What's next for ROS?

 $\bullet \bullet \bullet$

ROSCon JP Tokyo, Japan September, 2018

The Organization



Open Robotics

We support the development, distribution, and adoption of open software and hardware for use in robotics research, education, and product development.

The Team



History: From lab to product



Robot for Research and Innovation

.....

PR2 is a robotics research and development platform that lets you innovate right out of the box. No more building hardware and software from scratch.

LOOK INSIDE



20 December 2008 Navigation

Milestone 1 Reached!

Submitted by Anonymous on Sat, 12/20/2008 - 00:42



We cleanly passed our first major milestone this morning, with one of the Alpha PR2 robots (Gandalf) autor kilometers two days in a row. Gandalf had been doing a π -kilometer run each day for the past two weeks, the milestone complete until we had two consecutive clean runs. In the process, we improved the navigati avoid low obstacles (scooters are popular here, and weren't seen by the first version of the software), to n uncharted territory when stuck, and of course by fixing a few bugs.

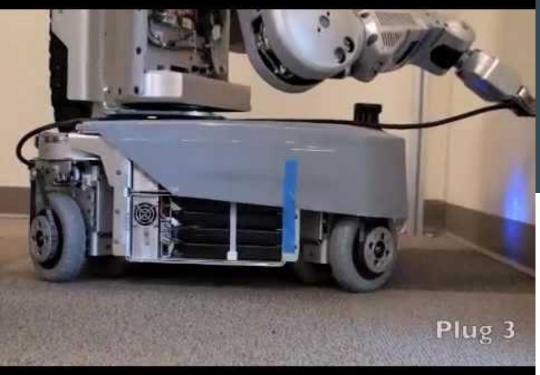
This milestone is very important: It demonstrates the hardware of the PR2 (except arms), from casters to to sensors. It demonstrates the software on the robot from the device drivers to the executive, from the co

EROS 0.4 mango tango http://ros.sourceforge.net

10 February 2009 First advertised release

EROS 0.5 mojito mambo http://ros.sourceforge.net

7 May 2009 Second advertised release



1 June 2009 Navigation + manipulation

Milestone 2 Reached! Submitted by Anonymous on Mon, 06/01/2009 - 21:17



Today at 6pm, one of our PR2 alpha robots successfully completed Milestone 2 by performing a circuit of 10 plugin goals in just under an hour. It had previously completed the first part of the milestone, which was successful navigation around the office for 26.2 miles (a marathon). The first

22 January 2010 ROS 1.0 PR2s offered to labs

Milestone 3 Complete: PR2 Betas Ready and ROS 1.0

Submitted by admin on Fri, 01/22/2010 - 17:42



Today, we finished our third milestone! Simply put, ROS has reached 1.0 status. We also recently unveiled and the PR2 Beta Program, which will distribute approximately 10 PR2 robots at no cost.

Of course, it's a lot more than that. Since work began on Milestone 3, there are now:

- 203 ROS software tutorials
- 29 ROS Stacks at 1.0 status, which contain a total of 186 ROS Packages
- 21 Completed Use Cases, requiring well over one hundred user studies



17 September 2012 First ROS-based commercial (non-research) robot

Rethink ROS

By Tully Foote on September 17, 2012 10:22 PM | No Comments | No TrackBacks

Cross Posted from the Open Source Robotics Foundation Blog

There's exciting news out of Boston today with the launch of <u>Rethink Robotics's</u> new robot. Rethink Robotics is developing a family of low cost and highly intelligent robots that can perform simple tasks in a manufacturing environment, increasing the productivity of the people around them. Rethink Robotics was founded by Rodney Brooks, former Director of the <u>MIT</u> <u>Computer Science & Artificial Intelligence Laboratory</u>, and co-Founder of <u>iRob</u>

Rethink's robots can be taken out of the box, taught a task by <u>anyone</u>, and sta eliminating the need for systems integration. They are safe to interact with peo easy to train and retrain on the fly. They are nothing like any existing industrial

While all of this is very exciting for the robotics industry, and certainly for our fr personally find most exciting is the role played by ROS in today's news. Rethin words of CEO Scott Eckert, "built upon ROS." We had some hint from Rethink ROSCon 2012 that they were doing something with ROS, but we were very player that ROS is such a central part of Baxter.

(some of the) ROS-based products available today

















Gazebo: Simulate your robot(s)

Importance of Simulation

Design

Prototype configurations and sensor placement.

Experiment with different scenarios.

Testing

Simulation based CI

Scale up with cloud computing

Tools to understand and debug tests

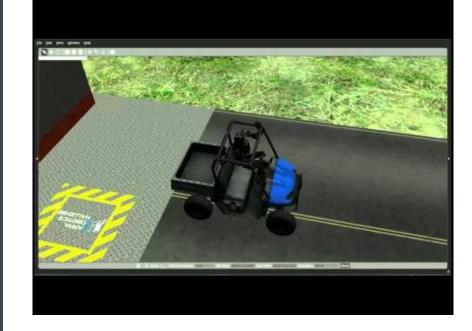
Productivity

Reduce constraint on shared hardware

Less overhead with software-only system

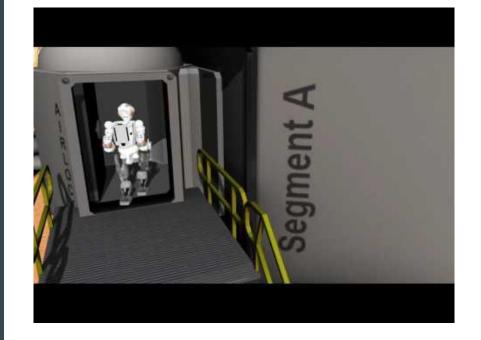
Simulation is very safe

Simulation: Robots for Disaster Response



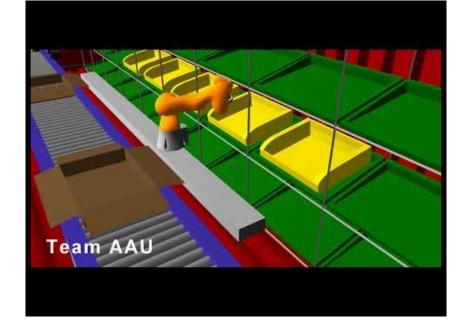
Virtual Robotics Challenge, 2013

Simulation: Robots for Planetary Exploration



Space Robotics Challenge, 2017

Simulation: Robots for Industrial Automation



Agile Robotics for Industrial Automation Competition, 2018

Simulation: Boats for Ocean Monitoring



Virtual Maritime Robotics Challenge, 2019

Metrics: Community size & health

Documentation

The ROS wiki

|) → C ⁱ D ③ wiki.ros.o | rg | 🖸 🏠 | ¥ II\ 🗆 🔾 | | | | |
|---|--|-------------------------|--------------------|--|--|--|--|
| Register before Au | ROSCon 2018 will be in Madrid, September 29 gust 11th and take advantage of early registration an | | | | | | |
| ROS.org | About Support Discussion Forum Service Status | s Q&A answers.ros.org | Search: Submi | | | | |
| Documentation | Browse Software | News | Download | | | | |
| Documentation | | | | | | | |
| ROS (Robot Operating System) provides libr provides hardware abstraction, device driver ROS is licensed under an open source, BSD | Wiki Distributions ROS/Installation | | | | | | |
| Available Translations: German Spanish F Pycoxwi (Russian) Thai Turkish 简体中文 | ROS/Tutorials RecentChanges | | | | | | |
| ROS: | | | FindPage Papers | | | | |
| Install | | | Papers | | | | |
| Install ROS on your machine. | | | | | | | |
| Getting Started | Page Edit (Text) | | | | | | |
| Learn about various concepts, o | Edit (Text) Edit (GUI) | | | | | | |
| Tutorials | into | | | | | | |
| Step-by-step instructions for lea | Subscribe | | | | | | |
| Contribute | Add Link | | | | | | |
| How to get involved with the RO | Attachments | | | | | | |
| Support | More Actions: | | | | | | |
| What to do if something doesn't | work as expected. | | User | | | | |
| Quality Assurance | BrianGerkey | | | | | | |
| How to ensure that your ROS-ba | Settings | | | | | | |
| Software: | | | Logout | | | | |
| Distributions | | | | | | | |
| View the different release Distrib | utions for BOS | | | | | | |
| Packages | | | | | | | |
| Search the 2000+ software libra | ries available for BOS. | | | | | | |
| Core Libraries | | | | | | | |
| | | | | | | | |
| APIs by language and topic. | | | | | | | |

- 178K monthly users**
 - 35% annual increase*
- 1.49M annual users***
- 24.48M annual page views***
 - Source: Google Analytics
 - * July 2018 vs. July 2017
 - ** Month ending July 31, 2018
 - *** Year ending July 31, 2018

Documentation

The ROS wiki

| 1. | United States | 34,710 (19.08%) |
|-----|------------------|-----------------------|
| 2. | China | 31,946 (17.56%) |
| 3. | Japan | 15,518 (8.53%) |
| 4. | 🥅 Germany | 12,711 (6.99%) |
| 5. | 💶 India | 8,400 (4.62%) |
| 6. | Philippines | 7,235 (3.98%) |
| 7. | 📧 South Korea | 6,790 (3.73%) |
| 8. | 🔡 United Kingdom | 4,325 (2.38%) |
| 9. | 🔚 Taiwan | 4,233 (2.33%) |
| 10. | France | 3,725 (2.05%) |

- Global impact: USA constitutes 19% of users***
- Partial translations in 14 languages
 - Source: Google Analytics
 - * July 2018 vs. July 2017
 - ** Month ending July 31, 2018
 - *** Year ending July 31, 2018

Binary packaging

The ROS build farm

| O build.ros.org | | | | | G C | Search | | ☆ [| ≙ ♣ | ŵ | ♥ 🗎 | |
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| Project Relationship | Jbin_uT64 | Jdev | Jdoc J | lpr Jsrc, | ,uT | Jsrc_uV | Kbin_dj_dJ64 | Kbin_djv8_ | 8vLb, | Kbin_u> | 132 | |
| Check File Fingerprint | Kbin_uX64 | Kbin_u | chf_uXhf | Kbin_uxvi | _uXv8 | Kdev | Kdoc Kpr | Ksrc_dJ | Ksrc_u | K Lb | in_ds_dS6 | 6 |
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| rel trigger-jobs | | indigo ros | distro-cache | 8 | | 4 min #1624 | 15 sec - | N/A | | 43 se | c | |
| rel dsv8 trigger-jobs | | | econfigure-i | | | | 179 13 min - #1848 | N/A | | | 10 sec | |

- 327K monthly downloaders**

 41% annual increase*
- 16.2M monthly binary packages downloaded**
 - 21% annual increase*
- 5.9TB monthly download traffic**
 - 25% annual increase*
 - Source: awstats @ OSUOSL
 - * July 2018 vs. July 2017
 - ** Month ending July 31, 2018

ROS 2: The next generation

Goals for ROS 2

product-ready

Use industry-standard middleware (e.g., DDS)

Build in security from the beginning

Support Linux, macOS, and Windows

mission-critical

Support real-time control

Static analysis (e.g., MISRA)

Document design choices

Support safety certification

...but also familiar

Keep the core concepts from ROS 1

Distributed systems

Federated development

Permissive open source license

Timeline for ROS 2

July 2018 August 2015 March 2014 **Bouncy Bolson:** December 2018 December 2016 Alpha 1: first ROS Work begins at first distro with **Crystal Clemmys** Beta 1 **Open Robotics** 2 release external packages September 2014 **July 2016** September 2018 December 2017 **First ROSCon talk** Alpha 7: first **Ardent Apalone**: **TurtleBot 3 runs** on ROS 2 TurtleBot 2 demo first distro ROS 2

(some of the) Companies supporting ROS 2 development



ROS 2 & Gazebo Use Case: Automotive

Open non-competitive features Safety and security do not differentiate.

Shared Engineering

Example: ROS Navigation

A path planner and obstacle avoidance library.

Forked and modified by numerous companies, who contribute upstream.



Goal: Reference implementations

High quality, best in class implementation of commonly required components.

Vendors customize as needed, but also contribute upstream.

Anecdote: ABS Brakes

- Concept existed for many years
- Companies modified and applied their own features

Simulation: Automobiles



Autonomous vehicles require hundreds of millions of miles (or more) to prove reliability. [1]

^{1.} Kalra, Nidhi and Susan M. Paddock. Driving to Safety: How Many Miles of Driving Would It Take to Demonstrate Autonomous Vehicle Reliability?. Santa Monica, CA: RAND Corporation, 2016.

Software Platforms

apollo

https://github.com/ApolloAuto/apollo



https://github.com/CPFL/Autoware

".. an open, reliable and secure software platform for its partners to develop their own autonomous driving systems ..." -- http://apollo.auto

"We use the latest technologies, such as ROS (Robot Operating System), and are able to see the results quickly and directly in the vehicle. It is extremely exciting to be working on such an important area for the future." -- André Müller, BMW

Hardware Platforms

Autonomous Stuff

Supplies components and engineering services for automotive autonomy.

https://github.com/astuff



Dataspeed ADAS Kit

Complete solution to control throttle, brake, steering, and shifting.

https://bitbucket.org/DataspeedInc/

Successful Exit: HERE





HERE mapping fleet running ROS



Dec 2015

Nokia Closes Its \$2.8B Sale of HERE to the Audi, BMW, And Daimler Car Consortium

Successful Exit: Cruise Automation





"GM reportedly spent over \$1 billion on a tiny startup that holds a key to the future of driving" --Business Insider



Sep 2018

"Cruise Automation's self driving car runs on top on ROS" --ROSCon 2018 program

Philosophy: Be active in open source

Provide Feedback Let projects know about your problems and needs.

Private communication

ros@openrobotics.org | sime

sim@openrobotics.org

Contribute Upstream code when possible.

What?

- Bug fixes and patches
- Tools and applications that don't affect value proposition.

Why?

- Less code for you to maintain.
- More testing.
- Build a user group.

Publicize Share your experience. Support publication of your usage.

http://www.ros.org/ http://gazebosim.org/



https://www.openrobotics.org

