

# ROS robot operating system

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# Overview

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1. ROS Introduction
2. ROS 1 vs. ROS 2
3. Some interesting details
4. Hands-on

# Getting ROS container (preparation)

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- go to <https://github.com/apresland/ros2-turtlebot3-sim>
- start with item 2. (download docker image)

# ROS Intro

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- ROS is a shortcut of **R**obot **O**perating **S**ystem
- but is not only an OS but rather a robot development framework
- tools (simulation, debugging, visualisation, ...), code (core, "nodes", "drivers", ...) and community (tutorials, wiki, forum, ...)
- Open Source (BSD License, no "Copyleft")
- [What is ROS \(00:03:12 Video\) from ROS: Home](#)

# ROS Intro cont.

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- Development started 2007 at Stanford AI Lab
- Since 2012 developed from non-profit Open Source Robotics Foundation (OSRF)
- Since 2013 ROS Industrial Consortium (in addition)
- Annual Conference [ROSCon](#)
- Link to [ROS: Home](#)

# ROS versions: ROS 1 vs. ROS 2

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## ROS 1

- Development from 2007 to 2020
- Long term support of latest version until 2025
- Huge community, extensive documentation
- Main OS: Ubuntu Linux

## ROS 2

- Development from 2017 (ongoing)
- Not compatible, but inter operable with ROS
- Aim: real-time capability
- Supports small platforms (microROS for microcontrollers) ...
- ... and additional operating systems (macOS, Windows)

# Into the details

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## (Graph) concept

- "Node": abstraction of hardware or logic, a node is an executable that uses ROS to communicate with other nodes
- "Topic": nodes can publish messages to a topic as well as subscribe to a topic to receive messages
- "Master": name service for ROS (i.e. helps nodes find each other)
- "rosout": ROS equivalent of stdout/stderr
- "Parameter Server": shared dictionary that is accessible via network APIs. Nodes can use this server to store and retrieve parameters at runtime, e.g. configuration parameters.

## more details

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**roscore = Master + rosout + parameter server**

- controls and monitors nodes and configuration
- first thing to start if using ROS 1
- no longer available on ROS 2 (replaced by peer-to-peer communication)



# more details

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## **ROS services**

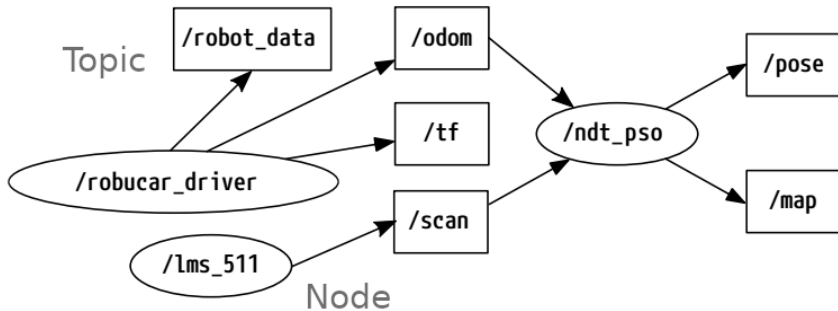
- alternative to topics
- for remote procedure calls
- request / response message pairs

## **ROS bags**

- for recording and playback of messages
- efficient format
- e.g. for simulation

# Visualization of nodes and topics (rqt\_graph)

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# more details

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## build environment

- Own package related to cmake
  - "catkin\_make = cmake + make"
- ROS 1: catkin package
- ROS 2: ament package

## runtime environment

- ROS 1: Ubuntu Linux
- ROS 2: Ubuntu Linux, Red Hat Enterprise Linux, macOS, Windows 10
- cpp: built from libraries, e.g. from rclcpp "ros" cpp library
- Python: using packages installed in (virtual) environment

# more details

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## ROS (debugging) tools

- `ros2 wtf -r`
- rqt tools
  - `rqt_graph` (see slide 8)
  - `rqt_plot` plots topic values over time
  - `rqt_console` displays log outputs
- `rosviz`
- `rviz` for data visualization, e.g. robot position in 3D
- ...

## **Part 2 - Hands-on**

# Getting ROS container

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- go to <https://github.com/apresland/ros2-turtlebot3-sim>
- from README do items 1. and 2.

# Running ROS container

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- go to <https://github.com/apresland/ros2-turtlebot3-sim>
- continue with item 3. of README
- the container contains a robot simulation and visualisation
- the robot can be teleoperated
- the simulated robot works like a physical ROS robot system and ROS tools can be used with it

# What's next? (Things you can try out)

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You can

- run command `ros2 topic list -v` to print a list of all active ros topics
- get to know rqt (see [ROS 2 rqt introduction](#))
- run command `ros2 wtf -r` to print a summary of your ROS system and possible issues with it
- write a new node (see [ROS 2 publisher tutorial](#))
- write a new service (see [ROS 2 service tutorial](#))
- log to bagfile and play back (see [ROS 2 bag tutorial](#))



# Some information about the docker container

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- Note that the folder **/workspace** of your linux system is mapped to folder **/dev\_ws** of your container if the container is started from the correct location. This allows to download / clone / change files on your native system and use the tools in the container to compile / run your code.
- Tools available in the container:
  - rviz2 (start from terminal with command `rviz2`): visualization of robot perception etc.
  - rqt (command `rqt`): graph, logging, image visualization (if there is a camera)
  - vi editor for viewing files

# Cheat Sheet

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| Command                           | Description                     |
|-----------------------------------|---------------------------------|
| <ros2 cmd> -h                     | display help                    |
| ros2 node list                    | shows current ROS nodes         |
| ros2 topic list -v                | shows current ROS topics        |
| ros2 topic info <topic>           | information on a specific topic |
| ros2 run <packagename> <nodename> | starts this node                |
| ros2 wtf                          | analyse system                  |
| ros2 bag record -a                | start recording of all topics   |
| ros2 param set                    | set a ROS parameter             |
| ros2 param list                   | list all ROS parameters         |

# Where to get help from

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- [ROS 1 Wiki](#)
- [ROS 1 Tutorials](#)
- [ROS 1 + 2 Forum](#)
- [ROS 2 \(galactic geochelone\) Documentation](#)
- [ROS 2 Tutorials](#)
- ROS community is large and there is a lot of documentation, tutorials, a forum, ... on [www](#).

# References

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- ROS: Home - <https://www.ros.org/>
- [https://de.wikipedia.org/wiki/Robot\\_Operating\\_System](https://de.wikipedia.org/wiki/Robot_Operating_System)
- <https://answers.ros.org/question/351470/where-is-roscore-in-ros2/>
- ROS 2 documentation: <https://docs.ros.org/en/galactic/index.html>
- <https://answers.ros.org/question/187748/catkin-vs-cmake/>

# The End