



Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences

b-it Bonn-Aachen
International Center for
Information Technology

Introduction to ROS

Foundation Course

August 20, 2019

Hassan Umari

1. What is ROS?

- 1.1 What ROS is
- 1.2 What ROS is NOT

2. Analogy Between ROS and Operating Systems

3. Features of ROS

- 3.1 Language independent
- 3.2 Distributed and Modular
- 3.3 A lot of libraries and tools
- 3.4 Bad Things About ROS

4. ROS Concepts

- 4.1 File system level
- 4.2 Computation graph level
- 4.3 Community level



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What ROS is

Robot Operating System

- Short for: Robot Operating System.
- A collection of libraries and tools.
- It helps software developers create robot applications.



How Robotics
Research Keeps...

Re-Inventing the Wheel

First, someone publishes...



...and they write code that barely works but lets them publish...



...a paper with a proof-of-concept robot.



This prompts another lab to try to build on this result...



But inevitably, time runs out...



...and countless sleepless nights are spent writing code from scratch.



So, a grandiose plan is formed to write a new software API...



...but they can't get any details on the software used to make it work...



...and all the code used by previous lab members is a mess.

What ROS is

Robot Operating System

- A way to standardize writing software for robots.
- It enhances **code reusability** 

- ROS is open-source .
- It is a meta-operating system.
- ROS can be installed on Ubuntu and Debian (so it's currently supported on Linux only).



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What ROS is NOT

Robot Operating System

- It is NOT a programming language.
- It is NOT an integrated development environment (IDE).
- It is NOT a stand-alone operating system



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Analogy Between ROS and Operating Systems



Software Applications

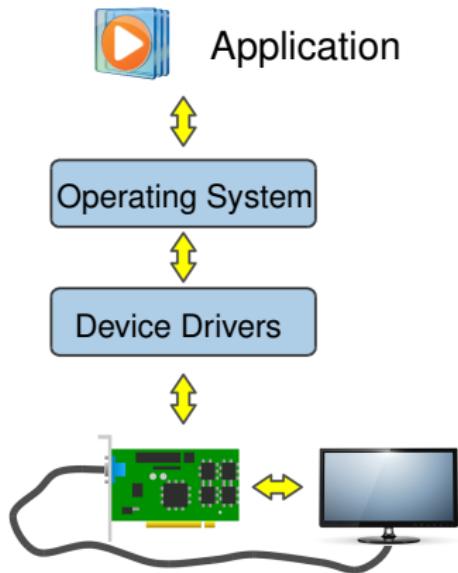
work on



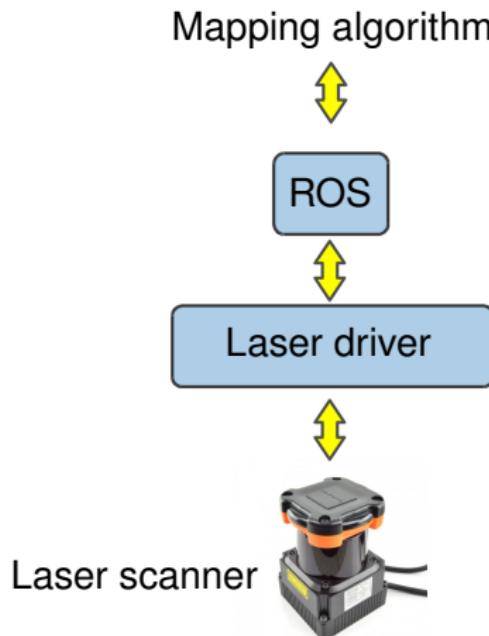
Different hardware



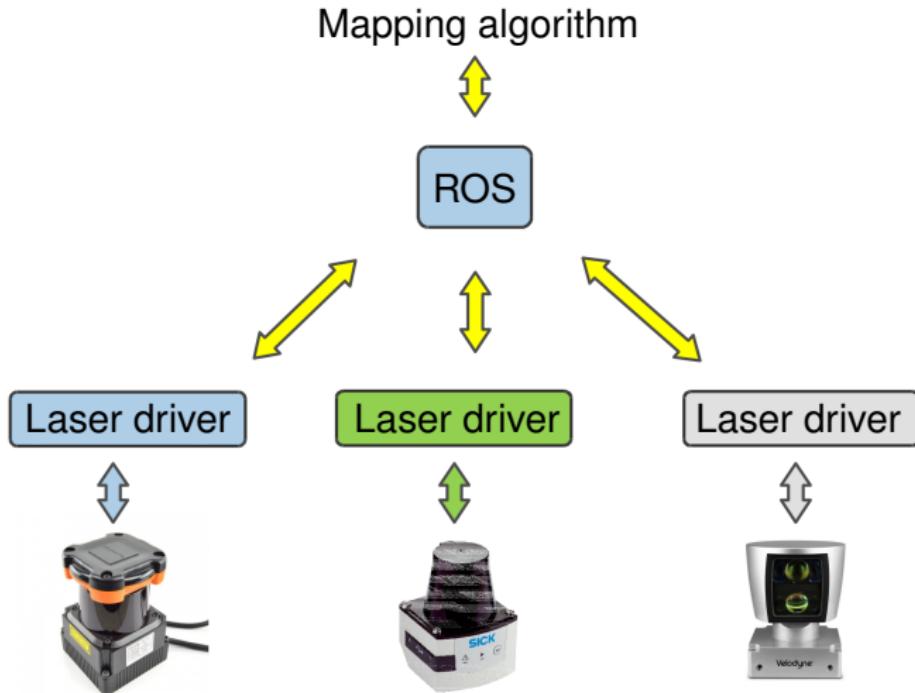
Analogy Between ROS and Operating Systems



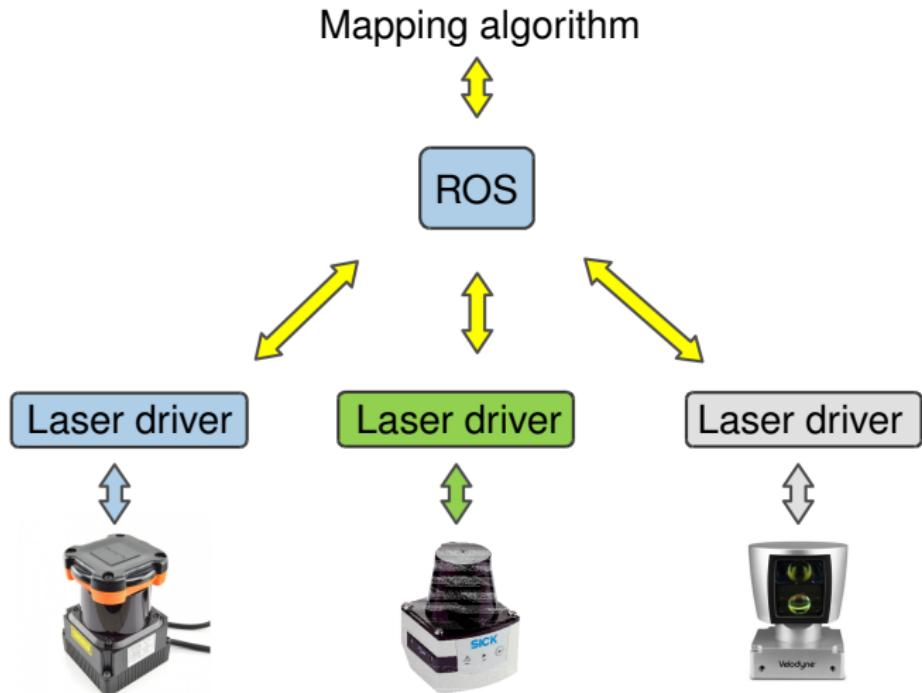
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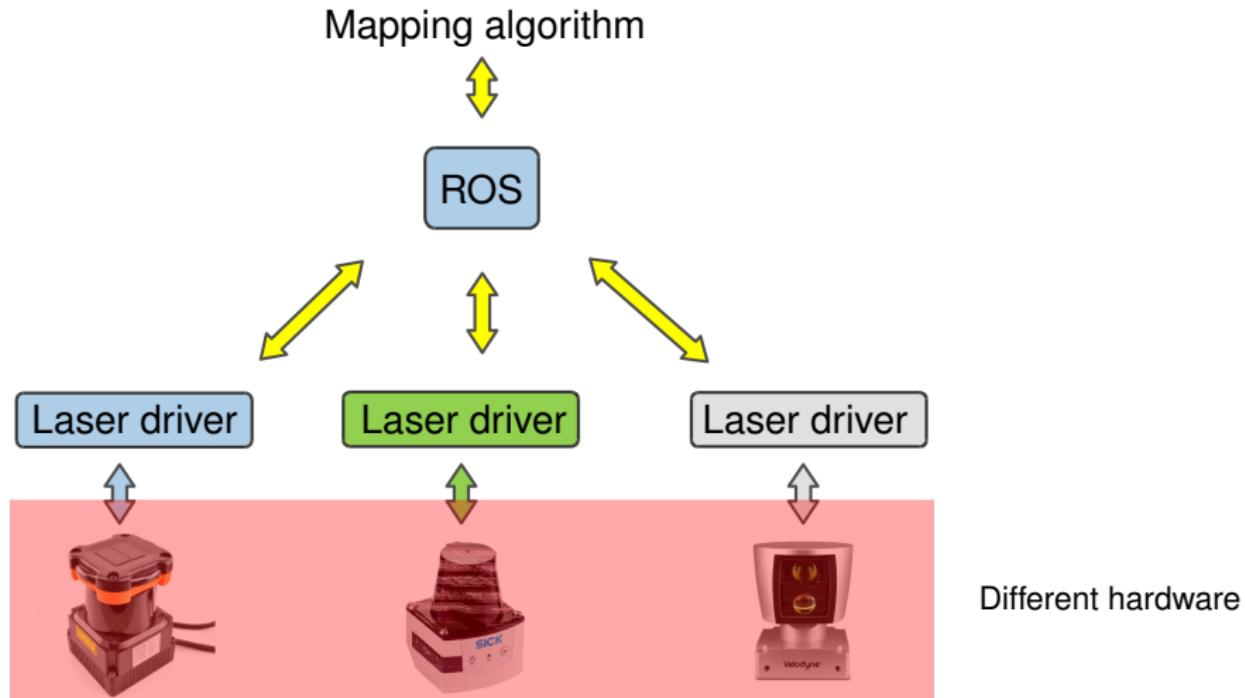
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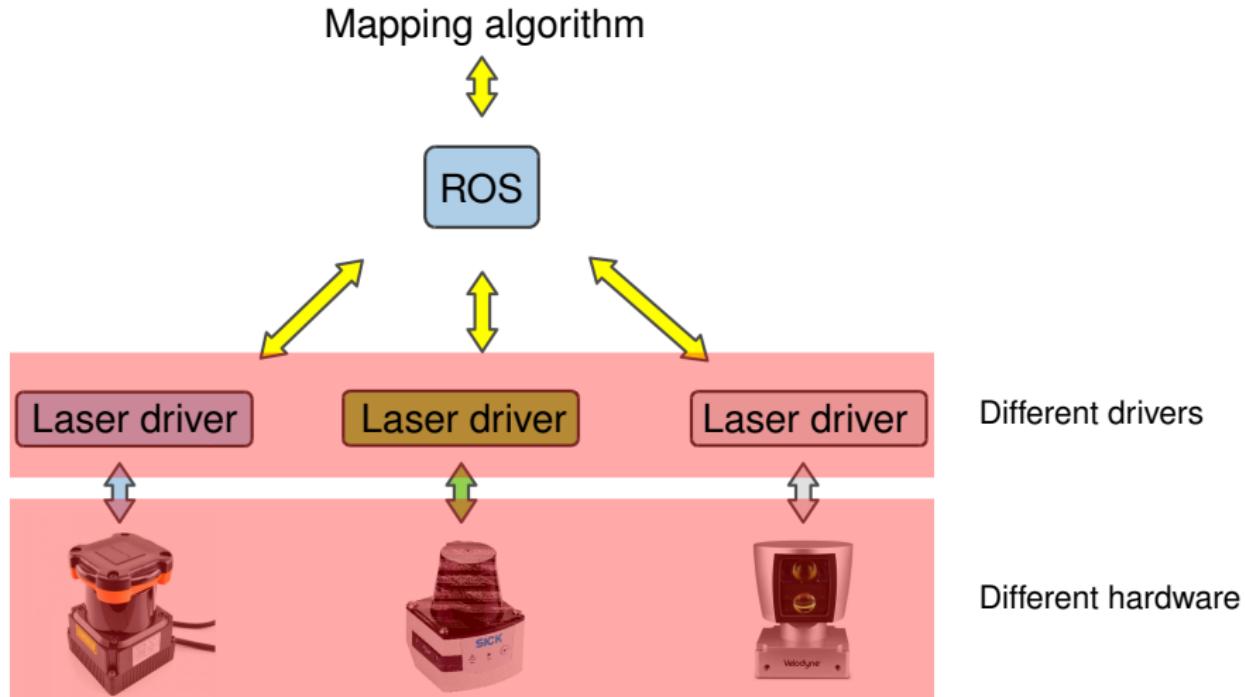
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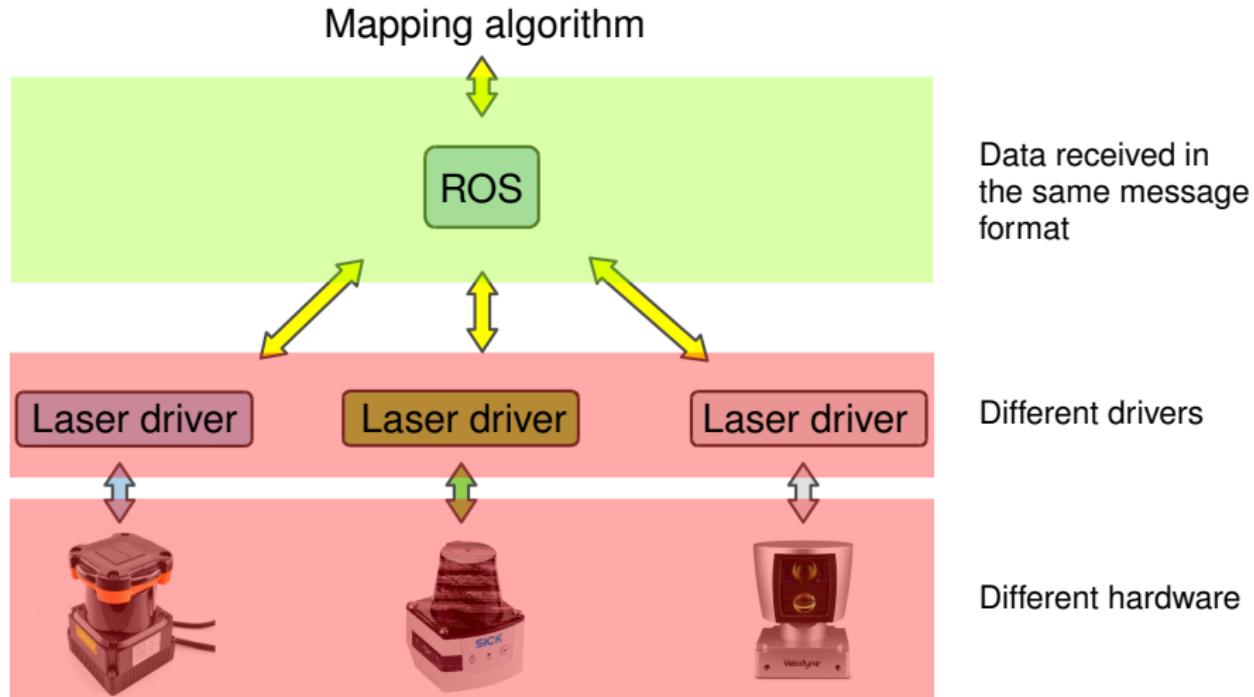
Analogy Between ROS and Operating Systems



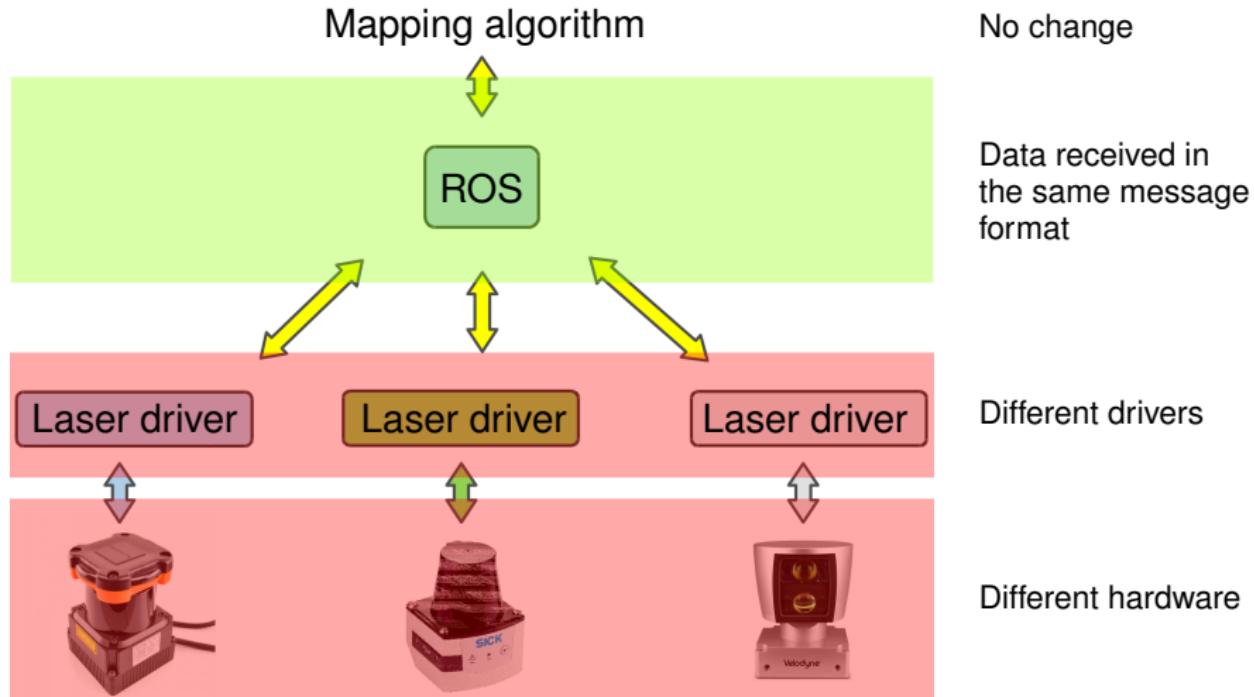
Analogy Between ROS and Operating Systems



Analogy Between ROS and Operating Systems



Analogy Between ROS and Operating Systems



Analogy Between ROS and Operating Systems

Mapping

Navigation

pick & place

Robot Applications

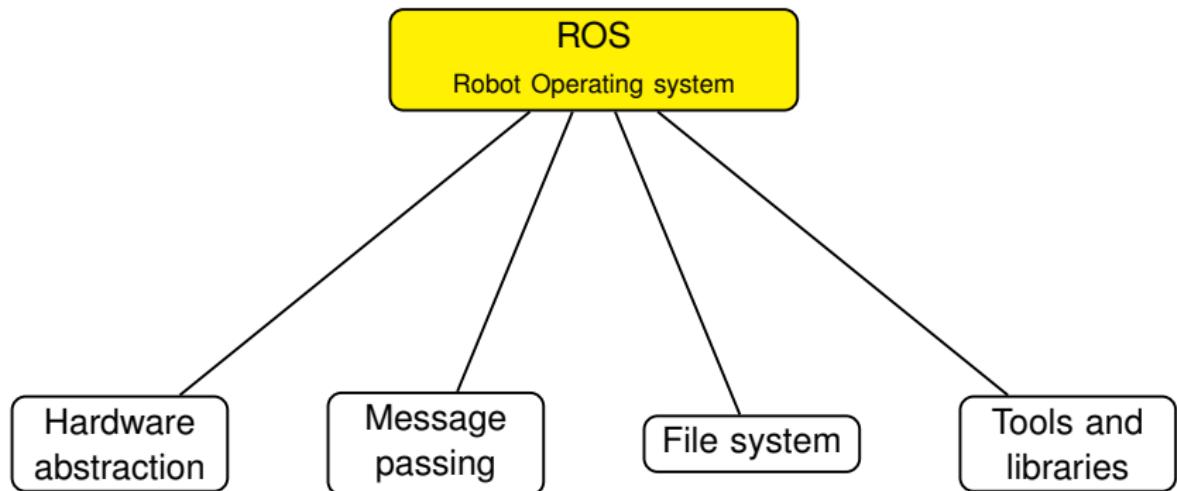
work on



Different hardware



Analogy Between ROS and Operating Systems



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Features of ROS

- Language independent.
- Distributed and Modular.
- A lot of libraries and tools.
- Open Source.
- Active Community.



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Features of ROS

Language independent

- ROS functionalities are implemented as a library in different programming languages.
- These libraries are referred to as ROS client libraries.



Language independent

Features of ROS

ROS client libraries.

- Main ROS Client libraries:
 - roscpp
 - rospy
 - roslib
- Experimental ROS client libraries:
 - rosjava
 - rosruby
 - and some others..
- ROS support on MATLAB:
 - Robotics System Toolbox



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Distributed and Modular

Features of ROS

- ROS supports running processes on multiple computers connected together through a LAN.
- In a system running ROS, there will be multiple of processes where each process can do certain task. A process can be changed without altering the remaining processes.



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A lot of libraries and tools

Features of ROS

- Examples of libraries:
 - Navigation stack.
 - SLAM (gmapping, hector SLAM, etc..).
 - Localization (amcl, etc..).
 - Motion planning for manipulators (MoveIt)
 - Support for popular libraries (OpenCV, PCL).
- Examples of tools:
 - RVIZ:3D Visualization.
 - ROS bag files: Logging Sensor Data.
 - Catkin: A Build System.
 - Command line tools.



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Bad Things About ROS

- Learning ROS needs time.
- It needs a computer. Does not work on a microcontroller!
- Not optimized for multiple robots.
- Supported only on Linux, no support for Windows or macOS.



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ROS Concepts

ROS concepts

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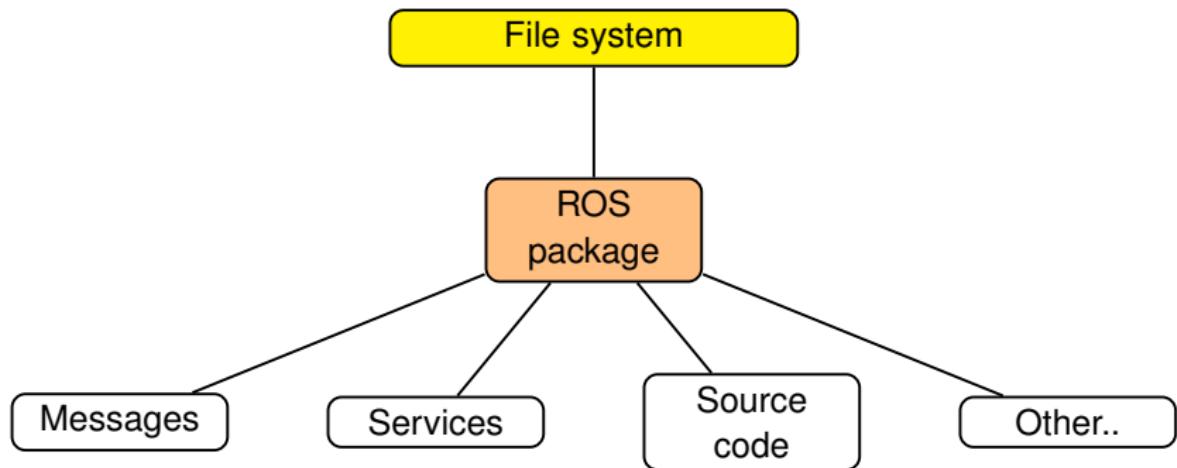
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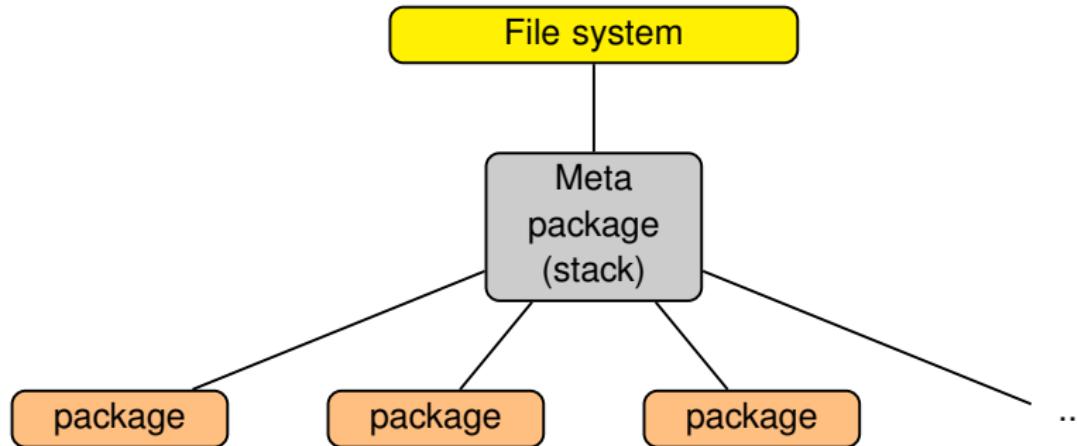
File system level

ROS Concepts



File system level

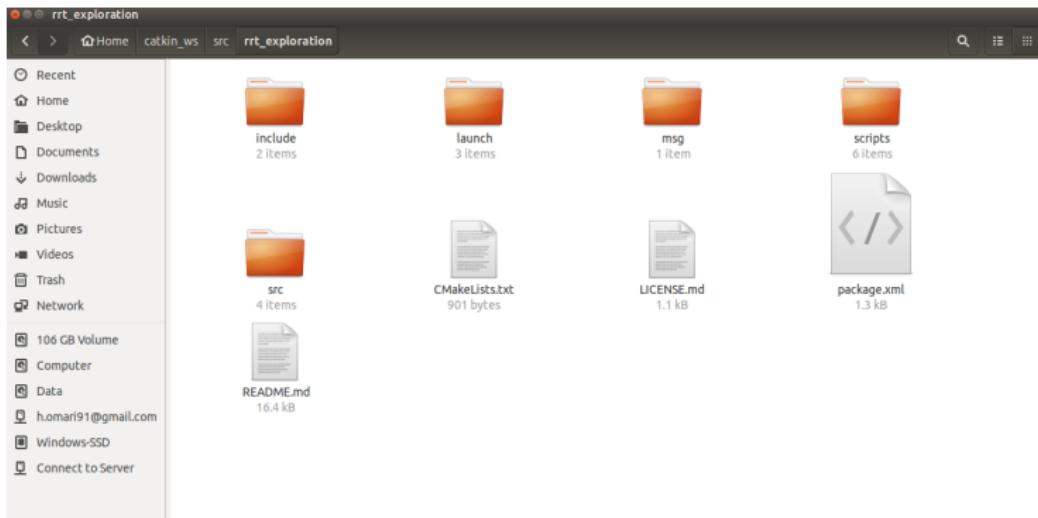
ROS Concepts



File system level

ROS Concepts

Inside a ROS package:



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Computation graph level

ROS Concepts

- In an application that uses ROS, the computations are executed by a collection of processes called Nodes.
- Nodes are connected together in a peer-to-peer network.
- This network of nodes do all the computation and is referred to as ROS computation graph.
- ROS Nodes can be run on single or multiple computers.



Computation graph level

ROS Concepts

Concepts related to ROS computation graph:

1. Nodes.
2. Topics.
3. Messages.
4. Master.
5. Parameter Server.
6. Services.
7. Bags.



Computation graph level

ROS Concepts

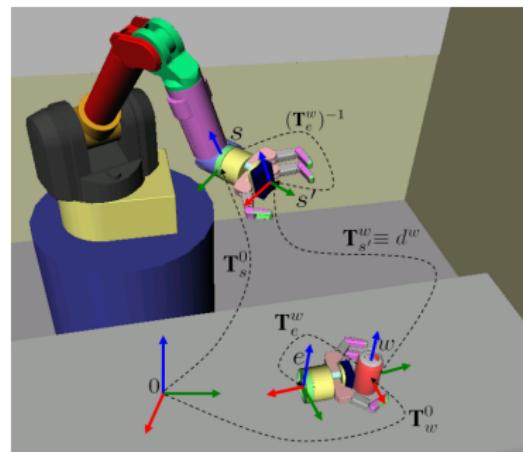
1- Nodes:

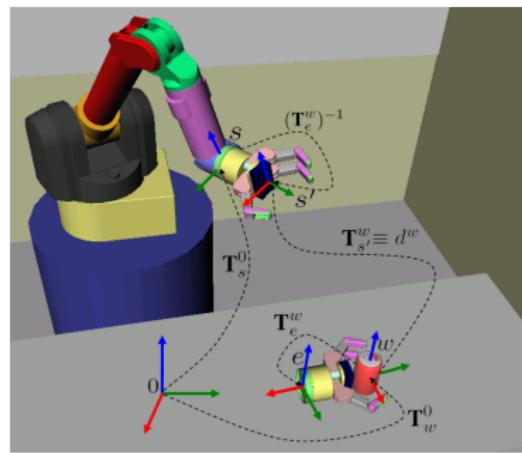
- A ROS node is a process that exchanges data with other processes through ROS network.
- It may be a python script, a C++ written process, or even a MATLAB script.
- Nodes perform computation.

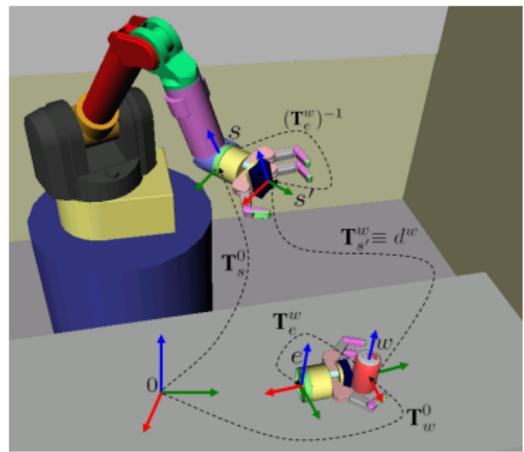
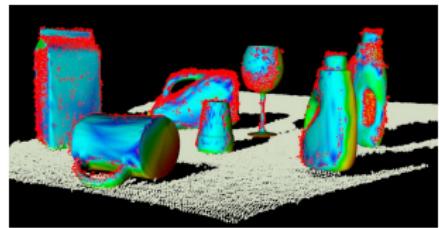












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