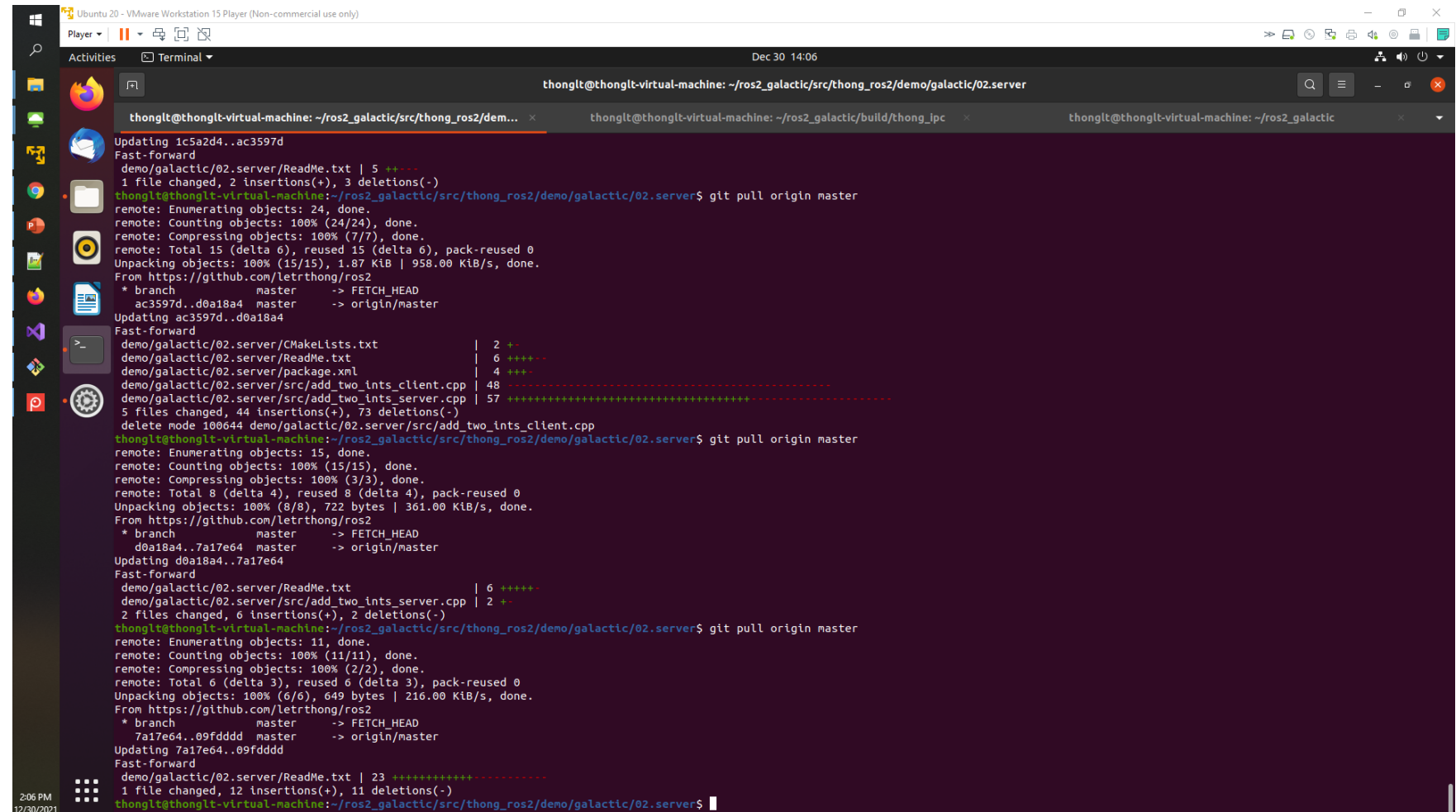


ROS 2

Setup ROS 2 on Virtual Ubuntu OS

<https://docs.ros.org/en/galactic/Installation.html>



The screenshot shows a terminal window in a virtual machine (Ubuntu 20 - VMware Workstation 15 Player). The terminal displays the following commands and output:

```
thonglt@thonglt-virtual-machine: ~/ros2_galactic/src/thong_ros2/demo/galactic/02.server
thonglt@thonglt-virtual-machine: ~/ros2_galactic/src/thong_ros2/dem...
thonglt@thonglt-virtual-machine: ~/ros2_galactic/build/thong_ipc
thonglt@thonglt-virtual-machine: ~/ros2_galactic

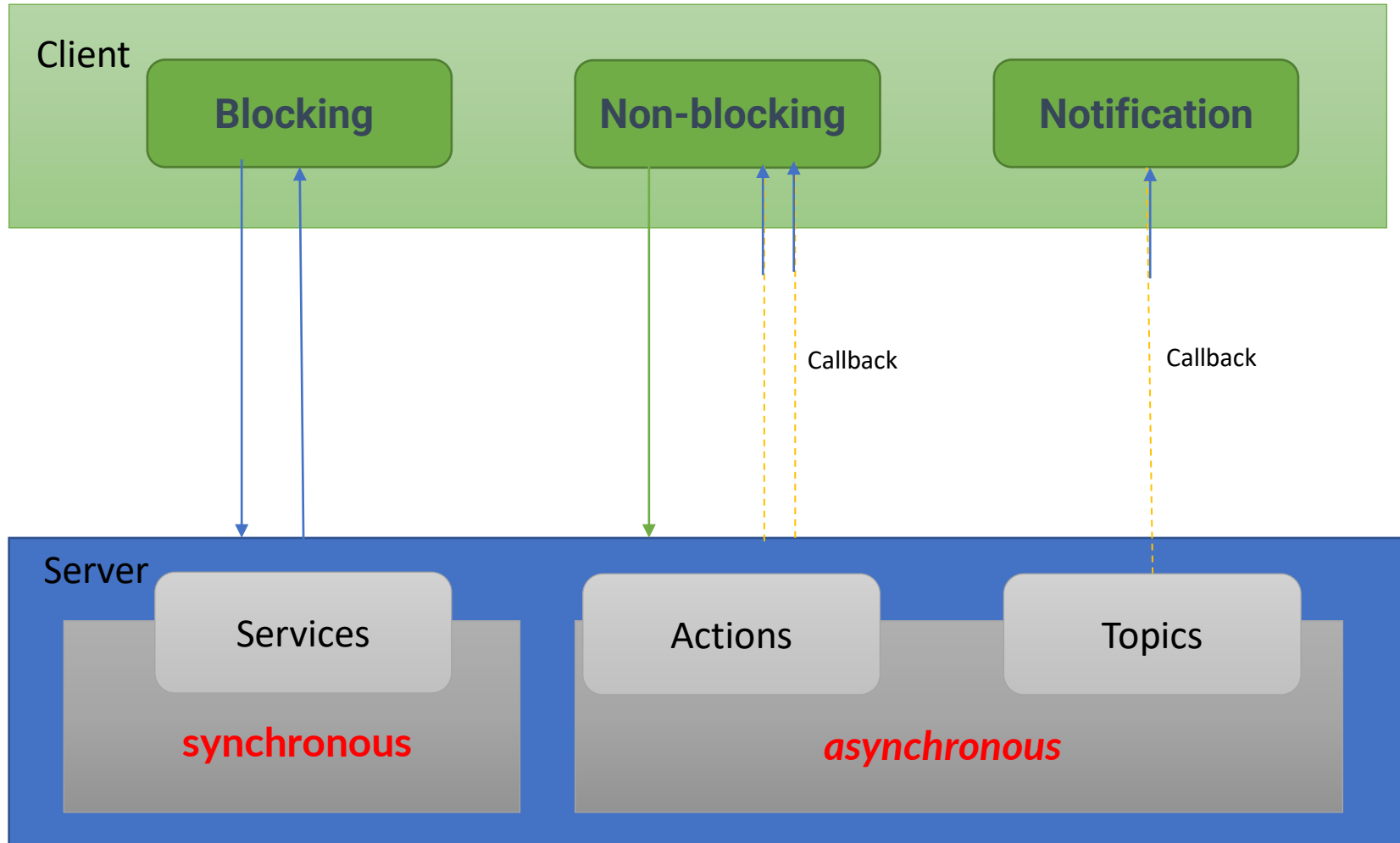
Updating 1c5a2d4..ac3597d
Fast-forward
 demo/galactic/02.server/ReadMe.txt | 5 +---
 1 file changed, 2 insertions(+), 3 deletions(-)
thonglt@thonglt-virtual-machine: ~/ros2_galactic/src/thong_ros2/demo/galactic/02.server$ git pull origin master
remote: Enumerating objects: 24, done.
remote: Counting objects: 100% (24/24), done.
remote: Compressing objects: 100% (7/7), done.
remote: Total 15 (delta 6), reused 15 (delta 6), pack-reused 0
Unpacking objects: 100% (15/15), 1.87 KiB | 958.00 KiB/s, done.
From https://github.com/letrthong/ros2
 * branch      master      -> FETCH_HEAD
   ac3597d..d0a18a4 master  -> origin/master
Updating ac3597d..d0a18a4
Fast-forward
 demo/galactic/02.server/CMakeLists.txt | 2 +-
 demo/galactic/02.server/ReadMe.txt    | 6 +---
 demo/galactic/02.server/package.xml   | 4 +---
 demo/galactic/02.server/src/add_two_ints_client.cpp | 48
 demo/galactic/02.server/src/add_two_ints_server.cpp | 57
 5 files changed, 44 insertions(+), 73 deletions(-)
 delete mode 100644 demo/galactic/02.server/src/add_two_ints_client.cpp
thonglt@thonglt-virtual-machine: ~/ros2_galactic/src/thong_ros2/demo/galactic/02.server$ git pull origin master
remote: Enumerating objects: 15, done.
remote: Counting objects: 100% (15/15), done.
remote: Compressing objects: 100% (3/3), done.
remote: Total 8 (delta 4), reused 8 (delta 4), pack-reused 0
Unpacking objects: 100% (8/8), 722 bytes | 361.00 KiB/s, done.
From https://github.com/letrthong/ros2
 * branch      master      -> FETCH_HEAD
   d0a18a4..7a17e64 master  -> origin/master
Updating d0a18a4..7a17e64
Fast-forward
 demo/galactic/02.server/ReadMe.txt | 6 +---
 demo/galactic/02.server/src/add_two_ints_server.cpp | 2 +-
 2 files changed, 6 insertions(+), 2 deletions(-)
thonglt@thonglt-virtual-machine: ~/ros2_galactic/src/thong_ros2/demo/galactic/02.server$ git pull origin master
remote: Enumerating objects: 11, done.
remote: Counting objects: 100% (11/11), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 6 (delta 3), reused 6 (delta 3), pack-reused 0
Unpacking objects: 100% (6/6), 649 bytes | 216.00 KiB/s, done.
From https://github.com/letrthong/ros2
 * branch      master      -> FETCH_HEAD
   7a17e64..09fd4dd master  -> origin/master
Updating 7a17e64..09fd4dd
Fast-forward
 demo/galactic/02.server/ReadMe.txt | 23 +-----
 1 file changed, 12 insertions(+), 11 deletions(-)
thonglt@thonglt-virtual-machine: ~/ros2_galactic/src/thong_ros2/demo/galactic/02.server$
```

Thong LT

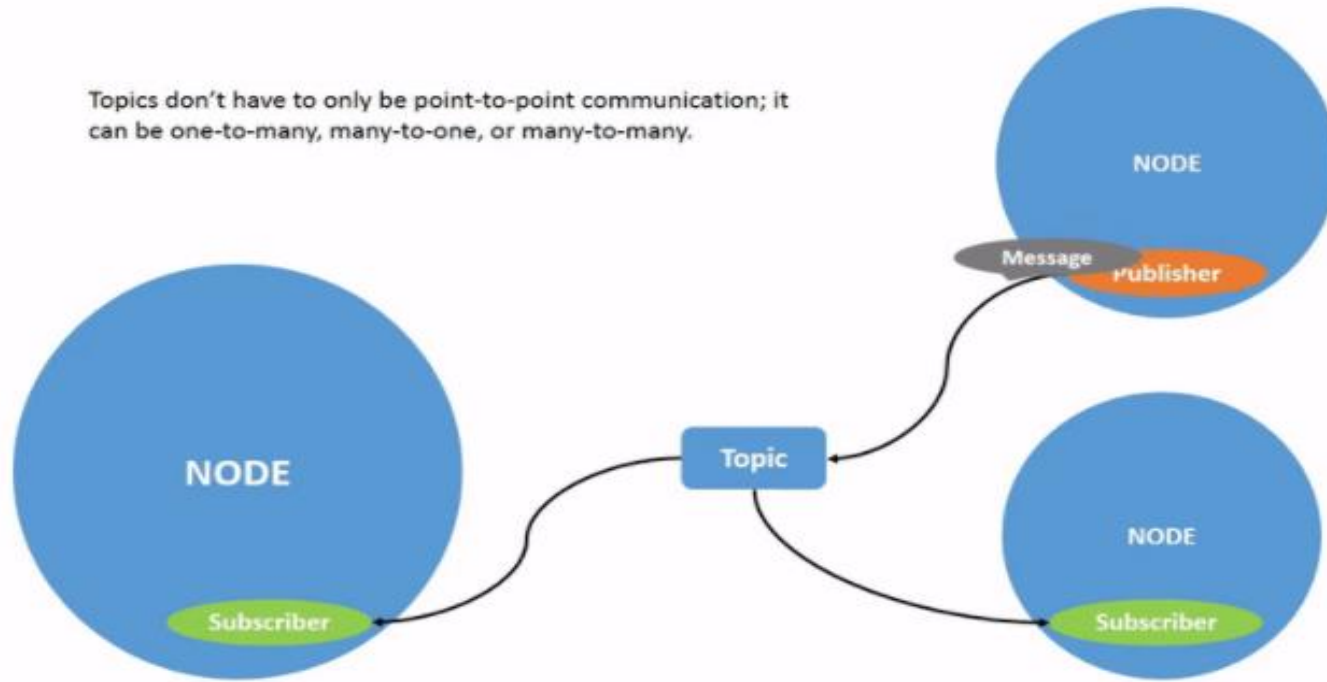


<https://aws.amazon.com/blogs/robotics/ros2-foxy-fitzroy-robot-development/>

IPC



Topics don't have to only be point-to-point communication; it can be one-to-many, many-to-one, or many-to-many.

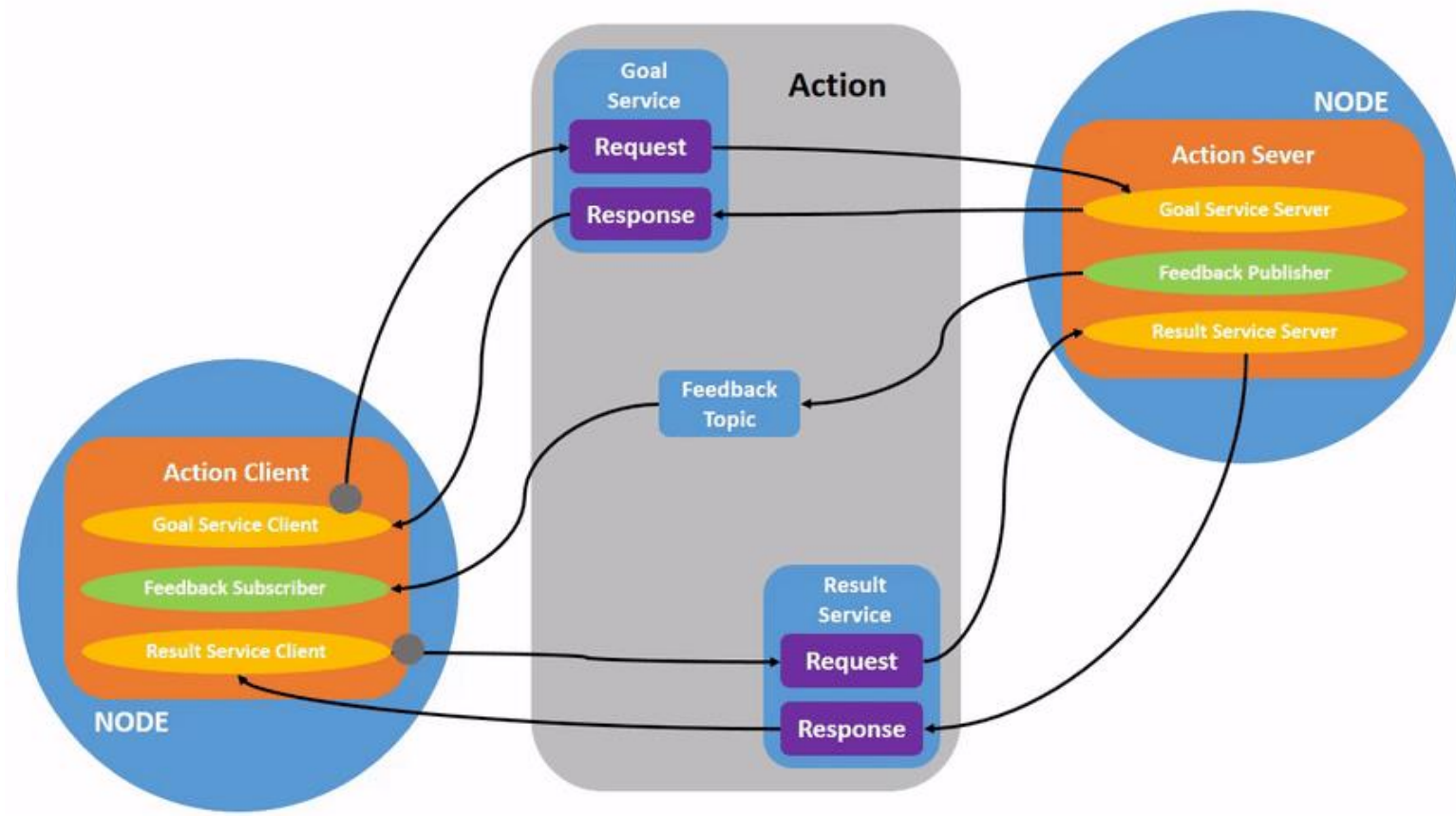


Nodes <https://github.com/ros2/examples/tree/master/rclcpp/>

Topics

Services

Parameter server



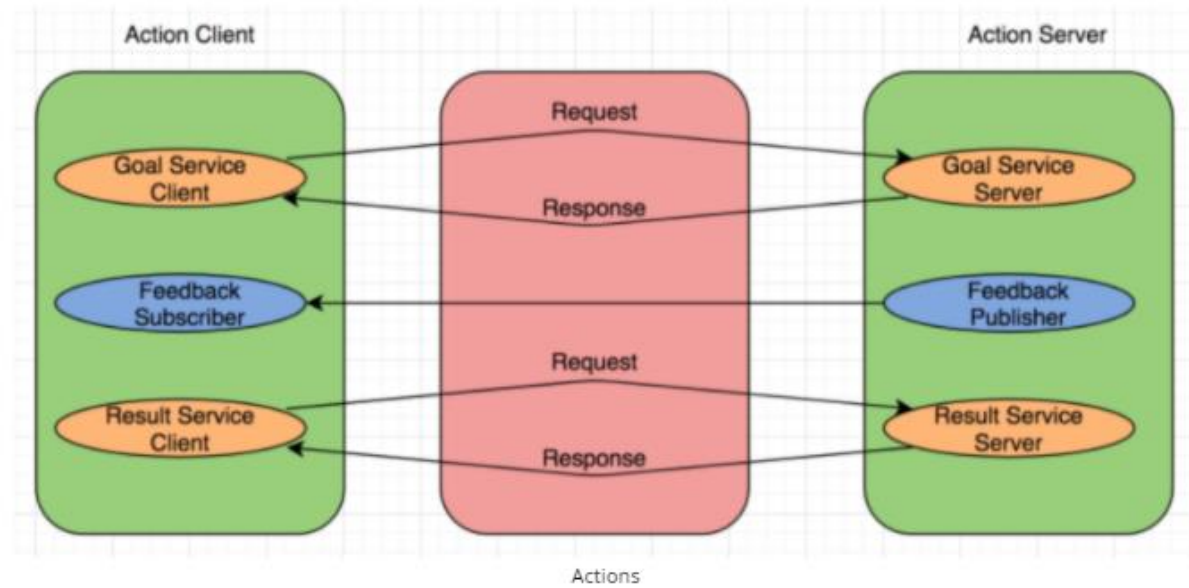
<https://docs.ros.org/en/foxy/Tutorials/Understanding-ROS2-Actions.html>

Nodes

Topics

Services

Parameter server



Exercises you will be doing

Topics

- Control the TurtleBot3 robot based on the laser readings.

Services

- Create a service to control the TurtleBot3 robot using input strings.

Actions

- Create a custom action to control the TurtleBot3 robot while reading the robot's status.

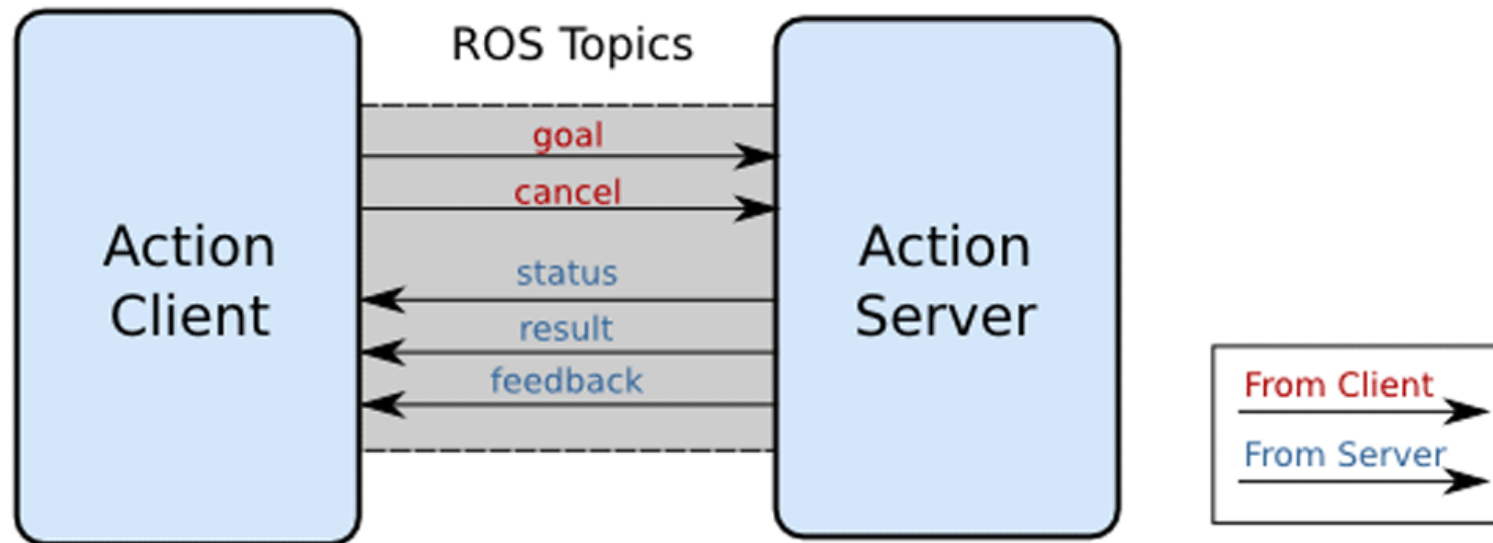
https://www.reddit.com/r/ROS/comments/nrzk9d/ros2_basics_for_python/

2. Order online

- a. Place your order (**request**).
- b. Order confirmation notice (**feedback**).
- c. Possibly cancel the order (**cancel**).
- d. Check up your order status once in a while (**status**).
- e. *Do other things*.
- f. Pizza is delivered (**response**).

To wrap up, consider the image below, saying roughly saying the same thing we have been saying, only in a “thousand words”:

Action Interface



Install packets

1. Install ros2

- Ubuntu Linux - Focal Fossa (20.04) 64-bit

Step1.

<https://docs.ros.org/en/galactic/Installation/Ubuntu-Development-Setup.html>

Step2.

<https://docs.ros.org/en/galactic/Installation/Ubuntu-Install-Debians.html>

```
sudo apt install ros-galactic-desktop  
source /opt/ros/galactic/setup.bash
```

2. Install packets in C++ (rclcpp)

3. Install packets for testing

```
source /opt/ros/galactic/setup.bash  
ros2 run demo_nodes_cpp talker
```

```
source /opt/ros/galactic/setup.bash  
ros2 run demo_nodes_py listener
```


Cli on ros 2

- ros2 node list
- ros2 node info <node_name>

```
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ros2 node list
/talker
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ros2 node info talker
Unable to find node 'talker'
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ros2 node info /talker
/talker
Subscribers:
  /parameter_events: rcl_interfaces/msg/ParameterEvent
Publishers:
  /chatter: std_msgs/msg/String
  /parameter_events: rcl_interfaces/msg/ParameterEvent
  /rosout: rcl_interfaces/msg/Log
Service Servers:
  /talker/describe_parameters: rcl_interfaces/srv/DescribeParameters
  /talker/get_parameter_types: rcl_interfaces/srv/GetParameterTypes
  /talker/get_parameters: rcl_interfaces/srv/GetParameters
  /talker/list_parameters: rcl_interfaces/srv/ListParameters
  /talker/set_parameters: rcl_interfaces/srv/SetParameters
  /talker/set_parameters_atomically: rcl_interfaces/srv/SetParametersAtomically
Service Clients:

Action Servers:

Action Clients:

thonglt@thonglt-virtual-machine:~/ros2_galactic$
```

rclcpp

- `ros2 node list`
- `ros2 node info <node_name>`

rclcpp

How to create an example

<https://docs.ros.org/en/galactic/Tutorials/Writing-A-Simple-Cpp-Service-And-Client.html>

installing system dependencies.

<http://wiki.ros.org/rosdep>

<http://wiki.ros.org/rosdep/Tutorials/How%20to%20add%20a%20system%20dependency>

<https://colcon.readthedocs.io/en/released/>

ROS 2 package and packets in workspaces

<https://docs.ros.org/en/foxy/Tutorials/Creating-Your-First-ROS2-Package.html>

Example at

<https://docs.ros.org/en/galactic/Features.html>

<https://github.com/ros2/examples/tree/master/rclcpp>

<https://roboticsbackend.com/create-a-ros2-cpp-package/>

rcldcpp

interface

https://github.com/ros2/example_interfaces/tree/master/msg

```
thonglt@thonglt-virtual-machine:~/ros2_galactic/src/ros2/example_interfaces$ ls
action CHANGELOG.rst CMakeLists.txt CONTRIBUTING.md LICENSE mapping_rules.yaml msg package.xml README.md srv
thonglt@thonglt-virtual-machine:~/ros2_galactic/src/ros2/example_interfaces$ cat package.xml
<?xml version="1.0"?>
<?xml-model href="http://download.ros.org/schema/package_format3.xsd" schematypens="http://www.w3.org/2001/XMLSchema"?>
<package format="3">
  <name>example_interfaces</name>
  <version>0.9.2</version>
  <description>Contains message and service definitions used by the examples.</description>
  <maintainer email="jacob@openrobotics.org">Jacob Perron</maintainer>
  <license>Apache License 2.0</license>

  <author email="dthomas@openrobotics.org">Dirk Thomas</author>

  <buildtool_depend>ament_cmake</buildtool_depend>

  <buildtool_depend>rosidl_default_generators</buildtool_depend>

  <depend>action_msgs</depend>

  <exec_depend>rosidl_default_runtime</exec_depend>

  <member_of_group>rosidl_interface_packages</member_of_group>

  <export>
    <build_type>ament_cmake</build_type>
    <ros1_bridge mapping_rules="mapping_rules.yaml"/>
  </export>
</package>
```

colcon

- <https://colcon.readthedocs.io/en/released/user/quick-start.html>

```
$ mkdir -p /tmp/workspace/src      # Make a workspace directory with a src subdirectory
$ cd /tmp/workspace                # Change directory to the workspace root
$ <...>                            # Populate the `src` directory with packages
$ colcon list                      # List all packages in the workspace
$ colcon graph                     # List all packages in the workspace in topological order
                                   # and visualize their dependencies

$ colcon build                     # Build all packages in the workspace
$ colcon test                      # Test all packages in the workspace
$ colcon test-result --all         # Enumerate all test results
$ . install/local_setup.bash       # Setup the environment to use the built packages
$ <...>                           # Use the built packages
```

Build an example

```
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ls
build  install  log  ros2.repos  src
thonglt@thonglt-virtual-machine:~/ros2_galactic$
thonglt@thonglt-virtual-machine:~/ros2_galactic$ pwd
/home/thonglt/ros2_galactic
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ls
build  install  log  ros2.repos  src
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ls src/
ament  eclipse-cyclonedds  eclipse-iceoryx  eProsima  osrf  ros  ros2  ros-perception
thonglt@thonglt-virtual-machine:~/ros2_galactic$
```

- <https://github.com/ros2/examples>

Build an example from ros2

Step1: `cd src`

Step2: `git clone https://github.com/letrthong/ros2_thong_ros2`

Step3: `cd ..`

Step4: `colcon list | grep "thong"`

Step5: `colcon build --packages-select select --allow-overriding thong_ipc`

Step6: `. ~/ros2_galactic/install/local_setup.bash`

Step7: `ros2 run ipc_demo.out`

Build source from ros2

```
thonglt@thonglt-virtual-machine:~/ros2_galactic/src$ git clone https://github.com/letrthong/ros2_thong_ros2
Cloning into 'thong_ros2'...
remote: Enumerating objects: 193, done.
remote: Counting objects: 100% (193/193), done.
remote: Compressing objects: 100% (116/116), done.
remote: Total 193 (delta 73), reused 173 (delta 53), pack-reused 0
Receiving objects: 100% (193/193), 1.90 MiB | 1.52 MiB/s, done.
Resolving deltas: 100% (73/73), done.
thonglt@thonglt-virtual-machine:~/ros2_galactic/src$ cd ..
thonglt@thonglt-virtual-machine:~/ros2_galactic$ colcon list | grep "thong"
ipc      src/thong ros2/demo/galactic/02.server (ros.ament cmake)
```

```
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ls
build install log ros2.repos src
thonglt@thonglt-virtual-machine:~/ros2_galactic$ ros2 run thong_ipc server.out
[INFO] [1640846155.392159783] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 0'
[INFO] [1640846155.890899578] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 1'
[INFO] [1640846156.391771209] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 2'
[INFO] [1640846156.891455485] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 3'
[INFO] [1640846157.391081928] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 4'
[INFO] [1640846157.891389583] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 5'
[INFO] [1640846158.391618777] [minimal_publisher]: Publishing: 'Thong LT Hello, world! 6'
```

<https://github.com/letrthong/ros2/tree/master/demo/galactic/02.server#readme>

<https://github.com/letrthong/ros2/tree/master/demo/galactic/02.server>

Build an example from os2_galactic

```
thonglt@thonglt-virtual-machine: ~/ros2/demo/g... x thonglt@thonglt-virtual-machine: ~/ros2_galactic... x
thonglt@thonglt-virtual-machine:~/ros2_galactic/src/ros2/demos/demo_nodes_cpp$ cd ..
thonglt@thonglt-virtual-machine:~/ros2_galactic/src/ros2/demos$ cd ..
thonglt@thonglt-virtual-machine:~/ros2_galactic/src/ros2$ cd ..
thonglt@thonglt-virtual-machine:~/ros2_galactic/src$ cd ..
Files t@thonglt-virtual-machine:~/ros2_galactic$ colcon list | grep "demo_nodes_cpp"
demo_nodes_cpp src/ros2/demos/demo_nodes_cpp (ros.ament_cmake)
demo_nodes_cpp_native src/ros2/demos/demo_nodes_cpp_native (ros.ament_cmake)
thonglt@thonglt-virtual-machine:~/ros2_galactic$ colcon build --packages-select demo_nodes_cpp
Starting >>> demo_nodes_cpp
Finished <<< demo_nodes_cpp [6.84s]

Summary: 1 package finished [11.8s]
thonglt@thonglt-virtual-machine:~/ros2_galactic/build/demo_nodes_cpp$ ls | grep "talker"
talker
talker_loaned_message
talker_serialized_message
test_talker_listener__rmw_cyclonedds_cpp.py
test_talker_listener__rmw_cyclonedds_cpp.py.configured
test_talker_listener__rmw_fastrtps_cpp.py
test_talker_listener__rmw_fastrtps_cpp.py.configured
test_talker_listener__rmw_fastrtps_dynamic_cpp.py
test_talker_listener__rmw_fastrtps_dynamic_cpp.py.configured
thonglt@thonglt-virtual-machine:~/ros2_galactic/build/demo_nodes_cpp$
```

```
colcon build --packages-select demo_nodes_cpp
. ~/ros2_galactic/install/local_setup.bash
ros2 run demo_nodes_cpp talker
```