LAB 01 Report

Mobile Robotics: Introduction to ROS2

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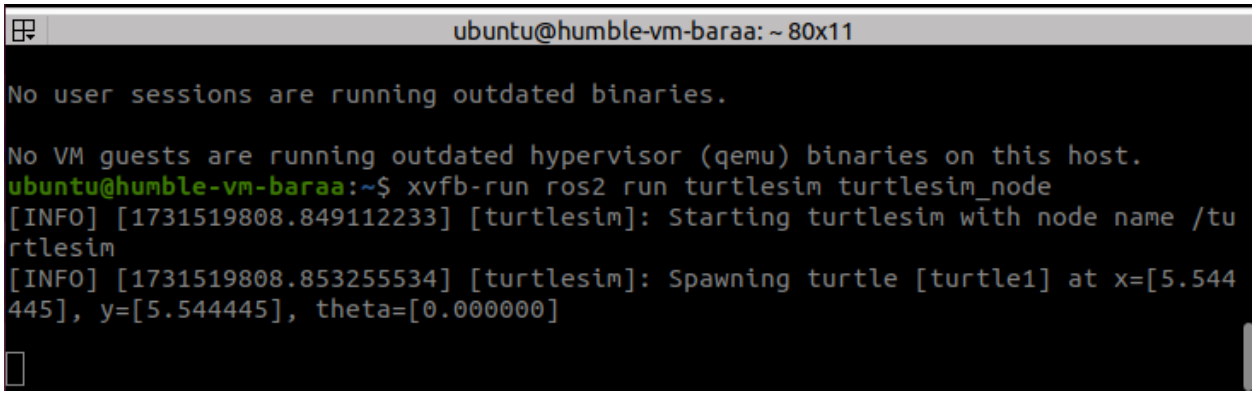
Group: 02

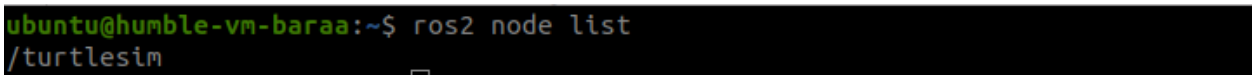
ROS2: robot operating system, is an SDK to build robot applications

- Basic Concepts and tools:
  - Turtlesim: simulator
  - Nodes:

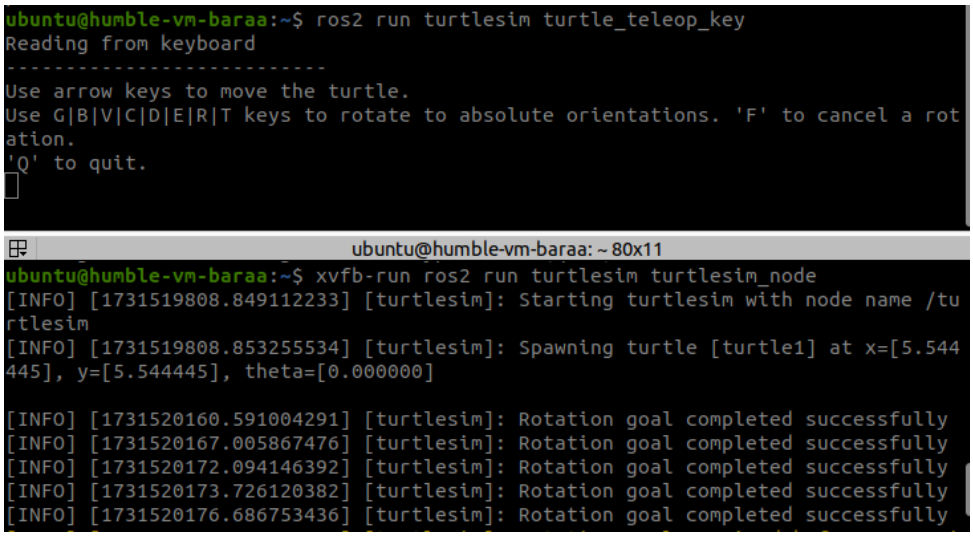
To run a node:
ros2 run <package_name> <executable_name>
ros2 run turtlesim turtlesim_node

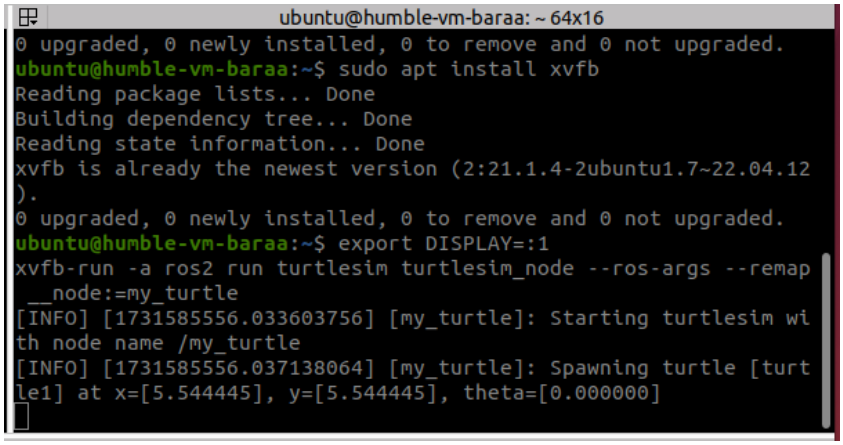


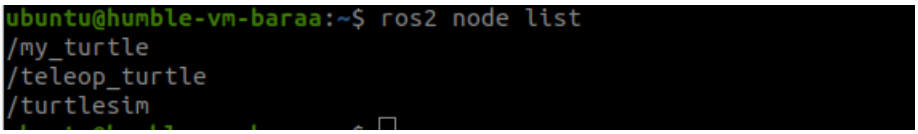
To see the list of nodes



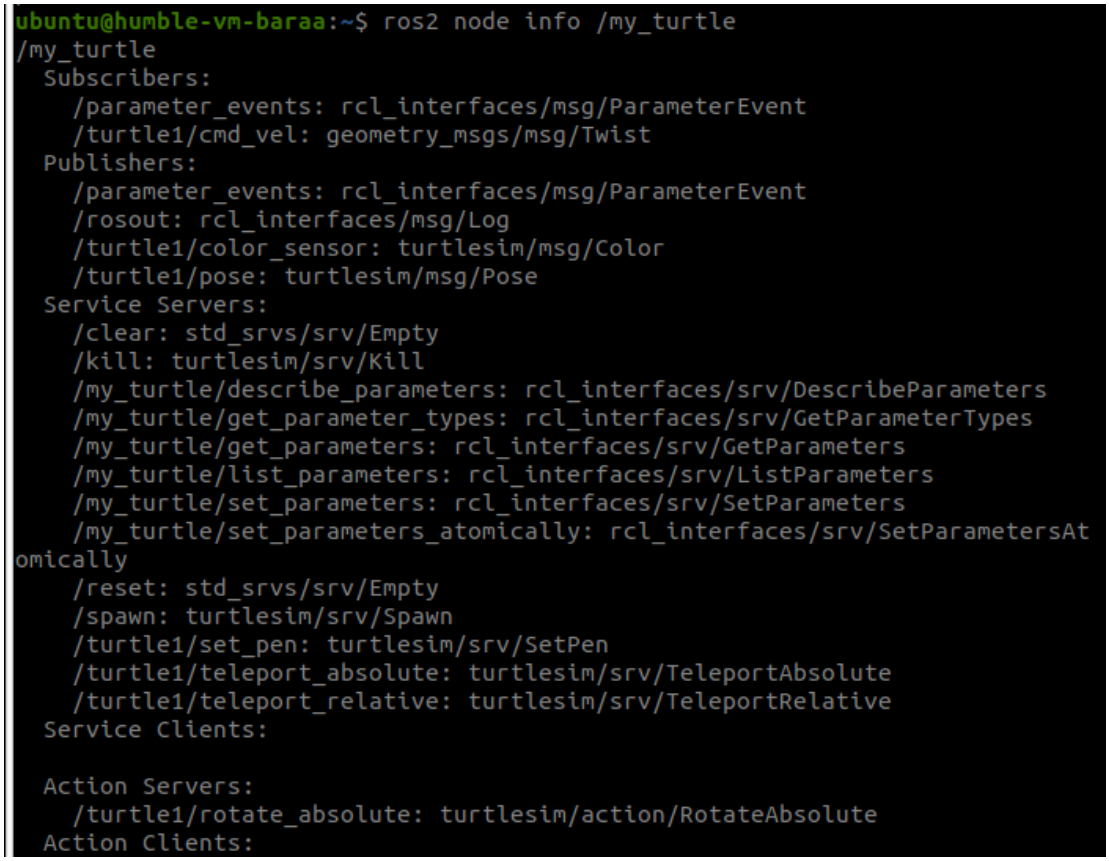
To run a teleop node:







To know information about a node:



- Topics:

To see the list of Topics

```
ubuntu@humble-vm-baraa:~$ ros2 topic list
/parameter_events
/rosout
/turtle1/cmd_vel
/turtle1/color_sensor
/turtle1/pose
ubuntu@humble-vm-baraa:~$ ros2 topic list -t
/parameter_events [rcl_interfaces/msg/ParameterEvent]
/rosout [rcl_interfaces/msg/Log]
/turtle1/cmd_vel [geometry_msgs/msg/Twist]
/turtle1/color_sensor [turtlesim/msg/Color]
/turtle1/pose [turtlesim/msg/Pose]
```

Details about a topic

```
ubuntu@humble-vm-baraa:~$ ros2 topic echo turtle1/cmd_vel
linear:
  x: 0.0
  y: 0.0
  z: 0.0
angular:
  x: 0.0
  y: 0.0
  z: 2.0
---
linear:
  x: 0.0
  y: 0.0
  z: 0.0
angular:
  x: 0.0
  y: 0.0
  z: -2.0
```

information about the topic

```
ubuntu@humble-vm-baraa:~$ ros2 topic info /turtle1/cmd_v
el
Type: geometry_msgs/msg/Twist
Publisher count: 1
Subscription count: 3
```

To see what structure of data the topic can receive

```
ubuntu@humble-vm-baraa:~$ ros2 interface show geometry_m
sgs/msg/Twist
# This expresses velocity in free space broken into its
linear and angular parts.

Vector3  linear
        float64 x
        float64 y
        float64 z
Vector3  angular
        float64 x
        float64 y
        float64 z
```

To publish data into a topic, optionally at rate 1hz:

```
ubuntu@humble-vm-baraa:~$ ros2 topic pub --once /t
urtle1/cmd_vel geometry_msgs/msg/Twist "{linear:{x
: 2.0, y: 0.0, z: 0.0}, angular: {x: 0.0, y: 0.0,
z: 1.8}}"
publisher: beginning loop
publishing #1: geometry_msgs.msg.Twist(linear=geom
etry_msgs.msg.Vector3(x=2.0, y=0.0, z=0.0), angula
r=geometry_msgs.msg.Vector3(x=0.0, y=0.0, z=1.8))
```

```
ubuntu@humble-vm-baraa:~$ ros2 topic pub --rate 1
/turtle1/cmd_vel geometry_msgs/msg/Twist "{linear:
{x: 2.0, y: 0.0, z: 0.0}, angular: {x: 0.0, y: 0.0
, z: 1.8}}"
publisher: beginning loop
publishing #1: geometry_msgs.msg.Twist(linear=geom
etry_msgs.msg.Vector3(x=2.0, y=0.0, z=0.0), angula
r=geometry_msgs.msg.Vector3(x=0.0, y=0.0, z=1.8))

publishing #2: geometry_msgs.msg.Twist(linear=geom
etry_msgs.msg.Vector3(x=2.0, y=0.0, z=0.0), angula
r=geometry_msgs.msg.Vector3(x=0.0, y=0.0, z=1.8))

publishing #3: geometry_msgs.msg.Twist(linear=geom
etry_msgs.msg.Vector3(x=2.0, y=0.0, z=0.0), angula
r=geometry_msgs.msg.Vector3(x=0.0, y=0.0, z=1.8))

publishing #4: geometry_msgs.msg.Twist(linear=geom
etry_msgs.msg.Vector3(x=2.0, y=0.0, z=0.0), angula
r=geometry_msgs.msg.Vector3(x=0.0, y=0.0, z=1.8))
```

```
---
x: 6.373311996459961
y: 5.178264617919922
theta: 2.2911999225616455
linear_velocity: 0.0
angular_velocity: 0.0
---
x: 4.690451622009277
y: 5.925806522369385
theta: -0.8687853217124939
linear_velocity: 0.0
angular_velocity: 0.0
---
x: 6.373311996459961
y: 5.178264617919922
theta: 2.2911999225616455
linear_velocity: 0.0
angular_velocity: 0.0
---
```

```
ubuntu@humble-vm-baraa:~$ ros2 topic hz /turtle1/p
ose
average rate: 62.598
        min: 0.015s max: 0.017s std dev: 0.00046s
window: 64
average rate: 62.559
        min: 0.015s max: 0.017s std dev: 0.00054s
window: 127
average rate: 82.359
        min: 0.002s max: 0.020s std dev: 0.00544s
window: 250
average rate: 92.990
        min: 0.001s max: 0.020s std dev: 0.00577s
```

- Services:

Services list

```
^Cubuntu@humble-vm-baraa:~$ ros2 service list
/clear
/kill
/my_turtle/describe_parameters
/my_turtle/get_parameter_types
/my_turtle/get_parameters
/my_turtle/list_parameters
/my_turtle/set_parameters
/my_turtle/set_parameters_atomically
/reset
/spawn
/teleop_turtle/describe_parameters
/teleop_turtle/get_parameter_types
/teleop_turtle/get_parameters
/teleop_turtle/list_parameters
/teleop_turtle/set_parameters
/teleop_turtle/set_parameters_atomically
/turtle1/set_pen
/turtle1/teleport_absolute
/turtle1/teleport_relative
/turtlesim/describe_parameters
/turtlesim/get_parameter_types
/turtlesim/get_parameters
/turtlesim/list_parameters
/turtlesim/set_parameters
/turtlesim/set_parameters_atomically
```

A service type exploration

```
ubuntu@humble-vm-baraa:~$ ros2 service type  /clear
std_srvs/srv/Empty
```

Service list with type:

```
ubuntu@humble-vm-baraa:~$ ros2 service list -t
/clear [std_srvs/srv/Empty]
/kill [turtlesim/srv/Kill]
/my_turtle/describe_parameters [rcl_interfaces/srv/DescribeParameters]
/my_turtle/get_parameter_types [rcl_interfaces/srv/GetParameterTypes]
/my_turtle/get_parameters [rcl_interfaces/srv/GetParameters]
/my_turtle/list_parameters [rcl_interfaces/srv/ListParameters]
/my_turtle/set_parameters [rcl_interfaces/srv/SetParameters]
/my_turtle/set_parameters_atomically [rcl_interfaces/srv/SetParametersAtomically]
/reset [std_srvs/srv/Empty]
/spawn [turtlesim/srv/Spawn]
/teleop_turtle/describe_parameters [rcl_interfaces/srv/DescribeParameters]
/teleop_turtle/get_parameter_types [rcl_interfaces/srv/GetParameterTypes]
/teleop_turtle/get_parameters [rcl_interfaces/srv/GetParameters]
/teleop_turtle/list_parameters [rcl_interfaces/srv/ListParameters]
/teleop_turtle/set_parameters [rcl_interfaces/srv/SetParameters]
/teleop_turtle/set_parameters_atomically [rcl_interfaces/srv/SetParametersAtomically]
/turtle1/set_pen [turtlesim/srv/SetPen]
/turtle1/teleport_absolute [turtlesim/srv/TeleportAbsolute]
/turtle1/teleport_relative [turtlesim/srv/TeleportRelative]
/turtlesim/describe_parameters [rcl_interfaces/srv/DescribeParameters]
/turtlesim/get_parameter_types [rcl_interfaces/srv/GetParameterTypes]
/turtlesim/get_parameters [rcl_interfaces/srv/GetParameters]
/turtlesim/list_parameters [rcl_interfaces/srv/ListParameters]
/turtlesim/set_parameters [rcl_interfaces/srv/SetParameters]
/turtlesim/set_parameters_atomically [rcl_interfaces/srv/SetParametersAtomically]
```

Exploring services of a type

```
ubuntu@humble-vm-baraa:~$ ros2 service find std_srvs/srv/Empty
/clear
/reset
```

Trying the spawn service

```
ubuntu@humble-vm-baraa:~$ ros2 interface show turtlesim/srv/Spawn
float32 x
float32 y
float32 theta
string name # Optional.  A unique name will be created and returned if this is empty
---
string name
```

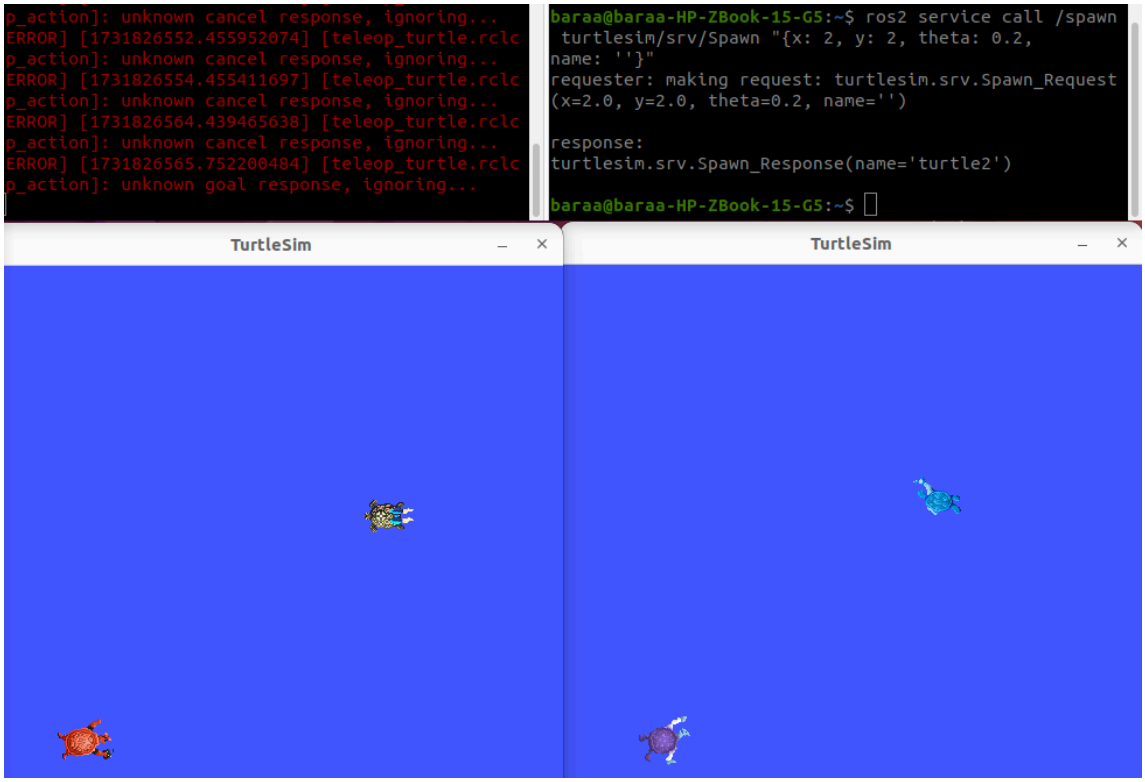
Trying the empty services:

```
ubuntu@humble-vm-baraa:~$ ros2 interface show std_srvs/srv/Empty
---
```

service calls:

```
ubuntu@humble-vm-baraa:~$ ros2 service call /clear std_srvs/srv/Empty
waiting for service to become available...
requester: making request: std_srvs.srv.Empty_Request()

response:
std_srvs.srv.Empty_Response()
```

```
ubuntu@humble-vm-baraa:~$ ros2 service call /spawn turtlesim/srv/Spawn "
{x: 2, y: 2, theta: 0.2, name: 'kiki'}"
requester: making request: turtlesim.srv.Spawn_Request(x=2.0, y=2.0, theta=0.2, name='kiki')

response:
turtlesim.srv.Spawn_Response(name='kiki')
```



- Parameters:

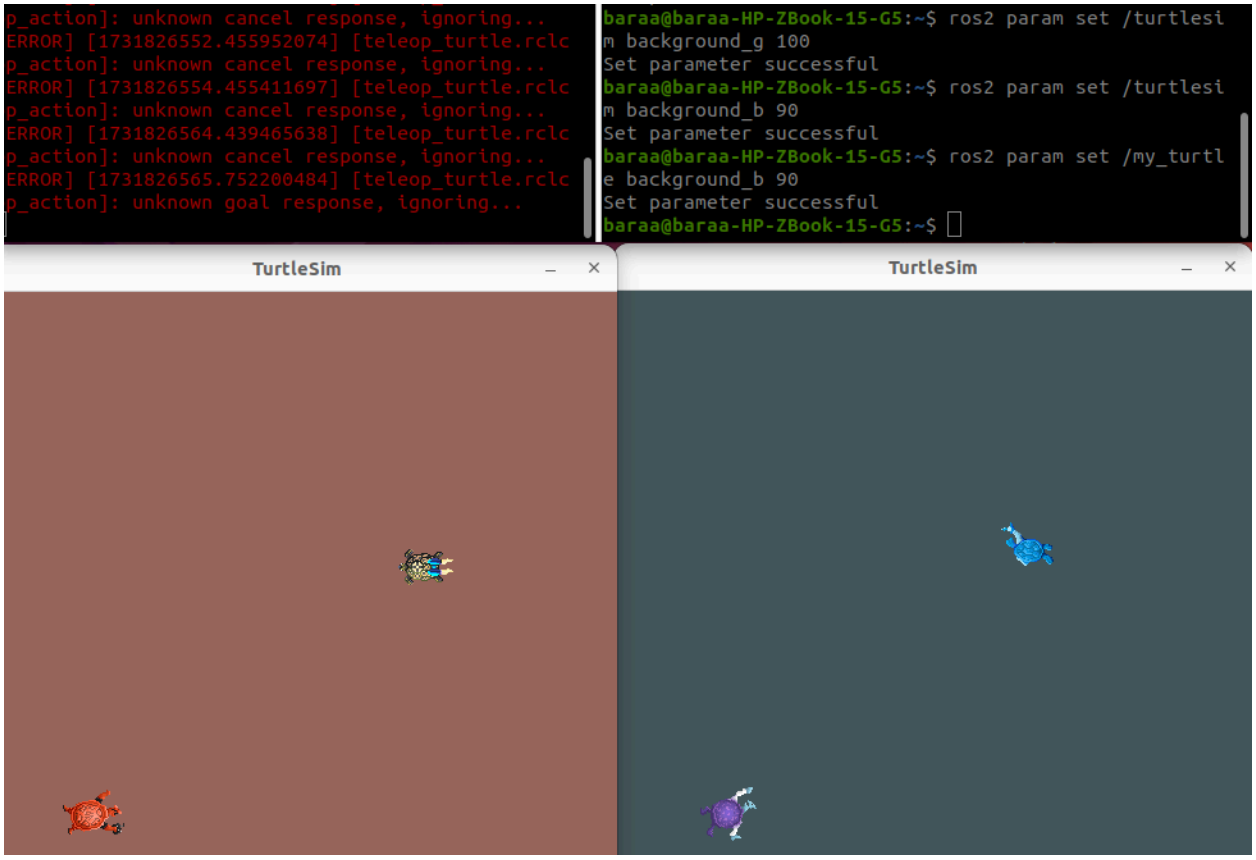
Parameters list

```
ubuntu@humble-vm-baraa:~$ ros2 param list
/my_turtle:
  background_b
  background_g
  background_r
  qos_overrides./parameter_events.publisher.depth
  qos_overrides./parameter_events.publisher.durability
  qos_overrides./parameter_events.publisher.history
  qos_overrides./parameter_events.publisher.reliability
  use_sim_time
/teleop_turtle:
  qos_overrides./parameter_events.publisher.depth
  qos_overrides./parameter_events.publisher.durability
  qos_overrides./parameter_events.publisher.history
  qos_overrides./parameter_events.publisher.reliability
  scale_angular
  scale_linear
  use_sim_time
/turtlesim:
  background_b
  background_g
  background_r
  qos_overrides./parameter_events.publisher.depth
  qos_overrides./parameter_events.publisher.durability
  qos_overrides./parameter_events.publisher.history
  qos_overrides./parameter_events.publisher.reliability
  use_sim_time
```

Setting and getting the parameters and changing them

```
ubuntu@humble-vm-baraa:~$ ros2 param get /my_turtle background_r
Integer value is: 69
ubuntu@humble-vm-baraa:~$ ros2 param get /my_turtle background_g
Integer value is: 86
ubuntu@humble-vm-baraa:~$ ros2 param get /my_turtle background_b
Integer value is: 255
```

```
ubuntu@humble-vm-baraa:~$ ros2 param set /my_turtle background_b 100
Set parameter successful
```



Parameters of a node:

```
ubuntu@humble-vm-baraa:~$ ros2 param dump /my_turtle
/my_turtle:
  ros__parameters:
    background_b: 100
    background_g: 86
    background_r: 69
    qos_overrides:
      /parameter_events:
        publisher:
          depth: 1000
          durability: volatile
          history: keep_last
          reliability: reliable
    use_sim_time: false
```

Parameters dump into a file

```
ubuntu@humble-vm-baraa:~$ ros2 param load /my_turtle my_turtle.yaml
Set parameter background_b successful
Set parameter background_g successful
Set parameter background_r successful
Set parameter qos_overrides./parameter_events.publisher.depth failed: parameter 'qos_override
s./parameter_events.publisher.depth' cannot be set because it is read-only
Set parameter qos_overrides./parameter_events.publisher.durability failed: parameter 'qos_ove
rrides./parameter_events.publisher.durability' cannot be set because it is read-only
Set parameter qos_overrides./parameter_events.publisher.history failed: parameter 'qos_overri
des./parameter_events.publisher.history' cannot be set because it is read-only
Set parameter qos_overrides./parameter_events.publisher.reliability failed: parameter 'qos_ov
errides./parameter_events.publisher.reliability' cannot be set because it is read-only
Set parameter use_sim_time successful
```

- Actions:

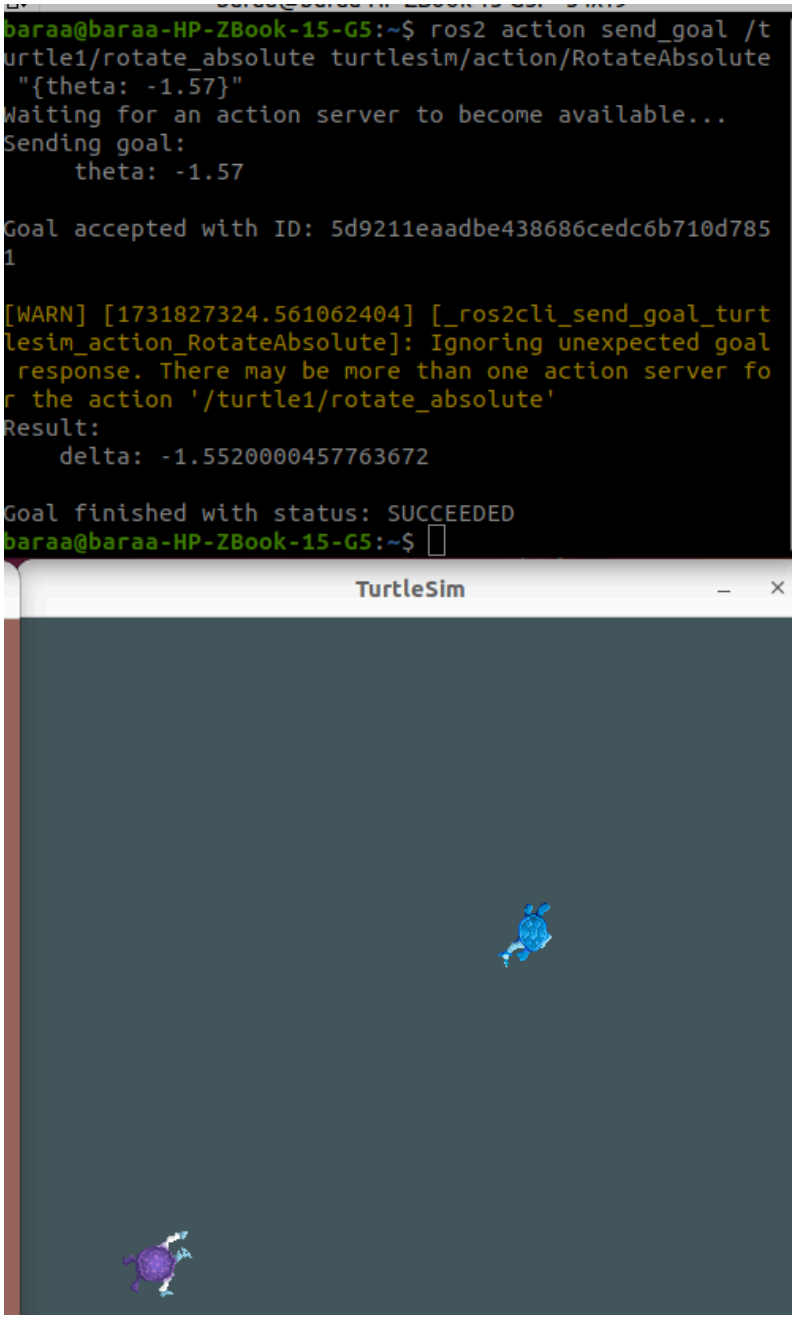
```
ubuntu@humble-vm-baraa:~$ ros2 action list
/turtle1/rotate_absolute
ubuntu@humble-vm-baraa:~$ ros2 action list -t
/turtle1/rotate_absolute [turtlesim/action/RotateAbsolute]
```

```
ubuntu@humble-vm-baraa:~$ ros2 interface show turtlesim/action/
RotateAbsolute
# The desired heading in radians
float32 theta
---
# The angular displacement in radians to the starting position
float32 delta
---
# The remaining rotation in radians
float32 remaining
```

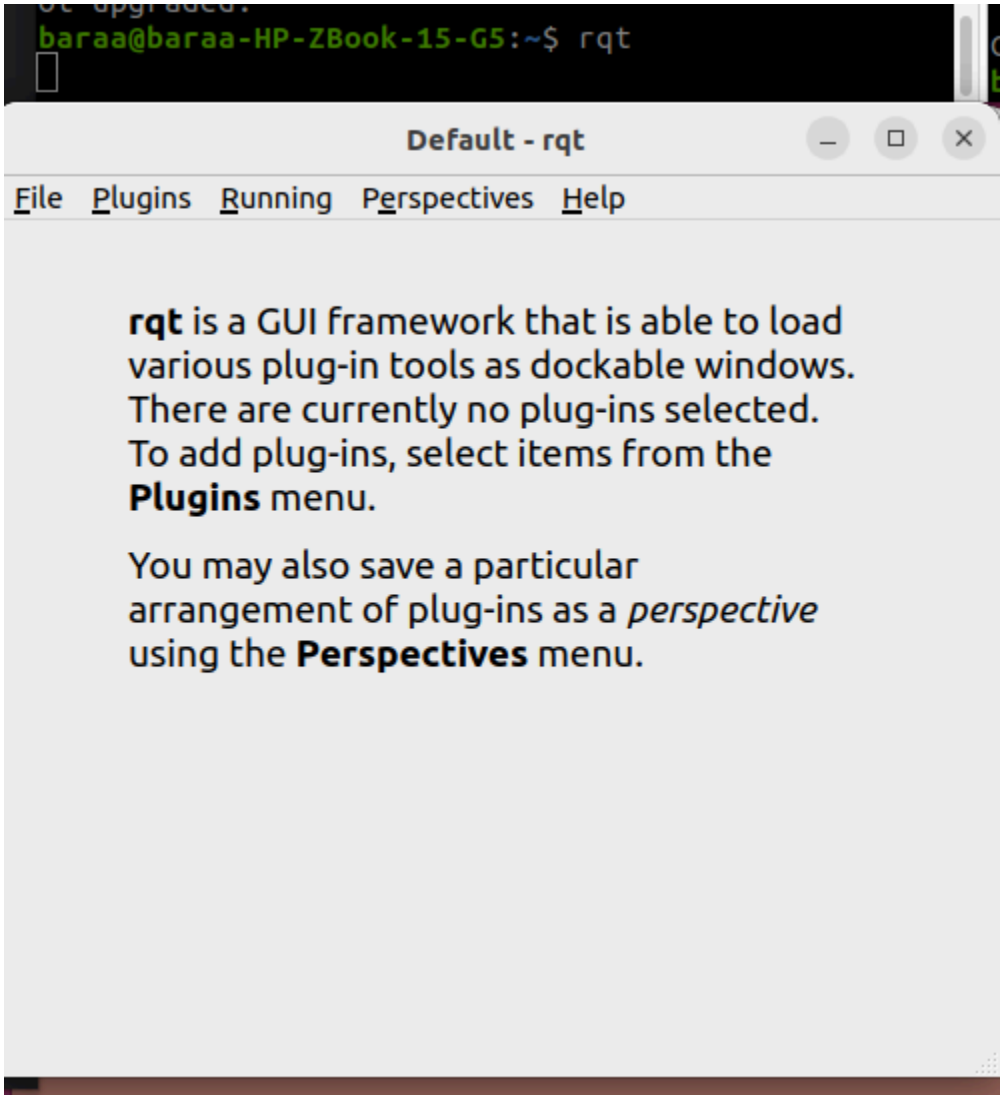
```
ubuntu@humble-vm-baraa:~$ ros2 action send_goal /turtle1/rotate
_absolute turtlesim/action/RotateAbsolute "{theta: 1.57}"
Waiting for an action server to become available...
Sending goal:
     theta: 1.57

Goal accepted with ID: 786ed0d6e6db453fbc62bfea0b54db75

Result:
    delta: -1.5360000133514404

Goal finished with status: SUCCEEDED
```

```
ubuntu@humble-vm-baraa:~$ ros2 action send_goal /turtle1/rotate
_absolute turtlesim/action/RotateAbsolute "{theta: 1.57}" --fee
dback
Waiting for an action server to become available...
Sending goal:
     theta: 1.57

Feedback:
    remaining: 0.018000006675720215

Goal accepted with ID: c4264a9031ca4e799aea70b7ac898aa4

Result:
    delta: 0.0

Goal finished with status: SUCCEEDED
```

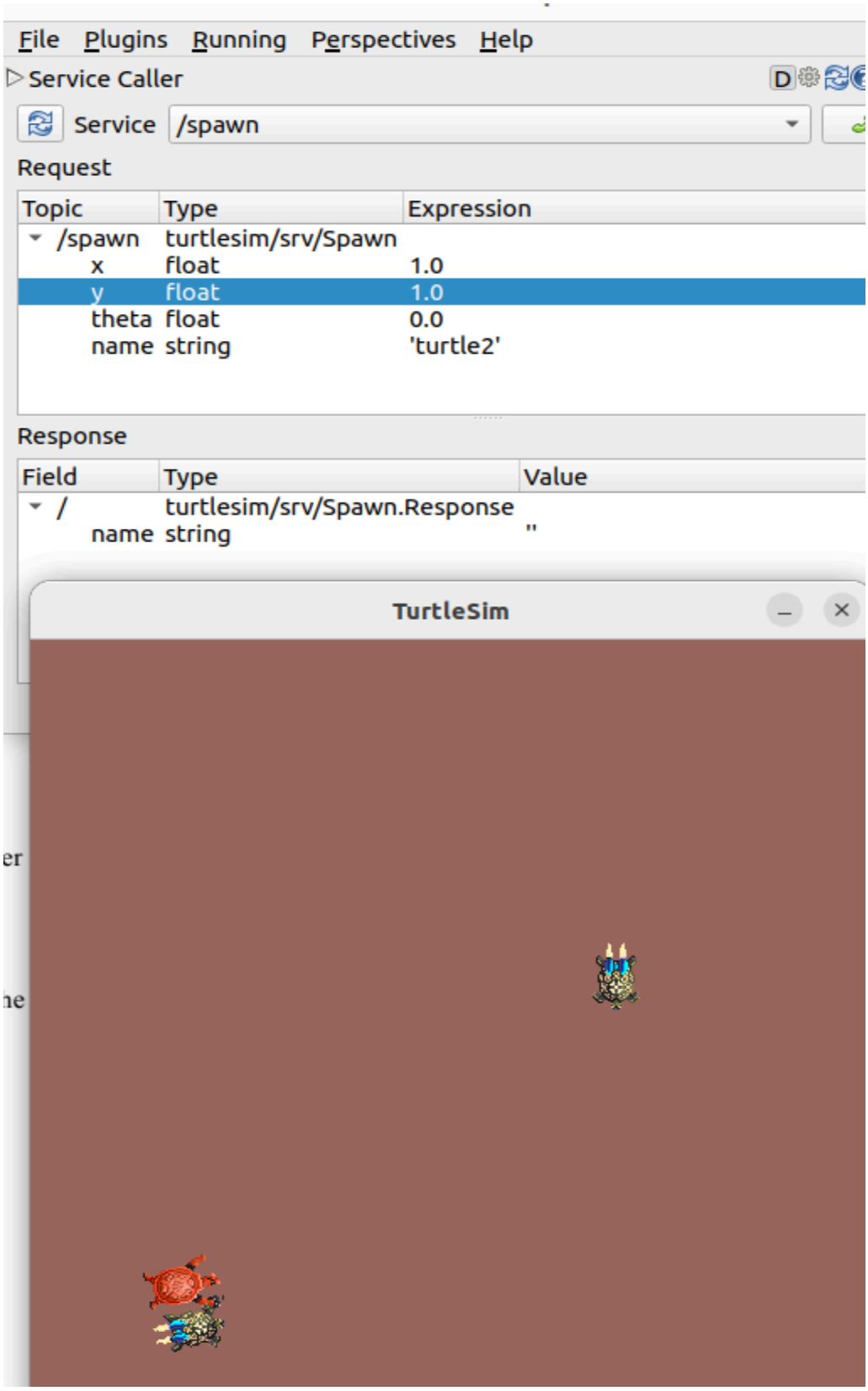
```
ubuntu@humble-vm-baraa:~$ ros2 action send_goal /turtle1/rotate
_absolute turtlesim/action/RotateAbsolute "{theta: -1.57}" --fe
edback
Waiting for an action server to become available...
Sending goal:
     theta: -1.57

Feedback:
    remaining: -0.14600002765655518

Goal accepted with ID: 398d3e96e1e149f183956e2ab1f30077

Feedback:
    remaining: -0.12999999523162842

Feedback:
    remaining: -0.11400008201599121

Feedback:
    remaining: -0.09800004959106445

Feedback:
    remaining: -0.0820000171661377

Feedback:
    remaining: -0.06600010395050049

Feedback:
    remaining: -0.05000007152557373

Feedback:
    remaining: -0.03400003910064697

Feedback:
    remaining: -0.018000006675720215

Result:
    delta: 0.12800000607967377

Goal finished with status: SUCCEEDED
```


baraa@baraa-HP-ZBook-15-G5:~$ ros2 action send_goal /turtle1/rotate_absolute turtlesim/action/RotateAbsolute "{theta: -1.57}"
Waiting for an action server to become available...
Sending goal:
theta: -1.57
Goal accepted with ID: 5d9211eaadbe438686cedc6b710d7851
[WARN] [1731827324.561062404] [_ros2cli_send_goal_turtlesim_action_RotateAbsolute]: Ignoring unexpected goal response. There may be more than one action server for the action '/turtle1/rotate_absolute'
Result:
delta: -1.5520000457763672
Goal finished with status: SUCCEEDED
baraa@baraa-HP-ZBook-15-G5:~$
TurtleSim

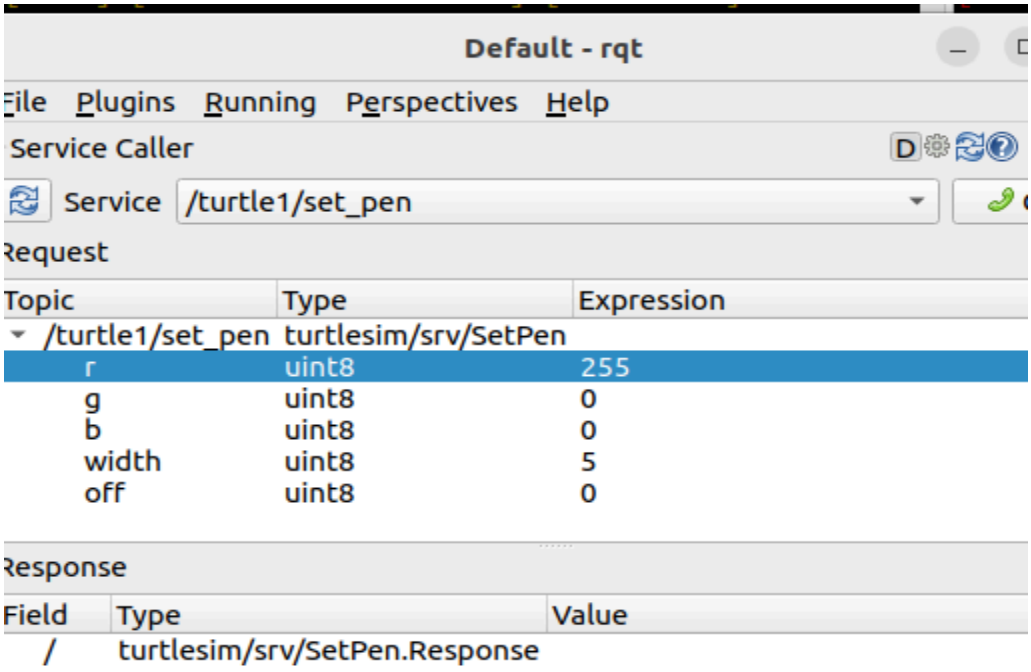
- RQT:

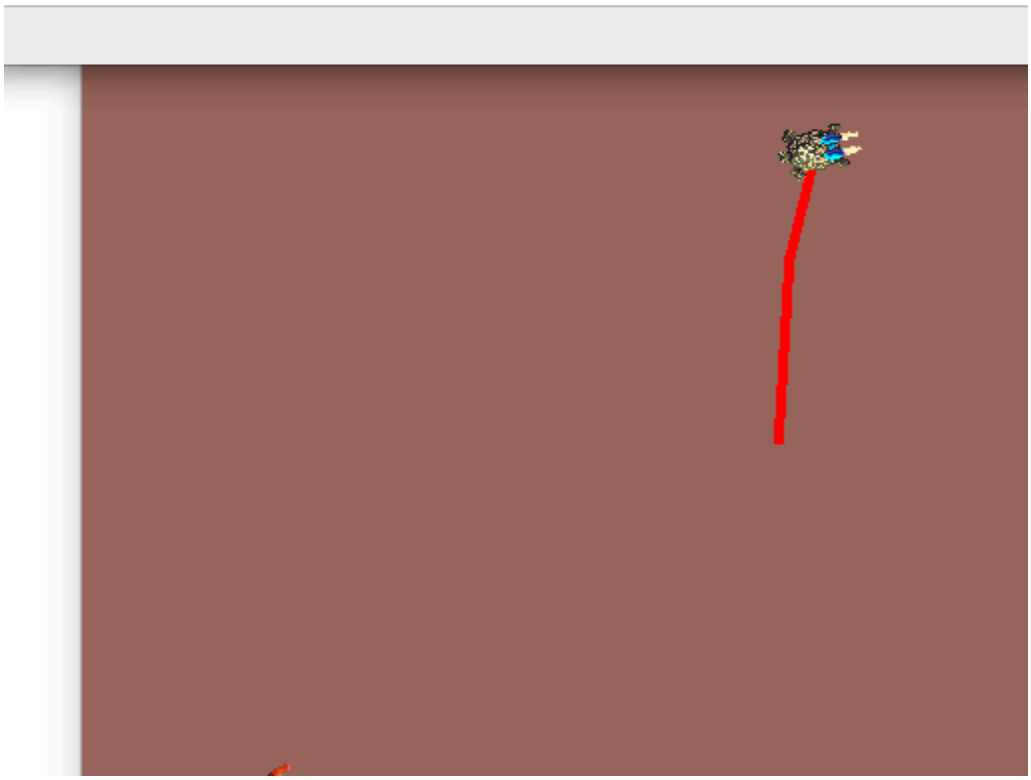

baraa@baraa-HP-ZBook-15-G5:~$ rqt
Default - rqt
File Plugins Running Perspectives Help
rqt is a GUI framework that is able to load various plug-in tools as dockable windows. There are currently no plug-ins selected. To add plug-ins, select items from the Plugins menu.
You may also save a particular arrangement of plug-ins as a perspective using the Perspectives menu.

Running a service

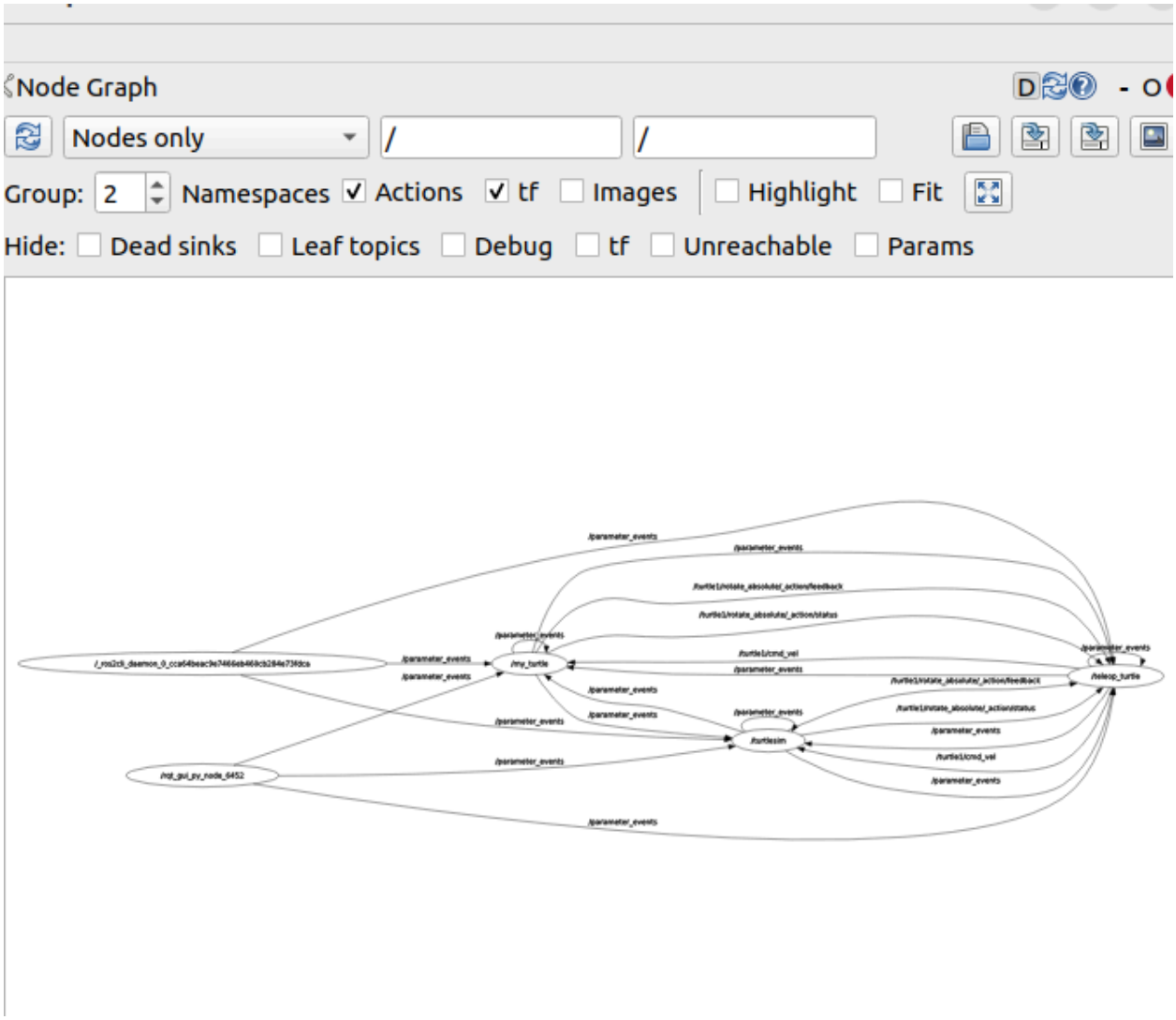


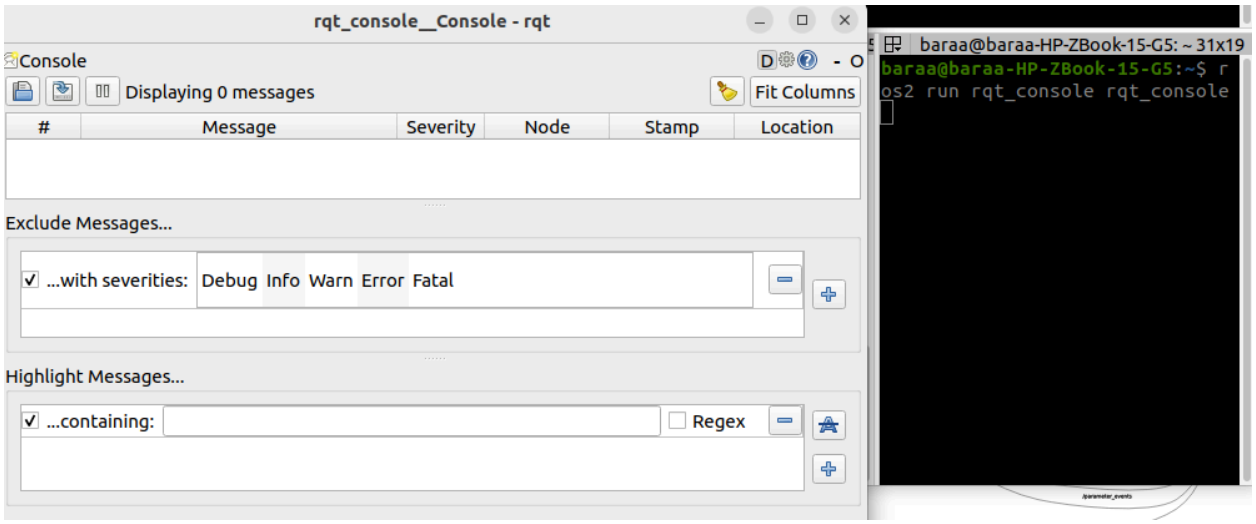
Changing parameters:



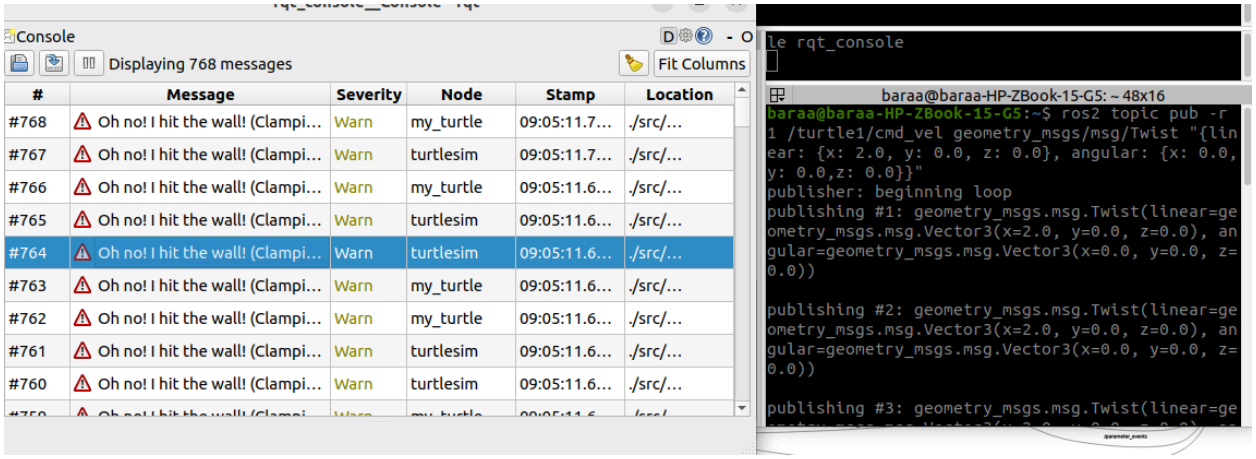


Node Graph

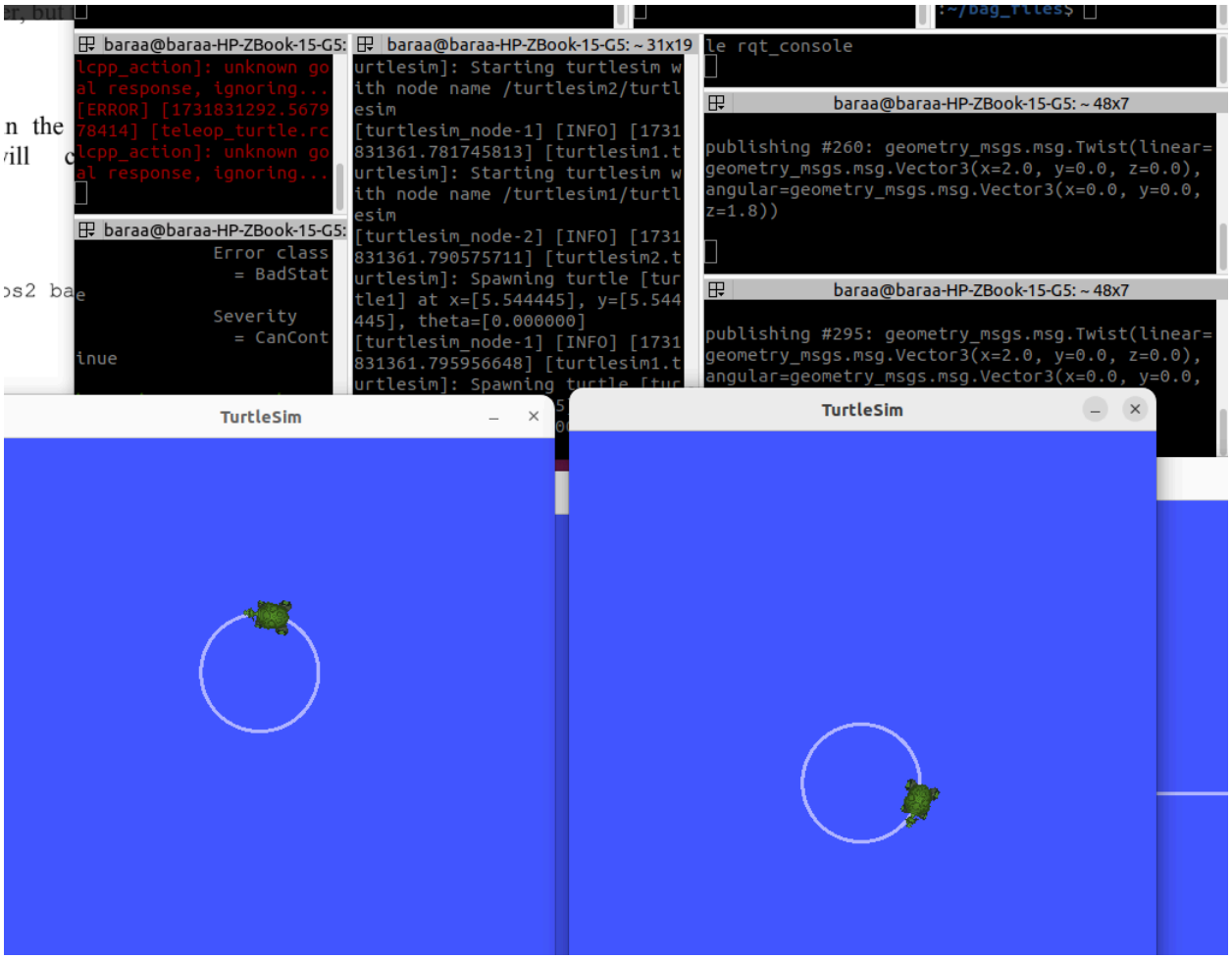

Node Graph
Nodes only
/
/
Group: 2
Namespaces
Actions
tf
Images
Highlight
Fit
Hide:
Dead sinks
Leaf topics
Debug
tf
Unreachable
Params
/parameter_events
/my_turtle
/turtlesim
/teleop_turtle
/turtle1/cmd_vel
/turtle1/rotate_absolute/_action/feedback
/turtle1/rotate_absolute/_action/status


rqt_console__Console - rqt
Console
Displaying 0 messages
Fit Columns
#
Message
Severity
Node
Stamp
Location
Exclude Messages...
...with severities:
Debug
Info
Warn
Error
Fatal
Highlight Messages...
...containing:
Regex
baraa@baraa-HP-ZBook-15-G5: ~ 31x19
baraa@baraa-HP-ZBook-15-G5:~$ r
os2 run rqt_console rqt_console

The console



- Launching nodes:



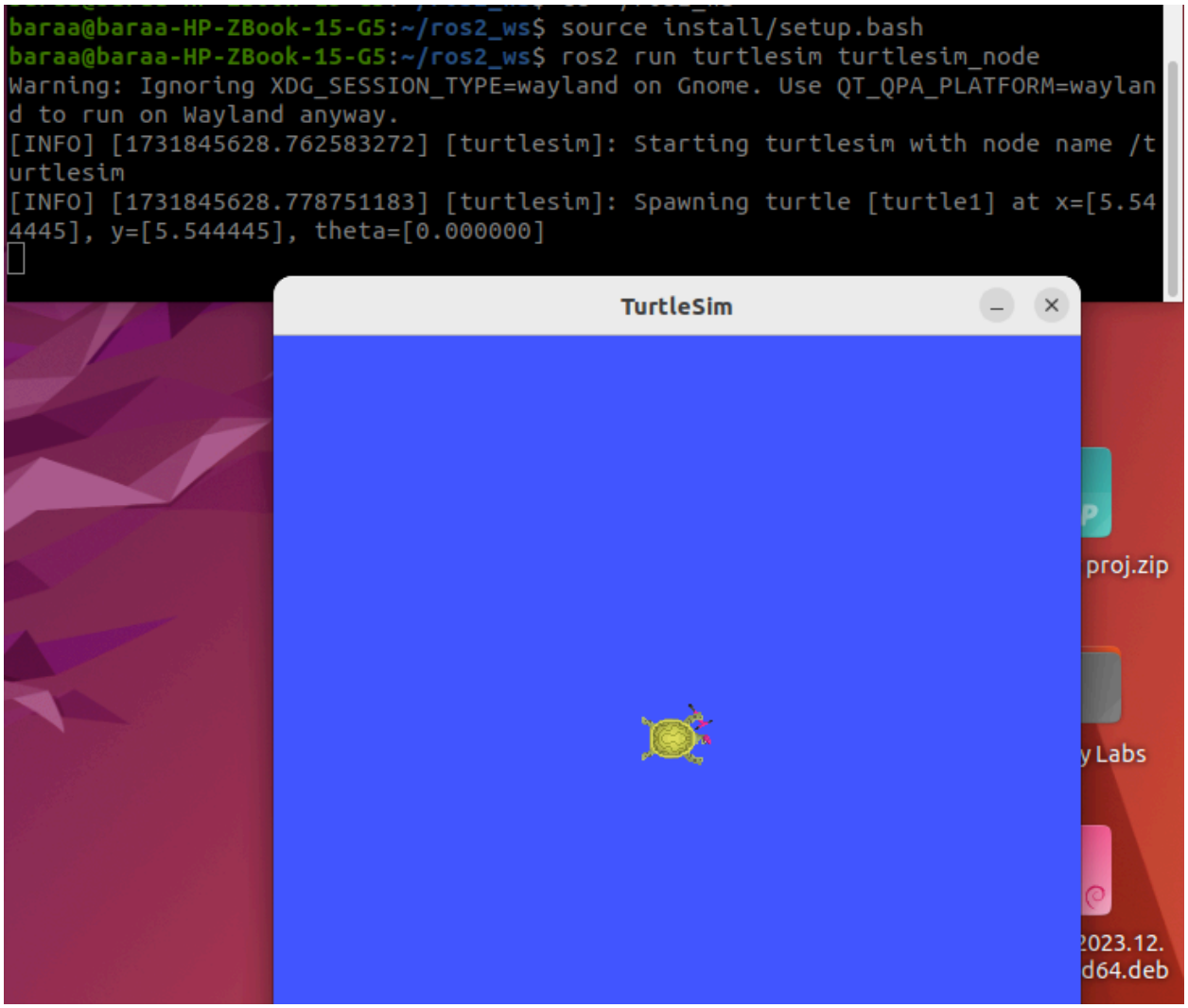
- Recording and playing back data:

```
baraa@baraa-HP-ZBook-15-G5:~/bag_files$ ls
rosbag2_2024_11_17-09_13_33
baraa@baraa-HP-ZBook-15-G5:~/bag_files$ ros2 bag in
fo rosbag2_2024_11_17-09_13_33

Files:             rosbag2_2024_11_17-09_13_33_0.db
3
Bag size:          25.0 KiB
Storage id:        sqlite3
Duration:          0.000000000s
Start:             Apr 12 2262 00:47:16.854775807 (
9223372036.854775807)
End:               Apr 12 2262 00:47:16.854775807 (
9223372036.854775807)
Messages:          0
Topic information: Topic: /turtle1/cmd_vel | Type:
geometry_msgs/msg/Twist | Count: 0 | Serialization
Format: cdr

baraa@baraa-HP-ZBook-15-G5:~/bag_files$
```

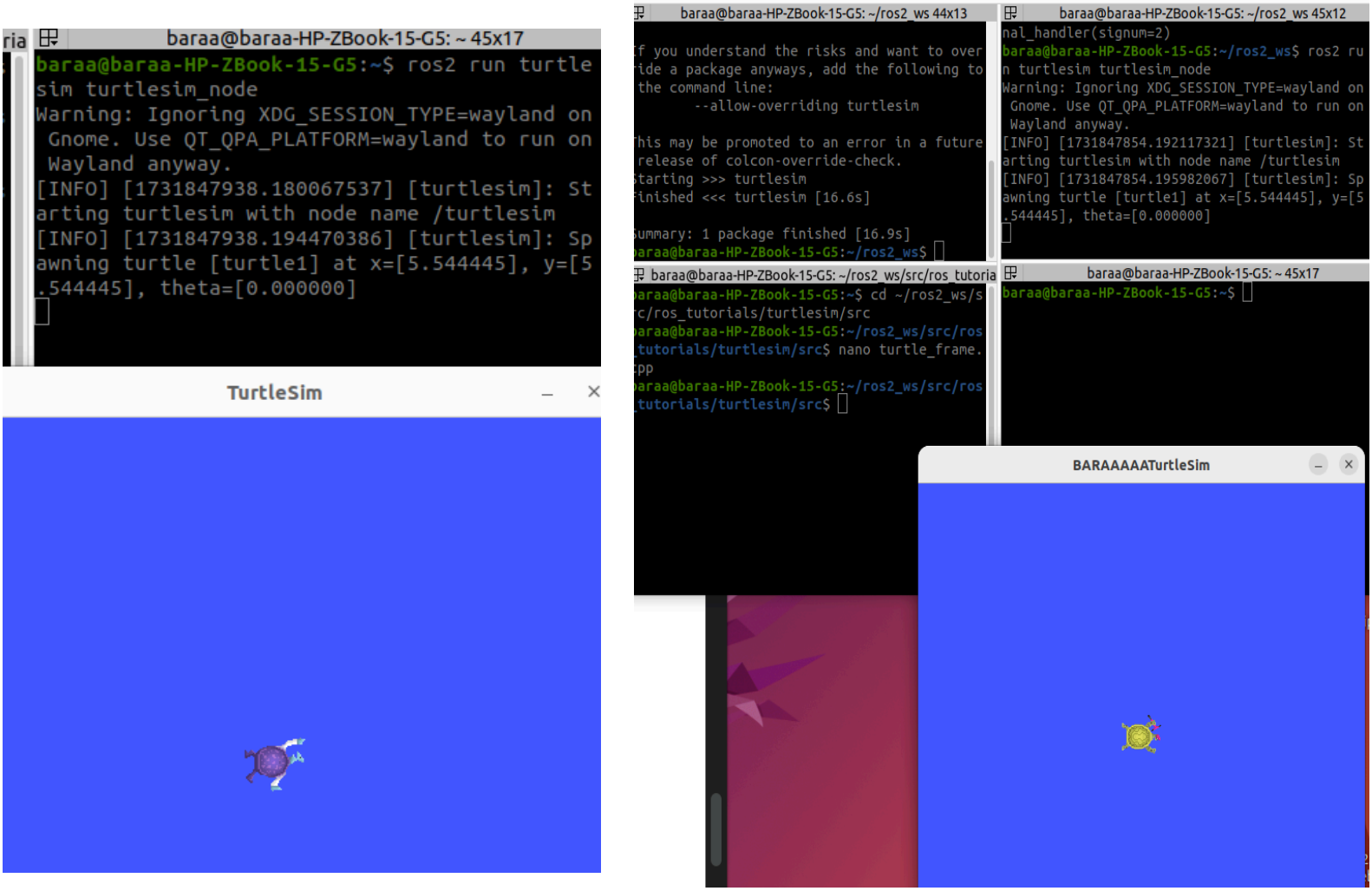
```
baraa@baraa-HP-ZBook-15-G5:~/ros2_ws$ rosdep install
-i --from-path src --rosdistro humble -y
#All required rosdeps installed successfully
```

```
baraa@baraa-HP-ZBook-15-G5:~/ros2_ws$ colcon build
[0.691s] WARNING:colcon.colcon_core.package_selection:Some selected packages are already built in one or mor
e underlay workspaces:
        'turtlesim' is in: /opt/ros/humble
If a package in a merged underlay workspace is overridden and it installs headers, then all packages in the
overlay must sort their include directories by workspace order. Failure to do so may result in build failure
s or undefined behavior at run time.
If the overridden package is used by another package in any underlay, then the overriding package in the ove
rlay must be API and ABI compatible or undefined behavior at run time may occur.

If you understand the risks and want to override a package anyways, add the following to the command line:
        --allow-overriding turtlesim

This may be promoted to an error in a future release of colcon-override-check.
Starting >>> turtlesim
[Processing: turtlesim]
Finished <<< turtlesim [36.2s]

Summary: 1 package finished [36.8s]
```

- Workspace


baraa@baraa-HP-ZBook-15-G5:~/ros2_ws$ source install/setup.bash
baraa@baraa-HP-ZBook-15-G5:~/ros2_ws$ ros2 run turtlesim turtlesim_node
Warning: Ignoring XDG_SESSION_TYPE=wayland on Gnome. Use QT_QPA_PLATFORM=waylan
d to run on Wayland anyway.
[INFO] [1731845628.762583272] [turtlesim]: Starting turtlesim with node name /t
urtlesim
[INFO] [1731845628.778751183] [turtlesim]: Spawning turtle [turtle1] at x=[5.54
4445], y=[5.544445], theta=[0.000000]
TurtleSim
proj.zip
y Labs
2023.12.
d64.deb

Overlay and underlay difference



- Building Package:

```
baraa@baraa-HP-ZBook-15-G5:~/ros2_ws/src$ ros2 pkg create --build-
type ament_cmake --license Apache-2.0 cpp_pubsub
going to create a new package
package name: cpp_pubsub
destination directory: /home/baraa/ros2_ws/src
package format: 3
version: 0.0.0
description: TODO: Package description
maintainer: ['baraa <baraa@todo.todo>']
licenses: ['Apache-2.0']
build type: ament_cmake
dependencies: []
creating folder ./cpp_pubsub
creating ./cpp_pubsub/package.xml
creating source and include folder
creating folder ./cpp_pubsub/src
creating folder ./cpp_pubsub/include/cpp_pubsub
creating ./cpp_pubsub/CMakeLists.txt
```

```
baraa@baraa-HP-ZBook-15-G5:~/ros2_ws$ colcon build --packag
es-select cpp_pubsub
Starting >>> cpp_pubsub
Finished <<< cpp_pubsub [0.15s]

Summary: 1 package finished [0.41s]
```

Trying the talker created

```
baraa@baraa-HP-ZBook-15-G5:~/ros2_ws$ ros2 run cpp_pubsub talker
[INFO] [1731850933.133799667] [minimal_publisher]: Publishing: 'Hi, greetings from BARAA 0'
[INFO] [1731850933.633796632] [minimal_publisher]: Publishing: 'Hi, greetings from BARAA 1'
[INFO] [1731850934.133790538] [minimal_publisher]: Publishing: 'Hi, greetings from BARAA 2'
[INFO] [1731850934.633859906] [minimal_publisher]: Publishing: 'Hi, greetings from BARAA 3'
[INFO] [1731850935.133884981] [minimal_publisher]: Publishing: 'Hi, greetings from BARAA 4'
```