UNIVERSITY OF SOUTH CAROLINA

# CSCE 574 ROBOTICS

## ROS overview

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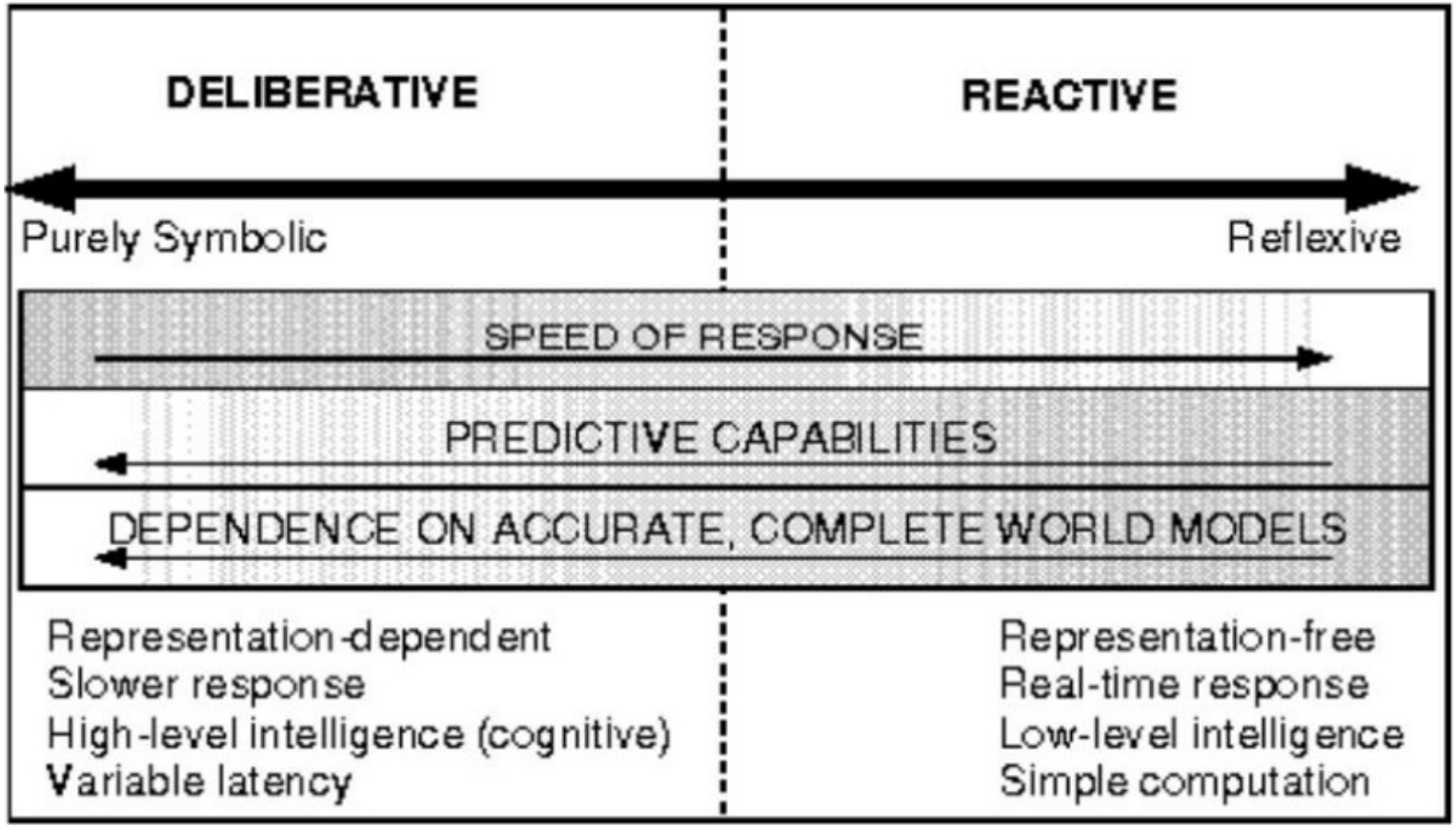
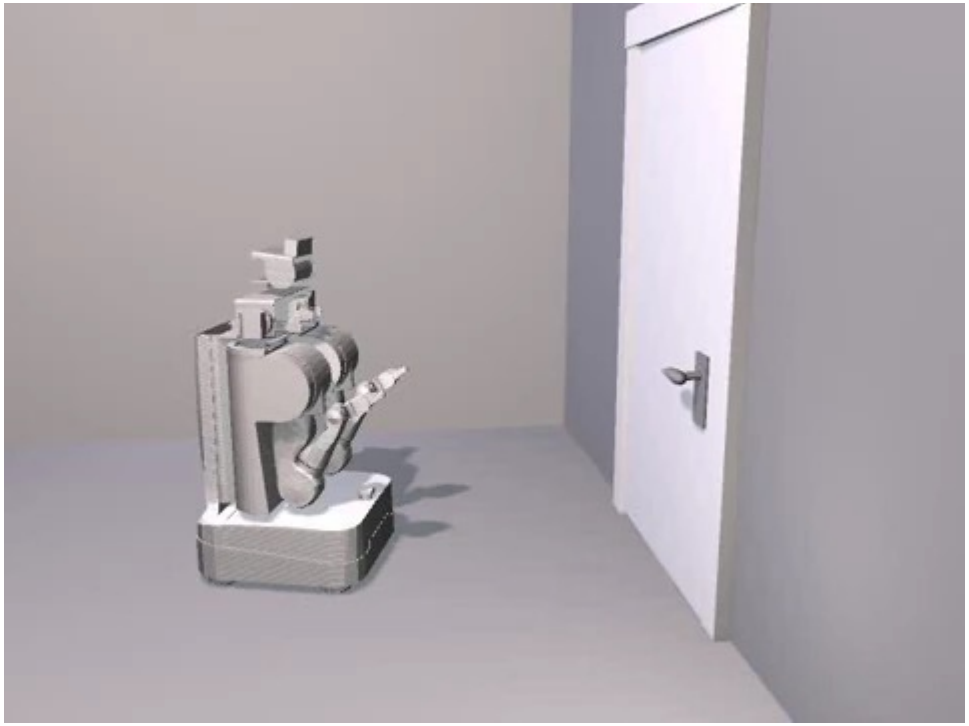
# Spectrum of control

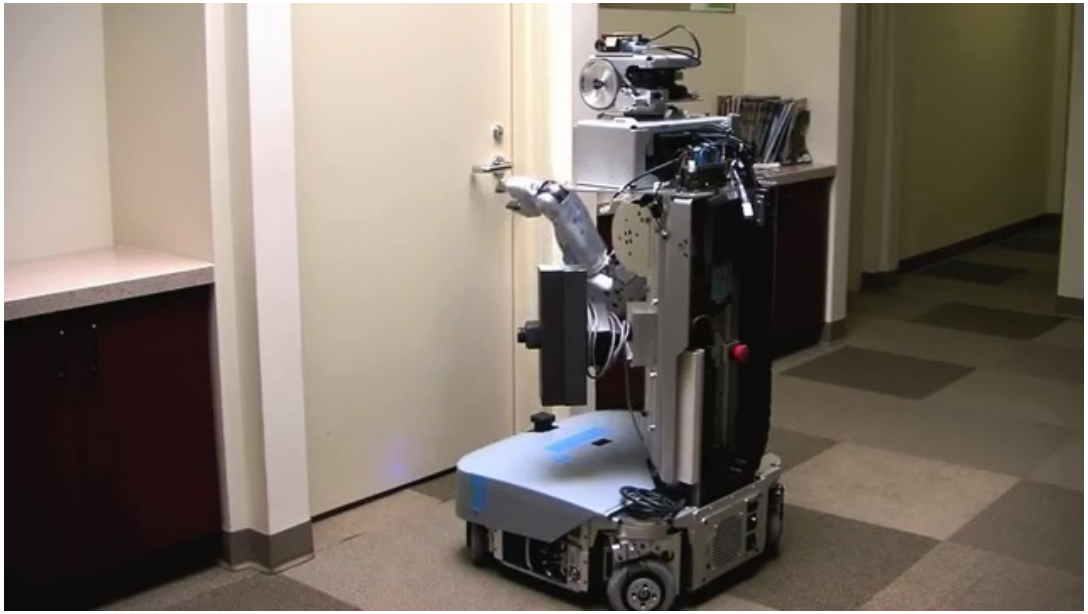



Source: [Arkin, 1998, MIT Press]

# Middleware

# WillowGarage PR2 (2007)





Source: WillowGarage

# ROS

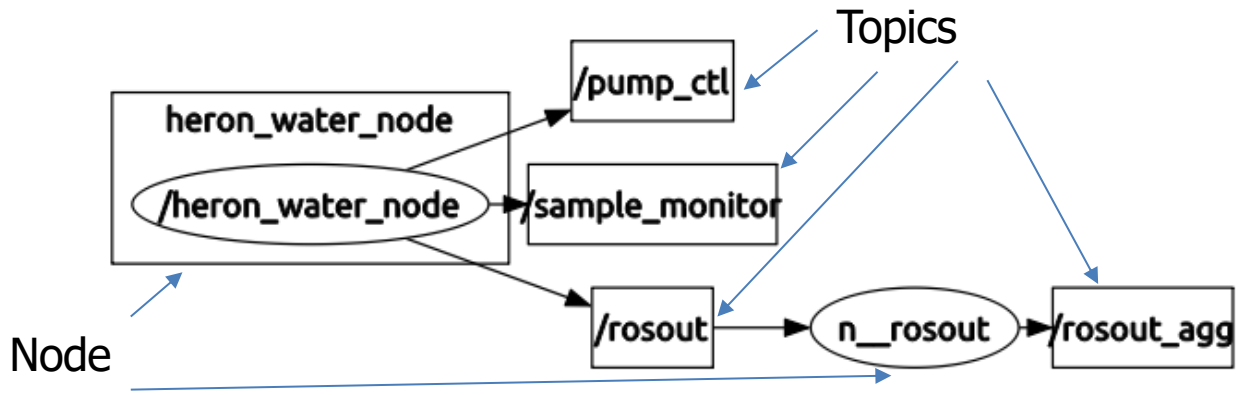


# ROS

- The Robot Operating System (ROS) is a flexible framework for writing robot software
  - It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms
- Developed and Maintained by the Open Source Robotics Foundation (OSRF)
- "The primary goal of ROS is to support *code reuse* in robotics research and development."

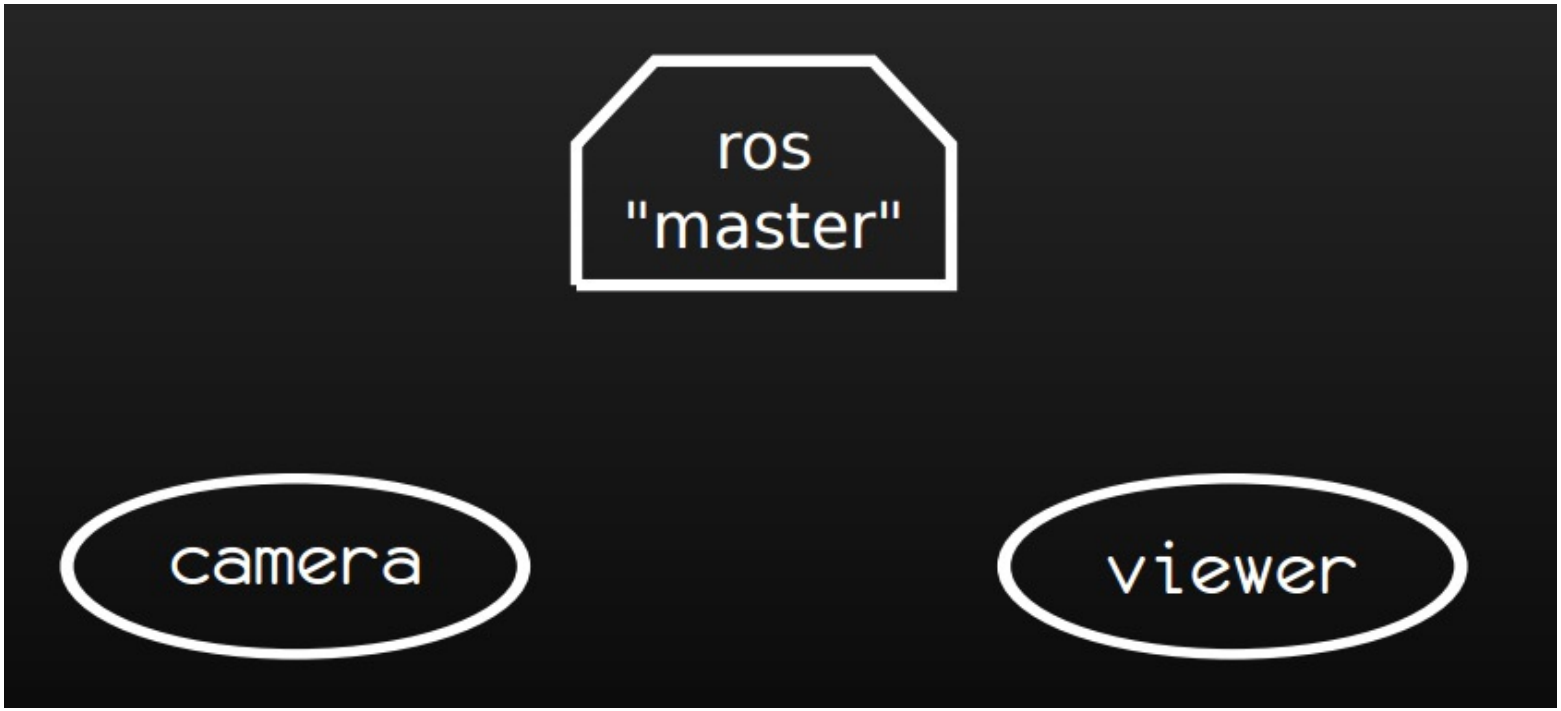
# ROS

- ROS is based on publish/subscribe message passing approach
- The core elements are:
  - ROS master: process that provides naming and registration to the rest of the nodes
  - Nodes: processes implementing robotic components
  - Topics: named buses over which nodes exchange messages



# ROS overview

- Process for making two nodes interact with each other



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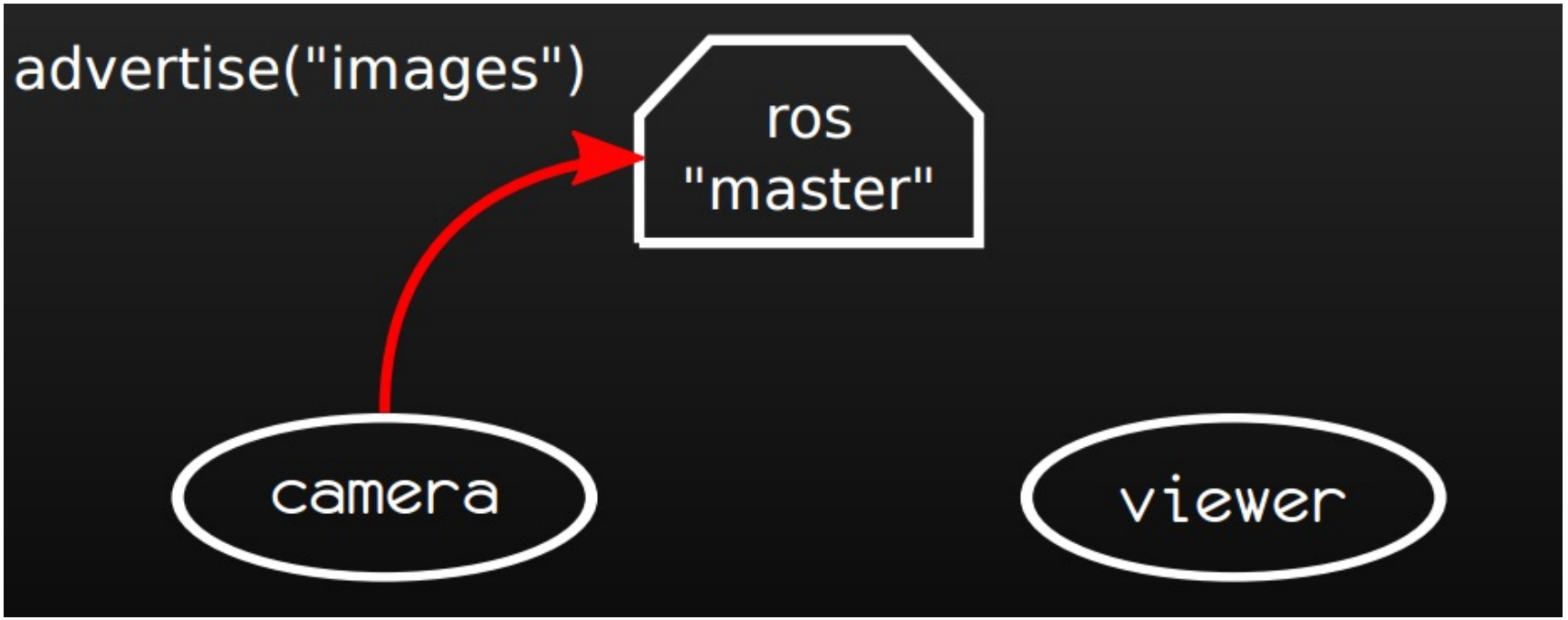

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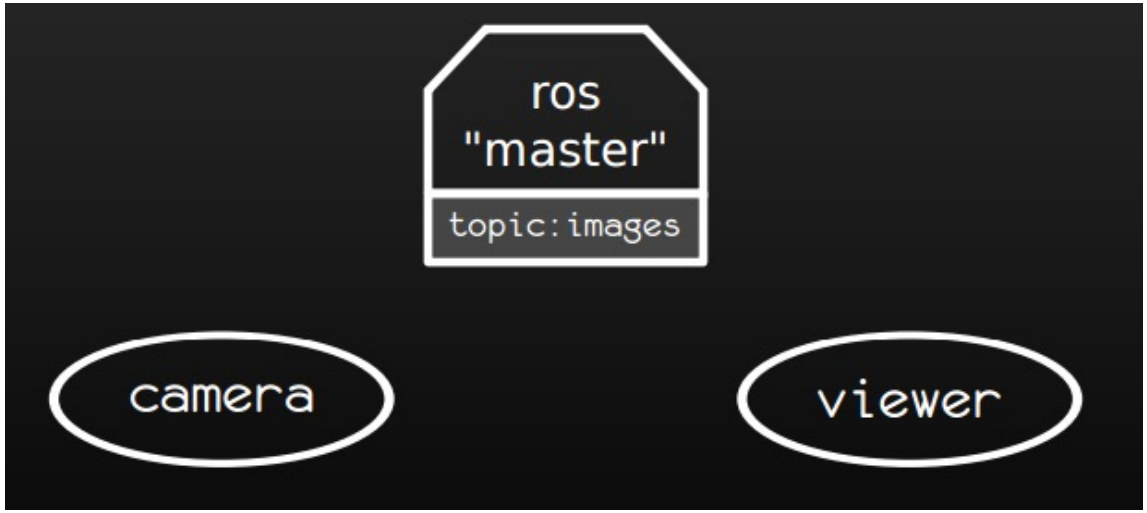

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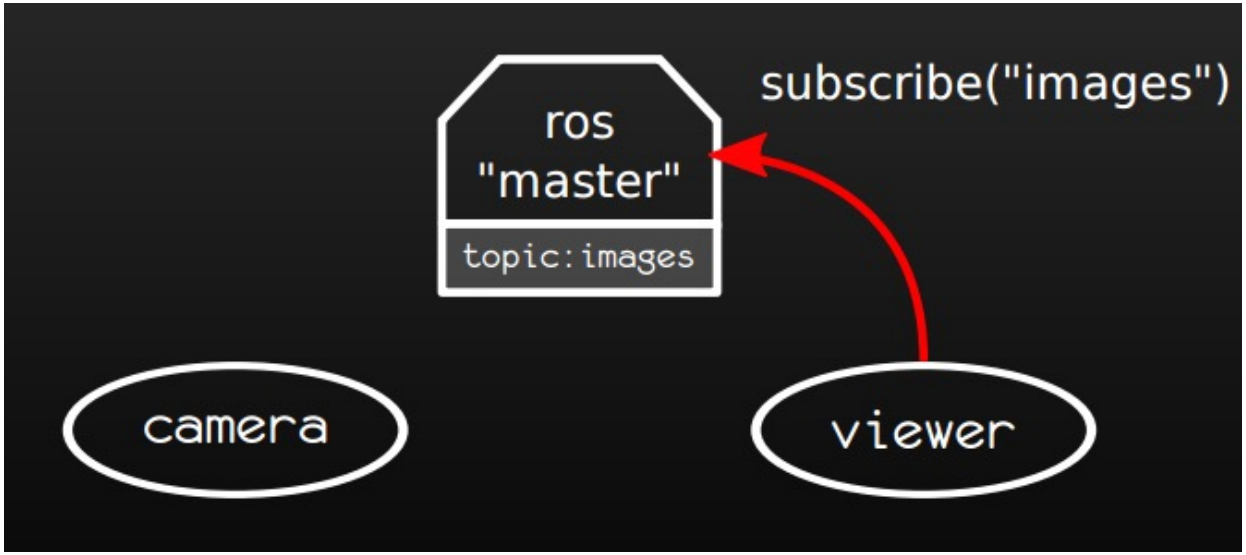

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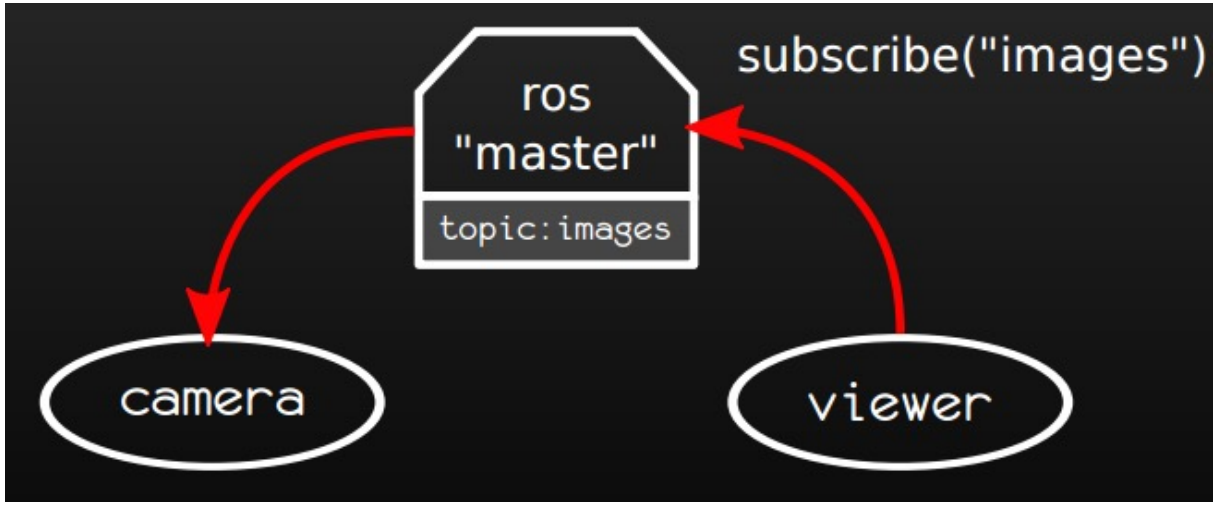

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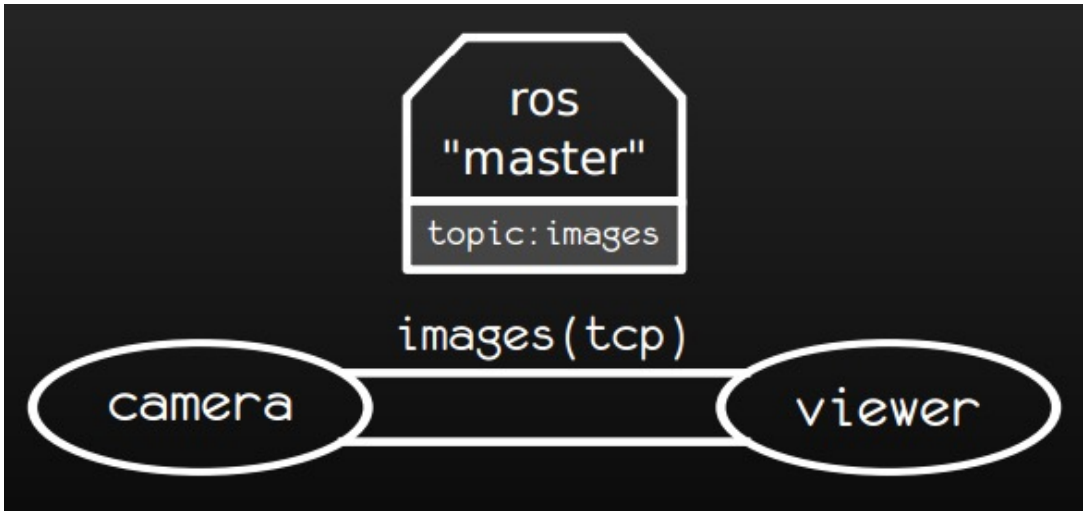

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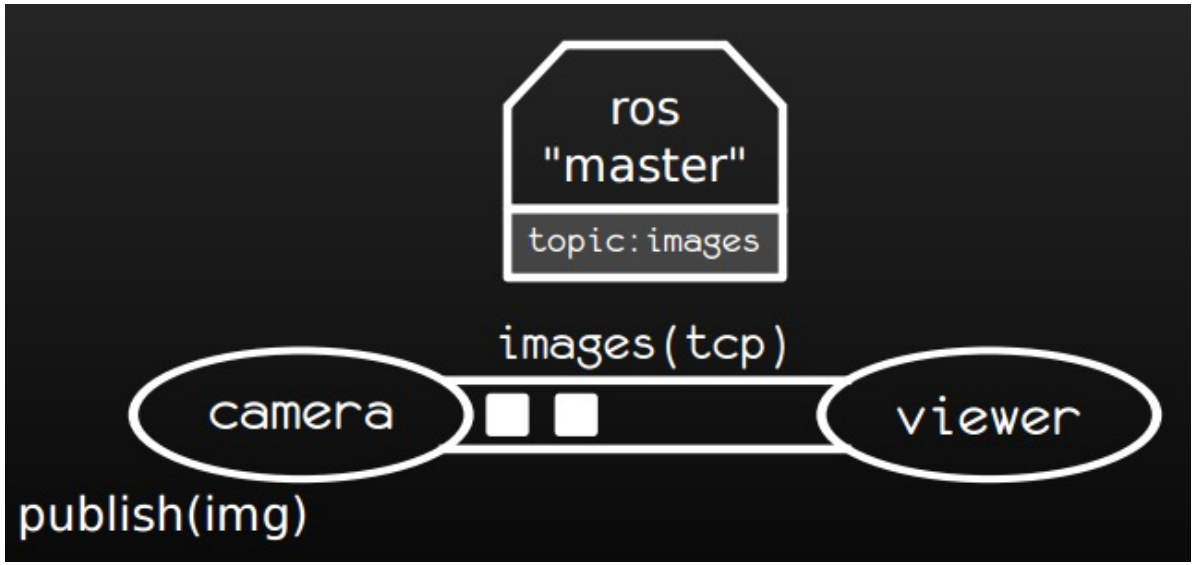

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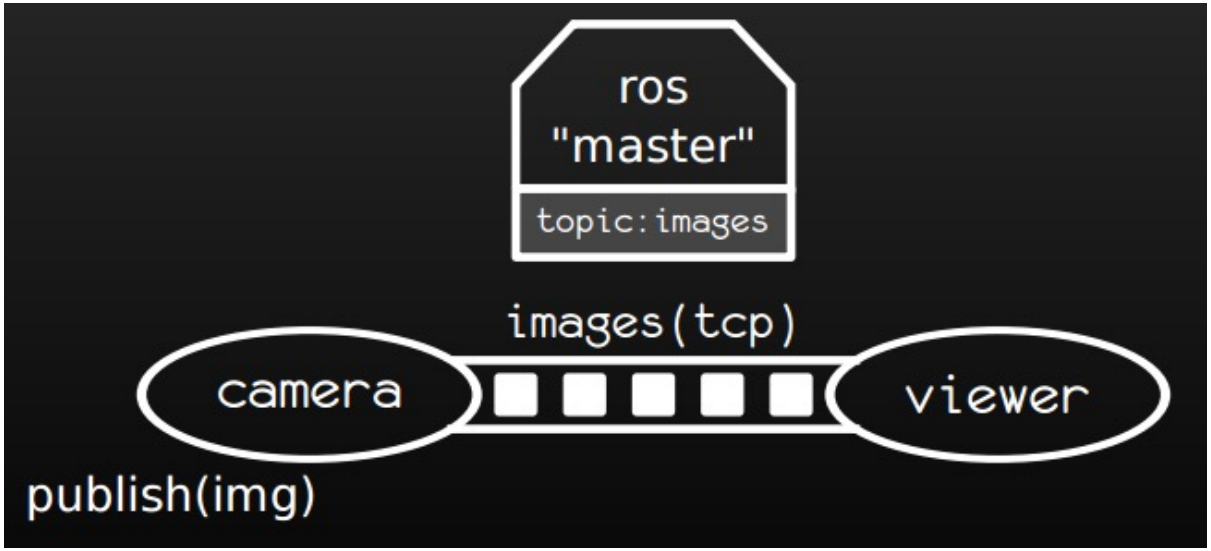

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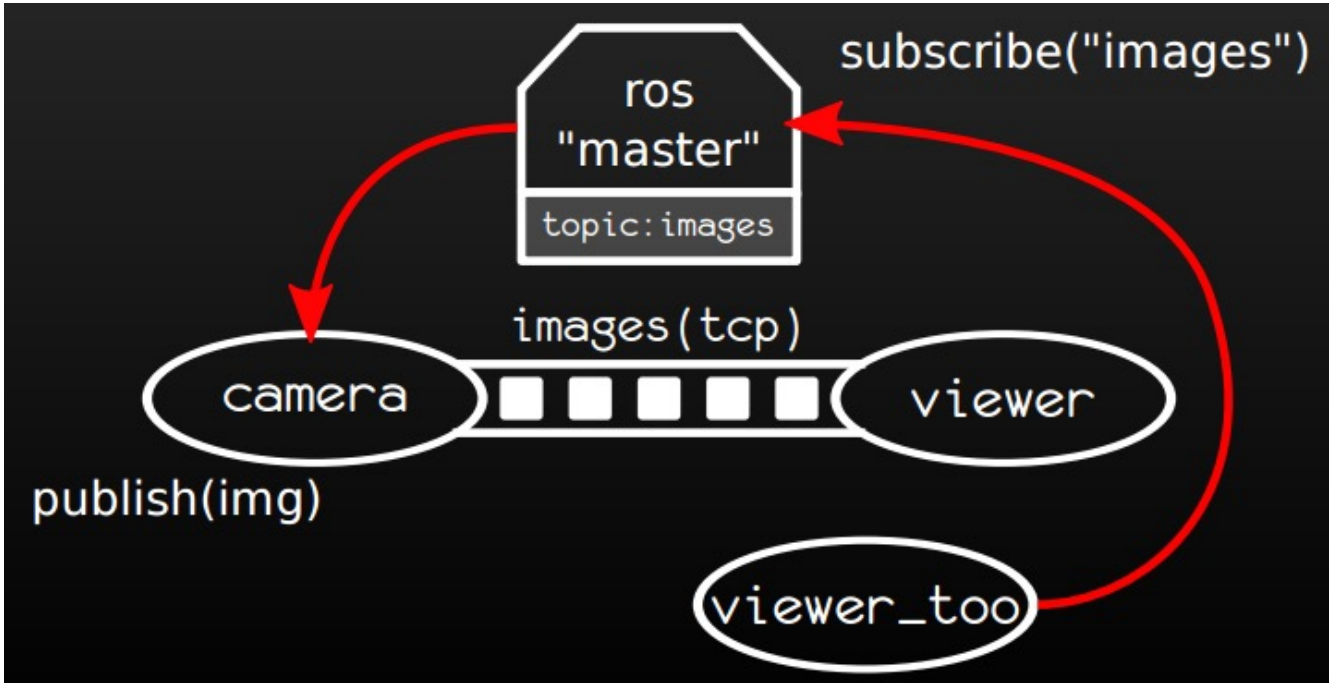

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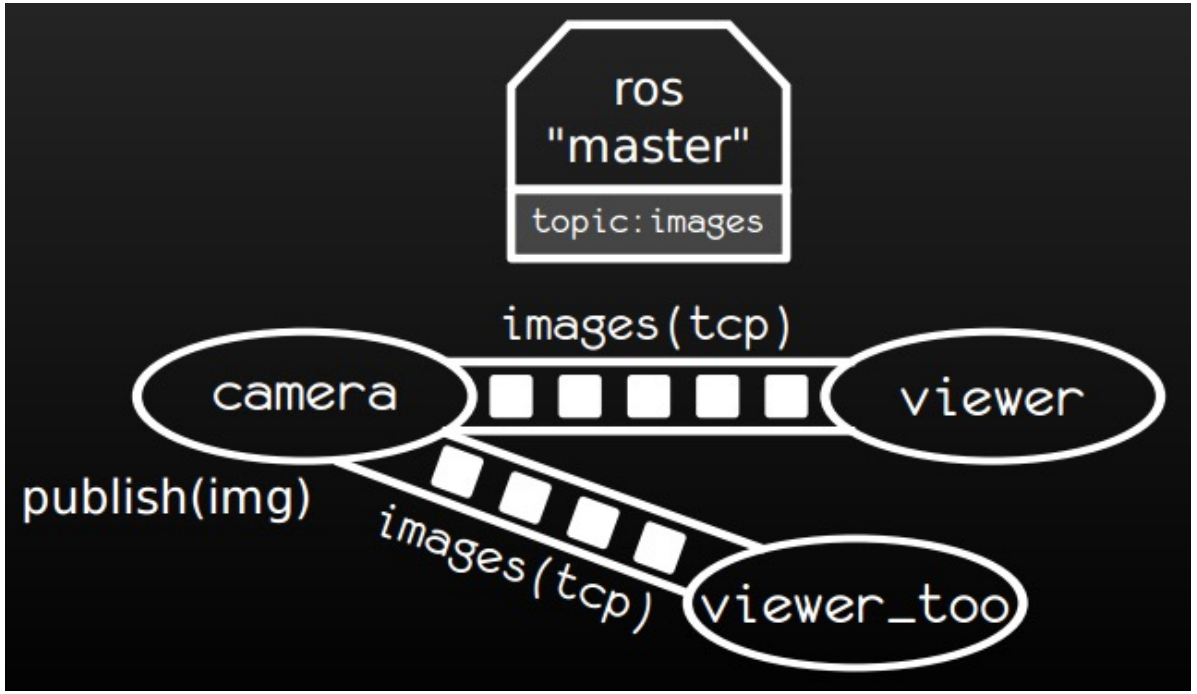
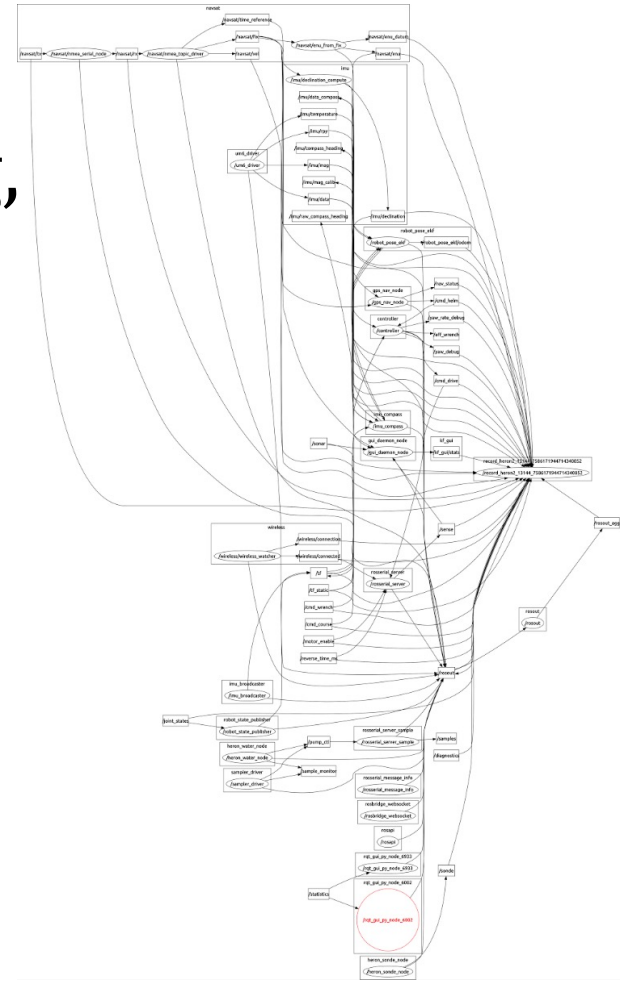
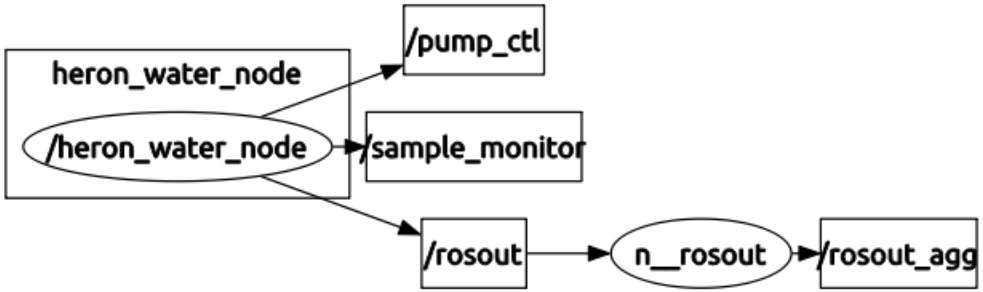


# ROS overview

- Typically, a node represents one task (driver, localization, mapping, path planning, …)
- Nodes run in parallel
- To debug problems, use rqt_graph





# ROS overview

- The main mean of communication in ROS are topics and messages

- However, there are other ways for nodes to communicate with each other
  - Services: similar to Remote Procedure Calls
  - Actionlib: preemptable tasks

# ROS overview

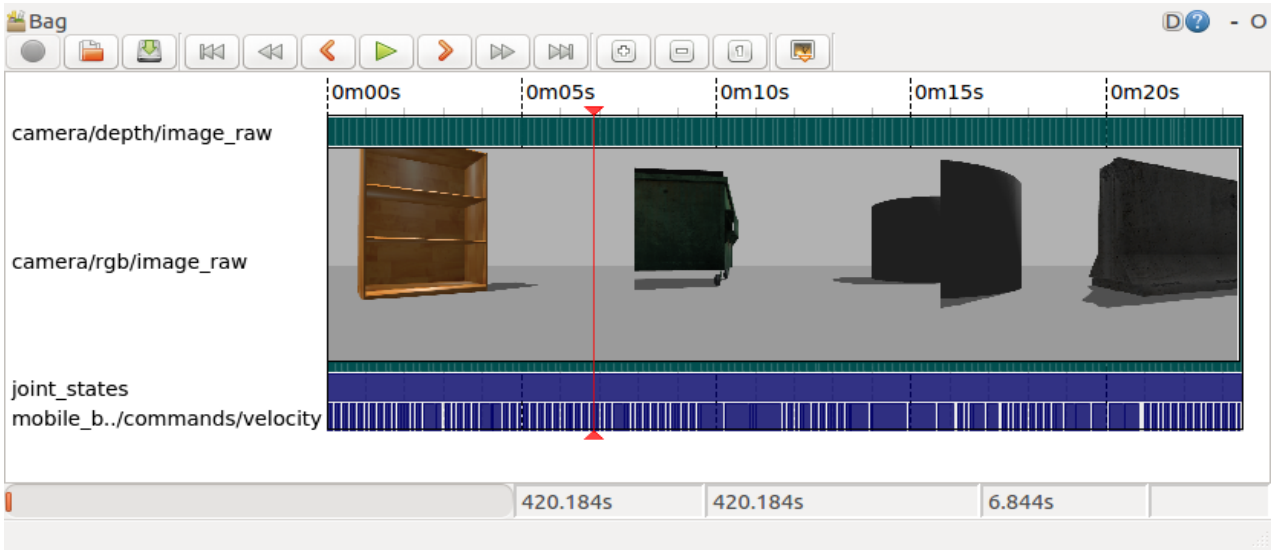
- How to decide what to use:
  - Topics: especially for stream of data
  - Services: execution of fast tasks
  - Actions: execution of tasks that need to be tracked and should be preempted in some cases

# ROS overview

- Parameters can be easily set
  - Statically: rosparam
  - Dynamically: rqt_reconfigure
- Be careful in which namespace the parameters are defined: global or private

# ROS overview

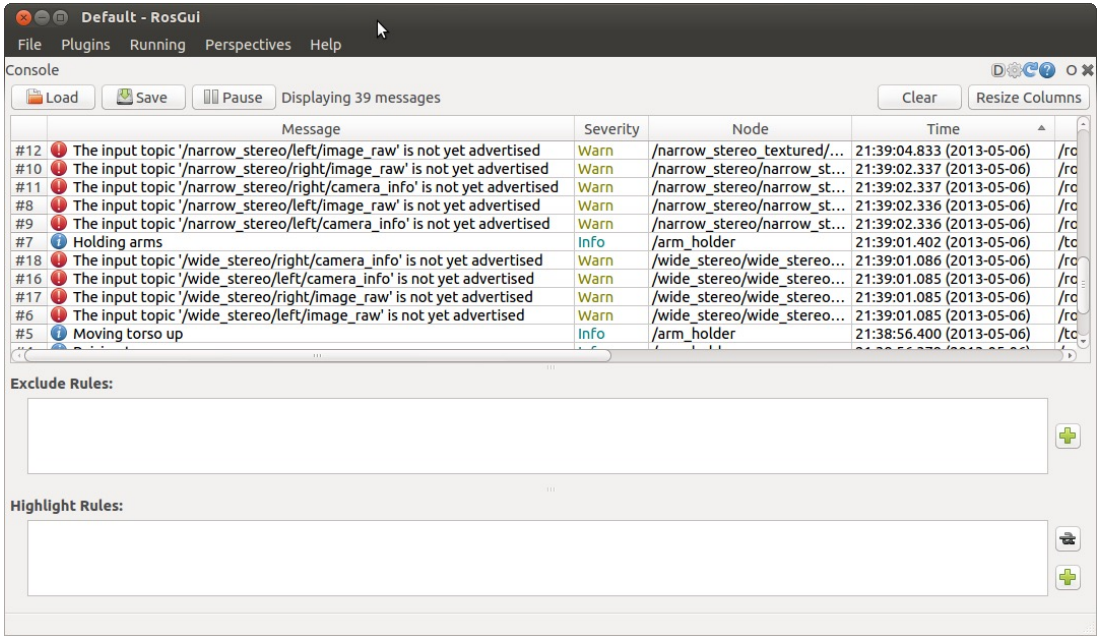
- Logging data streams can be achieved by using rosbag
- Remember the ROS parameter sim_time especially to run algorithms on bag files




Source: ros.org

# ROS overview

- Logging messages are published in rosout topic
  - Different log levels should be used according to the severity of the message
- rqt_console can be used to visualize them



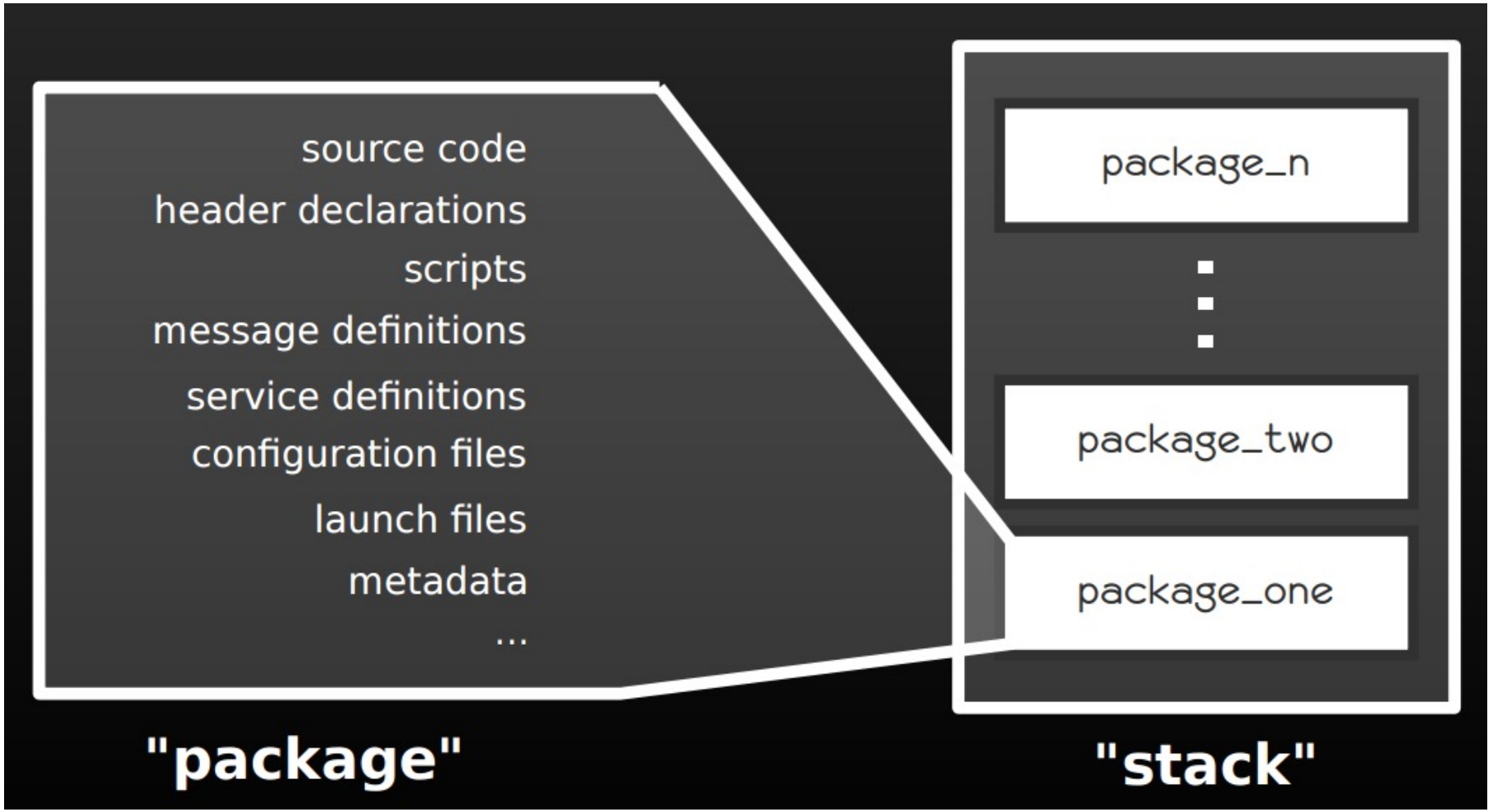



Source: ros.org

# ROS tools

- **Navigate**: roscd, rosls
- **Setup**: catkin_init_workspace, catkin_create_pkg
- **Configure**: package.xml, CmakeLists.txt
- **Build**: catkin_make
- **Execute**: roscore, rosrun, roslaunch, rosparam, rqt_reconfigure
- **Inspect**: rosnode, rostopic, rosservice
- **Debug**: rqt_graph, rostest, rqt_plot
- **Log & Analyze**: rosbag, rqt_bag, rqt_console

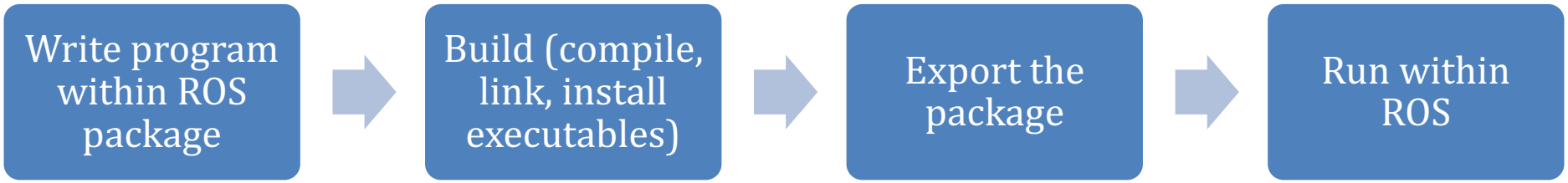
# ROS packages



# ROS distribution

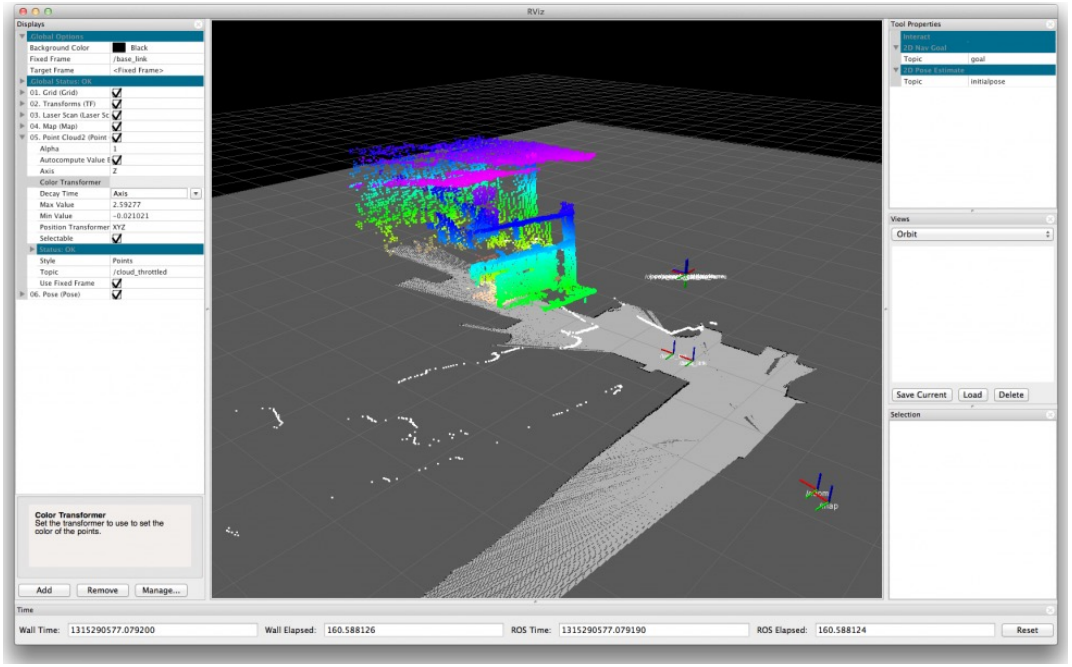

- Note that in Ubuntu, there are many packages ready just to be installed with sudo apt-get install

# From source code to executable



# ROS tools

- rviz can be used to visualize data



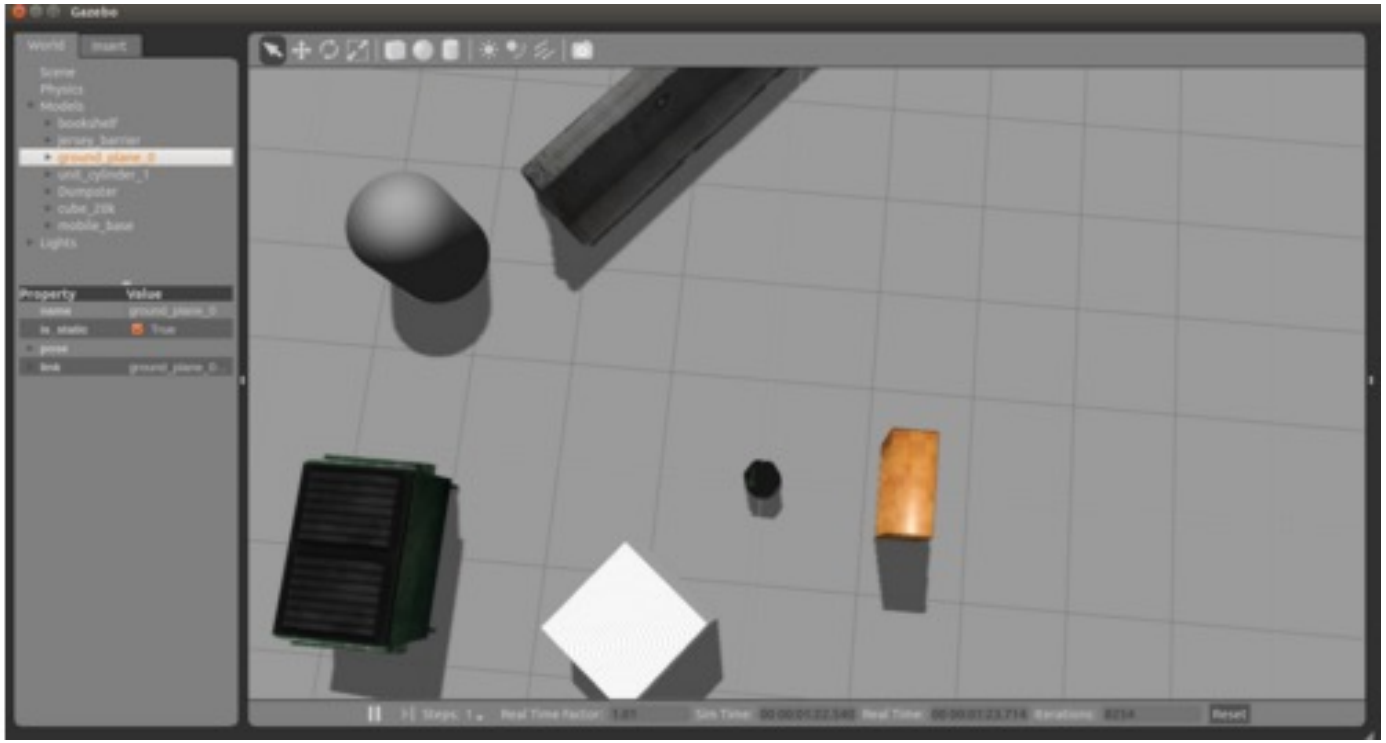

Source: iheartrobotics.com

# ROS tools

- Stage, 2D simulator

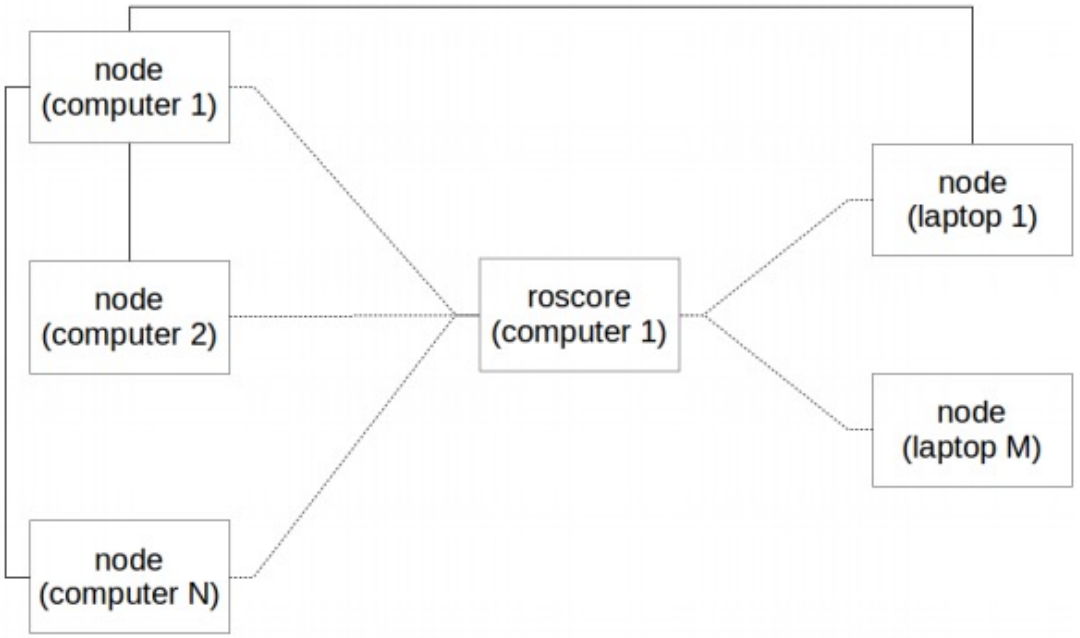
# ROS tools

- Gazebo, 3D simulator



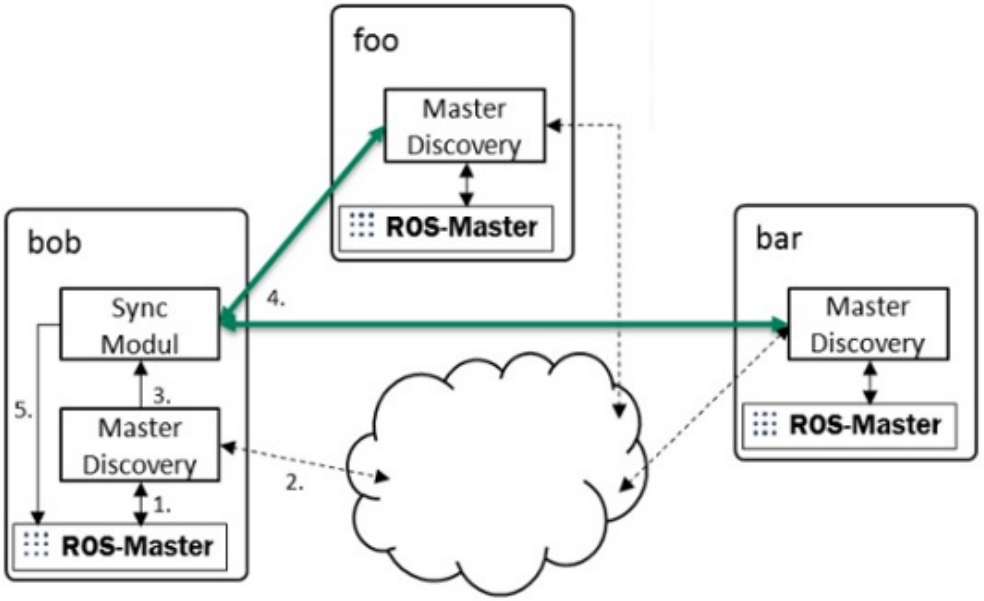
# ROS overview

- In a multirobot settings, a possibility is to share the ROS master over all of the computers



# ROS overview

- However, to have the system more robust, *multi-master-fkie* can be used to allow robots to see other ROS masters



# Summary

- Problems to solve in robotics
  - Localization, Mapping, Planning
- Robot software architectures with some history
  - Deliberative
  - Reactive
  - Hybrid
- Middleware
  - ROS
    - Core elements
    - Packages
    - Tools

# Questions?