# 02. Linux, ROS introduction

# Lecture

# Linux principles



- (Was) the only OS supported by ROS
- Security
- Efficieny
- Open-source
- Community support
- User freedom
- Distributions: **Ubuntu**, Linux Mint, Debian, etc.
- Terminal usage more dominant

# Suggestion

Install **Terminator** terminal emulator:

sudo apt update sudo apt install terminator

#### Linux commands

#### See some basic commands below:

- Run as administrator with sudo
- Manual of command man, e.g. man cp
- Package management apt, e.g. apt update, apt install
- Navigation cd
- List directory contents ls
- Create file touch
- Copy file cp
- Move file mv
- Remove file rm
- Make directory mkdir
- Remove directory rmdir
- Make a file executable chmod +x <filename>
- Safe restart: Crtl + Alt + PrtScr + REISUB
- If not sure, just google the command

#### $ROS 1 \rightarrow ROS 2$

- ROS 2 was rewritten from scratch
- More modular architecture
- Improved support for real-time systems
- Support for multiple communication protocols
- Better interoperability with other robotic systems
- Focus on standardization and industry collaboration
- No ROS Master
- No Devel space
- rclpy, rclcpp
- More structured code (Node class)

- Different build system
- Platforms: Windows, OS X, Linux

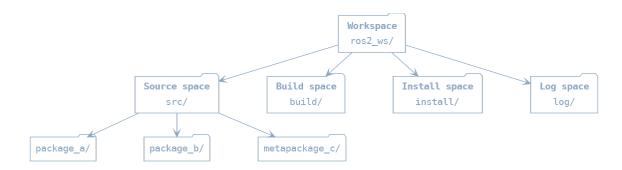
## ROS principles

#### **ROS** workspace



#### Colcon workspace

A folder where packages are modified, built, and installed.



- Source space:
  - Source code of colcon packages
  - Space where you can extract/checkout/clone source code for the packages you want to build
- · Build space
  - · Colcon is invoked here to build packages
  - Colcon and CMake keep intermediate files here
- Install space:
  - Each package will be installed here; by default each package will be installed into a separate subdirectory
- Log space:
  - Contains various logging information about each colcon invocation

#### ROS package principle

Enough functionality to be useful, but not too much that the package is heavyweight and difficult to use from other software.

## ROS dependencies

After cloning a new package, use the following command to install depenencies:

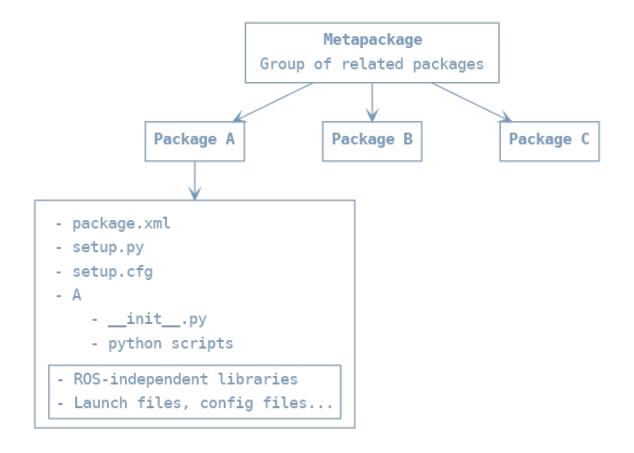
rosdep install --from-paths src --ignore-src -r -y

#### **ROS** package

- Main unit to organize software in ROS
- Buildable and redistributable unit of ROS code
- Consists of (in the case of Python packages):
  - package.xml file containing meta information about the package
    - name
    - version
    - description
    - dependencies
    - etc.
  - setup.py containing instructions for how to install the package
  - setup.cfg is required when a package has executables, so ros2 run can find them
  - /<package\_name> a directory with the same name as your package, used by ROS 2 tools to find your package, contains init .py
  - Anything else
- ros2 run turtlesim turtlesim\_node

## CMake

For CMake packages (C++), the package contents will be different.



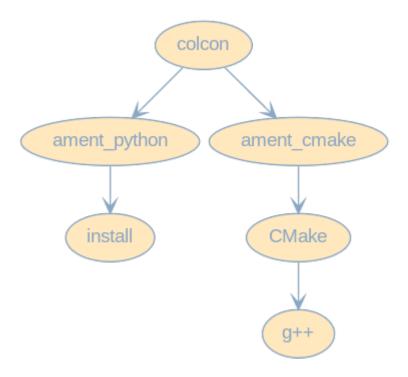
#### **ROS** node

- Executable part of ROS:
  - python scripts
  - compiled C++ code
- A process that performs computation
- Inter-node communication:
  - ROS topics (streams)
  - ROS parameter server
  - Remote Procedure Calls (RPC)
  - ROS services
  - ROS actions
- Meant to operate at a fine-grained scale
- Typically, a robot control system consists of many nodes, like:
  - Trajectory planning
  - Localization

- Read sensory data
- Process sensory data
- Motor control
- User interface
- etc.

### **ROS build system---Colcon**

• System for building software packages in ROS



### **Environmental setup file**

- setup.bash
- generated during init process of a new workspace
- extends shell environment
- ROS can find any resources that have been installed or built to that location

source ~/ros2\_ws/install/setup.bash

## Practice

#### 1: Turtlesim

1. Start turtlesim\_node and turtle\_teleop\_key nodes with the following commands, in separate terminal windows:

ros2 run turtlesim turtlesim node

ros2 run turtlesim turtle\_teleop\_key



In **Terminator**, you can further divide the given window with Ctrl-Shift-O, Ctrl-Shift-E key combinations. Ctrl-Shift-W closes the active window.

# Abort execution

Ctrl-C

2. Running the following ROS commands can provide useful information:

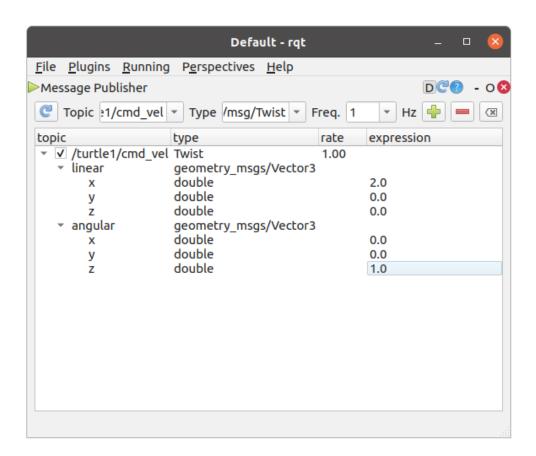
```
ros2 wtf
ros2 node list
ros2 node info /turtlesim
ros2 topic list
ros2 topic info /turtle1/cmd_vel
ros2 interface show geometry_msgs/msg/Twist
ros2 topic echo /turtle1/cmd_vel
```

3. Start rqt\_gui with the following command:

```
ros2 run rqt_gui rqt_gui
```

4. Display the running nodes and topics in  $rqt_gui$ : Plugins  $\rightarrow$  Introspection  $\rightarrow$  Node Graph.

5. Publish to the /turtle1/cmd\_vel topic also using rqt\_gui : Plugins  $\rightarrow$  Topics  $\rightarrow$  Message Publisher.



## 2: ROS 2 workspace creation

1. Let's create a new ROS2 workspace with the name ros2\_ws.

```
mkdir -p ~/ros2_ws/src
```

## 3: ROS 2 package creation

1. Let's create a new ROS2 package with the name <code>ros2\_course</code> and a Hello World.

cd ~/ros2\_ws/src
ros2 pkg create --build-type ament\_python --node-name hello ros2\_course



ros2 pkg create --build-type ament\_python <package\_name>

2. Build the workspace.

cd ~/ros2\_ws colcon build --symlink-install



The option --symlink-install links the source scripts to the Install space, so we don't have to build again after modification.

3. Insert the following line at the end of the ~/.bashrc file:

source ~/ros2\_ws/install/setup.bash

# Import to QtCreator

New file or project  $\rightarrow$  Other project  $\rightarrow$  ROS Workspace. Select Colcon as Build System and ros2\_ws as Workspace path.

# Import to CLion

Set the Python interpreter to Python 3.8, /usr/bin/python3 . Add the follwong path: /opt/ros/foxy/lib/python3.8/site-packages . Hozzuk létre a compile\_commands.json fájlt a ~/ros2 ws/build könyvtárban az alábbi tartalommal:

1

4. Test Hello World:

### 4: Implementing a Publisher in Python

1. Navigate to the ros2\_ws/src/ros2\_course/ros2\_course folder and create the talker.py file with the content below.

```
import rclpy
from rclpy.node import Node
from std_msgs.msg import String
class MinimalPublisher(Node):
  def __init__(self):
    super(). init ('minimal publisher')
    self.publisher = self.create publisher(String, 'chatter', 10)
    timer period = 0.5 # seconds
    self.timer = self.create_timer(timer_period, self.timer_callback)
    self.i = 0
  def timer callback(self):
    msg = String()
    msg.data = 'Hello World: %d' % self.i
    self.publisher_.publish(msg)
    self.get_logger().info('Publishing: "%s"' % msg.data)
    self.i += 1
def main(args=None):
  rclpy.init(args=args)
  minimal publisher = MinimalPublisher()
  rclpy.spin(minimal publisher)
  # Destroy the node explicitly
  # (optional - otherwise it will be done automatically
  # when the garbage collector destroys the node object)
  minimal publisher.destroy node()
  rclpy.shutdown()
if __name__ == '__main__':
  main()
```

2. Add a new entry point in the setup.py file:

```
'talker = ros2_course.talker:main',
```

1. Build and run the node:

```
cd ~/ros2_ws
colcon build --symlink-install
ros2 run ros2_course talker
```

2. Check the output of the node using ros2 topic echo command or rqt gui.

## 5: Implementing a Subscriber in Python

1. Navigate to the ros2\_ws/src/ros2\_course/ros2\_course folder and create the listener.py file with the content below.

```
import rclpy
from rclpy.node import Node
from std_msgs.msg import String
class MinimalSubscriber(Node):
  def __init__(self):
    super().\_init\_('minimal\_subscriber')
    self.subscription = self.create_subscription(
       String,
       'chatter',
       self.listener callback,
    self.subscription # prevent unused variable warning
  def listener callback(self, msg):
     self.get_logger().info('I heard msg: "%s"' % msg.data)
def main(args=None):
  rclpy.init(args=args)
  minimal subscriber = MinimalSubscriber()
  rclpy.spin(minimal subscriber)
  # Destroy the node explicitly
  # (optional - otherwise it will be done automatically
  # when the garbage collector destroys the node object)
  minimal_subscriber.destroy_node()
```

```
rclpy.shutdown()

if __name__ == '__main__':
    main()
```

2. Add a new entry point in the setup.py file:

```
'listener = ros2_course.listener:main',
```

3. Build and run both nodes:

```
cd ~/ros2_ws
colcon build --symlink-install
ros2 run ros2_course talker

ros2 run ros2_course listener
```

1. Use rqt\_gui to display the nodes and topics of the running system:

```
ros2 run rqt_gui rqt_gui
```

# Useful links

- ROS 2 Tutorials
- What is a ROS 2 package?