The Latest Advances In ROS 2

Katherine Scott
Developer Advocate
Open Robotics
@kscottz

Overview

- What is ROS?
  - Why you should care
  - How it relates to PX4
  - Social Proof
  - General Features
  - Resources to Get Started
- Recent Advances
- Relevant Projects

Why should I care about this ROS stuff?

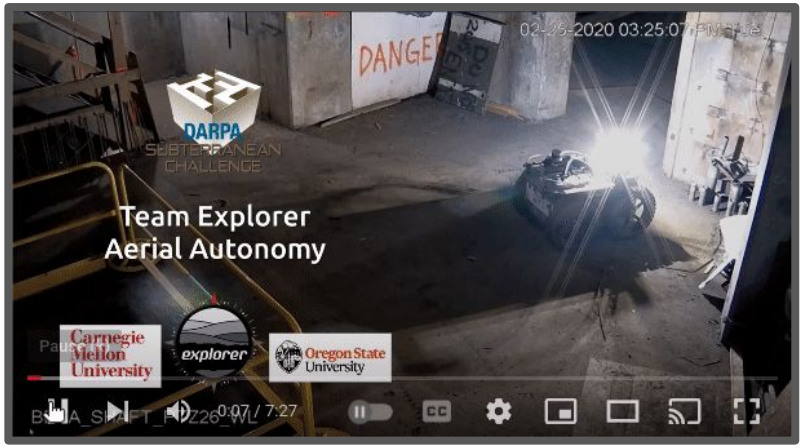
ROS is FOSS used all over the world to build the most advanced robots.

ROS has lots of relevant features that enable advanced drone behaviors.

Motivation

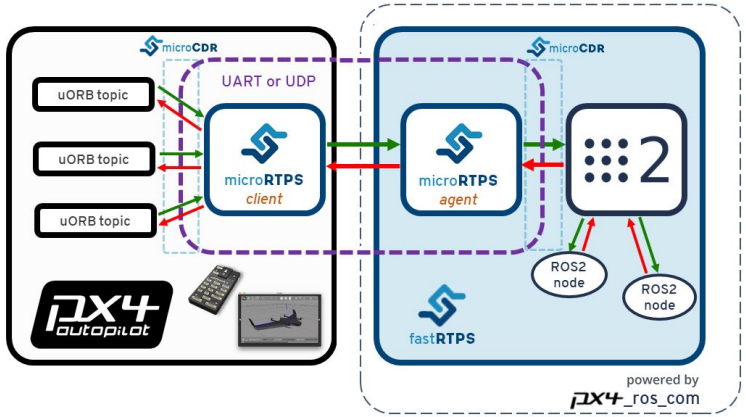
MAVROS

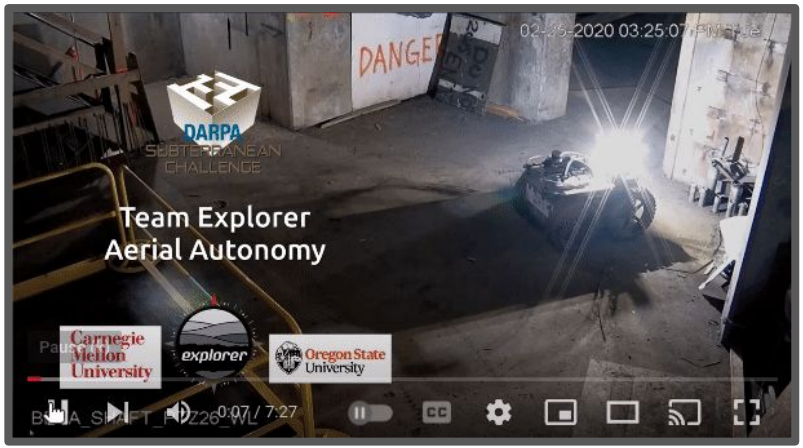
ROS



BUILD COOL STUFF

Motivation





BUILD COOL STUFF

Social Proof – Who uses ROS

ROS 2 TSC

ADLINK
Apex.AI
BOSCH
TOYOTA RESEARCH INSTITUTE
Microsoft
amazon
ubuntu
intel
SAMSUNG
PICKNIK
open robotics
DEVCOM GROUND VEHICLE SYSTEMS CENTER
LG Electronics
ROVER ROBOTICS
eProsima The Middleware Experts
iRobot
SONY
ROBOTIS
WIND

ROS Industrial

78 Members
bit.ly/ROSIMembers

Government

- NASA
- NHSTA / USDOT
- DARPA
- Army / Navy / AF
- NIST
- Dozens of Universities
- Singapore Hospital System

Want to work at one of these places? They all use ROS

How big is ROS?

	Year Ending July 2020	Year ending July 2021	YoY Change
Total Packages	402,106	600,660	49.38%
Distinct Packages	16,083	19,884	23.63%
Deb Downloads	395,187,333	**595,524,493**	50.69%
Data Served (TB)	231	156	-32.26%

Direct downloads from packages.ros.org - August 2020 - July 2021

Why ROS 2?

Tooling

- Message Passing
- Sync / Async Commands
- Simulation
- Visualization
- Logging
- Deployment
- Package Mgmt
- ***Don't reinvent the wheel***

Track Record

- Decade of development
- Many dev resources
- Used in every robotics vertical
- No vendor lock-in
- Open Source

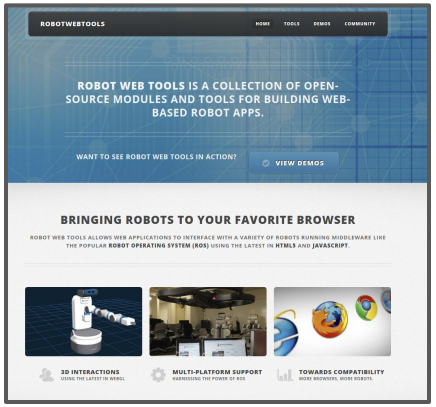
Time to Market

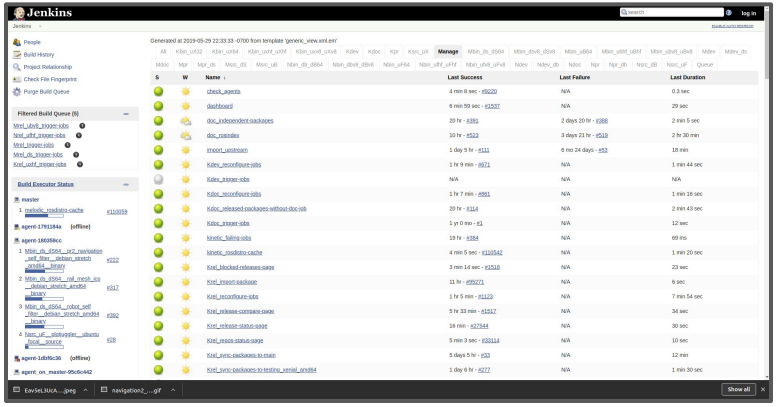
- ROS is Python for robots
- Focus on your core capabilities
- Hardware agnostic
- Make it work, then make it fast

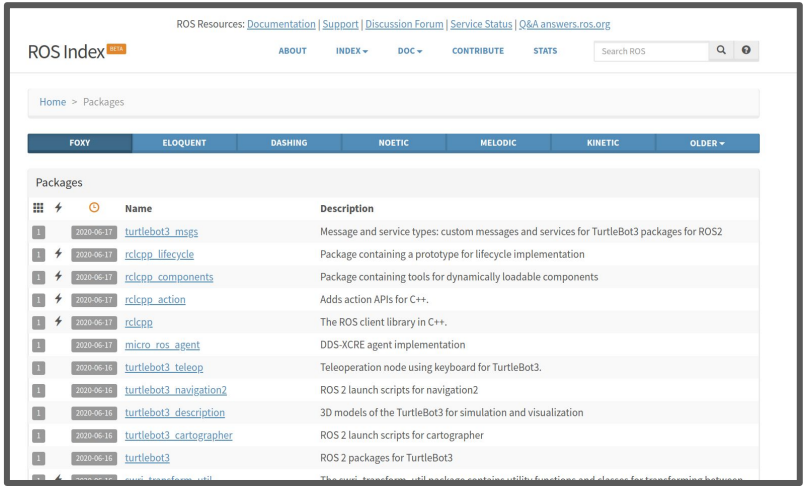
We keep it real! We're not selling you a product. We're just a community of engineers

ROS Packages: Batteries Included

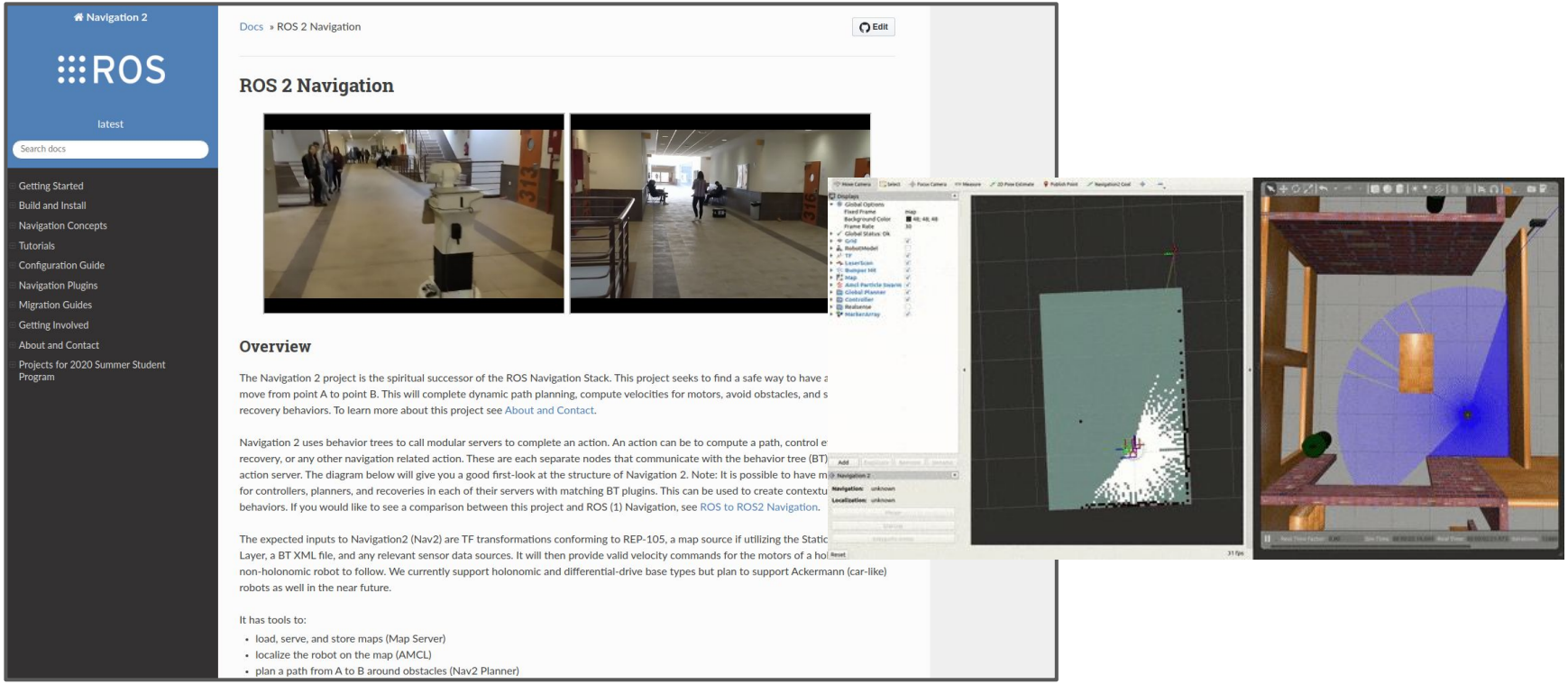
- ROS has a concept of packages.
  - Collections of code, that can be combined
- C++, Python, and many others!
- ROS federation means we need a multi-repo, multilingual meta build tool: Colcon
- Analogous to PIP / Python Wheels



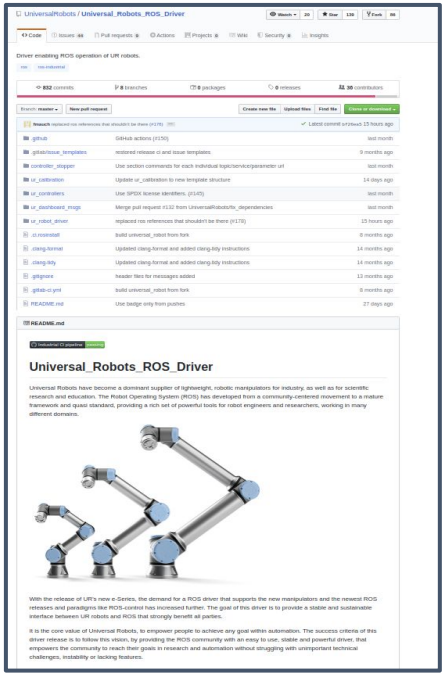


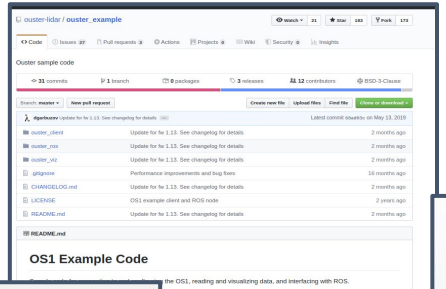


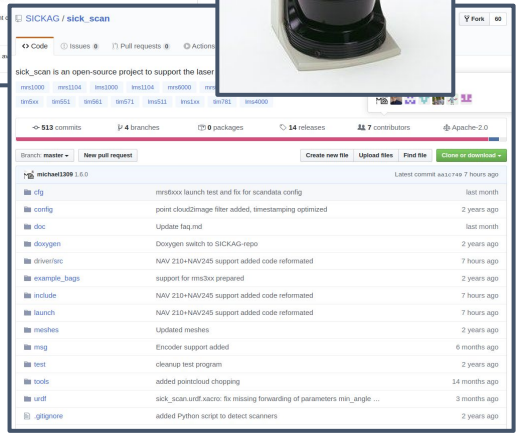
Don’t Reinvent: SLAM / Navigation

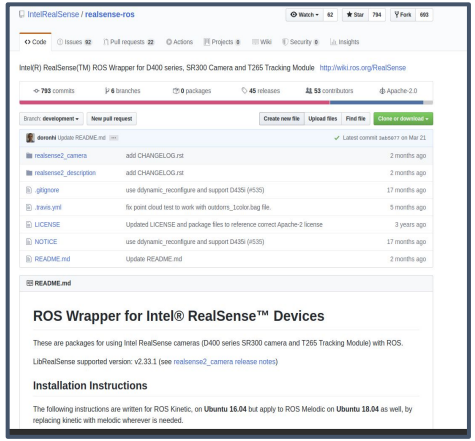


ROS: Getting to Plug and Play Hardware







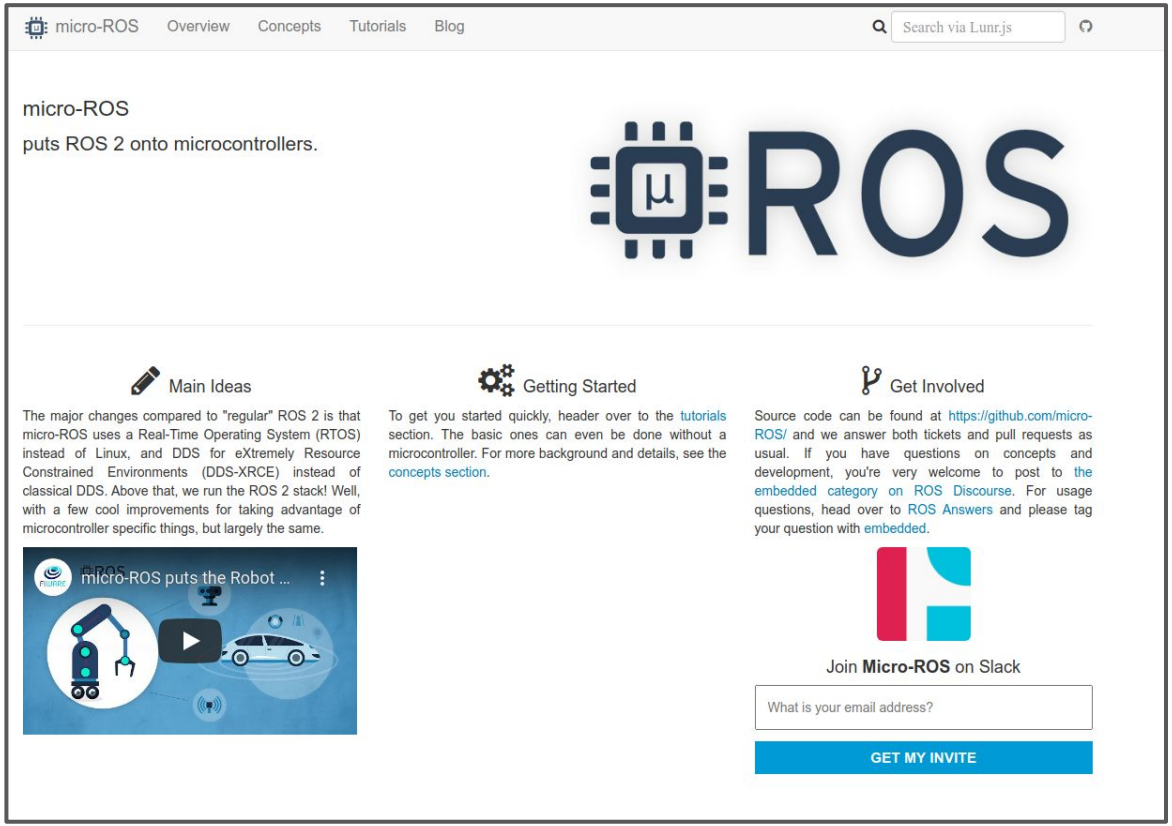


ROS 2: Hardware Ready

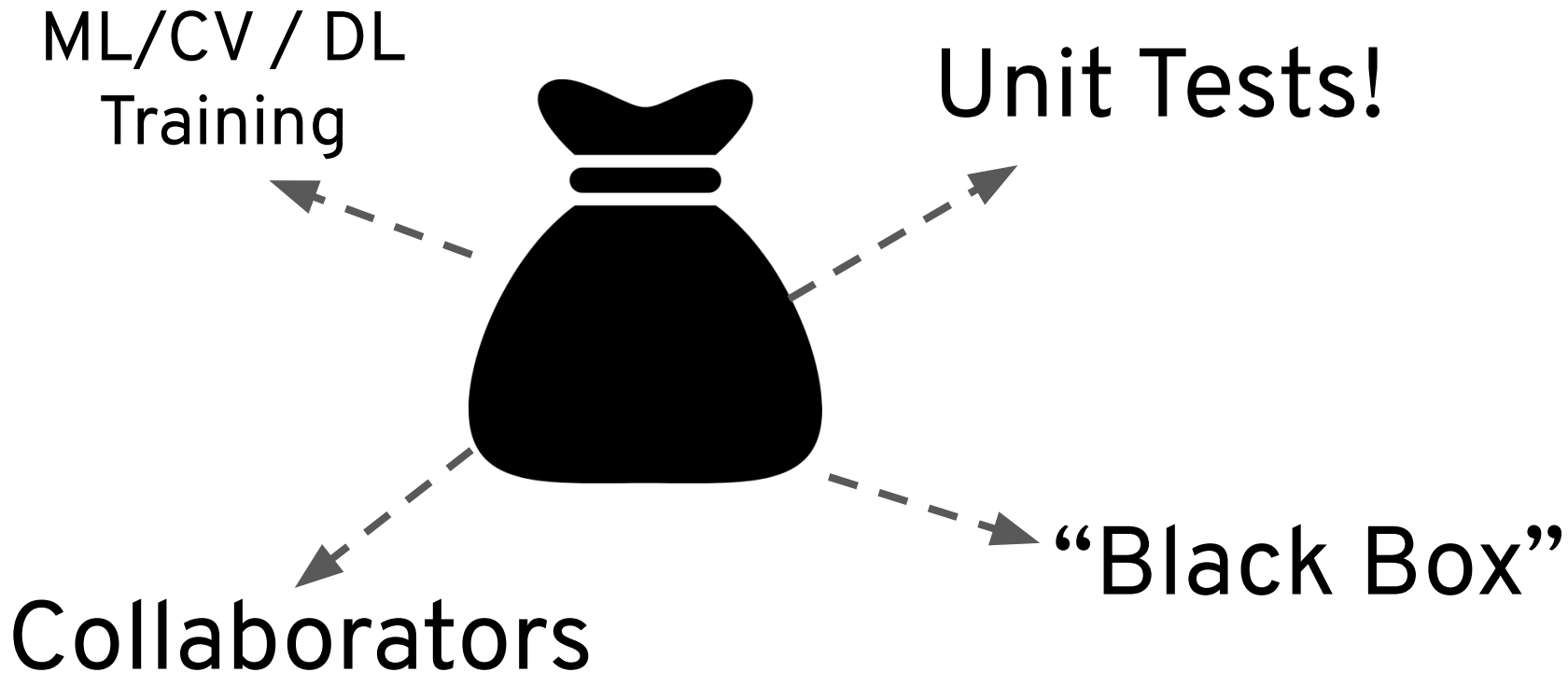
Bridge between ROS 2 DDS layer and an RTOS

Currently on a bunch of different RTOSs

Recent IDE integration make life easier

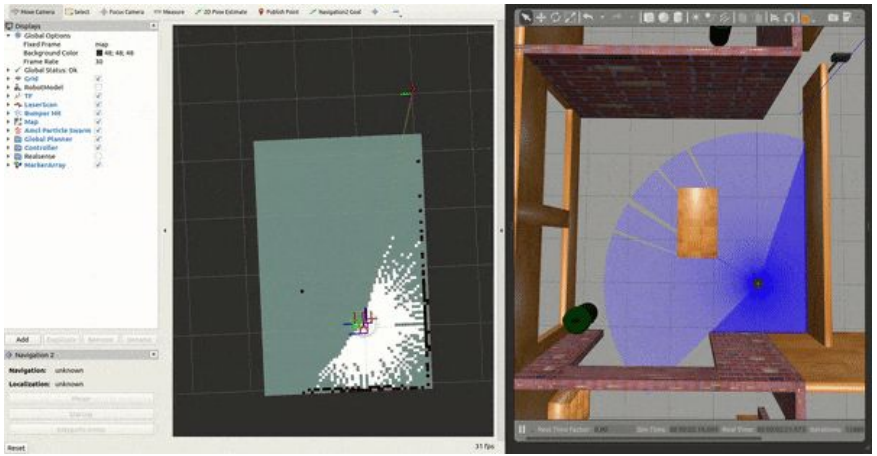


BAGS ARE AMAZING



Don’t Reinvent: Simulation

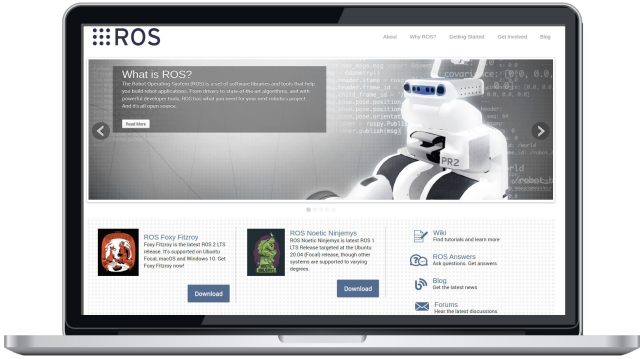
- Ignition Gazebo, build a virtual robot
- Simulate Physics, robots, and sensors
- Plays well with ROS 2
- Allows you build, test, and debug from the comfort of your desk.
- Gazebo Fortress is recommended for Humble



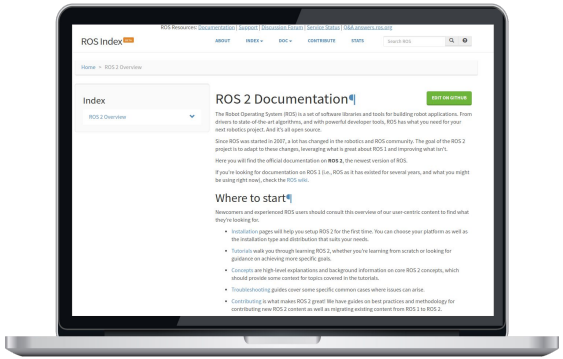
open robotics

ROS 2

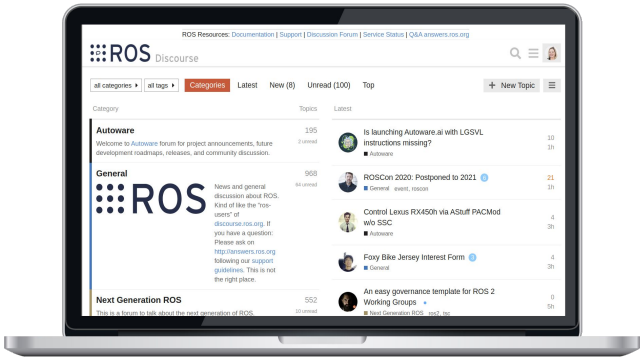
Where to get started?



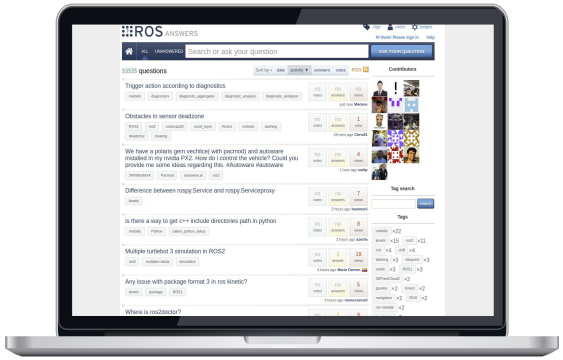
[ros.org](ros.org)



docs.ros.org



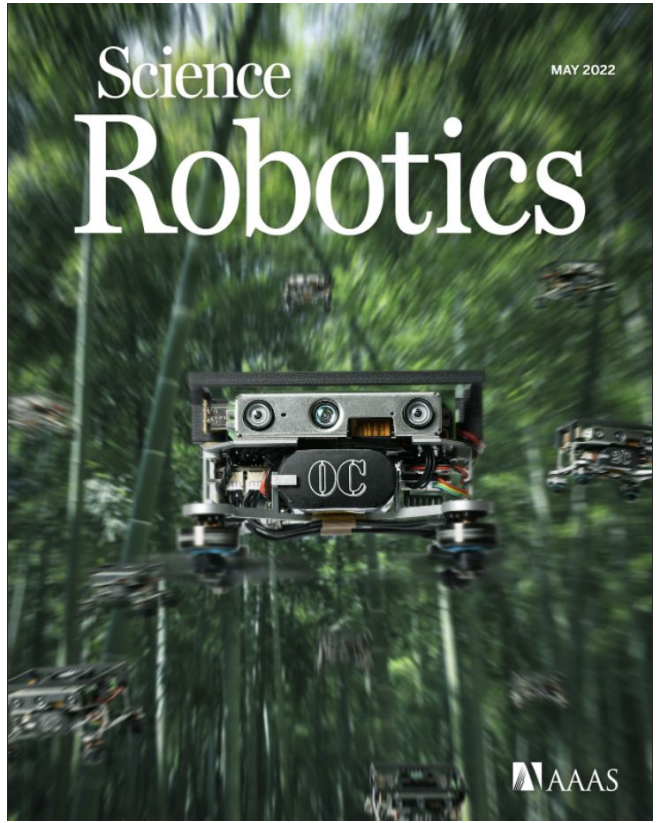
discourse.ros.org



answers.ros.org

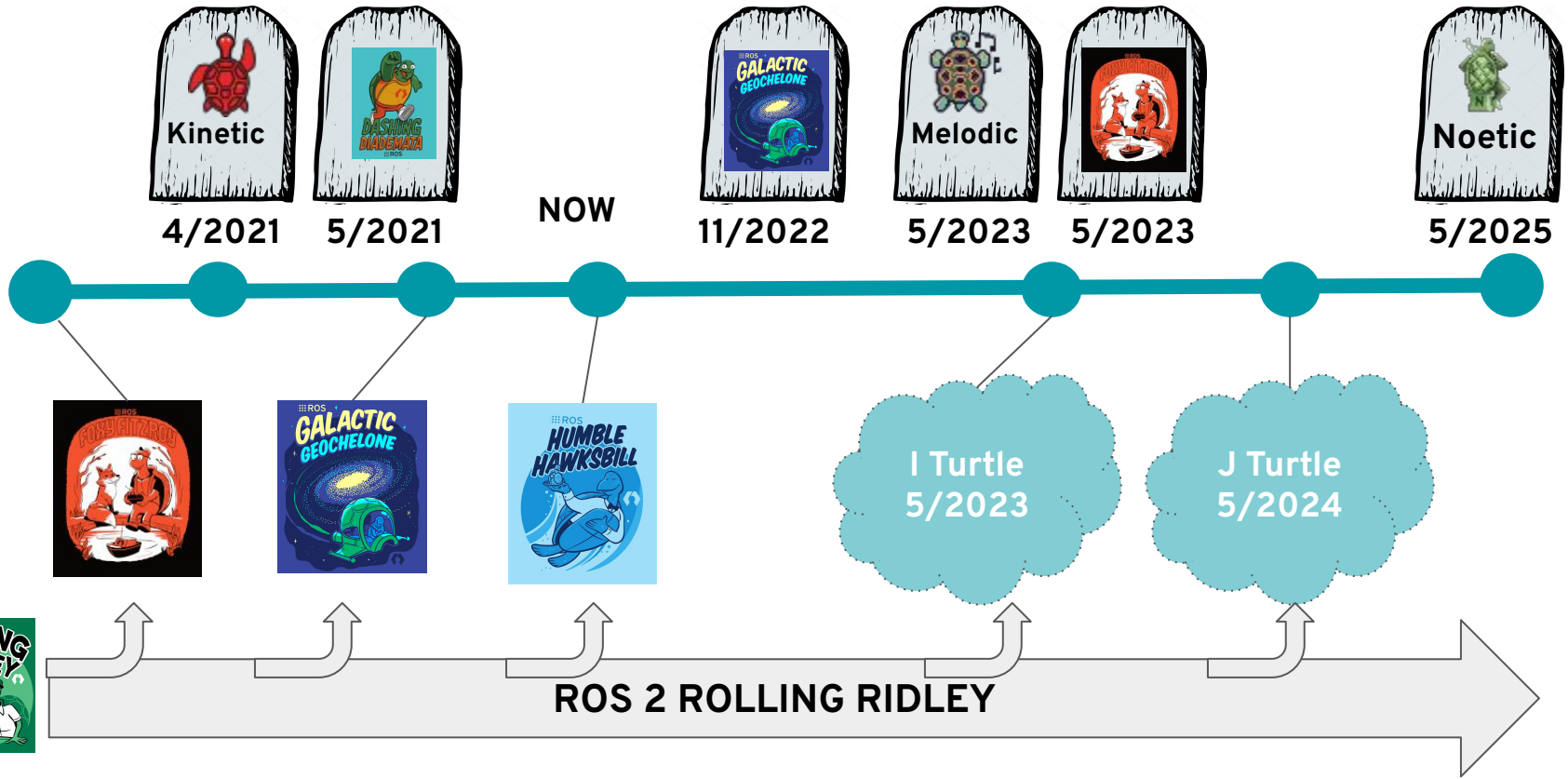
NEW ROS 2 Paper

- Design considerations for ROS 2
- Five “real-world” applications
- Land, Sea, Air, Space, Industry
- Auterion’s ROS Applications
- ROS for NASA VIPER
- **PLEASE USE THIS FOR CITING ROS 2**



bit.ly/ROS2Science

REP-2000: Distro Lifecycle



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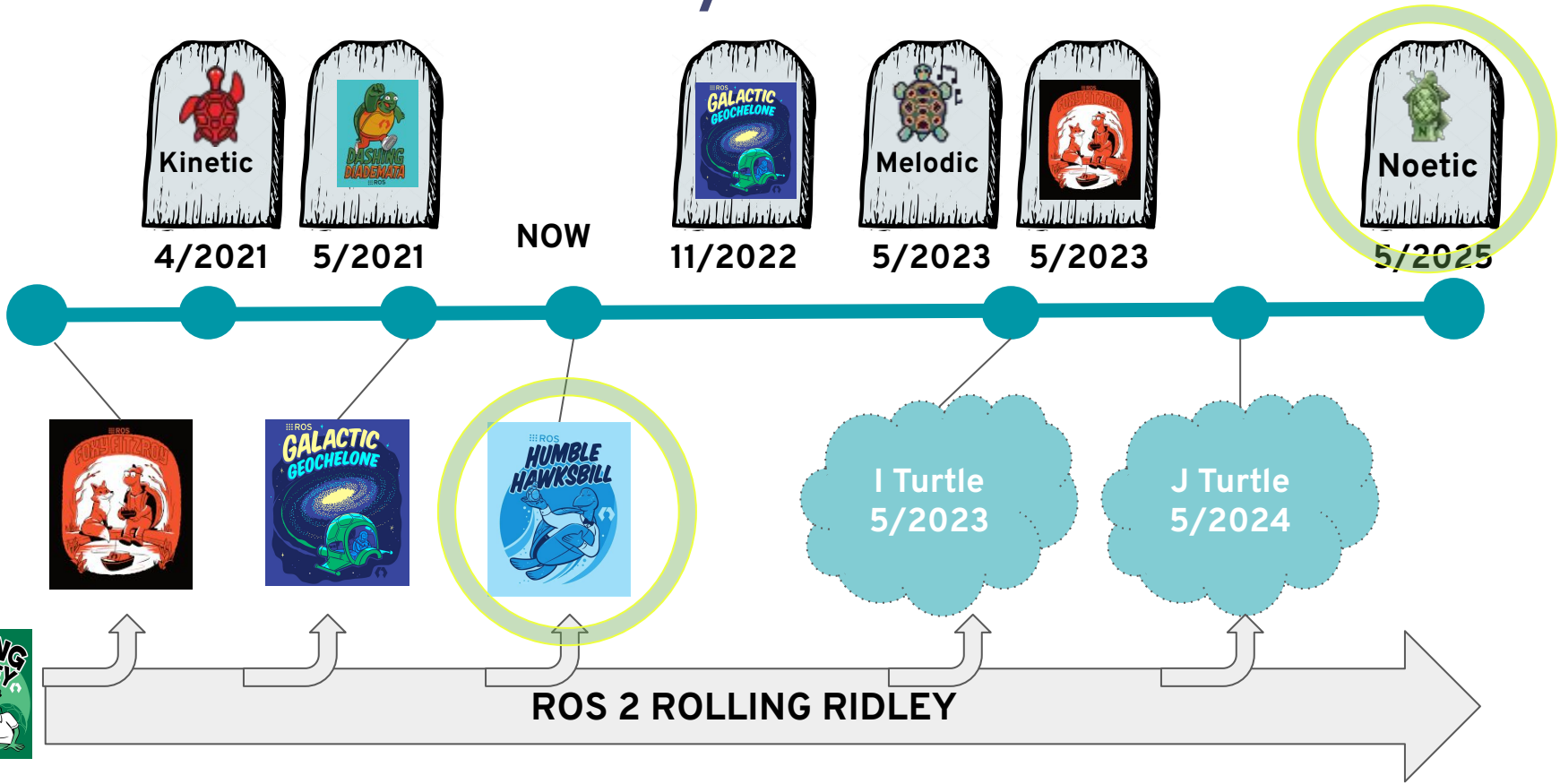

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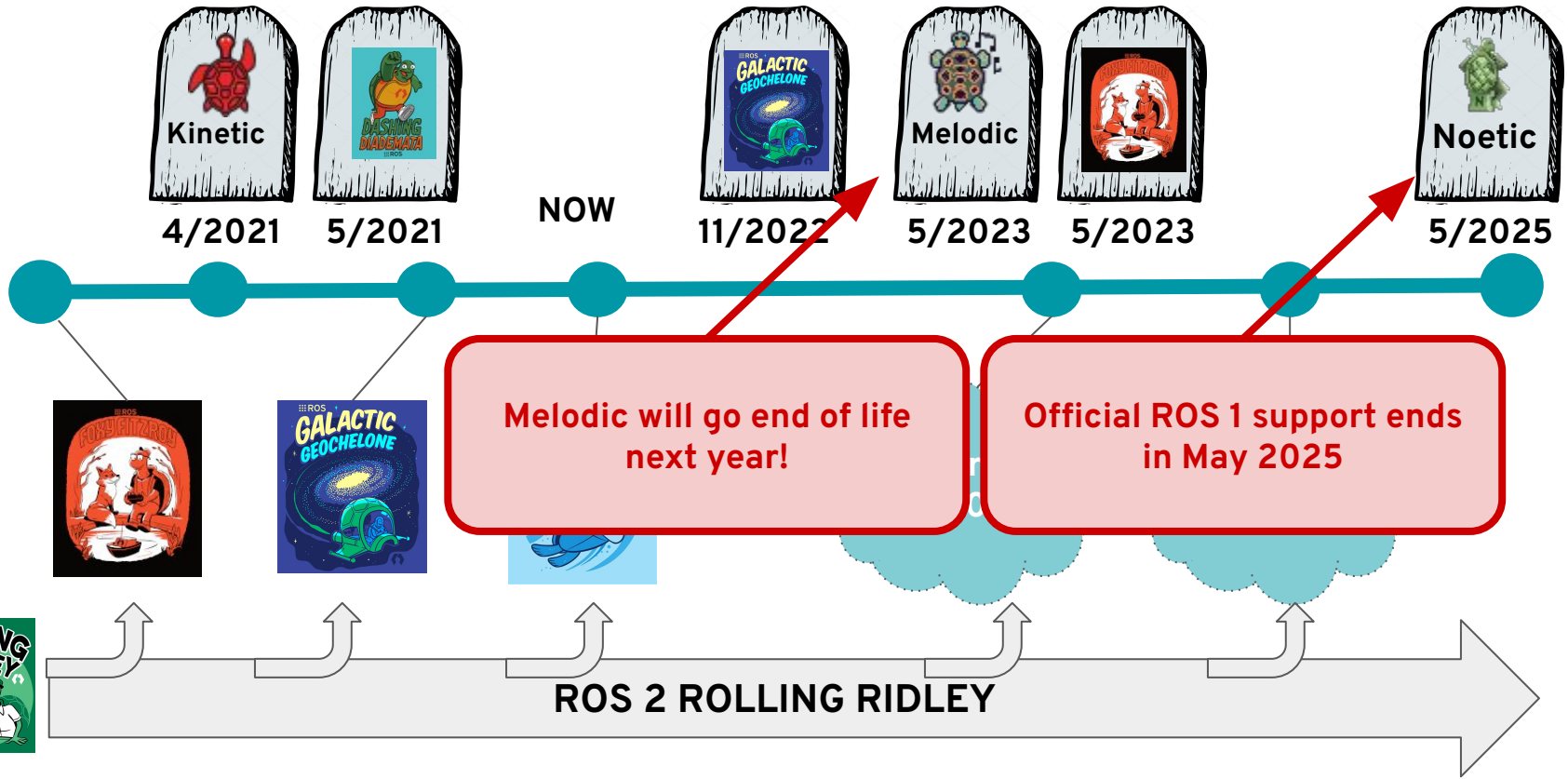


YOU SHOULD BE THINKING ABOUT MOVING TO ROS 2

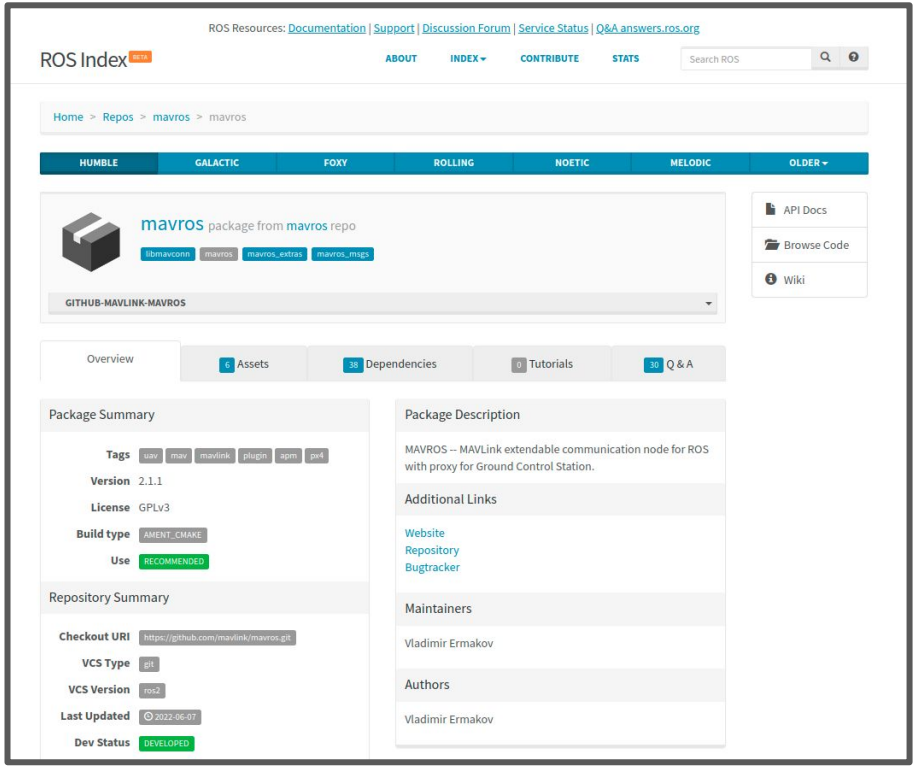
ROS 2 Humble Hawksbill

- **Long term support until 2027**
- Binaries and docker containers available
- Lots of new docs and great features with TONS of features from the community
- If you are getting started, start here

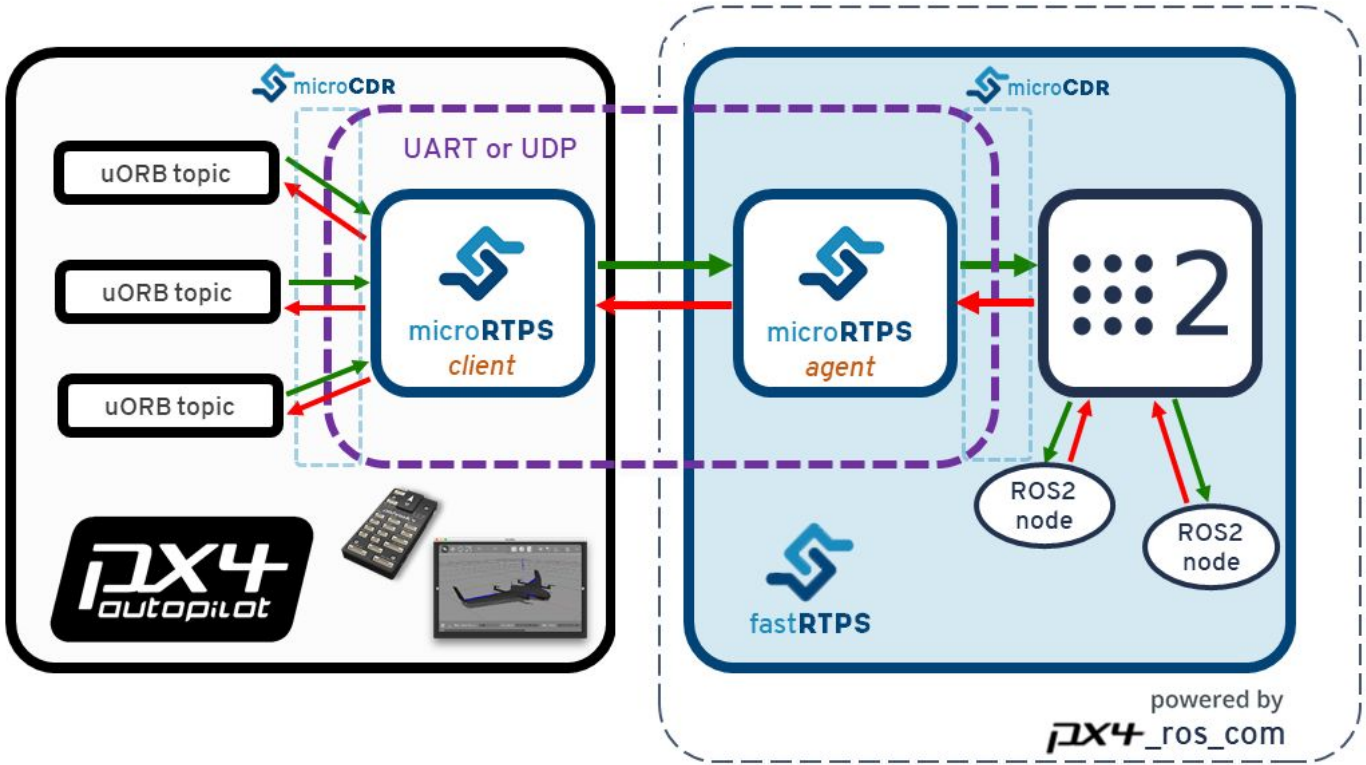
bit.ly/ROS2Humble

MAVROS Now Available in ROS 2 Humble

- Humble was released a month ago and MavROS packages are already available
- ROS 2 only works with MavROS 2.0
- Fairly robust set of tutorials and API documentation

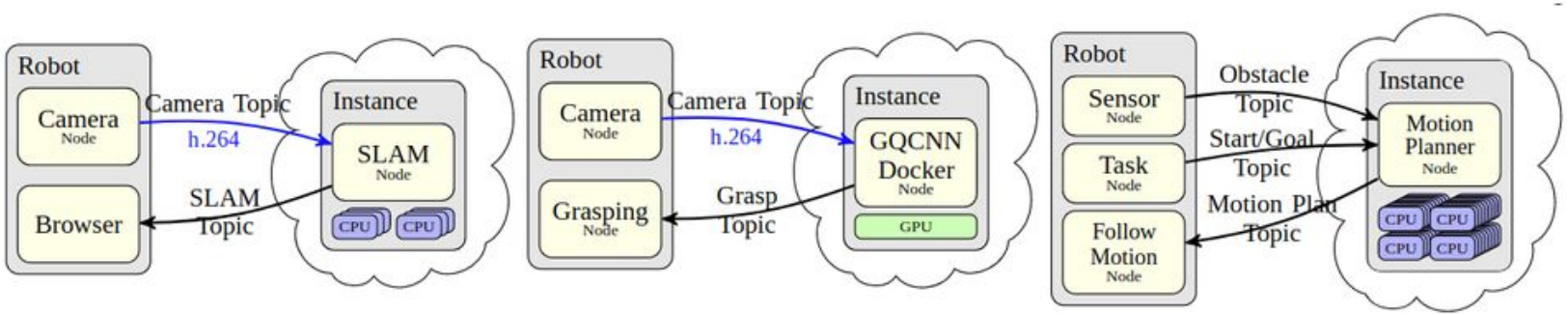


Connecting PX4 to ROS 2 Humble



bit.ly/PX4ROS2

FogROS 2 (UC Berkeley / Ken Goldberg)

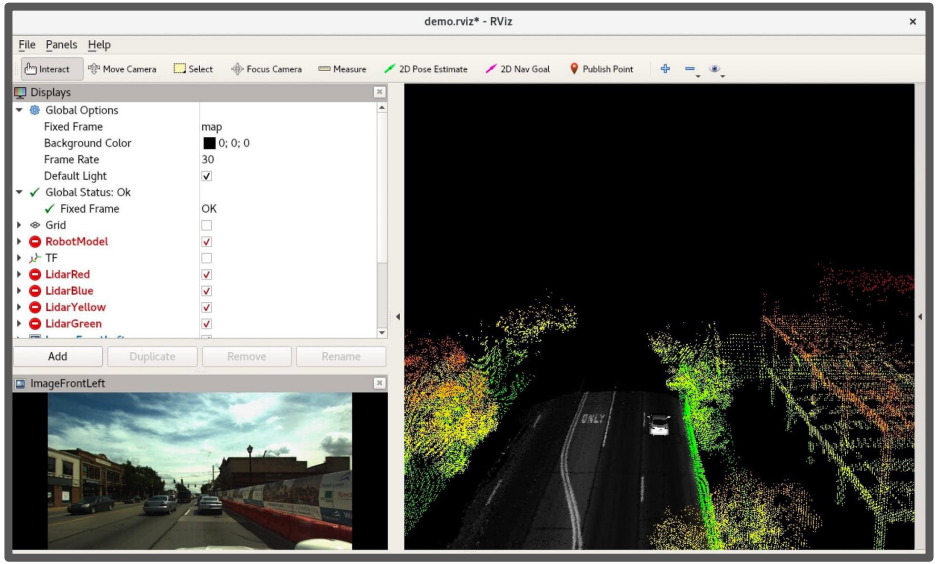


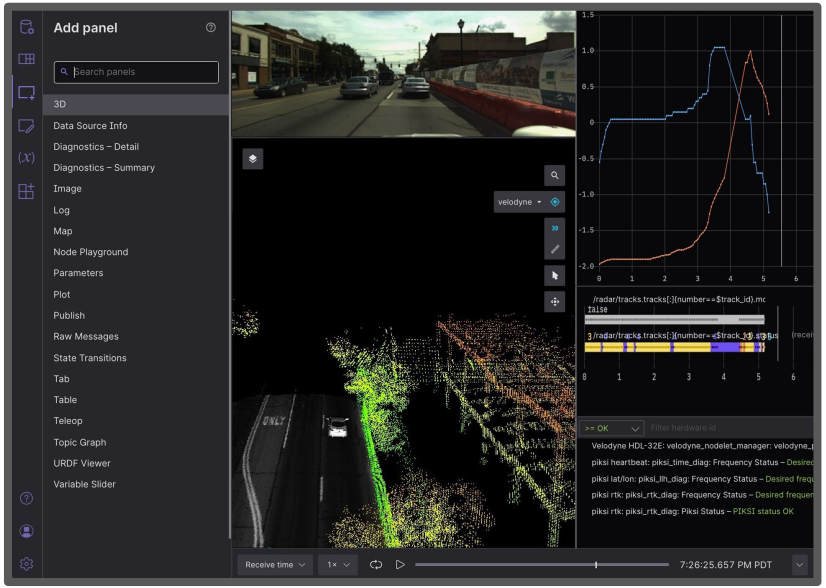
- Solves problem of off loading compute / storage to the “cloud”
- Useful when you have 5G / Good Wifi
- Solves: 3D reconstruction, data logging, deep learning, heavy planning tasks
- Currently AWS but promises for other clouds

bit.ly/FogROS2

User Friendly

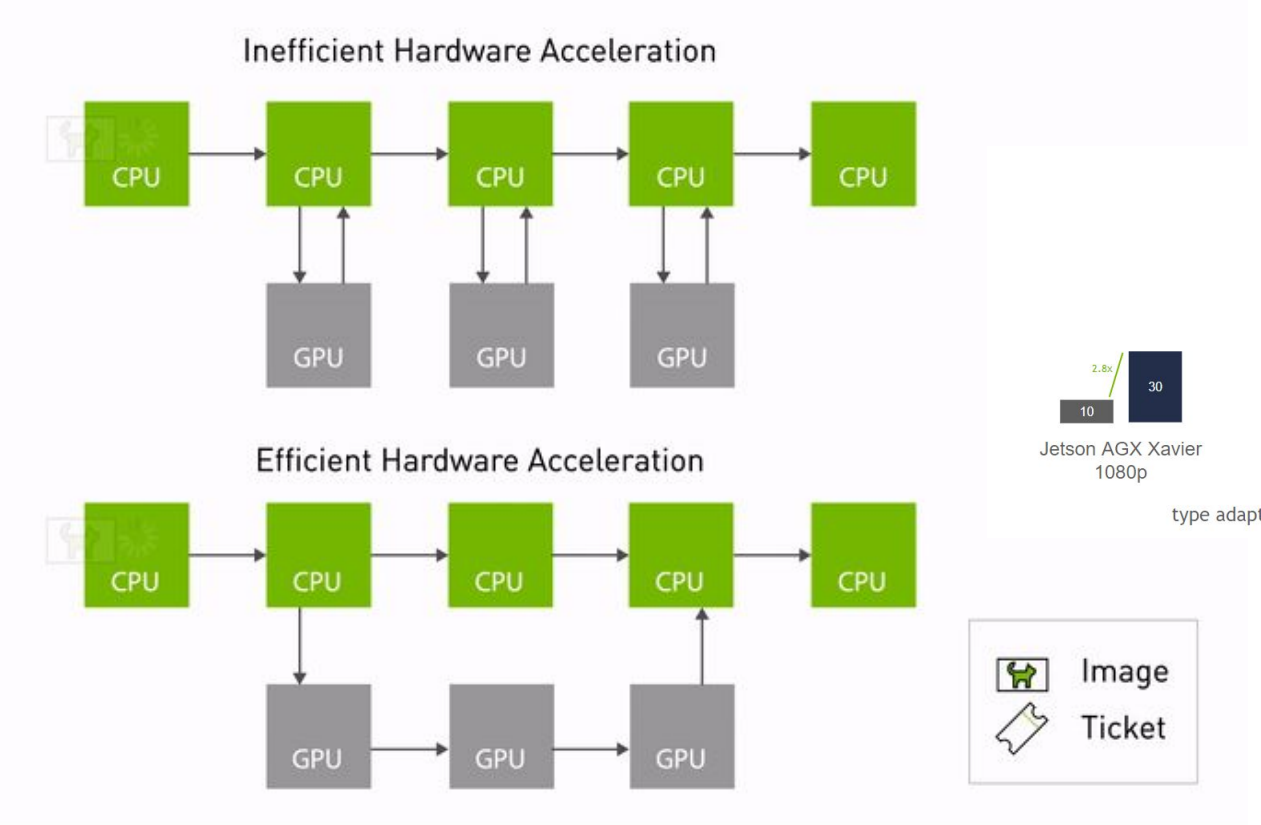
Community and companies are filling in the gaps

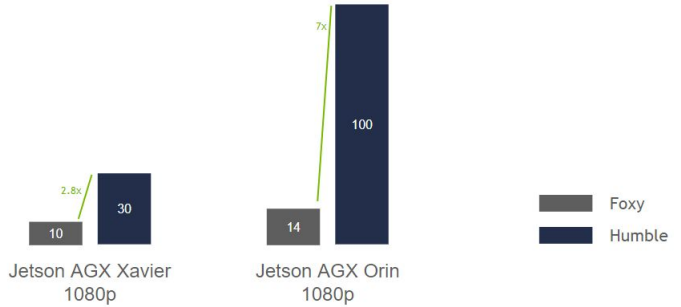




foxglove

NVIDIA Hardware Support => FAST PERCEPTION

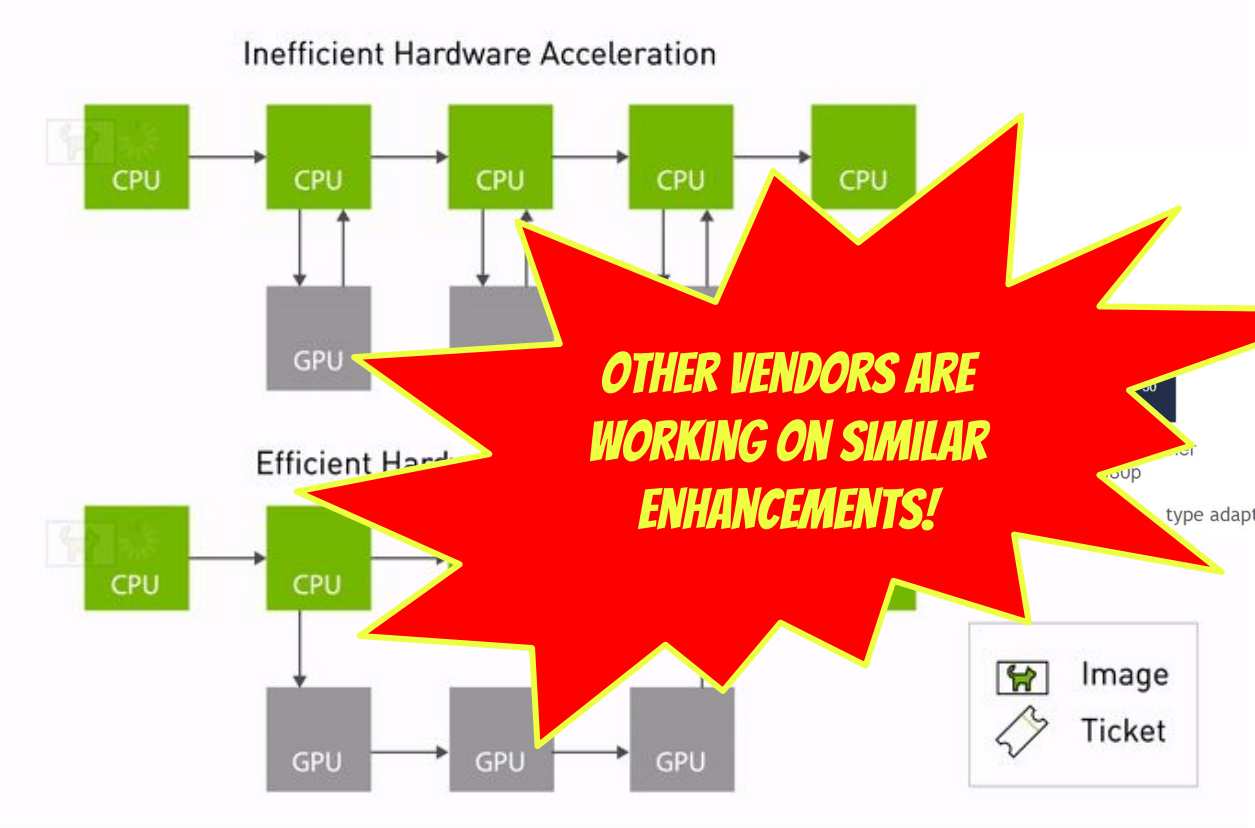




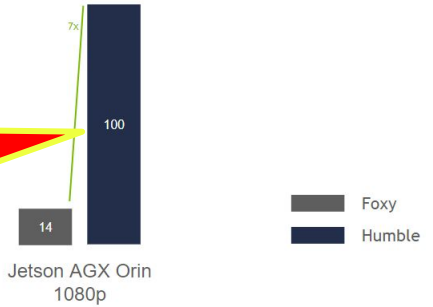
type adapt framework performance comparison

bit.ly/NVIDIAROS2

NVIDIA Hardware Support => FAST PERCEPTION



OTHER VENDORS ARE WORKING ON SIMILAR ENHANCEMENTS!



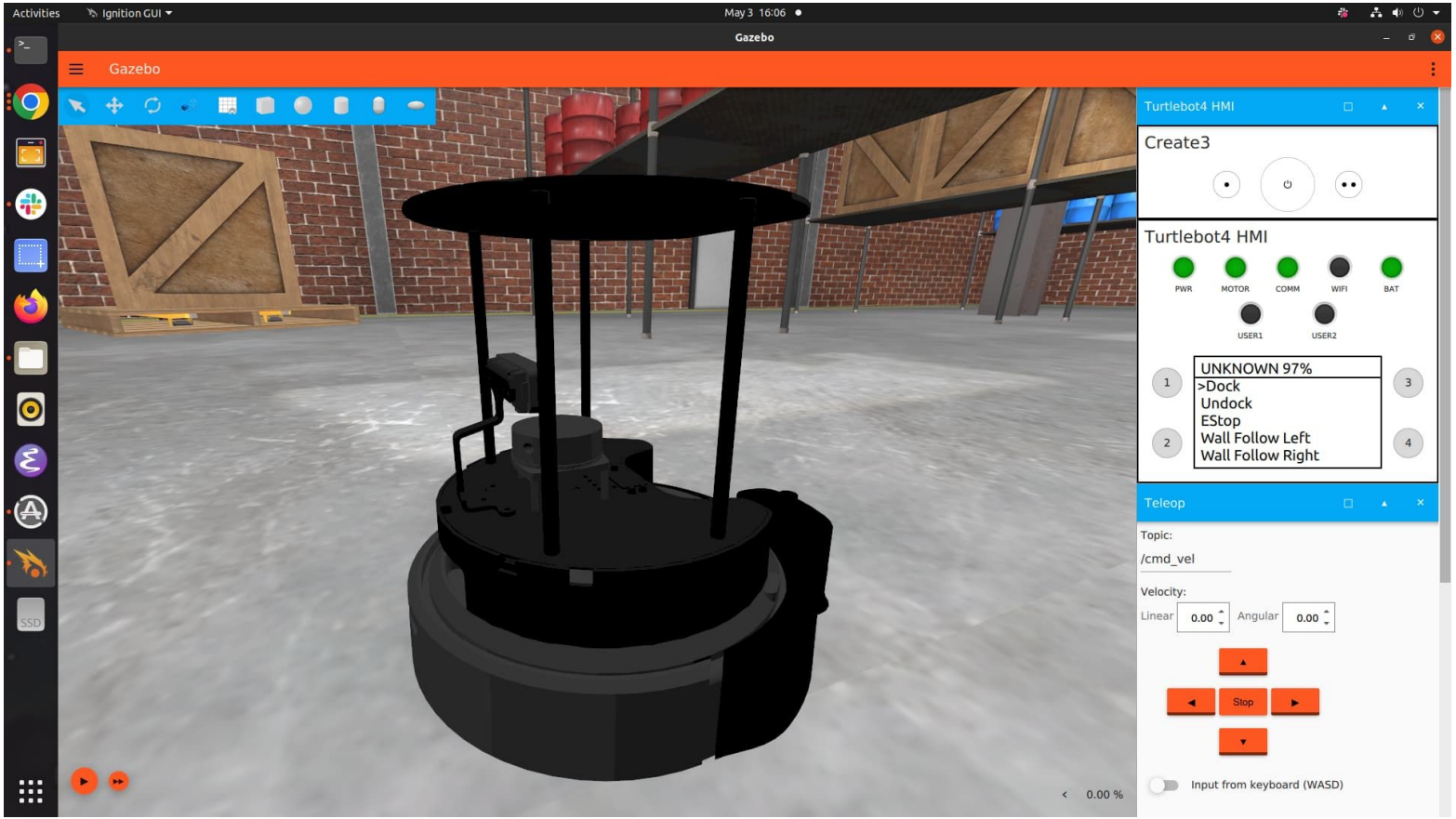
type adapt framework performance comparison

bit.ly/NVIDIAROS2

TurtleBot 4 Launch

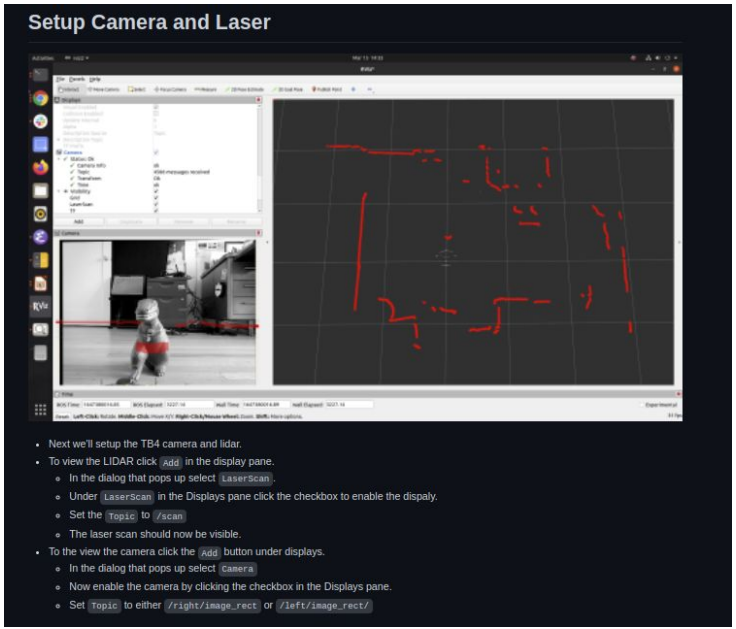
	TurtleBot 4	TurtleBot 4 Lite
SIZE AND WEIGHT		
EXTERNAL DIMENSIONS (LxWxH)	341 x 339 x 351 mm (13.4 x 13.3 x 13.8 in)	341 x 339 x 192 mm (13.4 x 13.3 x 7.5 in)
WEIGHT	3.9 kg (8.6 lbs)	3.3 kg (7.2 lbs)
WHEELS (Diameter)	72 mm (0.55 in)	
GROUND CLEARANCE	4.5 mm (0.17 in)	
SPEED AND PERFORMANCE		
MAX PAYLOAD	9 Kg - Default 15 kg - Custom Configuration	
MAX SPEED	0.31 m/s (safe mode), 0.46 m/s (cliff sensors disabled)	
MAX ROTATIONAL SPEED	1.90 rad/s	
BATTERY AND POWER SYSTEM		
CHEMISTRY	26 Wh Lithium Ion (14.4V nominal) Rechargable	
CHARGE TIME	2.5 hrs	
OPERATINGTME	2.5 - 4.0 hrs (load dependent)	
USER POWER	VBAT @ 300mA, 12V @TBD mA, 5V @ 500mA 3.3V @ 250mA	VBAT @ 1.9A (14.4V nominal) Low current 5V and 3.3V via Raspeberry Pi GPIO

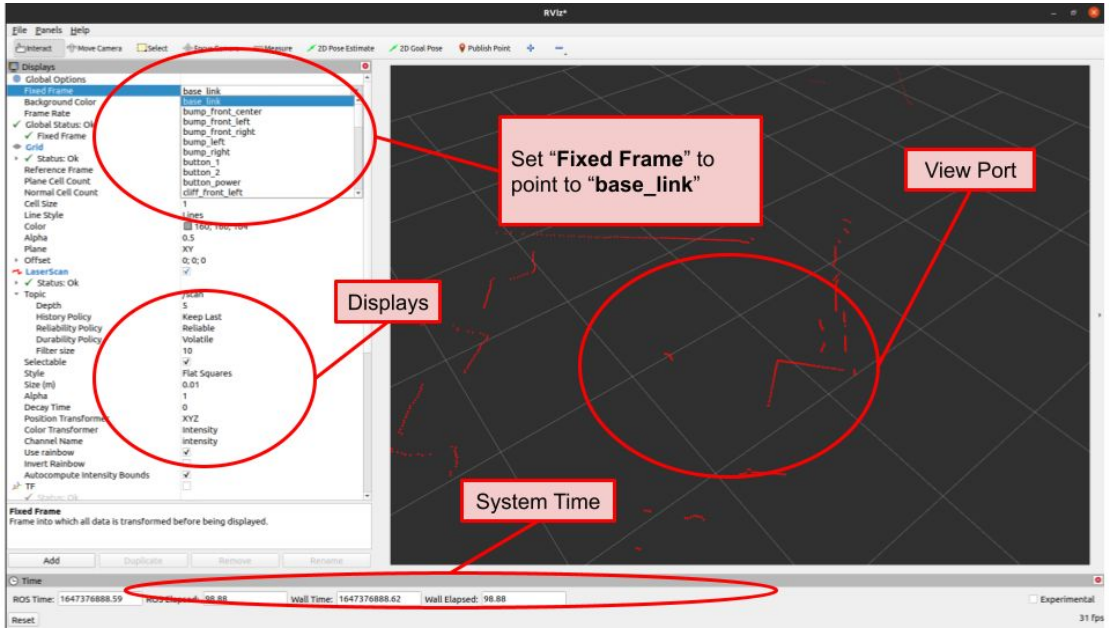
bit.ly/AboutTB4



bit.ly/TB4Sim

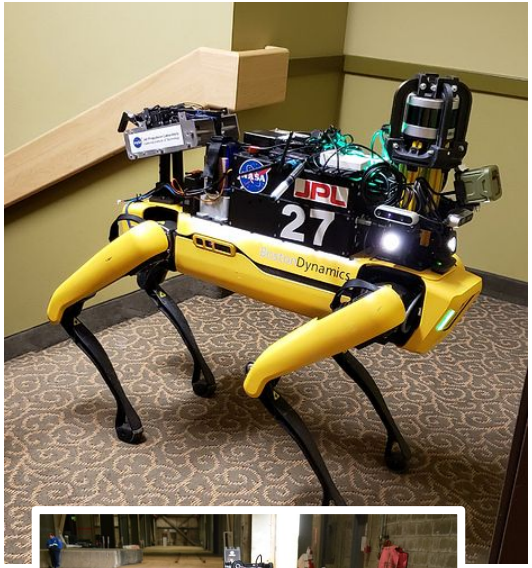
Lessons – coming soon

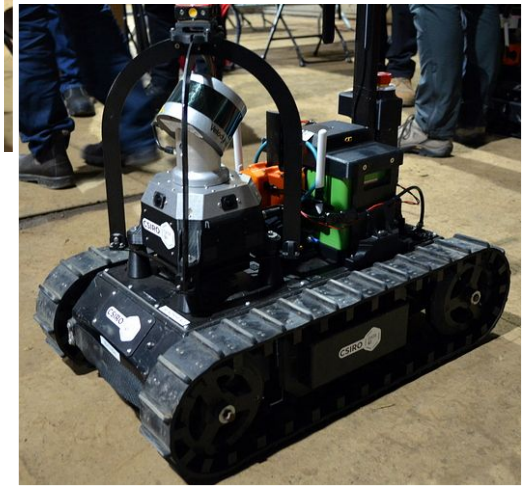


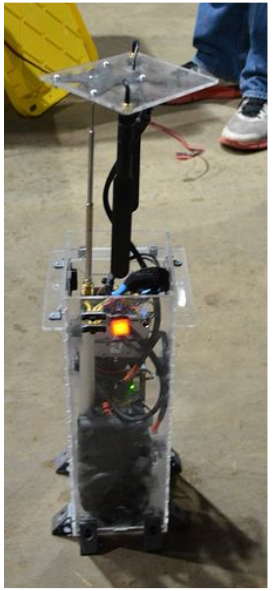


bit.ly/TB4Lesson

Recent Advances: DARPA SubT Challenge

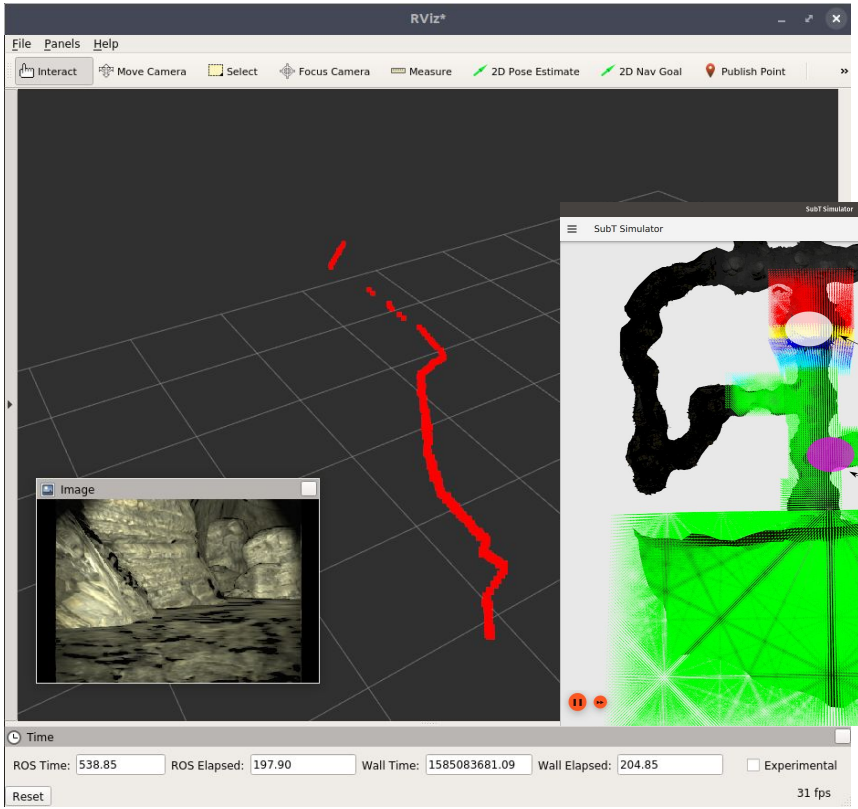


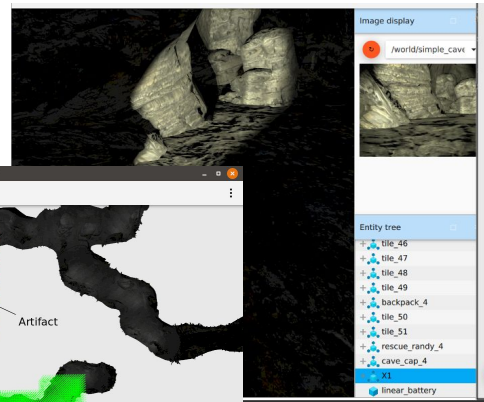


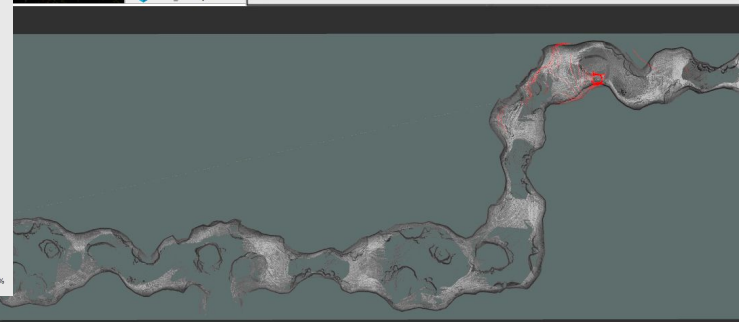


Give DARPA SubT A Try

bit.ly/SubTSeries







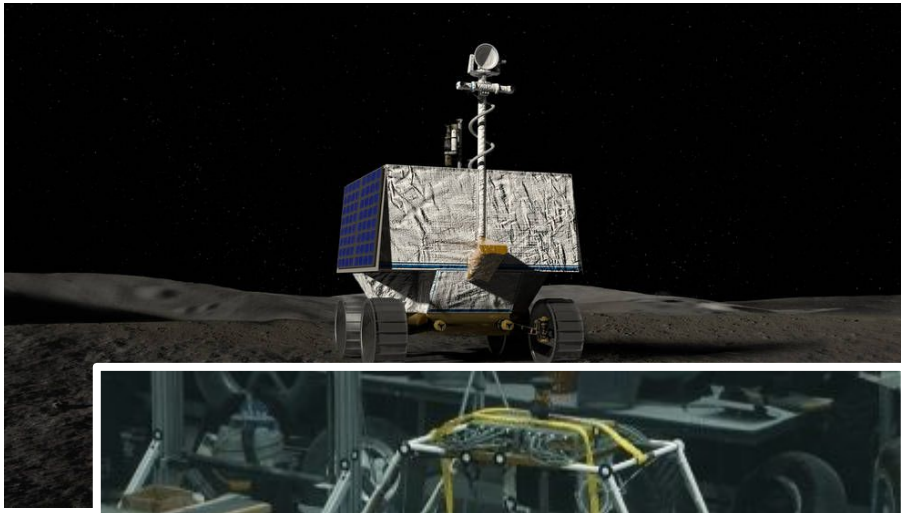
Lookin Ahead: Space

Volatiles Investigating Polar Exploration Rover, or VIPER

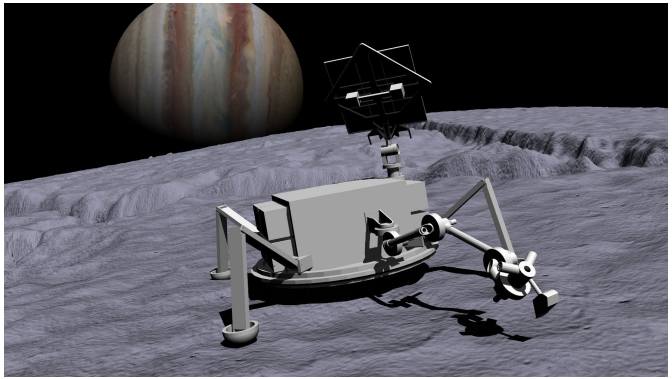
Moon mission late 2023

“With all the incoming data from the rover, the MOC team makes use of a web-based data visualization platform developed by NASA called Open Mission Control Technologies. The Open MCT software is open source, making it freely available not only for space missions like VIPER, but other applications in the public and private sectors.”

“Collaborations with industry are also feeding into key aspects of VIPER’s software operating system. Rather than creating only custom code, the rover’s flight and ground-based software will make extensive use of open source software, including key components adapted from the ***Robot Operating System 2 (ROS 2)*** *which is widely used in everything from robot vacuum cleaners to autonomous drones and self-driving cars. “*



Looking Ahead: Space ROS



Europa Lander Simulation

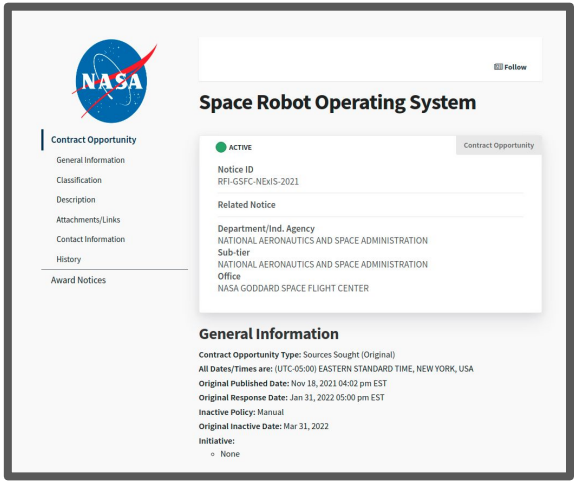
"The NASA Ames Intelligent Systems Division's Ocean Worlds Autonomy Testbed for Exploration Research and Simulation (OceanWATERS) software team announced their 9th public release of the OceanWATERS open source software on December 13, 2021"

bit.ly/OceanWATERS

Astrobee

"Three NASA Astrobee free-flying robots have been operating inside the International Space Station (ISS) since 2019. T Astrobee's flight software performs vision-based localization, provides autonomous navigation, docking and perching, manages various sensors and actuators, and supports human-robot interaction with co-located astronauts via screen-based displays, light signaling, and sound."

bit.ly/astrobee

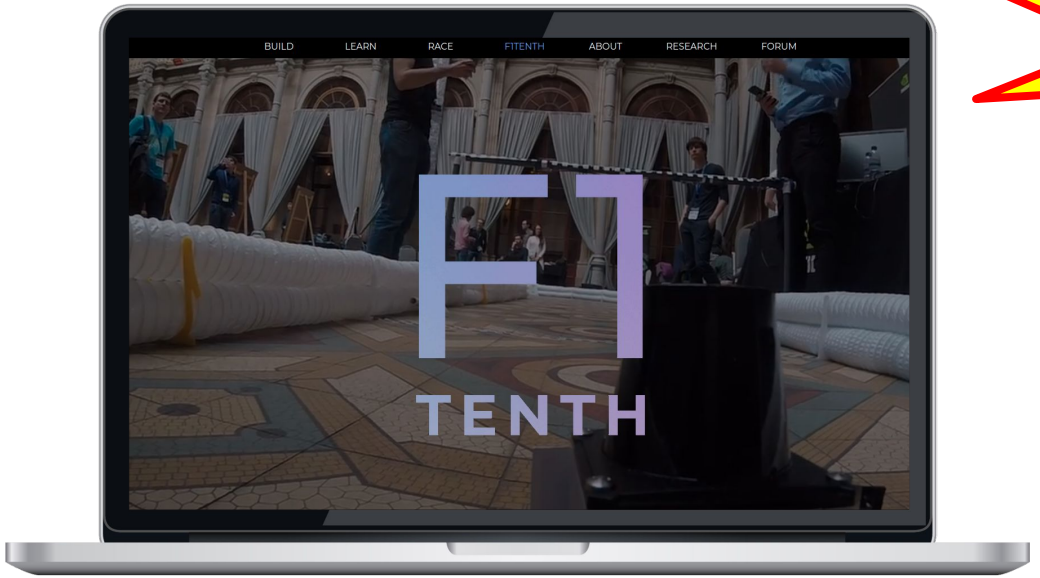


Space ROS

NASA, Blue Origin and industry partners are collaborating to develop the Space Robot Operating System (Space ROS) which is an open-source software framework the space robotics community can use to develop flight-quality robotic and autonomous space systems.

bit.ly/SpaceROS

New and Noteworthy!



f1tenth.org

Student Run
ROS+Autoware

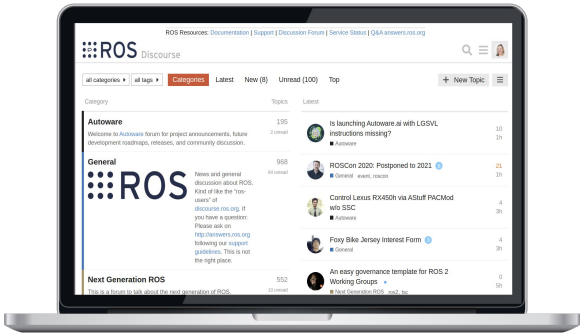
New and Noteworthy: Indy Autonomous Challenge

Stepping stone to

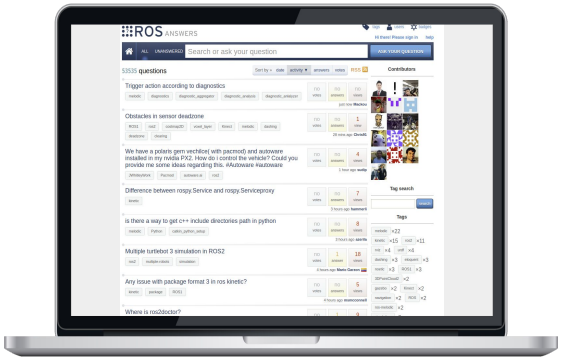
IndyAutonomousChallenge.com

INDY AUTONOMOUS CHALLENGE
OCT. 23, 2021

Shameless Self Promotion



discourse.ros.org



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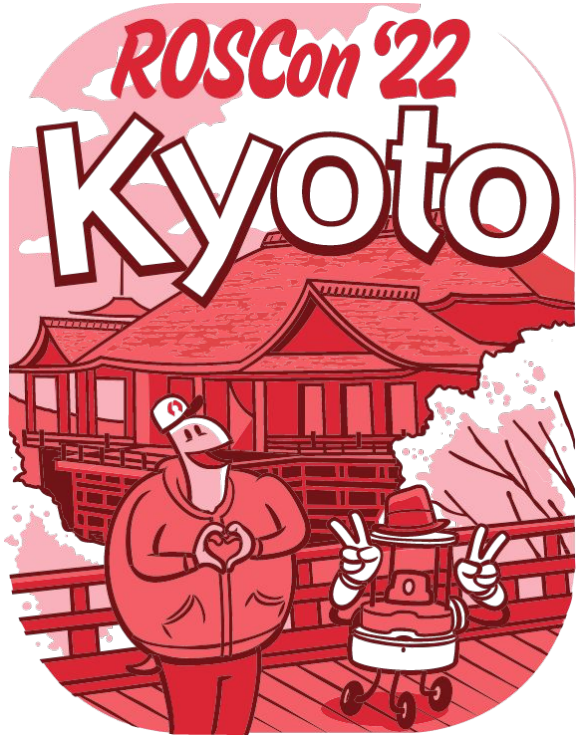

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