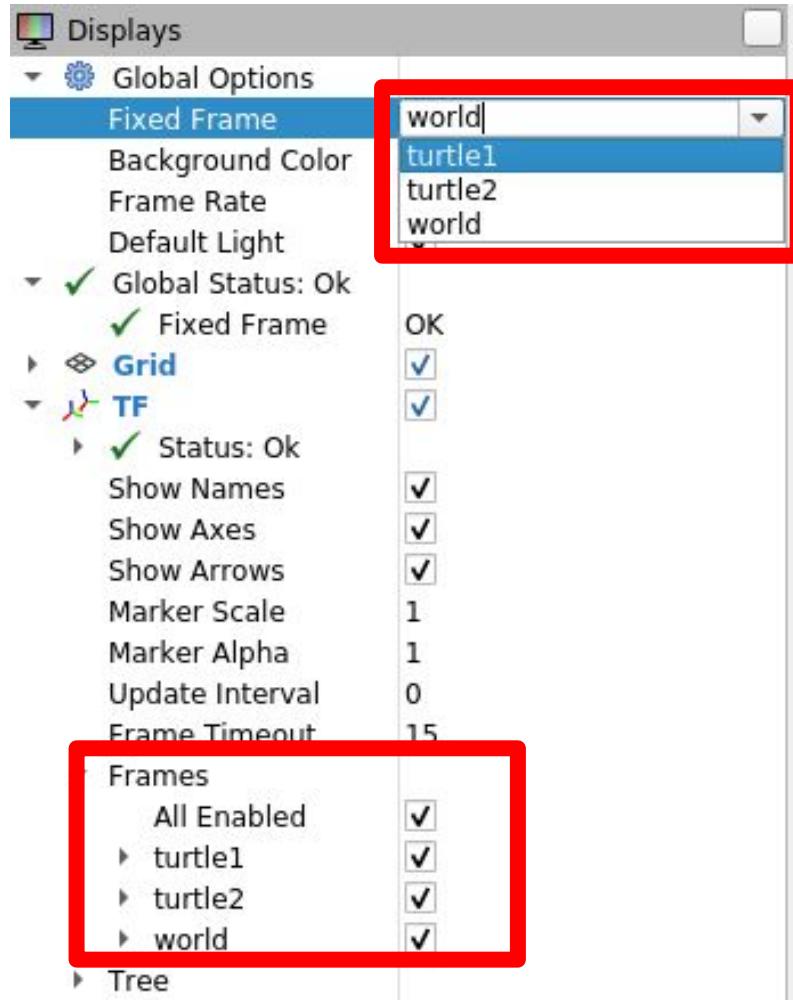


OK

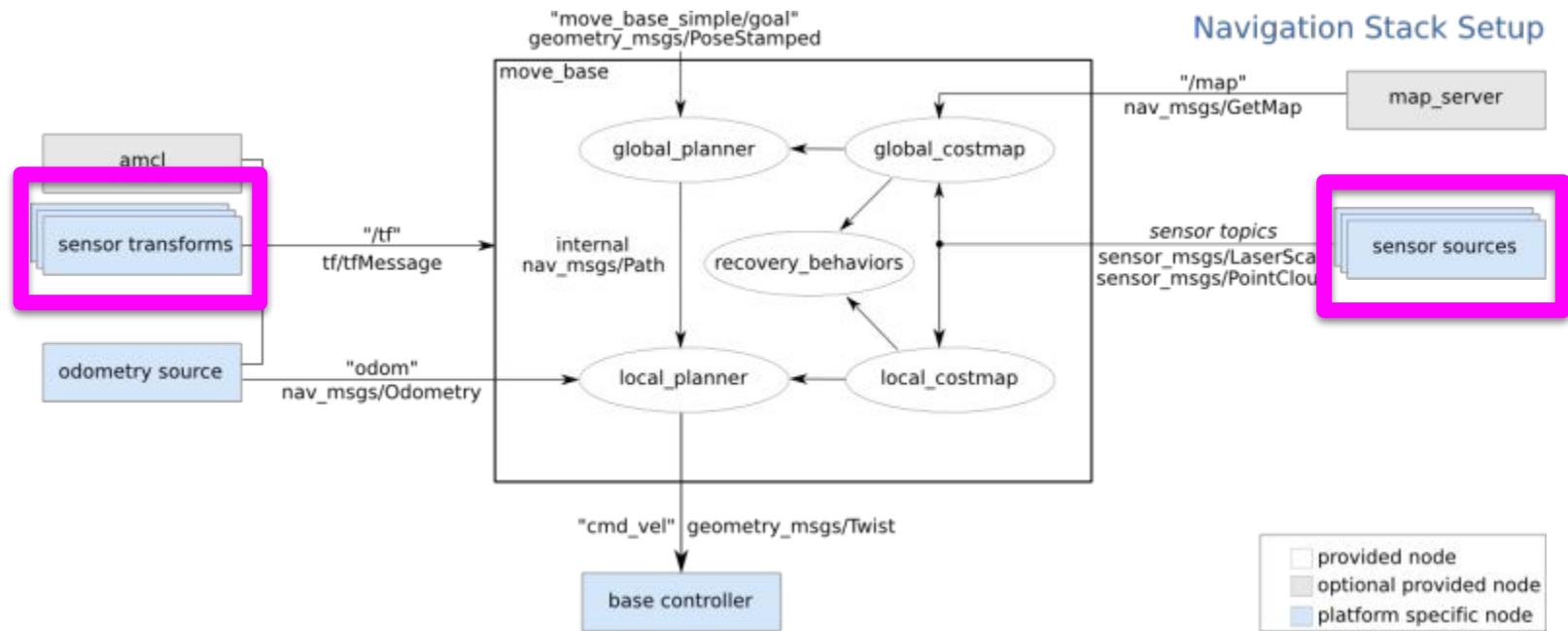


Displays	
▼	Global Options
Fixed Frame	world
Background Color	█ 48; 48; 48
Frame Rate	30
Default Light	✓
▼ ✓ Global Status: Ok	
✓ Fixed Frame	OK
► ⓧ Grid	✓
▼ ⓢ TF	✓
► ✓ Status: Ok	
Show Names	✓
Show Axes	✓
Show Arrows	✓
Marker Scale	1
Marker Alpha	1
Update Interval	0
Frame Timeout	15
► Frames	
► See	

Displays	
▼ Global Options	
Fixed Frame	world 
Background Color	█ 48; 48; 48
Frame Rate	30
Default Light	<input checked="" type="checkbox"/>
▼ Global Status: Ok	
Fixed Frame	OK
► Grid	<input checked="" type="checkbox"/>
▼ TF	<input checked="" type="checkbox"/>
Status: Ok	
Show Names	<input checked="" type="checkbox"/>
Show Axes	<input checked="" type="checkbox"/>
Show Arrows	<input checked="" type="checkbox"/>
Marker Scale	1
Marker Alpha	1
Update Interval	0
Frame Timeout	15
▼ Frames	
All Enabled	<input checked="" type="checkbox"/>
► turtle1	<input checked="" type="checkbox"/>
► turtle2	<input checked="" type="checkbox"/>
► world	<input checked="" type="checkbox"/>
► free	

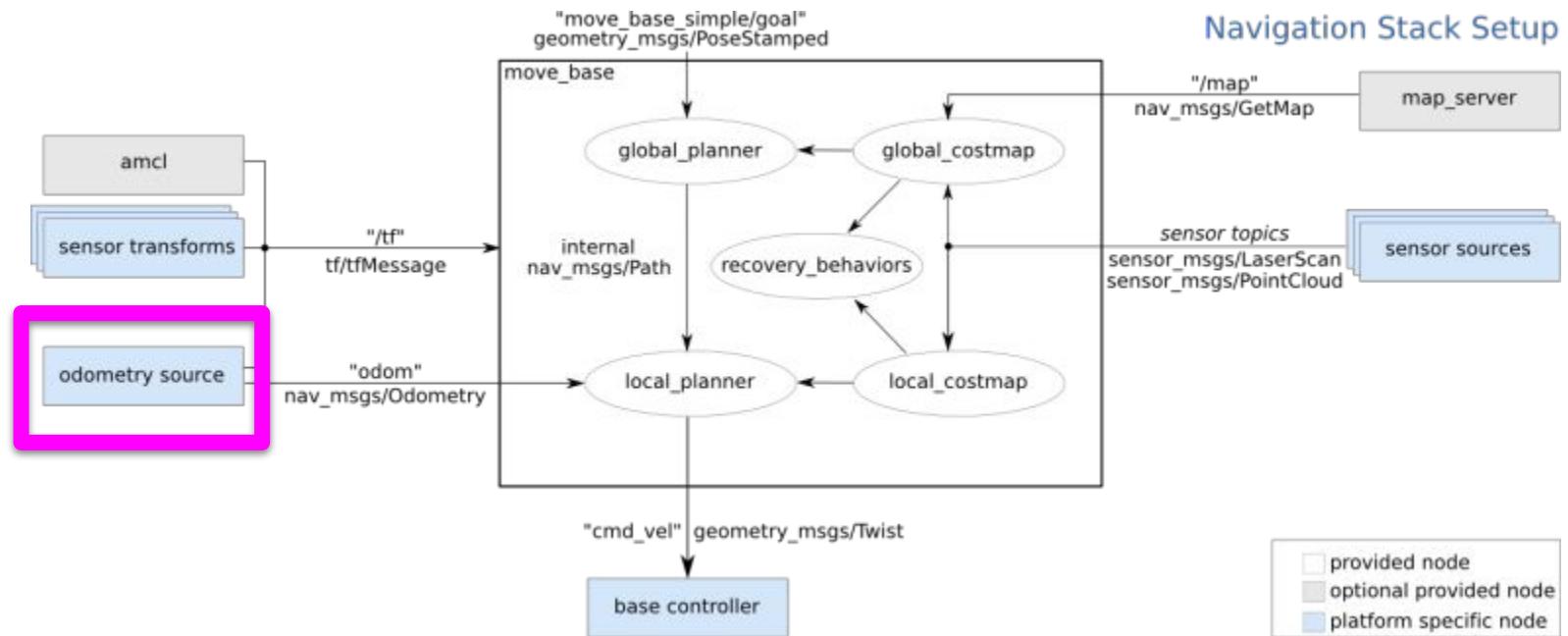


Sensor Information



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

Odometry Information



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

[nav_msgs/Odometry](#) Message

File: [nav_msgs/Odometry.msg](#)

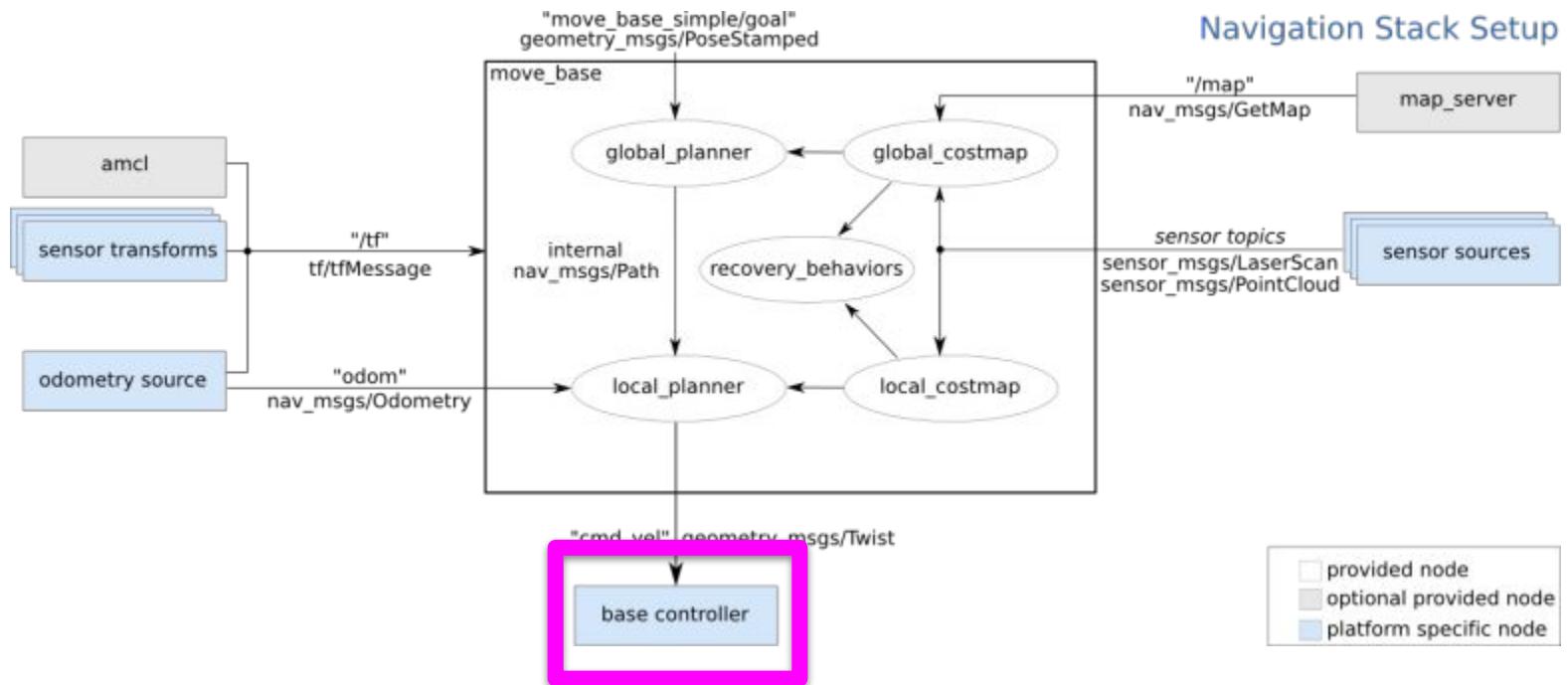
Raw Message Definition

```
# This represents an estimate of a position and velocity in free space.
# The pose in this message should be specified in the coordinate frame given by header.frame_id.
# The twist in this message should be specified in the coordinate frame given by the child_frame_id
Header header
string child_frame_id
geometry_msgs/PoseWithCovariance pose
geometry_msgs/TwistWithCovariance twist
```

Compact Message Definition

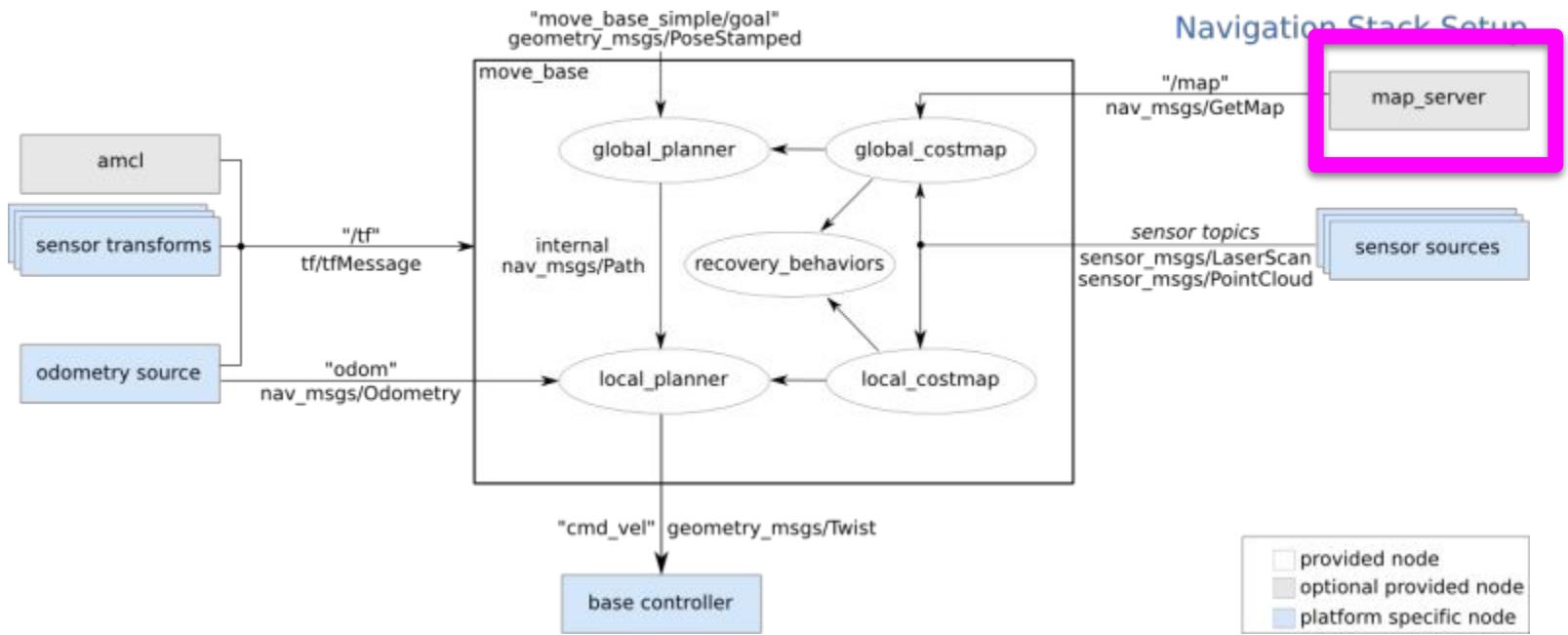
```
std_msgs/Header header
string child_frame_id
geometry_msgs/PoseWithCovariance pose
geometry_msgs/TwistWithCovariance twist
```

Base Controller



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

Mapping



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

nav_msgs/GetMap Service

File: `nav_msgs/GetMap.srv`

Raw Message Definition

```
# Get the map as a nav_msgs/OccupancyGrid
---
nav_msgs/OccupancyGrid map
```

Compact Message Definition

```
nav_msgs/OccupancyGrid map
```

nav_msgs/OccupancyGrid Message

File: `nav_msgs/OccupancyGrid.msg`

Raw Message Definition

```
# This represents a 2-
D grid map, in which each cell represents the probability of
# occupancy.

Header header

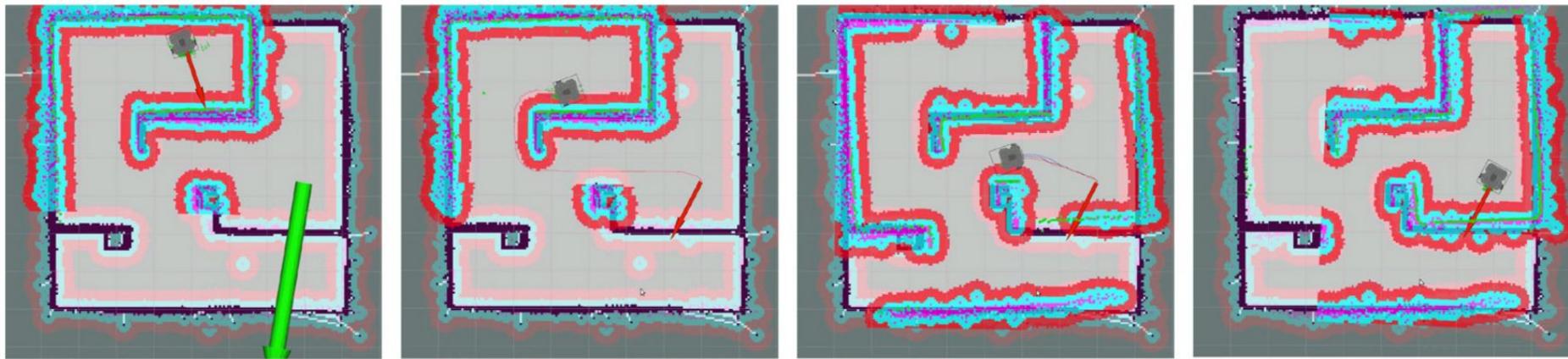
#MetaData for the map
MapMetaData info

# The map data, in row-major order, starting with (0,0). Occupancy
# probabilities are in the range [0,100]. Unknown is -1.
int8[] data
```

Compact Message Definition

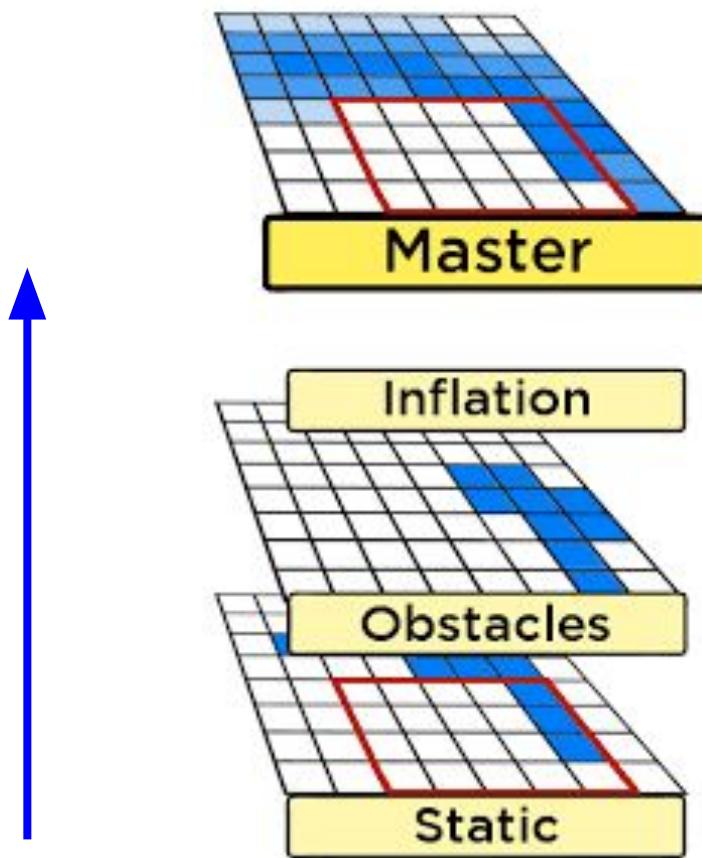
```
std_msgs/Header header
nav_msgs/MapMetaData info
int8[] data
```

Costmap

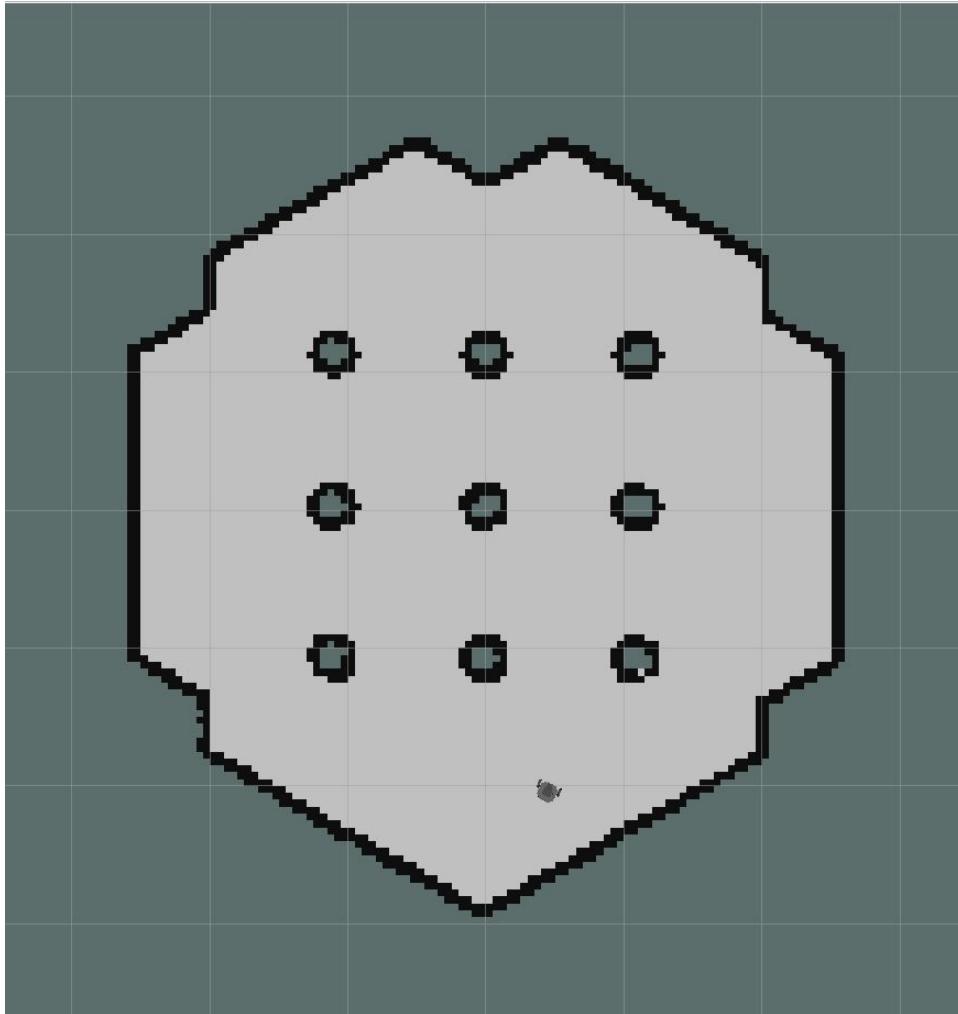


REF: <https://emanual.robotis.com/docs/en/platform/turtlebot3/navigation/>

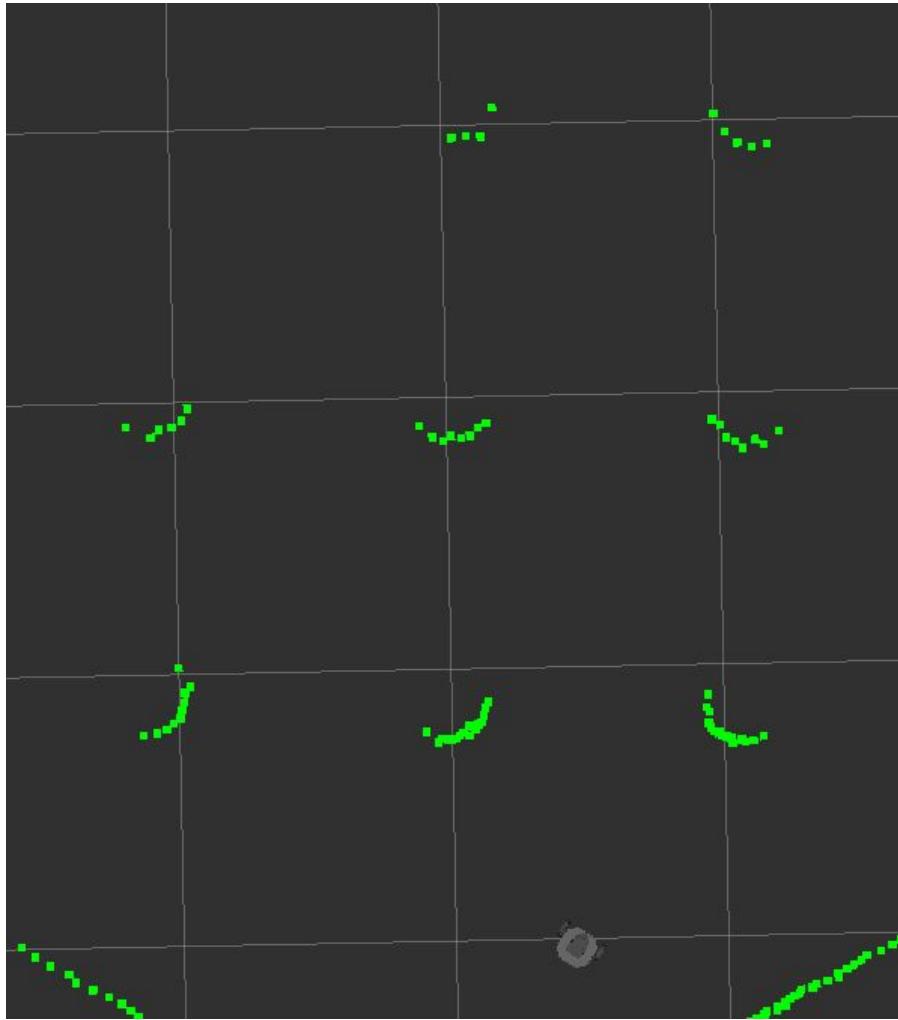
Costmap Layer



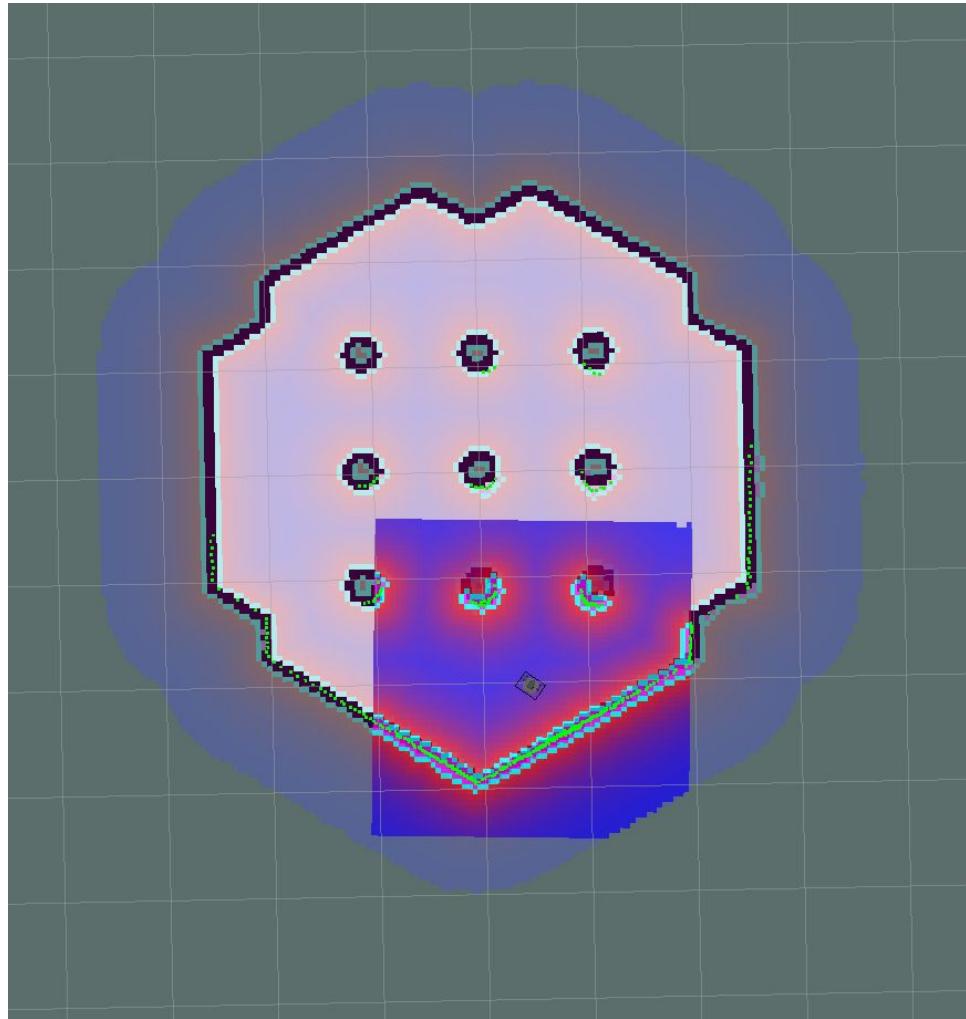
Static Map Layer

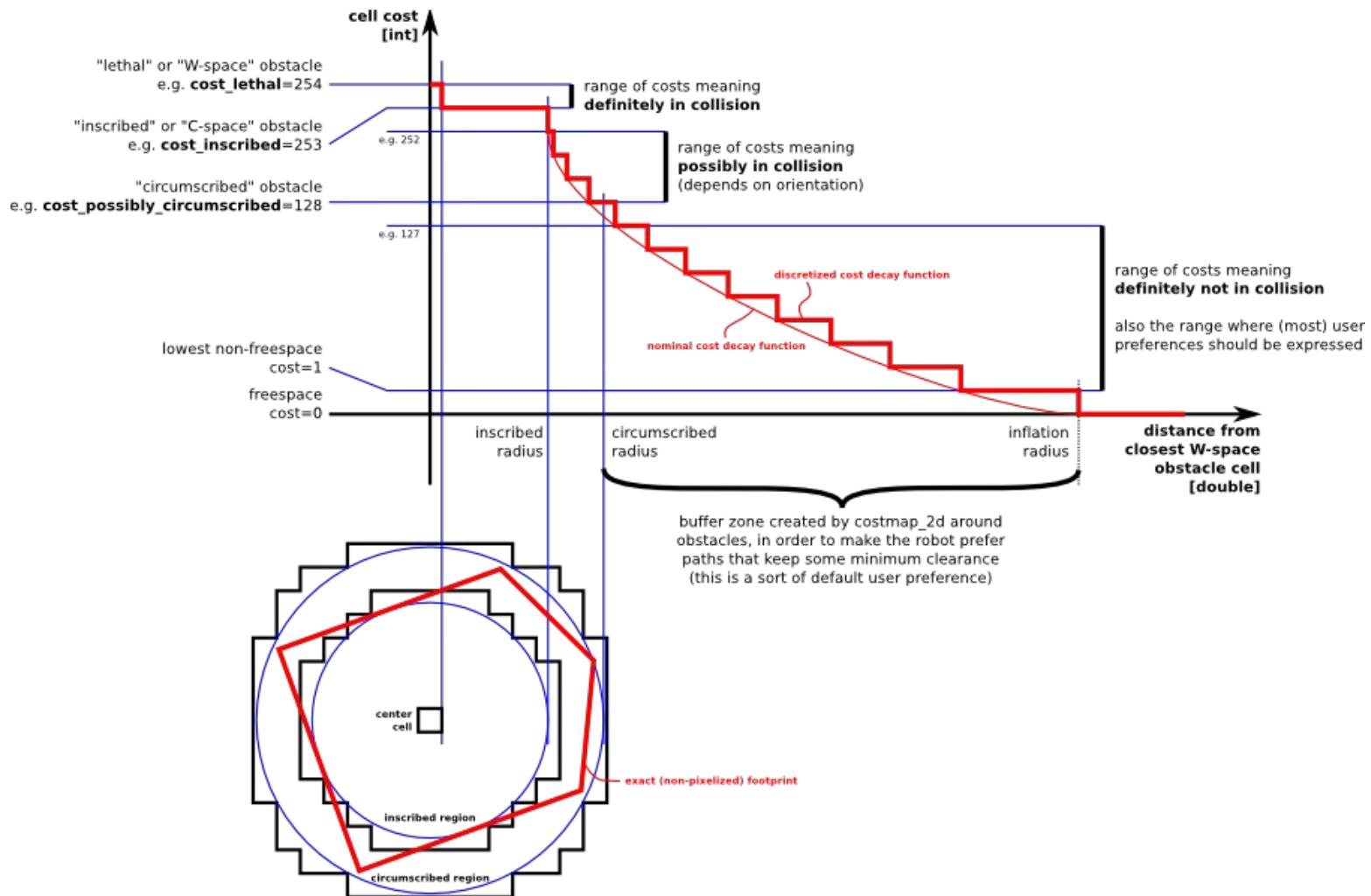


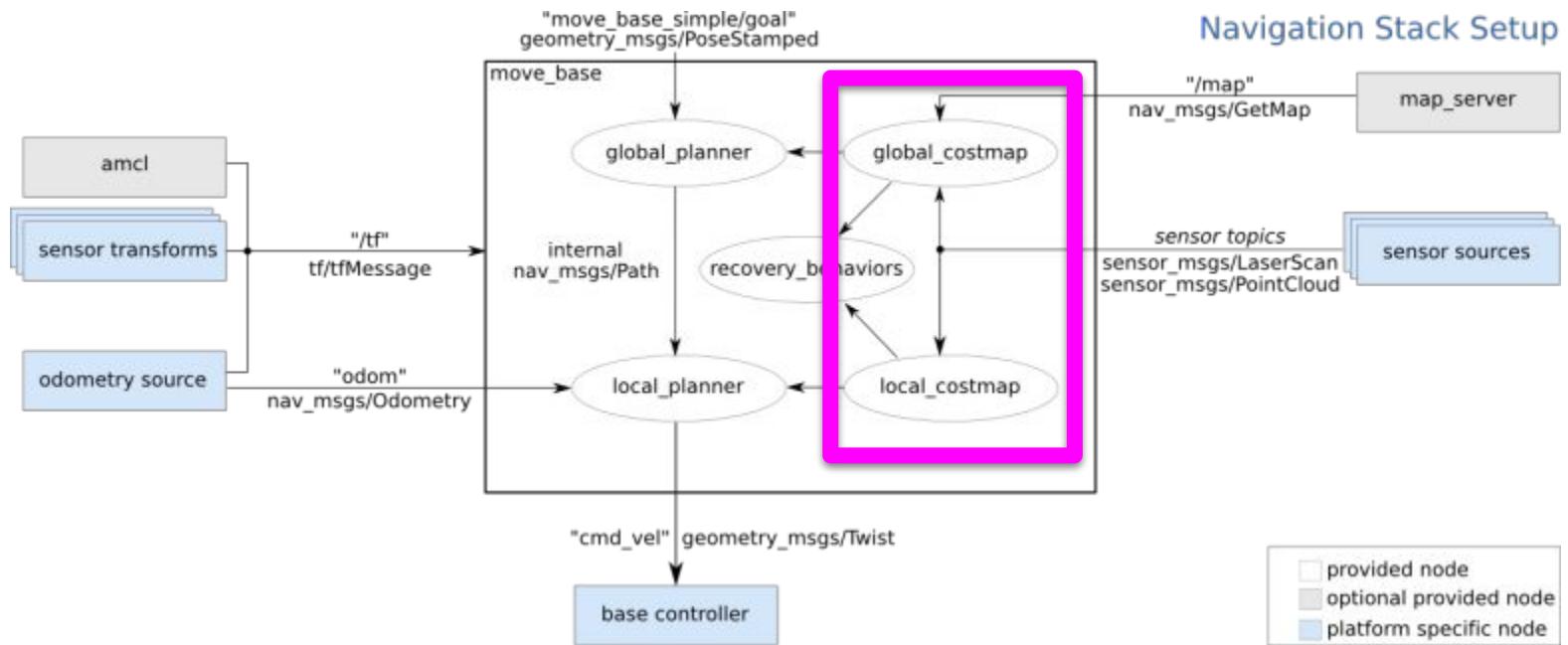
Obstacle Map Layer



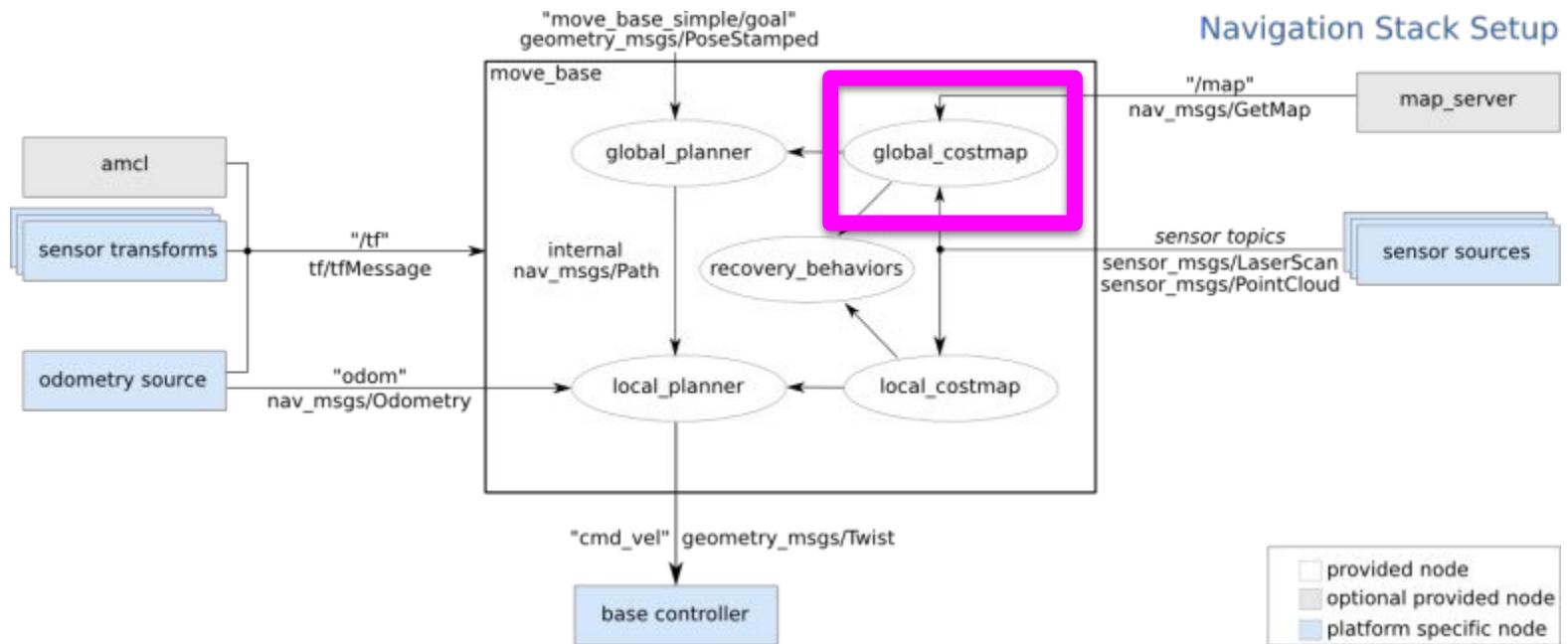
Inflation Layer



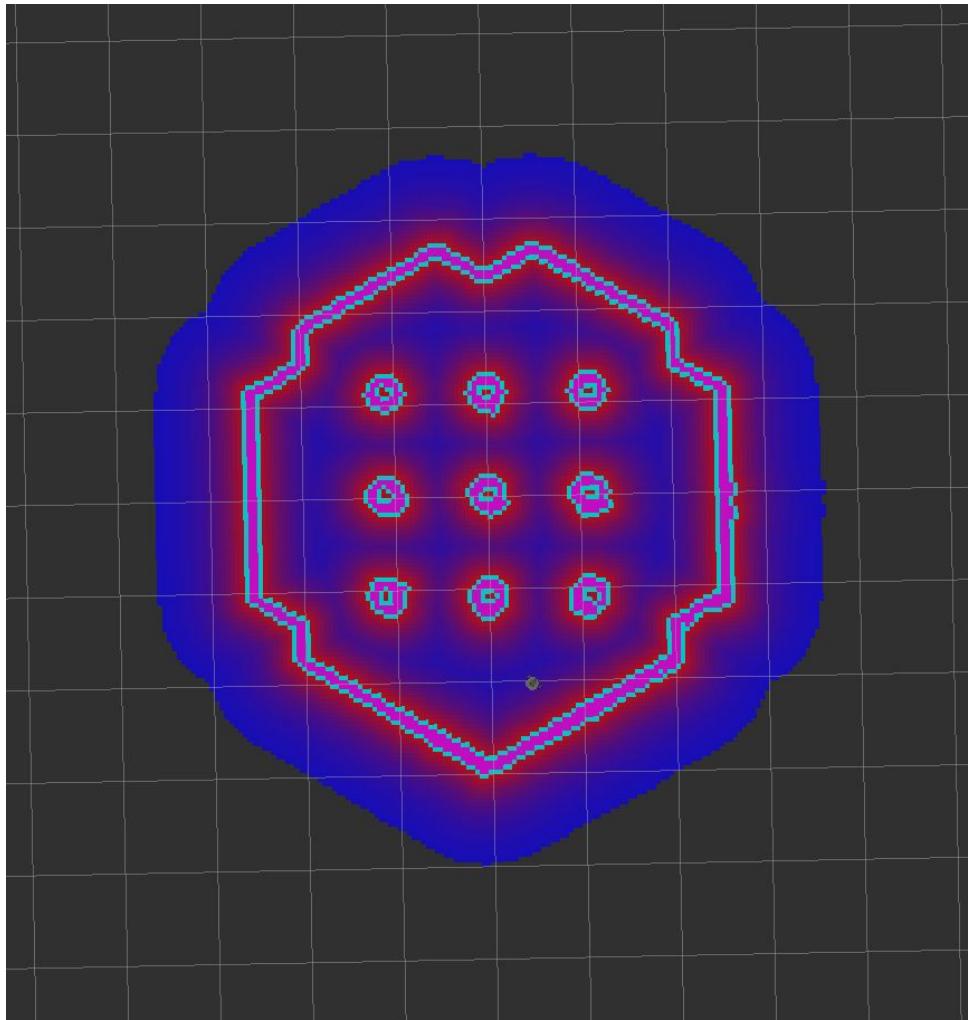


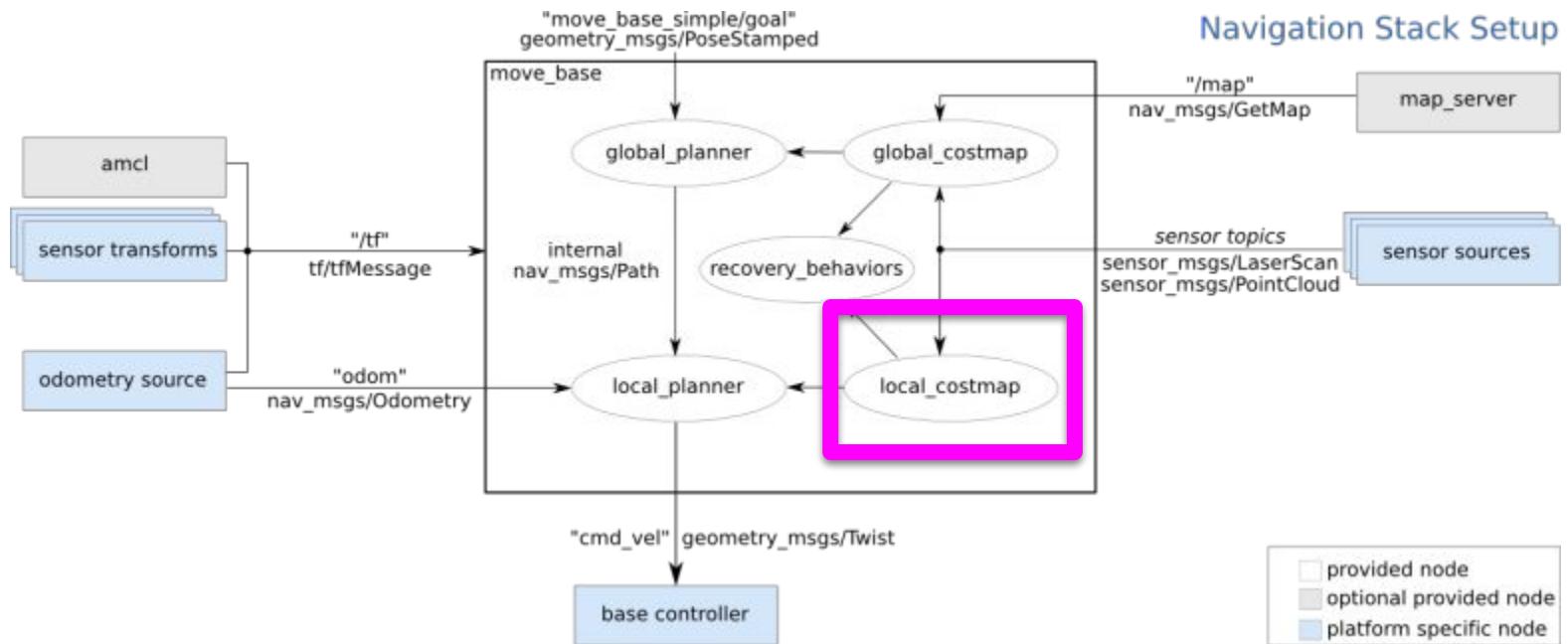


REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

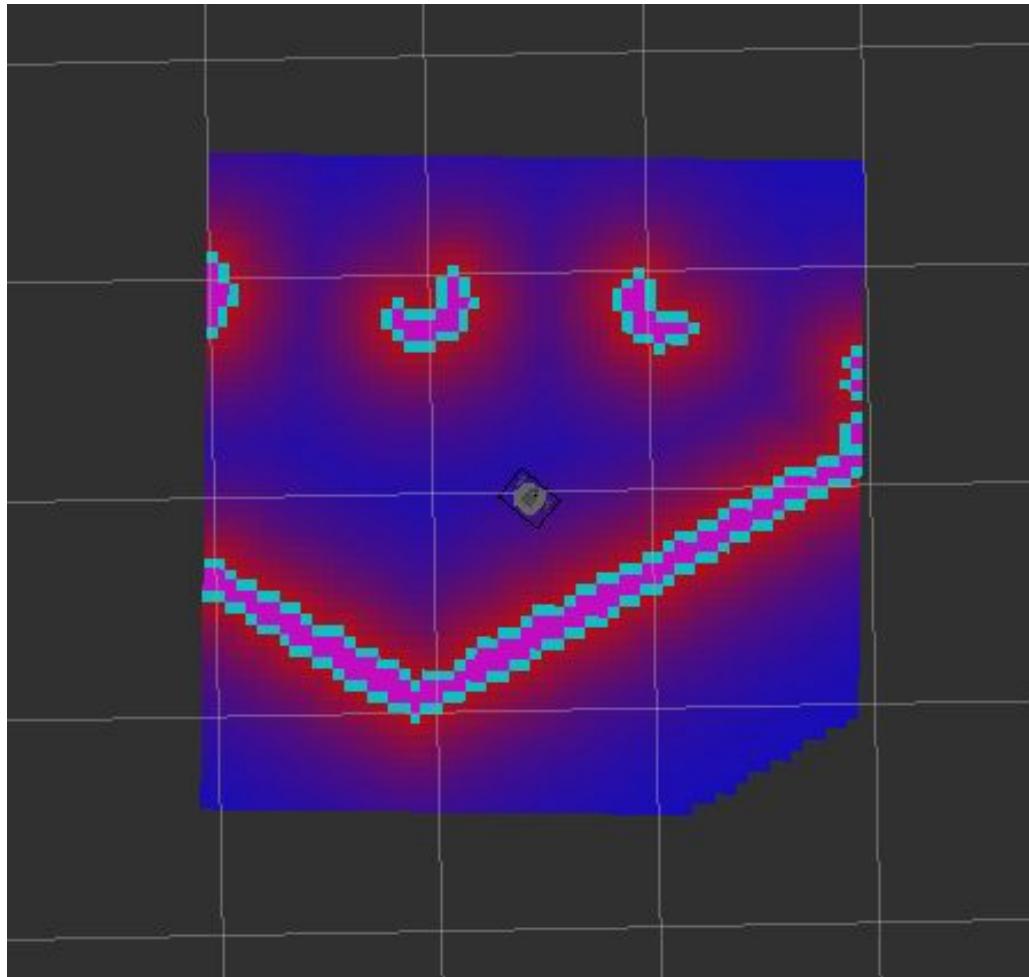


REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

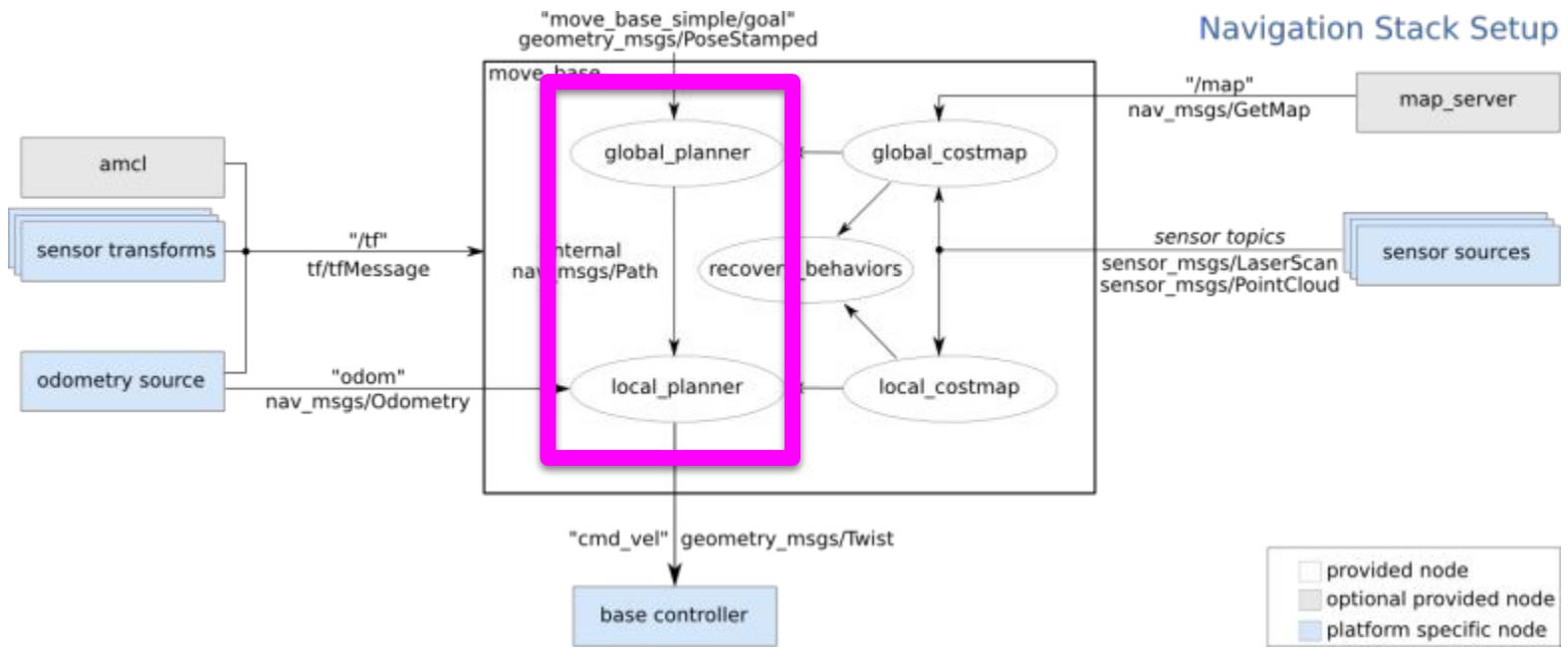




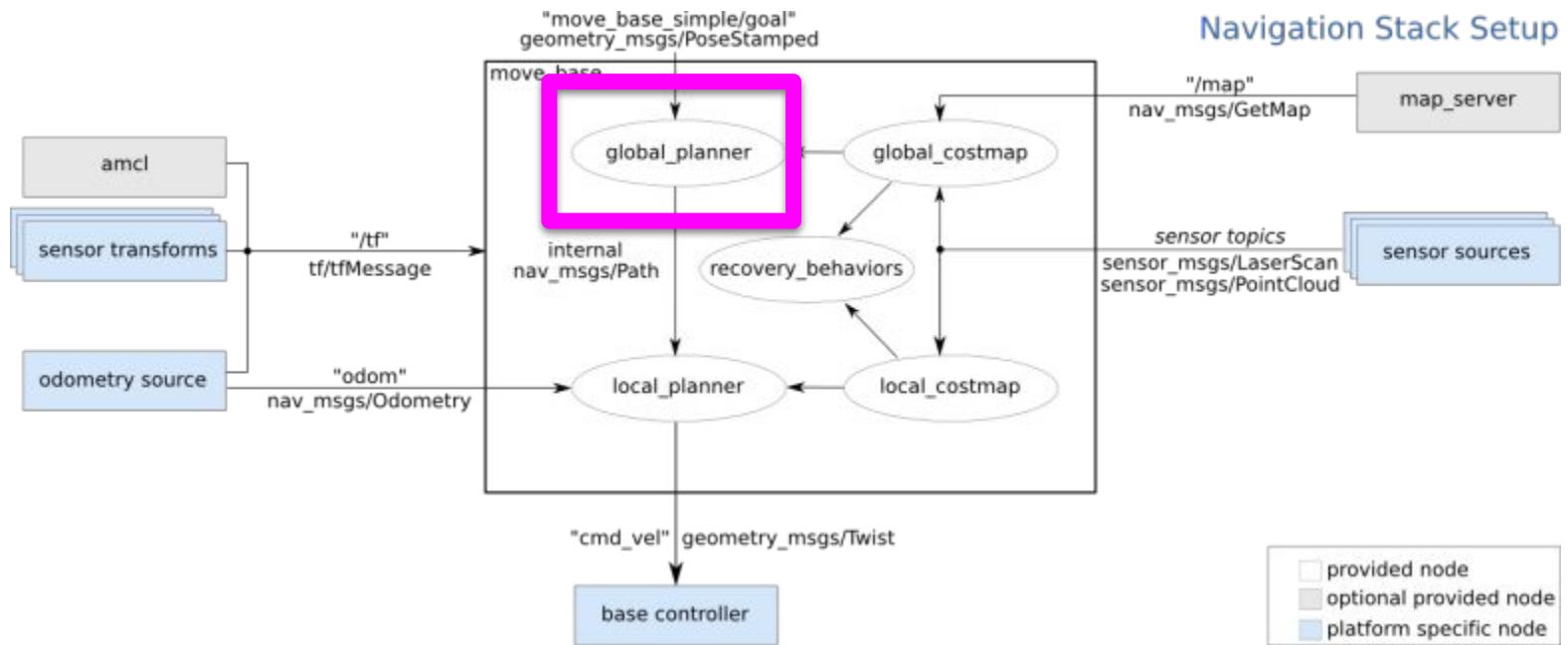
REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>



Planner



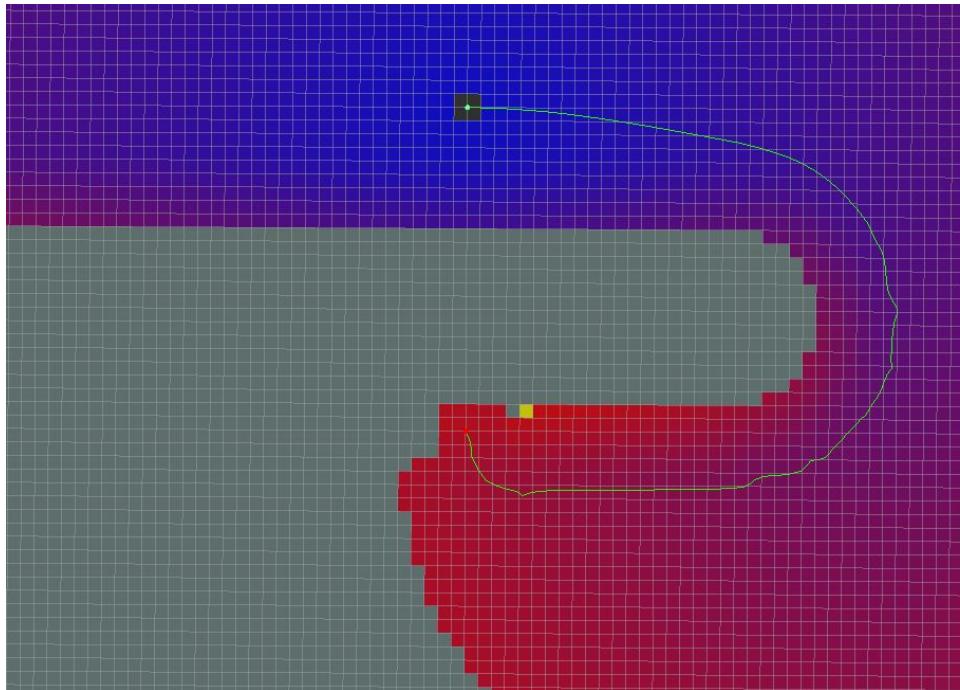
REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

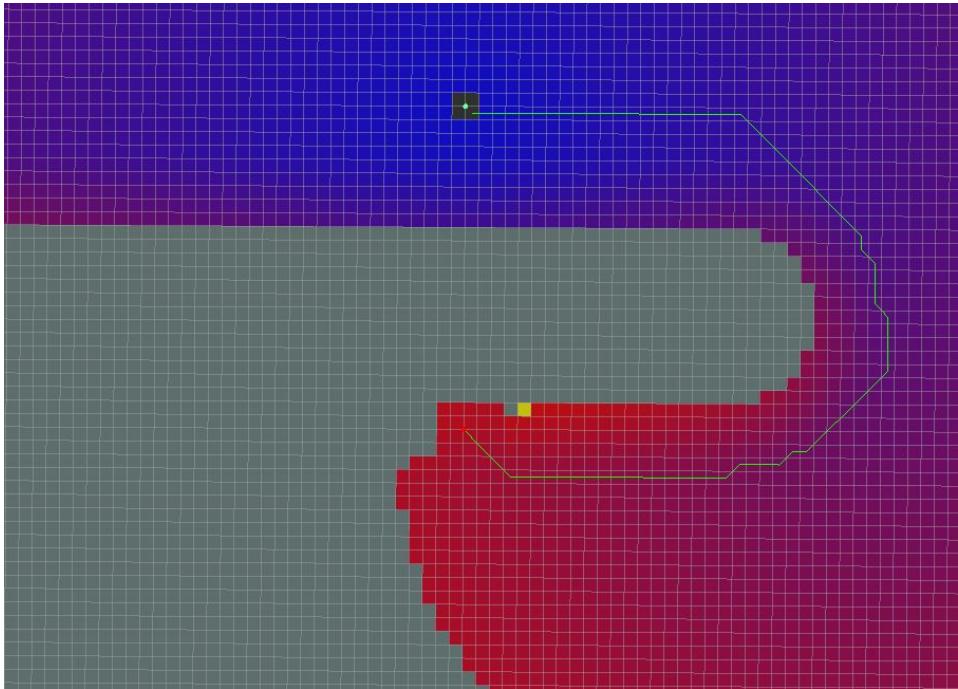
global_planner

Standard Behavior



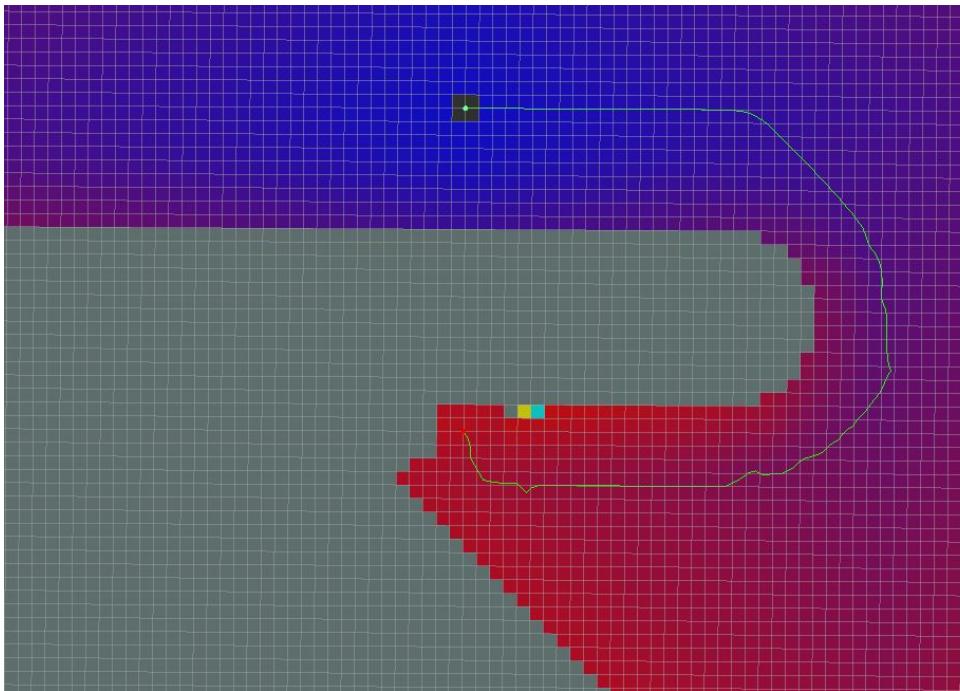
REF: http://wiki.ros.org/global_planner?distro=noetic

Grid Path



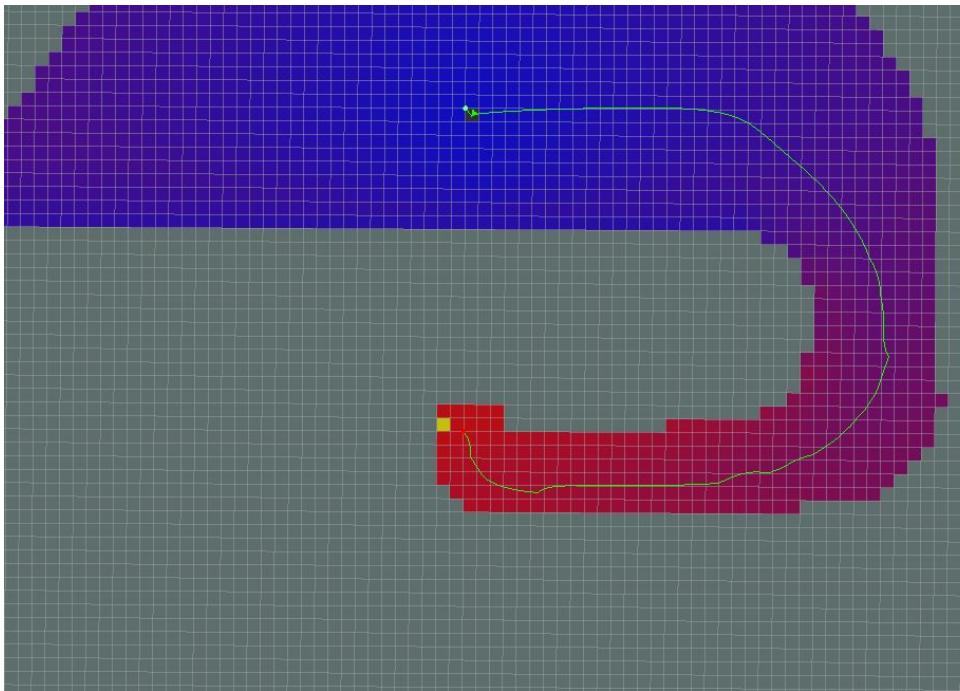
REF: http://wiki.ros.org/global_planner?distro=noetic

Simple Potential Calculation



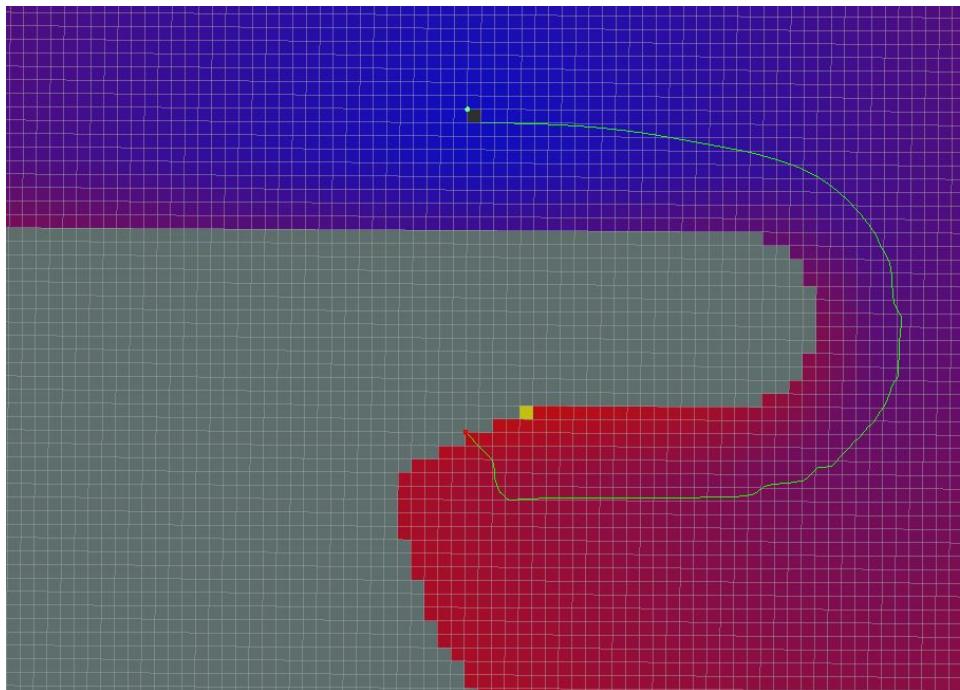
REF: http://wiki.ros.org/global_planner?distro=noetic

A* Path

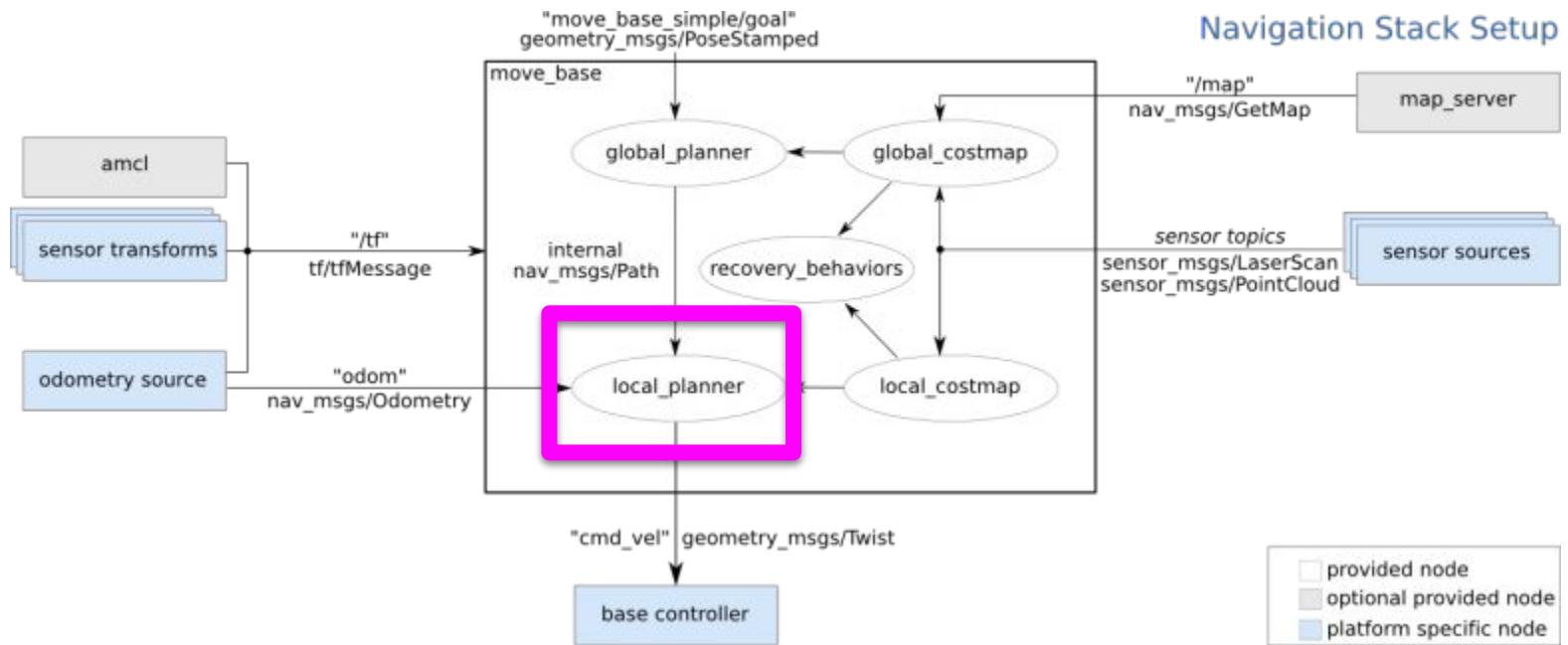


REF: http://wiki.ros.org/global_planner?distro=noetic

Old Navfn Behavior



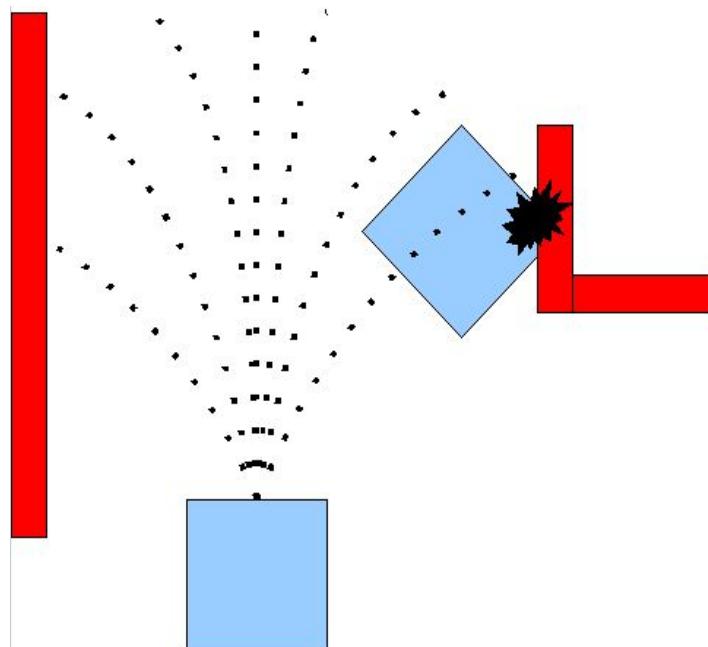
REF: http://wiki.ros.org/global_planner?distro=noetic



REF: <http://wiki.ros.org/navigation/Tutorials/RobotSetup>

dwa_local_planner

Dynamic Window Approach Local Planner



REF: http://wiki.ros.org/dwa_local_planner?distro=noetic

dwa_local_planner

The basic idea of the Dynamic Window Approach (DWA) algorithm is as follows:

1. Discretely sample in the robot's control space ($dx, dy, d\theta$)
2. For each sampled velocity, perform forward simulation from the robot's current state to predict what would happen if the sampled velocity were applied for some (short) period of time.
3. Evaluate (score) each trajectory resulting from the forward simulation, using a metric that incorporates characteristics such as: proximity to obstacles, proximity to the goal, proximity to the global path, and speed. Discard illegal trajectories (those that collide with obstacles).
4. Pick the highest-scoring trajectory and send the associated velocity to the mobile base.
5. Rinse and repeat.

Use navigation
with TurtleBot3
in Gazebo

```
$ sudo apt install ros-noetic-turtlebot3-navigation  
ros-noetic-dwa-local-planner
```

เปิด terminal

```
$ roscore
```

```
[REDACTED]:~# roscore
... logging to /root/.ros/log/a4938efa-7c5b-11ec-b410-0242ac110002/roslaunch-c0665c07a68b-2984.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:39823/
ros_comm version 1.15.13

SUMMARY
=====
PARAMETERS
* /rosdistro: noetic
* /rosversion: 1.15.13

NODES

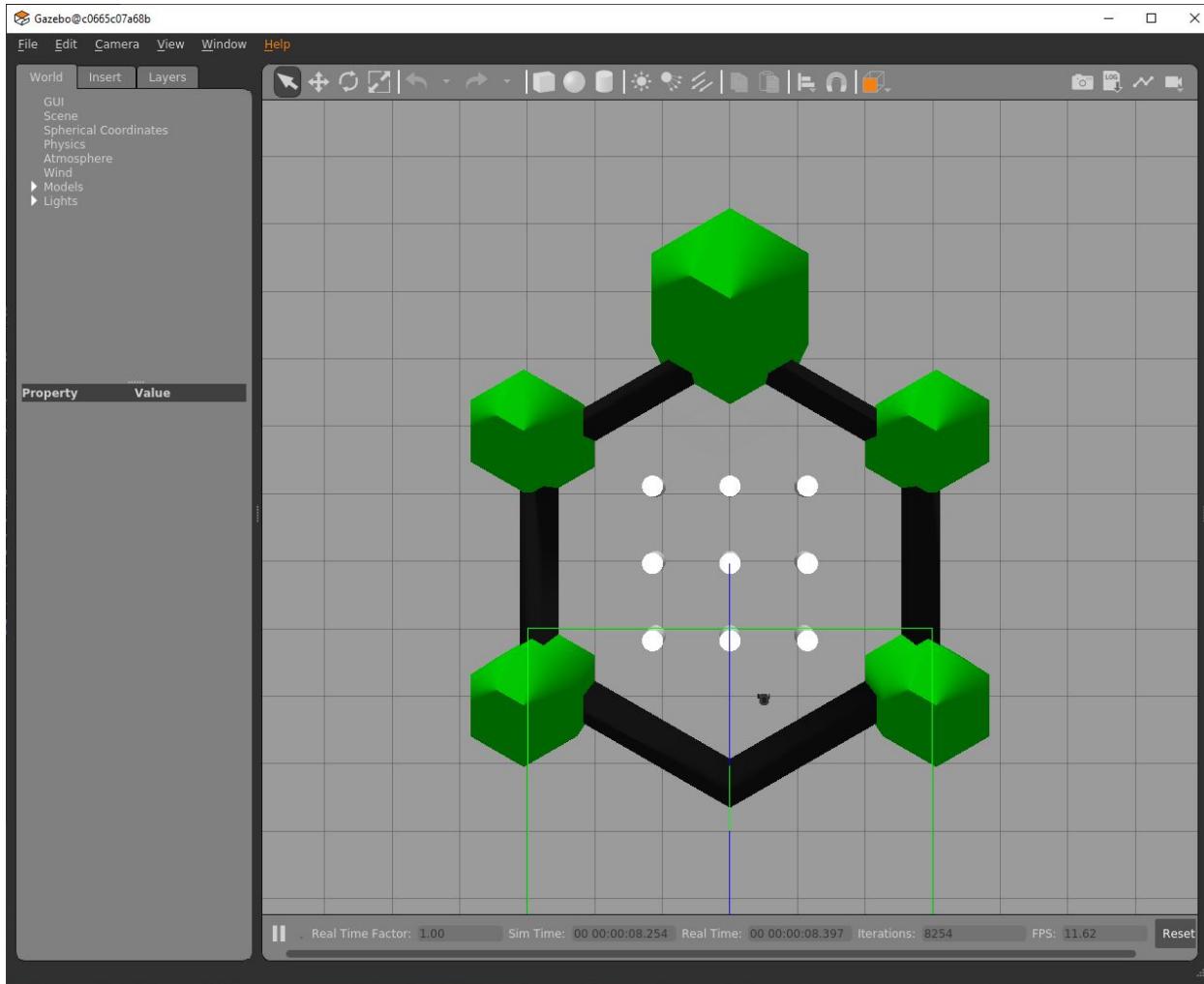
auto-starting new master
process[master]: started with pid [3008]
ROS_MASTER_URI=http://[REDACTED]:11311/

setting /run_id to [REDACTED]
process[rosout-1]: started with pid [3028]
started core service [/rosout]

-
```

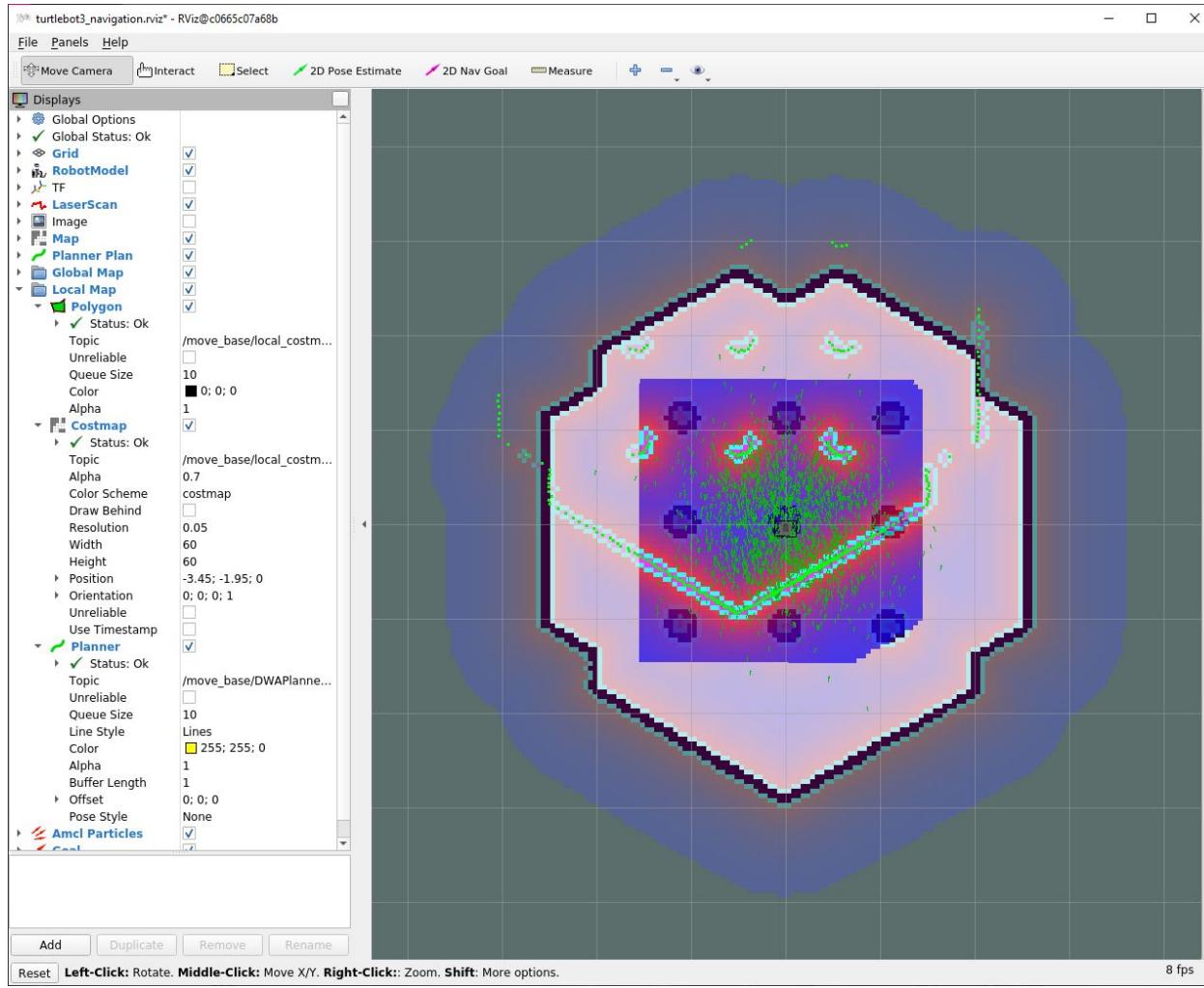
เปิดหน้าต่างใหม่

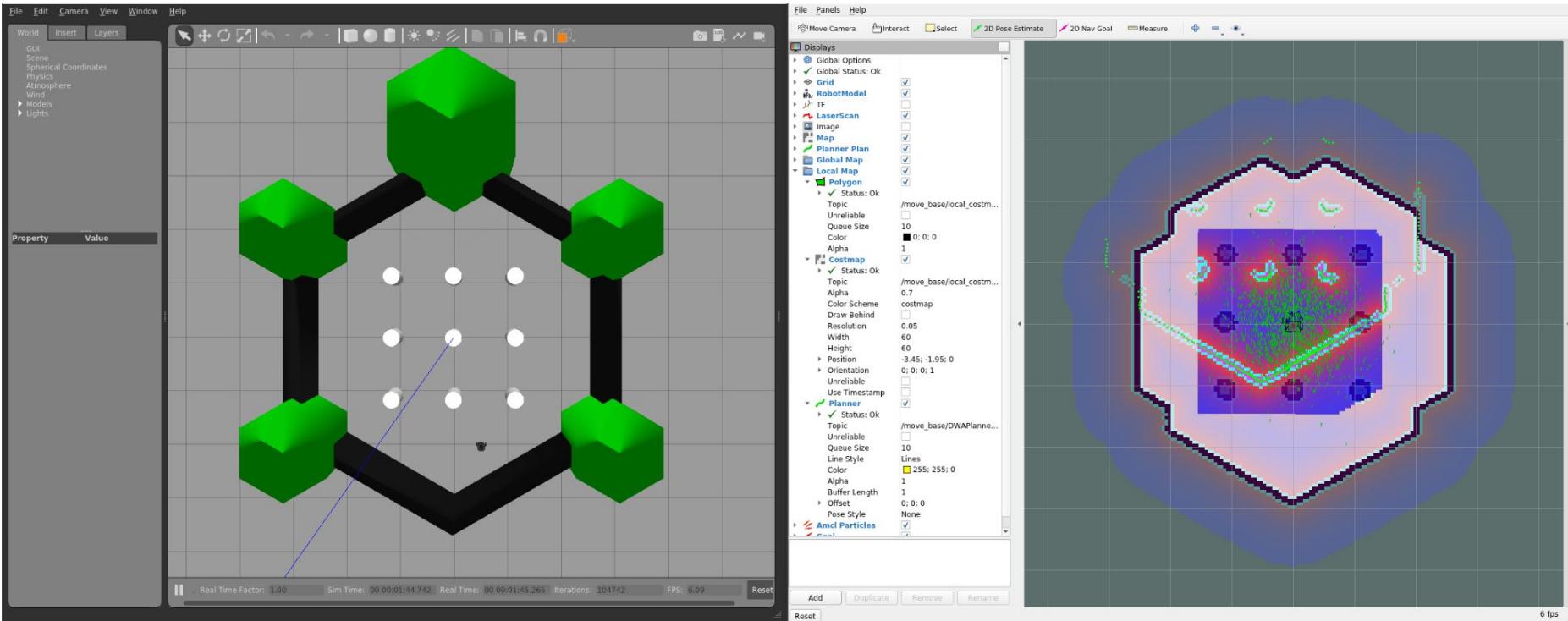
```
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```

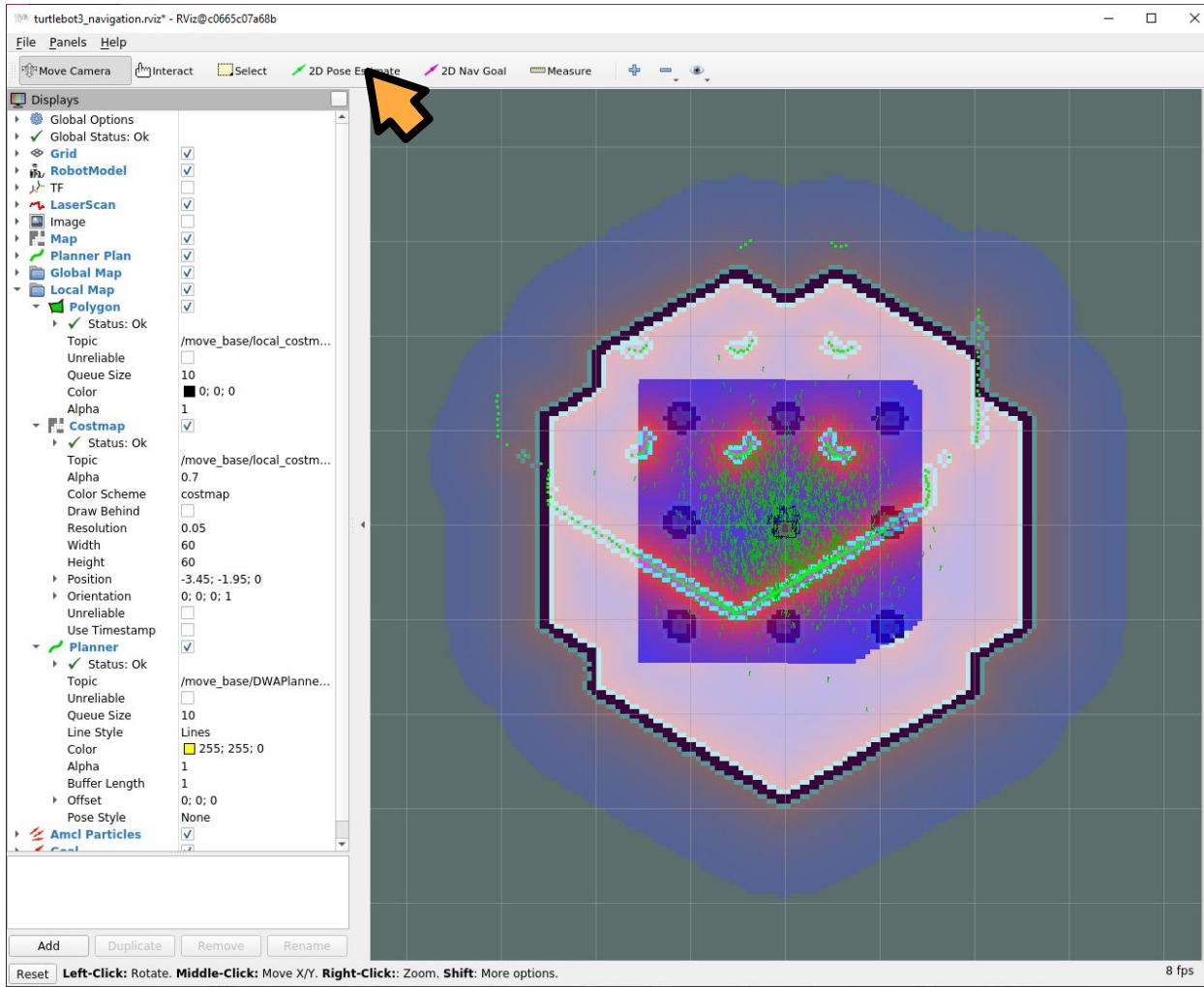


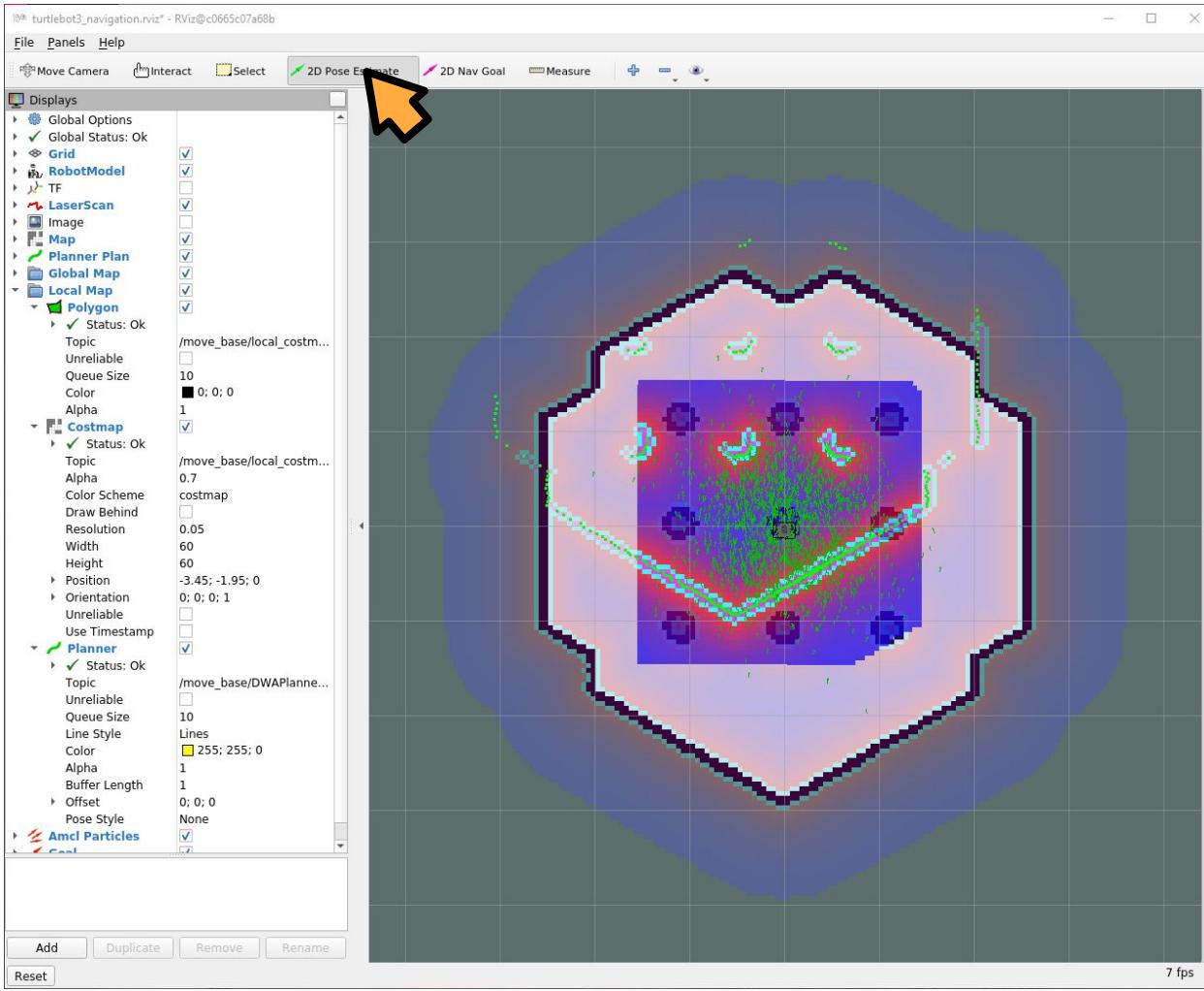
เปิดหน้าต่างใหม่

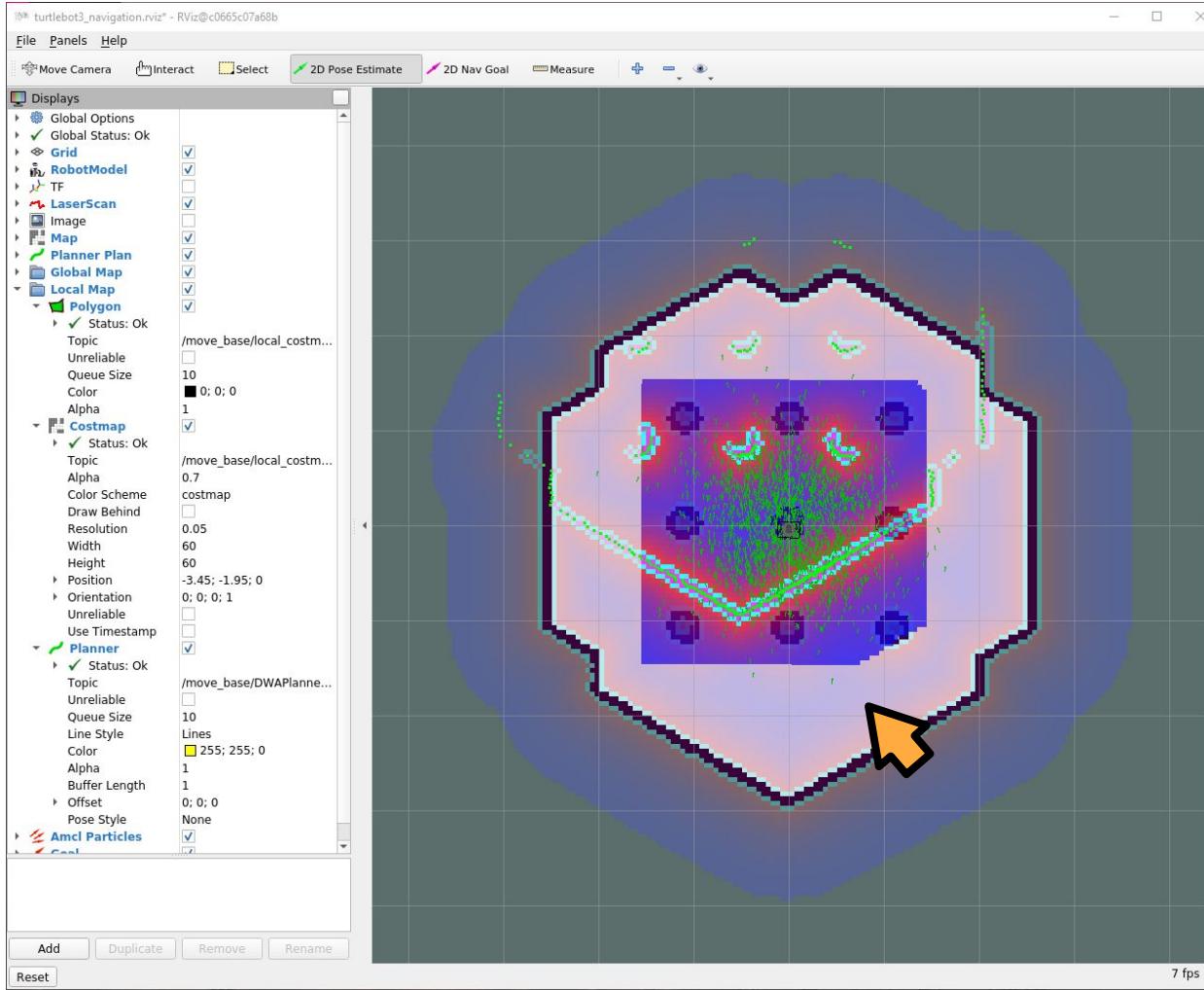
```
$ roslaunch turtlebot3_navigation turtlebot3_navigation.launch map_file:=$HOME/map.yaml
```

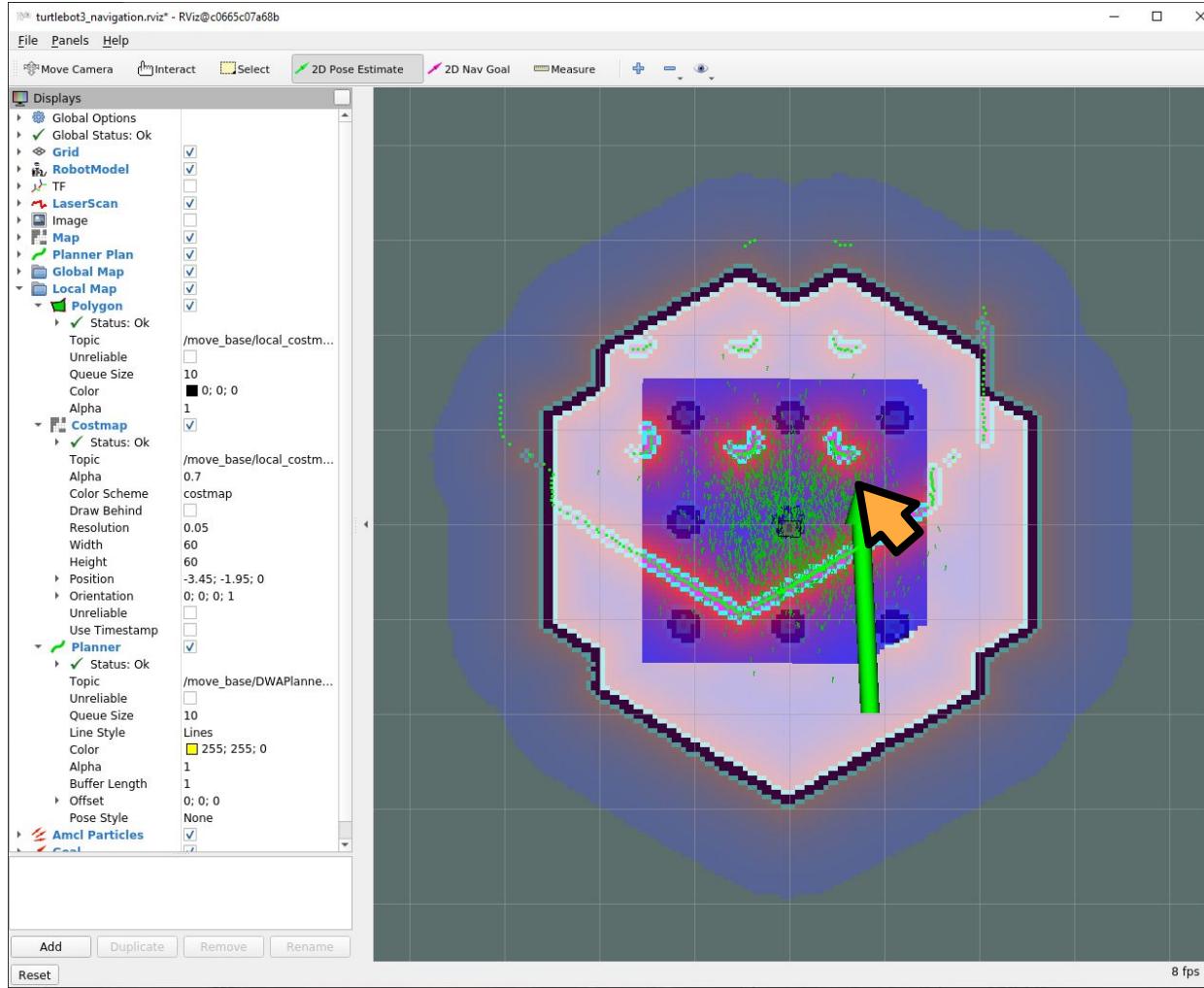


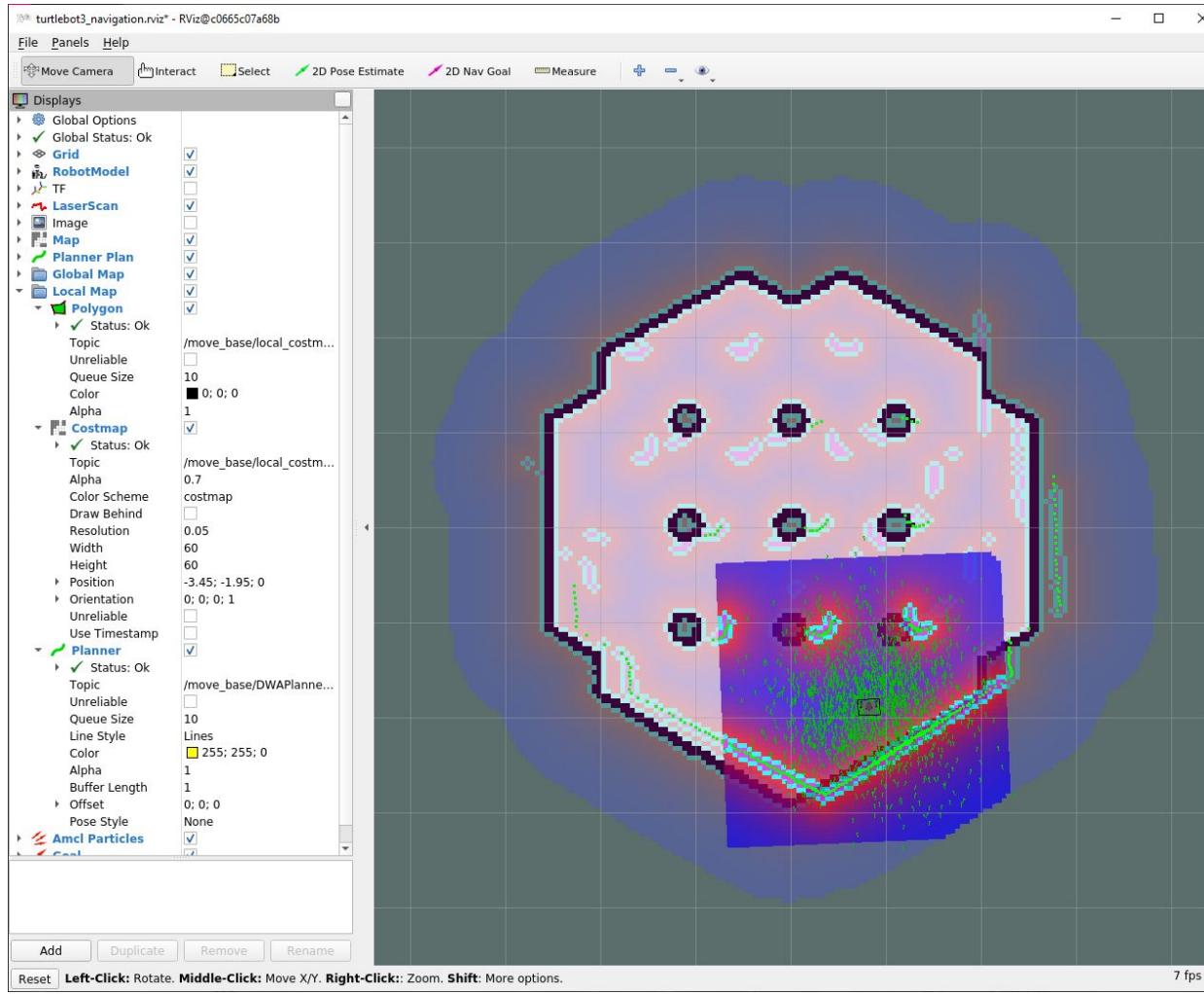












```
$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
```

```
:~$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
... logging to /root/.ros/log/3cadf654-97ea-11ec-8c45-0242ac110003/roslaunch-c0665c07a68b-19766.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:46375/

SUMMARY
=====
PARAMETERS
* /model: burger
* /rosdistro: noetic
* /rosversion: 1.15.13

NODES
/
  turtlebot3_teleop_keyboard (turtlebot3_teleop/turtlebot3_teleop_key)

ROS_MASTER_URI=http://localhost:11311

process[turtlebot3_teleop_keyboard-1]: started with pid [19791]

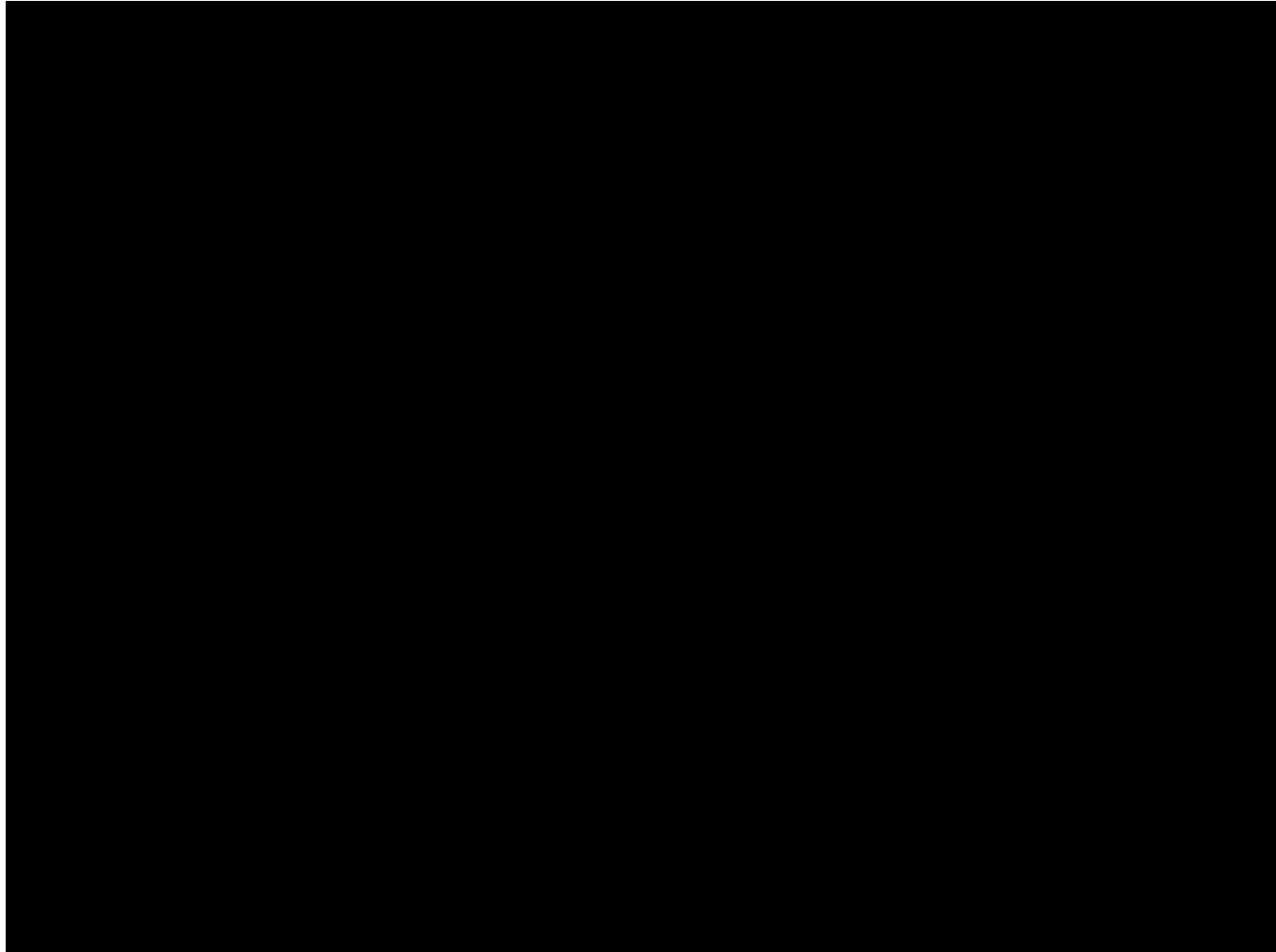
Control Your TurtleBot!
-----
Moving around:
      w
    a   s   d
      x

w/x : increase/decrease linear velocity (Burger : ~ 0.22, Waffle and Waffle Pi : ~ 0.26)
a/d : increase/decrease angular velocity (Burger : ~ 2.84, Waffle and Waffle Pi : ~ 1.82)

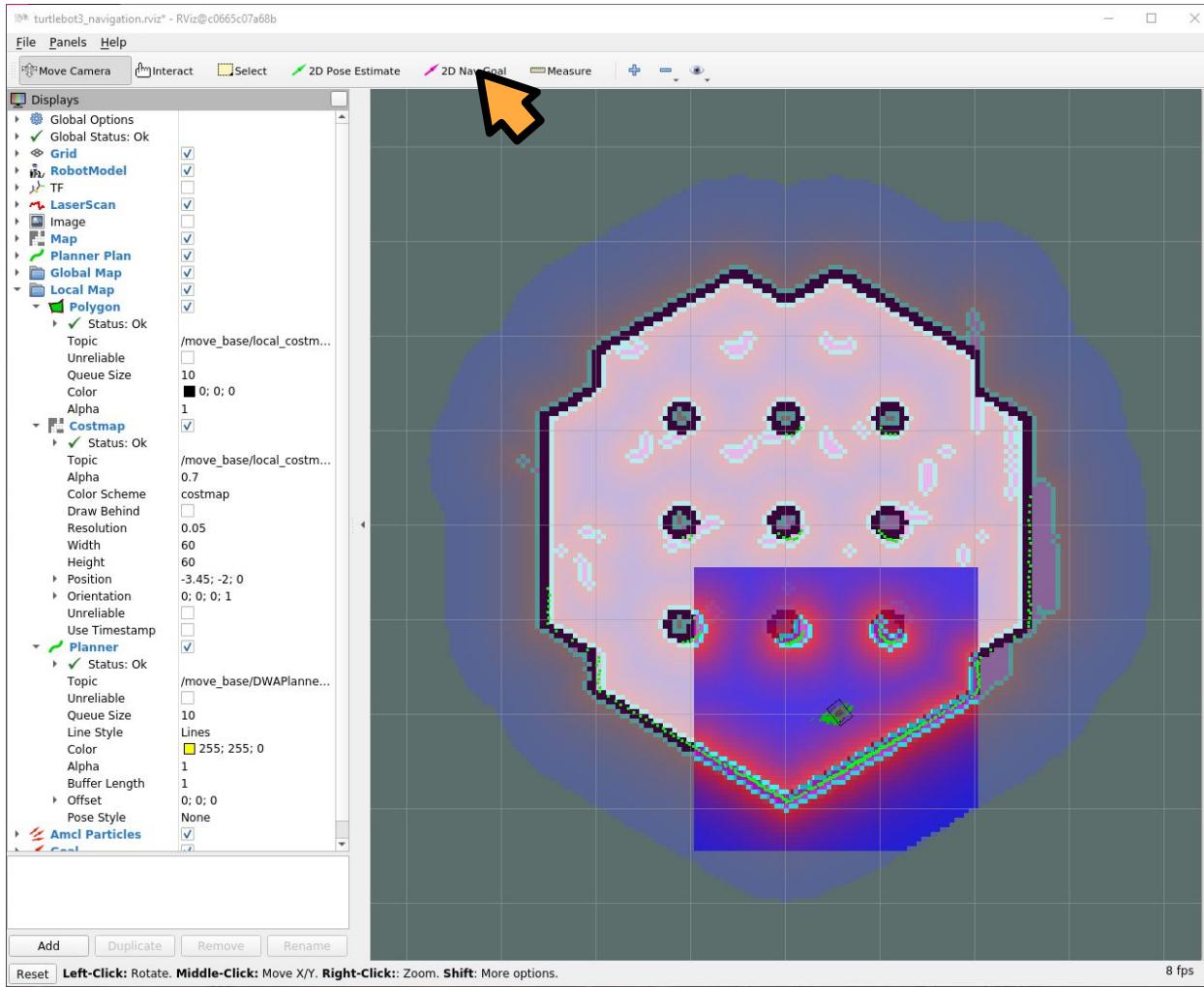
space key, s : force stop

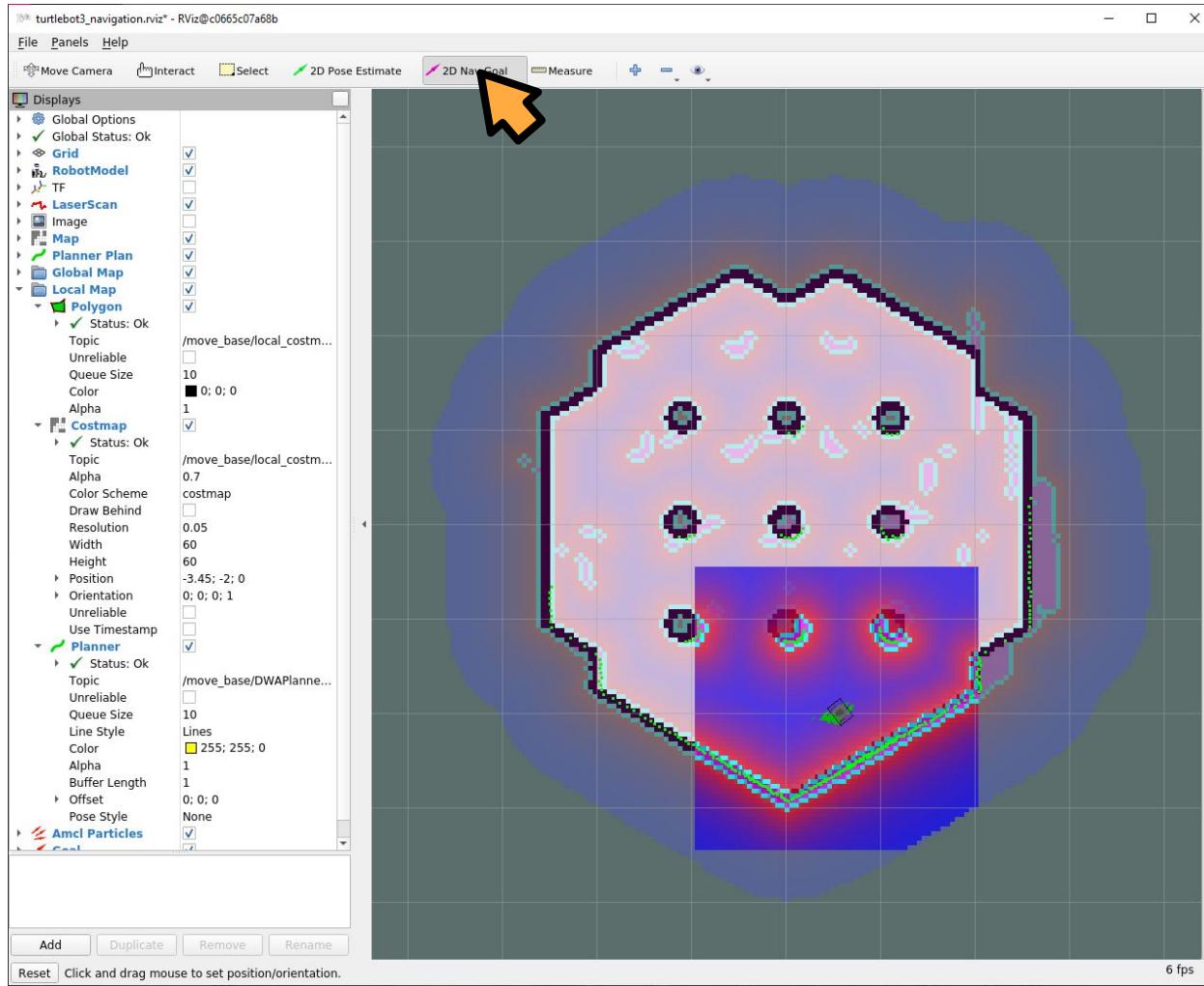
CTRL-C to quit
```

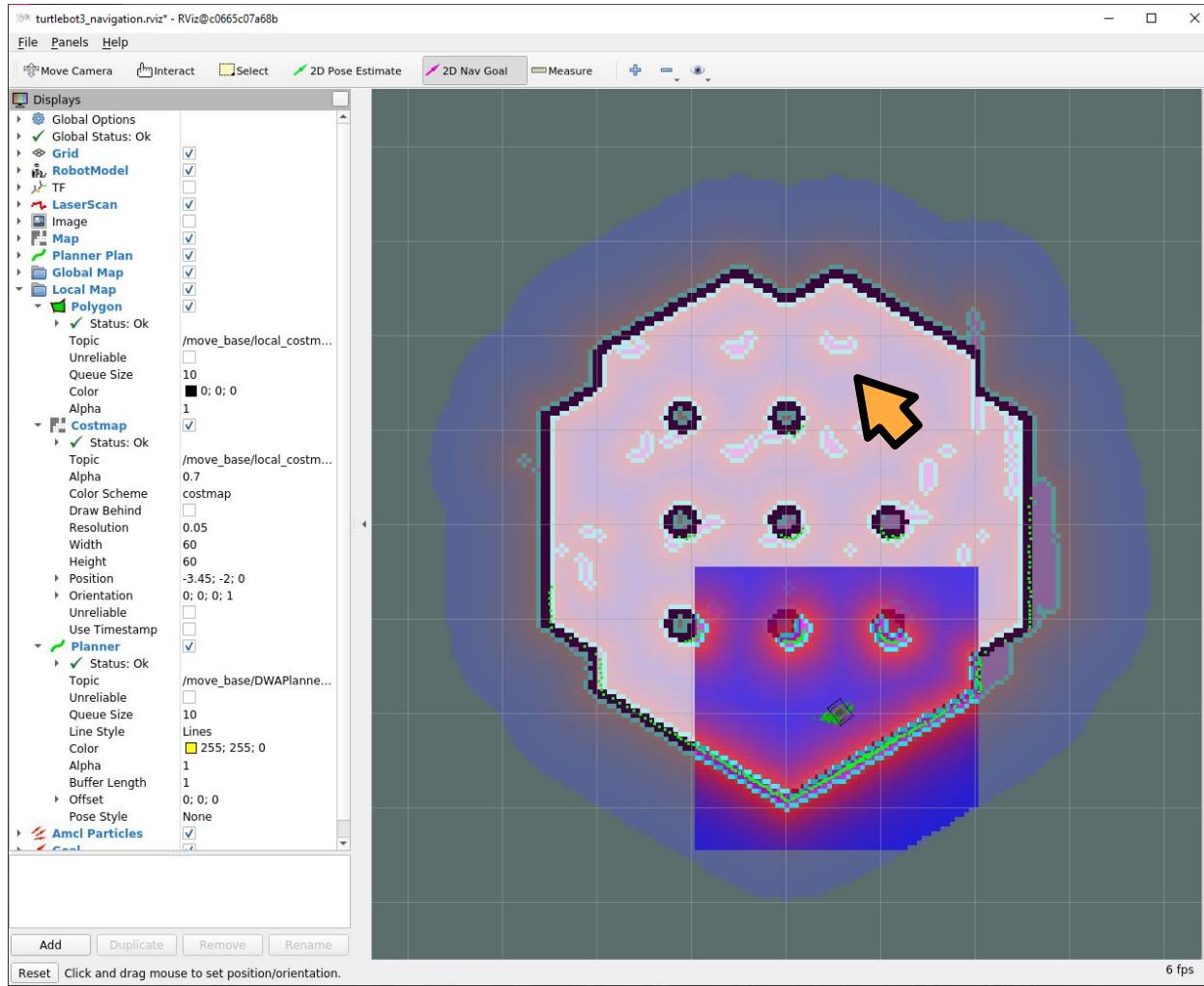
กด a หรือ d เพื่อให้หุ่นยนต์หมุนรอบตัวเอง เพื่อทำ
การ localization

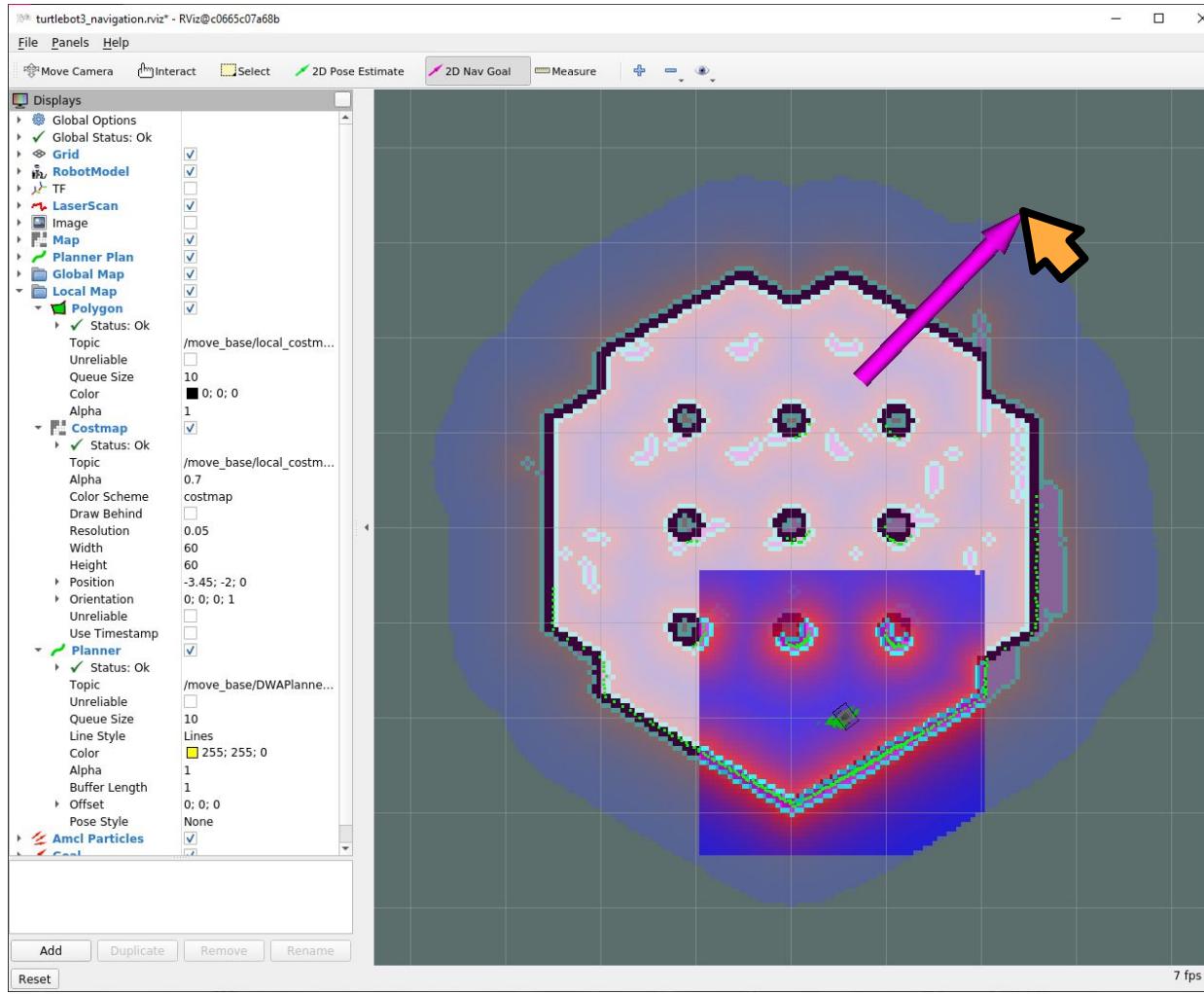


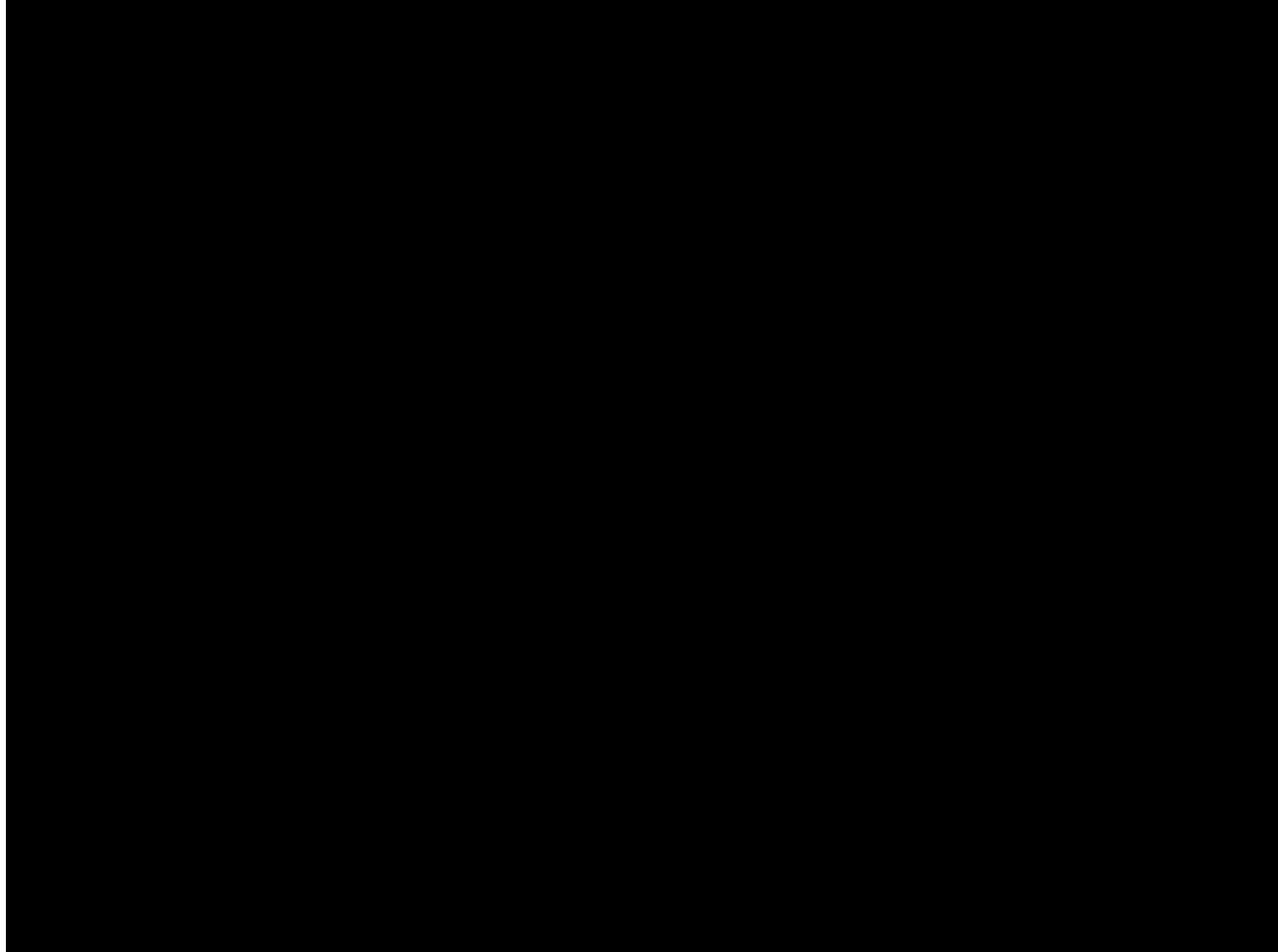
กด S เพื่อหยุด









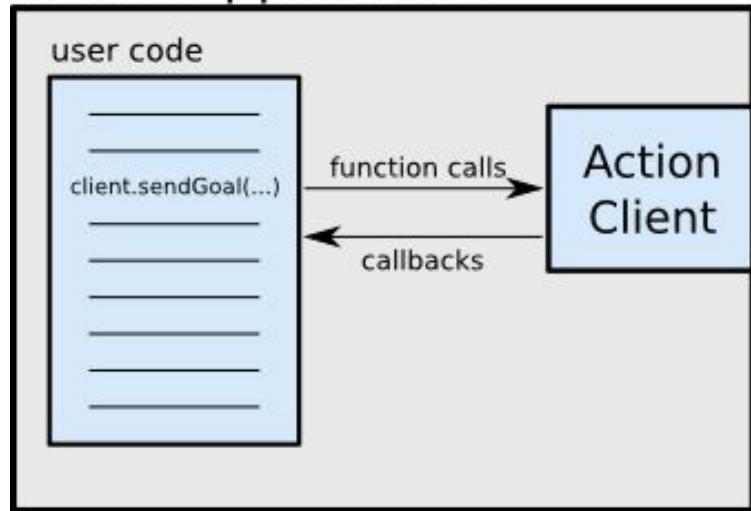


Tuning GUIDE

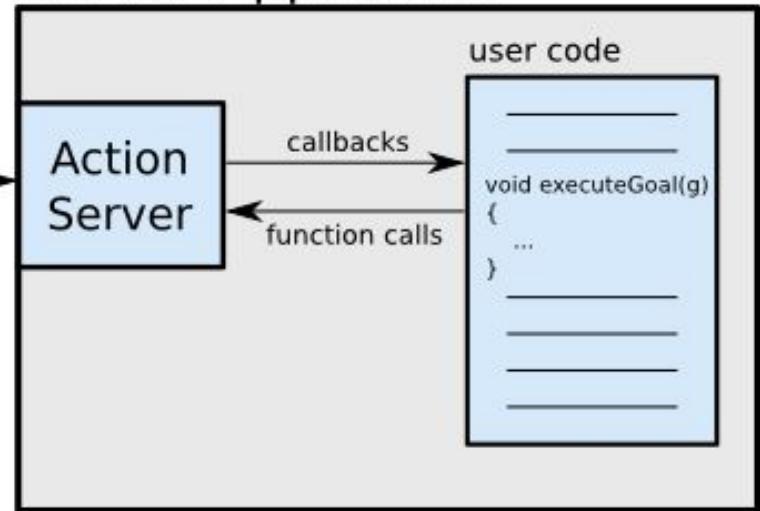
<http://kaiyuzh.me/documents/navguide.pdf>

ROS actionlib

Client Application

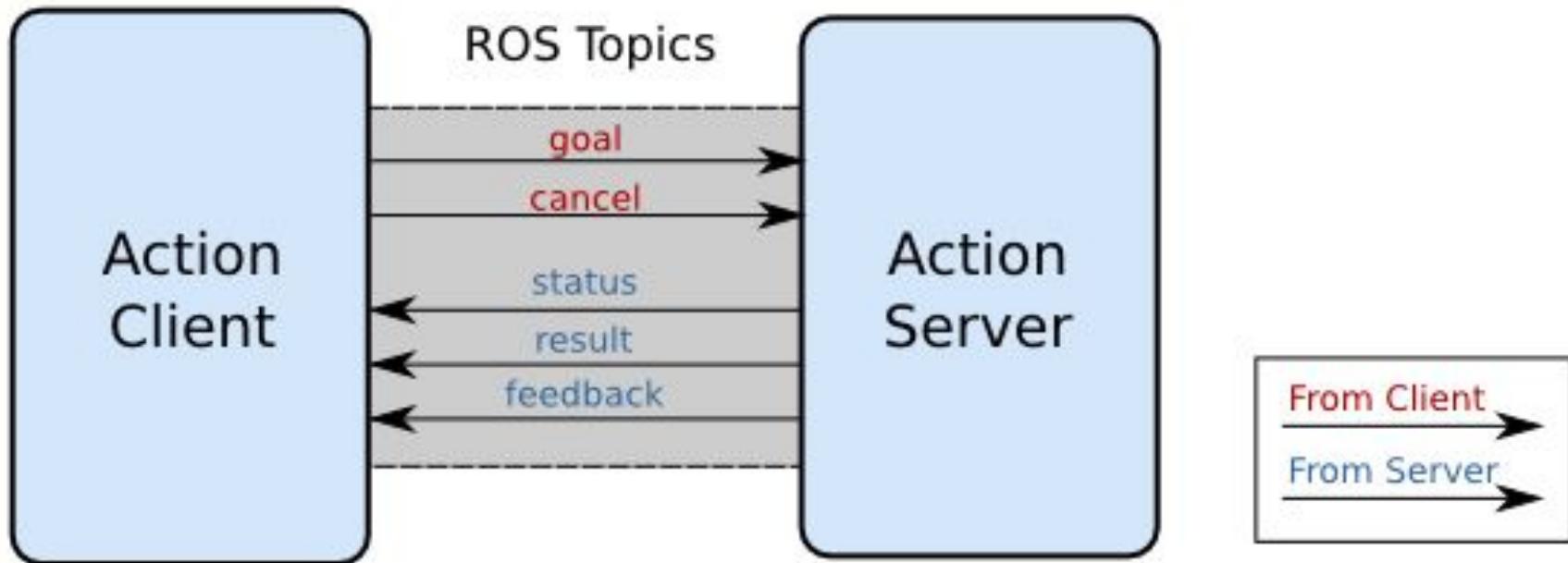


Server Application



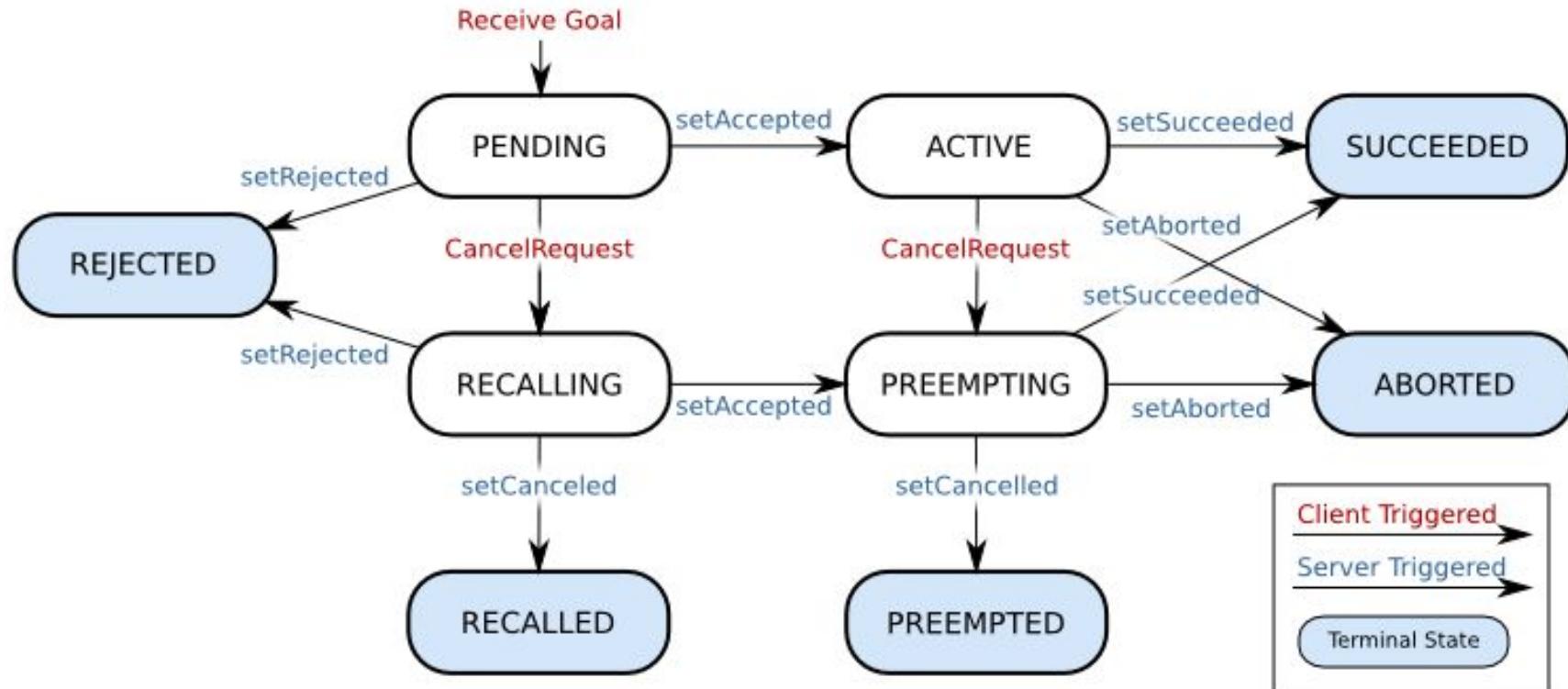
REF: <http://wiki.ros.org/actionlib>

Action Interface

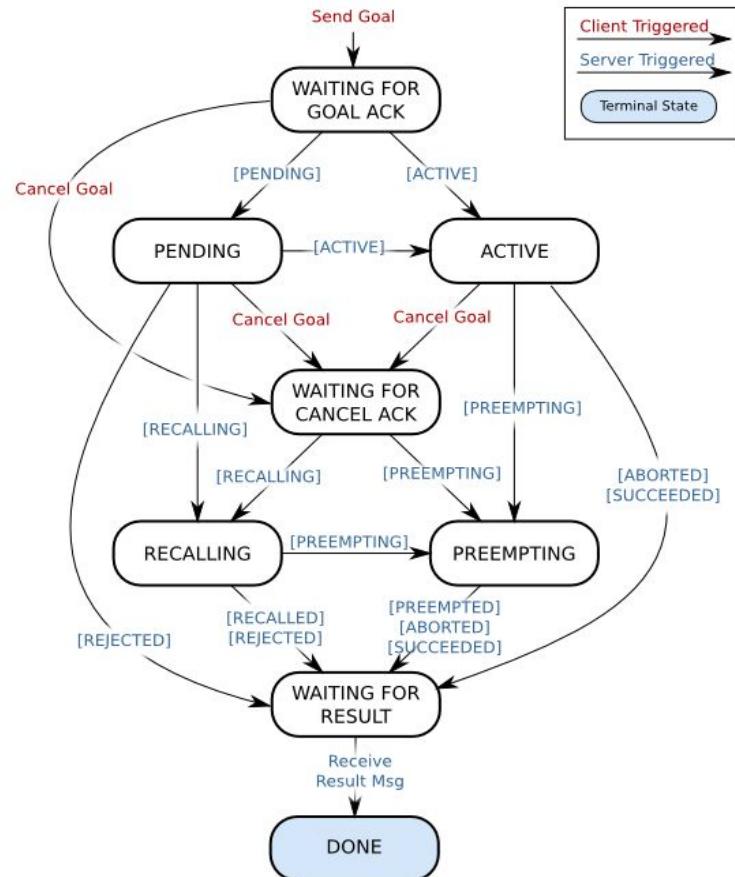


REF: <http://wiki.ros.org/actionlib/DetailedDescription>

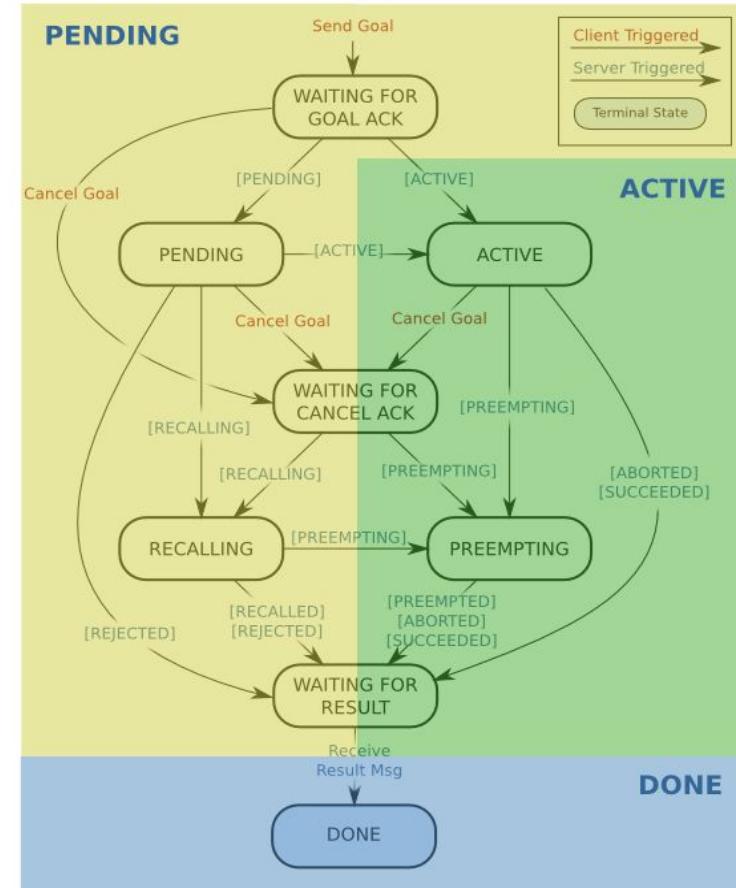
Server State Transitions



Client State Transitions

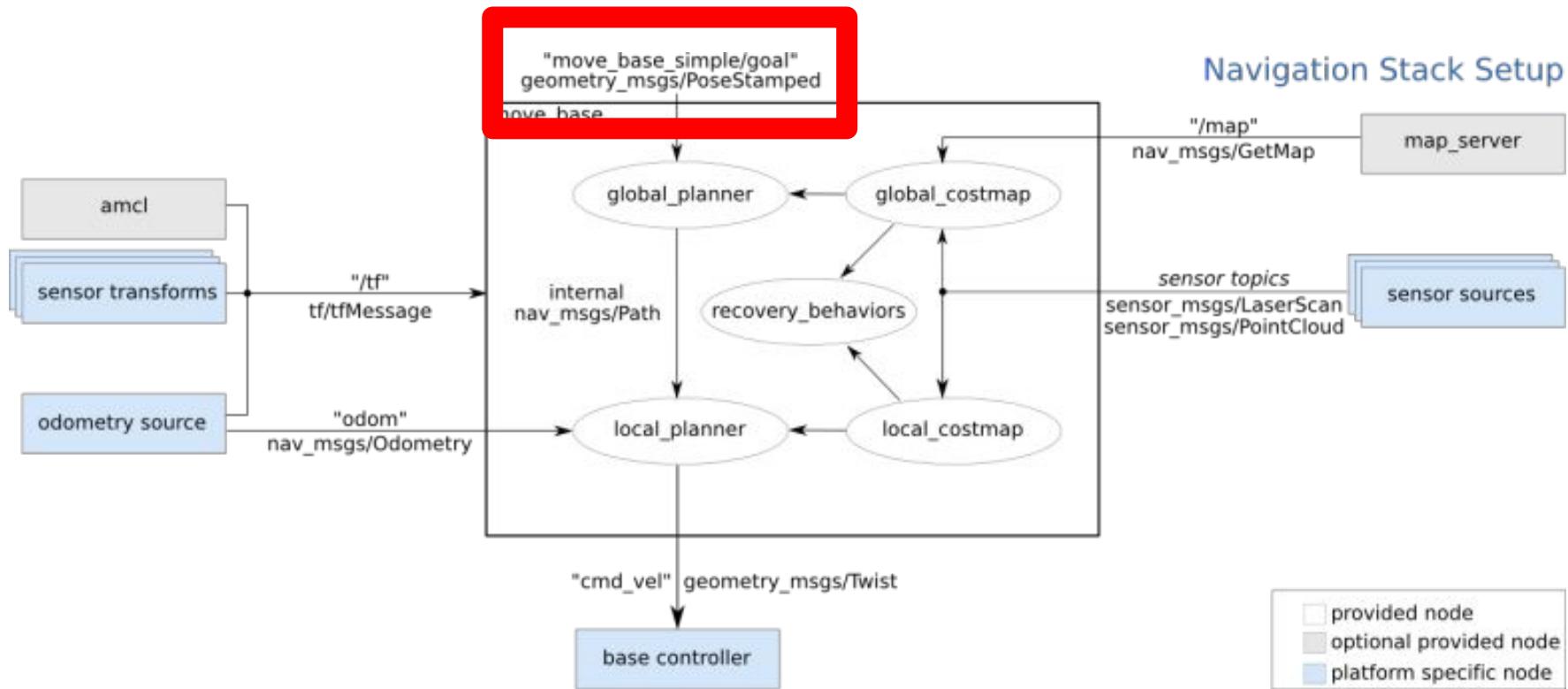


Simple Client State Transitions



Navigation to point

move_base



REF: http://wiki.ros.org/move_base

http://wiki.ros.org/move_base

`move_base` action API

`move_base` action API

Action Subscribed Topics

- `move_base/goal` ([*move_base_msgs/MoveBaseActionGoal*](#))

A goal for `move_base` to pursue in the world.

- `move_base/cancel` ([*actionlib_msgs/GoalID*](#))

A request to cancel a specific goal.

move_base action API

Action Published Topics

- move_base/feedback ([move_base_msgs/MoveBaseActionFeedback](#))

Feedback contains the current position of the base in the world.

- move_base/status ([actionlib_msgs/GoalStatusArray](#))

Provides status information on the goals that are sent to the move_base action.

- move_base/result ([move_base_msgs/MoveBaseActionResult](#))

Result is empty for the move_base action.

move_base Subscribed Topics

move_base Subscribed Topics

- move_base_simple/goal ([*geometry_msgs/PoseStamped*](#))

Provides a non-action interface to move_base for users that don't care about tracking the execution status of their goals.

move_base Published Topics

move_base Published Topics

- cmd_vel ([*geometry_msgs/Twist*](#))

A stream of velocity commands meant for execution by a mobile base.

`move_base` Services

move_base Services

- ~make_plan ([nav_msgs/GetPlan](#))

Allows an external user to ask for a plan to a given pose from move_base without causing move_base to execute that plan.

- ~clear_unknown_space ([std_srvs/Empty](#))

Allows an external user to tell move_base to clear unknown space in the area directly around the robot. This is useful when move_base has its costmaps stopped for a long period of time and then started again in a new location in the environment.

* Available in versions from 1.1.0-groovy

- ~clear_costmaps ([std_srvs/Empty](#))

Allows an external user to tell move_base to clear obstacles in the costmaps used by move_base. This could cause a robot to hit things and should be used with caution.

* New in 1.3.1

move_base in ROSPy

```
$ cd tutorial_ws/src/
```

```
$ catkin_create_pkg my_navigation roscpp rospy std_msgs actionlib
```

```
$ cd ../
```

```
$ catkin_make
```

```
$ rospack profile
```

```
$ cd src/my_navigation/src
```

```
$ gedit my_navigation.py
```

my_navigation.py

```
1 #!/usr/bin/env python
2 import rospy
3 from move_base_msgs.msg import MoveBaseAction, MoveBaseGoal
4 import actionlib
5 from actionlib_msgs.msg import *
6 from tf.transformations import quaternion_from_euler
7 from geometry_msgs.msg import Pose, Point, Quaternion
8 import csv
```

```
10  class RobotNavigation():
11      def __init__(self):
12          rospy.init_node('nav_test', anonymous=False)
13          rospy.on_shutdown(self.shutdown)
14          #tell the action client that we want to spin a thread by default
15          self.move_base = actionlib.SimpleActionClient("move_base", MoveBaseAction)
16          rospy.loginfo("wait for the action server to come up")
17          #allow up to 5 seconds for the action server to come up
18          self.move_base.wait_for_server(rospy.Duration(5))
19
```

```
56     def shutdown(self):
57         stop_goal = MoveBaseGoal()
58         self.move_base.send_goal(stop_goal)
59         rospy.loginfo("Stop")
60
```

```
42     def read_csv(self):
43         thisdict = {}
44         with open("/root/tutorial_ws/src/my_navigation/src/location.csv", "r") as csv_file:
45             csv_reader = csv.reader(csv_file, delimiter = ',')
46             for row in csv_reader:
47                 print(row)
48                 thisdict[row[0]] = [row[1], row[2], row[3]]
49         return thisdict
```

```
51     def read_position(self,position_name):  
52         dict_position = self.read_csv()  
53         rospy.loginfo(dict_position[position_name])  
54         return dict_position[position_name]  
55
```

```
20     def go_to_location(self, position_name):
21         x,y,theta = self.read_position(position_name)
22         x,y,theta = float(x), float(y), float(theta)
23         #convert euler to quaternion
24         q = quaternion_from_euler(0,0,theta)
25         goal = MoveBaseGoal()
26         goal.target_pose.header.frame_id = 'map'
27         goal.target_pose.header.stamp = rospy.get_rostime()
28         goal.target_pose.pose = Pose(Point(x, y, 0.000), Quaternion(q[0], q[1], q[2], q[3]))
29         self.move_base.send_goal(goal)
30         print("Waiting for result")
31         success = self.move_base.wait_for_result(rospy.Duration(60))
32         print("Return result: ",success)
33         state = self.move_base.get_state()
34         result = False
35         if success and state == GoalStatus.SUCCEEDED:
36             # We made it!
37             result = True
38         else:
39             self.move_base.cancel_goal()
40             self.goal_sent = False
41     return result
```

```
61 if __name__ == '__main__':
62     try:
63         robot_nav = RobotNavigation()
64         print(robot_nav.go_to_location("location_name"))
65     except rospy.ROSInterruptException:
66         rospy.loginfo("Exception thrown")
```

```
$ chmod +x my_navigation.py
```

```
$ gedit location.csv
```

location.csv

เปิด terminal

```
$ roscore
```

```
[REDACTED]:~# roscore
... logging to /root/.ros/log/a4938efa-7c5b-11ec-b410-0242ac110002/roslaunch-c0665c07a68b-2984.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:39823/
ros_comm version 1.15.13

SUMMARY
=====
PARAMETERS
* /rosdistro: noetic
* /rosversion: 1.15.13

NODES

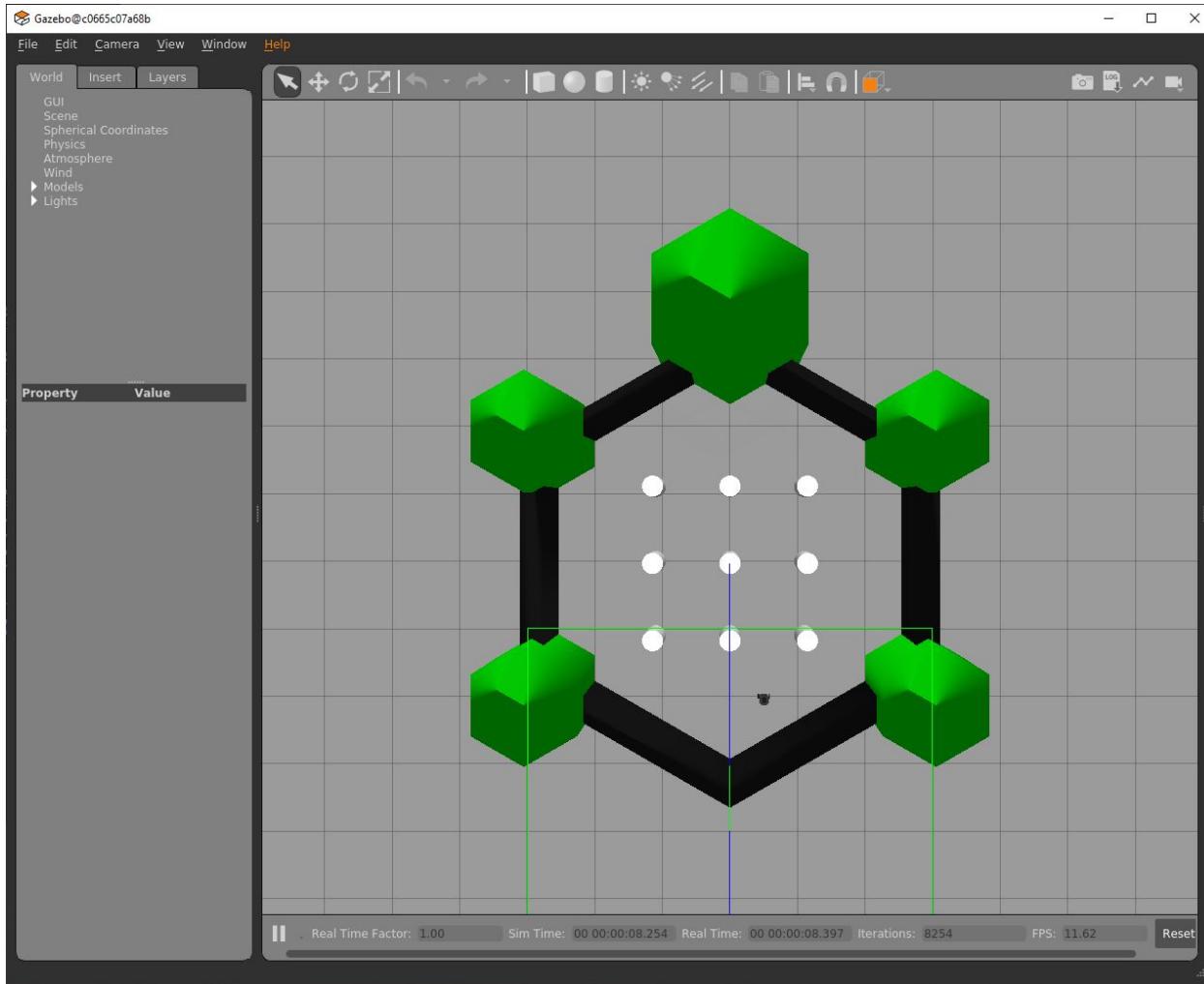
auto-starting new master
process[master]: started with pid [3008]
ROS_MASTER_URI=http://[REDACTED]:11311/

setting /run_id to [REDACTED]
process[rosout-1]: started with pid [3028]
started core service [/rosout]

-
```

เปิดหน้าต่างใหม่

```
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```



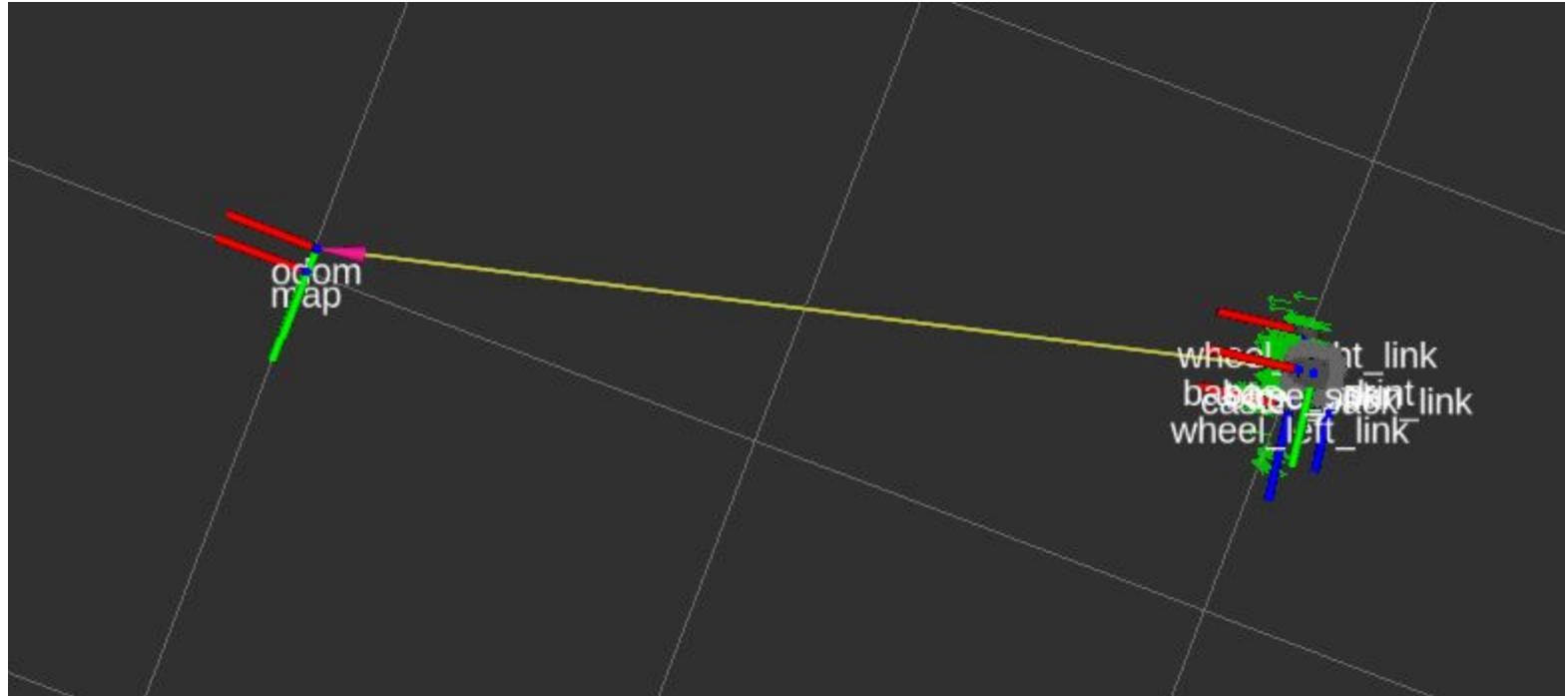
เปิดหน้าต่างใหม่

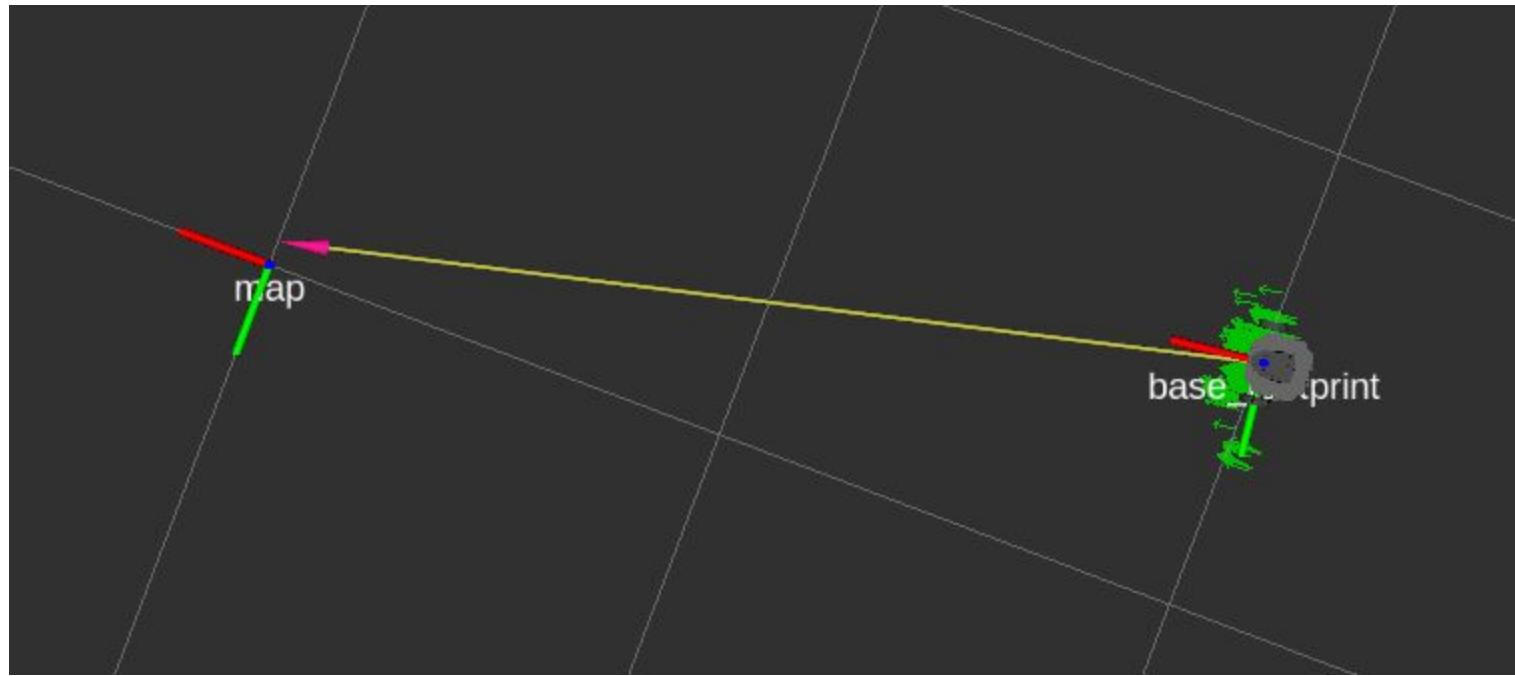
```
$ roslaunch turtlebot3_navigation turtlebot3_navigation.launch map_file:=$HOME/map.yaml
```

เปิดหน้าต่างใหม่

```
$ rosrun my_navigation my_navigation.py
```

Find point in map





```
$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
```

```
:~$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
... logging to /root/.ros/log/3cadf654-97ea-11ec-8c45-0242ac110003/roslaunch-c0665c07a68b-19766.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:46375/

SUMMARY
=====
PARAMETERS
* /model: burger
* /rosdistro: noetic
* /rosversion: 1.15.13

NODES
/
  turtlebot3_teleop_keyboard (turtlebot3_teleop/turtlebot3_teleop_key)

ROS_MASTER_URI=http://localhost:11311

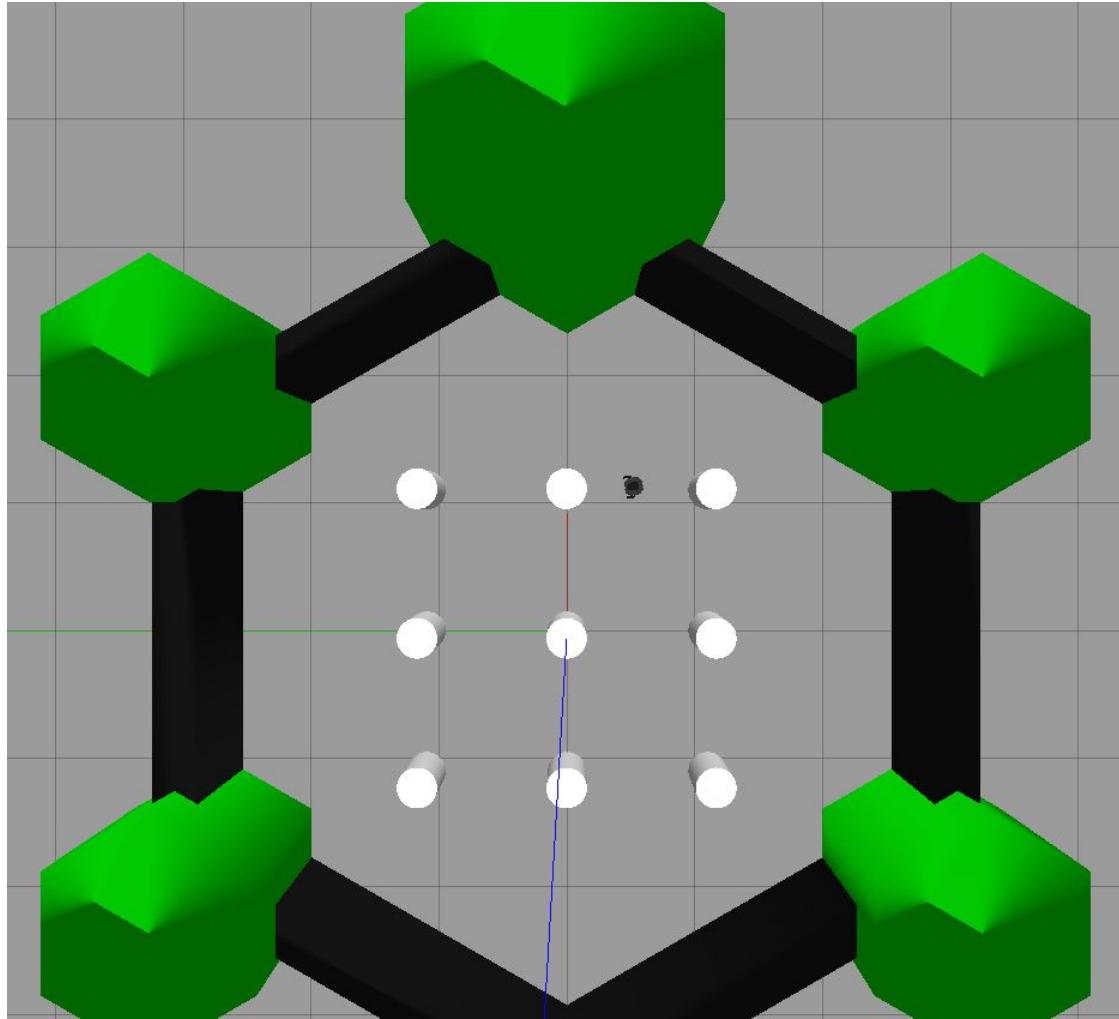
process[turtlebot3_teleop_keyboard-1]: started with pid [19791]

Control Your TurtleBot!
-----
Moving around:
      w
    a   s   d
      x

w/x : increase/decrease linear velocity (Burger : ~ 0.22, Waffle and Waffle Pi : ~ 0.26)
a/d : increase/decrease angular velocity (Burger : ~ 2.84, Waffle and Waffle Pi : ~ 1.82)

space key, s : force stop

CTRL-C to quit
```





```
$ rosrun tf2_tools echo.py map base_footprint
```

```
130 root@c0665c07a68b:~$ rosrun tf2_tools echo.py map base_footprint
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
             in RPY (radian) [-0.000, -0.000, 1.747]
             in RPY (degree) [-0.003, -0.001, 100.095]
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
             in RPY (radian) [-0.000, -0.000, 1.747]
             in RPY (degree) [-0.003, -0.001, 100.095]
At time 339.63, (current time 339.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
             in RPY (radian) [-0.000, -0.000, 1.747]
             in RPY (degree) [-0.003, -0.001, 100.090]
```

```
130 root@c0665c07a68b:~$ rosrun tf2_tools echo.py map base_footprint
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.095]
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.095]
At time 339.63, (current time 339.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.090]
```

```
$ gedit location.csv
```

```
1 "home",-1.995,-0.567,0.083
```

```
130 root@c0665c07a68b:~$ rosrun tf2_tools echo.py map base_footprint
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
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              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.090]
```

```
1 "home",-1.995,-0.567,0.083  
2 "position2",1.124,-0.533,1.747
```

```
130 root@c0665c07a68b:~$ rosrun tf2_tools echo.py map base_footprint
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.095]
At time 338.63, (current time 338.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.095]
At time 339.63, (current time 339.647)
- Translation: [1.124, -0.533, -0.000]
- Rotation: in Quaternion [-0.000, -0.000, 0.767, 0.642]
              in RPY (radian) [-0.000, -0.000, 1.747]
              in RPY (degree) [-0.003, -0.001, 100.090]
```

```
1 "home",-1.995,-0.567,0.083  
2 "position2",1.124,-0.533,1.747
```

```
$ gedit my_navigation.py
```

```
61 if __name__ == '__main__':
62     try:
63         robot_nav = RobotNavigation()
64         print(robot_nav.go_to_location("location_name"))
65     except rospy.ROSInterruptException:
66         rospy.loginfo("Exception thrown")
```

```
61 if __name__ == '__main__':
62     try:
63         robot_nav = RobotNavigation()
64         print(robot_nav.go_to_location("position2"))
65     except rospy.ROSInterruptException:
66         rospy.loginfo("Exception thrown")
```

```
$ rosrun my_navigation my_navigation.py
```