ROS

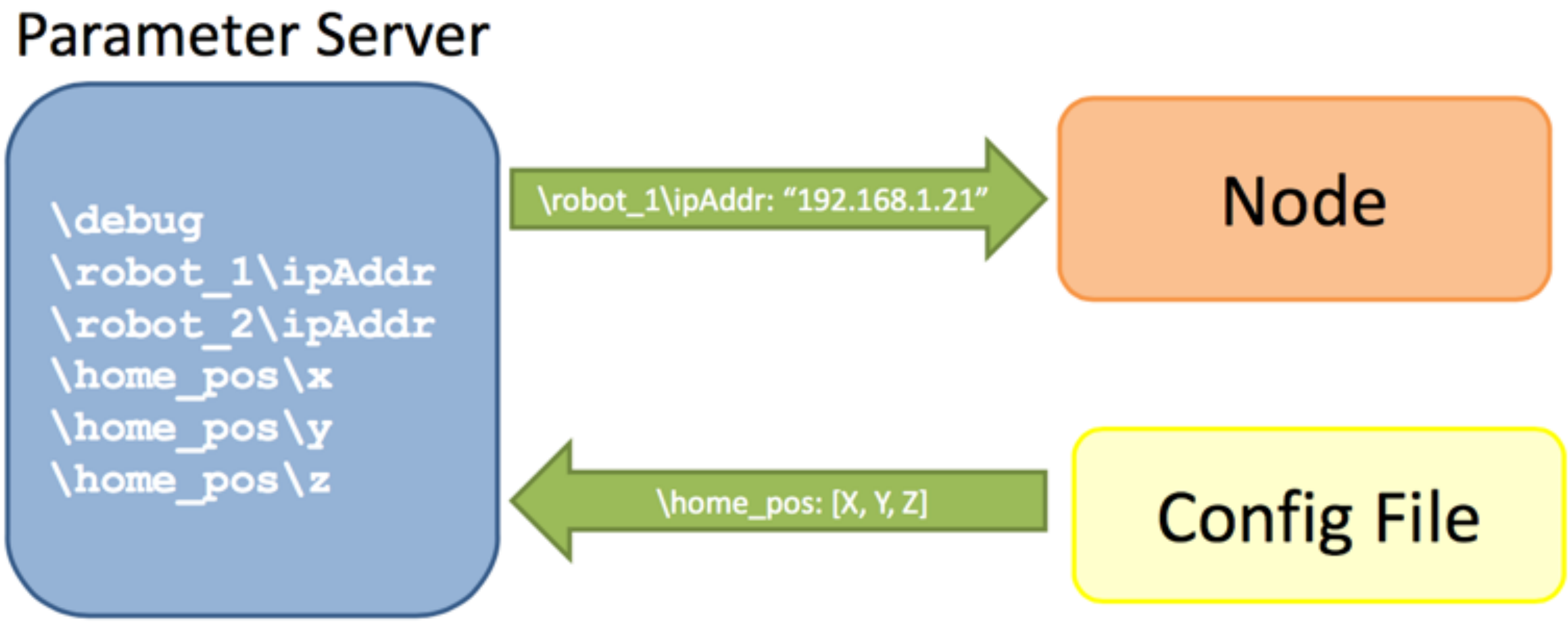
Pub-Sub, Parameters, Services, Roslaunch etc

Agenda

- Publishing messages to topics
- Subscribing to topics
- Differential drive robots
- Sending velocity commands
- roslaunch

ROS Parameters

- Parameters are like global data
- Accessed through the Parameter Server
- Typically handled by roscore



Setting Parameters

- Command line

```
rosrun my_pkg load_robot _ip:=“192.168.1.21” rosparam set “/debug”
true
```

- Programs

```
nh.setParam(“name”, “left”);
```

Namespaces

- Folder Hierarchy allows Separation:
- Separate nodes can co-exist, in different “namespaces”
- –relative vs. absolute name references
- Accessed through rose::NodeHandle object
    - also sets default Namespace for access
        - Global (root) Namespace

```
ros::NodeHandle global();
global.getParam(“test”);
```

        - Fixed Namespace:

```
ros::NodeHandle fixed(“/myApp”);
global.getParam(“test”);
```

Parameters: C++ API

- NodeHandle object methods
- nh.hasParam(key)
  - Returns true if parameter exists
- nh.getParam(key, &value)
  - Gets value, returns T/F if exists.
- nh.param(key, &value, default)
  - Get value (or default, if doesn’t exist)
- nh.setParam(key, value)
  - Sets value
- nh.deleteParam(key)
  - Deletes parameter

ros::Publisher

- Manages an advertisement on a specific topic
- A Publisher is created by calling NodeHandle::advertise()
  - Registers this topic in the master node
- Example for creating a publisher:

```
ros::Publisher chatter_pub = node.advertise<std_msgs::String>("chatter", 1000);
```

  - First parameter is the topic name
  - Second parameter is the queue size
- Once all the publishers for a given topic go out of scope the topic will be unadvertised

ros::Publisher

- Messages are published on a topic through a call to publish()
- Example:

```
std_msgs::String msg;
chatter_pub.publish(msg);
```

- The type of the message object must agree with the type given as a template parameter to the advertise<>() call

Talker and Listener

- We now create a new package with two nodes:
  - talker publishes messages to topic “chatter”
  - listener reads the messages from the topic and prints them out to the screen
- First create the package

```
$ cd ~/catkin_ws/src
catkin_create_pkg chat_pkg std_msgs rospy roscpp
```

- Open the package source directory in QtCreator and add a C++ source file named Talker.cpp
- Copy the following code into it

Talker.cpp

```
#include "ros/ros.h"
#include "std_msgs/String.h"
#include <sstream>

int main(int argc, char **argv)
{
    ros::init(argc, argv, "talker"); // Initiate new ROS node named "talker"

    ros::NodeHandle node;
    ros::Publisher chatter_pub = node.advertise<std_msgs::String>("chatter", 1000);
    ros::Rate loop_rate(10);

    int count = 0;
    while (ros::ok()) // Keep spinning loop until user presses Ctrl+C
    {
        std_msgs::String msg;

        std::stringstream ss;
        ss << "hello world " << count;
        msg.data = ss.str();
        ROS_INFO("%s", msg.data.c_str());

        chatter_pub.publish(msg);

        ros::spinOnce(); // Need to call this function often to allow ROS to process incoming messages

        loop_rate.sleep(); // Sleep for the rest of the cycle, to enforce the loop rate
        count++;
    }
    return 0;
}
```

Subscribing to a Topic

- To start listening to a topic, call the method subscribe() of the node handle
    - This returns a Subscriber object that you must hold on to until you want to unsubscribe
- Example for creating a subscriber:

```
ros::Subscriber sub = node.subscribe("chatter", 1000, messageCallback);
```

- First parameter is the topic name
- Second parameter is the queue size
- Third parameter is the function to handle the message

Listener.cpp

```cpp
#include "ros/ros.h"
#include "std_msgs/String.h"

// Topic messages callback
void chatterCallback(const std_msgs::String::ConstPtr& msg)
{
    ROS_INFO("I heard: [%s]", msg->data.c_str());
}

int main(int argc, char **argv)
{
    // Initiate a new ROS node named "listener"
    ros::init(argc, argv, "listener");
    ros::NodeHandle node;

    // Subscribe to a given topic
    ros::Subscriber sub = node.subscribe("chatter", 1000, chatterCallback);

    // Enter a loop, pumping callbacks
    ros::spin();

    return 0;
}
```

ros::spin()

- The ros::spin() creates a loop where the node starts to read the topic, and when a message arrives messageCallback is called
- ros::spin() will exit once ros::ok() returns false
    - For example, when the user presses Ctrl+C or when ros::shutdown() is called

Using Class Methods as Callbacks

- Suppose you have a simple class, Listener:

```
class Listener
{
     public: void callback(const std_msgs::String::ConstPtr& msg);
};
```

- Then the NodeHandle::subscribe() call using the class method looks like this:

```
Listener listener;
ros::Subscriber sub = node.subscribe("chatter", 1000, &Listener::callback,
&listener);
```

Compile the Nodes

- Add the following to the package’s CMakeLists file

```
cmake_minimum_required(VERSION 2.8.3)
project(chat_pkg)
…

## Declare a cpp executable
add_executable(talker src/Talker.cpp)
add_executable(listener src/Listener.cpp)

## Specify libraries to link a library or executable target against
target_link_libraries(talker ${catkin_LIBRARIES})
target_link_libraries(listener ${catkin_LIBRARIES})
```

Building the Nodes

- Now build the package and compile all the nodes using the catkin_make tool:

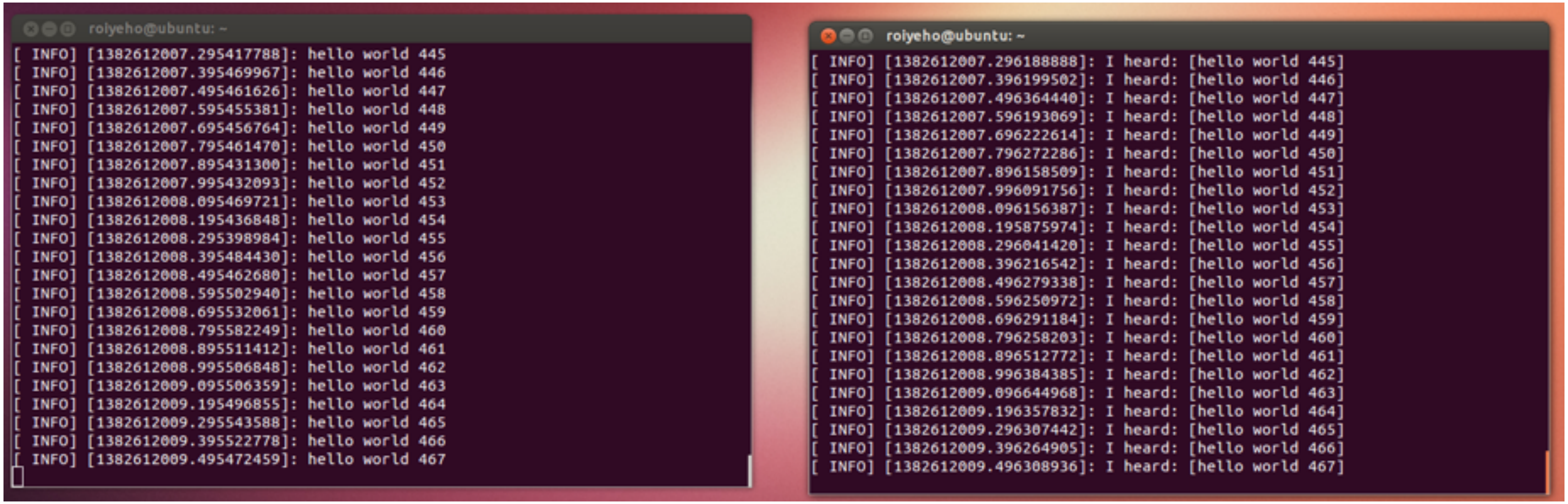
```
cd ~/catkin_ws
catkin_make
```

- This will create two executables, talker and listener, at ~/catkin_ws/devel/lib/chat_pkg

Running the Nodes From Terminal

- Run roscore
- Run the nodes in two different terminals:

```
$ rosrun chat_pkg talker
$ rosrun chat_pkg listener
```

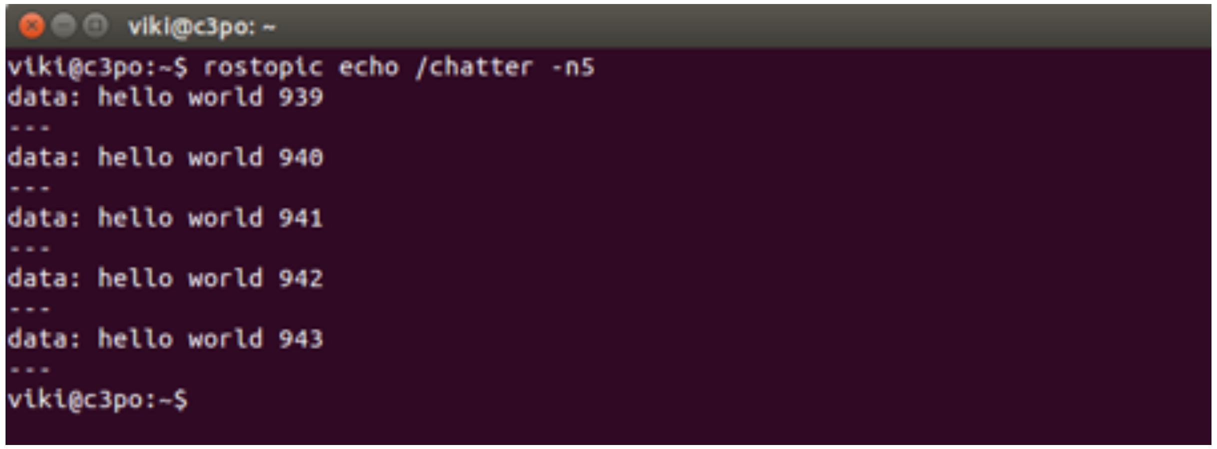


```
[ INFO] [1382612007.295417788]: hello world 445
[ INFO] [1382612007.395469967]: hello world 446
[ INFO] [1382612007.495461626]: hello world 447
[ INFO] [1382612007.595455381]: hello world 448
[ INFO] [1382612007.695456764]: hello world 449
[ INFO] [1382612007.795461470]: hello world 450
[ INFO] [1382612007.895431300]: hello world 451
[ INFO] [1382612007.995432093]: hello world 452
[ INFO] [1382612008.095469721]: hello world 453
[ INFO] [1382612008.195436848]: hello world 454
[ INFO] [1382612008.295398984]: hello world 455
[ INFO] [1382612008.395484430]: hello world 456
[ INFO] [1382612008.495462680]: hello world 457
[ INFO] [1382612008.595502940]: hello world 458
[ INFO] [1382612008.695532061]: hello world 459
[ INFO] [1382612008.795582249]: hello world 460
[ INFO] [1382612008.895511412]: hello world 461
[ INFO] [1382612008.995506848]: hello world 462
[ INFO] [1382612009.095506359]: hello world 463
[ INFO] [1382612009.195496855]: hello world 464
[ INFO] [1382612009.295543588]: hello world 465
[ INFO] [1382612009.395522778]: hello world 466
[ INFO] [1382612009.495472459]: hello world 467
```

```
[ INFO] [1382612007.296188888]: I heard: [hello world 445]
[ INFO] [1382612007.396199502]: I heard: [hello world 446]
[ INFO] [1382612007.496364440]: I heard: [hello world 447]
[ INFO] [1382612007.596193069]: I heard: [hello world 448]
[ INFO] [1382612007.696222614]: I heard: [hello world 449]
[ INFO] [1382612007.796272286]: I heard: [hello world 450]
[ INFO] [1382612007.896158509]: I heard: [hello world 451]
[ INFO] [1382612007.996091756]: I heard: [hello world 452]
[ INFO] [1382612008.096156387]: I heard: [hello world 453]
[ INFO] [1382612008.195875974]: I heard: [hello world 454]
[ INFO] [1382612008.296041420]: I heard: [hello world 455]
[ INFO] [1382612008.396216542]: I heard: [hello world 456]
[ INFO] [1382612008.496279338]: I heard: [hello world 457]
[ INFO] [1382612008.596250972]: I heard: [hello world 458]
[ INFO] [1382612008.696291184]: I heard: [hello world 459]
[ INFO] [1382612008.796258203]: I heard: [hello world 460]
[ INFO] [1382612008.896512772]: I heard: [hello world 461]
[ INFO] [1382612008.996384385]: I heard: [hello world 462]
[ INFO] [1382612009.096644968]: I heard: [hello world 463]
[ INFO] [1382612009.196357832]: I heard: [hello world 464]
[ INFO] [1382612009.296307442]: I heard: [hello world 465]
[ INFO] [1382612009.396264905]: I heard: [hello world 466]
[ INFO] [1382612009.496308936]: I heard: [hello world 467]
```

Running the Nodes From Terminal

- You can use **rosnode** and **rostopic** to debug and see what the nodes are doing
- Examples:
  - $rosnode info /talker
  - $rosnode info /listener
  - $rostopic list
  - $rostopic info /chatter
  - $rostopic echo /chatter

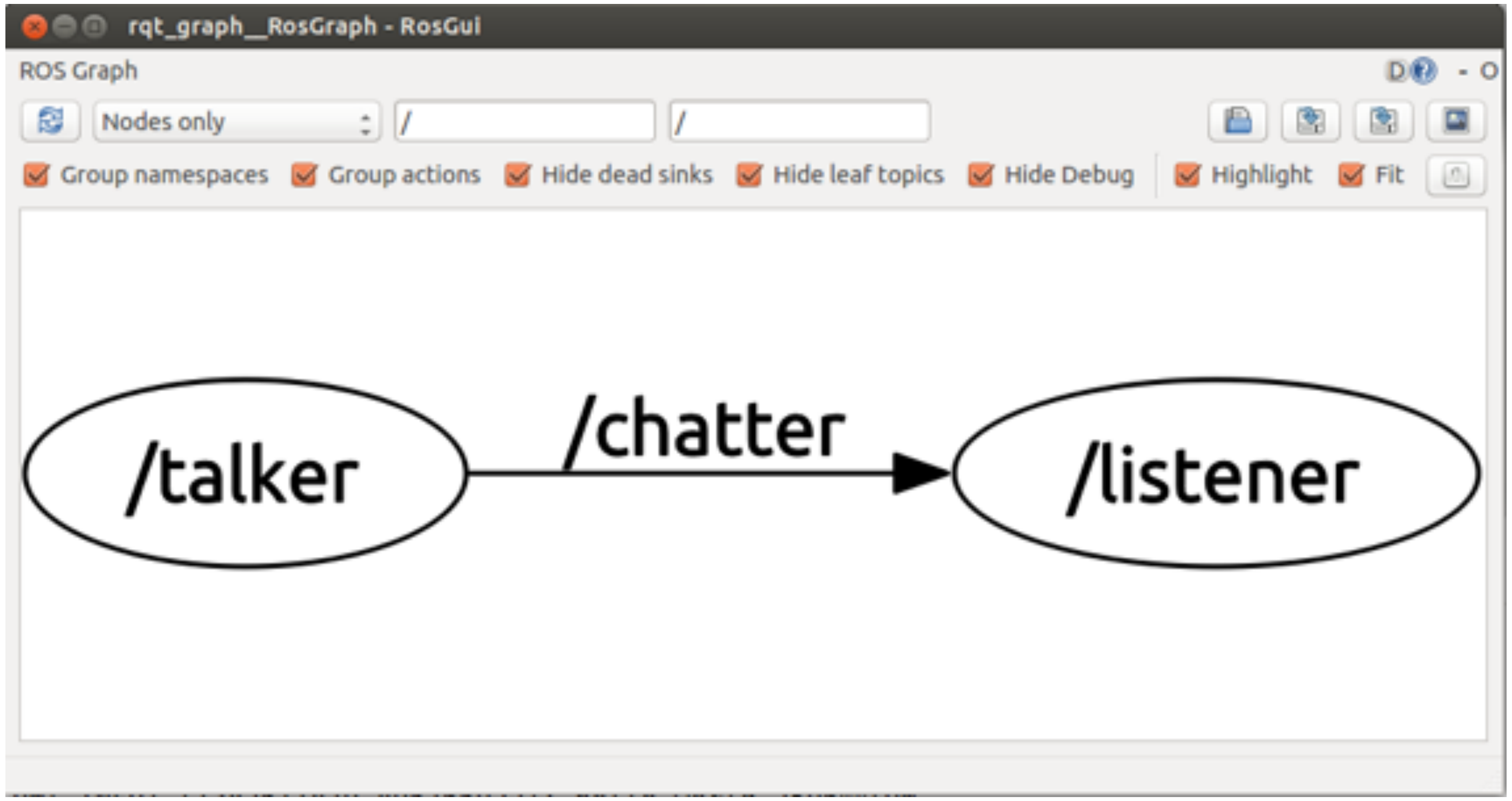


```
viki@c3po:~$ rostopic echo /chatter -n5
data: hello world 939
---
data: hello world 940
---
data: hello world 941
---
data: hello world 942
---
data: hello world 943
---
viki@c3po:~$
```

rqt_graph

- rqt_graph creates a dynamic graph of what's going on in the system
- Use the following command to run it:

```
$ rosrun rqt_graph rqt_graph
```



Nodes only

/

/

☑ Group namespaces ☑ Group actions ☑ Hide dead sinks ☑ Hide leaf topics ☑ Hide Debug ☑ Highlight ☑ Fit

ROS Services

- The next step is to learn how to read the map in your ROS nodes
- For that purpose we will use a ROS service called **static_map** from the package map_server
- Services use the request/reply paradigm instead of the publish/subscribe model

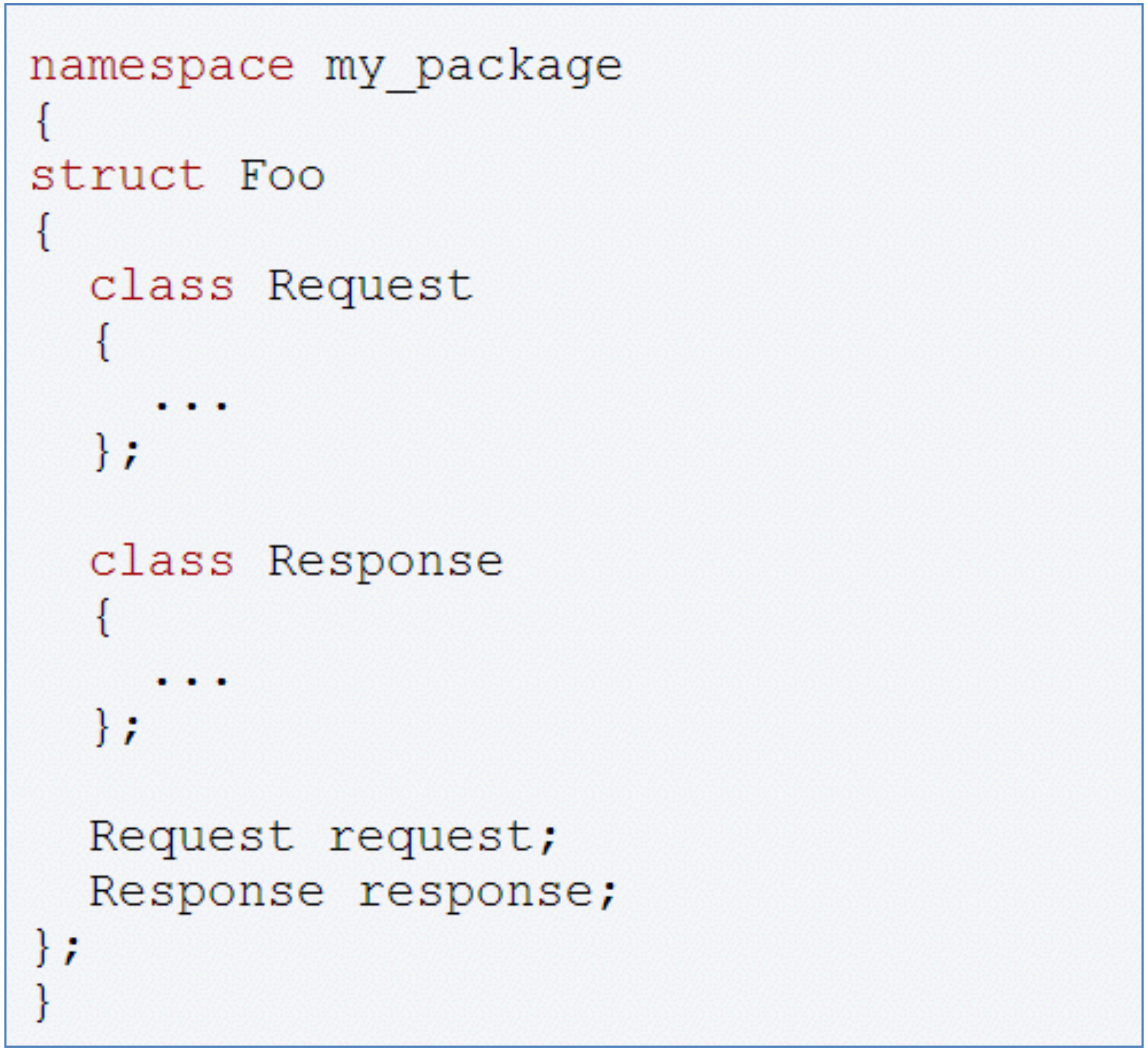
Service Definitions

- ROS Services are defined by srv files, which contains a request message and a response message.
    - These are identical to the messages used with ROS Topics
- roscpp converts these srv files into C++ source code and creates 3 classes
- The names of these classes come directly from the srv filename:

  my_package/srv/Foo.srv →

    - my_package::Foo – service definition
    - my_package::Foo::Request – request message
    - my_package::Foo::Response – response message

Generated Structure



```
namespace my_package
{
struct Foo
{
  class Request
  {
    ...
  };

  class Response
  {
    ...
  };

  Request request;
  Response response;
};
}
```

Calling Services

- Since service calls are blocking, it will return once the call is done
    - If the service call succeeded, call() will return true and the value in srv.response will be valid.
    - If the call did not succeed, call() will return false and the value in srv.response will be invalid.

```
ros::NodeHandle nh;
ros::ServiceClient client =
nh.serviceClient<my_package::Foo>("my_service_name");
my_package::Foo foo;
foo.request.<var> = <value>;
...
if (client.call(foo)) {
    ...
}
```

roslaunch

- **roslaunch** is a tool for easily launching multiple ROS nodes as well as setting parameters on the Parameter Server
- It takes in one or more XML configuration files (with the .launch extension) that specify the parameters to set and nodes to launch
- If you use **roslaunch**, you do not have to run **roscore** manually

Launch File Example

- Launch file for launching both the talker and listener nodes (chat.launch):

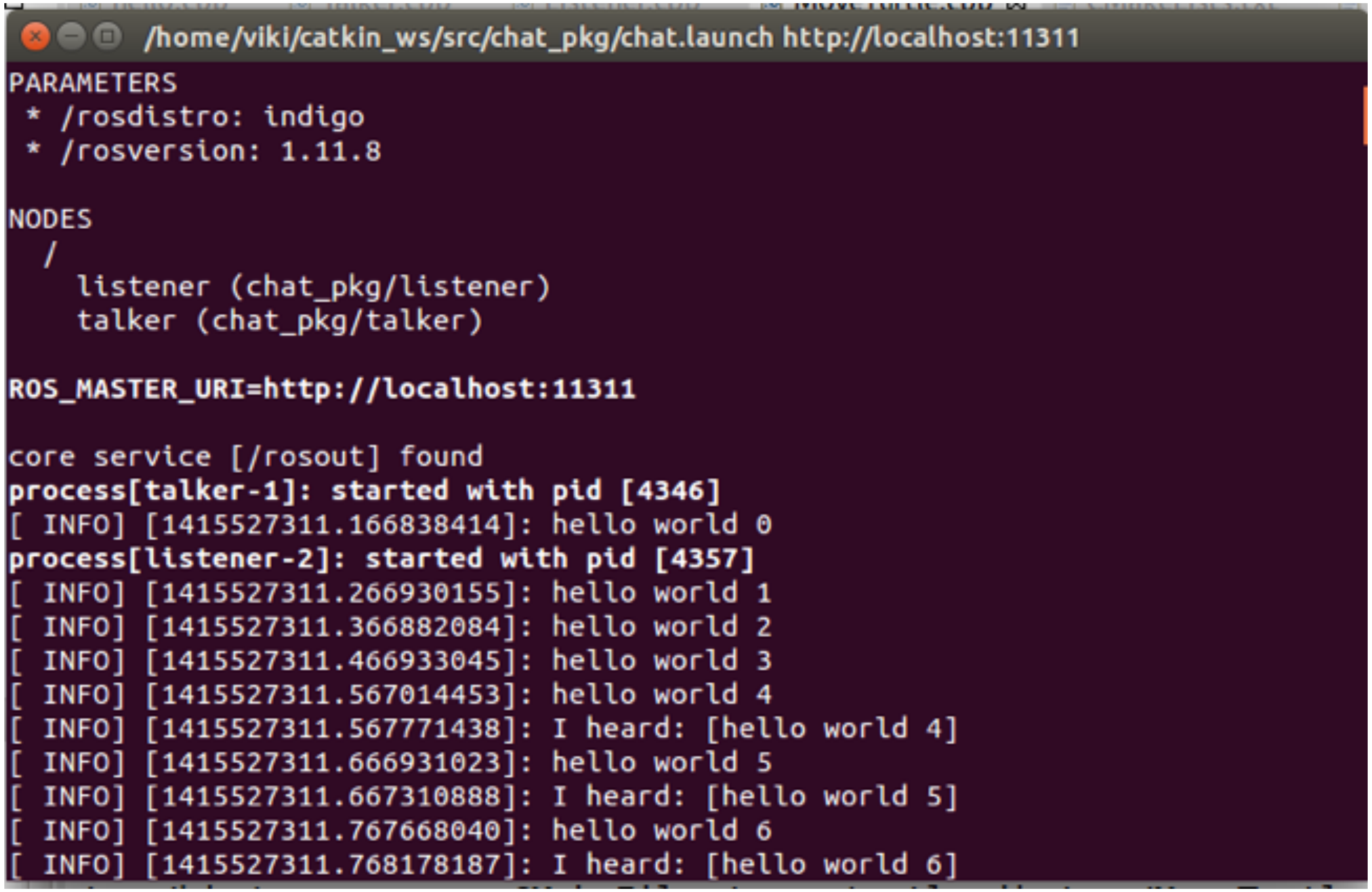
```
<launch>
  <node name="talker" pkg="chat_pkg" type="talker" output="screen"/>
  <node name="listener" pkg="chat_pkg" type="listener" output="screen"/>
</launch>
```

  - output="screen" makes the ROS log messages appear on the launch terminal window

- To run a launch file use:

```
$ roslaunch chat_pkg chat.launch
```

Launch File Example



/home/viki/catkin_ws/src/chat_pkg/chat.launch http://localhost:11311

```
PARAMETERS
 * /rosdistro: indigo
 * /rosversion: 1.11.8

NODES
  /
    listener (chat_pkg/listener)
    talker (chat_pkg/talker)

ROS_MASTER_URI=http://localhost:11311

core service [/rosout] found
process[talker-1]: started with pid [4346]
[ INFO] [1415527311.166838414]: hello world 0
process[listener-2]: started with pid [4357]
[ INFO] [1415527311.266930155]: hello world 1
[ INFO] [1415527311.366882084]: hello world 2
[ INFO] [1415527311.466933045]: hello world 3
[ INFO] [1415527311.567014453]: hello world 4
[ INFO] [1415527311.567771438]: I heard: [hello world 4]
[ INFO] [1415527311.666931023]: hello world 5
[ INFO] [1415527311.667310888]: I heard: [hello world 5]
[ INFO] [1415527311.767668040]: hello world 6
[ INFO] [1415527311.768178187]: I heard: [hello world 6]
```