Packages and launch files in ROS 2

Olivier Kermorgant

ANF ROS2

CENTRALE NANTES

LS2N

Regroup commands that should work together

- Run several nodes at the same time
- Remap topics (hard-coded in node code source)
- Run nodes inside a namespace
- Set / load some parameters
- Include other launch files

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- `apt install ros-${ROS_DISTRO}-slider-publisher`
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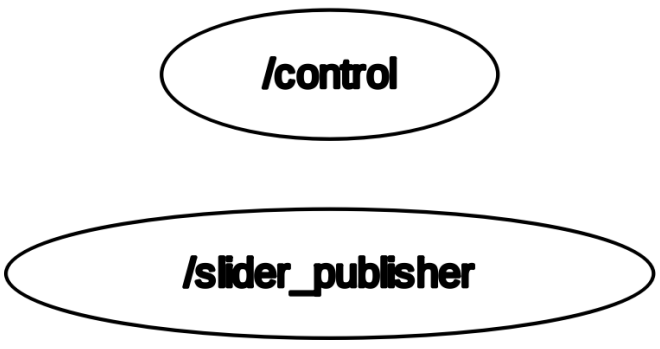
Running two nodes that should communicate

```
# publishes on setpoint by default, needs a command line argument
ros2 run slider_publisher slider_publisher setpoint.yaml

# listens to angle_setpoint
ros2 run anf_launch control.py
```




```
> ros2 wtf --report
   TOPIC LIST
topic : /angle_setpoint
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topic : /setpoint
publisher count : 1
subscriber count : 0
```

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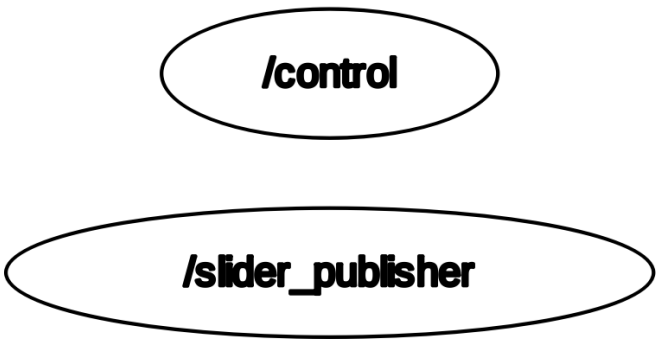


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Remappings are for nodes not made to work together

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ros2 run slider_publisher slider_publisher setpoint.yaml

ros2 run anf_launch control.py --ros-args -r /angle_setpoint:=/setpoint
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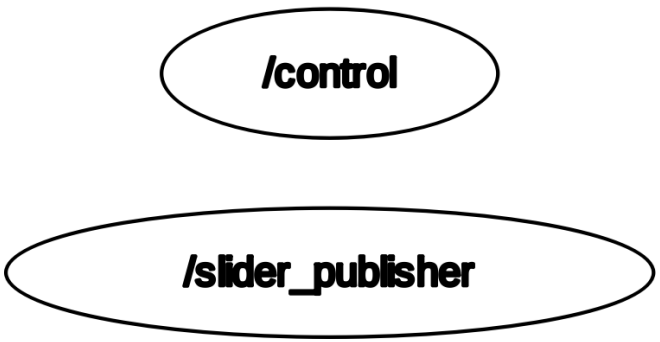


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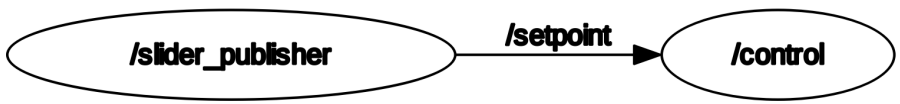

Any file in ROS belongs to a given package

- Atomic way to share and identify code
- Can be CMake-based or pure Python

A package is identified by its `package.xml` file

- Give the name + dependencies (other ROS packages or other libraries)

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```
1  <?xml version="1.0"?>
2  <package format="3">
3    <name>simulation_2d</name>
4    <version>2.0.0</version>
5    <description>The simulation2D package</description>
6    <maintainer email="olivier.kermorgant@ec-nantes.fr">Olivier Kermorgant</maintainer>
7
8    <license>MIT</license>
9    <buildtool_depend>ament_cmake</buildtool_depend>
10
11   <depend>geometry_msgs</depend>
12   <depend>rclcpp</depend>
13   <depend>sensor_msgs</depend>
14   <depend>urdfdom</depend>
15
16   <export>
17     <build_type>ament_cmake</build_type>
18   </export>
19 </package>
```

A package may contain:

- C++ code → `include/` `src/`
- Python code→ `scripts/`
- robot descriptions → `urdf/` `meshes/`
- launch files → `launch/`
- custom messages → `msg/` `srv/`
- actually any file

Package name is used:

- to run its nodes `ros2 run pkg node`
- as the namespace for its custom messages
- to find any file inside
- as a dependency for another package

ROS packages - what's inside?

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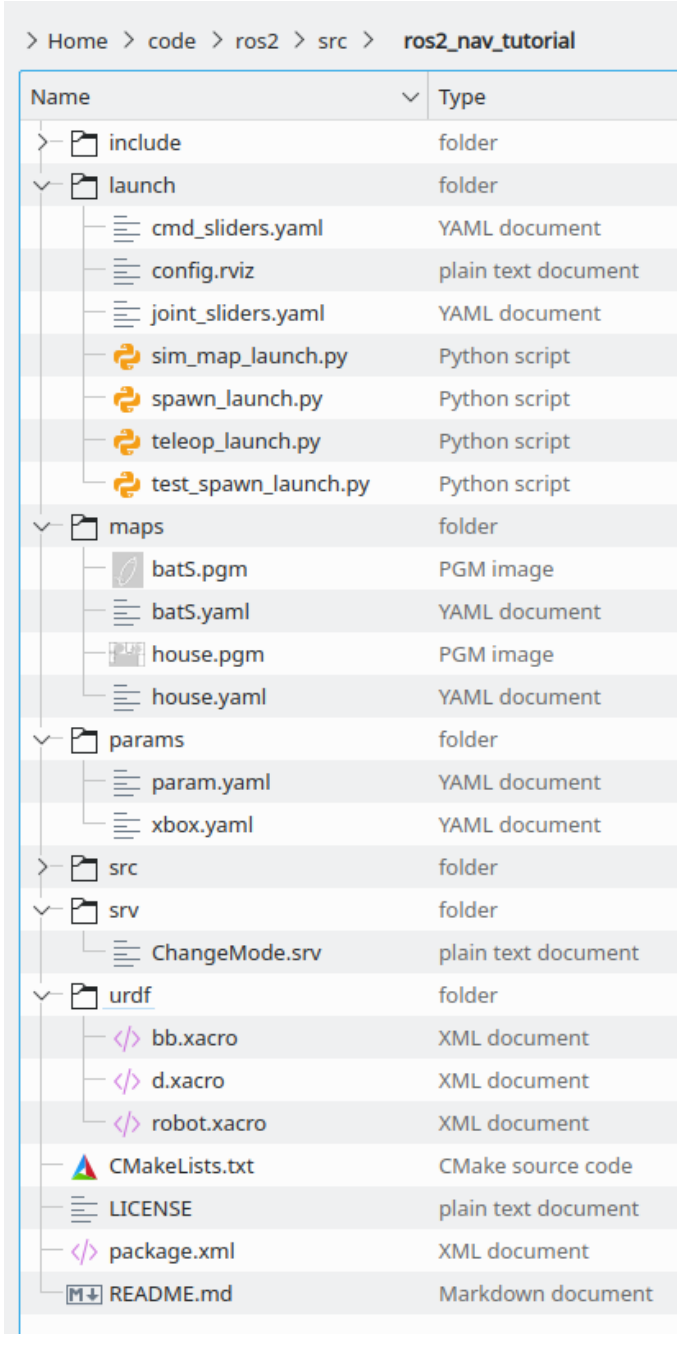

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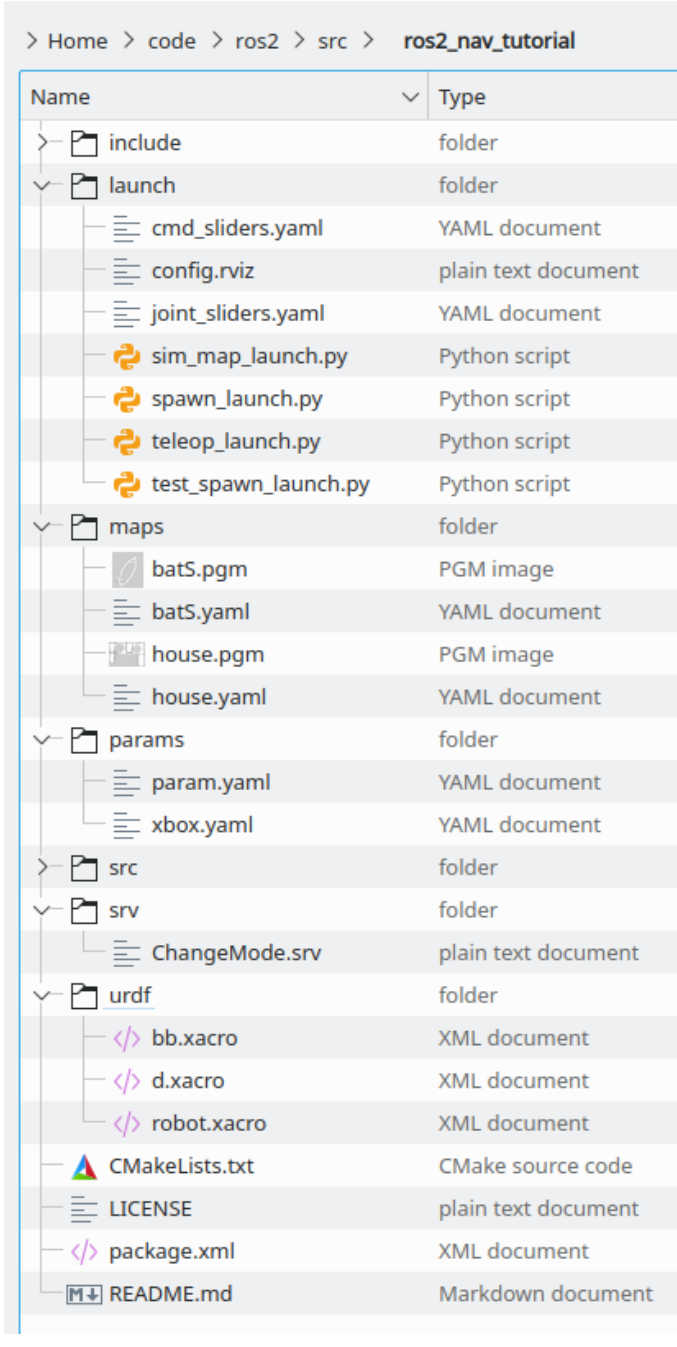

ROS launch files

- Forward launch parameters to nodes
- Run commands, get their output
- Conditional or namespaced groups

ROS 2:

- More or less same as ROS 1
- Syntax slightly different
- No condition groups, no command output (xacro)

- De-facto standard, same capabilities as in ROS 1
- New features:
  - Composition
  - Adapting parameters from a YAML file
  - Actually anything you can do in Python
- Used in all tutorials / popular packages

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XML launch: ROS 1 vs ROS 2

```xml
<?xml version="1.0"?>
<launch>

<node name="rviz" pkg="rviz" type="rviz" respawn="true" output="screen"
    args="-d $(find my_package)/launch/config.rviz"/>

<!-- Namespacing / xacro-->
<group ns="bb8">
   <param name="robot_description" command="$(find xacro)/xacro $(find my_package)/urdf/bb8.xacro"/>
   <node name="robot_state_publisher" pkg="robot_state_publisher" type="robot_state_publisher"/>
</group>
</launch>
```

```xml
<?xml version="1.0"?>
<launch>

<node name="rviz2" pkg="rviz2" exec="rviz2" respawn="true" output="screen"
    args="-d $(find-pkg-share my_package)/launch/config.rviz"/>

<!-- no xacro... have to use URDF -->
<group>
   <push-ros-namespace namespace="bb8"/>
   <node name="robot_state_publisher" pkg="robot_state_publisher" exec="robot_state_publisher"
      args="$(find-pkg-share my_package)/urdf/bb8.urdf"/>
</group>
</launch>
```

Python or XML launch files: running RViz

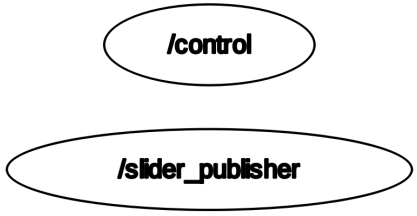
```xml
<?xml version="1.0"?>
<launch>
<node name="rviz2" pkg="rviz2" exec="rviz2" respawn="true" output="screen"
    args="-d $(find-pkg-share my_package)/launch/config.rviz"/>
</launch>
```


```python
import os
from ament_index_python.packages import get_package_share_directory
from launch import LaunchDescription
from launch_ros.actions import Node

def generate_launch_description():
    rviz_config_dir = os.path.join(
            get_package_share_directory('my_package'),
            'launch',
            'config.rviz')

    return LaunchDescription([
        Node(
            package='rviz2',
            executable='rviz2',
            name='rviz2',
            arguments=['-d', rviz_config_dir],
            output='screen', respawn='true'),
    ])
```

Basic launch file that runs 2 nodes without remapping

```
ros2 run slider_publisher slider_publisher path/to/setpoint.yaml # publishes on /setpoint
ros2 run anf_launch control.py # listens to /angle_setpoint
```

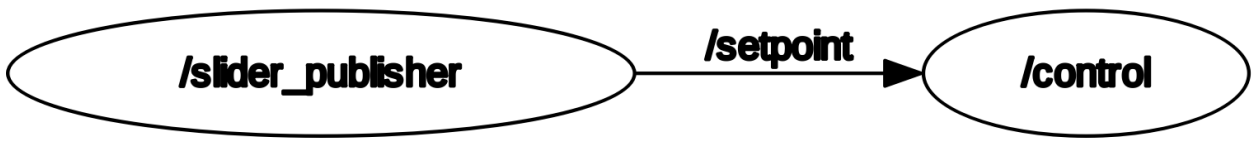
```
from simple_launch import SimpleLauncher

def generate_launch_description():

    sl = SimpleLauncher()

    sl.node('anf_launch', 'control.py')

    sl.node('slider_publisher',
            arguments = [sl.find('anf_launch', 'setpoint.yaml')])

    return sl.launch_description()
```



Basic launch file that runs 2 nodes with remapping

```
ros2 run slider_publisher slider_publisher path/to/setpoint.yaml
ros2 run anf_launch control.py --ros-args -r /angle_setpoint:=/setpoint
```

```python
from simple_launch import SimpleLauncher

def generate_launch_description():

    sl = SimpleLauncher()

    sl.node('anf_launch', 'control.py',
            remappings = {'angle_setpoint': 'setpoint'})

    sl.node('slider_publisher',
            arguments = [sl.find('anf_launch', 'setpoint.yaml')])

    return sl.launch_description()
```



Classical argument passing from launch to node

```
from simple_launch import SimpleLauncher

def generate_launch_description():

    sl = SimpleLauncher()
    sl.declare_arg('Kp', 0.1)

    sl.node('anf_launch', 'control.py',
            remappings = {'angle_setpoint': 'setpoint'},
            parameters = {'Kp': sl.arg('Kp')})

    sl.node('slider_publisher',
            arguments = [sl.find('anf_launch', 'setpoint.yaml')])

    return sl.launch_description()
```

```
ros2 launch anf_launch cmd_launch.py Kp:=0.3
```

Basic launch file that runs `turtlesim` with a control node

```python
def generate_launch_description():

    ld = LaunchDescription()

    # run turtlesim (will spawn turtle1)
    sim_node = Node(package='turtlesim', executable='turtlesim_node')
    ld.add_action(sim_node)

    # declare a (Boolean) argument
    ld.add_action(DeclareLaunchArgument('manual', default_value=False))
    manual = LaunchConfiguration('manual')

    # open-loop node
    loop_node = Node(package='anf_launch', executable='loop', condition = UnlessCondition(manual))

    # manual node
    slider_config = f"{lookup('anf_launch')}/launch/Turtle.yaml"
    slider_node = Node(package='slider_publisher', executable='slider_publisher', name='turtle1',
                       condition = IfCondition(manual),
                       arguments = [slider_config])

    # namespaced group with those 2 nodes
    namespaced = GroupAction([PushRosNamespace('turtle1'),loop_node, slider_node])
    ld.add_action(namespaced)

    return ld
```

Basic launch file that runs `turtlesim` with a control node

```python
from launch import LaunchDescription
from launch_ros.actions import Node, PushRosNamespace
from launch.actions import DeclareLaunchArgument, GroupAction
from launch.conditions import IfCondition, UnlessCondition
from launch.substitutions import LaunchConfiguration
from ament_index_python.packages import get_package_share_directory as lookup

def generate_launch_description():

    ld = LaunchDescription()

    # run turtlesim (will spawn turtle1)
    sim_node = Node(package='turtlesim', executable='turtlesim_node')
    ld.add_action(sim_node)

    # declare a (Boolean) argument
    ld.add_action(DeclareLaunchArgument('manual', default_value=False))
    manual = LaunchConfiguration('manual')

    # open-loop node
    loop_node = Node(package='anf_launch', executable='loop', condition = UnlessCondition(manual))

    # manual node
    slider_config = f"{lookup('anf_launch')}/launch/Turtle.yaml"
    slider_node = Node(package='slider_publisher', executable='slider_publisher', name='turtle1',
                       condition = IfCondition(manual),
                       arguments = [slider_config])

    # namespaced group with those 2 nodes
    namespaced = GroupAction([PushRosNamespace('turtle1'),loop_node, slider_node])
    ld.add_action(namespaced)

    return ld
```

Exposes a much lighter interface to write launch files

```python
from simple_launch import SimpleLauncher

def generate_launch_description():

    sl = SimpleLauncher(use_sim_time = False)
    sl.declare_arg('manual', False)

    # run turtlesim with turtle1
    sl.node('turtlesim', 'turtlesim_node')

    # run the open-loop or manual control
    with sl.group(ns='turtle1'):

        with sl.group(unless_arg='manual'):
            # open loop control in this block
            sl.node('anf_launch', 'loop')

        with sl.group(if_arg='manual'):
            # manual control
            sl.node('slider_publisher', 'slider_publisher',name='turtle1',
                    arguments=[sl.find('anf_launch', 'Turtle.yaml')])

    return sl.launch_description()
```

https://github.com/oKermorgant/simple_launch

Using containers: official composition example

```
import launch
from launch_ros.actions import ComposableNodeContainer
from launch_ros.descriptions import ComposableNode

def generate_launch_description():
    container = ComposableNodeContainer(
            name='my_container',
            package='rclcpp_components',
            executable='component_container',
            composable_node_descriptions=[
                ComposableNode(
                    package='composition',
                    plugin='composition::Talker',
                    name='talker'),
                ComposableNode(
                    package='composition',
                    plugin='composition::Listener',
                    name='listener')
            ],
    )
    return launch.LaunchDescription([container])
```

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            ],
    )
    return launch.LaunchDescription([container])
```

```python
from simple_launch import SimpleLauncher

def generate_launch_description():
    sl = SimpleLauncher()

    # load Talker and Listener into new container
    with sl.container(name='my_container'):
        sl.node(package='composition', plugin='Talker', name='talker')
        sl.node(package='composition', plugin='Listener', name='listener')

    return sl.launch_description()
```

Passing parameters in Python launch files

```
# Node arguments are lists
Node(package='rviz2', executable='rviz2', name='rviz2',
     arguments=['-d', rviz_config_dir])

# Node parameters are a list of single-entry dictionaries
Node(package, executable, name,
     parameters=[{'use_sim_time': True}, {'robot_description': urdf_xml}])

# Node remappings are a list of (key, value) pairs
Node(package, executable, name,
     remappings=[('/cmd_vel', 'command'), ('/pose', 'odom')])

# Included launch parameters are a list of (key, value) pairs
IncludeLaunchDescription(
               AnyLaunchDescriptionSource('included_launch.py'),
               launch_arguments=[('namespace', namespace), ('use_sim_time', 'true')])
```

`simple_launch`: dictionaries everywhere except arguments

```
# Node arguments are still lists
sl.node(package='rviz2', executable='rviz2', name='rviz2',
     arguments=['-d', rviz_config_dir])

# Node parameters
sl.node(package, executable, name,
     parameters={'use_sim_time': True, 'robot_description': urdf_xml})

# Node remappings
sl.node(package, executable, name,
       remappings={'/cmd_vel': 'command', '/pose': 'odom'})

# Included launch parameters
sl.include(package, 'included_launch.py',
               launch_arguments={'namespace': namespace, 'use_sim_time': 'true'})
```

The main voodoo of Python launch files: Arguments are not classical Python types

```
sl.declare_arg('namespace', 'turtle')

# try to build topic '<namespace>/odom'
odom_topic = sl.arg('turtle') + '/odom' # does not work

odom_topic = sl.path_join(sl.arg('turtle'), 'odom') # ok
```

```
sl.declare_arg('urdf', 'robot.urdf')

urdf_path = '/path/to' + sl.arg('urdf') # nope

sl.node('robot_state_publisher',
        parameters = Command(['xacro', '/path/to', sl.arg('urdf')])) # ok

# does the same
sl.robot_state_publisher('pkg', 'sub-folder', sl.arg('urdf'))
```

The *Opaque Function* approach to convert arguments to raw Python types

```
# many many imports
def launch_setup(context):
    n = launch.substitutions.LaunchConfiguration('num_robots')
    print(type(n)) # LaunchConfiguration
    n_performed = n.perform(context)
    print(type(n_performed)) # int

def generate_launch_description():
    return launch.LaunchDescription([
        launch.actions.DeclareLaunchArgument('num_robots'),
        OpaqueFunction(function = launch_setup)
        ])
```

```python
from simple_launch import SimpleLauncher
sl = SimpleLauncher()
sl.declare_arg('num_robots')

def launch_setup():
  n = sl.arg('num_robots')
  print(type(n)) # int

generate_launch_description = sl.generate_launch_description(launch_setup)
```

Allows getting launch arguments as raw Python types

Prefered when no other solution

Main issue: debugging more difficult

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from simple_launch import SimpleLauncher
sl = SimpleLauncher()
sl.declare_arg('num_robots')

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/you
questions?
/me