OSRF - ROS / Gazebo updates

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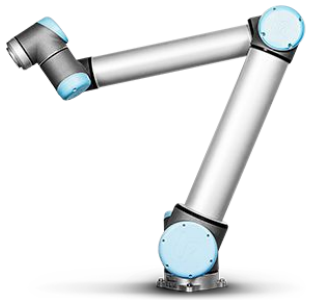
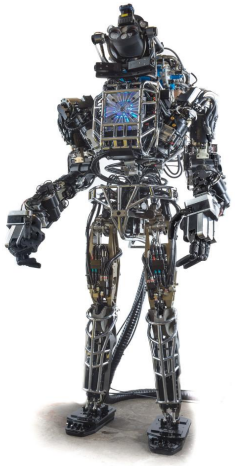
Buenos Aires

Overview

- ROS
  - What is ROS
  - Where are we now?
  - Example communication
  - Where do we want to go?
- Gazebo
  - Overview
  - Where are we now?
  - Where do we want to go?

ROS motivation





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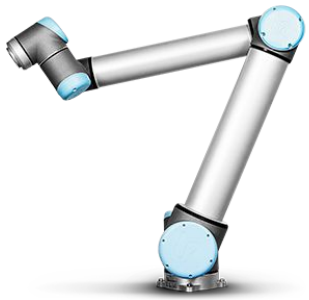
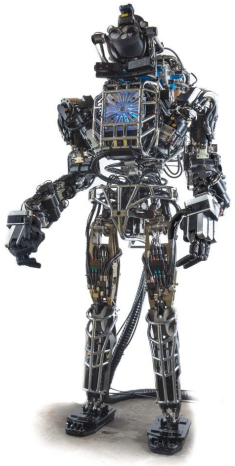
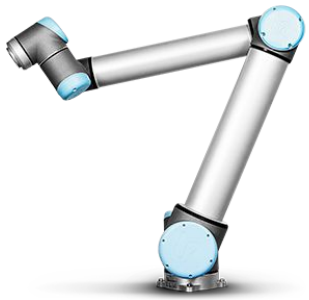
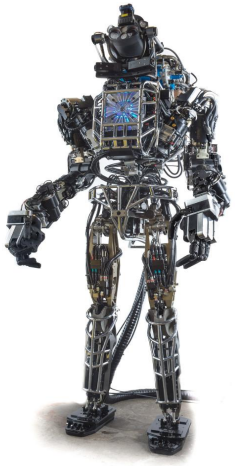




actuate

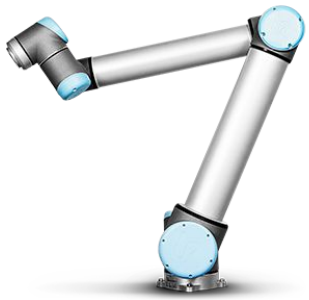
ROS motivation

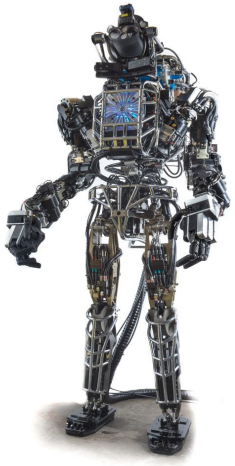


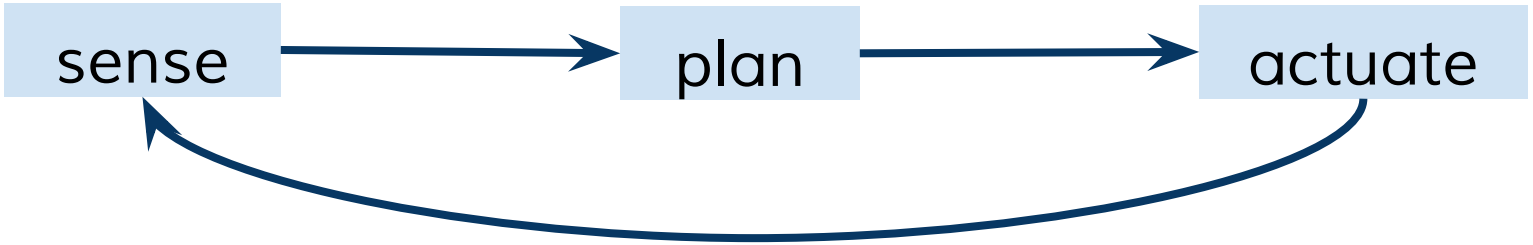


plan → actuate

ROS motivation







ROS motivation

- motors
- hydraulic joints
- turn on lights
- start recording a video
- ...

ROS motivation

- cameras
- LIDARs
- sonars
- microphones
- encoders
- pressure sensors
- ...

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- signal processing
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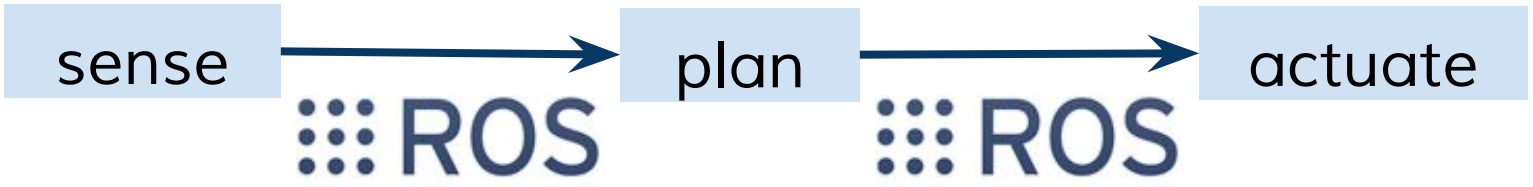

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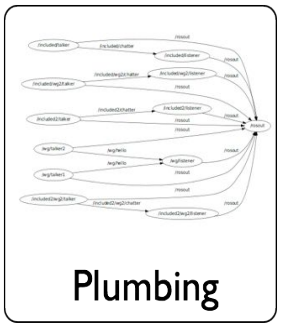
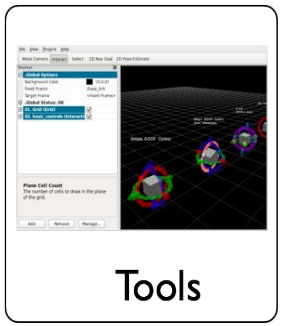
ROS Overview

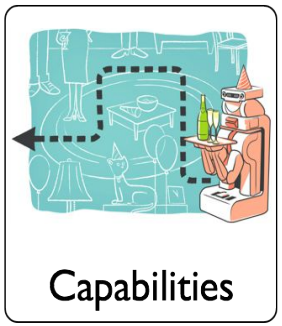
ROS =


Plumbing

+


Tools

+


Capabilities

+


Ecosystem

Libraries and tools for programming robots

Used in labs, classrooms and companies around the world

ROS Statistics

Metrics as of July 2015 ():

- Unique IPs downloading ROS debs: ~45,000/month
- Academic papers citing original paper: 1843
- Robot models officially supported: >101
- wiki.ros.org pageviews: ~37,000/day

Longest distance a ROS robot has traveled from Earth: 435 km

http://wiki.ros.org/Metrics

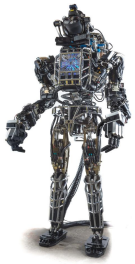
Where are we now?

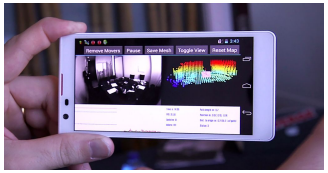
- Maturity
- Robustness
- Community
- Openness
- Interoperability
- Modularity
- Federated development model
- Richness

Where is ROS used?

- NASA: Robonaut 2
- Rethink Robotics: Baxter
- ROS-Industrial: (de)palletizing
- RightHand Robotics: ReFlex Hand
- Boston Dynamics: ATLAS
- PAL Robotics: REEM-C
- HERE: 3D mapping cars
- Google ATAP: Project Tango
- Blue River: Precision Farming
- Savioke: SaviOne
- Fetch Robotics: Fetch

... and many more!





How did we get here?

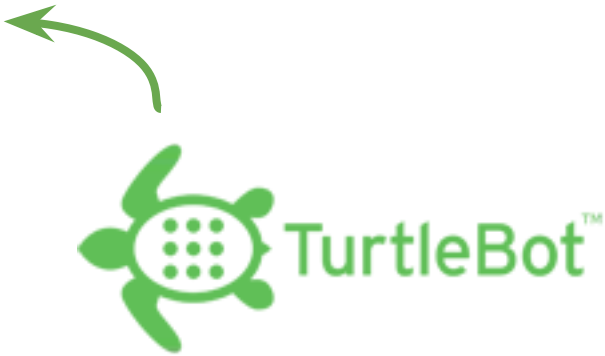
Enabling reuse

Ease of use

Flexibility

Scalability

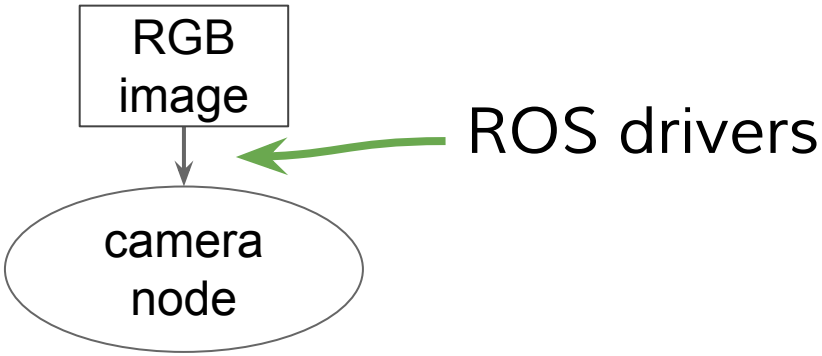
ROS communication



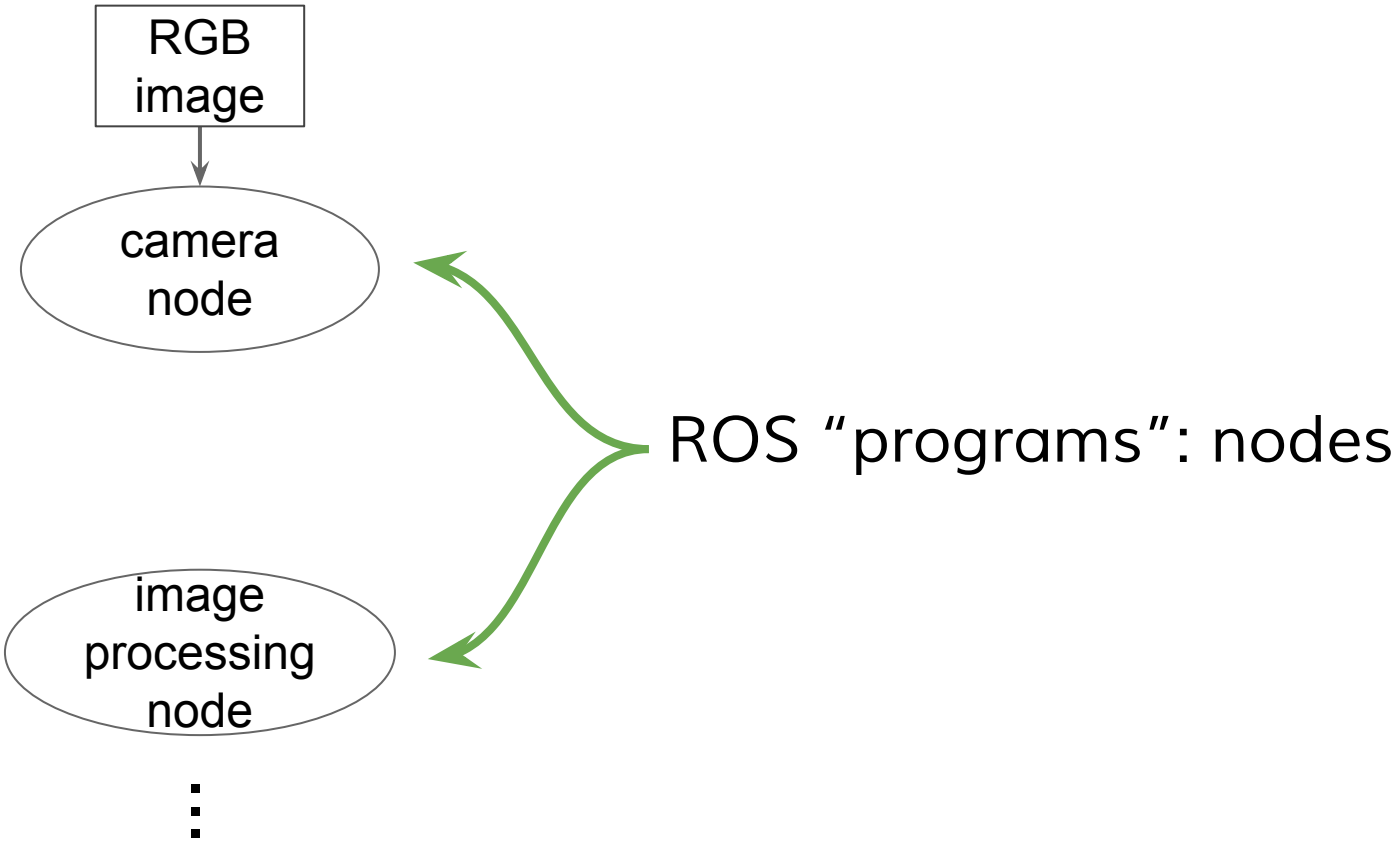
ROS communication

RGB
image

ROS communication



ROS communication



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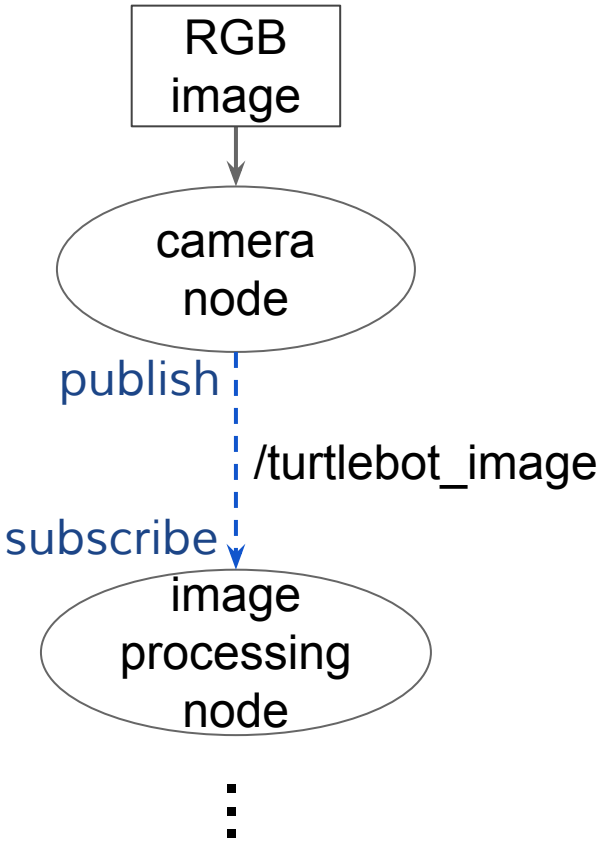
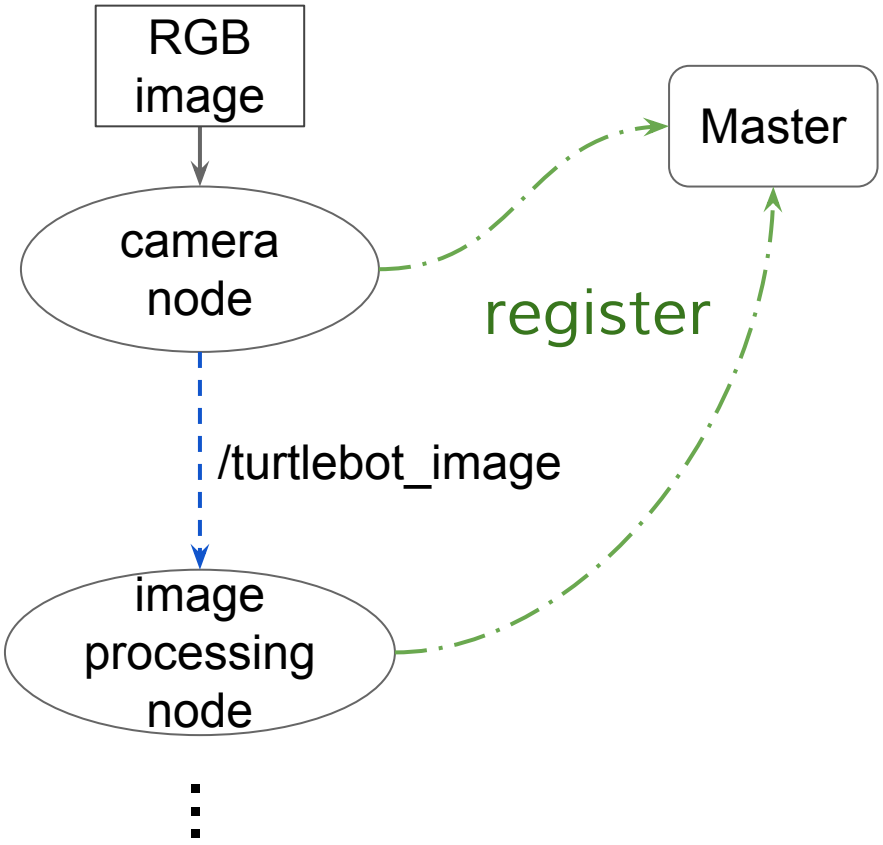
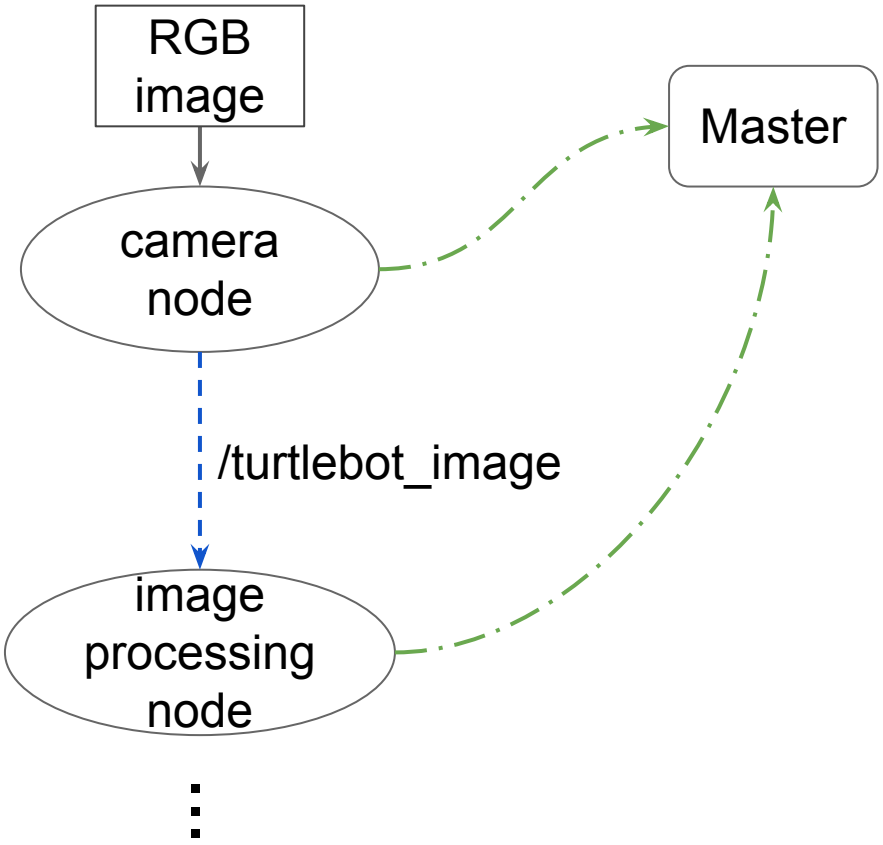


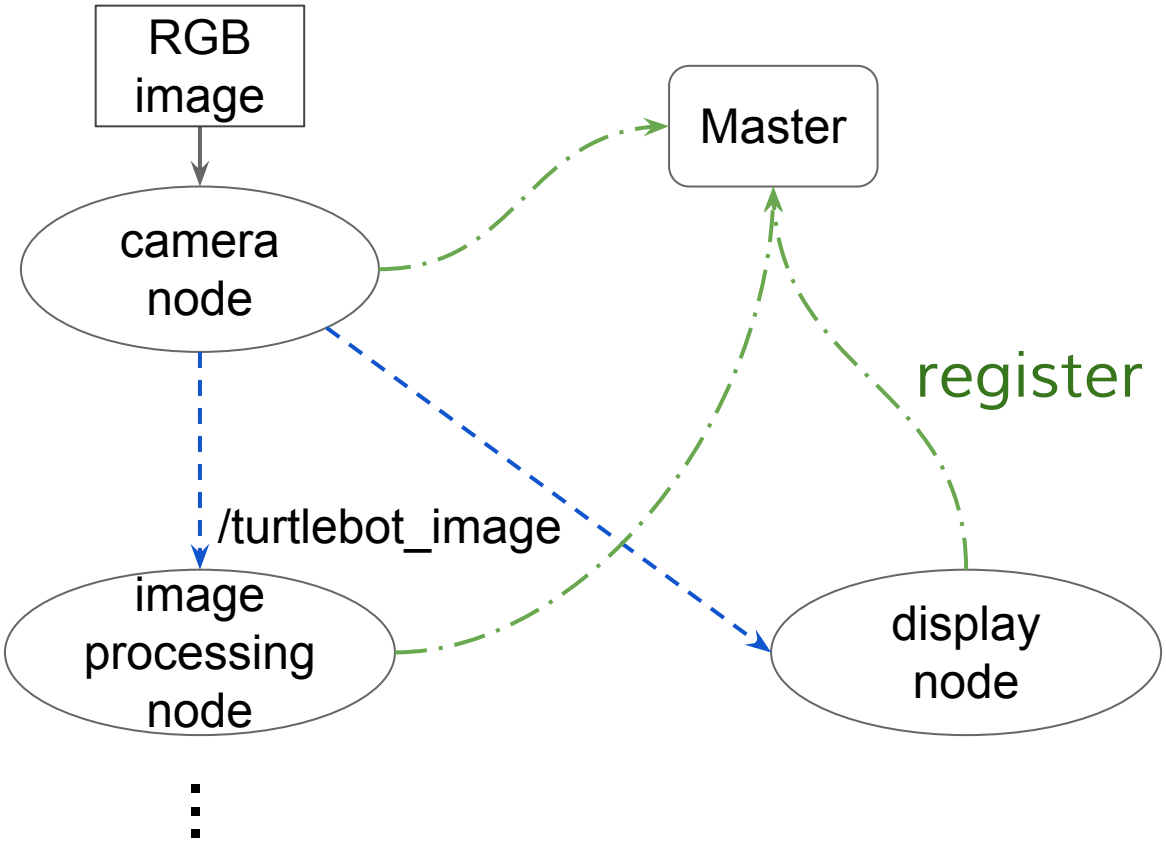
ROS communication



ROS communication



ROS communication



Where do we want to go?

2

“bare-metal” micro controllers

(better integration with)
real-time control

support multi-robot systems
involving unreliable networks etc.

reduce the gap between
prototyping and final products

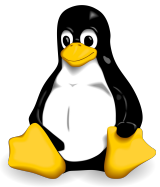
Data Distribution Service (DDS)

= discovery + serialization + transport

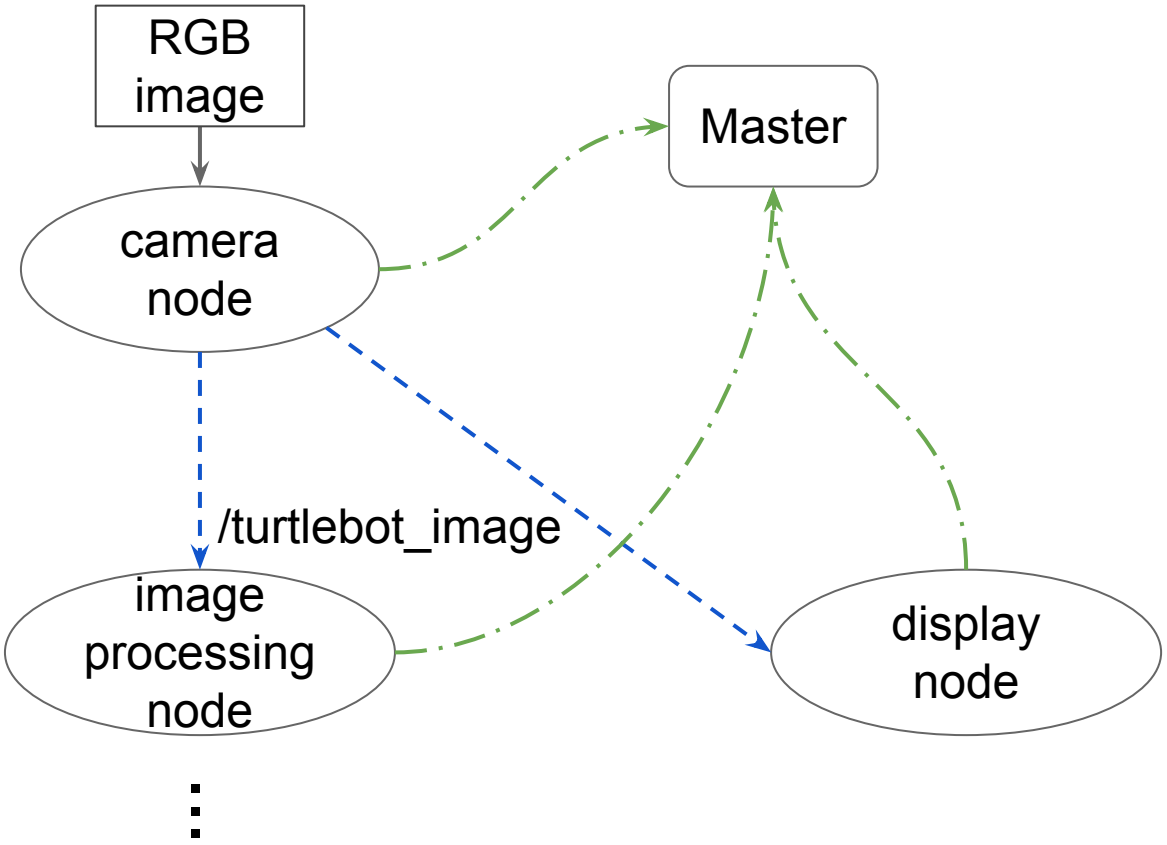
- Proven industry standard
- Configurable quality of service to handle many networking situations
- Real-time capable
- Master-less discovery
- Multiple implementations (~12)

How is ROS 2 different?

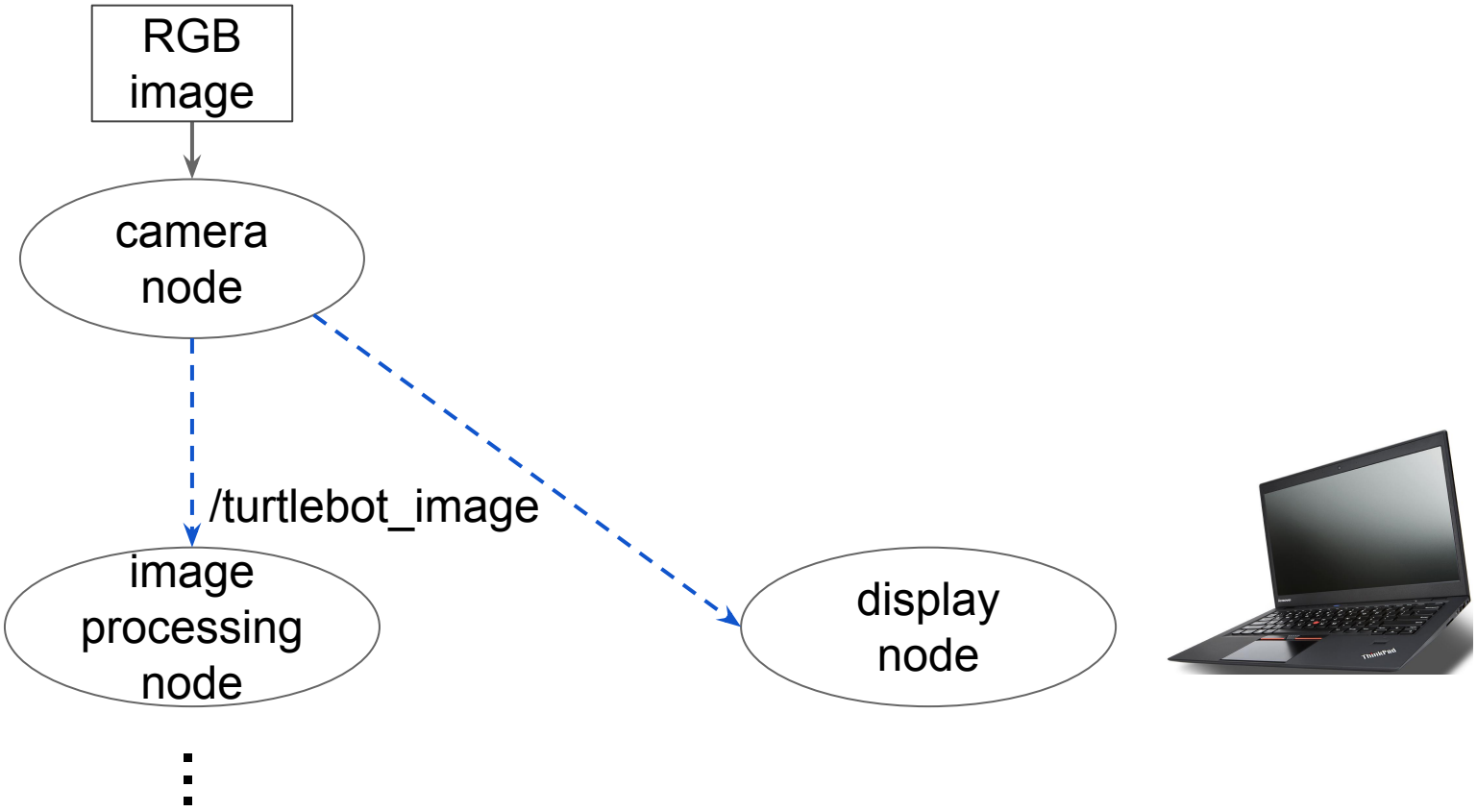
- DDS (Data Distribution Service) as middleware
- Real time capable
- Embedded
- Linux, Mac and Windows
- Modern API
- C++11, Python 3
- Minimal dependencies
- Easier to work with multiple nodes in one process
- More dynamic run-time features like topic remapping and aliasing
- And much more!



ROS 1 communication



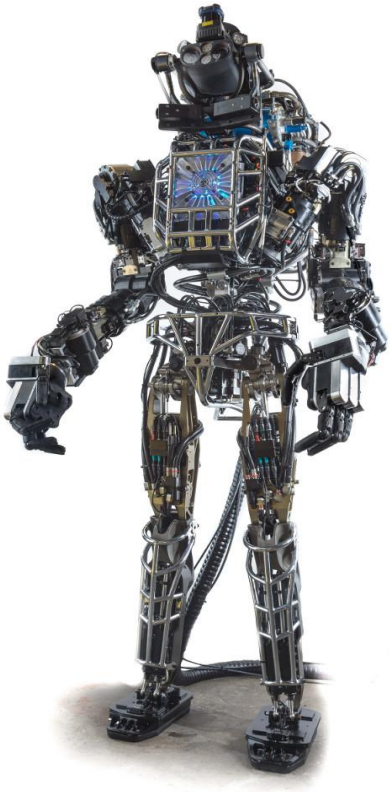
ROS 2 communication



Get involved!

http://ros.org
http://answers.ros.org

But…



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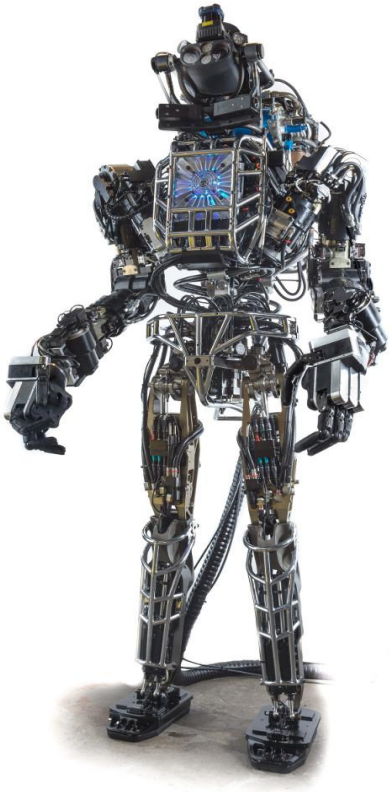
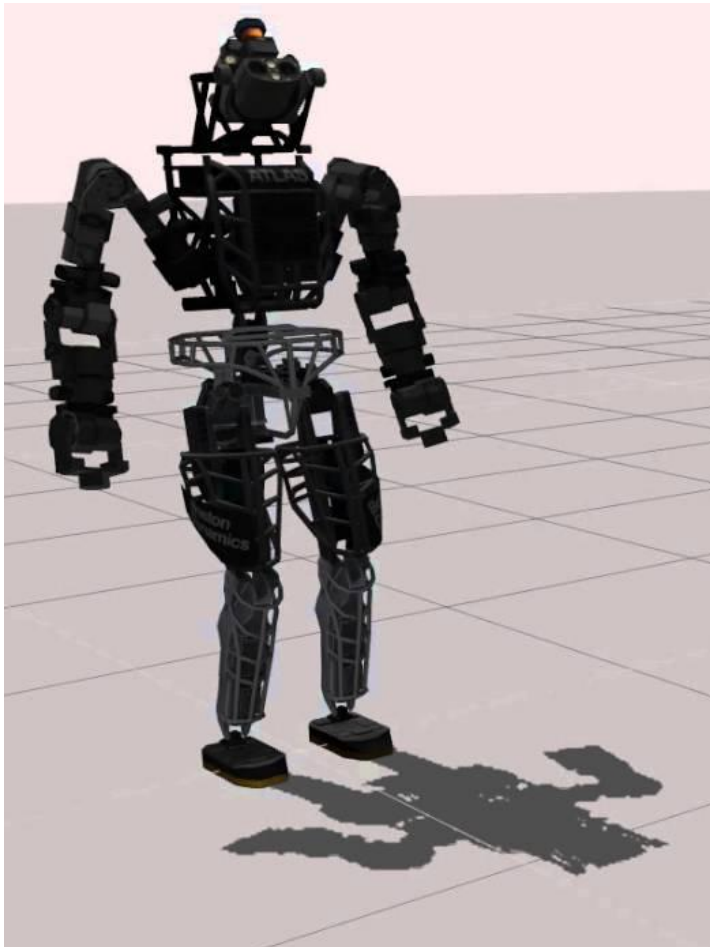
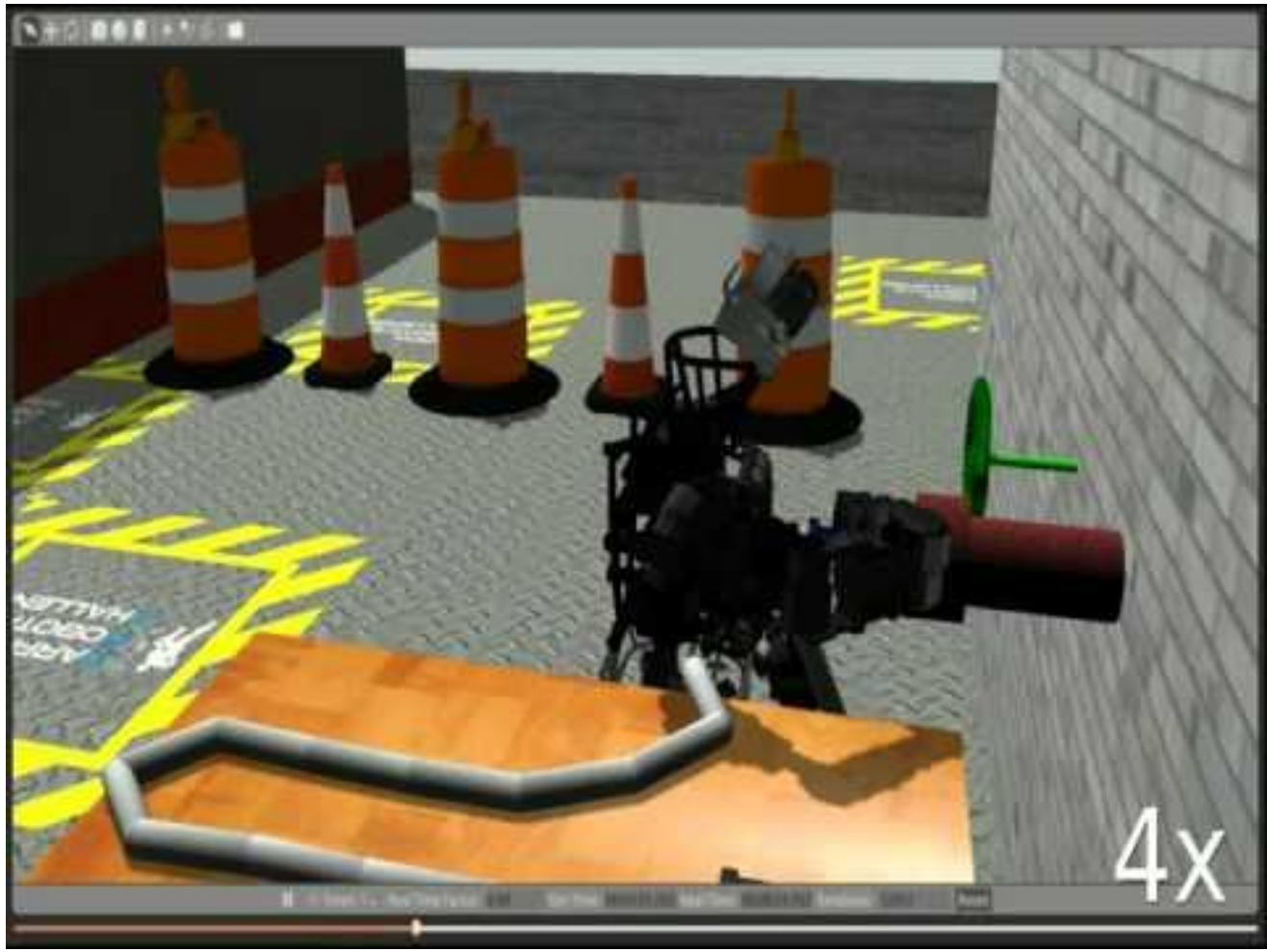




Gazebo



GAZEBO

Gazebo

Goal

Best possible substitute for physical robot

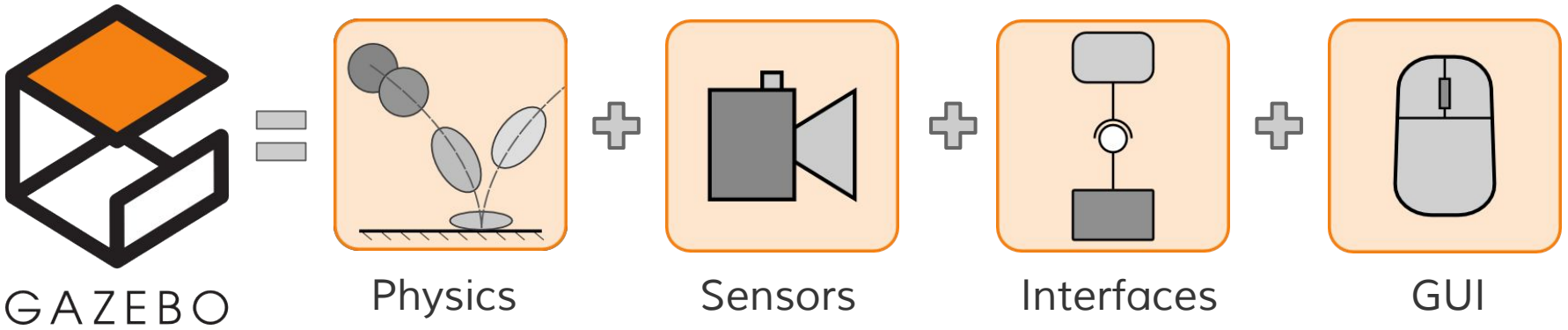
Use cases

- Prototyping of robot components and control
- Software testing and verification
- Competitions

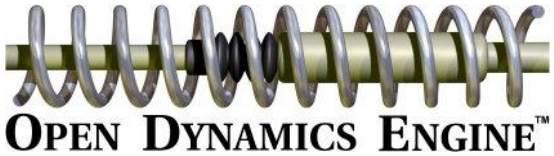
Gazebo 6 statistics

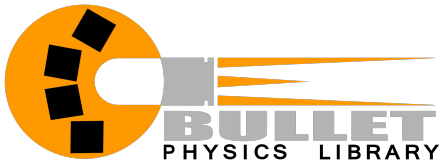
Birth	Fall 2002
Downloads	1k/month
Lines of code	266k
Lines of comments	89k
Test function coverage	47.9%
Test branch coverage	39.1%
Tests	901
Contributors	60+

Gazebo architecture



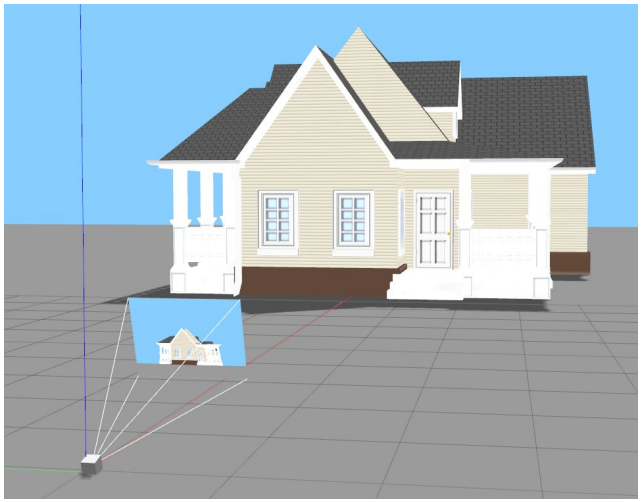
Physics engines

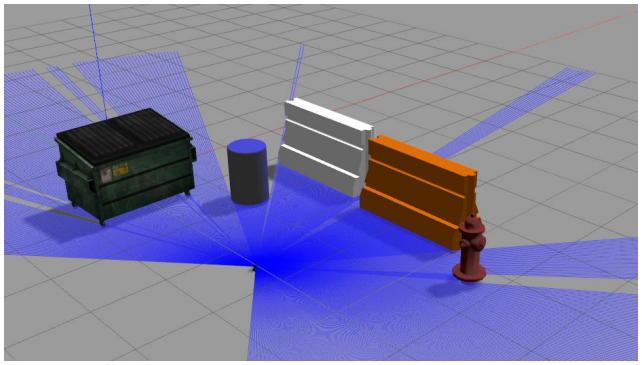




Sensors

- camera
  - stereo camera
  - wide angle camera
  - depth camera
- IMU
- GPS
- altimeter
- magnetometer
- force/torque
- sonar
- ...





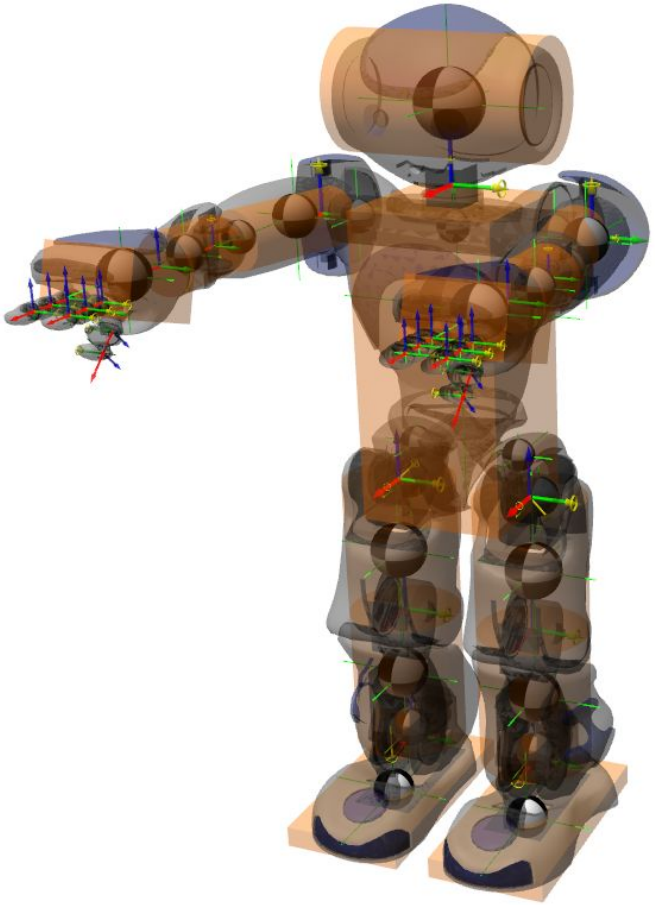
Graphical User Interface (GUI)

Control models

- Apply forces to joints and links
- PID position and velocity
- Mouse & text placement

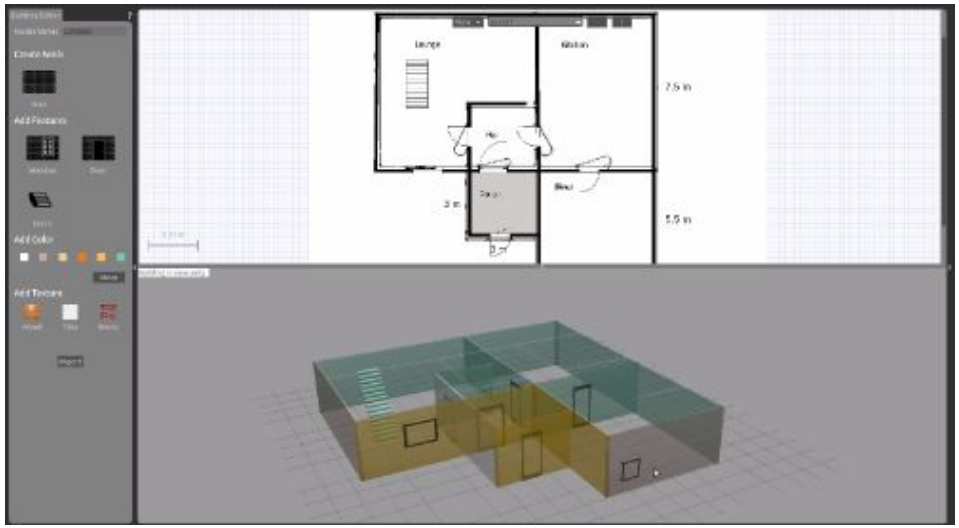
Visualizations

- Contacts
- Joints
- CoM, inertia
- Frames
- Orthogonal view

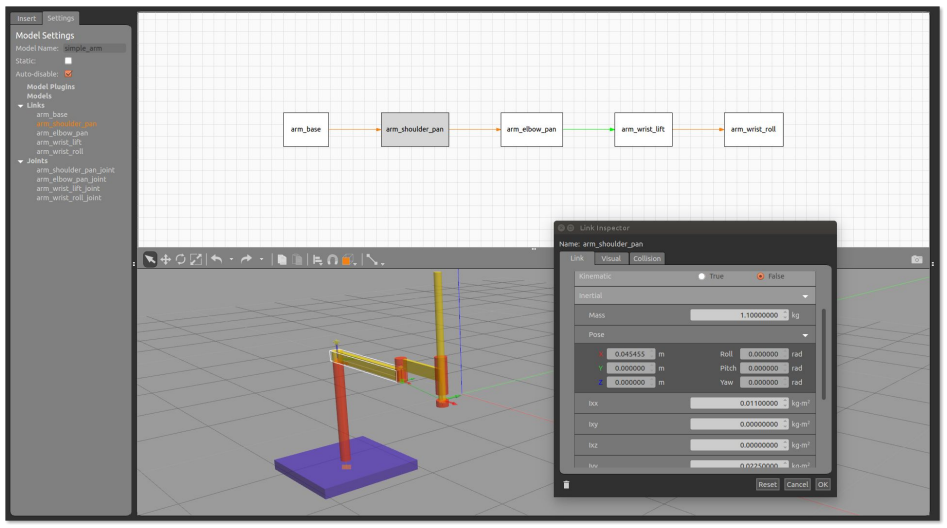


Graphical User Interface (GUI)

Building Editor



Model Editor



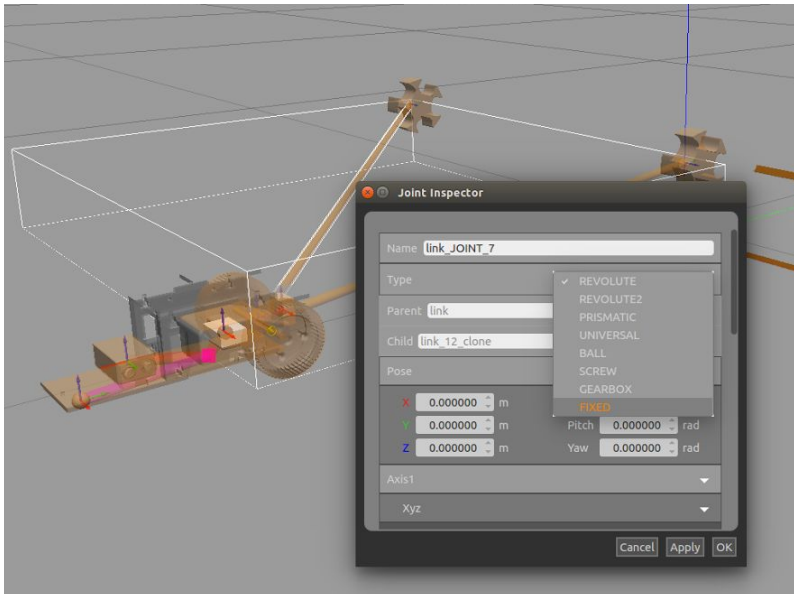
Simulation in the cloud

CloudSim

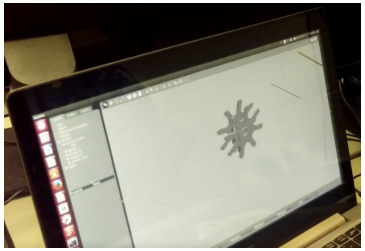
GzWeb

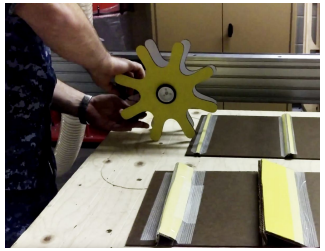
HAPTIX

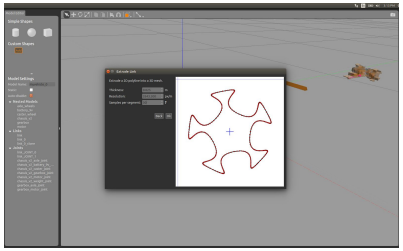
MENTOR2



Electrical connections







Import laser-cutter files

Get involved!

http://gazebosim.org
http://answers.gazebosim.org

Thank you!

Questions?