

# OSRF - ROS / Gazebo updates

Louise Poubel

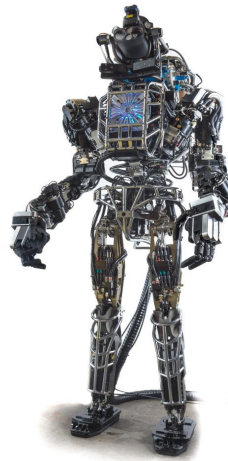
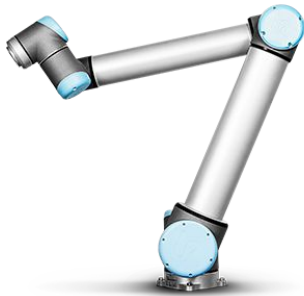
November 2015

Santiago

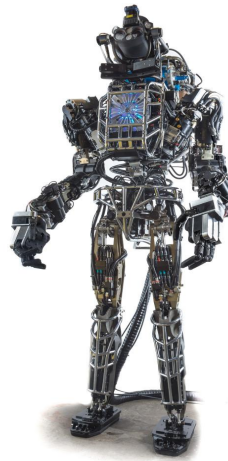
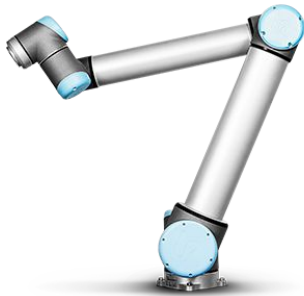
# Overview

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

# ROS motivation

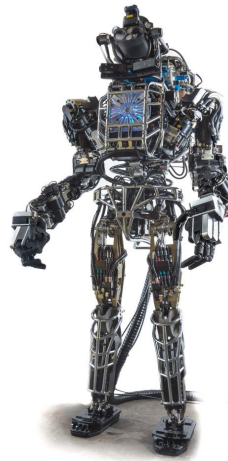
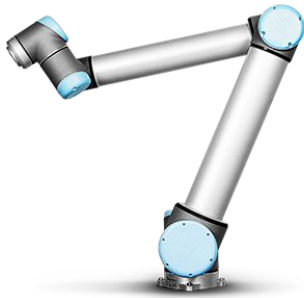


# ROS motivation

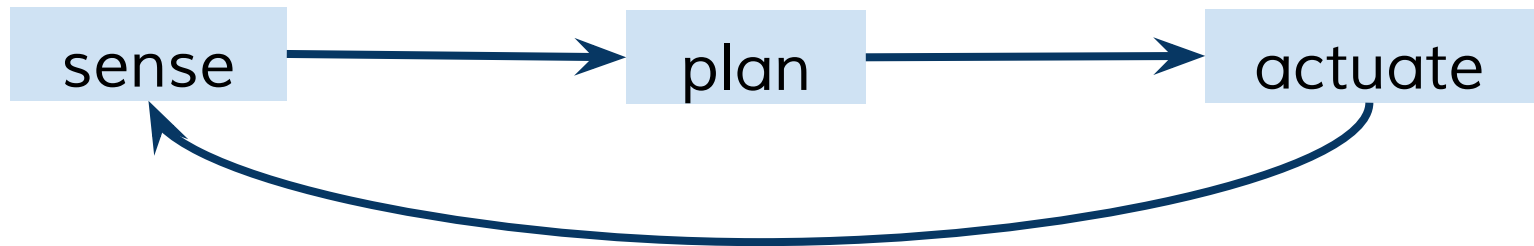
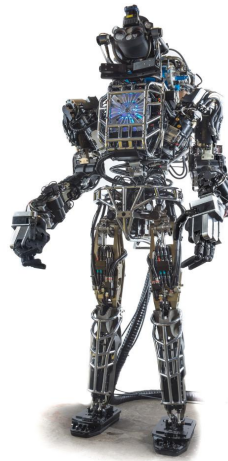
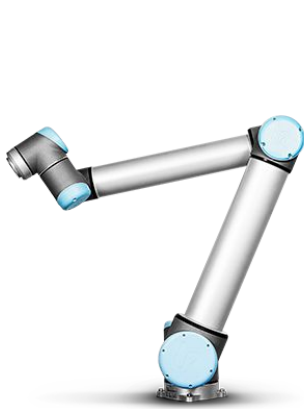


actuate

# ROS motivation



# ROS motivation



# ROS motivation



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

# ROS motivation



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

- motors
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# ROS motivation



- cameras
- LIDARs
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- computer vision
- signal processing
- motion planning
- SLAM
- ...

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# ROS motivation



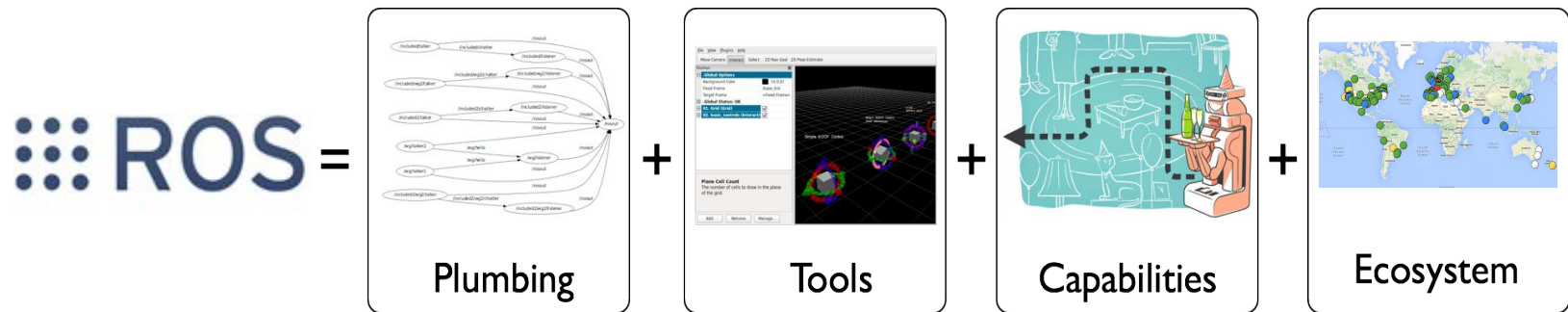
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 ROS

# ROS Overview



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

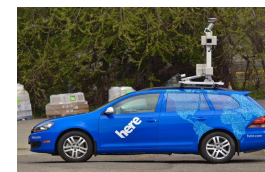
<http://wiki.ros.org/Metrics>

# 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



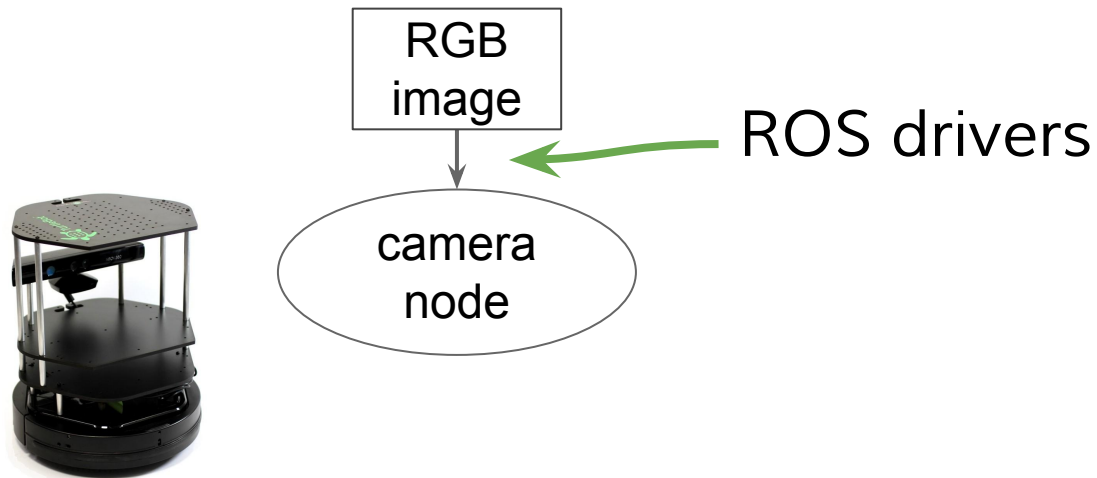


# ROS communication

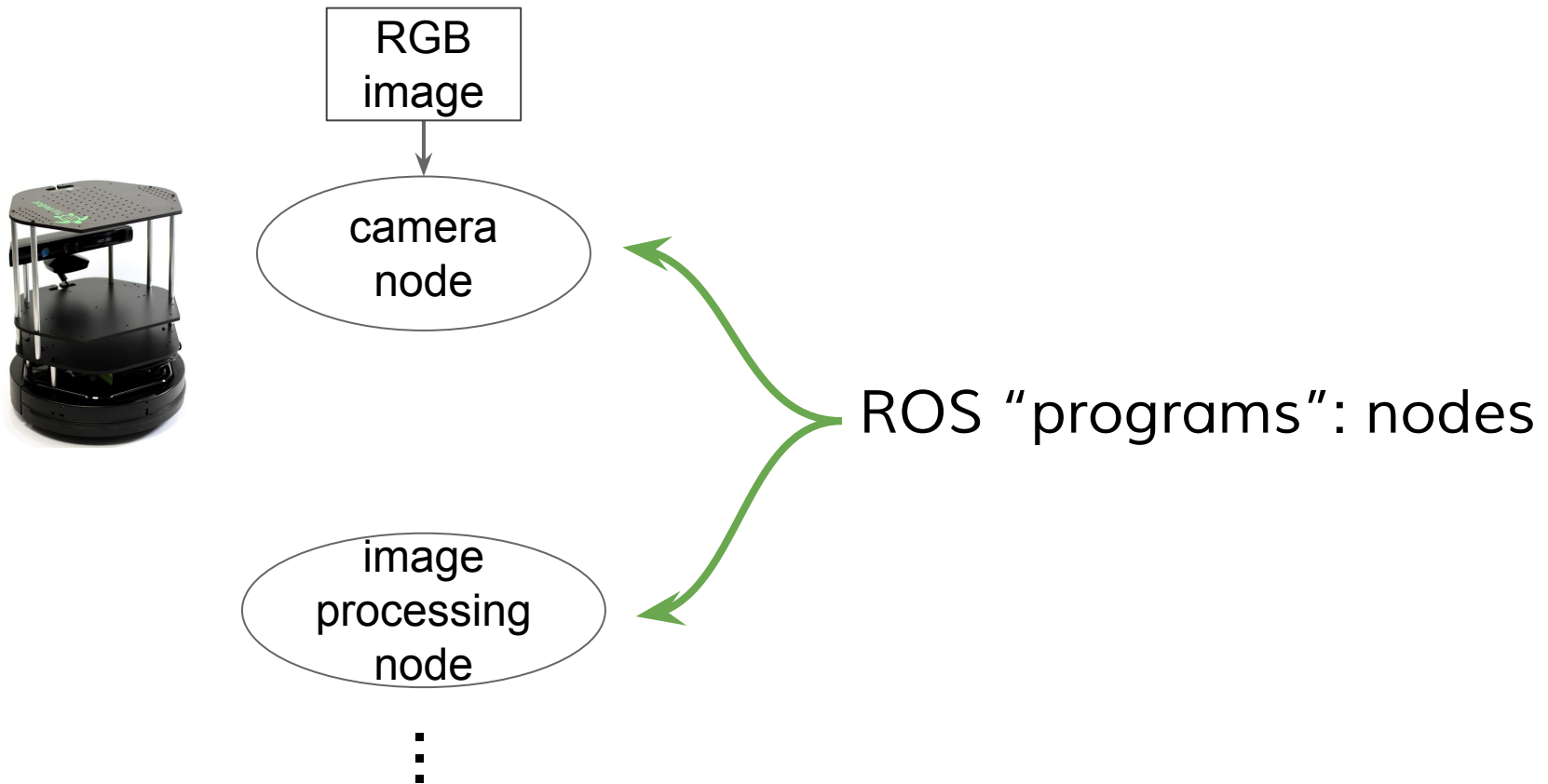
RGB  
image



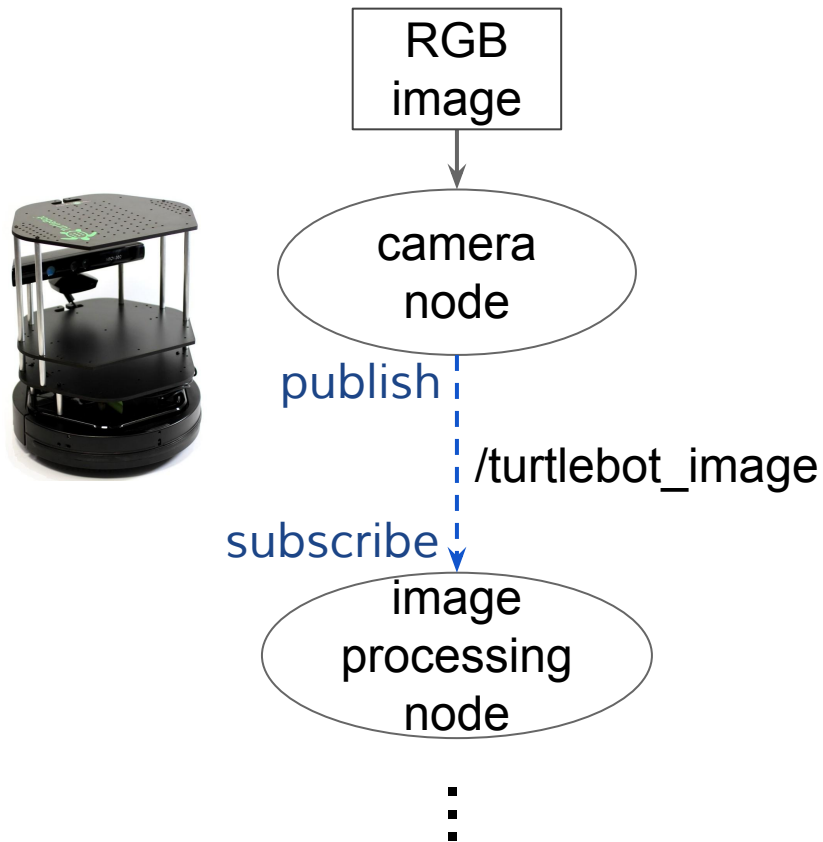
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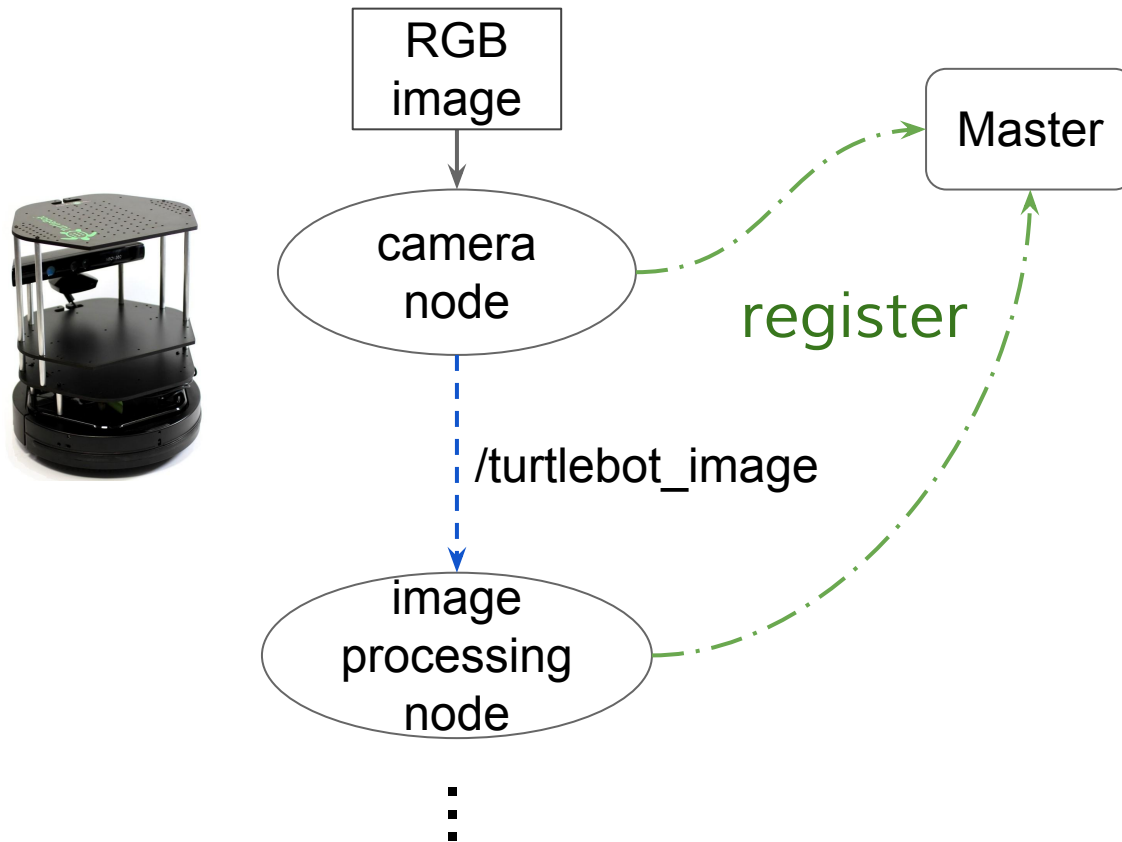
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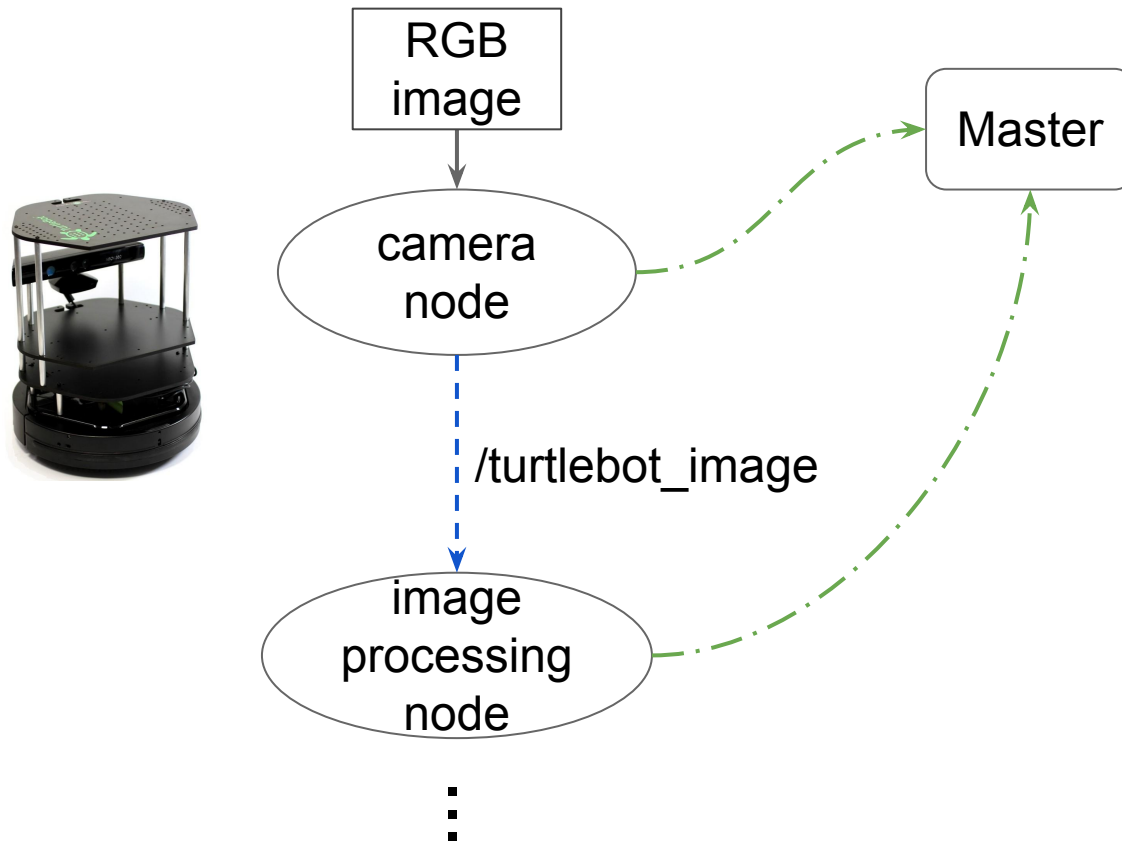
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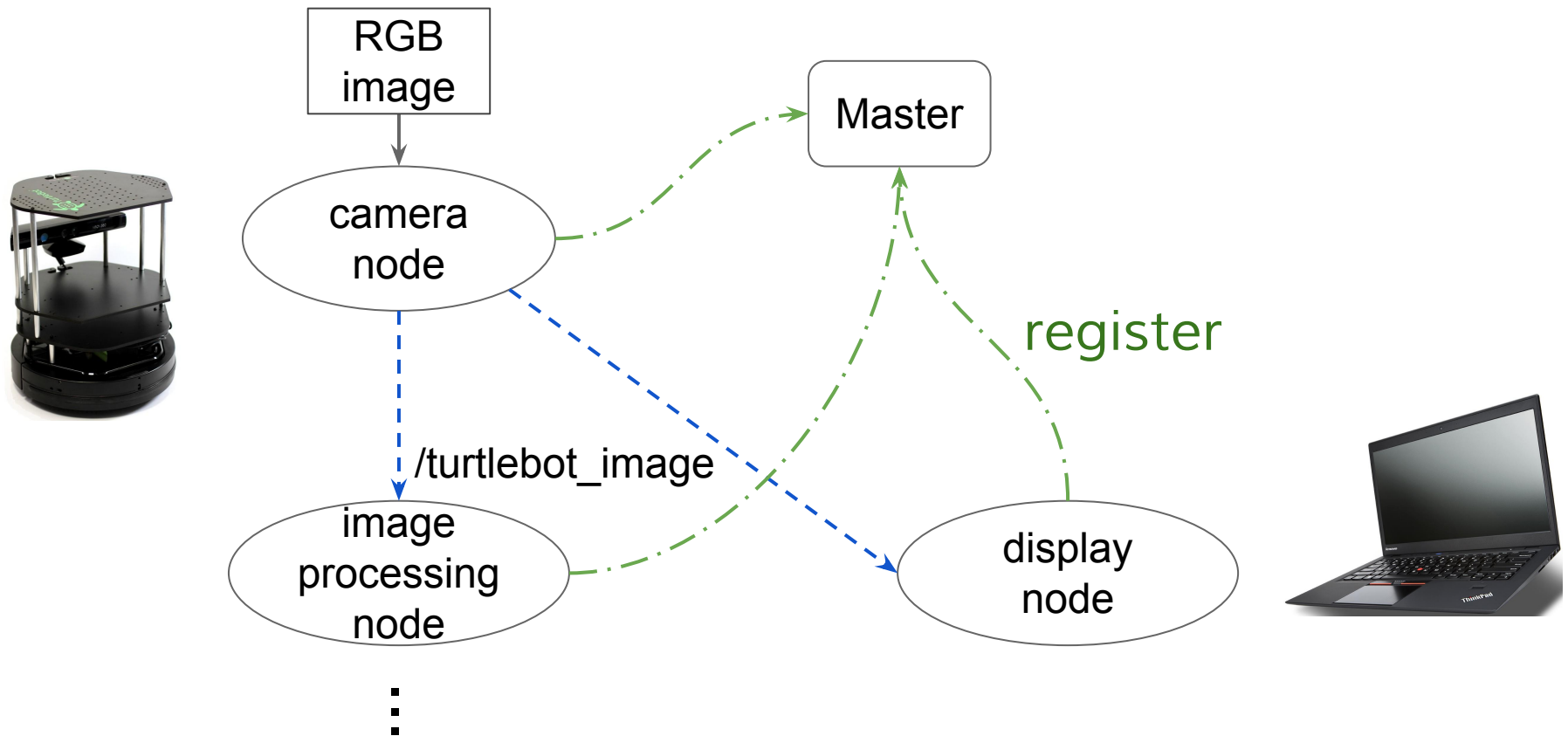
# ROS communication



# 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)



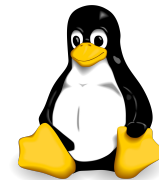
= discovery + serialization + transport

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

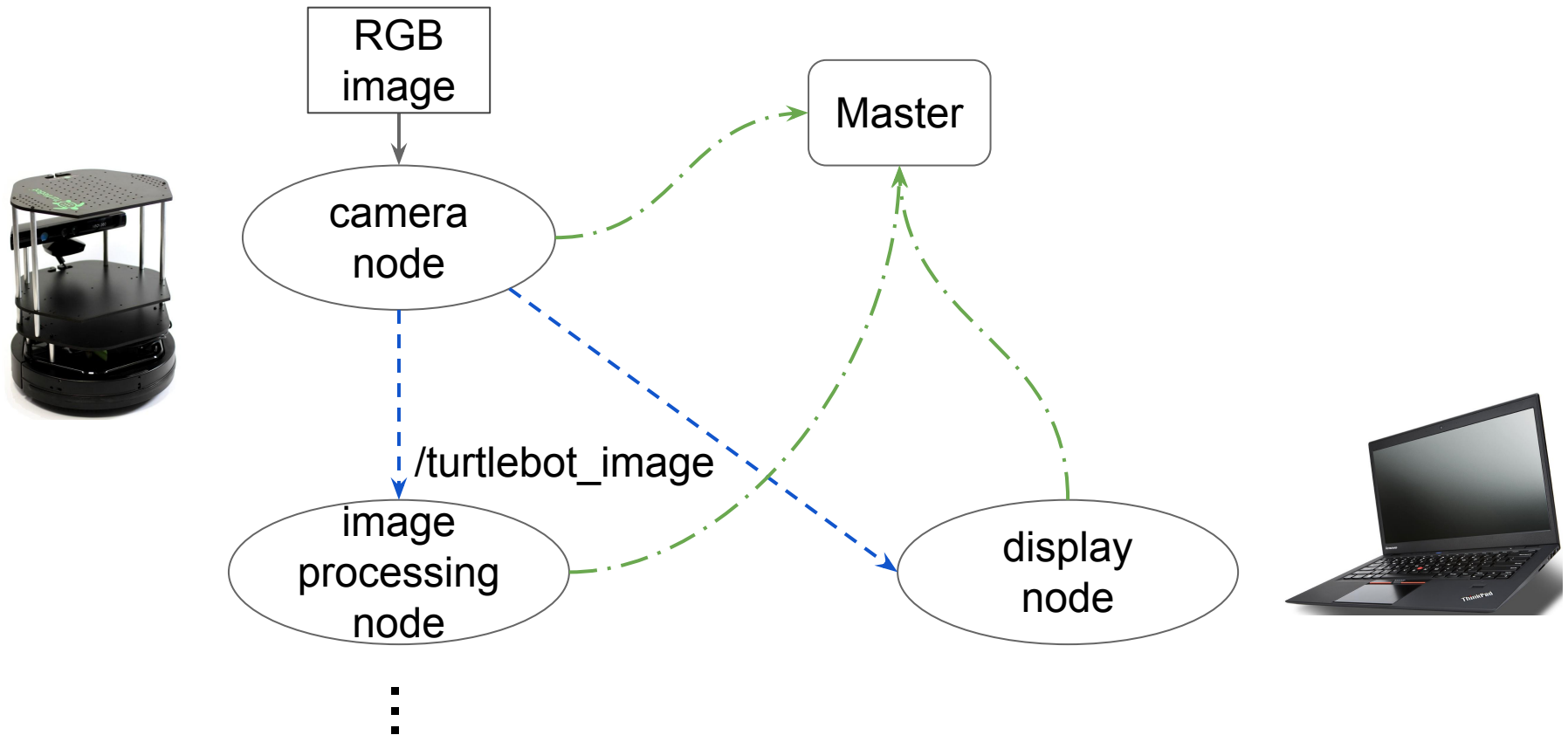


# How is ROS 2 different?

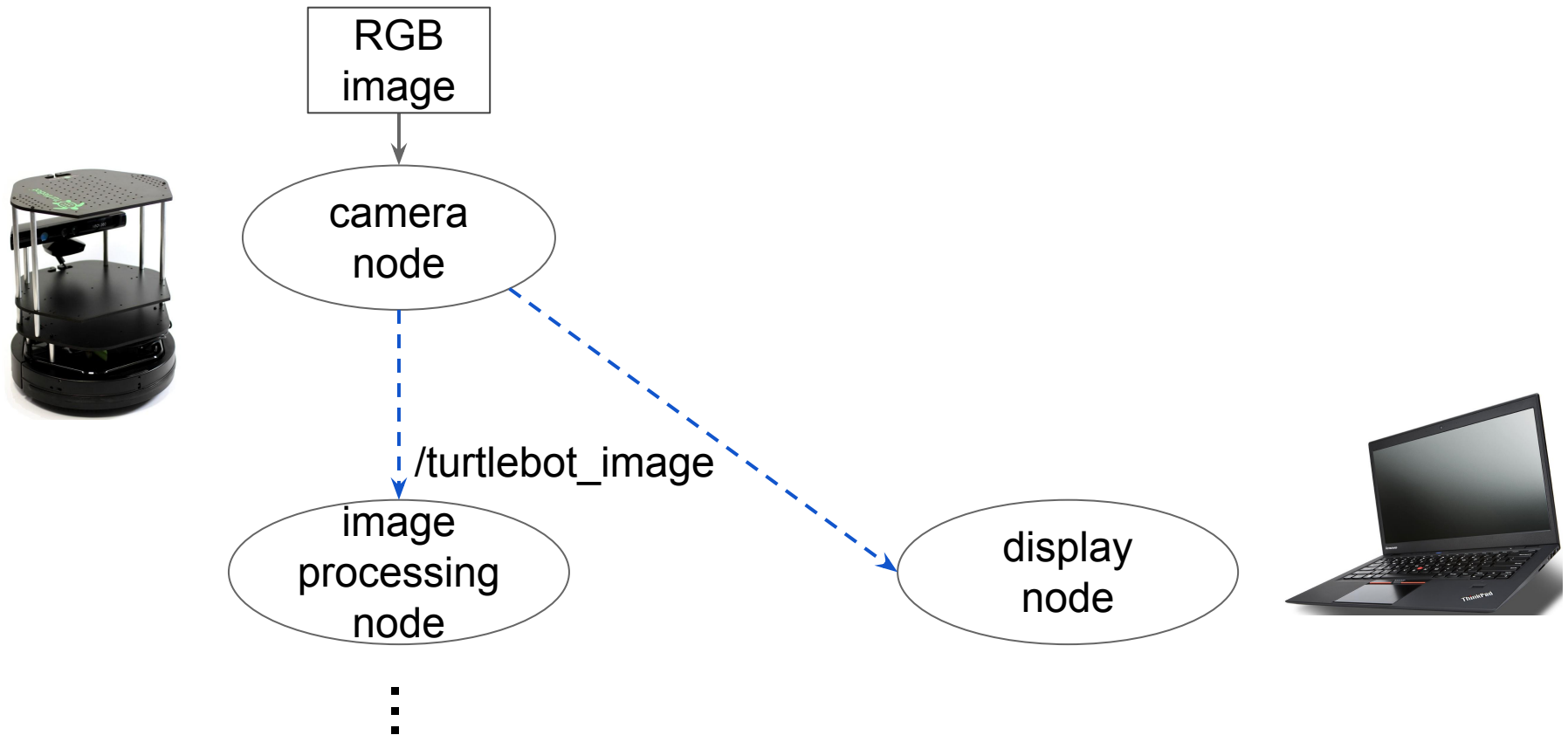
- DDS (Data Distribution Service) as middleware
- Real time capable
- Embedded
- Linux, Mac and Windows
- Modern API
- C++11, Python 3
- Minimal dependencies
- Easier to work with multiple nodes in one process
- More dynamic run-time features like topic remapping and aliasing
- And much more!



# ROS 1 communication



# ROS 2 communication



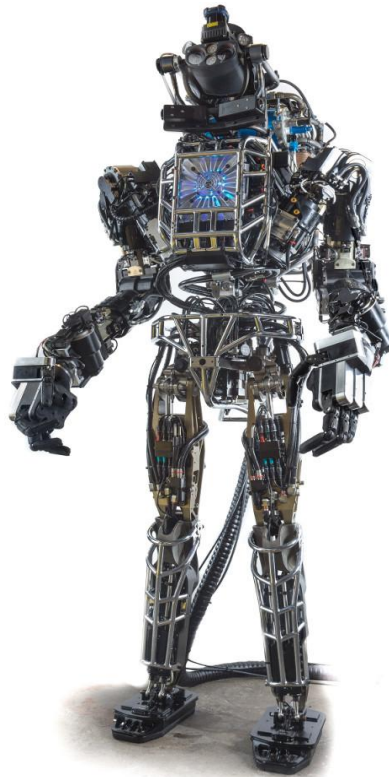
# Get involved!



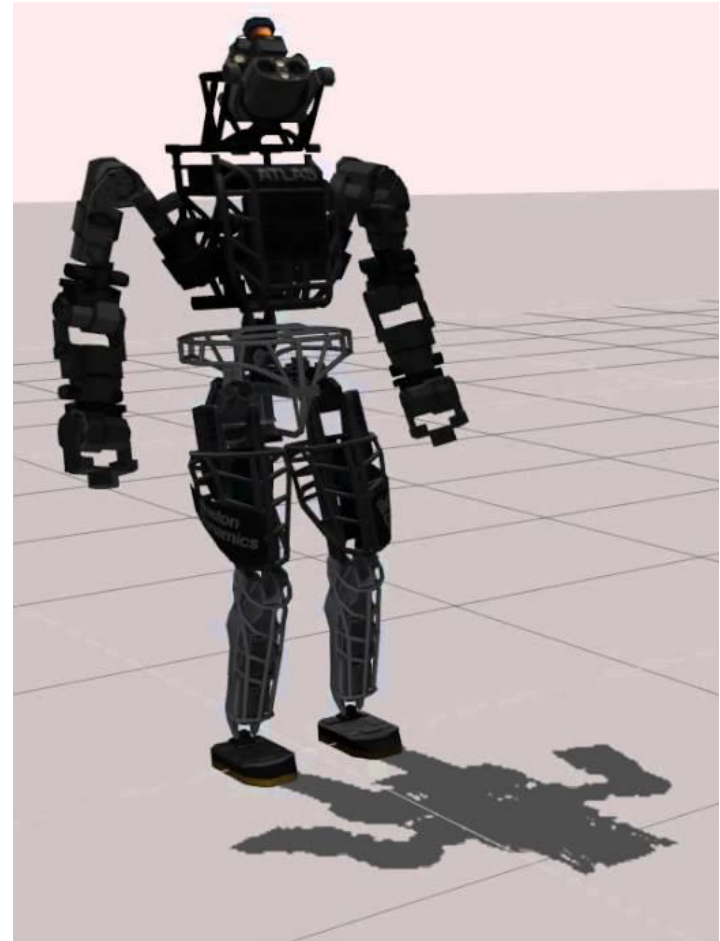
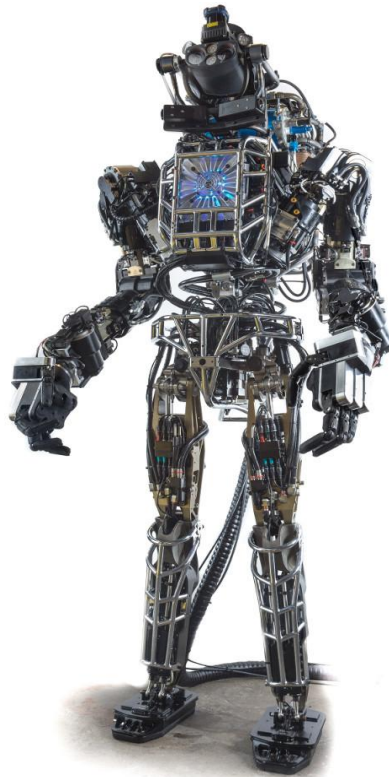
<http://ros.org>

<http://answers.ros.org>

But...



But...



# Gazebo



GAZEBO





# Gazebo

## Goal

Best possible substitute for physical robot

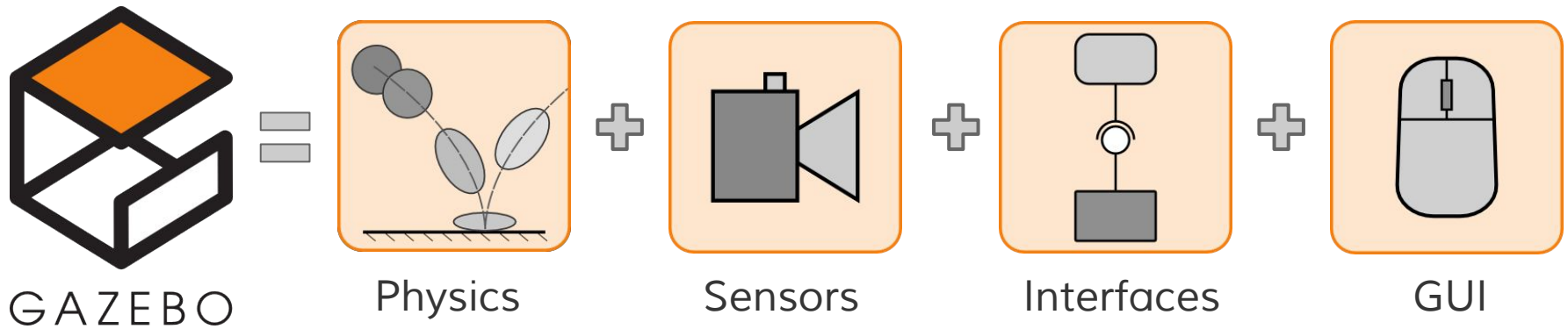
## Use cases

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

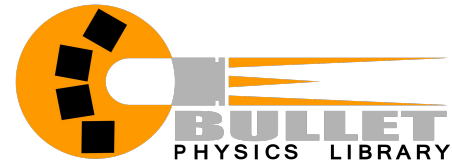
# Gazebo 6 statistics

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

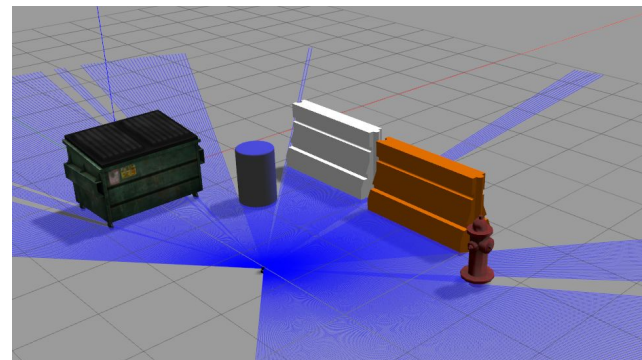
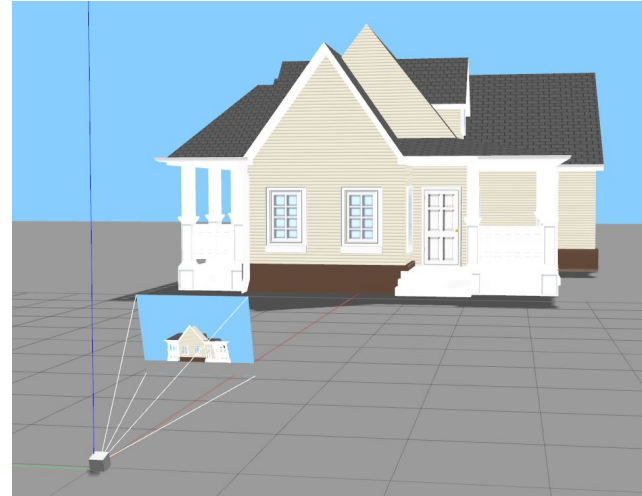


# Physics engines



# 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

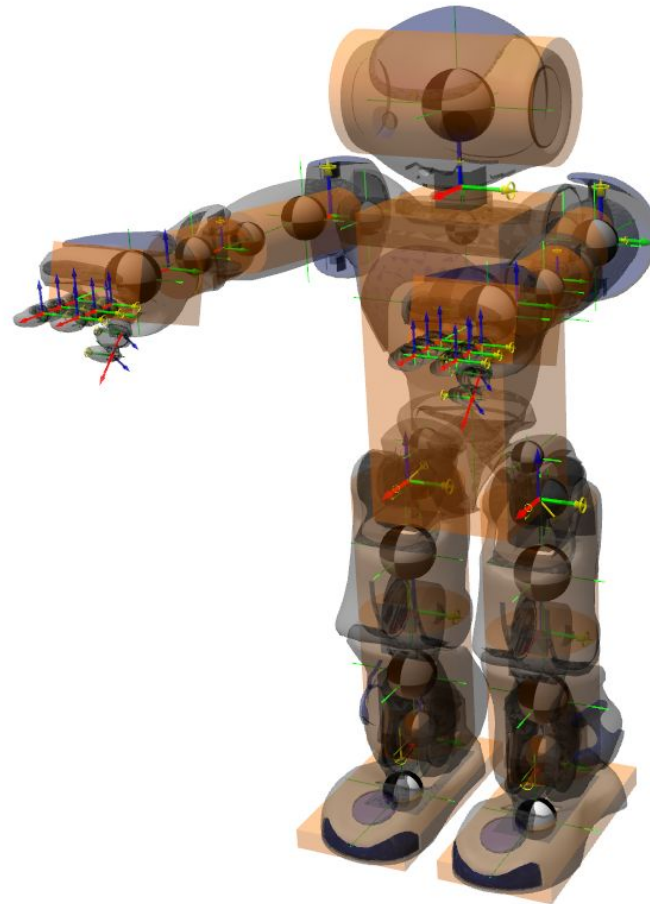
Contacts

Joints

CoM, inertia

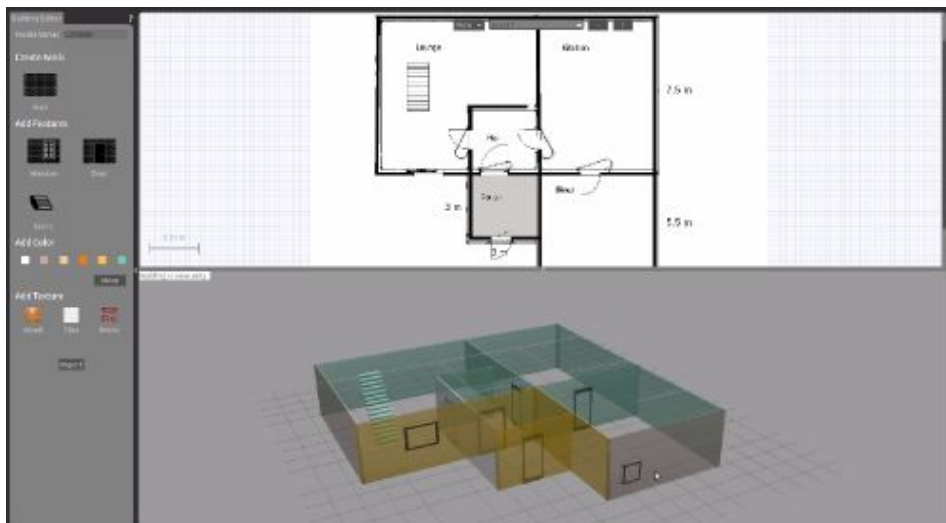
Frames

Orthogonal view

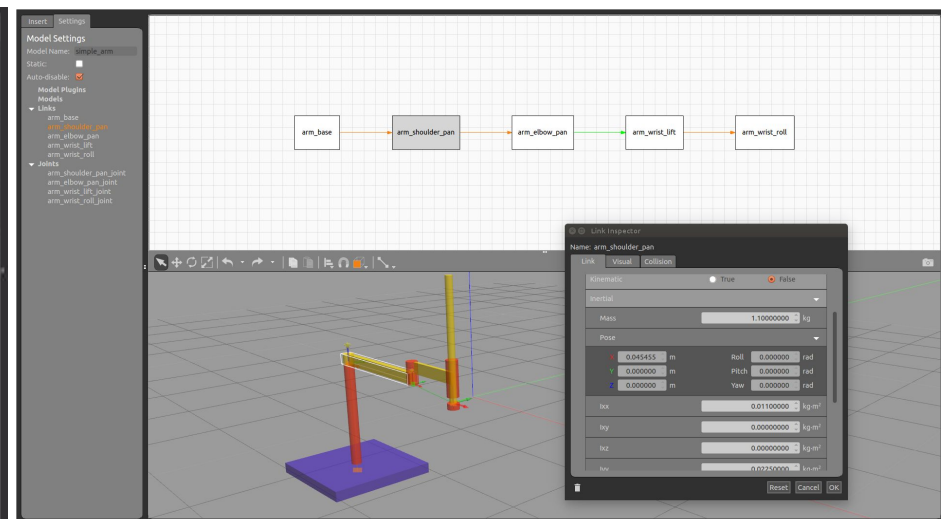


# Graphical User Interface (GUI)

## Building Editor



## Model Editor

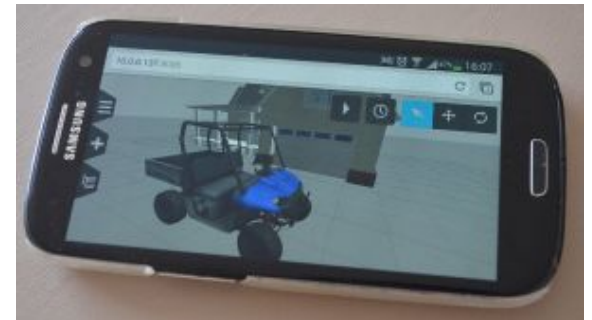


# Simulation in the cloud

CloudSim



GzWeb

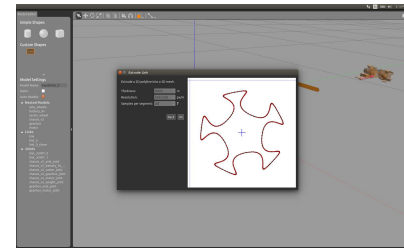
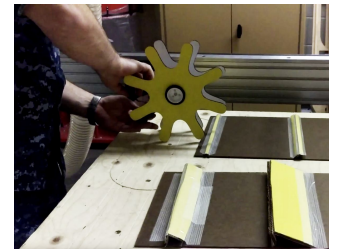
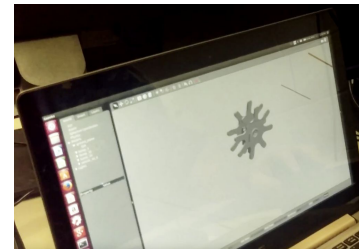
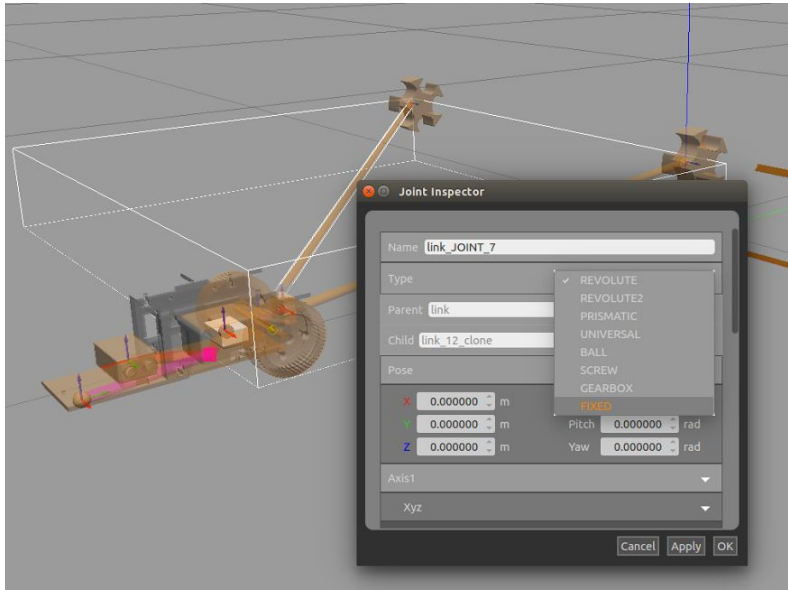
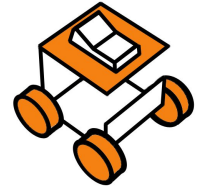




# HAPTIX



# MENTOR2



Electrical connections

Import laser-cutter files

# Get involved!



GAZEBO

<http://gazebosim.org>

<http://answers.gazebosim.org>

Thank you!

Questions?