



## Contents

Table of Figures .....	5
<b>ROS TERMS .....</b>	<b>6</b>
<b>TURTLESIM PACKAGE .....</b>	<b>7</b>
<b>rospack List Packages.....</b>	<b>7</b>
<b>rospack help.....</b>	<b>8</b>
<b>ROSCORE.....</b>	<b>9</b>
<b>CREATE A TOPIC AND A MESSAGE.....</b>	<b>10</b>
<b>Create a Topic /hello and A String Message with rostopic pub.....</b>	<b>10</b>
<b>New Topic /hello from rostopic list .....</b>	<b>10</b>
<b>Data for Topic /hello- message .....</b>	<b>10</b>
<b>New Node caused by rostopic pub .....</b>	<b>10</b>
<b>Node Information.....</b>	<b>11</b>
<b>Kill A Node.....</b>	<b>11</b>
<b>ROS NODES, TOPICS, AND SERVICES USING TURTLESIM .....</b>	<b>12</b>
<b>roscnode, rostopic help .....</b>	<b>13</b>
<b>TURTLESIM NODE .....</b>	<b>14</b>
<b>ROS Nodes with Turtlesim .....</b>	<b>14</b>
<b>roscnode list .....</b>	<b>14</b>
<b>TURTLESIM NODE TOPICS AND MESSAGES .....</b>	<b>15</b>
<b>Messages.....</b>	<b>16</b>
<b>PARAMETER SERVER.....</b>	<b>18</b>
<b>roscparam help.....</b>	<b>18</b>
<b>roscparam list for turtlesim node .....</b>	<b>18</b>
<b>change parameters for color of turtle background .....</b>	<b>19</b>
<b>roscparam get .....</b>	<b>19</b>
<b>roscparam set .....</b>	<b>19</b>
<b>roscparam get turtlesim parameters.....</b>	<b>20</b>
<b>ROS SERVICES TO MOVE TURTLE .....</b>	<b>21</b>
<b>teleport_absolute .....</b>	<b>21</b>
<b>teleport_relative.....</b>	<b>21</b>
<b>MAKE TURTLE RUN IN A CIRCLE WITH TURTLESIM.....</b>	<b>24</b>
<b>type of message for cmd_vel.....</b>	<b>24</b>
<b>MOVE TURTLE ONCE .....</b>	<b>25</b>

rostopic hz .....	27
rostopic hz /turtle1/pose.....	27
rqt_plot.....	28
<b>ENABLE KEYBOARD CONTROL OF TURTLE .....</b>	<b>30</b>
rosrun turtlesim turtle_teleop_key.....	30
New Node /teleop_turtle .....	30
Node /turtlesim after /teleop_turtle .....	31
Determine data from Topic /turtle1/cmd_vel in Indigo.....	34
To find turtle’s position in window use /turtle1/pose .....	35
Clear the screen .....	36
rqt_graph .....	36
<b>PYTHON and TURTLESIM .....</b>	<b>38</b>
LETS CONTROL THE TURTLE- Publish to /turtle1/cmd_vel:.....	38
<b>ROSBAG.....</b>	<b>40</b>
rosbag help.....	40
rosbag help.....	40
rosbag info .....	42
rosbag play.....	43
Recording a subset of the data.....	45
To name the bag file and selectively record .....	46
The limitations of rosbag record/play .....	47
<b>APPENDIX I. REFERENCES.....</b>	<b>48</b>
<b>GETTING STARTED WITH TURTLESIM.....</b>	<b>48</b>
<i>GENTLE INTRODUCTION O’KANE CHAPTER 2 .....</i>	<i>48</i>
<b>TUTORIALS USING TURTLESIM – A LIST .....</b>	<b>48</b>
<b>ROS CONCEPTS.....</b>	<b>48</b>
<b>ROSCORE .....</b>	<b>48</b>
<b>ROS MASTER.....</b>	<b>48</b>
Clearpath diagram of Master .....	48
<b>ROS NODES AND TURTLESIM .....</b>	<b>48</b>
<b>ROS TOPICS AND TURTLESIM .....</b>	<b>49</b>
<b>ROSSERVICE .....</b>	<b>49</b>
<b>ROSSERVICE AND ROS SERVICE PARAMETERS.....</b>	<b>49</b>
<b>ROSSERVICE AND ROS TELEPORT PARAMETER .....</b>	<b>49</b>
<b>USING RQT_PLOT, RQT_CONSOLE AND ROSLAUNCH WITH TURTLESIM.....</b>	<b>49</b>
<a href="http://wiki.ros.org/rqt_plot">http://wiki.ros.org/rqt_plot</a> .....	49

<b>ROSBAG TURTLESIM EXAMPLE</b> .....	49
<b>TURTLESIM EXAMPLE</b> .....	49
<b>DATA LOGGING USING ROSBAG</b> .....	49
<b>INTRODUCTION TO TF AND TURTLESIM</b> .....	49
<b>YAML Command LINE</b> .....	50
<b>APPENDIX II. TURTLESIM MANIFEST (PACKAGE.XML)</b> .....	51
<b>APPENDIX III. TURTLESIM DIRECTORIES AND FILES</b>	
<b>tlharmanphd@D125-43873:~\$ locate turtlesim</b> .....	52
<b>APPENDIX 1V. INDIGO VS GROOVY</b> .....	55
<b>APPENDIX V. TURTLESIM CHEATSHEET</b> .....	56

## Table of Figures

Figure 1 ROSCORE Command .....	9
Figure 2 Turtlesim Window .....	14
Figure 3 Turtlesim Window Color Change .....	19
Figure 4 Turtle After Absolute Move .....	21
Figure 5 Turtle After Relative Move .....	22
Figure 6 Turtle Running in A Circle .....	26
Figure 7 Selection of Plotting for rqt_plot .....	28
Figure 8 Plot of /turtle1/pose/x and /pose/y .....	29
Figure 9 Turtlesim After Moving .....	32
Figure 10 Four Turtlesim Windows using Terminator .....	33
Figure 11 Turtle responds to published topic .....	35
Figure 12 Turtlesim graph showing communication .....	36
Figure 13 RQT_GRAPH for /turtlesim .....	37
Figure 14 Windows for turtlesim .....	41
Figure 15 Turtle moved with keyboard keys with rosbag recording .....	42
Figure 16 Turtle Replay of rosbag data .....	44
Figure 17 Turtle rosbag replay at 2x speed .....	45
Figure 18 Turtle moving with subset of rosbag data .....	47

## ROS TERMS

Before a beginner even opens a web tutorial or book or sees a ROS video, it is helpful to learn a few terms that pertain to ROS. These terms describe the main components of a ROS system.

Table 1. ROS Useful Terms		
Item	Type	Comment
Repositories	A <b>software repository</b> is a storage location from which <a href="#">software packages</a> may be retrieved and installed on a computer.	<a href="http://en.wikipedia.org/wiki/Software_repository">http://en.wikipedia.org/wiki/Software_repository</a>  GitHub is used to download the ROS packages used by the Baxter system: <a href="http://sdk.rethinkrobotics.com/wiki/Workstation_Setup">http://sdk.rethinkrobotics.com/wiki/Workstation_Setup</a>
Packages	Contains files to allow execution of ROS programs	A package typically contains source files and executable scripts that can be BASH, Python, or other code.
Manifest Package.xml	Information about a package	The manifest defines properties about the package such as the package name, version numbers, authors, maintainers, and dependencies on other packages.
ROS Master	Registers the name and location of each node.	Allows nodes to communicate. Nodes can be in different computers.
Parameter Server	Data types that define certain information for nodes.	Certain nodes require parameters to define aspects of the node.
Nodes	Processes that execute commands.	Executable code written in Python or C++ usually. Python nodes use the client library <code>rospy</code>
Topic	Name of a message.	For example, Baxter’s cameras “publish” the image they receive as a topic with a name that indicates it is a camera image.
Services	Allows communication between nodes.	Used by nodes to communicate with other nodes and request a response.
Messages	Data sent between nodes.	Messages are “published” by a node and “subscribed to” by another node.
Bags	Data storage for messages.	Used to save and playback data such as sensor data.

*Table 1 ROS Terms*

The following tables define the help for the various ROS commands.

## TURTLESIM PACKAGE

**Be sure that the turtlesim package is loaded on your system. Open a terminal window and try the following commands:**

```
$ rospack find turtlesim
  opt/ros/indigo/share/turtlesim
```

```
$ rosls turtlesim          (List Files - Note no need to type full path)
  cmake images msg package.xml srv
  Read the package.xml, look at the images. Srv directory has services
```

```
$ pwd          (Show working directory – not at turtlesim)
```

```
$ roscd turtlesim
  /opt/ros/indigo/share/turtlesim
```

### **rospack List Packages**

Two of the ROS packages we are using in this report are **std\_msgs** and **turtlesim**. The command **rospack list** lists the packages and their directories on the workstation of which **std\_msgs** and **turtlesim** are only two of many.

```
tlharmanphd@D125-43873:~$ rospack list
.
.
std_msgs /opt/ros/indigo/share/std_msgs
.
turtlesim /opt/ros/indigo/share/turtlesim
.
.
```

Note that the distribution of ROS is Indigo.

To clear the screen of the long list:  
tlharmanphd@D125-43873:~\$ **clear**

## rospack help

tlharmanphd@D125-43873:/\$ **rospack help**

USAGE: rospack <command> [options] [package]

Allowed commands:

help  
cflags-only-I [--deps-only] [package]  
cflags-only-other [--deps-only] [package]  
depends [package] (alias: deps)  
depends-indent [package] (alias: deps-indent)  
depends-manifests [package] (alias: deps-manifests)  
depends-msgsrv [package] (alias: deps-msgsrv)  
depends-on [package]  
depends-on1 [package]  
depends-why --target=<target> [package] (alias: deps-why)  
depends1 [package] (alias: deps1)  
export [--deps-only] --lang=<lang> --attrib=<attrib> [package]  
find [package]  
langs  
libs-only-L [--deps-only] [package]  
libs-only-l [--deps-only] [package]  
libs-only-other [--deps-only] [package]  
list  
list-duplicates  
list-names  
plugins --attrib=<attrib> [--top=<toppkg>] [package]  
profile [--length=<length>] [--zombie-only]  
rosdep [package] (alias: rosdeps)  
rosdep0 [package] (alias: rosdeps0)  
vcs [package]  
vcs0 [package]  
Extra options:  
-q Quiets error reports.

If [package] is omitted, the current working directory  
is used (if it contains a manifest.xml).

tlharmanphd@D125-43873:~\$ **rospack depends turtlesim**

**cpp\_common**  
rostime  
roscpp\_traits  
roscpp\_serialization  
genmsg  
genpy  
message\_runtime  
rosconsole  
std\_msgs  
rosgraph\_msgs  
xmlrpcpp  
roscpp  
catkin  
rospack  
roslib  
std\_srvs



## ROSCORE

This starts ROS and creates the Master so that nodes can communicate.

```
tlharmanphd@D125-43873:~$ roscore
... logging to /home/tlharmanphd/.ros/log/2429b792-d23c-11e4-b9ee-3417ebbca982/roslaunch-
D125-43873-21164.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://D125-43873:60512/
ros_comm version 1.11.10
```

### SUMMARY

=====

### PARAMETERS

```
* /rostdistro: indigo
* /rosversion: 1.11.10      1.11.16 2/2016 HP 210 Laptop
```

### NODES

```
auto-starting new master
process[master]: started with pid [21176]
ROS_MASTER_URI=http://D125-43873:11311/ (Lab Workstation)

setting /run_id to 2429b792-d23c-11e4-b9ee-3417ebbca982
process[rosout-1]: started with pid [21189]
started core service [/rosout]
```

*Figure 1 ROSCORE Command*

From the ROS tutorial <http://wiki.ros.org/roscore>

roscore is a collection of [nodes](#) and programs that are pre-requisites of a ROS-based system. You **must** have a roscore running in order for ROS nodes to communicate. It is launched using the `roscore` command.

NOTE: If you use [roslaunch](#), it will automatically start `roscore` if it detects that it is not already running.

`roscore` will start up:

- a ROS [Master](#)
- a ROS [Parameter Server](#)
- a [rosout](#) logging node

Leave this window active but minimized so that the ROS Master is still available.

## CREATE A TOPIC AND A MESSAGE

After ROSCORE, two topics are /rosout and /rosout\_agg. Let's publish a topic to see how this works from Clearpath Robotics ROS-101 Practical Example.

In another terminal list the topics:

```
tlharmanphd@D125-43873:~$ rostopic list
/rosout
/rosout_agg
```

`rosout` is the name of the console log reporting mechanism in ROS. It can be thought as comprising several components:

For a little explanation from the ROS wiki:

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

- The ``rosout`` node for subscribing, logging, and republishing the messages.
- The `/rosout` topic
- The `/rosout_agg` topic for subscribing to an aggregated feed
- `rosgraph_msgs/Log` message type, which defines standard fields as well as [verbosity levels](#).

The `rosout` package only provides the `rosout` node.

### Create a Topic /hello and A String Message with `rostopic pub`

```
tlharmanphd@D125-43873:~$ rostopic pub /hello std_msgs/String "Hello User"
publishing and latching message. Press ctrl-C to terminate
```

### New Topic /hello from `rostopic list`

In a new window, note that the topic `/hello` is present using `rostopic list`.

```
tlharmanphd@D125-43873:~$ rostopic list
/hello
/rosout
/rosout_agg
```

### Data for Topic /hello- message

```
tlharmanphd@D125-43873:~$ rostopic echo /hello
data: Hello User
---
```

### New Node caused by `rostopic pub`

```
tlharmanphd@D125-43873:~$ rostopic list
/rosout
/rostopic_4375_1424715269456
```

Thus far, we have a new topic `/hello` and a new node `/rostopic_4375_1424715269456`. The topic number will change with each run since it indicates time as well as other information.

## Node Information

```
tlharmanphd@D125-43873:~$ rosnode info /rostopic_4375_1424715269456
```

```
-----  
Node [/rostopic_4375_1424715269456]  
Publications:  
* /hello [std_msgs/String]  
  
Subscriptions: None  
Services:  
* /rostopic_4375_1424715269456/set_logger_level  
* /rostopic_4375_1424715269456/get_loggers  
  
contacting node http://D125-43873:36024/ ...  
Pid: 4375  
Connections:  
* topic: /hello  
* to: /rostopic_4504_1424715395163  
* direction: outbound  
⑩ transport: TCPROS
```

This created the **topic** /hello with **topic type** std\_msgs/String. **Hello User** is the data.

We now have a new topic **/hello** with data that can be sent to the screen by the **echo** option of the **rostopic** command. There are now three topics as shown by the **rostopic list** command. The publications, subscriptions and services for the new node are shown by the **rosgode info** command.

This also created the node **/rostopic\_4375\_1424715269456** which is publishing the data of topic **/hello**.

From O’Kane Chapter 3 “By the way, the numbers in this output line represent the time—measured in seconds since January 1, 1970—when our ROS\_INFO\_STREAMline was executed.”

In our case, take the 10 digits that represent seconds, **1424715269** and show that this represents about 45 years (2015-1970).

## Kill A Node

You can close the window with the node /hello defined or kill the node with **rosgode kill <node>** command. The <node> here is **/rostopic\_4375\_1424715269456**.

```
tlharmanphd@D125-43873:~$ rosgode kill -h  
Usage: rosgode kill [node]...
```

```
Options:  
-h, --help show this help message and exit  
-a, --all kill all nodes
```

To check running process use **\$ps -ef** to see all the processes running.

## ROS NODES, TOPICS, AND SERVICES USING TURTLESIM

Before going through this section and especially the tutorials on [ros.org](http://ros.org), you should have read and understood the material about ROS covered in the *Introduction to Baxter* report by T.L. Harman and Carol Fairchild.

A READ OF THE FIRST FEW CHAPTERS IN BOOKS SUCH AS THE FOLLOWING WILL BE HELPFUL:

The textbook *Learning ROS for Robotics Programming* by Aaron Martinez is useful. The examples are in C++.

A *Gentle Introduction to ROS* by Jason M. O’Kane is very readable and can be downloaded from the site: <http://www.cse.sc.edu/~jokane/agitr/agitr-letter.pdf>  
The author’s website is <http://www.cse.sc.edu/~jokane/agitr/>

These other ROS books might be helpful as referenced by O’Kane:


[ROS by Example](#) by R. Patrick Goebel

Learning ROS for Robotics Programming - Second Edition

<https://www.packtpub.com/hardware-and-creative/learning-ros-robotics-programming-second-edition>

by Enrique Fernandez and others. The examples are in C++.

Always be sure to check of any changes in the Ubuntu or ROS distribution. This *Turtlesim Guide* is written using Ubuntu 14.04 and ROS Indigo.

 If you are new to ROS - don’t be impatient. There is a great deal to learn but the Turtlesim example shown here should make things easier.

The ROS official tutorials are at these WEB sites: <http://wiki.ros.org/turtlesim/Tutorials>

ROS Tutorials Helpful for the Examples to Follow:

- [ROS/Tutorials/UnderstandingNodes](#)
- [ROS/Tutorials/UnderstandingTopics](#)
- [ROS/Tutorials/UnderstandingServicesParams](#)

Other useful references are Listed in Appendix I

## roscnode, rostopic help

### tlharmanphd@D125-43873:~\$ **roscnode help**

roscnode is a command-line tool for printing information about ROS Nodes.

Commands:

		<b>Example</b>
roscnode ping	test connectivity to node	<b>(\$ roscnode ping &lt;node&gt;)</b>
roscnode list	list active nodes	
roscnode info	print information about node	<b>(\$ roscnode info &lt;node&gt;)</b>
roscnode machine	list nodes running on a particular machine or list machines	
roscnode kill	kill a running node	
roscnode cleanup	purge registration information of unreachable nodes	

Type roscnode <command> -h for more detailed usage, e.g. 'roscnode ping -h'

### tlharmanphd@D125-43873:~\$ **roscnode list -h**

Usage: roscnode list

Options:

-h, --help	show this help message and exit		
-u	list XML-RPC URIs		
-a, --all	list all information	roscnode kill	kill a running node
	roscnode cleanup	purge registration information of unreachable nodes	

### tlharmanphd@D125-43873:/\$ **rostopic help**

rostopic is a command-line tool for printing information about ROS Topics.

Commands:

rostopic bw	display bandwidth used by topic
rostopic echo	print messages to screen
rostopic find	find topics by type
rostopic hz	display publishing rate of topic
rostopic info	print information about active topic
rostopic list	list active topics
rostopic pub	publish data to topic
rostopic type	print topic type

Type rostopic <command> -h for more detailed usage, e.g. 'rostopic echo -h'

## TURTLESIM NODE

We will start the turtlesim node and explore its properties. In a new terminal create the turtlesim node from the package turtlesim:

```
tlharmanphd@D125-43873:~$ roslaunch turtlesim turtlesim_node
[ INFO] [1427212356.117628994]: Starting turtlesim with node name /turtlesim
[ INFO] [1427212356.121407419]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445],
theta=[0.000000]
```

The roslaunch command takes the arguments [package name] [node name]. The node creates the screen image and the turtle. Here the turtle is in the center in  $x=5.5$ ,  $y=5.5$  with no rotation.

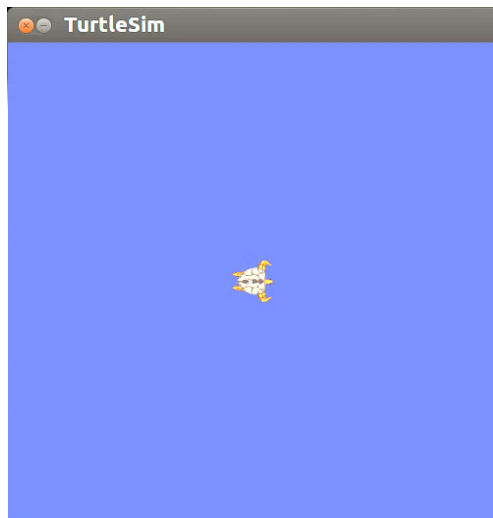


Figure 2 Turtlesim Window

Before moving the turtle, let's study the properties of the nodes, topics, service and messages available with turtlesim package in another window.

### ROS Nodes with Turtlesim

Open a new window. Most ROS commands have help screens that are usually helpful.

Using the **roslaunch** command we can determine information about any node. First list the two active nodes:

#### roslaunch list

```
tlharmanphd@D125-43873:~$ roslaunch list
  /rosout
  /turtlesim
```

Note the difference in notation between the node **/turtlesim** and the *package* **turtlesim**.



```
tlharmanphd@D125-43873:/$ rosservice help
```

Commands:

rosservice args	print service arguments
rosservice call	call the service with the provided arguments
rosservice find	find services by service type
rosservice info	print information about service
rosservice list	list active services
rosservice type	print service type
rosservice uri	print service ROSRPC uri

Type `rosservice <command> -h` for more detailed usage, e.g. `'rosservice call -h'`

Use the **\$rosservice list** command to see the services for the active node.

## Messages

```
tlharmanphd@D125-43873:/$ rosmmsg help
```

rosmmsg is a command-line tool for displaying information about ROS Message types.

Commands:

rosmmsg show	Show message description
rosmmsg list	List all messages
rosmmsg md5	Display message md5sum
rosmmsg package	List messages in a package
rosmmsg packages	List packages that contain messages

Type `rosmmsg <command> -h` for more detailed usage

If a topic publishes a message, we can determine the message type and read the message. This is shown in the example to determine the color of the background for the turtle.

```
tlharmanphd@D125-43873:~$ rostopic type /turtle1/color_sensor  
turtlesim/Color
```

The message type in the case of the topic `/turtle1/color_sensor` is **turtlesim/Color**.

The word “type” in this context is referring to the concept of a data type . It’s important to understand message types because they determine the content of the messages. That is, the message type of a topic tells you what information is included in each message on that topic, and how that information is organized.

From the message *type* we can find the format of the message. Be sure to note that Color in the message type starts with a capital letter. <http://wiki.ros.org/rostopic>



```
rosmmsg show  
tlharmanphd@D125-43873:~$ rosmmsg show turtlesim/Color  
  uint8 r  
  uint8 g  
  uint8 b
```

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

To understand the format of the message it is necessary to find the message type. The types include integers of 8, 16, 32, or 64 bits, floating point numbers, strings and other formats. The structure of the message type is:

<field> <constant>

where the field defines the type of data and the constant is the name. For example, the red color in the background is defined by **uint8 r** as shown below. This indicates that if we wish to modify the red value, an 8-bit unsigned integer is needed. The amount of red in the background is thus in the range of 0-255.

Example 1: Determine the color mixture of red, green, and blue in the background of our turtle.

```
tlharmanphd@D125-43873:~$ rostopic echo /turtle1/color_sensor  
r: 69  
g: 86  
b: 255  
---  
r: 69  
g: 86  
b: 255  
.  
.
```

The WEB site ColorChart explains the color chart. A later example will show how to change the background color for the turtle. The color values are **parameters** that can be changed.

## PARAMETER SERVER

### rosparam help

```
tlharmanphd@D125-43873:/$ rosparam help
```

rosparam is a command-line tool for getting, setting, and deleting parameters from the ROS Parameter Server.

Commands:

```
rosparam set      set parameter
rosparam get      get parameter
rosparam load     load parameters from file
rosparam dump     dump parameters to file
rosparam delete   delete parameter
rosparam list     list parameter names
```

```
tlharmanphd@D125-43873:~$ roscore
(Start ROS Master)
```

```
tlharmanphd@D125-43873:~$ rosparam list
/rostdistro
/roslaunch/uris/host_d125_43873__39549
/rosversion
/run_id
```

```
tlharmanphd@D125-43873:~$ rosparam get rosversion
'1.11.10 (1.11.16 2/08/2016)
```

```
tlharmanphd@D125-43873:~$ rosparam get rostdistro
'indigo
```

As the node publishes, the color of the background for example, it is possible to change the parameters. The command format is

### rosparam list for turtlesim node

To list the parameters for the turtlesim node:

```
tlharmanphd@D125-43873:/$ rosparam list
/background_r
/background_g
/background_b
/rostdistro
/roslaunch/uris/host_d125_43873__51759
/rosversion
```

```
/run_id
```

### change parameters for color of turtle background

Let's turn the turtle's background red. To do this, make the blue and green parameters equal to zero and saturate red = 255 by using the **rosparam set** command. Note the **clear** option from **rosservice** must be executed before the screen changes color.

#### rosparam get

```
tlharmanphd@D125-43873:~$ rosparam get /  
background_b: 255  
background_g: 86  
background_r: 69  
rostdistro: 'indigo'  
roslaunch:  
  uris: {host_d125_43873__60512: 'http://D125-43873:60512/'}  
rosversion: '1.11.10'  
run_id: 2429b792-d23c-11e4-b9ee-3417ebbca982
```

#### rosparam set

Change the colors:

```
tlharmanphd@D125-43873:/$ rosparam set background_b 0  
tlharmanphd@D125-43873:/$ rosparam set background_g 0  
tlharmanphd@D125-43873:/$ rosparam set background_r 255  
tlharmanphd@D125-43873:/$ rosservice call /clear
```

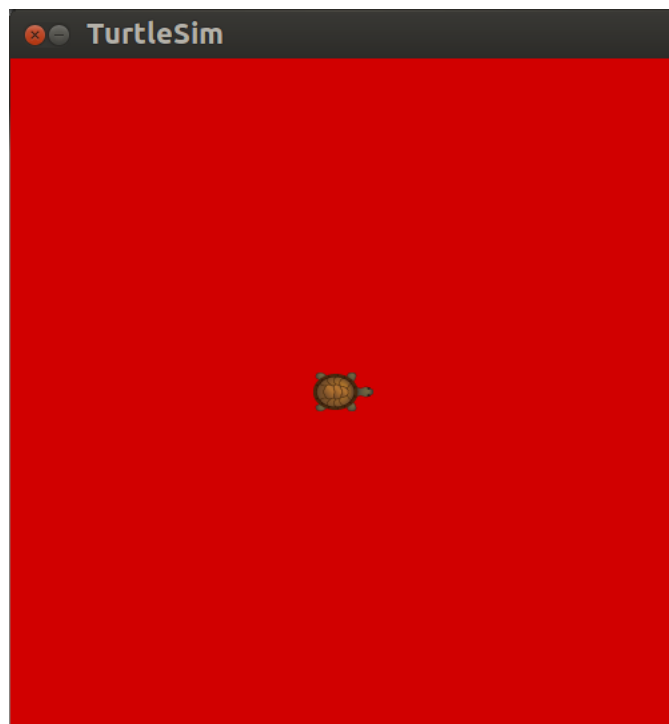


Figure 3 Turtlesim Window Color Change

## **rosparam get turtlesim parameters**

To check the results, use the **rosparam get** command.

```
tlharmanphd@D125-43873:~$ rosparam get /
  background_b: 0
  background_g: 0
  background_r: 255
  rosdistro: 'indigo'
  roslaunch:
    uris: {host_d125_43873__60512: 'http://D125-43873:60512/'}
  rosversion: '1.11.10'
  run_id: 2429b792-d23c-11e4-b9ee-3417ebbca982
```

## ROS SERVICES TO MOVE TURTLE

Services: (We can use ROS services to manipulate the turtle and perform other operations

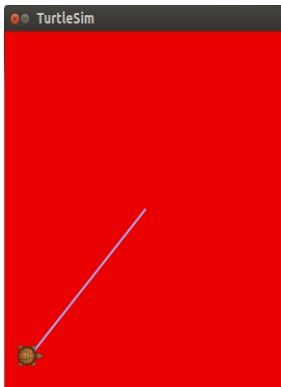
- the format is `$rosservice call <service> <arguments>`)

- \* `/turtle1/teleport_absolute`
- \* `/turtlesim/get_loggers`
- \* `/turtlesim/set_logger_level`
- \* `/reset`
- \* `/spawn`
- \* `/clear`
- \* `/turtle1/set_pen`
- \* `/turtle1/teleport_relative`
- \* `/kill`

The turtle can be moved using the `rosservice teleport` option. The format of the position is `[x y theta]`.

### **teleport\_absolute**

```
tlharmanphd@D125-43873:/$ rosservice call /turtle1/teleport_absolute 1 1 0
```

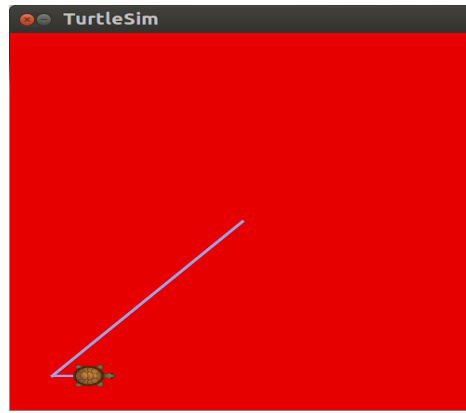


*Figure 4 Turtle After Absolute Move*

The relative teleport option moves the turtle with respect to its present position. The arguments are `[linear, angle]`

### **teleport\_relative**

```
tlharmanphd@D125-43873:/$ rosservice call /turtle1/teleport_relative 1 0
```



*Figure 5 Turtle After Relative Move*

Turtle now at  $x=2$ ,  $y=1$ .

## TURTLESIM NODE TOPIC POSE

Another topic for turtlesim node is the turtle's **pose**. This is the x, y position, angular direction, and the linear and angular velocity. In this example, the turtle is not moving as shown in Figure 5.

```
tlharmanphd@D125-43873:~$ rostopic info /turtle1/pose
Type: turtlesim/Pose
```

Publishers:

\* /turtlesim (<http://D125-43873:47701/>)

Subscribers: None

```
tlharmanphd@D125-43873:~$ rostopic type /turtle1/pose
turtlesim/Pose
```

```
tlharmanphd@D125-43873:~$ rosmmsg show turtlesim/Pose
float32 x
float32 y
float32 theta
float32 linear_velocity
float32 angular_velocity
```

```
tlharmanphd@D125-43873:/$ rostopic echo /turtle1/pose
x: 2.0
y: 1.0
theta: 0.0
linear_velocity: 0.0
angular_velocity: 0.0
---
x: 2.0
y: 1.0
theta: 0.0
linear_velocity: 0.0
angular_velocity: 0.0
.
.
.
```

Continuous output of the position, orientation, and velocities. Compare to the position on the turtle window. CRTL+c to stop output.

## MAKE TURTLE RUN IN A CIRCLE WITH TURTLESIM

```
tlharmanphd@D125-43873:~$ rosnode info /turtlesim
```

```
-----  
Node [/turtlesim]  
Publications:  
* /turtle1/color_sensor [turtlesim/Color]  
* /rosout [roscpp_msgs/Log]  
* /turtle1/pose [turtlesim/Pose]
```

```
Subscriptions:  
* /turtle1/cmd_vel [unknown type]
```

```
Services:  
* /turtle1/teleport_absolute  
* /turtlesim/get_loggers  
* /turtlesim/set_logger_level  
* /reset  
* /spawn  
* /clear  
* /turtle1/set_pen  
* /turtle1/teleport_relative  
* /kill
```

```
contacting node http://D125-43873:47701/ ...
```

```
Pid: 21255
```

```
Connections:
```

```
* topic: /rosout  
* to: /rosout  
* direction: outbound  
* transport: TCPROS
```

### type of message for cmd\_vel

```
tlharmanphd@D125-43873:~$ rostopic type /turtle1/cmd_vel  
geometry_msgs/Twist
```

```
tlharmanphd@D125-43873:~$ rosmmsg show geometry_msgs/Twist  
geometry_msgs/Vector3 linear  
float64 x  
float64 y  
float64 z  
geometry_msgs/Vector3 angular  
float64 x  
float64 y  
float64 z
```



## COMBINE TWO COMMANDS

```
tlharmanphd@D125-43873:~$ rostopic type /turtle1/cmd_vel | rosmmsg show
geometry_msgs/Vector3 linear
float64 x
float64 y
float64 z
geometry_msgs/Vector3 angular
float64 x
float64 y
float64 z
```

The requirement is for two vectors with 3 elements each. The message type is geometry\_msgs/Twist .

To get a list of messages for ROS of **geometry\_msgs**

[http://wiki.ros.org/geometry\\_msgs](http://wiki.ros.org/geometry_msgs)

This displays a verbose list of topics to publish to and subscribe to and their type:

```
tlharmanphd@D125-43873:~$ rostopic list -v
```

Published topics:

```
* /turtle1/color_sensor [turtlesim/Color] 1 publisher
* /rosout [rograph_msgs/Log] 1 publisher
* /rosout_agg [rograph_msgs/Log] 1 publisher
* /turtle1/pose [turtlesim/Pose] 1 publisher
```

Subscribed topics:

```
* /turtle1/cmd_vel [geometry_msgs/Twist] 1 subscriber
* /rosout [rograph_msgs/Log] 1 subscriber
```

## MOVE TURTLE ONCE

The following command will send a single message to turtlesim telling it to move with a linear velocity of 2.0, and an angular velocity of 1.8. It will move from its starting position along a circular trajectory for a distance and then stop.

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

## Where is the turtle?

```
tlharmanphd@D125-43873:~$ rostopic echo /turtle1/pose
```

```
x: 3.0583717823
y: 2.39454507828
theta: 1.81439995766
linear_velocity: 0.0
angular_velocity: 0.0
```

Use CNTL+c to stop the output of position, orientation and velocity.

From the ROS tutorial, a `geometry_msgs/Twist` msg has two vectors of three floating point elements each: `linear` and `angular`. In this case, `'[2.0, 0.0, 0.0]'` becomes the linear value with  $x=2.0$ ,  $y=0.0$ , and  $z=0.0$ , and `'[0.0, 0.0, 1.8]'` is the angular value with  $x=0.0$ ,  $y=0.0$ , and  $z=1.8$ . These arguments are actually in YAML syntax, which is described more in the [YAML command line documentation](#).

```
'[2.0, 0.0, 0.0]' '[0.0, 0.0, 1.8]'
```

You will have noticed that the turtle has stopped moving; this is because the turtle requires a steady stream of commands at 1 Hz to keep moving. We can publish a steady stream of commands using `rostopic pub -r` command:

Here we publish the topic `/turtle1/command_velocity` with the message to repeat the message at 1 second intervals with linear velocity 2 and angular velocity 1.8. The node `turtlesim` subscribes to the message as shown by the command `$ rostopic info /turtlesim` shown before with the subscription:

```
Subscribed topics:
```

```
* /turtle1/cmd_vel [geometry_msgs/Twist] 1 subscriber rostopic pub
```

To make the turtle move in a circle

```
harman@Laptop-M1210:~$ rostopic pub /turtle1/cmd_vel geometry_msgs/Twist -r 1 -- '[2.0, 0.0, 0.0]' '[0.0, 0.0, 1.8]'
```



*Figure 6 Turtle Running in A Circle*

## **rostopic hz**

Show the rate in Hz for publication (Cntl-C to stop data):

### **rostopic hz /turtle1/pose**

```
tlharmanphd@D125-43873:/$ rostopic hz /turtle1/pose
```

```
subscribed to [/turtle1/pose]
average rate: 62.501
  min: 0.016s max: 0.016s std dev: 0.00014s window: 62
average rate: 62.501
  min: 0.016s max: 0.016s std dev: 0.00014s window: 124
average rate: 62.504
  min: 0.016s max: 0.016s std dev: 0.00014s window: 187
average rate: 62.500
  min: 0.016s max: 0.016s std dev: 0.00014s window: 249
average rate: 62.496
  min: 0.015s max: 0.017s std dev: 0.00014s window: 300
```

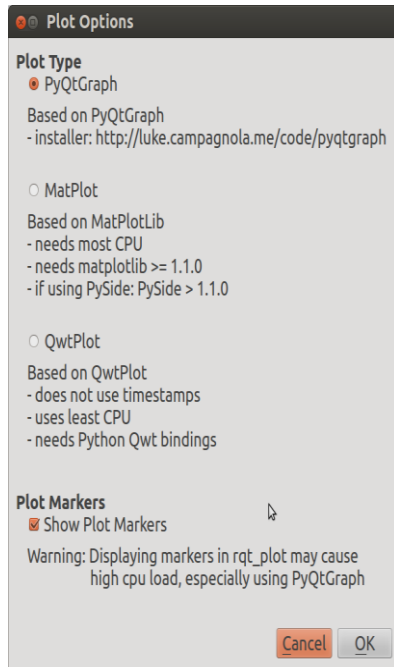
Output at about a 60 Hz rate. Updated every 16 ms.

## rqt\_plot

We can plot information about the nodes and topics.

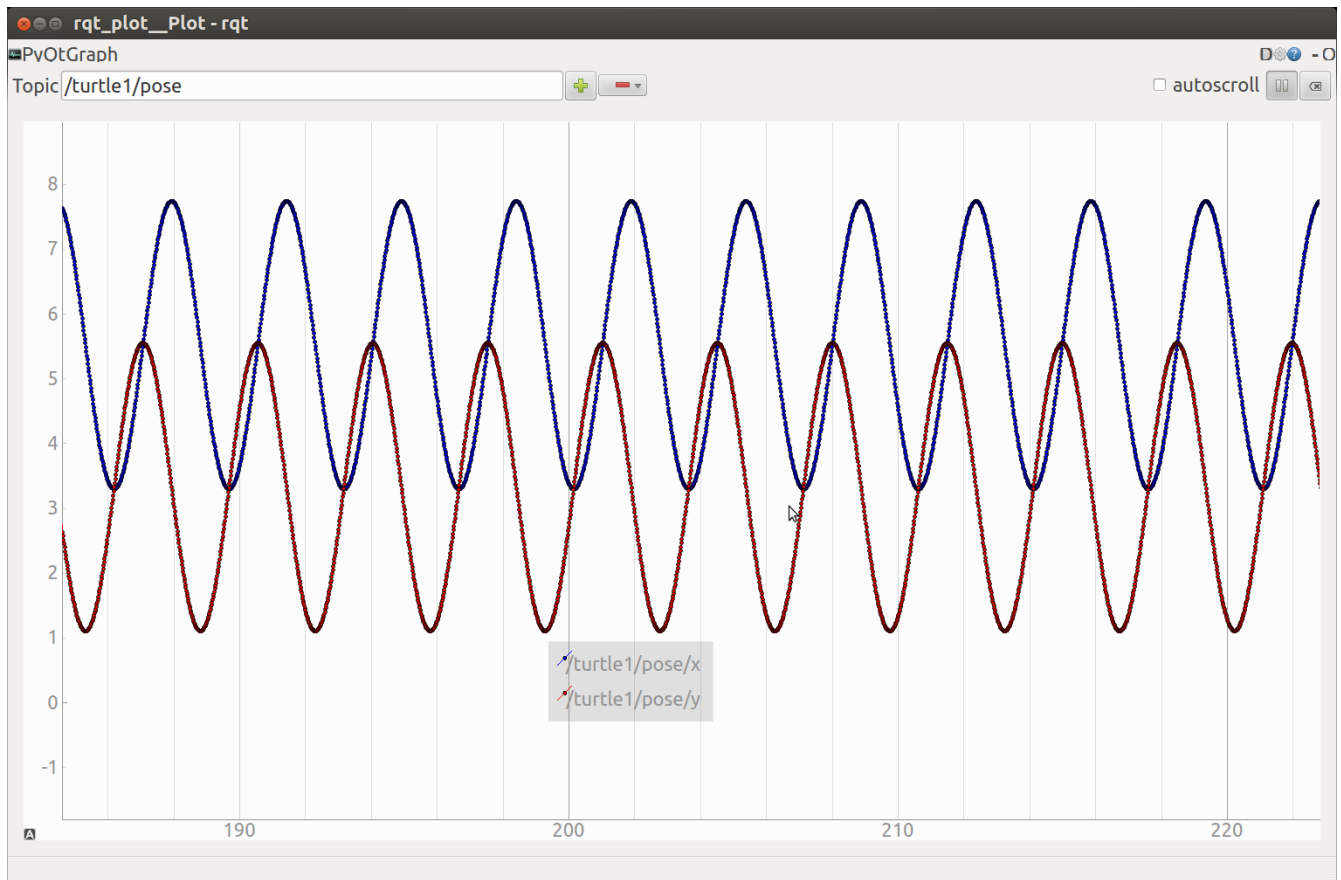
```
tlharmanphd@D125-43873:~$ rqt_plot
```

Select plotting type:



*Figure 7 Selection of Plotting for rqt\_plot*

Experiment with different plot types and controls allowed for the plot such as changing the scales, etc.



*Figure 8 Plot of /turtle1/pose/x and /pose/y*

Period of just over 3 seconds for 360 degree rotation. Note the periodic motion in x and y. Right click to change values for axes, etc.

With this plot, right click to set the axes ranges and other aspects of the plot. The pose has five values as shown before, but we have chosen to only plot the x and y variations as the turtle moves in a circle.

Choosing only x and y positions and experimenting with scales and autoscroll. See the tutorial for further help.

[http://wiki.ros.org/rqt\\_plot](http://wiki.ros.org/rqt_plot)

To plot from the command line, both of the following lines plot the same topics according to the wiki.

```
$ rqt_plot /turtle1/pose/x:y:z
$ rqt_plot /turtle1/pose/x /turtle1/pose/y /turtle1/pose/z
```

Obviously, if you want to change the topics to plot, you need to restart the program and give the new topic names.

## ENABLE KEYBOARD CONTROL OF TURTLE

In a third window, we execute a node that allows keyboard control of the turtle. Roscore is running in one window and turtlesim\_node in another.

### roslaunch turtlesim turtle\_teleop\_key

```
tlharmanphd@D125-43873:~$ roslaunch turtlesim turtle_teleop_key
```

```
Reading from keyboard
```

```
-----
```

```
Use arrow keys to move the turtle.
```

```
Up arrow      Turtle up
Down arrow    Turtle down
Right arrow   Rotate CW
Left arrow    Rotate CCW
```

```
tlharmanphd@D125-43873:~$ roslaunch list
```

```
/rosout
/rqt_gui_py_node_22321
/teleop_turtle
/turtlesim
```

### New Node /teleop\_turtle

```
tlharmanphd@D125-43873:~$ roslaunch info /teleop_turtle
```

```
-----
```

```
Node [/teleop_turtle]
```

```
Publications:
```

- \* /turtle1/cmd\_vel [geometry\_msgs/Twist]
- \* /rosout [roscpp\_msgs/Log]

```
Subscriptions: None
```

```
Services:
```

- \* /teleop\_turtle/get\_loggers
- \* /teleop\_turtle/set\_logger\_level

```
contacting node http://D125-43873:44984/ ...
```

```
Pid: 22585
```

```
Connections:
```

- \* topic: /rosout
  - \* to: /rosout
  - \* direction: outbound
  - \* transport: TCPROS
- \* topic: /turtle1/cmd\_vel
  - \* to: /turtlesim
  - \* direction: outbound
  - \* transport: TCPROS

```
Notice publication of /turtle1/cmd_vel [geometry_msgs/Twist]
```

## Node /turtlesim after /teleop\_turtle

tlharmanphd@D125-43873:~\$ **rostopic info /turtlesim**

-----  
Node [/turtlesim]

Publications:

- \* /turtle1/color\_sensor [turtlesim/Color]
- \* /rosout [roscpp\_msgs/Log]
- \* /turtle1/pose [turtlesim/Pose]

Subscriptions:

- \* /turtle1/cmd\_vel [geometry\_msgs/Twist]

Services:

- \* /turtle1/teleport\_absolute
- \* /reset
- \* /clear
- \* /turtle1/teleport\_relative
- \* /kill
- \* /turtlesim/get\_loggers
- \* /turtlesim/set\_logger\_level
- \* /spawn
- \* /turtle1/set\_pen

contacting node http://D125-43873:36624/ ...

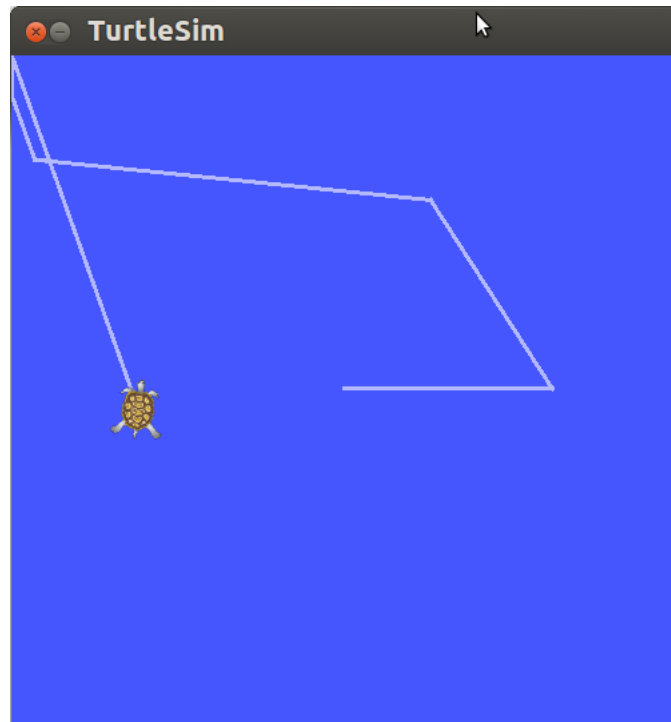
Pid: 22605

Connections:

- \* topic: /rosout
  - \* to: /rosout
  - \* direction: outbound
  - \* transport: TCPROS
- \* topic: /turtle1/pose
  - \* to: /rqt\_gui\_py\_node\_22321
  - \* direction: outbound
  - \* transport: TCPROS
- \* topic: /turtle1/cmd\_vel
  - \* to: /teleop\_turtle (http://D125-43873:44984/)
  - \* direction: inbound
  - \* transport: TCPROS

**Note:** New topic /turtle1/cmd\_vel to /teleop\_turtle

To move turtle with arrow keys, be sure the focus is on the window that started turtle\_teleop\_key.



*Figure 9 Turtlesim After Moving*



We start a fourth terminal window to view the information that is available through ROS for the Turtlesim. The commands in that window elicit data while the other windows keep the turtle active. To move the turtle, use window three.

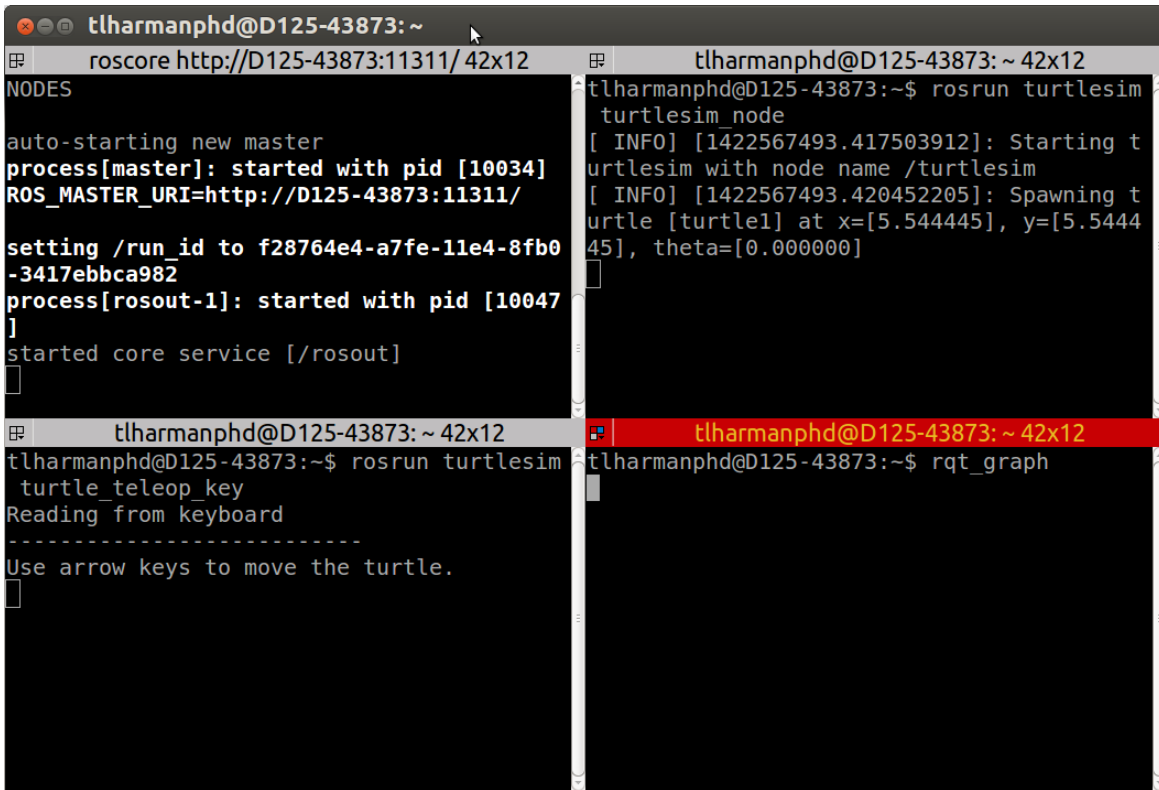


Figure 10 Four Turtlesim Windows using Terminator

The screen with four windows was created using Terminator. It is downloaded in Ubuntu from the Software Center Icon on the launcher: [http://en.wikipedia.org/wiki/Ubuntu\\_Software\\_Center](http://en.wikipedia.org/wiki/Ubuntu_Software_Center)

The terminator is described at this site: <https://apps.ubuntu.com/cat/applications/terminator/>

1. List the ROS parameters to get information about the ROS nodes. The nodes are generally the executable scripts in ROS.
2. Determine what information you can get for the node turtlesim.

(Publications and Subscriptions)

```
tlharmanphd@D125-43873:~$ rostopic list
/rosout
/rosout_agg
/turtle1/cmd_vel
/turtle1/color_sensor
/turtle1/pose
```

One important topic is /turtle1/cmd\_vel which will be **published** using the keyboard or by publishing the topic with the rostopic pub command.

## Determine data from Topic /turtle1/cmd\_vel in Indigo

The **rostopic echo** command shows the data sent by the node to control the turtle. As you move the turtle, the data are updated. As you press the arrow keys the displayed values will change: x velocity if linear motion, z velocity if rotation.

```
tlharmanphd@D125-43873:~$ rostopic echo /turtle1/cmd_vel
linear:
  x: 2.0          (Velocity ahead)
  y: 0.0
  z: 0.0
angular:
  x: 0.0
  y: 0.0
  z: 0.0
---
linear:
  x: 2.0
  y: 0.0
  z: 0.0
angular:
  x: 0.0
  y: 0.0
  z: 0.0
---
linear:
  x: -2.0
  y: 0.0
  z: 0.0
angular:
  x: 0.0
  y: 0.0
  z: 0.0
---
linear:
  x: 0.0
  y: 0.0
  z: 0.0
angular:
  x: 0.0
  y: 0.0
  z: 2.0  (Counter Clockwise Rotational velocity about z axis – out of window)
---
.
```

These show the parameters for **cmd\_vel** which are linear velocity and angular velocity. In this result, the turtle was moved linearly until the last output which shows a rotation.

To find turtle's position in window use `/turtle1/pose`

```
tlharmanphd@D125-43873:~$ rostopic echo /turtle1/pose
x: 5.5444444561
y: 5.5444444561
theta: 0.0
linear_velocity: 0.0
angular_velocity: 0.0
---
```

CNTL+c to stop output. Here the turtle is at rest in the center of the window.

If you return to the teleop\_key window and move the turtle with the arrow keys you can see the output of the pose message (turtlesim/Pose) change. Remember the format:

```
tlharmanphd@D125-43873:~$ rosmmsg show turtlesim/Pose
float32 x
float32 y
float32 theta
float32 linear_velocity
float32 angular_velocity
```

We can make the turtle turn in a circle by **publishing** the topic `/turtle1/command_velocity` as shown before using the node `/turtlesim`.

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

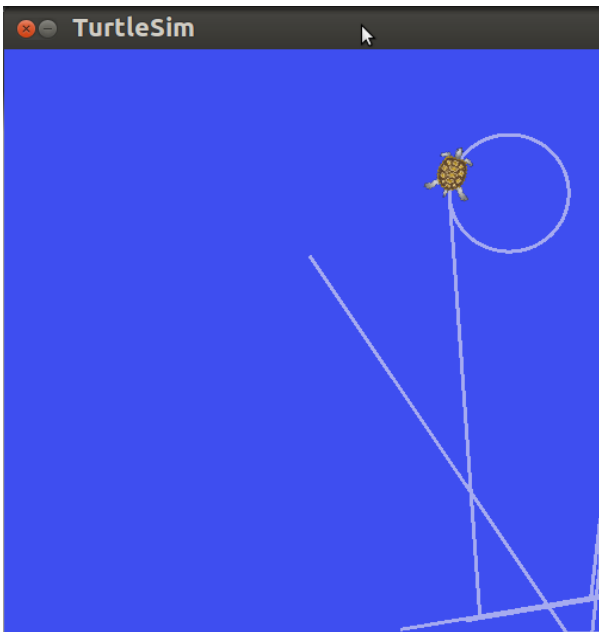


Figure 11 Turtle responds to published topic

The command will publish at a rate (-r) of once a second (1 Hz). The topic /turtle1/command\_velocity is followed by the message type turtlesim/Velocity that commands the turtle to turn with linear velocity 2.0 and angular velocity 1.8 according to the ROS tutorial:

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

As noted before, a turtlesim/Velocity message has two floating point elements : linear and angular. In this case, 2.0 becomes the linear value, and 1.8 is the angular value. These arguments are actually in YAML syntax, which is described more in the [YAML command line documentation](#).

### Clear the screen

When you want to CLEAR THE SCREEN

```
tlharmanphd@D125-43873:~$ rosservice call /clear
```

### rqt\_graph

There is another feature of ROS that is useful for those who wish to see a graphical view of the communication between nodes. We know that /teleop\_turtle node **publishes** a message on the topic called /turtle1/command\_velocity and the node /Turtlesim **subscribes** to those messages.

This can be shown in a graphical form with the command:

```
tlharmanphd@D125-43873:~$ rqt_graph
```

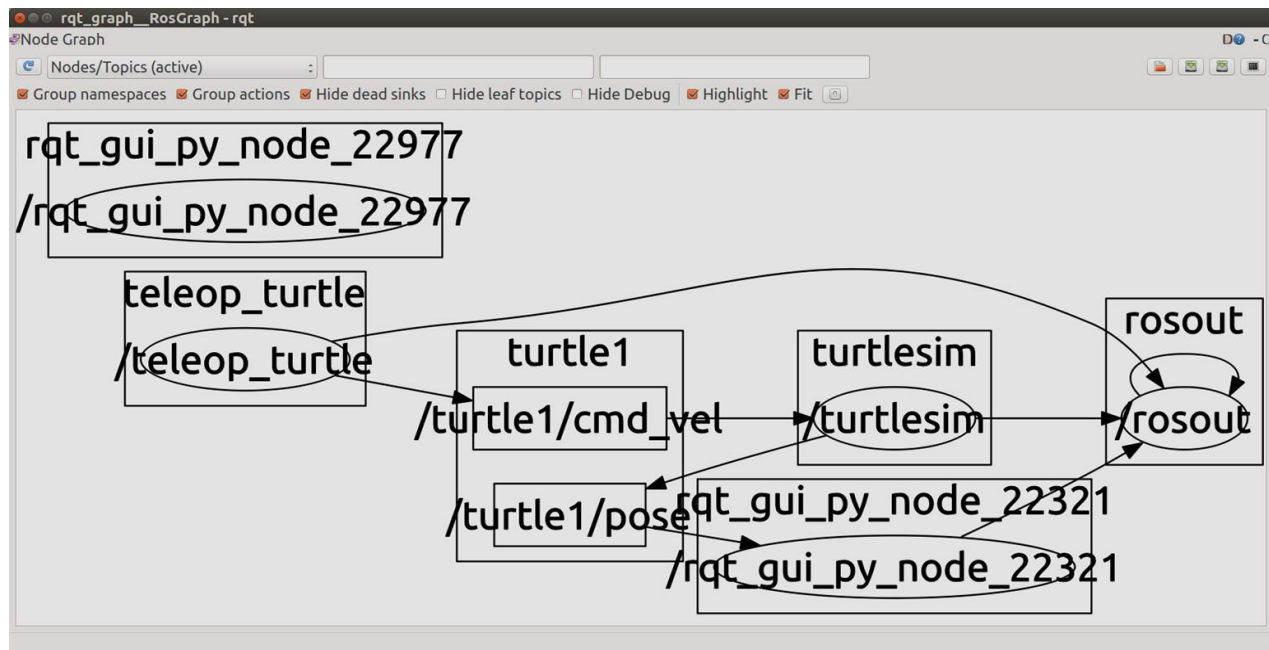


Figure 12 Turtlesim graph showing communication

The advantage of Turtlesim is as follows:

1. Easy to Learn and Use
2. Shows basic ROS capability
3. Can be downloaded with ROS for use on a laptop

To restrict the graph to the /turtlesim node:

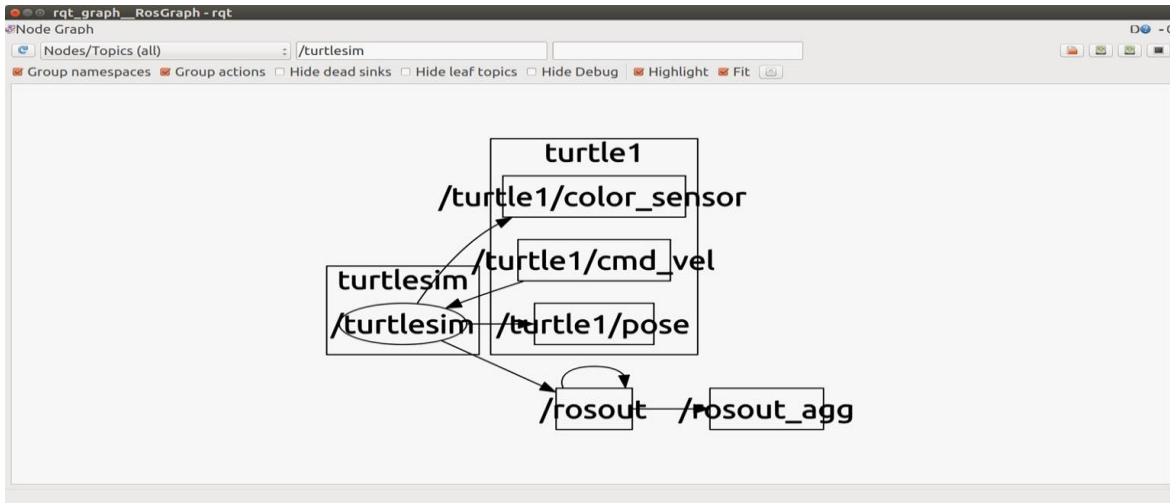


Figure 13 RQT\_GRAPH for /turtlesim

## PYTHON and TURTLESIM

LETS CONTROL THE TURTLE- Publish to /turtle1/cmd\_vel:  
( roscore and turtlesim\_node running)

Create a Python script turtlesim1.py and make executable (\$ chmod +x turtlesim1.py).

**\$ python turtlesim1.py (Make Executable \$chmod +x turtlesim1.py)**

```
[INFO] [WallTime: 1455313387.186692] Press CTRL+c to stop TurtleBot
[INFO] [WallTime: 1455313387.188315] Set rate 10Hz
```

```
#!/usr/bin/env python turtlesim1.py
# Execute as a python script
# Set linear and angular values of Turtlesim's speed and turning.
import rospy # Needed to create a ROS node
from geometry_msgs.msg import Twist # Message that moves base

class ControlTurtlesim():
    def __init__(self):
        # ControlTurtlesim is the name of the node sent to the master
        rospy.init_node('ControlTurtlesim', anonymous=False)

        # Message to screen
        rospy.loginfo(" Press CTRL+c to stop TurtleBot")

        # Keys CNTL + c will stop script
        rospy.on_shutdown(self.shutdown)

        # Publisher will send Twist message on topic
        # /turtle1/cmd_vel

        self.cmd_vel = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)

        # Turtlesim will receive the message 10 times per second.
        rate = rospy.Rate(10);
        # 10 Hz is fine as long as the processing does not exceed
        # 1/10 second.
        rospy.loginfo(" Set rate 10Hz")
        # Twist is geometry_msgs for linear and angular velocity
        move_cmd = Twist()
        # Linear speed in x in meters/second is + (forward) or
        # - (backwards)
        move_cmd.linear.x = 0.3 # Modify this value to change speed
        # Turn at 0 radians/s
        move_cmd.angular.z = 0
        # Modify this value to cause rotation rad/s

        # Loop and TurtleBot will move until you type CNTL+c
        while not rospy.is_shutdown():
            # publish Twist values to the Turtlesim node /cmd_vel
            self.cmd_vel.publish(move_cmd)
            # wait for 0.1 seconds (10 HZ) and publish again
            rate.sleep()

    def shutdown(self):
        # You can stop turtlebot by publishing an empty Twist message
        rospy.loginfo("Stopping Turtlesim")
```

```

self.cmd_vel.publish(Twist())
    # Give TurtleBot time to stop
    rospy.sleep(1)

if __name__ == '__main__':
    try:
        ControlTurtlesim()
    except:
        rospy.loginfo("End of the trip for Turtlesim")

$ rostopic list
  /ControlTurtlesim
  /rosout
  /teleop_turtle
  /turtlesim

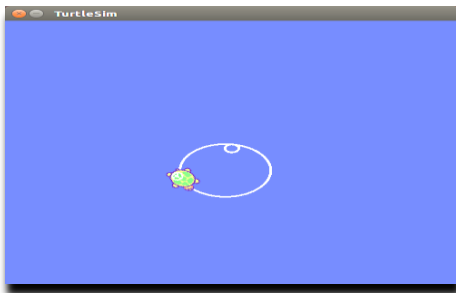
```

Change Python script turtlesim1.py to run turtle in a circle ( Make executable)

```

tlharmanphd@D125-43873:~/ros_ws$ python turtlesim2.py
[INFO] [WallTime: 1455383932.566053] Press CTRL+c to stop TurtleBot
[INFO] [WallTime: 1455383932.567306] Set rate 10Hz
^C[INFO] [WallTime: 1455383937.538077] Stopping Turtlesim

```

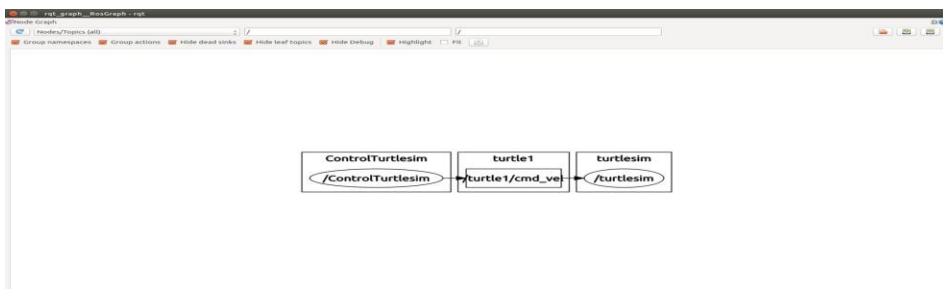


In turtlesim2.py Script

```

move_cmd = Twist()
    # Linear speed in x in meters/second is + (forward) or
    # - (backwards)
    move_cmd.linear.x = 2.0    # Modify this value to change speed
    # Turn at 1.8 radians/s
    move_cmd.angular.z = 1.8
    # Modify this value to cause rotation rad/s

```



## ROSBAG

### rosvag help

tlharmanphd@D125-43873:/\$ **rosvag help**

Usage: rosvag <subcommand> [options] [args]

A bag is a file format in ROS for storing ROS message data. The rosvag command can record, replay and manipulate bags.

Available subcommands:

- check Determine whether a bag is playable in the current system, or if it can be migrated.
- compress Compress one or more bag files.
- decompress Decompress one or more bag files.
- filter Filter the contents of the bag.
- fix Repair the messages in a bag file so that it can be played in the current system.
- help
- info Summarize the contents of one or more bag files.
- play Play back the contents of one or more bag files in a time-synchronized fashion.
- record Record a bag file with the contents of specified topics.
- reindex Reindexes one or more bag files.

For additional information, see <http://wiki.ros.org/rosvag>

*Table 2 ROS Help Information*

A bag is a file format in ROS for storing ROS message data. The rosvag command can record, replay and manipulate bags.

### rosvag help

Usage: rosvag <subcommand> [options] [args]

Available subcommands:

- check Determine whether a bag is playable in the current system, or if it can be migrated.
- compress Compress one or more bag files.
- decompress Decompress one or more bag files.
- filter Filter the contents of the bag.
- fix Repair the messages in a bag file so that it can be played in the current system.
- help
- info Summarize the contents of one or more bag files.
- play Play back the contents of one or more bag files in a time-synchronized fashion.
- record Record a bag file with the contents of specified topics.
- reindex Reindexes one or more bag files.



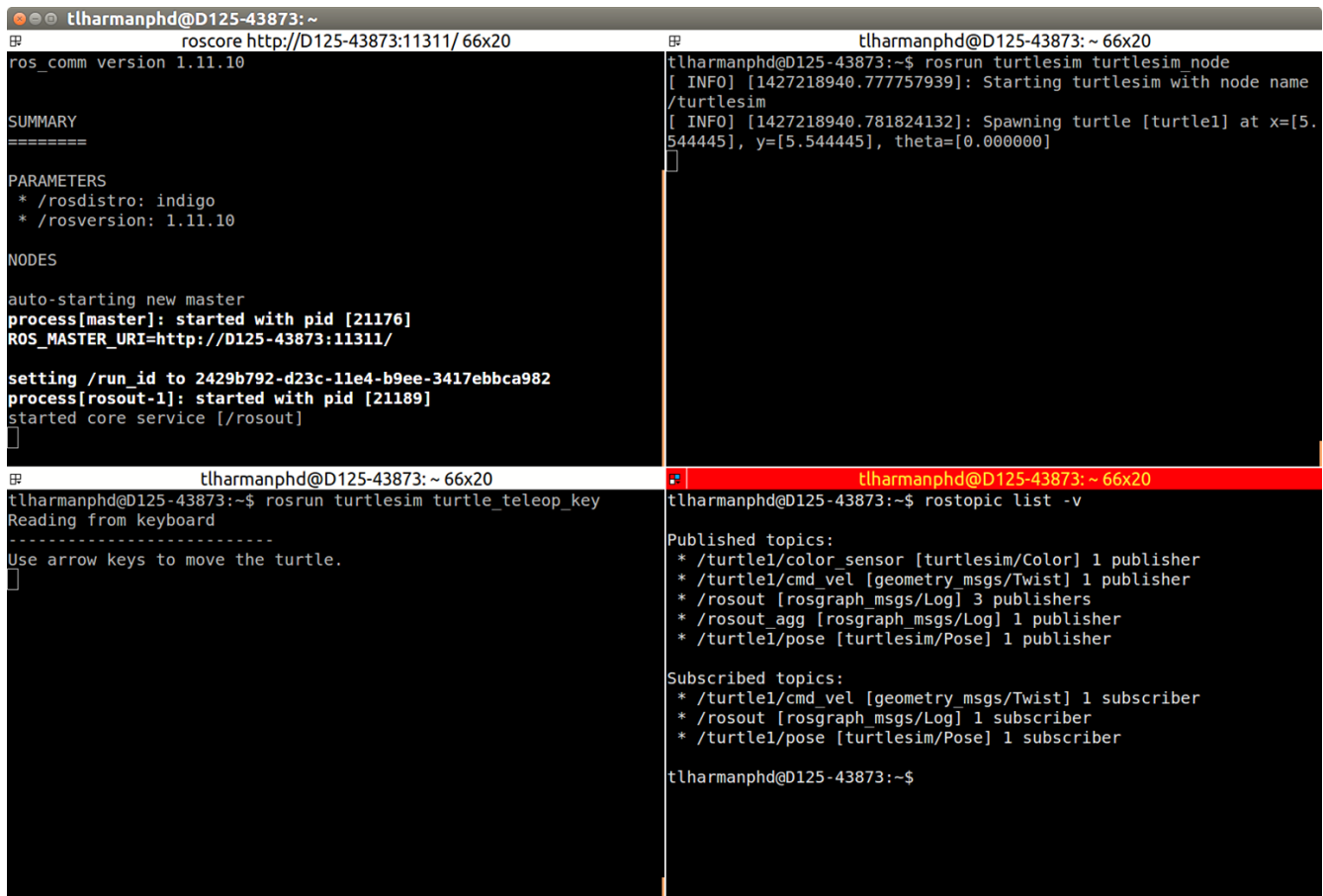
We will use the record and play option to learn how to save and replay messages.

For additional information, see <http://wiki.ros.org/rosbag>

References that describe the rosbag commands in more detail:

<http://wiki.ros.org/rosbag/Tutorials/Recording%20and%20playing%20back%20data>

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



```
tlharmanphd@D125-43873: ~
roscore http://D125-43873:11311/66x20
ros_comm version 1.11.10

SUMMARY
=====

PARAMETERS
* /rostdistro: indigo
* /rosversion: 1.11.10

NODES

auto-starting new master
process[master]: started with pid [21176]
ROS_MASTER_URI=http://D125-43873:11311/

setting /run_id to 2429b792-d23c-11e4-b9ee-3417ebbca982
process[rosout-1]: started with pid [21189]
started core service [/rosout]

tlharmanphd@D125-43873: ~ 66x20
tlharmanphd@D125-43873:~$ roslaunch turtlesim turtlesim.launch
[ INFO] [1427218940.777757939]: Starting turtlesim with node name
/turtlesim
[ INFO] [1427218940.781824132]: Spawning turtle [turtle1] at x=[5.
544445], y=[5.544445], theta=[0.000000]

tlharmanphd@D125-43873: ~ 66x20
tlharmanphd@D125-43873:~$ rostopic list -v

Published topics:
* /turtle1/color_sensor [turtlesim/Color] 1 publisher
* /turtle1/cmd_vel [geometry_msgs/Twist] 1 publisher
* /rosout [roscpp_msgs/Log] 3 publishers
* /rosout_agg [roscpp_msgs/Log] 1 publisher
* /turtle1/pose [turtlesim/Pose] 1 publisher

Subscribed topics:
* /turtle1/cmd_vel [geometry_msgs/Twist] 1 subscriber
* /rosout [roscpp_msgs/Log] 1 subscriber
* /turtle1/pose [turtlesim/Pose] 1 subscriber

tlharmanphd@D125-43873:~$
```

Figure 14 Windows for turtlesim

```
tlharmanphd@D125-43873:~$ pwd
/home/tlharmanphd
tlharmanphd@D125-43873:~$ mkdir bagfilesturtle
tlharmanphd@D125-43873:~$ ls -d b*
backup bagfilesturtle baxter.sh~
```

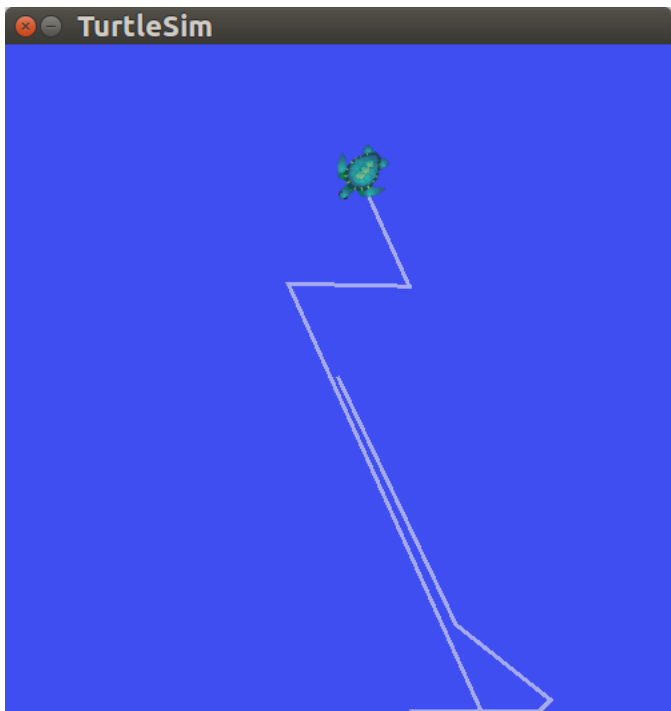
Here we are making a temporary directory to record data.

Then running `rosbag record` command with the option `-a` indicates that all published topics will be accumulated in a bag file.

Start to record the topics with the **`rosbag record -a`** command:

```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag record -a
[ INFO] [1427220792.012510086]: Recording to 2015-03-24-13-13-12.bag.
[ INFO] [1427220792.012714289]: Subscribing to /turtle1/color_sensor
[ INFO] [1427220792.015024218]: Subscribing to /turtle1/cmd_vel
[ INFO] [1427220792.017232168]: Subscribing to /rosout
[ INFO] [1427220792.019675036]: Subscribing to /rosout_agg
[ INFO] [1427220792.021687650]: Subscribing to /turtle1/pose
```

**Now change the focus to the `teleop_key` window move turtle with arrow keys for 10 or so seconds.**



*Figure 15 Turtle moved with keyboard keys with rosbag recording*

In the window running `rosbag record`, exit with a `Ctrl-C` when you have finished moving the turtle. Now examine the contents of the directory **`bagfilesturtle`**. You should see a file with a name that begins with the year, data, and time and the suffix `.bag`. This is the bag file that contains all topics published by any node in the time that `rosbag record` was running.

Now that we've recorded a bag file using `rosbag record` option we can examine it and play it back using the commands `rosbag info` and `rosbag play`. First we are going to see what's recorded in the bag file.

**`rosbag info`**

```
tlharmanphd@D125-43873:~/bagfilesturtle$ ls
2015-03-24-13-13-12.bag
```

Here the name is the date and time.

```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag info 2015-03-24-13-13-12.bag
path:      2015-03-24-13-13-12.bag
version:   2.0
duration:  1:22s (82s)
start:     Mar 24 2015 13:13:12.02 (1427220792.02)
end:       Mar 24 2015 13:14:34.58 (1427220874.58)
size:      823.2 KB
messages:  10736
compression: none [1/1 chunks]
types:     geometry_msgs/Twist [9f195f881246fdfa2798d1d3eebca84a]
           rosgraph_msgs/Log  [acffd30cd6b6de30f120938c17c593fb]
           turtlesim/Color    [353891e354491c51aabe32df673fb446]
           turtlesim/Pose     [863b248d5016ca62ea2e895ae5265cf9]
topics:    /rosout             160 msgs   : rosgraph_msgs/Log (2 connections)
           /rosout_agg        156 msgs   : rosgraph_msgs/Log
           /turtle1/cmd_vel   130 msgs   : geometry_msgs/Twist
           /turtle1/color_sensor 5145 msgs  : turtlesim/Color
           /turtle1/pose      5145 msgs  : turtlesim/Pose
```

This tells us topic names and types as well as the number (count) of each message topic contained in the bag file. We can see that of the topics being advertised that we saw in the rostopic output, four of the five were actually published over our recording interval. As we ran rosbag record with the -a flag it recorded all messages published by all nodes.

The next step in this tutorial is to replay the bag file to reproduce behavior in the running system. First kill the teleop program that may be still running from the previous section - Ctrl-c in the terminal where you started turtle\_teleop\_key.

## rosbag play

Leave turtlesim running or restart with a “fresh” turtle.

```
tlharmanphd@D125-43873:~$ rosrund turtlesim turtlesim_node
[ INFO] [1427221332.211909961]: Starting turtlesim with node name /turtlesim
[ INFO] [1427221332.225487283]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445],
theta=[0.000000]
```

In a terminal window run the following command in the directory where you took the original bag file:

```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag play 2015-03-24-13-13-12.bag
[ INFO] [1427221486.993700128]: Opening 2015-03-24-13-13-12.bag
```

Waiting 0.2 seconds after advertising topics... done.

Hit space to toggle paused, or 's' to step.

[RUNNING] Bag Time: 1427220874.545656 Duration: 82.521750 / 82.553575

Done.



*Figure 16 Turtle Replay of rosbag data*

Turtle begins executing messages from its last location.

In its default mode rosbag play will wait for a certain period (.2 seconds) after advertising each message before it actually begins publishing the contents of the bag file. Waiting for some duration allows any subscriber of a message to be alerted that the message has been advertised and that messages may follow. If rosbag play publishes messages immediately upon advertising, subscribers may not receive the first several published messages. The waiting period can be specified with the `-d` option.

Eventually the topic `/turtle1/command_velocity` will be published and the turtle should start moving in turtlesim in a pattern similar to the one you executed from the teleop program. The duration between running rosbag play and the turtle moving should be approximately equal to the time between the original rosbag record execution and issuing the commands from the keyboard in the beginning part of the tutorial. You can have rosbag play not start at the beginning of the bag file but instead start some duration past the beginning using the `-s` argument. A final option that may be of interest is the `-r` option, which allows you to change the rate of publishing by a specified factor. If you execute:

```
rosbag play -r 2 <your bagfile>
```

You should see the turtle execute a slightly different trajectory - this is the trajectory that would have resulted had you issued your keyboard commands twice as fast.

After - the motion will start on playback from the current position of the turtle.

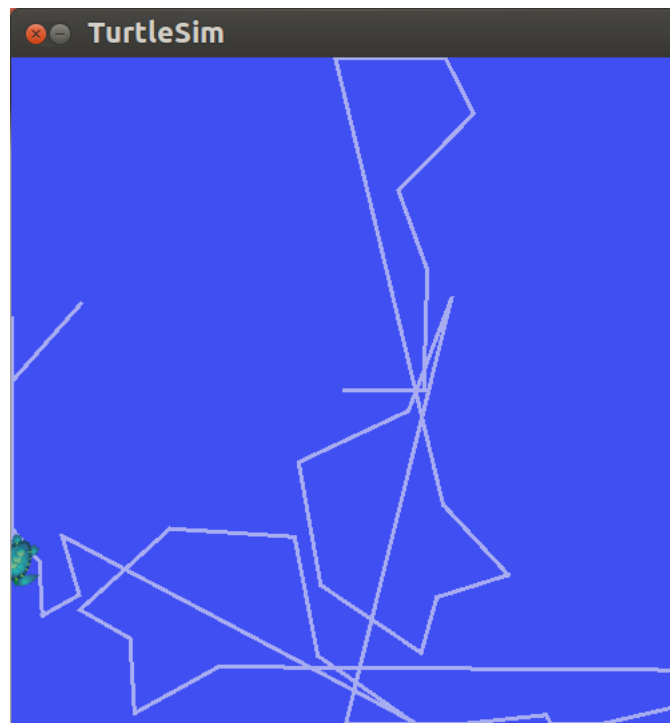
```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag play -r2 2015-03-24-13-13-12.bag  
[ INFO] [1427221716.127268792]: Opening 2015-03-24-13-13-12.bag
```

Waiting 0.2 seconds after advertising topics... done.

Hit space to toggle paused, or 's' to step.

```
[RUNNING] Bag Time: 1427220874.545836 Duration: 82.521930 / 82.553575
```

Done.



*Figure 17 Turtle rosbag replay at 2x speed*

### **Recording a subset of the data**

When running a complicated system, such as the pr2 software suite, there may be hundreds of topics being published, with some topics, like camera image streams, potentially publishing huge amounts of data. In such a system it is often impractical to write log files consisting of all topics to disk in a single bag file. The rosbag record command supports logging only particular topics to a bag file, allowing a user to only record the topics of interest to them.

## To name the bag file and selectively record

(This option is the letter O)

```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag record -O cmdvel /turtle1/cmd_vel
/turtle1/pose
[ INFO] [1427222327.911823890]: Subscribing to /turtle1/cmd_vel
[ INFO] [1427222327.914523800]: Subscribing to /turtle1/pose
[ INFO] [1427222327.917503556]: Recording to cmdvel.bag.
```

```
tlharmanphd@D125-43873:~/bagfilesturtle$ ls
2015-03-24-13-13-12.bag cmdvel.bag
```

**Move the turtle with the keys with focus on the teleop window.** The -O argument tells rosbag record to log to a file named subset.bag, and the topic arguments cause rosbag record to only subscribe to these two topics. Move the turtle around for several seconds using the keyboard arrow commands, and then Ctrl-c in the rosbag window to stop the rosbag record.

```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag info cmdvel.bag
path:      cmdvel.bag
version:   2.0
duration:  1:01s (61s)
start:     Mar 24 2015 13:38:48.20 (1427222328.20)
end:       Mar 24 2015 13:39:49.94 (1427222389.94)
size:      311.4 KB
messages:  3972
compression: none [1/1 chunks]
types:     geometry_msgs/Twist [9f195f881246fdfa2798d1d3eebca84a]
           turtlesim/Pose      [863b248d5016ca62ea2e895ae5265cf9]
topics:    /turtle1/cmd_vel  112 msgs  : geometry_msgs/Twist
           /turtle1/pose    3860 msgs  : turtlesim/Pose
```

```
tlharmanphd@D125-43873:~/bagfilesturtle$ rosbag play cmdvel.bag
[ INFO] [1427222827.531968073]: Opening cmdvel.bag
```

Waiting 0.2 seconds after advertising topics... done.

Hit space to toggle paused, or 's' to step.

```
[RUNNING] Bag Time: 1427222389.908203 Duration: 61.712115 / 61.743916
Done.
```

**WATCH THE TURTLE MOVE!**



*Figure 18 Turtle moving with subset of rosbag data*

### **The limitations of rosbag record/play**

In the previous section you may have noted that the turtle's path may not have exactly mapped to the original keyboard input - the rough shape should have been the same, but the turtle may not have exactly tracked the same path. The reason for this is that the path tracked by turtlesim is very sensitive to small changes in timing in the system, and rosbag is limited in its ability to exactly duplicate the behavior of a running system in terms of when messages are recorded and processed by rosrecord, and when messages are produced and processed when using roslaunch. For nodes like turtlesim, where minor timing changes in when command messages are processed can subtly alter behavior, the user should not expect perfectly mimicked behavior.

## APPENDIX I. REFERENCES

### GETTING STARTED WITH TURTLESIM

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

### GENTLE INTRODUCTION O’KANE CHAPTER 2

<http://www.cse.sc.edu/~jokane/agitr/agitr-letter-start.pdf>

### TUTORIALS USING TURTLESIM – A LIST

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

---

## ROS CONCEPTS

ROS has three levels of concepts: the Filesystem level, the Computation Graph level, and the Community level. These levels and concepts are summarized below and later sections go into each of these in greater detail.

The filesystem level concepts mainly cover ROS resources that you encounter on disk, such as packages, metapackages, manifests, repositories, messages, and services

The *Computation Graph* is the peer-to-peer network of ROS processes that are processing data together. The basic Computation Graph concepts of ROS are *nodes*, *Master*, *Parameter Server*, *messages*, *services*, *topics*, and *bags*, all of which provide data to the Graph in different ways.

The ROS Community Level concepts are ROS resources that enable separate communities to exchange software and knowledge. These resources include distributions, repositories, ROS wiki, ROS answers, and a Blog.

In addition to the three levels of concepts, ROS also defines two types of **names** -- Package Resource Names and Graph Resource Names -- which are discussed below.

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

## ROSCORE

From the ROS tutorial <http://wiki.ros.org/roscore>

roscore is a collection of **nodes** and programs that are pre-requisites of a ROS-based system. You **must** have a roscore running in order for ROS nodes to communicate. It is launched using the `roscore` command.

## ROS MASTER

The ROS Master provides naming and registration services to the rest of the **nodes** in the ROS system. It tracks publishers and subscribers to **topics** as well as **services**. The role of the Master is to enable individual ROS nodes to locate one another. Once these nodes have located each other they communicate with each other peer-to-peer.

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

### Clearpath diagram of Master

<http://www.clearpathrobotics.com/blog/how-to-guide-ros-101/>

## ROS NODES AND TURTLESIM

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



## ROS TOPICS AND TURTLESIM

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

### ROSSERVICE

rosservice contains the rosservice command-line tool for listing and querying ROS [Services](#)

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

### ROSSERVICE AND ROS SERVICE PARAMETERS

This tutorial introduces ROS services, and parameters as well as using the [rosservice](#) and [rosparam](#) commandline tools.

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

<http://wiki.ros.org/Parameter%20Server>

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

<http://www.cse.sc.edu/~jokane/agitr/agitr-small-param.pdf> (Chapter 7 of O'Kane)

### ROSSERVICE AND ROS TELEPORT PARAMETER

Let's bring the turtle to a known starting point using absolute teleportation. Its inputs are [x y theta]. The origin [0 0 0] is offscreen so we will start with [1 1 0]. The turtle should be facing to the right (0\*).

```
rosservice call /turtle1/teleport_absolute 1 1 0
```

<https://sites.google.com/site/ubrobotics/ros-documentation>

### USING RQT\_PLOT, RQT\_CONSOLE AND ROSLAUNCH WITH TURTLESIM

[http://wiki.ros.org/rqt\\_plot](http://wiki.ros.org/rqt_plot)

This tutorial introduces ROS using [rqt\\_console](#) and [rqt\\_logger\\_level](#) for debugging and [roslaunch](#) for starting many nodes at once.

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

### ROSBAG TURTLESIM EXAMPLE

This tutorial will teach you how to record data from a running ROS system into a .bag file, and then to play back the data to produce similar behavior in a running system.

**Keywords:** data, rosbag, record, play, info, bag

### TURTLESIM EXAMPLE

<http://wiki.ros.org/rosbag/Tutorials/Recording%20and%20playing%20back%20data/>

### DATA LOGGING USING ROSBAG

[http://www.fer.unizg.hr/\\_download/repository/p08-rosbag.pdf](http://www.fer.unizg.hr/_download/repository/p08-rosbag.pdf)

### INTRODUCTION TO TF AND TURTLESIM

This tutorial will give you a good idea of what tf can do for you. It shows off some of the tf power in a multi-robot example using [turtlesim](#). This also introduces using [tf\\_echo](#), [view\\_frames](#), [rqt\\_tf\\_tree](#), and [rviz](#).

<http://wiki.ros.org/tf/Tutorials/Introduction%20to%20tf/>

## **YAML Command LINE**

Several ROS tools ([rostopic](#), [rosservice](#)) use the YAML markup language on the command line. YAML was chosen as, in most cases, it offers a very simple, nearly markup-less solution to typing in typed parameters.

For a quick overview of YAML, please see [YAML Overview](#).

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

## APPENDIX II. TURTLESIM MANIFEST (PACKAGE.XML)

tlharmanphd@D125-43873:~\$ **gedit /opt/ros/indigo/share/turtlesim/package.xml**

```
<?xml version="1.0"?>
<package>
  <name>turtlesim</name>
  <version>0.5.2</version>
  <description>
    turtlesim is a tool made for teaching ROS and ROS packages.
  </description>
  <maintainer email="dthomas@osrfoundation.org">Dirk Thomas</maintainer>
  <license>BSD</license>

  <url type="website">http://www.ros.org/wiki/turtlesim</url>
  <url type="bugtracker">https://github.com/ros/ros_tutorials/issues</url>
  <url type="repository">https://github.com/ros/ros_tutorials</url>
  <author>Josh Faust</author>

  <buildtool_depend>catkin</buildtool_depend>

  <build_depend>geometry_msgs</build_depend>
  <build_depend>libqt4-dev</build_depend>
  <build_depend>message_generation</build_depend>
  <build_depend>qt4-qmake</build_depend>
  <build_depend>roscpp</build_depend>
  <build_depend>roscpp_serialization</build_depend>
  <build_depend>roslib</build_depend>
  <build_depend>rostime</build_depend>
  <build_depend>std_msgs</build_depend>
  <build_depend>std_srvs</build_depend>

  <run_depend>geometry_msgs</run_depend>
  <run_depend>libqt4</run_depend>
  <run_depend>message_runtime</run_depend>
  <run_depend>roscpp</run_depend>
  <run_depend>roscpp_serialization</run_depend>
  <run_depend>roslib</run_depend>
  <run_depend>rostime</run_depend>
  <run_depend>std_msgs</run_depend>
  <run_depend>std_srvs</run_depend>
</package>
```

### APPENDIX III. TURTLESIM DIRECTORIES AND FILES

**tlharmanphd@D125-43873:~\$ locate turtlesim**

```
/home/ceng5931/Documents/simple turtlesim~  
/home/ceng5931/Documents/how to/How to run turtlesim  
/home/fairchildc/Desktop/Turtlesim/turtlesim .odt  
/home/fairchildc/Desktop/baxter 2_12_2015/work on turtlesim 2_12_2015.odt  
/home/louiseli/Desktop/How To/How to run turtlesim Indigo  
/home/louiseli/Desktop/How To/How to run turtlesim Indigo~  
/home/louiseli/Desktop/How To/How to run turtlesimGroovy  
/home/louiseli/Desktop/How To/How to run turtlesim~  
/home/tlharmanphd/Desktop/0_BaxterFrom  
Office/Copied/UsersGuide/turtlesimFiles1_23_2015A.docx  
/home/tlharmanphd/Desktop/Baxter Guides/turtlesimUpdatesIndigo.odt  
/home/tlharmanphd/Guides_data/Turtlesim/turtlesimFiles.odt  
/home/tlharmanphd/Guides_data/Turtlesim/turtlesimFiles1_23_2015.odt  
/home/tlharmanphd/Guides_data/Turtlesim/turtlesimFiles1_23_2015A.docx  
/home/tlharmanphd/Guides_data/Turtlesim/turtlesimwindows2015-01-29 14:18:27.png  
/home/tlharmanphd/Videos/turtlesimNode 2015-02-21 16:01:00.png  
/opt/ros/indigo/include/turtlesim  
/opt/ros/indigo/include/turtlesim/Color.h  
/opt/ros/indigo/include/turtlesim/Kill.h  
/opt/ros/indigo/include/turtlesim/KillRequest.h  
/opt/ros/indigo/include/turtlesim/KillResponse.h  
/opt/ros/indigo/include/turtlesim/Pose.h  
/opt/ros/indigo/include/turtlesim/SetPen.h  
/opt/ros/indigo/include/turtlesim/SetPenRequest.h  
/opt/ros/indigo/include/turtlesim/SetPenResponse.h  
/opt/ros/indigo/include/turtlesim/Spawn.h  
/opt/ros/indigo/include/turtlesim/SpawnRequest.h  
/opt/ros/indigo/include/turtlesim/SpawnResponse.h  
/opt/ros/indigo/include/turtlesim/TeleportAbsolute.h  
/opt/ros/indigo/include/turtlesim/TeleportAbsoluteRequest.h  
/opt/ros/indigo/include/turtlesim/TeleportAbsoluteResponse.h  
/opt/ros/indigo/include/turtlesim/TeleportRelative.h  
/opt/ros/indigo/include/turtlesim/TeleportRelativeRequest.h  
/opt/ros/indigo/include/turtlesim/TeleportRelativeResponse.h  
/opt/ros/indigo/lib/turtlesim  
/opt/ros/indigo/lib/pkgconfig/turtlesim.pc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/__init__.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/__init__.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg/_Color.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg/_Color.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg/_Pose.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg/_Pose.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg/__init__.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/msg/__init__.pyc
```

/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_Kill.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_Kill.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_SetPen.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_SetPen.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_Spawn.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_Spawn.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_TeleportAbsolute.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_TeleportAbsolute.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_TeleportRelative.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_TeleportRelative.pyc  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_\_init\_\_.py  
/opt/ros/indigo/lib/python2.7/dist-packages/turtlesim/srv/\_\_init\_\_.pyc  
/opt/ros/indigo/lib/turtlesim/draw\_square  
/opt/ros/indigo/lib/turtlesim/mimic  
/opt/ros/indigo/lib/turtlesim/turtle\_teleop\_key  
/opt/ros/indigo/lib/turtlesim/turtlesim\_node  
/opt/ros/indigo/share/turtlesim  
/opt/ros/indigo/share/common-lisp/ros/turtlesim  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg/Color.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg/Pose.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg/\_package.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg/\_package\_Color.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg/\_package\_Pose.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/msg/turtlesim-msg.asd  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/Kill.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/SetPen.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/Spawn.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/TeleportAbsolute.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/TeleportRelative.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/\_package.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/\_package\_Kill.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/\_package\_SetPen.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/\_package\_Spawn.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/\_package\_TeleportAbsolute.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/\_package\_TeleportRelative.lisp  
/opt/ros/indigo/share/common-lisp/ros/turtlesim/srv/turtlesim-srv.asd  
/opt/ros/indigo/share/turtlesim/cmake  
/opt/ros/indigo/share/turtlesim/images  
/opt/ros/indigo/share/turtlesim/msg  
/opt/ros/indigo/share/turtlesim/package.xml  
/opt/ros/indigo/share/turtlesim/srv  
/opt/ros/indigo/share/turtlesim/cmake/turtlesim-msg-extras.cmake  
/opt/ros/indigo/share/turtlesim/cmake/turtlesim-msg-paths.cmake  
/opt/ros/indigo/share/turtlesim/cmake/turtlesimConfig-version.cmake  
/opt/ros/indigo/share/turtlesim/cmake/turtlesimConfig.cmake  
/opt/ros/indigo/share/turtlesim/images/box-turtle.png  
/opt/ros/indigo/share/turtlesim/images/diamondback.png

```
/opt/ros/indigo/share/turtlesim/images/electric.png
/opt/ros/indigo/share/turtlesim/images/fuerte.png
/opt/ros/indigo/share/turtlesim/images/groovy.png
/opt/ros/indigo/share/turtlesim/images/hydro.png
/opt/ros/indigo/share/turtlesim/images/hydro.svg
/opt/ros/indigo/share/turtlesim/images/indigo.png
/opt/ros/indigo/share/turtlesim/images/indigo.svg
/opt/ros/indigo/share/turtlesim/images/palette.png
/opt/ros/indigo/share/turtlesim/images/robot-turtle.png
/opt/ros/indigo/share/turtlesim/images/sea-turtle.png
/opt/ros/indigo/share/turtlesim/images/turtle.png
/opt/ros/indigo/share/turtlesim/msg/Color.msg
/opt/ros/indigo/share/turtlesim/msg/Pose.msg
/opt/ros/indigo/share/turtlesim/srv/Kill.srv
/opt/ros/indigo/share/turtlesim/srv/SetPen.srv
/opt/ros/indigo/share/turtlesim/srv/Spawn.srv
/opt/ros/indigo/share/turtlesim/srv/TeleportAbsolute.srv
/opt/ros/indigo/share/turtlesim/srv/TeleportRelative.srv
/usr/share/doc/ros-indigo-turtlesim
/usr/share/doc/ros-indigo-turtlesim/changelog.Debian.gz
/var/lib/dpkg/info/ros-indigo-turtlesim.list
/var/lib/dpkg/info/ros-indigo-turtlesim.md5sums
tlharmanphd@D125-43873:~$ l
```

03/25/15

```
tlharmanphd@D125-43873:~$ cd /opt/ros/indigo/lib/turtlesim
tlharmanphd@D125-43873:/opt/ros/indigo/lib/turtlesim$ ls -la
total 400
drwxr-xr-x  2 root root  4096 Mar 16 20:56 .
drwxr-xr-x 105 root root 20480 Mar 18 15:47 ..
-rwxr-xr-x  1 root root 72248 Feb 20 13:18 draw_square
-rwxr-xr-x  1 root root 59832 Feb 20 13:18 mimic
-rwxr-xr-x  1 root root 220920 Feb 20 13:18 turtlesim_node
-rwxr-xr-x  1 root root 27112 Feb 20 13:18 turtle_teleop_key
tlharmanphd@D125-43873:/opt/ros/indigo/lib/turtlesim$
```

## APPENDIX 1V. INDIGO VS GROOVY

### SOME CHANGES FOR TURTLESIM UPDATE INDIGO (3/2015)

Go through all examples and also update References in the Appendix.

#### Command the turtle with cmd\_vel (Not command\_velocity)

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

```
($rostopic pub /turtle1/command_velocity turtlesim/Velocity -r 1 -- 4.0 -1.8 for groovy)
```

#### rostopic type for /turtle1/cmd\_vel

```
$rostopic type /turtle1/cmd_vel //indigo  
geometry_msgs/Twist
```

```
$rostopic type /turtle1/command_velocity //groovy  
turtlesim/Velocity
```

```
$rostopic type /turtle1/pose  
turtlesim/Pose
```

#### Echo cmd\_vel to show pose

```
$rostopic echo /turtle1/cmd_vel //indigo  
linear:  
x: 4.0  
y: 0.0  
z: 0.0  
angular:  
x: 0.0  
y: 0.0  
z: 1.8
```

```
$rostopic echo /turtle1/command_velocity // groovy  
linear: 2.0  
angular: -1.79999995232
```

## APPENDIX V. TURTLESIM CHEATSHEET

02/13/16 Turtlesim Cheat Sheet

1. **\$ roscore** (leave running but minimize)

2. **2<sup>nd</sup> Terminal**

3. **\$ rosrunc turtlesim turtlesim\_node**

(See the turtle with Blue Background – leave terminal window running and view turtle)

4. **3<sup>rd</sup> Terminal**

**\$ rosnode info turtlesim (Determine node information)**

```
tlharmanphd@D125-43873:~$ rosnode info turtlesim
```

```
-----  
Node [/turtlesim]
```

```
Publications:
```

- \* /turtle1/color\_sensor [turtlesim/Color]
- \* /rosout [roscpp\_msgs/Log]
- \* /turtle1/pose [turtlesim/Pose]

```
Subscriptions:
```

- \* /turtle1/cmd\_vel [unknown type]

```
Services:
```

- \* /turtle1/teleport\_absolute
- \* /turtlesim/get\_loggers
- \* /turtlesim/set\_logger\_level
- \* /reset
- \* /spawn
- \* /clear
- \* /turtle1/set\_pen
- \* /turtle1/teleport\_relative
- \* /kill

```
contacting node http://D125-43873:41890/ ...
```

```
Pid: 7420
```

```
Connections:
```

- \* topic: /rosout
- \* to: /rosout
- \* direction: outbound
- \* transport: TCPROS

**NOW YOU HAVE THE INFORMATION TO CONTROL TURTLESIM!**



-----

Look at Colors

**\$ rostopic echo /turtle1/color\_sensor (r: b: g: Cntl+C to stop)**

-----

**rosparam get parameters and change color of background to Red**

tlharmanphd@D125-43873:~\$ **rosparam get /**

background\_b: 255

background\_g: 86

background\_r: 69

rostdistro: 'indigo'

roslaunch:

uris: {host\_d125\_43873\_\_60512: 'http://D125-43873:60512/'}

rosversion: '1.11.10'

run\_id: 2429b792-d23c-11e4-b9ee-3417ebbca982

**rosparam set**

Change the colors:

tlharmanphd@D125-43873:/\$ **rosparam set background\_b 0**

tlharmanphd@D125-43873:/\$ **rosparam set background\_g 0**

tlharmanphd@D125-43873:/\$ **rosparam set background\_r 255**

tlharmanphd@D125-43873:/\$ **rosservice call /clear (See Red!)**

-----

**Services Absolute and Relative Move**

**\$ rosservice call /turtle1/teleport\_absolute 1 1 0 (Move to 1,1)**

**\$ rosservice call /turtle1/teleport\_relative 1 0**

-----

**Check Turtle1's pose**

**\$ rostopic echo /turtle1/pose**

x: 1.0

y: 1.0

theta: 0.0

linear\_velocity: 0.0

angular\_velocity: 0.0

## **LETS CONTROL THE TURTLE- Publish to /turtle1/cmd\_vel: ( roscore and turtlesim\_node running)**

1. Command line
2. Keyboard
3. Joystick
4. Python

Subscriptions: /turtle1/cmd\_vel [unknown type]

```
$ rostopic type /turtle1/cmd_vel  
geometry_msgs/Twist
```

- 1a. Move a bit 1 command

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

- 1b. Move in a circle repeat at frequency \$ rostopic hz /turtle1/pose

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

## **2. \$ rosrn turtlesim turtle\_teleop\_key (Cntl+c to exit)**

Reading from keyboard

-----

Use arrow keys to move the turtle.

Up arrow	Turtle up
Down arrow	Turtle down
Right arrow	Rotate CW
Left arrow	Rotate CCW

```
$ rqt_graph (See the namespaces, nodes and topics)
```

3. Joystick

4. Python Creates node /ControlTurtlesim ; Publishes to /turtle1/cmd\_vel with Twist msg

```
$ python turtlesim1.py      (Make Executable $chmod +x turtlesim1.py
```

```
[INFO] [WallTime: 1455313387.186692] Press CTRL+c to stop TurtleBot  
[INFO] [WallTime: 1455313387.188315] Set rate 10Hz
```

```
#!/usr/bin/env python  turtlesim1.py  
# Execute as a python script  
# Set linear and angular values of Turtlesim's speed and turning.  
import rospy          # Needed to create a ROS node  
from geometry_msgs.msg import Twist  # Message that moves base  
  
class ControlTurtlesim():  
    def __init__(self):  
        # ControlTurtlesim is the name of the node sent to the master  
        rospy.init_node('ControlTurtlesim', anonymous=False)  
  
        # Message to screen  
        rospy.loginfo(" Press CTRL+c to stop TurtleBot")  
  
        # Keys CNTL + c will stop script  
        rospy.on_shutdown(self.shutdown)  
  
        # Publisher will send Twist message on topic  
        # /turtle1/cmd_vel  
  
        self.cmd_vel = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)  
  
        # Turtlesim will receive the message 10 times per second.  
        rate = rospy.Rate(10);  
        # 10 Hz is fine as long as the processing does not exceed  
        # 1/10 second.  
        rospy.loginfo(" Set rate 10Hz")  
        # Twist is geometry_msgs for linear and angular velocity  
        move_cmd = Twist()  
        # Linear speed in x in meters/second is + (forward) or  
        # - (backwards)  
        move_cmd.linear.x = 0.3  # Modify this value to change speed  
        # Turn at 0 radians/s  
        move_cmd.angular.z = 0  
        # Modify this value to cause rotation rad/s  
  
        # Loop and TurtleBot will move until you type CNTL+c  
        while not rospy.is_shutdown():  
            # publish Twist values to the Turtlesim node /cmd_vel  
            self.cmd_vel.publish(move_cmd)  
            # wait for 0.1 seconds (10 HZ) and publish again  
            rate.sleep()  
  
    def shutdown(self):  
        # You can stop turtlebot by publishing an empty Twist message  
        rospy.loginfo("Stopping Turtlesim")  
  
        self.cmd_vel.publish(Twist())  
        # Give TurtleBot time to stop  
        rospy.sleep(1)  
  
if __name__ == '__main__':
```

```
try:  
    ControlTurtlesim()  
except:  
    rospy.loginfo("End of the trip for Turtlesim")
```

```
$ rosnodetool list  
/ControlTurtlesim  
/rosout  
/teleop_turtle  
/turtlesim
```

Change Python script turtlesim1.py to run turtle in a circle ( Make executable)  
In ros\_ws

```
tlharmanphd@D125-43873:~/ros_ws$ python turtlesim2.py  
[INFO] [WallTime: 1455383932.566053] Press CTRL+c to stop TurtleBot  
[INFO] [WallTime: 1455383932.567306] Set rate 10Hz  
^C[INFO] [WallTime: 1455383937.538077] Stopping Turtlesim
```



In turtlesim2.py Script  
move\_cmd = Twist()  
    # Linear speed in x in meters/second is + (forward) or  
    # - (backwards)  
    **move\_cmd.linear.x = 2.0**    # Modify this value to change speed  
    # Turn at 1.8 radians/s  
    **move\_cmd.angular.z = 1.8**  
    # Modify this value to cause rotation rad/s