AuE 8230
Autonomy: Science and Systems

Critical Analysis of ROS, ROS-1 and ROS2

Chinmay Samak

Automation, Robotics and Mechatronics Laboratory (ARMLab)
Clemson University International Center for Automotive Research (CU-ICAR)

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Introduction to ROS and its variants

⠿ROS = [plumbing] + [tools] + [capabilities] + [community]

- NOT an OS – rather an SDK/middleware/meta-OS targeted towards robot software development

- Provides a message-passing system to share information

- Offers out-of-the-box support to launch, debugging, logging, visualization & playback tools

- Provides building blocks for drivers, algorithms (perception, planning, control), user-interfaces, etc.

- Connects to a global community of students, hobbyists, researchers, MNCs, govt. agencies, etc.

- Adopted and modified to many variants for optimal performance and application-specificity

⠿ROS   ⠿ROS industrial™   ⠿ROS2™   µ⠿ROS   AUTOWARE.AI   AUTOWARE.AUTO   AUTOWARE.IO

https://www.ros.org/blog/ecosystem/

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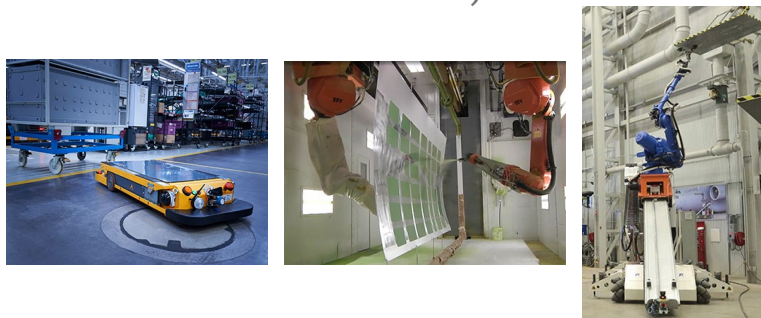
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Which kind of robots use which system?

- Manipulators, humanoids, wheeled mobile robots, autonomous vehicles, etc.

- TurtleBot 3, Nao, OpenCAV, AutoDRIVE etc.

- Industrial manipulators, mobile robots & mobile manipulators

- ABB, Adept, Fanuc, Motoman, KUKA, Robotiq, Universal Robots, etc.

- Manipulators and mobile robots

- Migrating from ROS to ROS2

- TurtleBot 4, Open Manipulator, etc.

https://robots.ros.org/
https://en.wikipedia.org/wiki/Robot_Operating_System

https://www.automate.org/industry-insights/ros-industrial-for-real-world-solutions

https://www.theconstructsim.com/a-list-of-robots-running-on-ros2/

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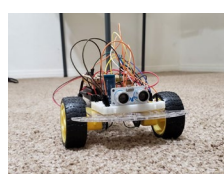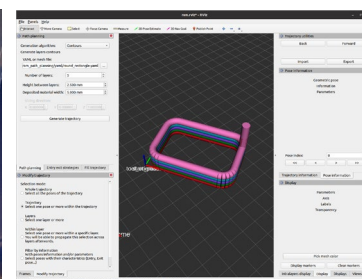Clemson University International Center for Automotive Research (CU-ICAR)

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How are they deployed?

ROS

- Hobby projects
- Robotics competitions
- Educational tools
- Academic research

ROS industrial

- Industrial automation
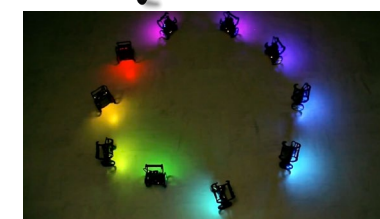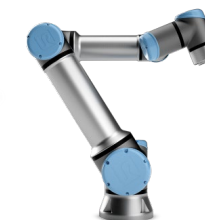- Product development
- Additive manufacturing
- Industrial research

ROS2

- Educational tools
- Academic research
- Migrating from ROS to ROS2

https://sites.google.com/view/opencav/
https://f1tenth.org/
https://robotx.org/

https://rosindustrial.org/news
https://youtu.be/-6yAk05et1Q
https://wiki.ros.org/Industrial/Roadmap

https://www.theconstructsim.com/a-list-of-robots-running-on-ros2/
https://bettstetter.com/swarmalatorbots/
https://bettstetter.com/drones-that-sync-and-swarm/

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What ancillary support resources are available?

ROS

- Documentation

  https://wiki.ros.org/

- Questions & answers

  https://answers.ros.org/questions/

- Support

  http://wiki.ros.org/Support

- Discussion forum

  https://discourse.ros.org/

ROS industrial™

- Documentation

  http://wiki.ros.org/Industrial

- Installation guide

  http://wiki.ros.org/Industrial/Install

- Tutorials

  http://wiki.ros.org/Industrial/Tutorials

- Discussion forum

  https://discourse.ros.org/c/ros-industrial

- Bug/feature tracking

  https://github.com/ros-industrial/ros_industrial_issues

ROS2™

- Documentation

  https://docs.ros.org/en/foxy/index.html

- Installation guide

  https://docs.ros.org/en/foxy/Installation.html

- Tutorials

  https://docs.ros.org/en/foxy/Tutorials.html

  https://docs.ros.org/en/foxy/How-To-Guides.html

- Concepts

  https://docs.ros.org/en/foxy/Concepts.html

- Support

  https://docs.ros.org/en/foxy/Contact.html

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By what features can they be differentiated?

ROS

- Centralized (master-based) node architecture
- C++ 03/11, Python 2
- Supported on Linux & macOS
- Custom serialization format
- Single node in a process
- Launch files in XML with limited functionalities

ROS industrial™

- Simple message
- Industrial robot client
- Industrial calibration
- Vendor specific packages
- Robot driver specification
- Software quality assurance

ROS 2™

- Distributed (peer-to-per) node architecture
- C++ 11/14/17, Python 3.5
- Supported on Linux, macOS, Windows, RTOS
- Based on data distribution service standard
- Multiple nodes in a process
- Launch files in Python enabling complex logic and conditioning

https://answers.ros.org/question/287470/what-is-the-difference-between-ros-and-ros2/
https://www.theconstructsim.com/infographic-ros-1-vs-ros-2-one-better-2/
https://www.generationrobots.com/blog/en/ros-vs-ros2/
http://design.ros2.org/articles/changes.html

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How to decide which one to use?

ROS

ROS industrial™

ROS 2™

After analysing the key differences between the 3 ROS variants, depending upon project requirements and application(s), one may choose to use ROS/ROS-I/ROS2 based on the following considerations:

- Beginners and students

- Hobby/educational projects

- Rapid prototyping

- Stable packages & debugging tools

- Community support

- Complete and detailed tutorials

- Robot/hardware drivers

- Developer tools

- Industrial calibration

- Human machine interfaces

- Industrial applications

- Enterprise scale deployment

- Consortium membership benefits

- Computer professional learners

- Robot security

- Real-time control

- Minimal dependencies

- Better portability

- Greater reliability & persistance

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Resources and References

- Quigley, Morgan & Conley, Ken & Gerkey, Brian & Faust, Josh & Foote, Tully & Leibs, Jeremy & Wheeler, Rob & Ng, Andrew, 2009, "ROS: an open-source Robot Operating System", ICRA Workshop on Open Source Software, 3

- Edwards, S.M., 2011, "Leveraging the Open Source Robot Operating System (ROS) for New Industrial Applications" Robotics Summit, Robotic Trends Virtual Conference Series, September

- Macenski, Steve & Foote, Tully & Gerkey, Brian & Lalancette, Chris & Woodall, William, 2022, Robot Operating System 2: Design, Architecture, and Uses In The Wild, 10.48550/arXiv.2211.07752

- Overview: https://ubuntu.com/robotics/what-is-ros

- ROS Documentation: http://wiki.ros.org/

- ROS-I Documentation: https://rosindustrial.org/

- ROS2 Documentation: https://docs.ros.org/en/foxy/index.html

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