02. Linux and ROS principles

Theory

Linux principles

- 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
```

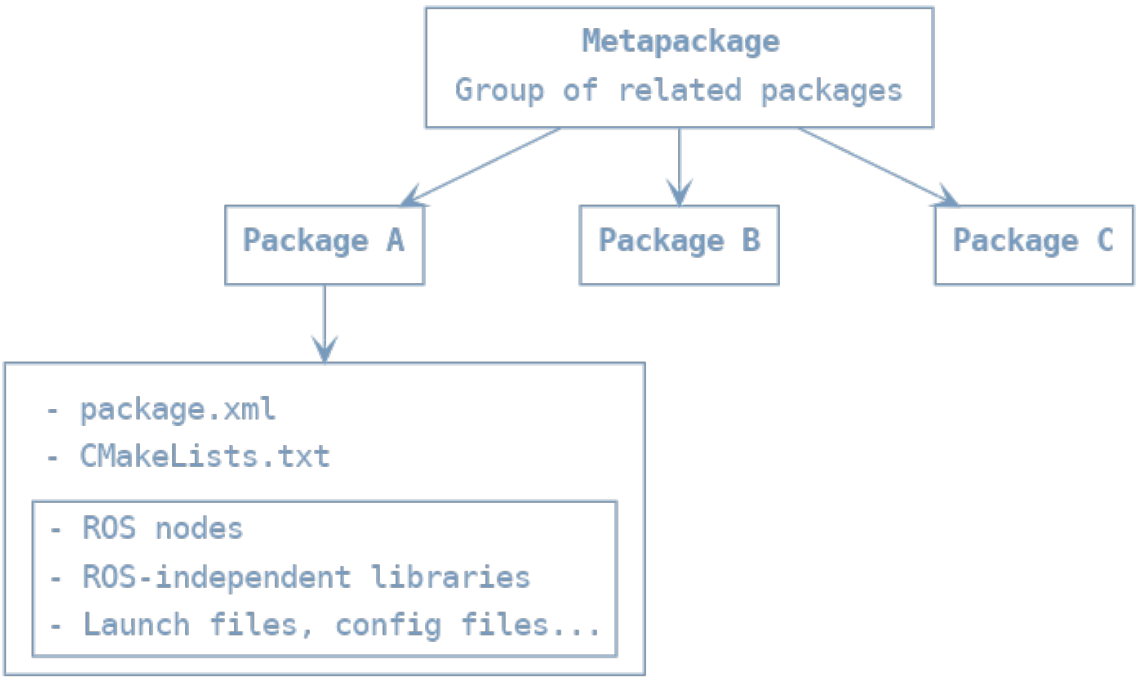
Linux commands

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`
- 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 principles

ROS file system



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 package

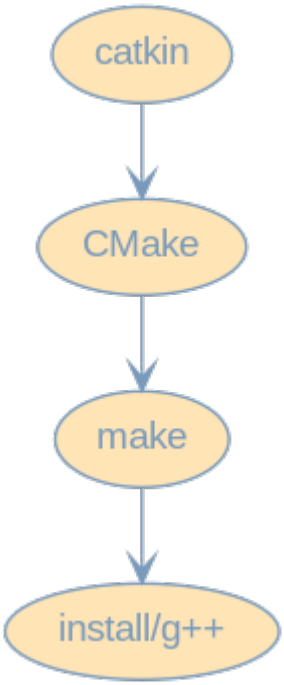
- Main unit to organize software in ROS
- Buildable and redistributable unit of ROS code
- Consosts of:
  - Manifest (package.xml): information about package
    - name
    - version
    - description
    - dependencies
    - etc.
  - CMakeLists.txt: *input for the CMake build system*
  - Anything else
- `rosrun turtlesim turtlesim_node`

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.

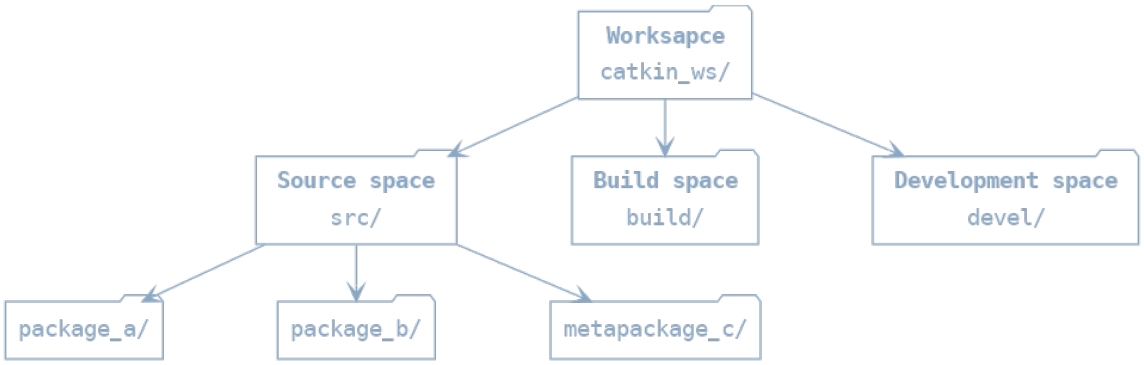
ROS build system---Catkin

- System for building software packages in ROS



ROS workspace

> **Catkin workspace**
>
> A folder where catkin packages are modified, built, and installed.



- Source space:
  - Source code of catkin packages
  - Space where you can extract/checkout/clone source code for the packages you want to build
- Build space
  - CMake is invoked here to build the catkin packages

    - CMake and catkin keep intermediate files here
- Devel space:
    - Built target are placed here prior to being installed

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 ~/catkin_ws/devel/setup.bash
```

ROS master

```
roscore
```

- Registers:
    - Nodes
    - Topics
    - Services
    - Parameters
- One per system
- `roslaunch` launches ROS master automatically

Gyakorlat

> **Warning!**
>
> At the end of the lesson, everybody must upload their **sources** to **Moodle** as a zip archive!

1: Turtlesim

1. Launch ROS master, `turtlesim_node` and `turtle_teleop_key` node by typing the following commands to separate terminal windows:

   > **Tip**
   >
   > In **Terminator**, `Ctrl-Shift-O` , `Ctrl-Shift-E` divides the terimal window, `Ctrl-Shift-W` closes the current window.

   ```
   roscore
   rosrun turtlesim turtlesim_node
   rosrun turtlesim turtle_teleop_key
   ```

   > **To stup running**
   >
   > `Ctrl-C`

2. Display the running nodes and topics using this command, in a separate terminal:

   ```
   rosrun rqt_graph rqt_graph
   ```

3. Try the following commands to gain more information about the currently running system:

   ```
   roswtf
   rospack list
   rospack find turtlesim
   rosnode list
   rosnode info
   rosnode info /turtlesim
   rostopic list
   rostopic info /turtle1/cmd_vel
   rosmsg show geometry_msgs/Twist
   rostopic echo /turtle1/cmd_vel
   ```

4. Type (or copy) the following command to the terminal:

```
rostopic pub /turtle1/cmd_vel geometry_msgs/Twist -r 1 -- '[2.0, 0.0, 0.0]' '[0.0, 0.0, 1.8]'
```

2: Catkin workspace

1. Install the catkin build tools package:

```
sudo apt update
sudo apt-get install python3-catkin-tools python3-osrf-pycommon
```

2. Copy the follwoing file to the end of file `~/.bashrc` :

```
source /opt/ros/noetic/setup.bash   # replace noetic by whatever your ROS distribution is
```

3. Create the workspace:

```
source /opt/ros/noetic/setup.bash
mkdir -p ~/catkin_ws/src
cd ~/catkin_ws
catkin init
```

3: Create a new ROS package

1. Create a new ROS package named `ros_course`, depends packages `std_msgs`, `rospy` and `roscpp`:

```
cd ~/catkin_ws/src
catkin create pkg ros_course --catkin-deps std_msgs rospy roscpp
```

> **Syntax**
>
> `catkin create pkg <PKG_NAME> --catkin-deps <DEP_1> <DEP_2>`

2. Open the file `package.xml` and fill the following tags:

```
<description>The beginner_tutorials package</description>

<maintainer email="you@yourdomain.tld">Your Name</maintainer>
```

3. Build the workspace:

```
cd ~/catkin_ws
catkin build
```

> **Danger**
>
> The commands `catkin build` and `catkin_make` are not meant to be used within the same workspace!

4. Append the following line to the file `~/.bashrc`:

```
source ~/catkin_ws/devel/setup.bash
```

4: Implement a Publisher in Python

1. Create folder named `scripts` in the `ros_course` package:

```
cd ~/catkin_ws/src/ros_course
mkdir scripts
cd scripts
```

2. Navigate to the `scripts` folder and create the file `talker.py`, fill it with the following content:

```
import rospy
from std_msgs.msg import String

def talker():
    rospy.init_node('talker', anonymous=True)
    pub = rospy.Publisher('chatter', String, queue_size=10)

    rate = rospy.Rate(10) # 10hz

    while not rospy.is_shutdown():
        hello_str = "hello world %s" % rospy.get_time()
```

```
        print(hello_str)
        pub.publish(hello_str)
        rate.sleep()


if __name__ == '__main__':
    try:
        talker()
    except rospy.ROSInterruptException:
        pass
```

3. Open `CMakeLists.txt` and find the commented out line starting with `catkin_install_python` (it is near line 167). Uncomment and edit as the following:

```
catkin_install_python(PROGRAMS scripts/talker.py
   DESTINATION ${CATKIN_PACKAGE_BIN_DESTINATION}
)
```

4. Build the node:

```
cd ~/catkin_ws
catkin build
```

5. Start ROS master and run the node. In separate terminal windows:

```
roscore
```

```
rosrun ros_course talker.py
```

6. Check the output of the node, in a separate terminal:

```
rostopic echo chatter
```

5: Implement a Subscriber in Python

1. Navigate to the `scripts` folder and create the file `listener.py`:

```
import rospy
from std_msgs.msg import String

def callback(data):
```

```
    print(rospy.get_caller_id() + "I heard " + data.data)

def listener():

    # In ROS, nodes are uniquely named. If two nodes with the same
    # name are launched, the previous one is kicked off. The
    # anonymous=True flag means that rospy will choose a unique
    # name for our 'listener' node so that multiple listeners can
    # run simultaneously.
    rospy.init_node('listener', anonymous=True)

    rospy.Subscriber("chatter", String, callback)

    # spin() simply keeps python from exiting until this node is stopped
    rospy.spin()



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

2. Modify `CMakeLists.txt`:

```
catkin_install_python(PROGRAMS scripts/talker.py scripts/listener.py
    DESTINATION ${CATKIN_PACKAGE_BIN_DESTINATION}
)
```

3. Build the workspace:

```
cd ~/catkin_ws
catkin build
```

4. Start ROS master and run the 2 nodes. In separate terminal windows:

```
roscore
```

```
rosrun ros_course talker.py
```

```
rosrun ros_course listener.py
```

5. Check the nodes and topic of the system:

```
rosrun rqt_graph rqt_graph
```

Warning!

At the end of the lesson, everybody must upload their **sources** to **Moodle** as a zip archive!

Links

- ROS Tutorials
- Curiosity rover simulation