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-$ROS_DISTRO-slider-publisher`
- `apt install ros-$ROS_DISTRO-simple-launch`

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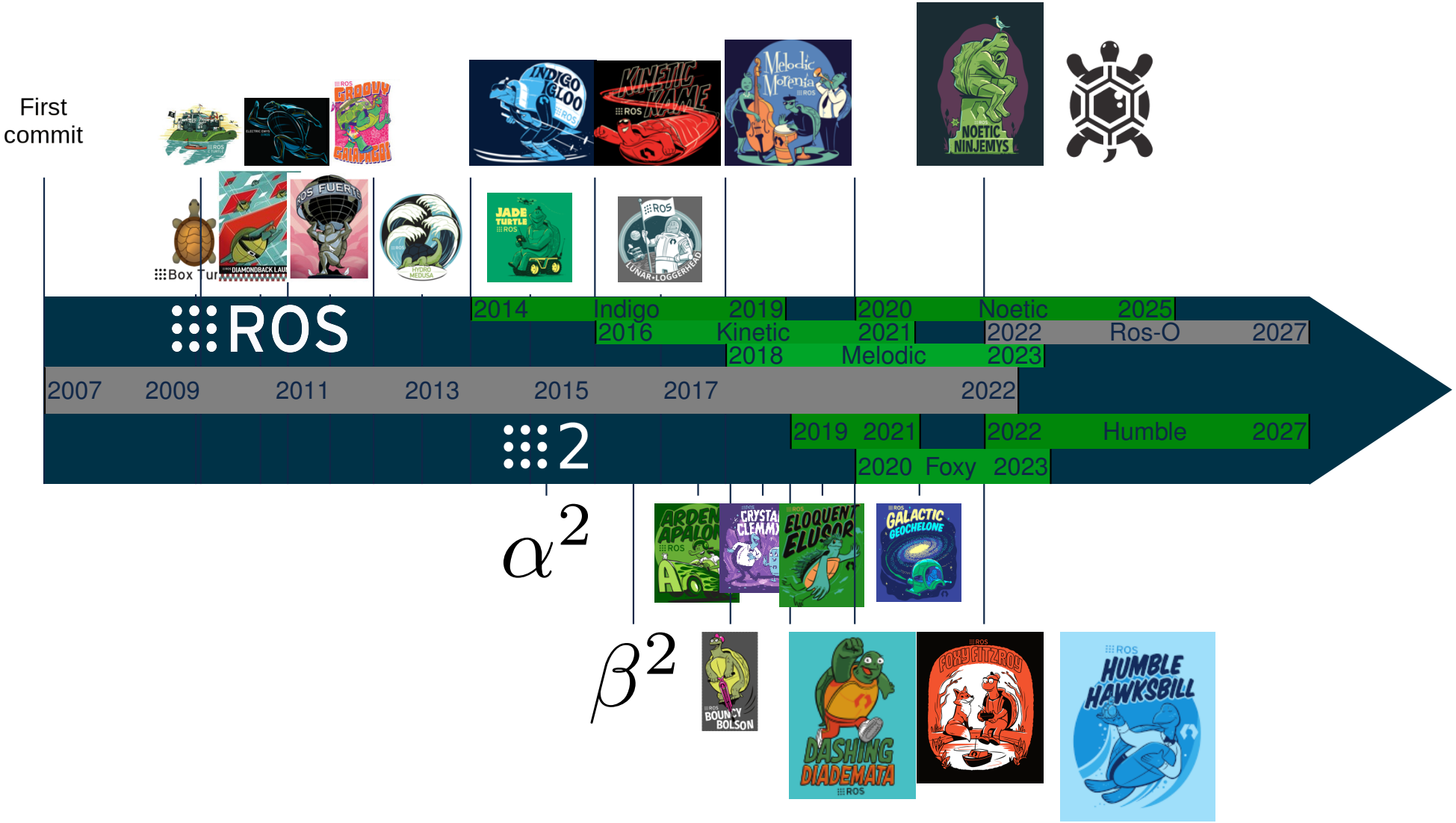
History of distributions - Long Term Support are what you want



In 2017: 200000 commits made by more than 2800 users

More than 2000 forks of `rosdistro` from package developpers

Running two nodes that should communicate

```
# publishes on /setpoint by default, needs a command line argument
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# needs a 'joint_name' parameter
ros2 run move_joint move_joint
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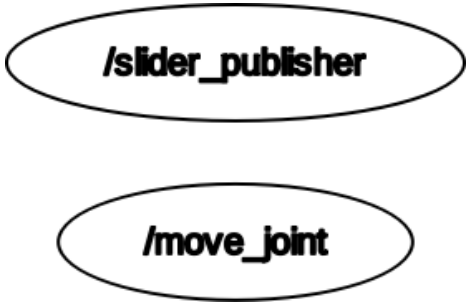


```
> ros2 wtf --report
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publisher count : 0
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topic : /setpoint
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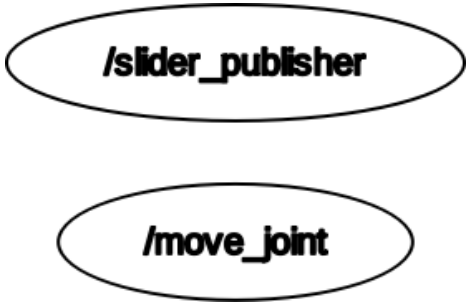


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Remappings are for nodes not made to work together

```
ros2 run slider_publisher slider_publisher ./slider_config.yaml

ros2 run move_joint --ros-args -r /joint_setpoint:=/setpoint -p joint_name:=right_e0
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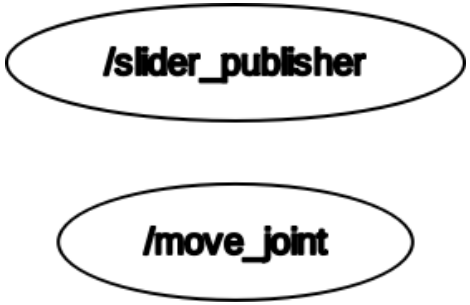


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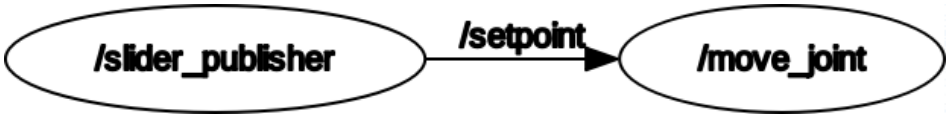

Any file in ROS belongs to a given package

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

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```xml
<?xml version="1.0"?>
<package format="3">
  <name>simulation_2d</name>
  <version>2.0.0</version>
  <description>The simulation2D package</description>
  <maintainer email="olivier.kermorgant@ec-nantes.fr">Olivier Kermorgant</maintainer>

  <license>MIT</license>
  <buildtool_depend>ament_cmake</buildtool_depend>

  <depend>geometry_msgs</depend>
  <depend>rclcpp</depend>
  <depend>sensor_msgs</depend>
  <depend>urdfdom</depend>

  <export>
    <build_type>ament_cmake</build_type>
  </export>
</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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> Home > code > ros2 > src > **ros2_nav_tutorial**

Name	Type
include	folder
launch	folder
cmd_sliders.yaml	YAML document
config.rviz	plain text document
joint_sliders.yaml	YAML document
sim_map_launch.py	Python script
spawn_launch.py	Python script
teleop_launch.py	Python script
test_spawn_launch.py	Python script
maps	folder
batS.pgm	PGM image
batS.yaml	YAML document
house.pgm	PGM image
house.yaml	YAML document
params	folder
param.yaml	YAML document
xbox.yaml	YAML document
src	folder
srv	folder
ChangeMode.srv	plain text document
urdf	folder
bb.xacro	XML document
d.xacro	XML document
robot.xacro	XML document
CMakeLists.txt	CMake source code
LICENSE	plain text document
package.xml	XML document
README.md	Markdown document

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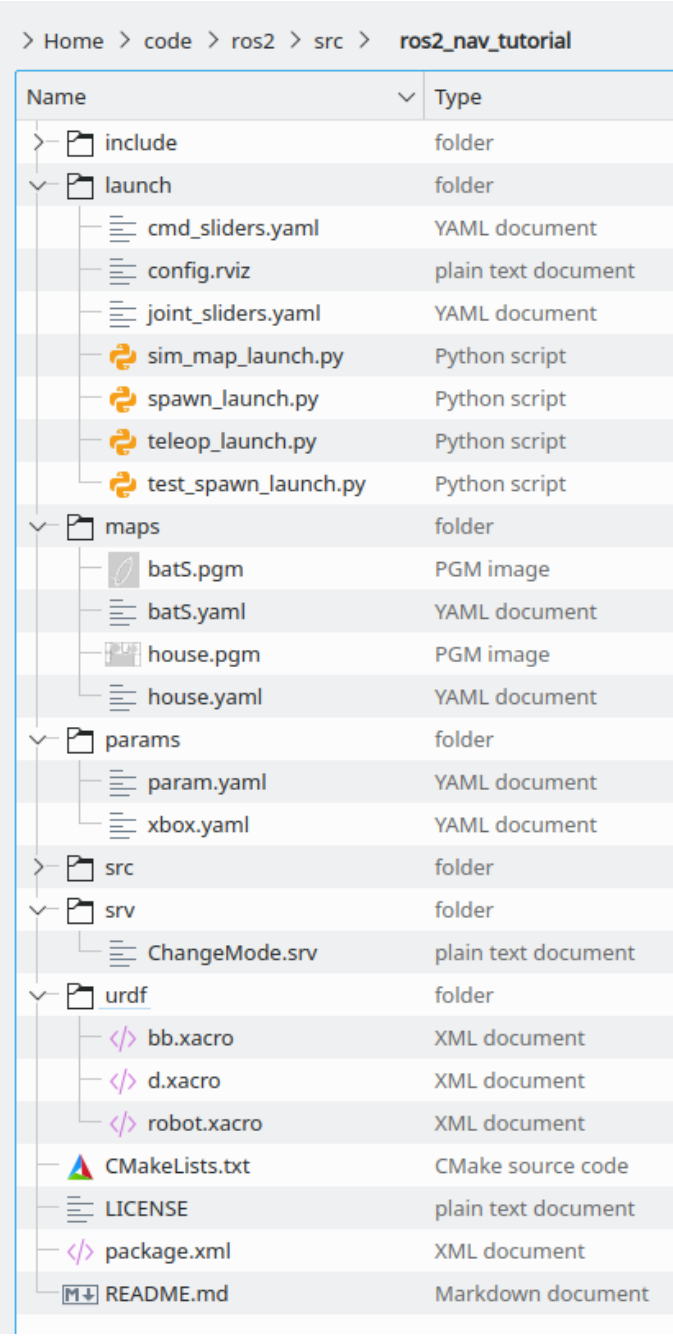

ROS launch files

- 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:
  - Substitutions
  - Load launch parameters from a YAML file
  - Conditionals / subcommands / lists
- 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="$(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="$(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="$(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'),
    ])
```

Basic launch file that runs 2 nodes without remapping

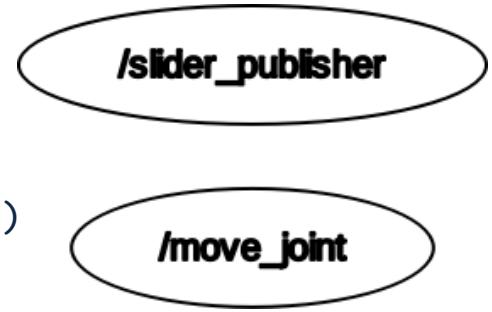
```
ros2 run slider_publisher slider_publisher # publishes on /setpoint
ros2 run move_joint move_joint # listens to /joint_setpoint
```

```python
from simple_launch import SimpleLauncher

def generate_launch_description():

    sl = SimpleLauncher()
    sl.node('slider_publisher', 'slider_publisher')
    sl.node('move_joint', 'move_joint')


    return sl.launch_description()
```



Basic launch file that runs 2 nodes with remapping

```
ros2 run slider_publisher slider_publisher path/to/slider_config.yaml
ros2 run move_joint move_joint --ros-args -r /joint_setpoint:=/setpoint -p joint_name:=right_e0
```

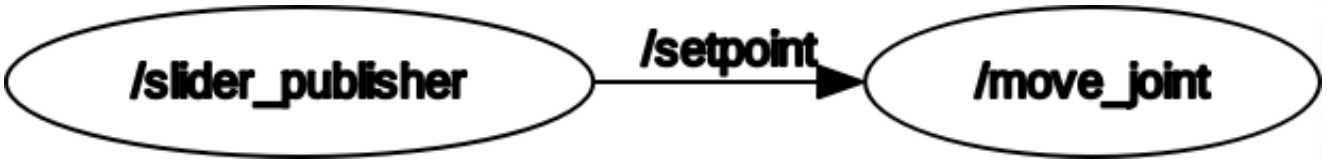
```python
from simple_launch import SimpleLauncher

def generate_launch_description():

    sl = SimpleLauncher()
    sl.node('slider_publisher', 'slider_publisher',
            arguments = [sl.find('my_pkg', 'slider_config.yaml')])

    sl.node('move_joint', 'move_joint',
            remappings={'/joint_setpoint': '/setpoint'},
            parameters={'joint_name': 'right_e0'})

    return sl.launch_description()
```



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

```python
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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                    name='listener')
            ],
    )
    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'))
```

Now for a few examples