

Introduction to ROS

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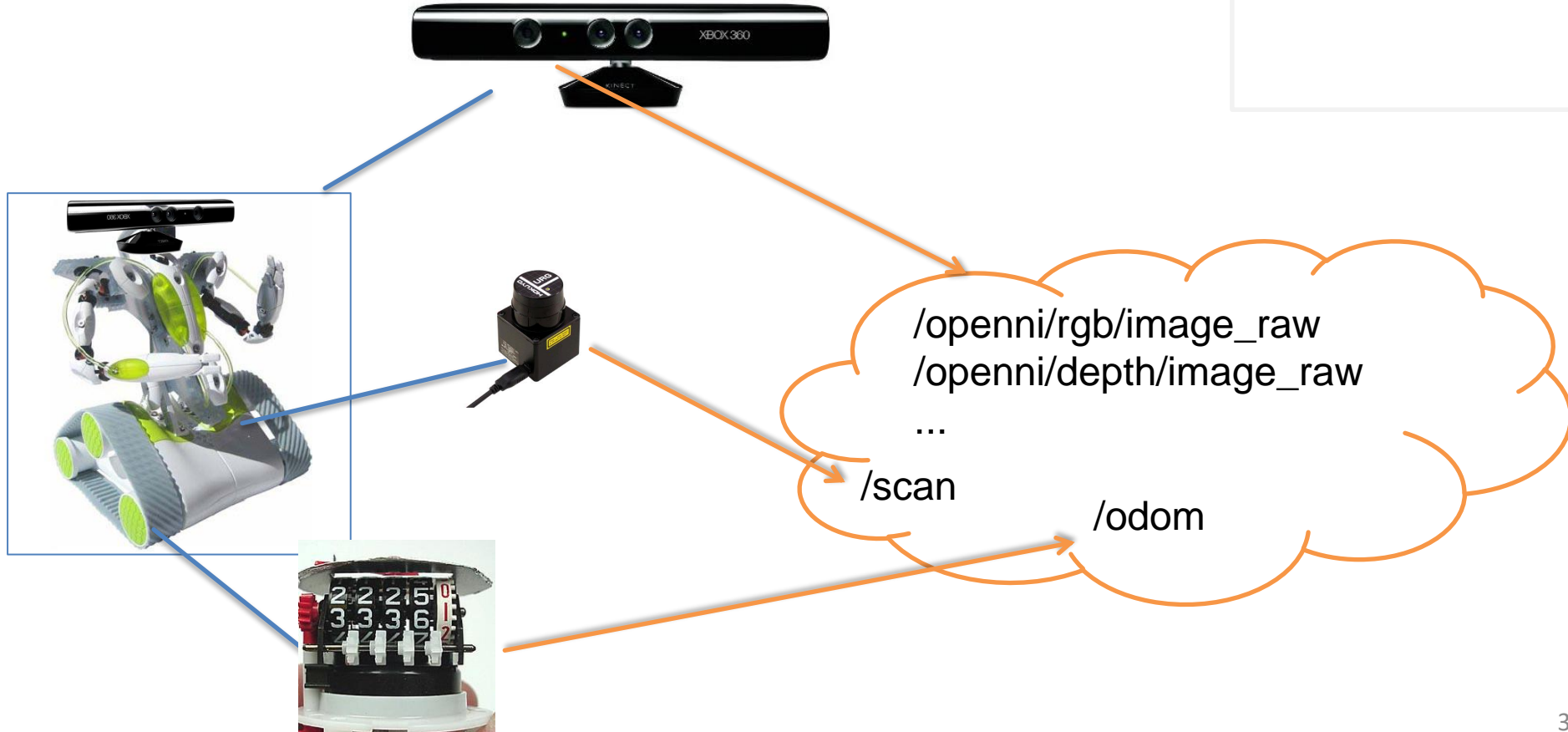
A middle-ware for robots

- ▶ Open-source, C++ and Python
- ▶ Framework
- ▶ Unified communication patterns
- ▶ Drivers, Hardware abstraction
- ▶ Contributors from all over the world

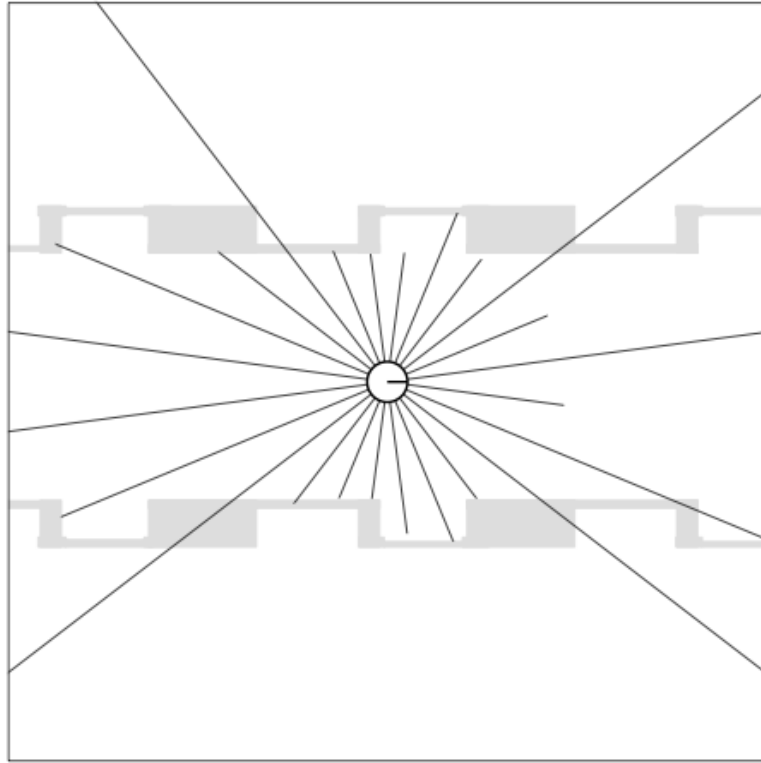
<http://www.ros.org/>

Tutorials: <http://www.ros.org/wiki/ROS/Tutorials>

ROS: Topics



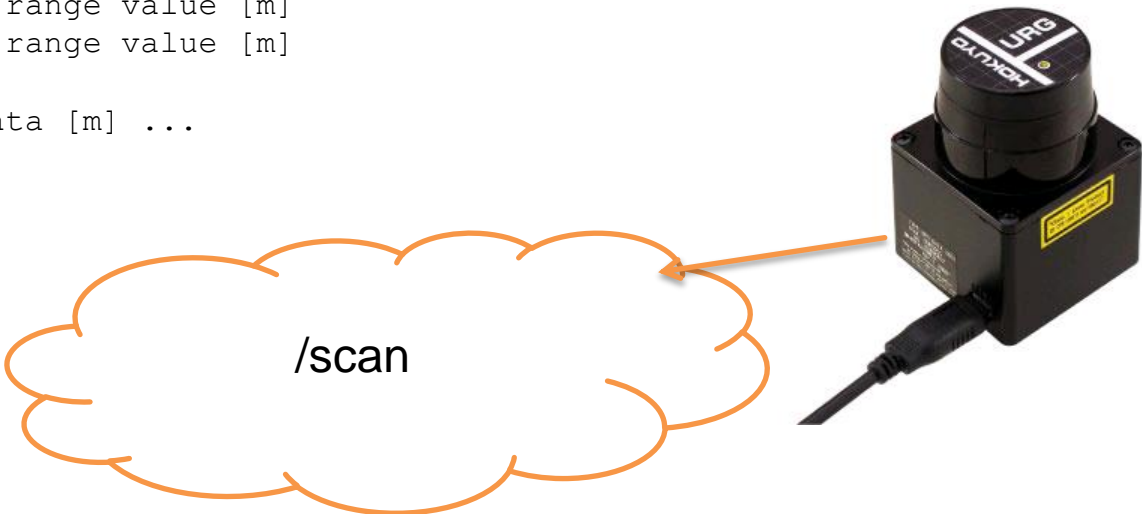
Example: Laser Scanner



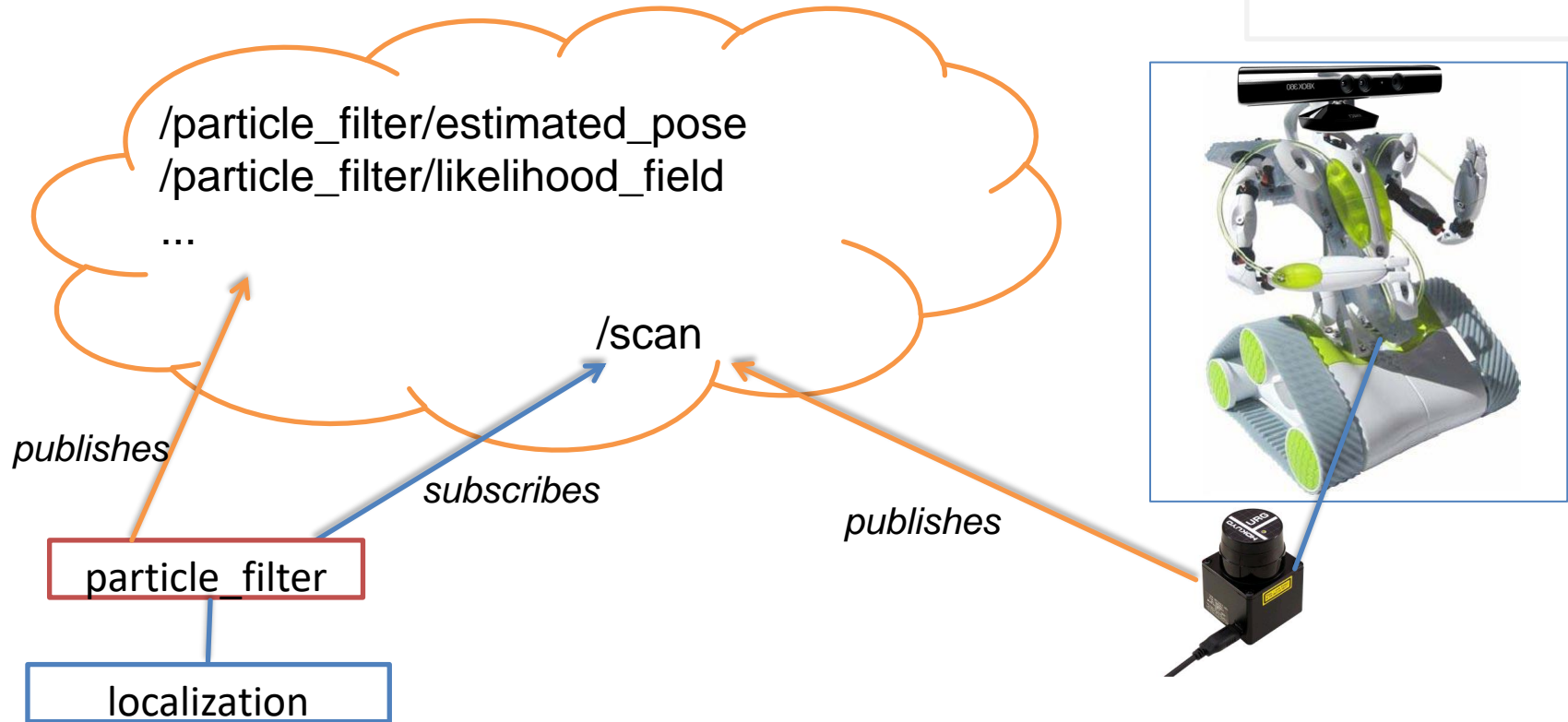
ROS: Messages

http://www.ros.org/doc/api/sensor_msgs/html/msg/LaserScan.html:

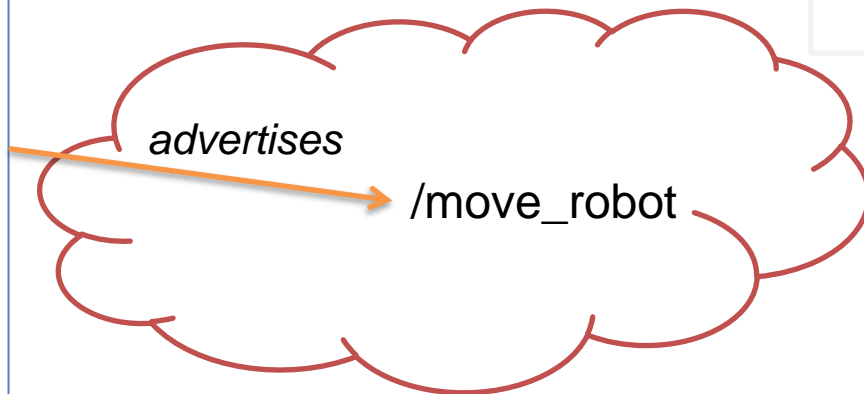
```
# ...  
float32 angle_min      # start angle of the scan [rad]  
float32 angle_max      # end angle of the scan [rad]  
float32 angle_increment # angular distance between  
                        # measurements [rad]  
  
float32 range_min      # minimum range value [m]  
float32 range_max      # maximum range value [m]  
  
float32[] ranges        # range data [m] ...
```



ROS: Subscribing to Topics



ROS: Services

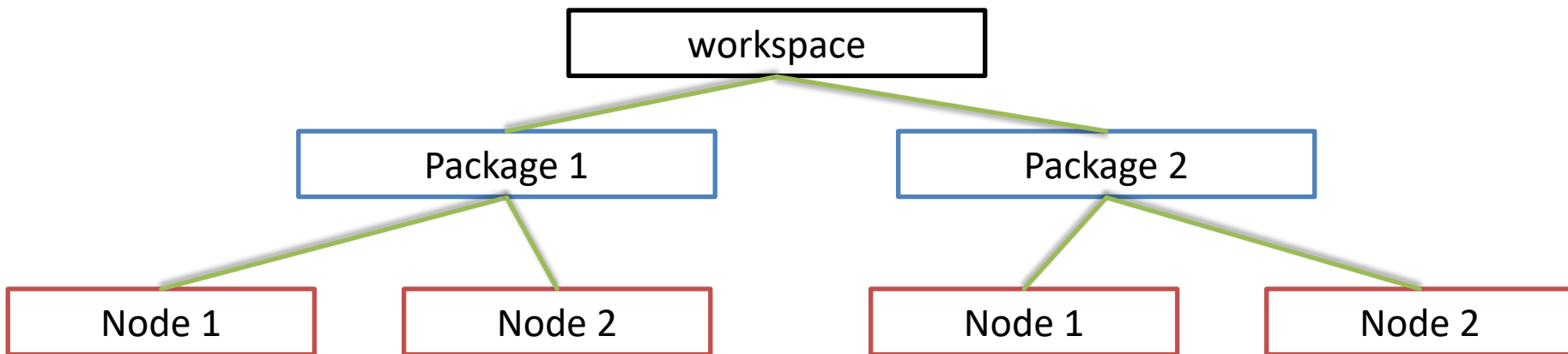


```
user@pc$:~/ rosservice call /move_robot 5.4 3.0
```

- Services are very similar to messages
- „Remote procedure call“: Services can have return values

ROS: Structural concepts

- ▶ A **package** contains **nodes**, **messages**, and **services**
- ▶ A **node** publishes+subscribes to topics, offers+calls services
- ▶ [A **workspace** contains packages (and meta-packages)]



Installing ROS on your computer

- ▶ Ubuntu 20.04.:
<http://wiki.ros.org/noetic/Installation>
 - Option: desktop-full
- ▶ The Virtualbox image comes with ROS noetic preinstalled
- ▶ Installing additional packages:
 - `sudo apt-get update`
 - `sudo apt-get install ros-noetic-navigation ros-noetic-slam-gmapping ros-noetic-rviz ros-noetic-roslib libwxgtk3.0-de`

Using a ROS Workspace

- ▶ Get our ROS workspace from ISIS2 and unpack it locally (e.g. in `/home/user/ws_assignment4`)
- ▶ Setup your workspace with:
 - `catkin_make`
(catkin is a wrapper for `cmake`)
- ▶ Setup your shell to use the workspace:
 - `source devel/setup.sh`
(you can also append this to your `~/.bashrc`)
- ▶ see also:
<http://www.ros.org/wiki/ROS/Tutorials/InstallingandConfiguringROSEnvironment>
- ▶ Build all packages in your Workspace:
 - `catkin_make`

ROS Commands



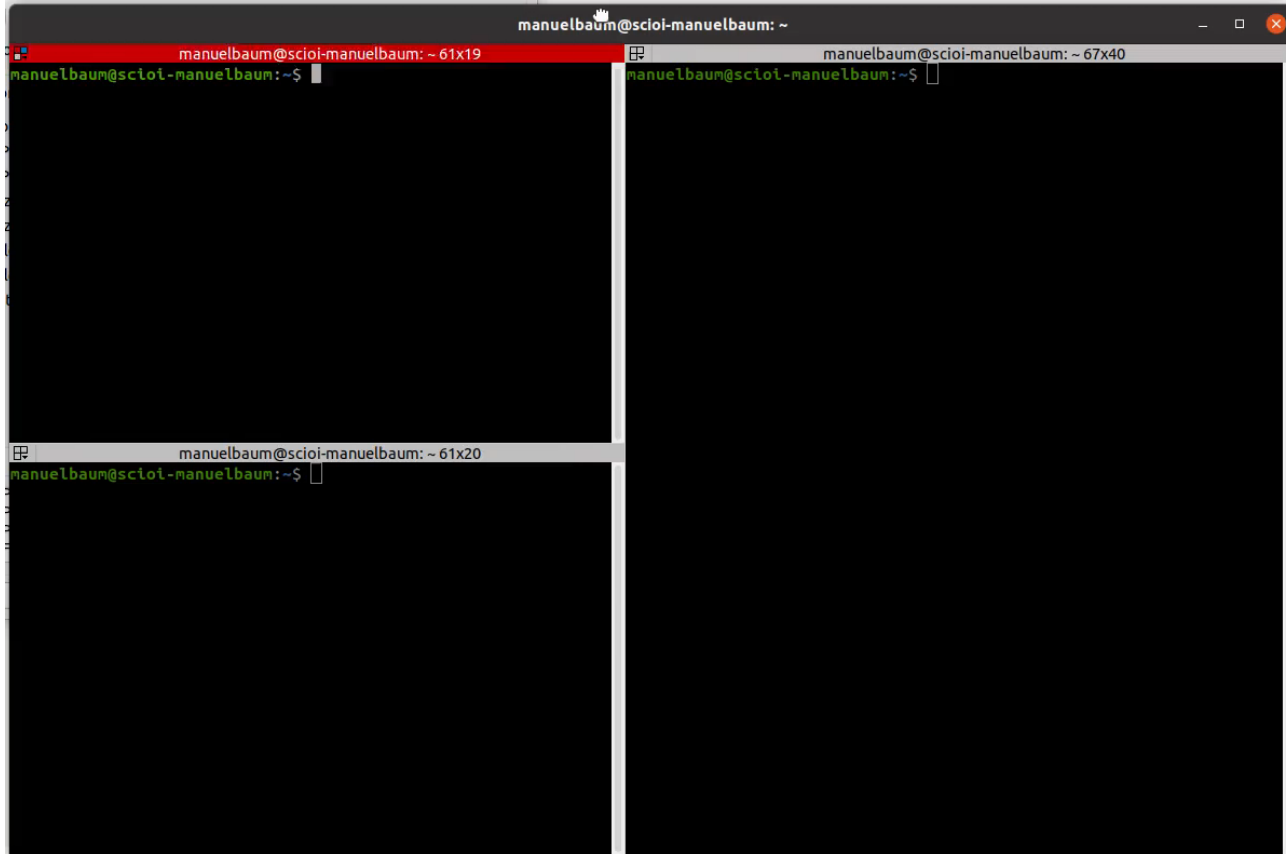
<http://wiki.ros.org/>

<http://wiki.ros.org/ROS/Tutorials>

How to start a ROS network

- ▶ Start server with `roscore`
- ▶ Nodes connect to the roscore at `$ROS_MASTER_URI`
 - Default: <http://localhost:11311>
 - But you can also connect multiple machines!
- ▶ `roslaunch`: run a node (executable) from a certain package
- ▶ `roslaunch turtlesim turtlesim_node`

ROS Commands Executed Part 1



The screenshot shows a terminal window titled "manuelbaum@scioi-manuelbaum: ~" with three tabs. The first tab, titled "manuelbaum@scioi-manuelbaum: ~ 61x19", shows the command `roscd` being executed, resulting in the output `/home/manuelbaum/catkin_ws/src`. The second tab, titled "manuelbaum@scioi-manuelbaum: ~ 67x40", shows the command `catkin config --install` being executed, resulting in the output `catkin config --install`. The third tab, titled "manuelbaum@scioi-manuelbaum: ~ 61x20", shows the command `catkin config --install` being executed, resulting in the output `catkin config --install`.

```
manuelbaum@scioi-manuelbaum: ~  
manuelbaum@scioi-manuelbaum: ~ 61x19  
manuelbaum@scioi-manuelbaum:~$ roscd  
/home/manuelbaum/catkin_ws/src  
manuelbaum@scioi-manuelbaum:~$  
manuelbaum@scioi-manuelbaum: ~ 67x40  
manuelbaum@scioi-manuelbaum:~$ catkin config --install  
catkin config --install  
manuelbaum@scioi-manuelbaum:~$  
manuelbaum@scioi-manuelbaum: ~ 61x20  
manuelbaum@scioi-manuelbaum:~$ catkin config --install  
catkin config --install  
manuelbaum@scioi-manuelbaum:~$
```

ROS Messages

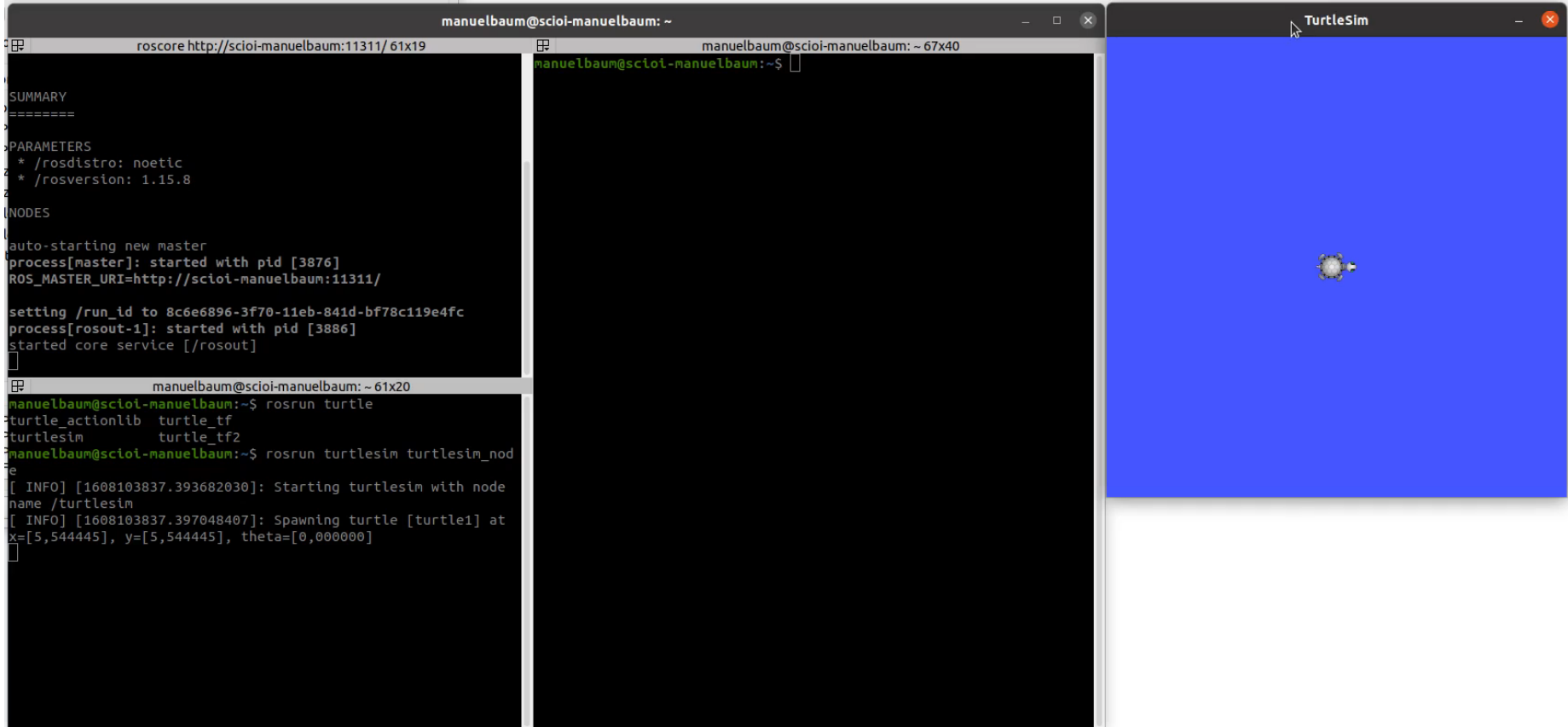
▶ rostopic

- list: Display a list of current topics
- echo <topic-name> : Display messages
 - `rostopic echo /turtle1/pose/`
- info <topic-name> : Display general information
 - `rostopic info /turtle1/pose/`

▶ rosmmsg

- show <msg-name> : Display a message definition
 - `rosmmsg show turtlesim/Pose`

ROS Commands Executed Part 2



The image shows a ROS environment setup. On the left, a terminal window titled 'manuelbaum@scioi-manuelbaum: ~' displays the output of 'roscore http://scioi-manuelbaum:11311/ 61x19'. It shows the start of a new master, setting of run_id, and starting of core services. Below it, another terminal window shows the execution of 'roslaunch turtle turtlesim' and 'roslaunch turtlesim turtlesim_node', which starts the turtlesim node with a specific name and spawns a turtle named 'turtle1' at a specific position and orientation. On the right, a window titled 'TurtleSim' shows a blue background with a small robot icon (turtle1) in the center.

```
manuelbaum@scioi-manuelbaum: ~
roscore http://scioi-manuelbaum:11311/ 61x19
SUMMARY
=====
PARAMETERS
* /roscore: noetic
* /roscore: 1.15.8
NODES
auto-starting new master
process[master]: started with pid [3876]
ROS_MASTER_URI=http://scioi-manuelbaum:11311/

setting /run_id to 8c6e6896-3f70-11eb-841d-bf78c119e4fc
process[roscout-1]: started with pid [3886]
started core service [/roscout]

manuelbaum@scioi-manuelbaum: ~ 61x20
manuelbaum@scioi-manuelbaum:~$ roslaunch turtle
turtle_actionlib turtle_tf
turtlesim turtlesim
manuelbaum@scioi-manuelbaum:~$ roslaunch turtlesim turtlesim_node
[ INFO ] [1608103837.393682030]: Starting turtlesim with node
name /turtlesim
[ INFO ] [1608103837.397048407]: Spawning turtle [turtle1] at
x=[5,544445], y=[5,544445], theta=[0,000000]
```

ROS Service

► **rosservice**

(service counterpart to rostopic)

- list: Display a list of available services
- call <srv-name> <params>: Call a ROS service
 - `rosservice call /turtle1/teleport_relative 3.0 1.0`

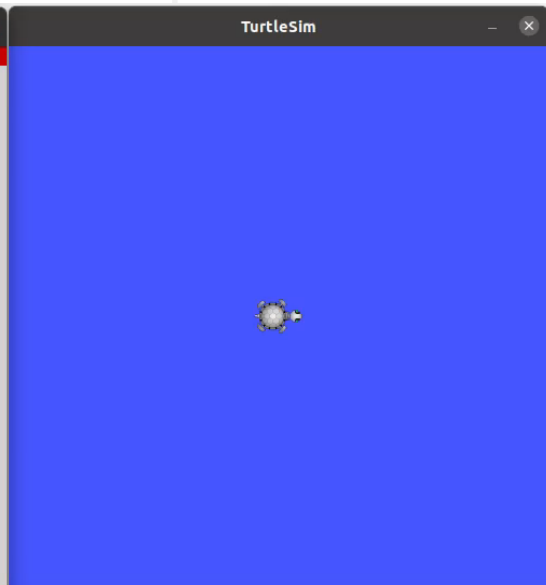
► **rossrv**

(service counterpart to rosmmsg)

- show <srv-name>: Display a service definition
 - `rossrv show turtlesim/TeleportRelative`

ROS Commands Executed Part 3

```
manuelbaum@scioi-manuelbaum: ~  
roscore http://scioi-manuelbaum:11311/ 61x19  
SUMMARY  
=====  
PARAMETERS  
* /roscore: noetic  
* /roscore: 1.15.8  
NODES  
auto-starting new master  
process[roscore]: started with pid [3876]  
ROS_MASTER_URI=http://scioi-manuelbaum:11311/  
setting /run_id to 8c6e6896-3f70-11eb-841d-bf78c119e4fc  
process[roscore-1]: started with pid [3886]  
started core service [/roscore]  
manuelbaum@scioi-manuelbaum: ~ 61x20  
manuelbaum@scioi-manuelbaum:~$ roslaunch turtle  
turtle_actionlib turtle_tf  
turtlesim turtlesim  
manuelbaum@scioi-manuelbaum:~$ roslaunch turtlesim turtlesim_node  
[ INFO ] [1608103837.393682030]: Starting turtlesim with node  
name /turtlesim  
[ INFO ] [1608103837.397048407]: Spawning turtle [turtle1] at  
x=[5,544445], y=[5,544445], theta=[0,000000]  
manuelbaum@scioi-manuelbaum: ~ 67x40  
y: 5.544444561004639  
theta: 0.0  
linear_velocity: 0.0  
angular_velocity: 0.0  
---  
x: 5.544444561004639  
y: 5.544444561004639  
theta: 0.0  
linear_velocity: 0.0  
angular_velocity: 0.0  
---  
x: 5.544444561004639  
y: 5.544444561004639  
theta: 0.0  
linear_velocity: 0.0  
angular_velocity: 0.0  
---  
x: 5.544444561004639  
y: 5.544444561004639  
theta: 0.0  
linear_velocity: 0.0  
angular_velocity: 0.0  
---  
x: 5.544444561004639  
y: 5.544444561004639  
theta: 0.0  
linear_velocity: 0.0  
angular_velocity: 0.0  
---  
^Cmanuelbaum@scioi-manuelbaum:~$ rostopic info /turtle1/pose  
Type: turtlesim/Pose  
Publishers:  
* /turtlesim (http://scioi-manuelbaum:37765/)  
Subscribers: None  
manuelbaum@scioi-manuelbaum:~$ rostopic show turtlesim/Pose  
float32 x  
float32 y  
float32 theta  
float32 linear_velocity  
float32 angular_velocity  
manuelbaum@scioi-manuelbaum:~$
```



ROS File System Tools

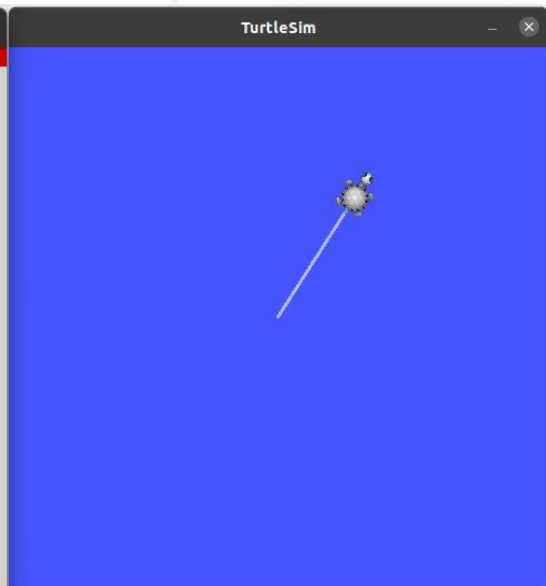
▶ **roscd**

- Jump immediately to a package/stack directory

roscd stack-or-package[/subdir]

ROS Commands Executed Part 4

```
manuelbaum@scioi-manuelbaum: ~  
roscore http://scioi-manuelbaum:11311/ 61x19  
SUMMARY  
=====  
PARAMETERS  
* /roscore: noetic  
* /rosversion: 1.15.8  
NODES  
auto-starting new master  
process[roscore]: started with pid [3876]  
ROS_MASTER_URI=http://scioi-manuelbaum:11311/  
setting /run_id to 8c6e6896-3f70-11eb-841d-bf78c119e4fc  
process[roscore-1]: started with pid [3886]  
started core service [/roscore]  
manuelbaum@scioi-manuelbaum: ~ 61x20  
manuelbaum@scioi-manuelbaum:~$ roslaunch turtle  
turtle_actionlib turtle_tf  
turtlesim turtlesim  
manuelbaum@scioi-manuelbaum:~$ roslaunch turtlesim turtlesim_node  
[ INFO ] [1608103837.393682030]: Starting turtlesim with node  
name /turtlesim  
[ INFO ] [1608103837.397048407]: Spawning turtle [turtle1] at  
x=[5,544445], y=[5,544445], theta=[0,000000]  
manuelbaum@scioi-manuelbaum: ~ 67x40  
* /turtlesim (http://scioi-manuelbaum:37765/)  
Subscribers: None  
manuelbaum@scioi-manuelbaum:~$ rostopic show turtlesim/Pose  
float32 x  
float32 y  
float32 theta  
float32 linear_velocity  
float32 angular_velocity  
manuelbaum@scioi-manuelbaum:~$ rosservice list  
/clear  
/kill  
/reset  
/roscore/get_loggers  
/roscore/set_logger_level  
/spawn  
/turtle1/set_pen  
/turtle1/teleport_absolute  
/turtle1/teleport_relative  
/turtlesim/get_loggers  
/turtlesim/set_logger_level  
manuelbaum@scioi-manuelbaum:~$ rosservice info /turtle1/teleport_re  
lative  
Node: /turtlesim  
URI: rosrpc://scioi-manuelbaum:44413  
Type: turtlesim/TeleportRelative  
Args: linear angular  
manuelbaum@scioi-manuelbaum:~$ rossrv show turtlesim/TeleportRelati  
ve  
float32 linear  
float32 angular  
---  
manuelbaum@scioi-manuelbaum:~$ rosservice call /turtle1/teleport_re  
lative 3.0 1.0  
manuelbaum@scioi-manuelbaum:~$
```



ROS Tools

- ▶ **roslaunch**: launches a set of nodes
 - defined by an XML configuration file
 - `roslaunch [<node>] <launch-file>`
 - *roscore* is started automatically (if not yet running)
- ▶ **catkin_make**: is a tool aware of ros packages dependencies
- ▶ **rosparam**: enables getting and setting parameter server values

ROS logging

- ▶ Log files are called *bag files*
- ▶ **rosbag play <file>**
 - Pause playing with space key and stepping with s
- ▶ **rosbag record <topic-names>**
 - will generate a ".bag" file
 - Use option -a to record all topics

That's it!



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

<http://wiki.ros.org/ROS/Tutorials>