

## ROS and Robotics

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# ROS and Robotics

February 1, 2021

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# Robotics is a Fascinating Field Development

# Challenges in Robotics

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## ■ Timing

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- Scheduling



# Challenges in Robotics

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- Timing
- Scheduling
- Physical Limitations

# Goals of ROS

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The primary goal of ROS is support code reuse and collaboration between robotics developers and researchers.

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- Thin
- ROS-agnostic Libraries
- Language Independence
- Easy Testing
- Scaling

# Thin

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- It will not get in the way of your code.

# Thin

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- It will not get in the way of your code.
- It will not wrap your `main()` function.

# Thin

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- It will not get in the way of your code.
- It will not wrap your `main()` function.
- ideally, code written for ROS can be used in other frameworks.

# ROS-agnostic Libraries

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- Developers write libraries for their project. Not for ROS

# ROS-agnostic Libraries

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- Developers write libraries for their project. Not for ROS
- Developers write libraries with well thought interfaces can work with ROS



# Language Independence

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- ROS core team supports python3 and C++ ROS language libraries.

# Language Independence

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- ROS core team supports python3 and C++ ROS language libraries.
- Community supports ROS libraries for many more languages
  - JS
  - Java
  - Go
  - C#
  - Rust

# Easy Testing

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- Testing made simple with libraries such as rostest.

# Easy Testing

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- Testing made simple with libraries such as rostest.
- Simulation possible with community supported simulation platforms.

# Scaling

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The ROS runtime is very light-weight making it suitable for large and small robotics projects

# Turtle Bot

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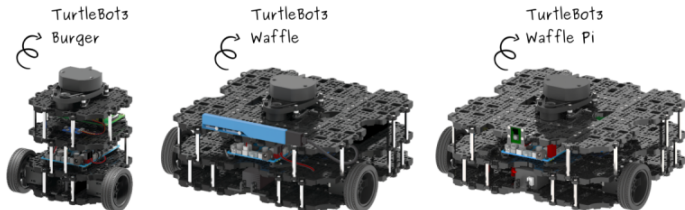
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Provided by Robotis in collaboration with the ROS project



# Turtle Mapping

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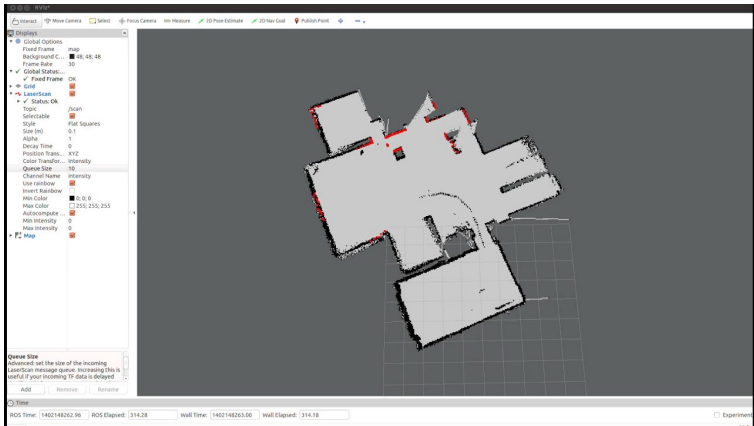
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# Turtle Examples

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<https://youtu.be/U0--ZJfmUEM>

<https://github.com/XRobots/ReallyUsefulRobot>



That's nice but...

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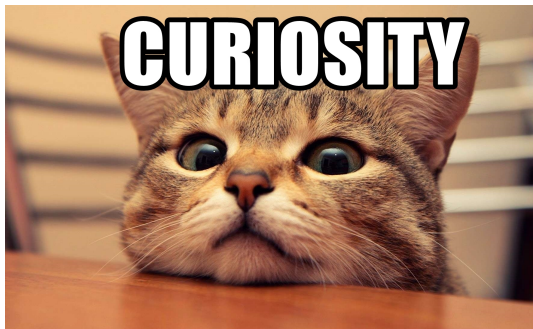
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# ROS Runtime

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- based on P2P network of multiple **processes**.

# ROS Runtime

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- based on P2P network of multiple **processes**.
- Graph vertices are ROS Nodes

# ROS Runtime

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- based on P2P network of multiple **processes**.
- Graph vertices are ROS Nodes
- Graph edges are ROS topics/services

# What are Nodes

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- Single responsibility **processes**

# What are Nodes

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- Single responsibility **processes**
- Able to publish to topics

# What are Nodes

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- Single responsibility **processes**
- Able to publish to topics
- Able to subscribe to topics

# What are Nodes

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- Single responsibility **processes**
- Able to publish to topics
- Able to subscribe to topics
- Nodes are anonymous



# What Nodes do

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Nodes manage devices such as these...

- LiDAR
- Depth Sensors
- Human Interface Controllers
- Motors
- Servos
- etc

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Nodes communicate by passing messages.

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Nodes communicate by passing messages.

- Merely a data structure

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Nodes communicate by passing messages.

- Merely a data structure
- Fields are typed

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Nodes communicate by passing messages.

- Merely a data structure
- Fields are typed
- Primitive & Array types supported.

# Messages

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Nodes communicate by passing messages.

- Merely a data structure
- Fields are typed
- Primitive & Array types supported.
- Can nest structures.

# Topics

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Messages are routed via topics.

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Messages are routed via topics.

- A name for the type of content of a message



# Topics

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Messages are routed via topics.

- A name for the type of content of a message
- Publishers & subscribers (Nodes) are anonymous

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Messages are routed via topics.

- A name for the type of content of a message
- Publishers & subscribers (Nodes) are anonymous
- Useful for decoupling production and consumption of information

# Topics

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Messages are routed via topics.

- A name for the type of content of a message
- Publishers & subscribers (Nodes) are anonymous
- Useful for decoupling production and consumption of information
- Multiple subscribers and active publishers

# Topics

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Questions

Messages are routed via topics.

- A name for the type of content of a message
- Publishers & subscribers (Nodes) are anonymous
- Useful for decoupling production and consumption of information
- Multiple subscribers and active publishers
- Constant data stream.

# Topics Showcase

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- Great for request response communication

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- Great for request response communication
- Similar to RPC

# Services

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- Great for request response communication
- Similar to RPC
- uses message structure for request and response



# Services

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- Great for request response communication
- Similar to RPC
- uses message structure for request and response
- Providing node offers service under a name

# Services

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- Great for request response communication
- Similar to RPC
- uses message structure for request and response
- Providing node offers service under a name
- Can be synchronous or asynchronous

# Services

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- Great for request response communication
- Similar to RPC
- uses message structure for request and response
- Providing node offers service under a name
- Can be synchronous or asynchronous
- Data only sent when requested

# Service Showcase

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- Middle ground between topics and services.

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- Middle ground between topics and services.
- Intended for long running tasks.

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- Middle ground between topics and services.
- Intended for long running tasks.
- Consist of three parts

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- Middle ground between topics and services.
- Intended for long running tasks.
- Consist of three parts
  - Goal



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- Middle ground between topics and services.
- Intended for long running tasks.
- Consist of three parts
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- Consist of three parts
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  - Result
  - Feedback

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- Preemptable

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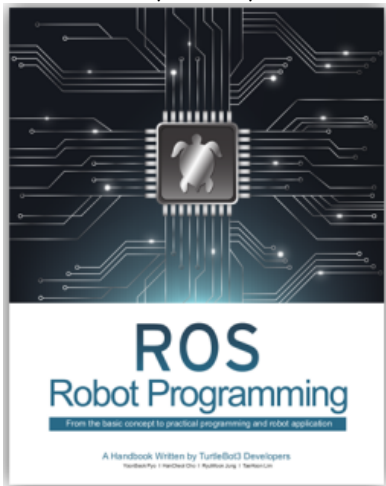
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<https://emanual.robotis.com/docs/en/platform/turtlebot3/learn/#books>



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## Deep dive course on ROS and robotics design

The Construct website interface displays a grid of ROS courses under the heading "TOP COURSES". The courses are:

- ROS Basics in 5 Days (Python) Noetic**: Learn the fundamentals of ROS to understand and be able to program robots. 40 hours. [Start Learning](#)
- ROS Basics in 5 Days (C++) Noetic**: Learn the fundamentals of ROS to understand and be able to program robots. 40 hours. [Start Learning](#)
- Linux for Robotics**: Learn the Linux fundamentals you'll need for robotics development. 9 hours. [Start Learning](#)
- Python 3 for Robotics Noetic**: Master the basics of Python 3 for robot programming. 6 hours. [Start Learning](#)
- ROS Navigation in 5 Days - Noetic**: Learn how to make your robot navigate autonomously by using the ROS Navigation Stack. 40 hours. [Start Learning](#)
- ROS2 Basics for C++ in 5 days Foxy**: Learn ROS2 basics now. It doesn't matter if you are new to ROS or a veteran, ROS2 is here to stay. 40 hours. [Start Learning](#)
- ROS2 Navigation**: Navigation is one of the key abilities for a robot to have. In this course you will learn how robots navigate in ROS2. 11 hours. [Start Learning](#)
- OpenCV Basics for Robotics - Noetic**: Learn how to work with OpenCV in ROS. 10 hours. [Start Learning](#)

<https://www.theconstructsim.com/>

# ROS1 vs ROS2

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- ROS1 Last version released in 2020
- ROS2 is a complete redesign
- Nodes, services, topics are very similar
- Starting new projects should use ROS2

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ROS is a meta-operating system that is designed to help you develop robotics software more efficiently.



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