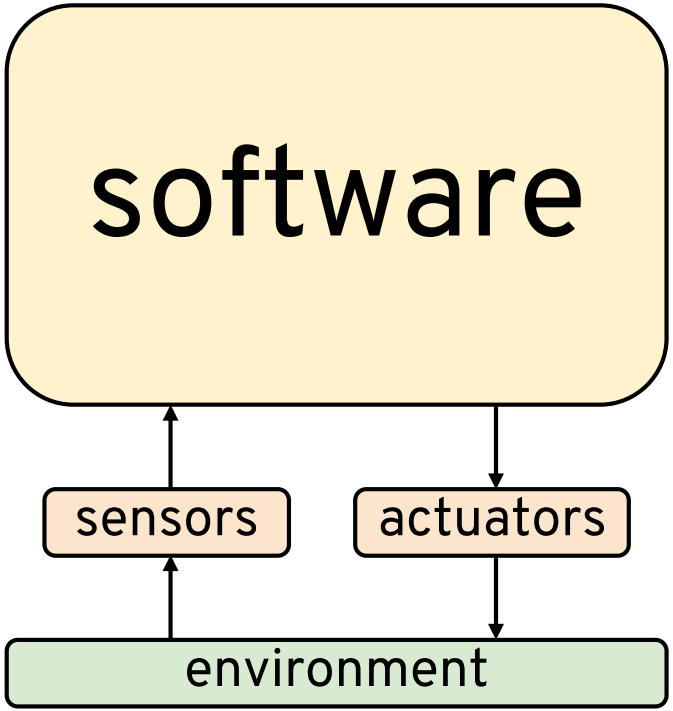
Open Source

High Performance Energy!

“A digital ecosystem is a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems”

Robot software is hard

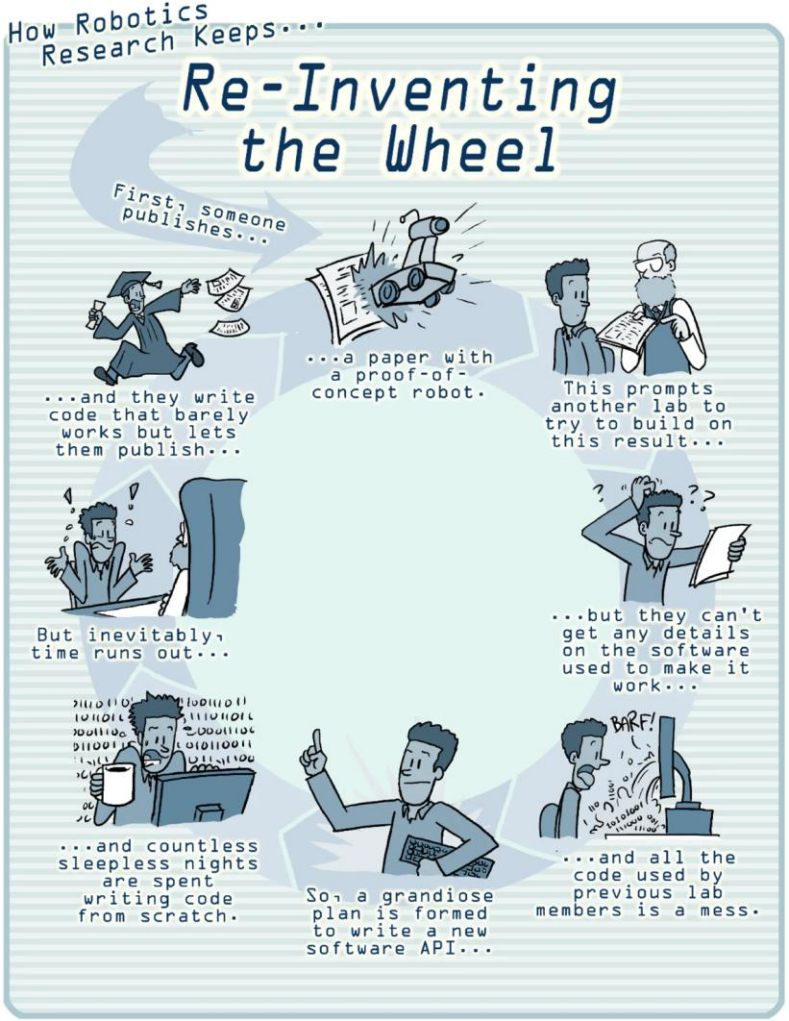
We need infrastructure to support experiments, build applications, and deploy solutions



The (Bad) Old Days

Academia

Researchers produced papers & videos, with little hope of reproducibility, much less reuse



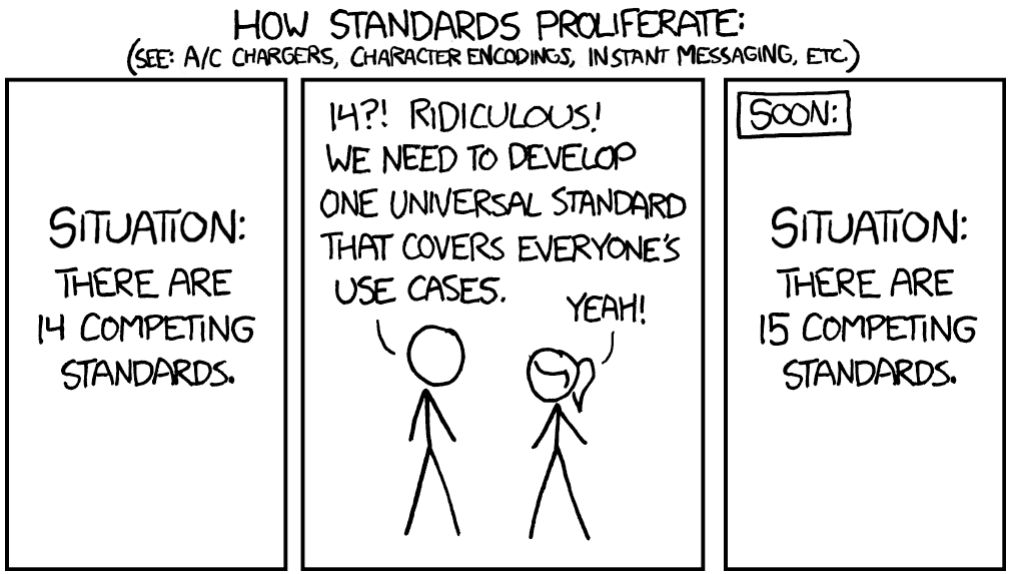
Government

R&D programs culminated in demos, quad charts, and reports; subsequent programs rarely leveraged prior results

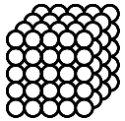
Industry

Commercial progress was slowed by re-implementation of basics and friction in using those results

Can we get everyone working together?



The industry is growing dramatically

~15% 

Global robot **density** CAGR

>1K 

global robot suppliers

88% 

companies **planning robotic adoption**

53% 

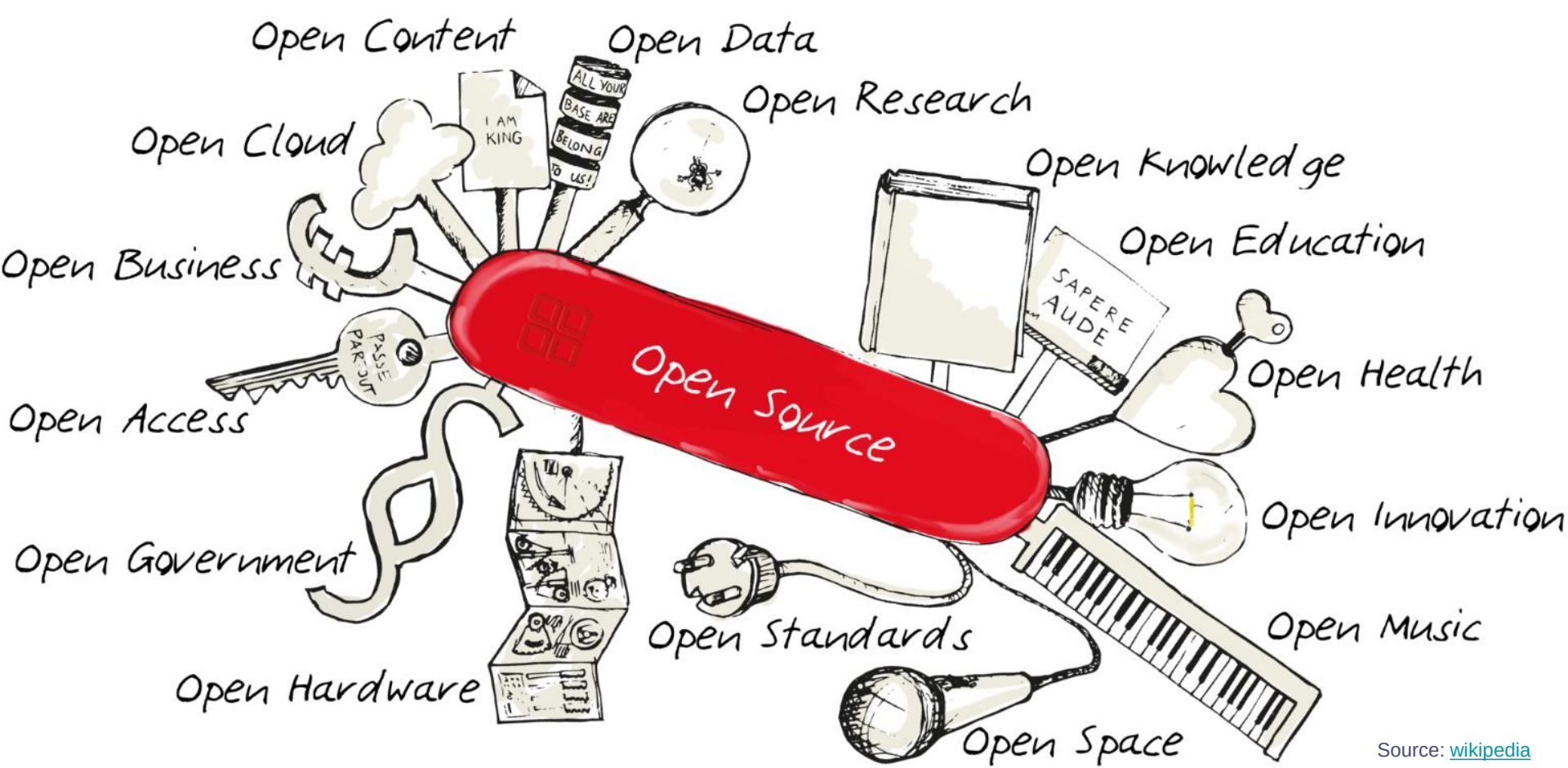
companies listing **cost of adoption** as a top 5 challenge to adoption

Source IFR

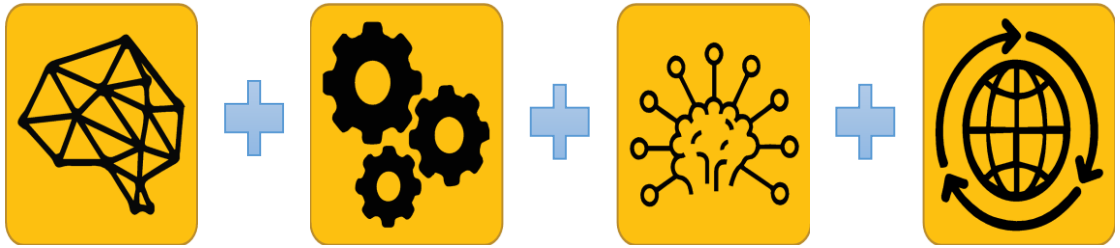
Source IFR

Source Zippia

Proposal: Leverage Open Source



Source: wikipedia

ROS = 

Permissive open source licensing (primarily Apache 2 or BSD) ensures compatibility with commerce

THE ROS PRODUCT FAMILY

ROS

Full stack
robotics SDK

ros.org

Gazebo

Cloud-ready
digital twin

gazebosim.org

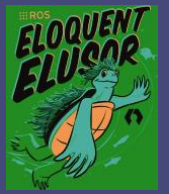
Open-RMF

Interoperable
fleet management

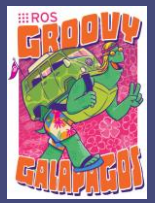
open-rmf.org

15 years of ROS development

2022

2007

First commercially available **ROS-based** robot

2010

ROS-based humanoid robot helping astronauts on the International Space Station

2014

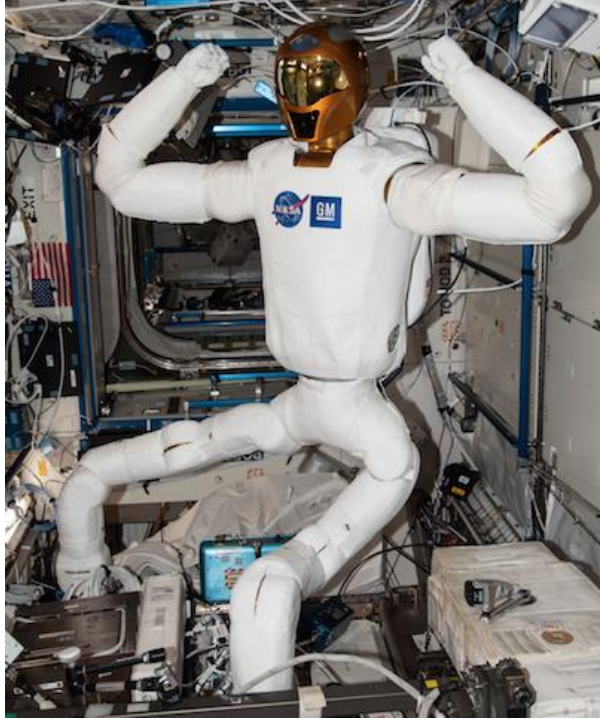
Singapore catalyzes **Open-RMF** for robot interoperability

2018

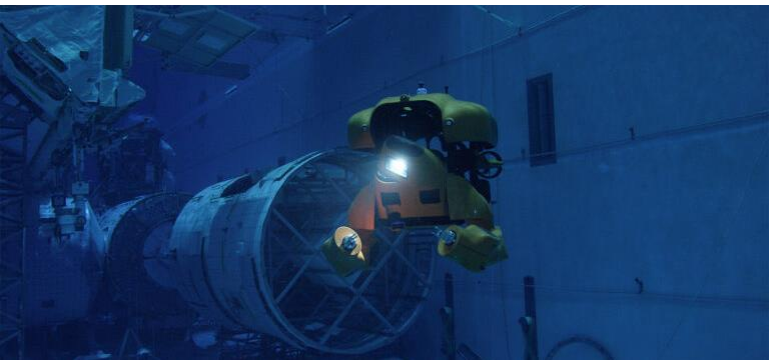
Automotive safety certification granted to **ROS-based** vehicle software system

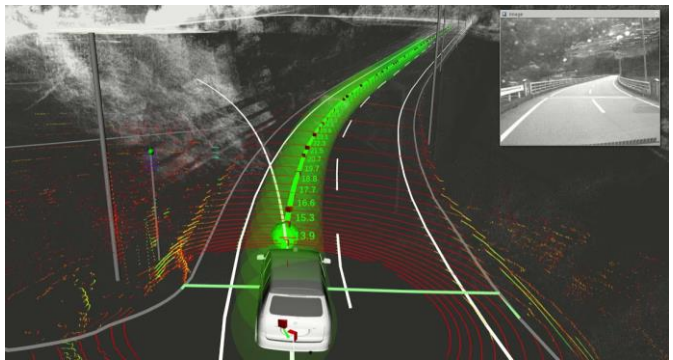
DARPA awards $1.5M in prizes to winners of robot search-and-rescue competition running on **Gazebo** in the cloud

2021



ROS robots are everywhere





ROS IN EVERY MARKET

Aerospace	Agriculture	Automotive	Consumer	Delivery	Logistics
NASA	John Deere	cruise	iRobot	prime	shopify
Blue Origin	Iron Ox	Apex.AI	astro	Caterpillar	Locus
Elroy Air	FarmWise	easymile	aibo	Starship	Otto Motors
motiv space systems	Greenfield Robotics	Autoware.AI	Piaggio Fast Forward	Robotis	fetch robotics Now Part of Zebra Technologies

GLOBAL IMPACT

2.2M

ROS installs & updates per month

>1.3K

Contributors to ROS in 2021

>$6B

Known acquisitions of ROS-based companies

>150

Organizations have sponsored ROSCon: Arm, Intel, BMW, Toyota, Google, Microsoft, and many more

The open source community builds upon us

6K

Public GitHub repositories using the topic **ros**

1K

Public GitHub repositories using the topic **gazebo**

Reference points for GitHub topic use:

- **android:** 96K (5.9M developers)
- **arduino:** 25K (30M active community members)
- **raspberry-pi:** 14K (38M units sold)

ROS is a global robotics hub

Selected ROSCon sponsors 2012-2021

Robot Providers

AETHON

CLEARPATH ROBOTICS™

Gaussian Robotics

Hanwha

LIONSBOT

MiR A BETTER WAY

ncs

OTTO MOTORS

OMRON

SESTO™

Panasonic

SENSERBOT

temi

swisslog

TurtleBot™

UBIQUITY ROBOTICS

Collaborators

Centre for Healthcare Assistive & Robotics Technology (CHART)

CHANGI airport group

GOVTECH SINGAPORE

IHiS Because IT's in Healthcare

MINISTRY OF HEALTH SINGAPORE

NATIONAL ROBOTICS PROGRAMME — Robotics Empowering People

ROS industrial consortium asia pacific

Infrastructure

ADEMCO

FUJITEC

dormakaba

KONE

Xnergy Autonomous Power Technologies

SI's and Solution Providers

clobot

Formant

FREEDOM ROBOTICS

HOPE technik

HOST® A Sonepar Company

inOrbit

m2Labo. AGRINNOVATION

KABAM ROBOTICS

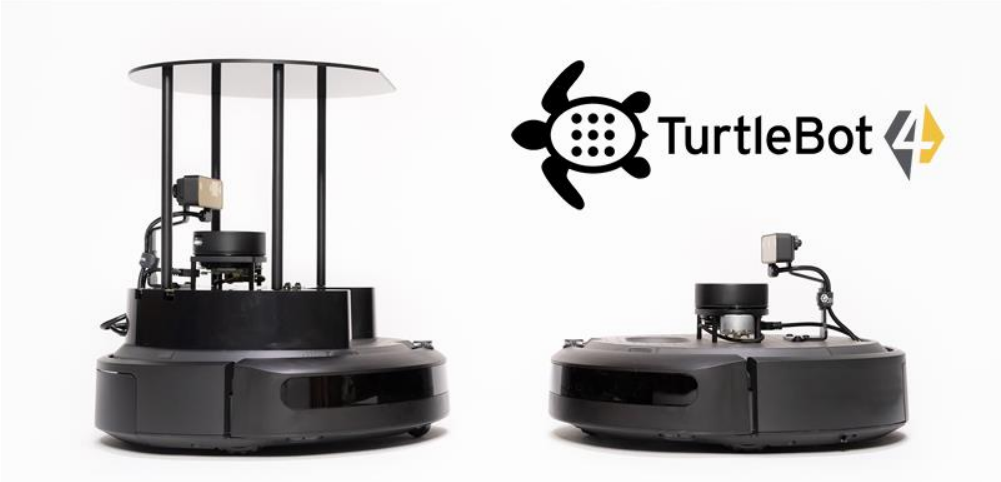
Medisys Innovation Innovation • Domain • Technology

Panasonic CONNECT

robotmanager™ by NCS

TR

Modern Times



Academia

Facilitated by ROS, GitHub, and other common resources, researchers commonly release code to accompany publications

[robotics-worldwide] [software] ROSboard: Live-streamed visuals in your web browser (ROS1+ROS2) -- Sun, 18 Jul 2
11:44:15 -0700

dheera at dheera.net (Dheera Venkatraman)

[robotics-worldwide] [software] Code release: HDF5 to ROS bag converter for event camera data -- Wed, 14 Jul 202
+0200

guillermo.gallego at ifi.uzh.ch (Guillermo Gallego)

[robotics-worldwide] [software] MoveIt 2.2.0 Released for ROS 2 Galactic & Rolling -- Thu, 8 Jul 2021 14:01:29 -0700

mark at picknik.ai (Mark Moll)

[robotics-worldwide] [software] Code release: EVO: Monocular Event-based VO/SLAM -- Thu, 8 Jul 2021 18:44:25 +0

scaramuzza.davide at gmail.com (Davide Scaramuzza)

[robotics-worldwide] [software] NVIDIA releasing Isaac SDK and Isaac Sim Open Beta -- Mon, 21 Jun 2021 17:49:03 +

miteshp at nvidia.com (Mitesh Patel)

[robotics-worldwide] [software] Releasing code for Patch-NetVLAD (visual place recognition / loop closure) -- Mon
2021 21:25:22 +0000

tobias.fischer at qut.edu.au (Tobias Fischer)

[robotics-worldwide] [software] Code and Data release: Time Lens: Event-based Video Frame Interpolation -- Tue, 1
2021 17:10:06 +0200

scaramuzza.davide at gmail.com (Davide Scaramuzza)

[robotics-worldwide] [software] Releasing VINSEval, an evaluation framework for unified comparison of VINS algori
Wed, 2 Jun 2021 19:40:47 +0000

stephan.weiss at aau.at (Weiss, Stephan Michael)

[robotics-worldwide] [software] Releasing Event-camera Calibration Toolbox -- Mon, 31 May 2021 19:32:03 +0200

scaramuzza.davide at gmail.com (Davide Scaramuzza)

[robotics-worldwide] [software] ChoiRbot: a ROS 2 Toolbox for Cooperative Robotics -- Mon, 31 May 2021 18:27:16 +0

giuseppe.notarstefano at unibo.it (Giuseppe Notarstefano)

using the classic Nesterov acceleration scheme [29]. The code to run the benchmarks is made freely available at: https://github.com/lmontaut/collision-detection-benchmark.

[4]Our code is available at https://github.com/wonderren/public_moes

respectively. Code, videos, and supplementary material can be found at `https://github.com/BerkeleyAutomation/FogROS`.

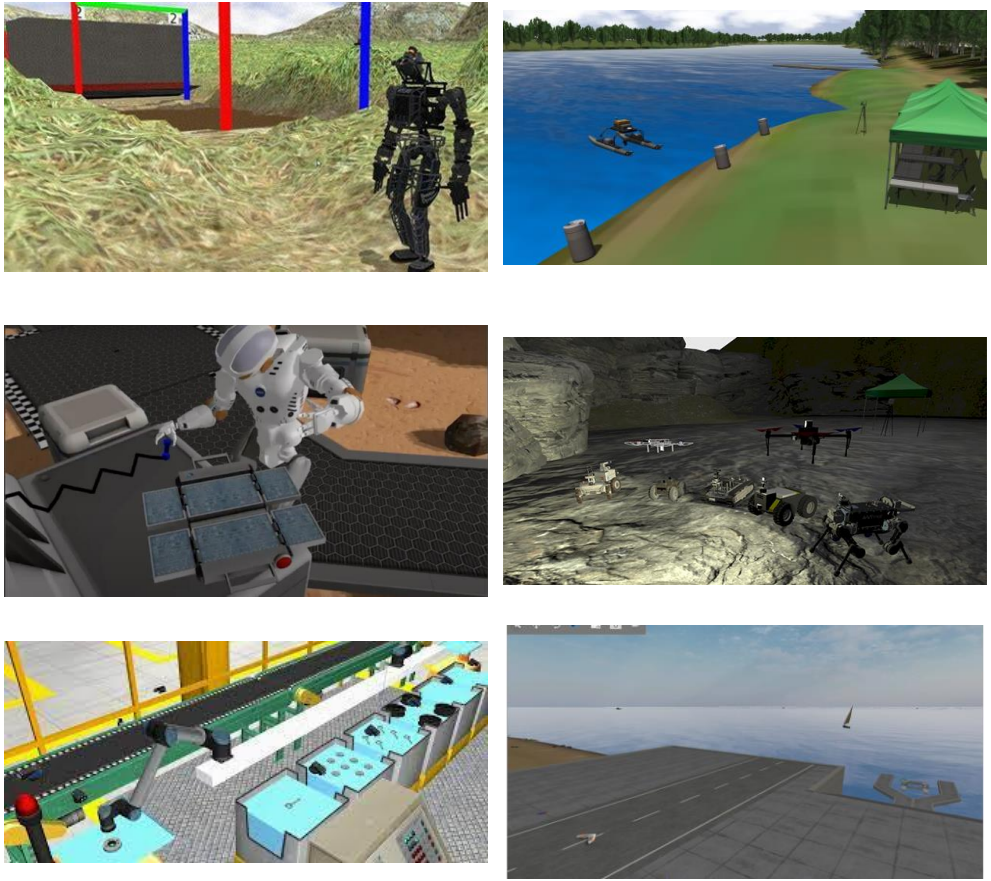
[2]The source code for our implementation of FMCW LiDAR is available in our fork of CARLA at `https://github.com/aevainc/carla`.

A TECHNOLOGY PIPELINE

From Classroom to Research to Production

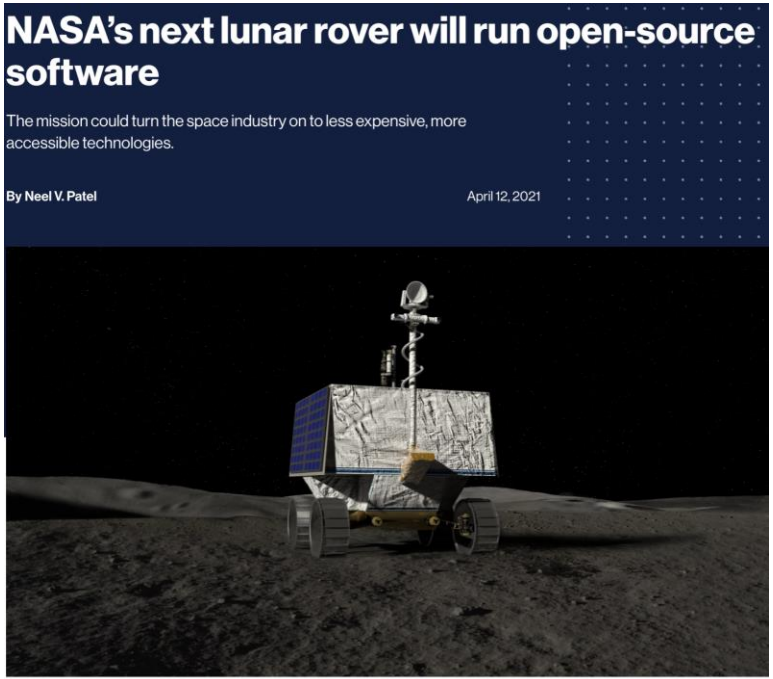
Government

R&D programs build directly on earlier results and PMs expect software to be delivered in a reusable manner



International robotics competitions using Gazebo 2013-2022

NASA VIPER



Gazebo for design, development, and test

ROS for ground flight software

Scheduled to launch 2024

Inspiration for Space ROS

Industry

2019: 6 River acquired by Shopify @ $450M

2021: Fetch acquired by Zebra @ $300M

2018: MiR acquired by Teradyne @ $272M

An explosion in commercial progress is being driven by ROS and other open infrastructure

2022: iRobot acquired by Amazon @ $1.7B

2019: Canvas acquired by Amazon

2021: Locus valued at $1B

COMMON CONCERNS

- *ROS isn't ready for industry*
- *ROS isn't safe/safe OS is required to build robots*
- *ROS is too big/heavyweight*
- *ROS is too complicated*
- *ROS is open source, which means it's not secure*

WHAT YOU CAN DO

Academia

- Share your code when you publish
- Demand the same when you review

Government

- Prefer (or require) open source solutions
- Test & measure with open source systems

Industry

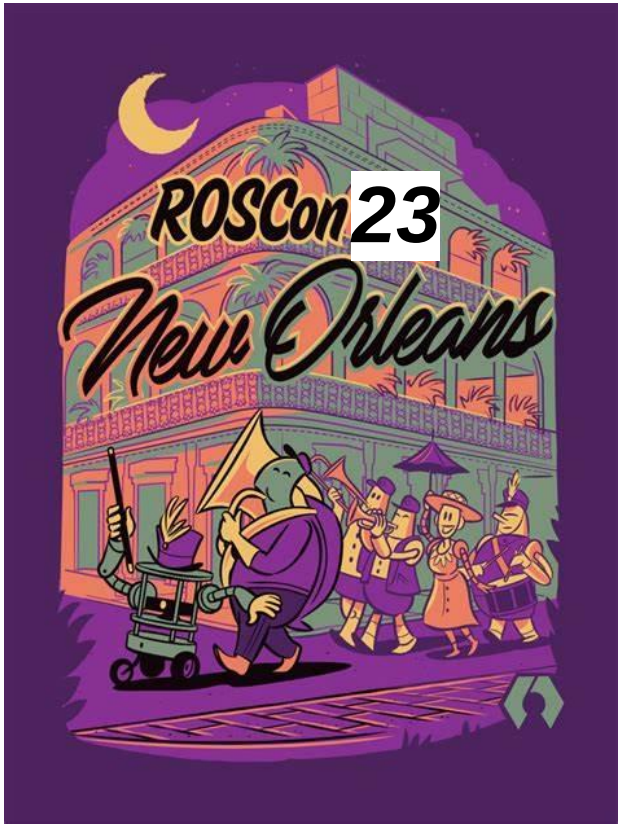
- Set policy for open source use and contribution
- Provide open source SDKs for your products

Everyone

- Use ROS in your work and help us to improve it
- Be public about your use of ROS

Join us!

open robotics



October 18-20, 2023