CS 309: Autonomous Intelligent Robotics
FRI I

Lecture 11: Publish/Subscribe & ROS Topics

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http://justinhart.net/teaching/2019_spring_cs309/

Configuring your environment

- http://wiki.ros.org/ROS/Tutorials/InstallingandConfiguringROSEnvironment
- You can manually configure your environment, but probably will not want to keep doing this
  - source /opt/ros/<distro>/setup.bash
    - Where distro is kinetic
- Configuring your environment sets up “environment variables”
  - $PATH
    - Where programs can be found
  - $ROS_PACKAGE_PATH
    - Where ROS packages, containing packaged stacks and programs can be found
  - Others

Creating a ROS Workspace

- mkdir -p ~/catkin_ws/src
- cd ~/catkin_ws/src
- catkin_init_workspace
  - This is different from the guide, both work
- catkin build

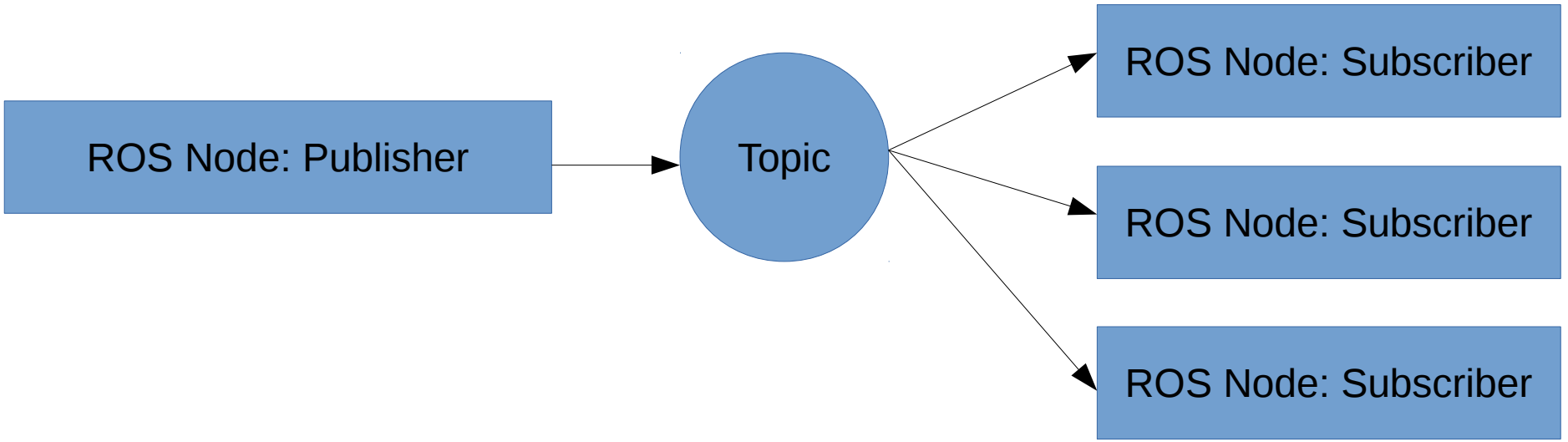
A quick primer on ROS Nodes

- http://wiki.ros.org/ROS/Tutorials/Understanding Nodes
  - The basic idea here is to show you how that you run
    - roscore
      - Which manages communications
    - turtlesim_node
      - Which connects to roscore in order to communicate

Publish/Subscribe

- ROS Topics use a Publish/Subscribe architecture
  - Publishers
    - Broadcast data on a “topic”
  - Subscribers
    - Multiple subscribers can read data from a topic simultaneously
  - Example
    - rviz example from Kinect v2 data

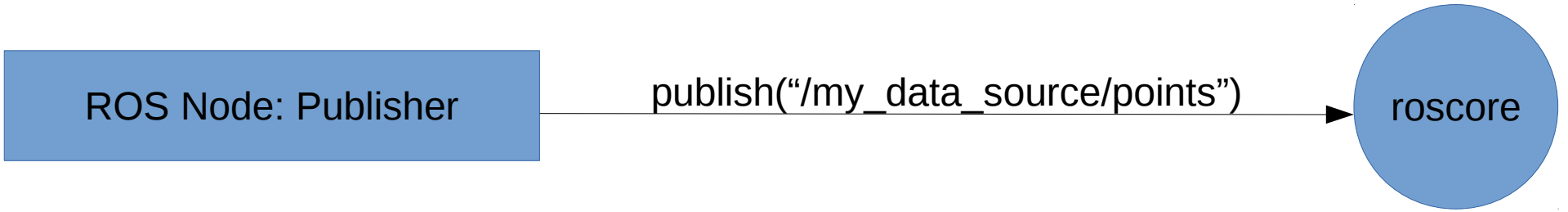
A simplified, conceptual diagram



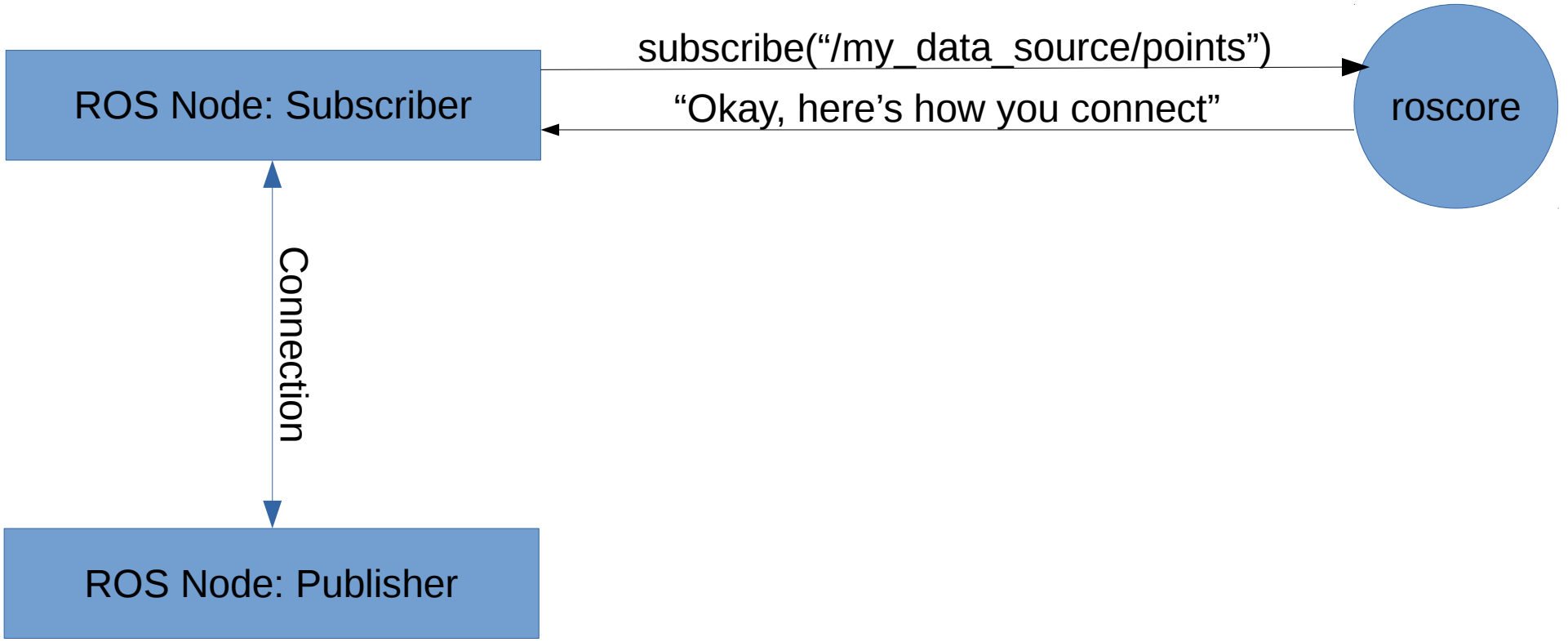
roscore

- The program roscore coordinates ROS communications
  - When a node publishes a topic, it registers this topic under a path in roscore with a name
  - Other nodes can subscribe to the topic using this name
  - These topic names can be configured in ROS launch and other configuration files, which we will later explore more in-depth

roscore, in practice



roscore, in practice



ROS Topics

- Connect over a network socket
  - Stored in $ROS_MASTER_URI
  - Default is http://localhost:11311
  - You probably won't use it in this class, but for RoboCup@Home, we use a network of 3 or 4 computers to drive the robot
    - To manage this, we use $ROS_MASTER_URI to coordinate communications

Understanding ROS topics

- http://wiki.ros.org/ROS/Tutorials/UnderstandingTopics
  - ROS Topics run on a publish/subscribe architecture
    - A “publisher” provides a stream of data
    - A “subscriber” listens to this stream
  - The first demo shows
    - turtlesim_node, which is a subscriber
    - turtlesim_teleop_key, which is a publisher
  - If alongside this we run rostopic echo, we can see the keys telling the turtle what to do
  - Stop at part 3.1 for more explanation

ROS Message Types

- Built into ROS is a special compiler for messaging
- You can specify ROS messages that are published on topics
- ROS Topics use a **very** simplified language
- The compiler outputs code in every language supported by ROS (usually C++ or Python)

ROS Message Types

- To use a ROS topic
  - You don’t **really** need to understand networking
- As we use it, each message type will be stored in a C++ class
  - The compilers in ROS write this class.
    - You do not.
    - You write a simple text file saying what goes into the message

ROS Message Types

- For most types of data used in robotics, ROS has already specified one of these message files
  - This is how all of these programs interoperate
  - If you use standard message types, your ROS nodes will work with existing ROS nodes
    - For instance, if you publish point cloud data using sensor_msgs/PointCloud, your point cloud data can be rendered in rviz and used by existing ROS nodes which utilize point cloud data!

Let’s look at a simple ROS message

- /opt/ros/kinetic/std_msgs/String.msg

Catkin workspace & build tools

- We briefly looked over this previously
  - ROS comes with build tools which build on make
    - Top-level tools which work like make
      - catkin_make
      - catkin build
        - This one is a bit better, but most tutorials will use catkin_make
    - catkin_init_workspace
      - Top-level script that initializes your catkin workspace
    - catkin_create_package
      - Shortcut script to make a ROS package for your nodes to go into.

Writing our first publisher

- String.msg is used in the ROS Publisher/Subscriber tutorial:
  - http://wiki.ros.org/ROS/Tutorials/CreatingPackage
  - http://wiki.ros.org/ROS/Tutorials/WritingPublisherSubscriber%28c%2B%2B%29

Writing our first subscriber

- Event-driven programming
  - Main loops are used in event-driven programming
  - The idea is to wait for something to happen, and then act on the thing that happened
    - The thing that happened is called an event

Writing our first subscriber

- The main loop allows the program to check if something has happened repeatedly
  - ros::spinOnce() does the checking
  - Subscribers check to see if a message has been published on a topic
- At the start of the program, a function called a “callback” is “registered” with the event-driven framework
  - In our case, that framework is ROS.
  - When the event happens, the callback is called.
- How this works will become more clear when we try it out

Writing our first subscriber

- Back to:
  - http://wiki.ros.org/ROS/Tutorials/WritingPublisherSubscriber%28c%2B%2B%29