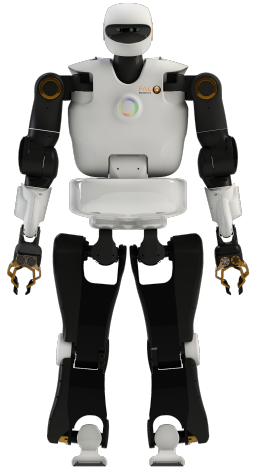
HOW to design ROS-powered robots

Luca Marchionni, CTO at PAL Robotics

September 22, Vancouver

ROSCon 2017



PAL ROBOTICS

Outline

- PAL Robotics
- Software overview and deployment
- Continuous integration
- Software release system
- Control architecture
- Whole Body Control
- Space Robotics Challenge

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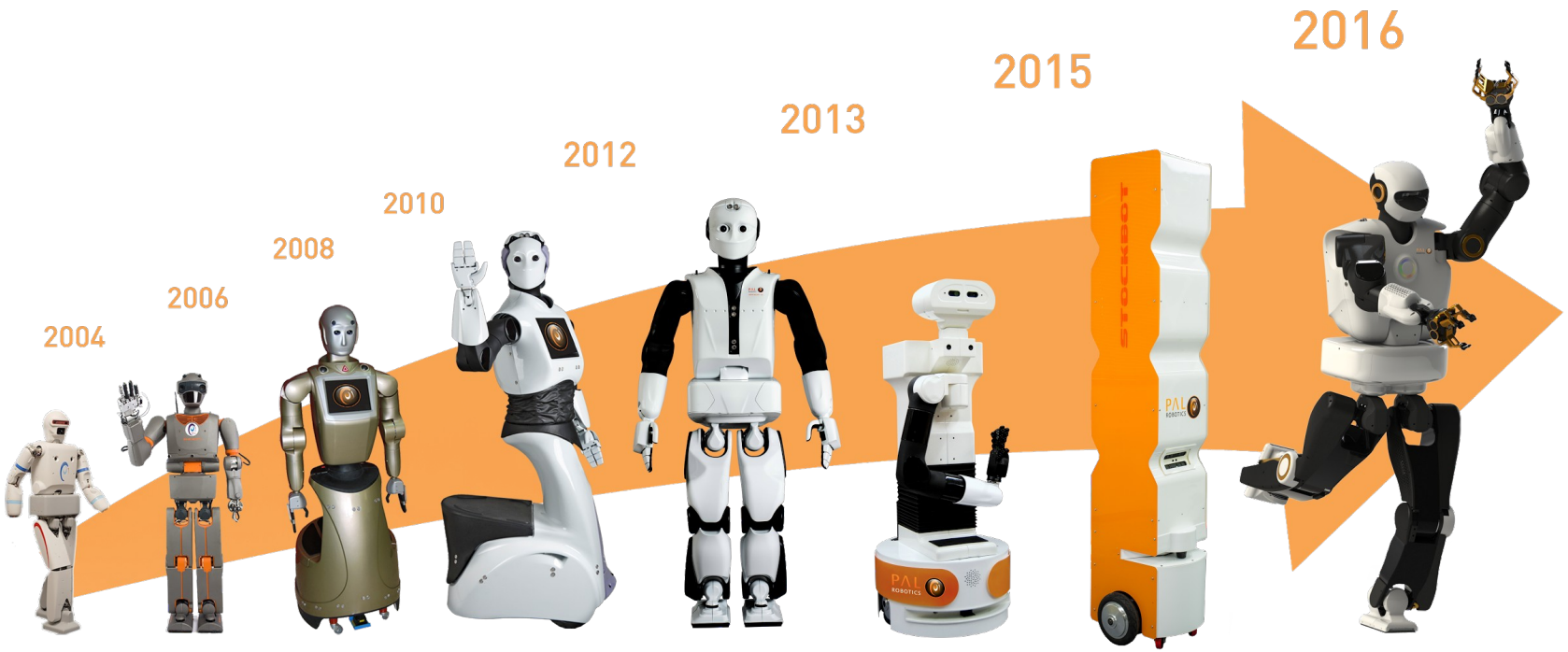
PAL Robotics in a nutshell



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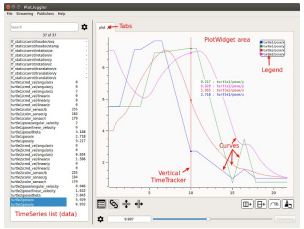
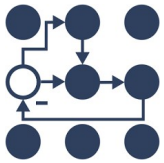
Partners and customers

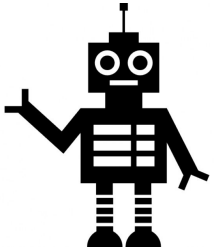
ROSCon 2017

Why do we use ROS?

- Shorten time to market
- Selling argument
- Leverage powerful development tools
- If you have the code, you can improve it
- Share the effort with community
- Contribute to create “standards”
- Build value, focus on core IP







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Public repositories

REEM

wiki.ros.org/Robots/REEM

wiki.ros.org/Robots/REEM/Tutorials

TIAGO

wiki.ros.org/Robots/TIAGo

wiki.ros.org/Robots/TIAGo/Tutorials

REEM-C

wiki.ros.org/Robots/REEM-C

wiki.ros.org/Robots/REEM-C/Tutorials

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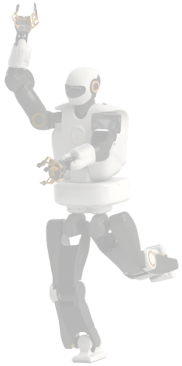
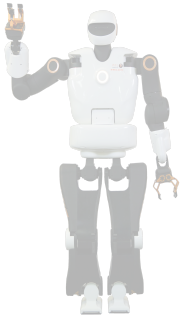
https://github.com/pal-robotics 72 repositories

https://github.com/pal-robotics-forks 60 repositories

Public repositories (coming soon)





TALOS

- New generation of biped robot
- Advanced mobility and manipulation skills for industrial tasks
- Full torque controllable robot
- EtherCAT communication bus
- High power/speed actuators
- 6 Kg arm payload

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Software overview

	Stable	Work in progress	Future?
Operating System	• Ubuntu 14.04 LTS 64-bit • Xenomai real-time • Linux Preemp-rt	• Ubuntu 16.04 LTS 64-bit • Linux Preemp-rt	• **Linux Real Time**
Robotics middleware	• Orocos 2.8 • ROS Indigo • PAL Dubnium	• Orocos 2.8 • ROS Kinetic • PAL Erbium	• **ROS 2.0** • **PAL Fermium**

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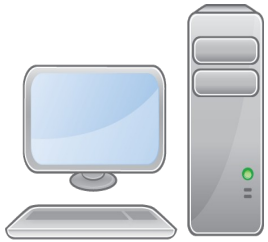
Software deployment



- Add/Overlay packages to a robot
- Validate package installation rules
- Discourage file editing on robot
- Multiple workspaces
- Test before release
- Restore original package version

PAL ROBOTICS

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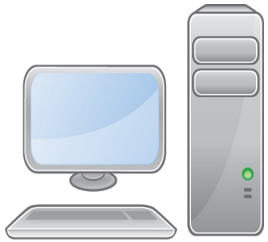

pal_deploy

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/opt/ros/indigo

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Software deployment

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/opt/pal/dubnium

/opt/ros/indigo

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Software deployment

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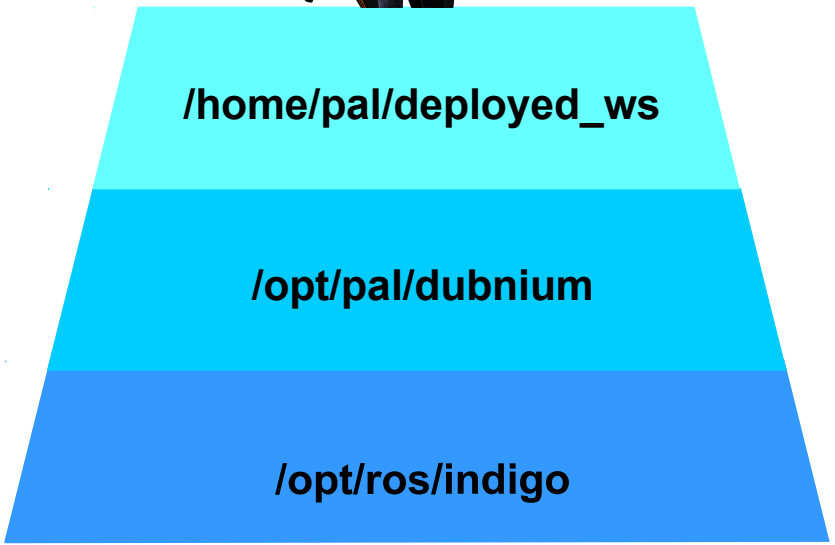

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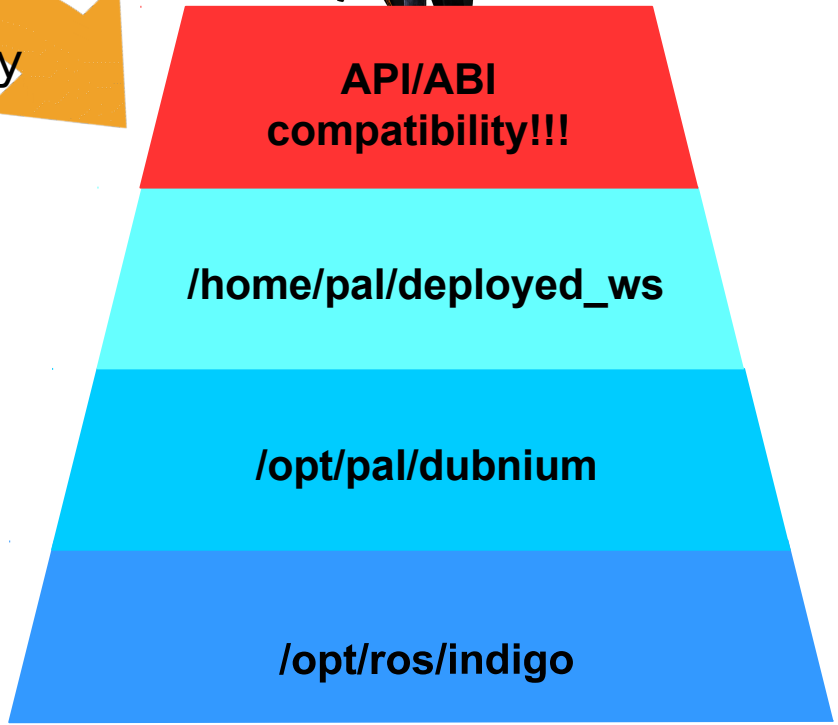

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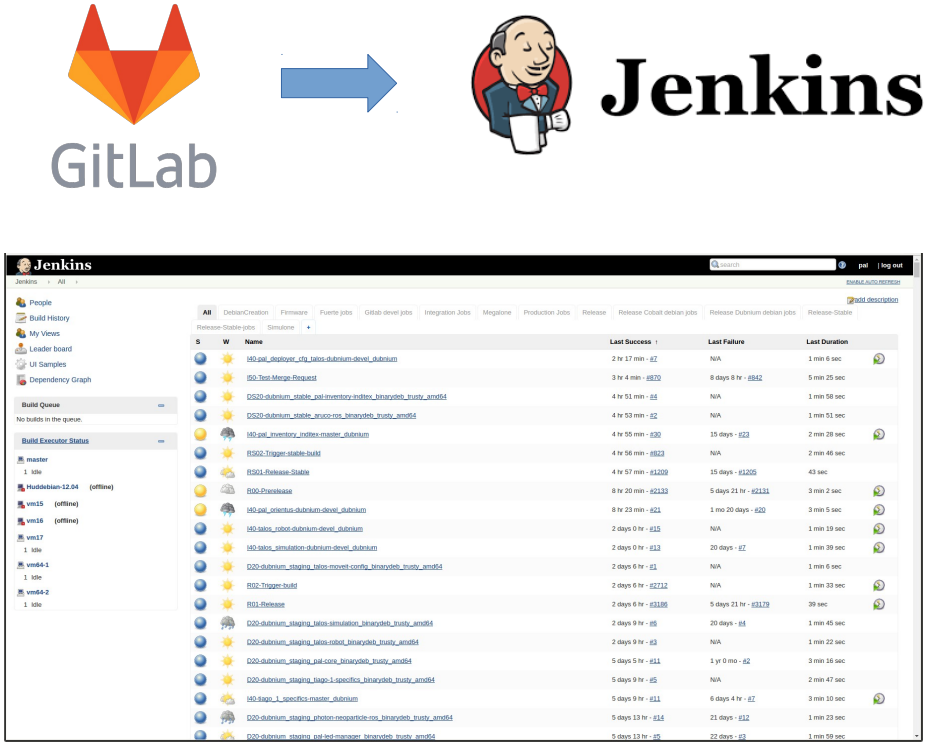
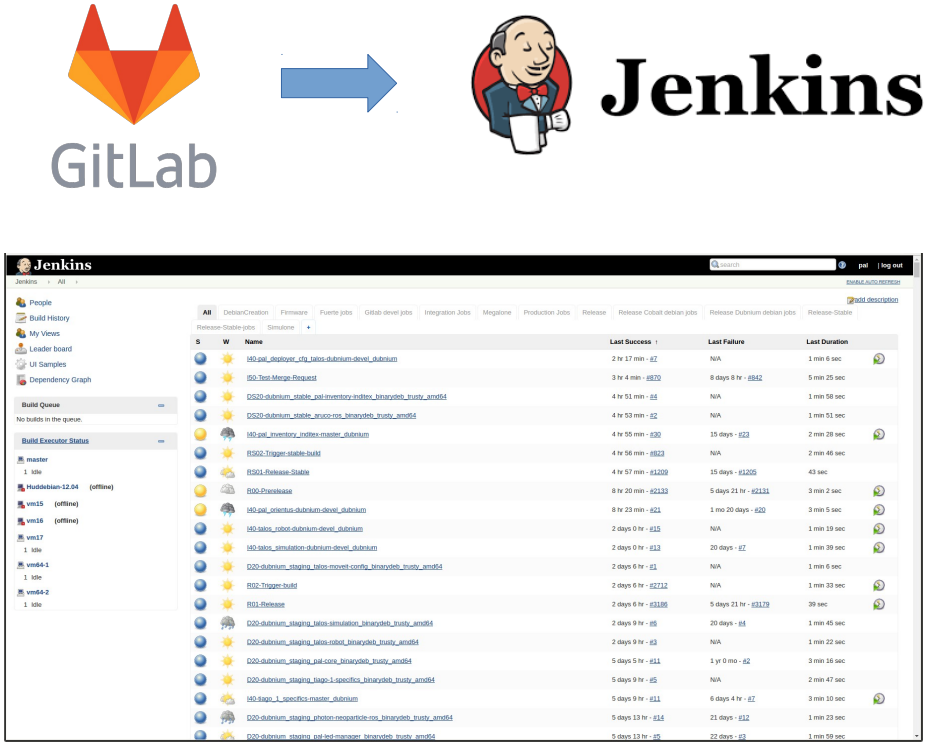
Continuous integration



- Builds in clean environment
- Unit testing
- Coverage
- API/ABI check
- Functional testing

Continuous integration



Notify developers and maintainers if:

- Compilation error
- Test failure
- Coverage below 70%
- API/ABI breaking

Run it on master/develop branch
(GitFlow branching model)

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Continuous integration

Jeremie Deray @jeremiederay added 1 commit 2 weeks ago

- `fe56d1f3` - moar tests

Compare with previous version

PAL Bot @anonymous commented 2 weeks ago

Reporter

extend-tests	build stable	tests 34/34	C++ coverage 99%	Py coverage --	API compatible	ABI compatible
master	build success	tests 22/22	C++ coverage 88%	Py coverage --	API No Info	ABI No Info

Build details in: http://venus:8080/job/I50-Test-Merge-Request/1840/

Edited less than a minute ago by Victor Lopez

Jeremie Deray @jeremiederay commented 2 weeks ago

Master

As pointed by @victor giving the `PropertyBag` a name may not be of any use... @victor @hilariotome let me know your opinion before I remove it from this PR.

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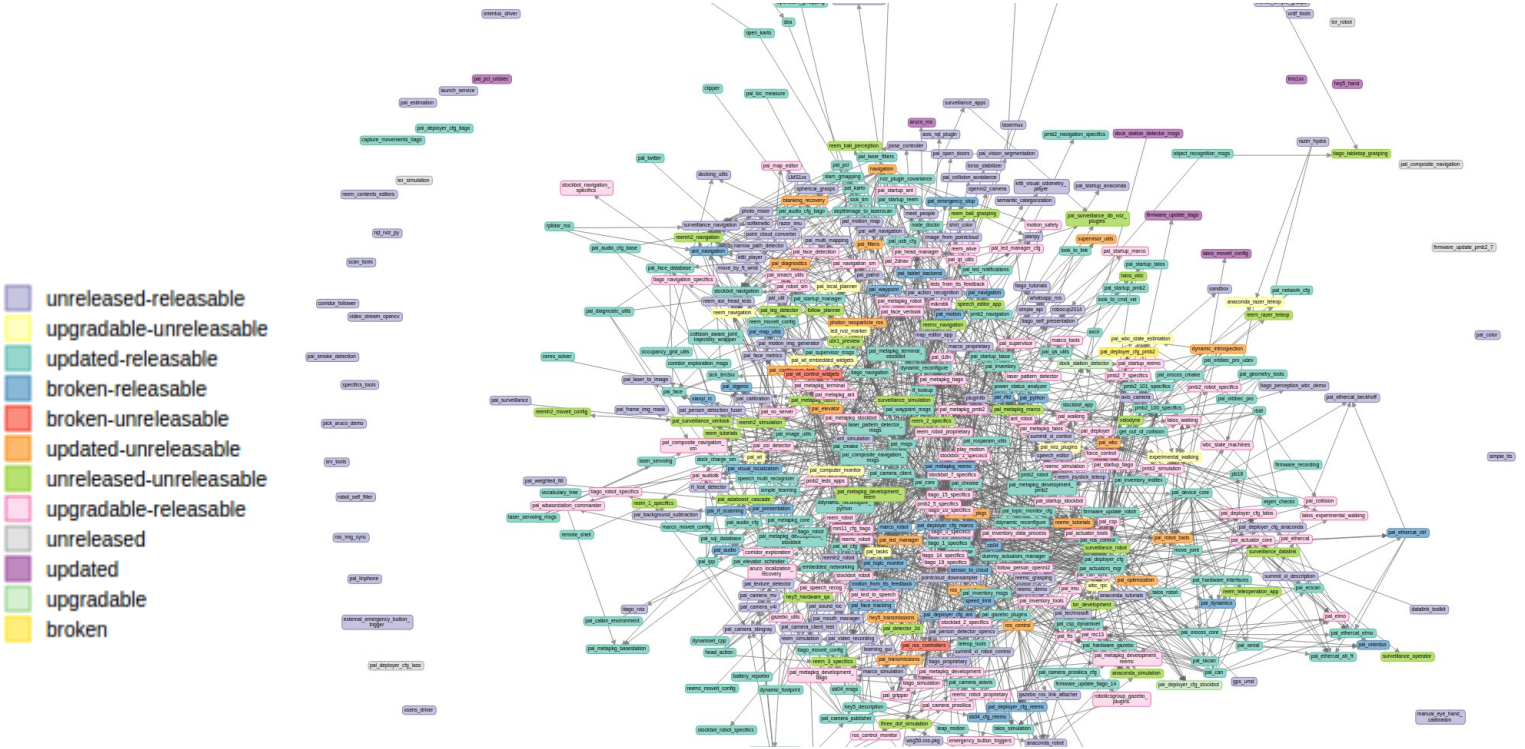
Software release system



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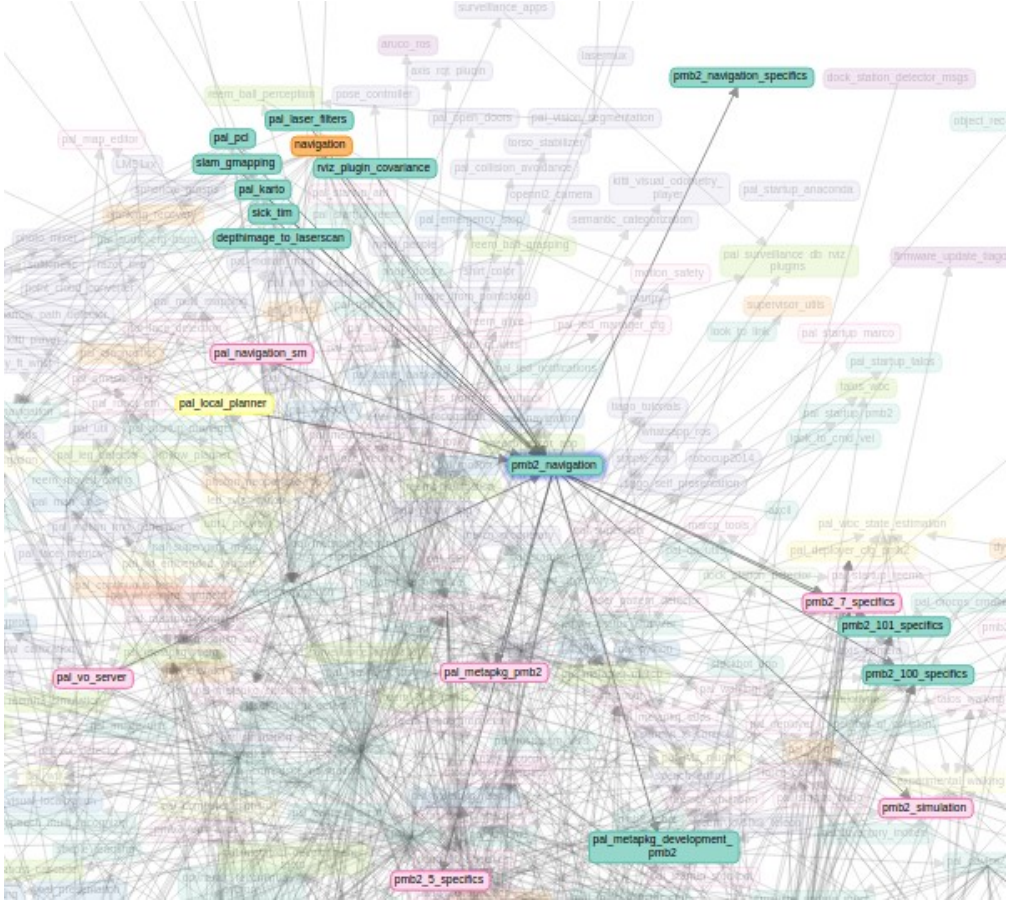
Software release system

- unreleased-releasable
- upgradable-unreleasable
- updated-releasable
- broken-releasable
- broken-unreleasable
- updated-unreleasable
- unreleased-unreleasable
- upgradable-releasable
- unreleased
- updated
- upgradable
- broken



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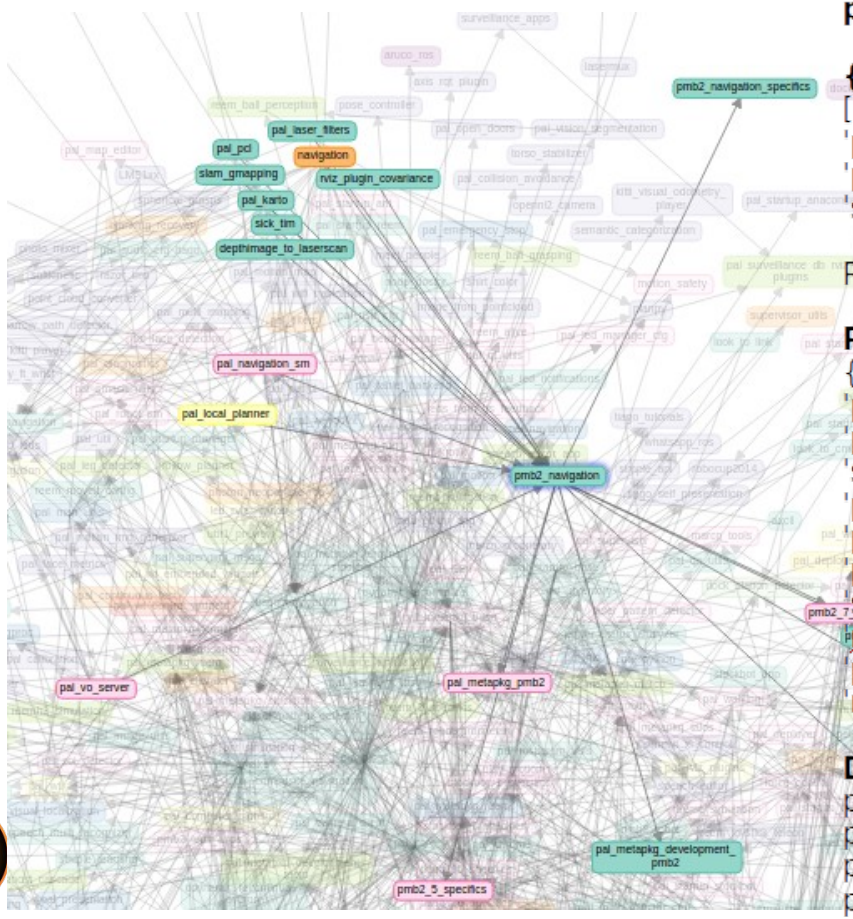

pmb2_navigation updated-releasable

{dubnium-devel} version depends on:
['depthimage_to_laserscan', 'pal_local_planner', 'pal_pcl', 'sick_tim', 'pal_navigation_sm', 'pal_laser_filters', 'pal_vo_server', 'slam_gmapping', 'rviz_plugin_covariance', 'pal_karto', 'navigation']
Released at version: 0.10.0-staging.0

Released against:
{'depthimage_to_laserscan': '1.0.8-staging.0', 'pal_local_planner': '2.0.1-staging.0', 'pal_pcl': '0.1.12-staging.0', 'sick_tim': '0.0.9-staging.0', 'pal_navigation_sm': '0.1.8-staging.0', 'pal_laser_filters': '0.0.2-staging.0', 'pal_vo_server': '0.0.16-staging.0', 'slam_gmapping': '1.3.6-staging.0', 'rviz_plugin_covariance': '0.0.5-staging.0', 'pal_karto': '0.7.1-staging.0', 'navigation': '1.11.28-staging.0'}

Depended on by
pal_metapkg_development_pmb2
pmb2_simulation
pal_metapkg_pmb2
pmb2_navigation_specifics

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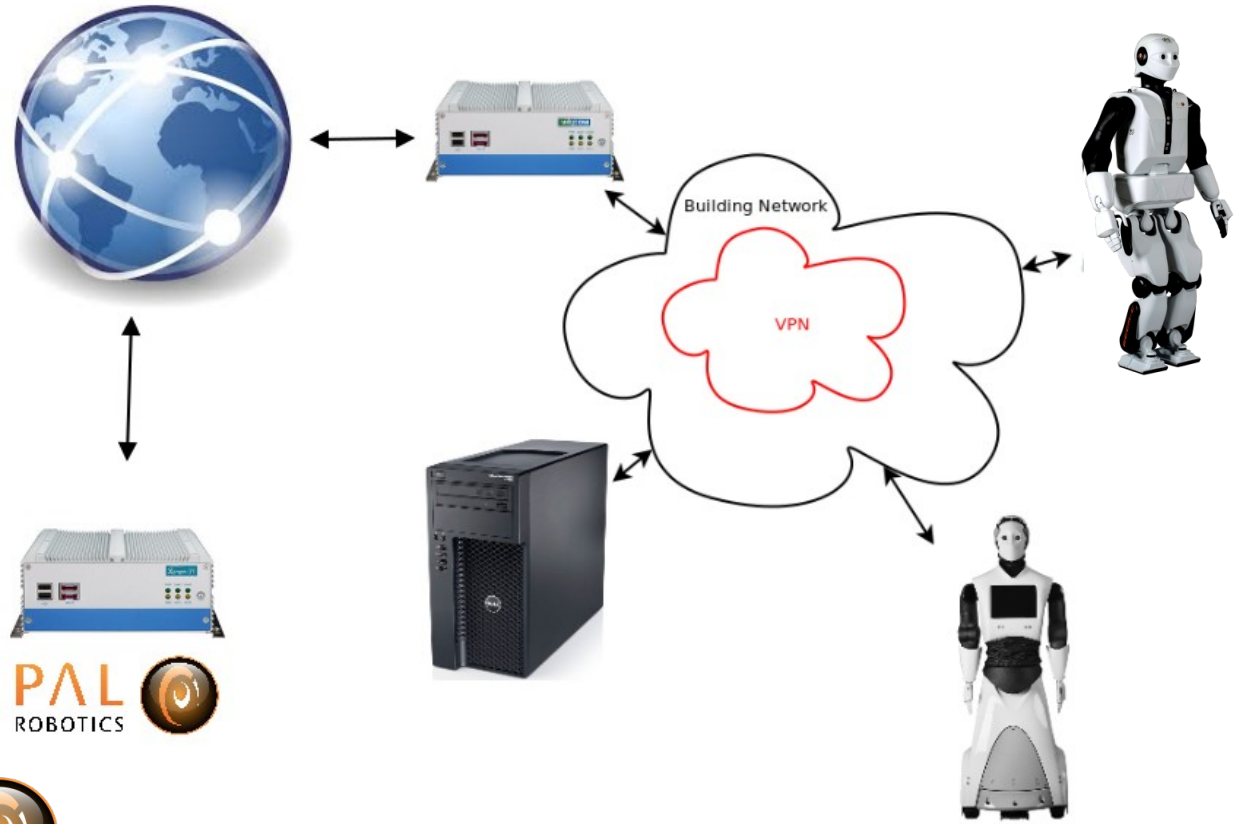
Software release system



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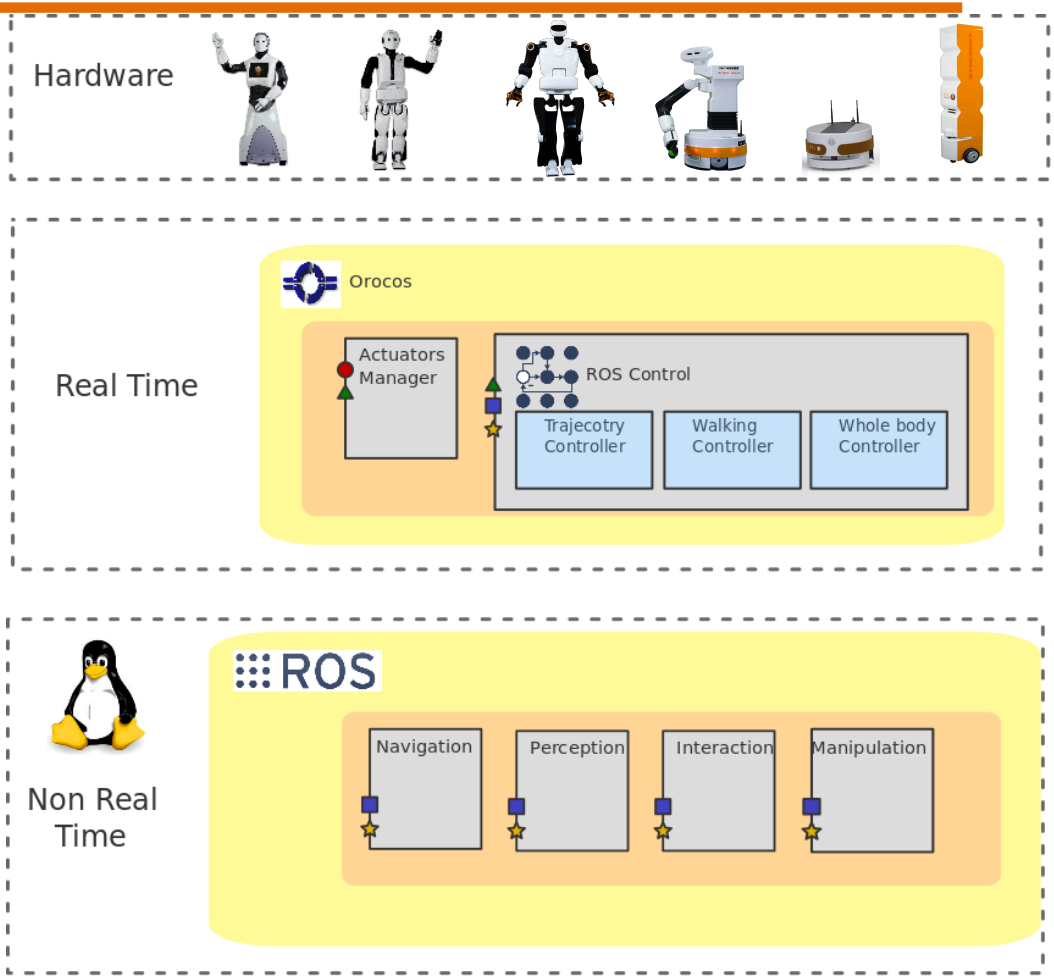
Control architecture



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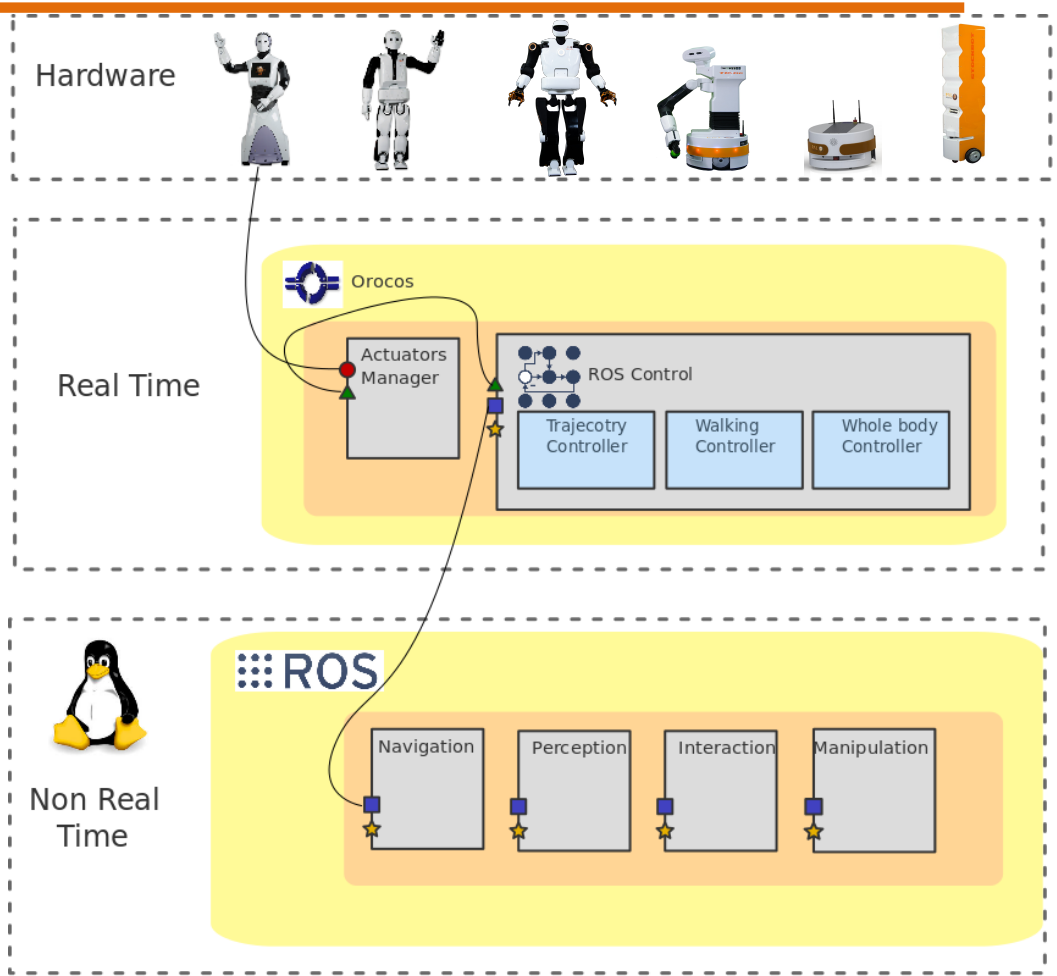

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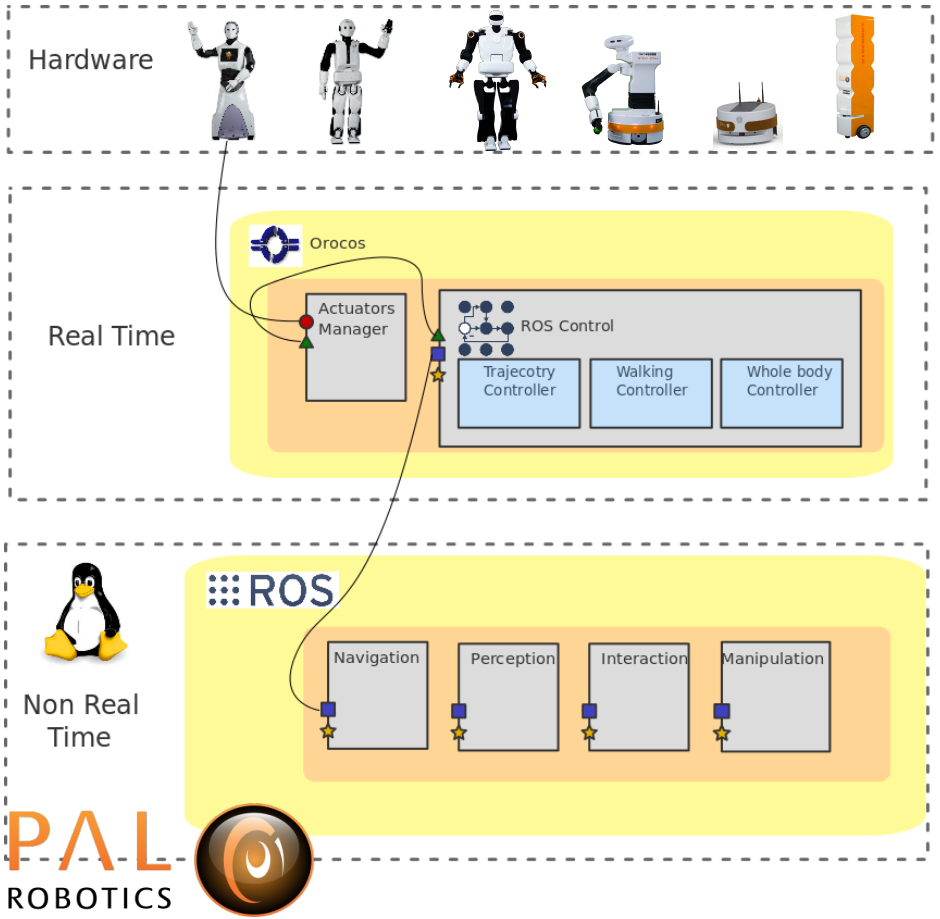


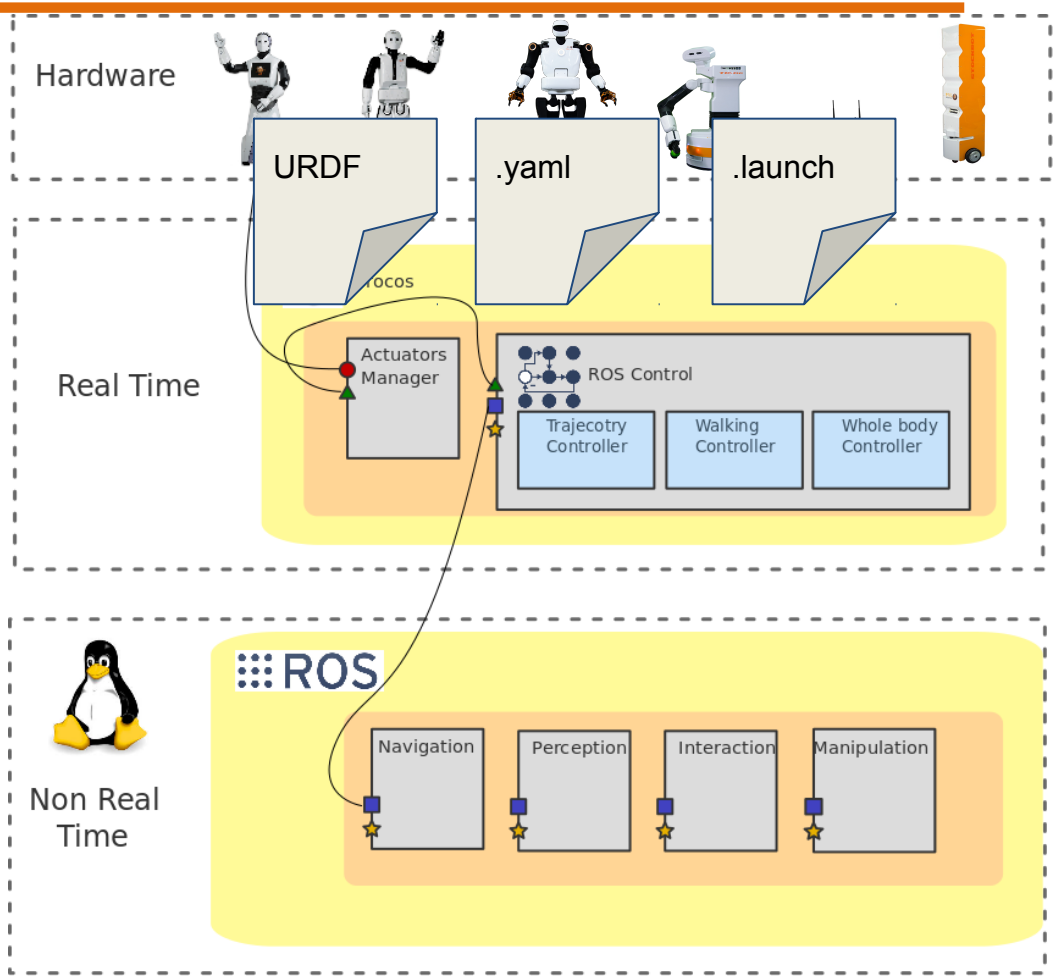
Why?

- Hardware needs real time communication
- Controllers need determinism regardless of system load

How?

- Xenomai co-kernel or Preempt-RT patch
- Never block the real time thread!

Control architecture



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Whole body control

1) set of simple, low-dimensional rules

2) the rules are sufficient to guarantee the correct execution of any single task or of simultaneous multiple tasks

3) exploiting the full capabilities of the entire body of redundant, floating-based robots in compliant multi-contact interaction with the environment

source: http://www.ieee-ras.org/whole-body-control

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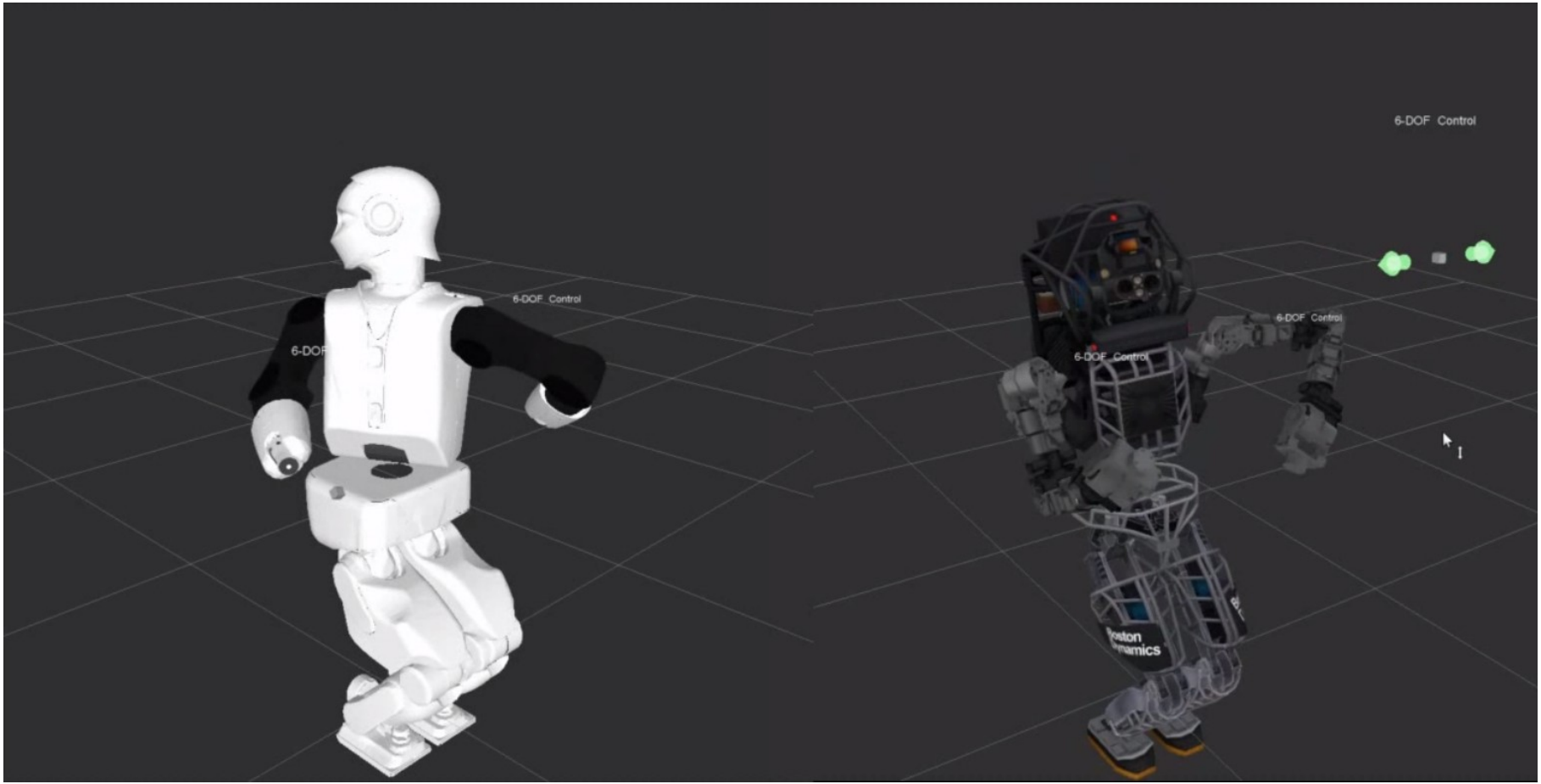
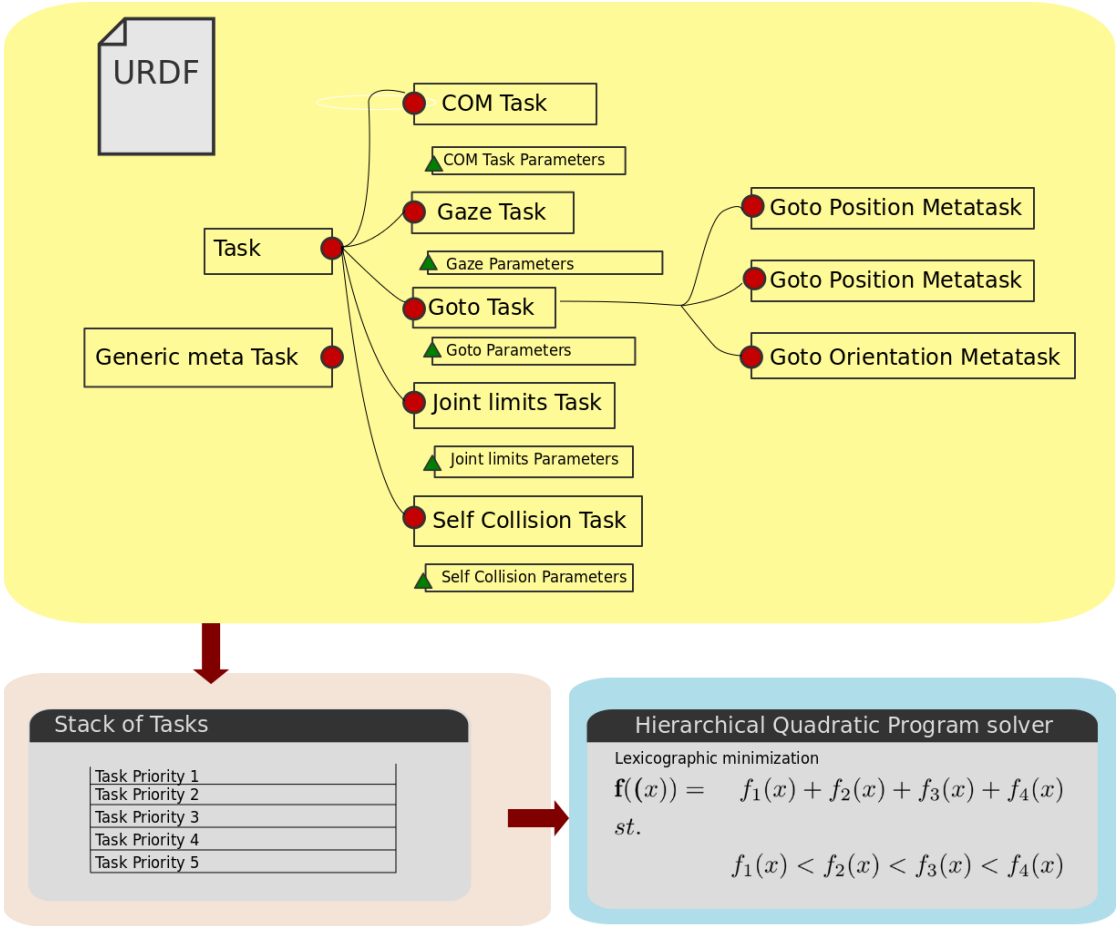
Whole body control



Whole body control



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Whole body control

Stack of Tasks	
High priority	Joint limits
	Self collision avoidance
	Fixed feet + CoM centered
	Gaze
	Hands position
	Torso orientation upright
Low priority	Joint reference posture

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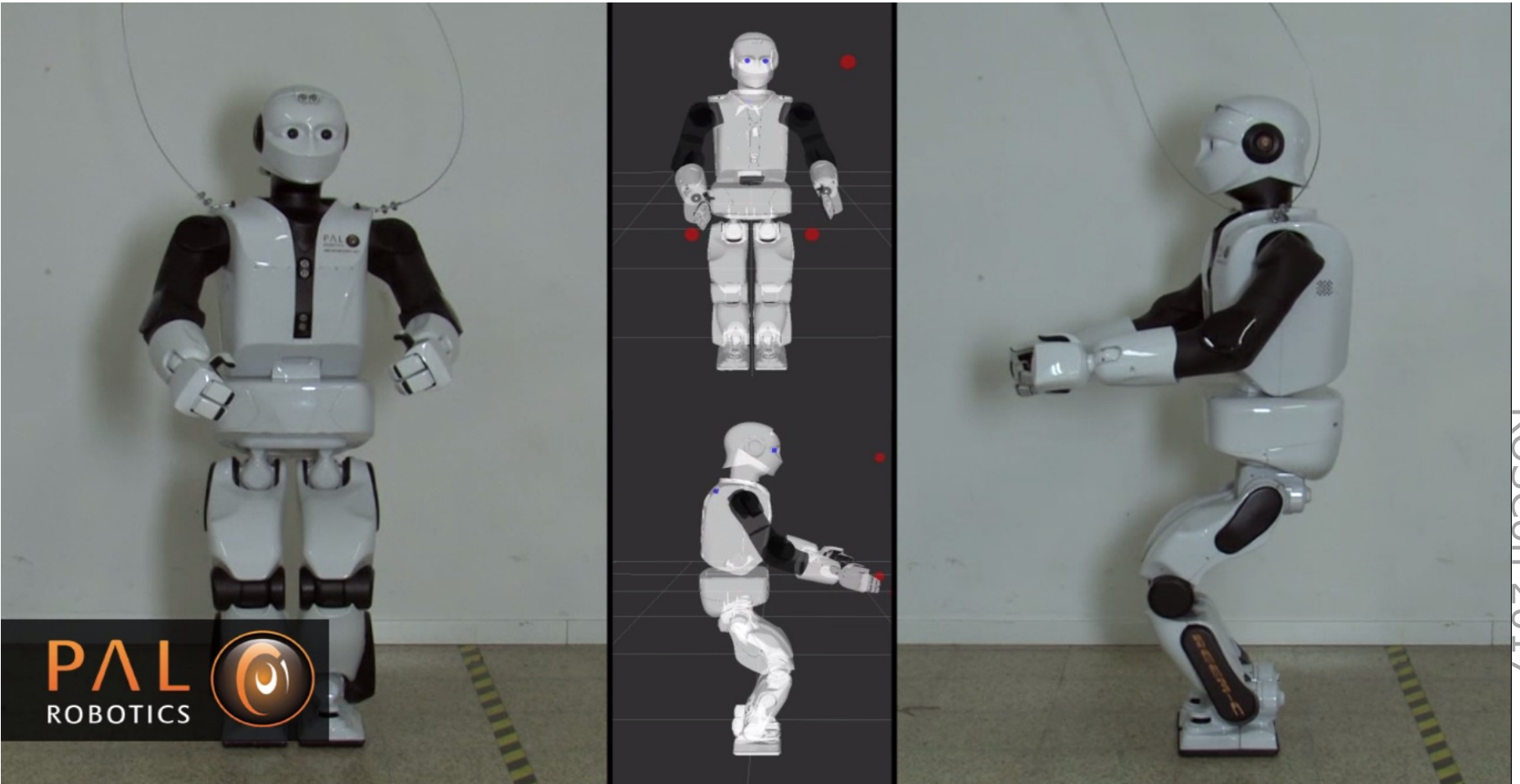
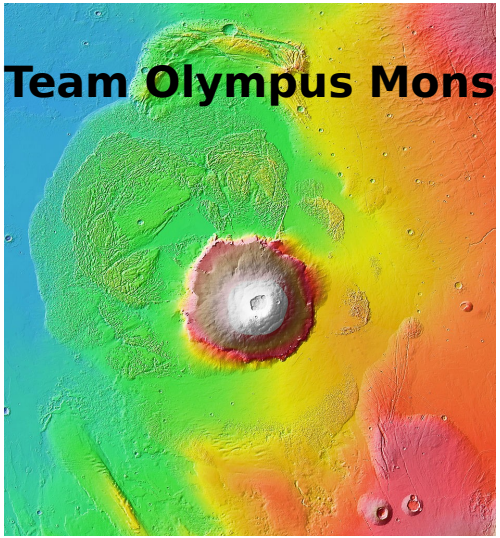
Whole body control



Whole body control

Space Robotics Challenge



- 440 inscribed teams, 20 finalists
- Control Valkyrie robot in simulated Mars mission
- Team composed by current and former PAL employees
- Ineligible for prize, motivated by passion for robotics

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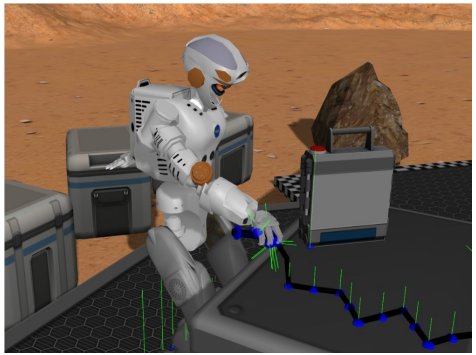
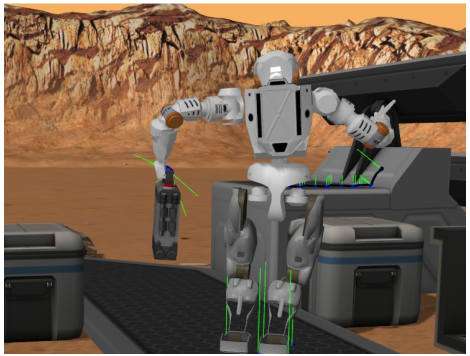
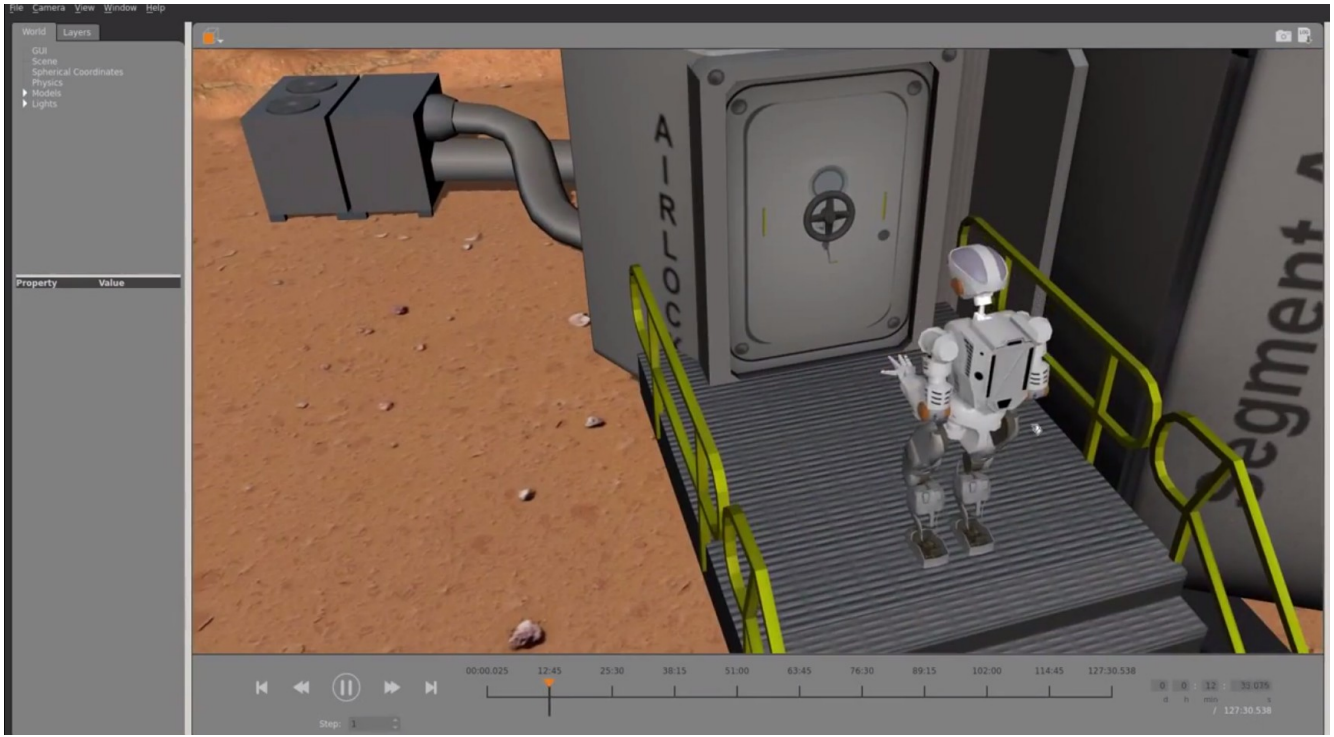
Space Robotics Challenge







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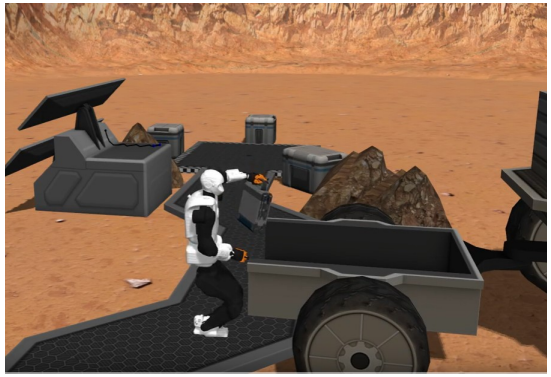
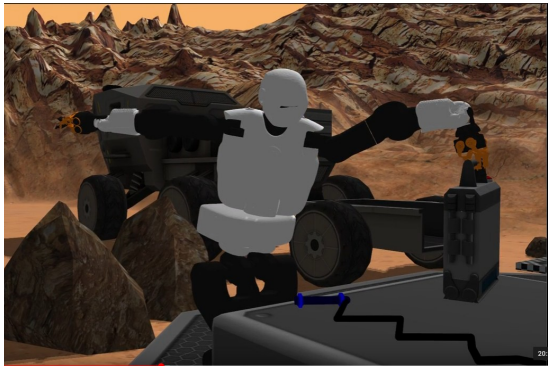
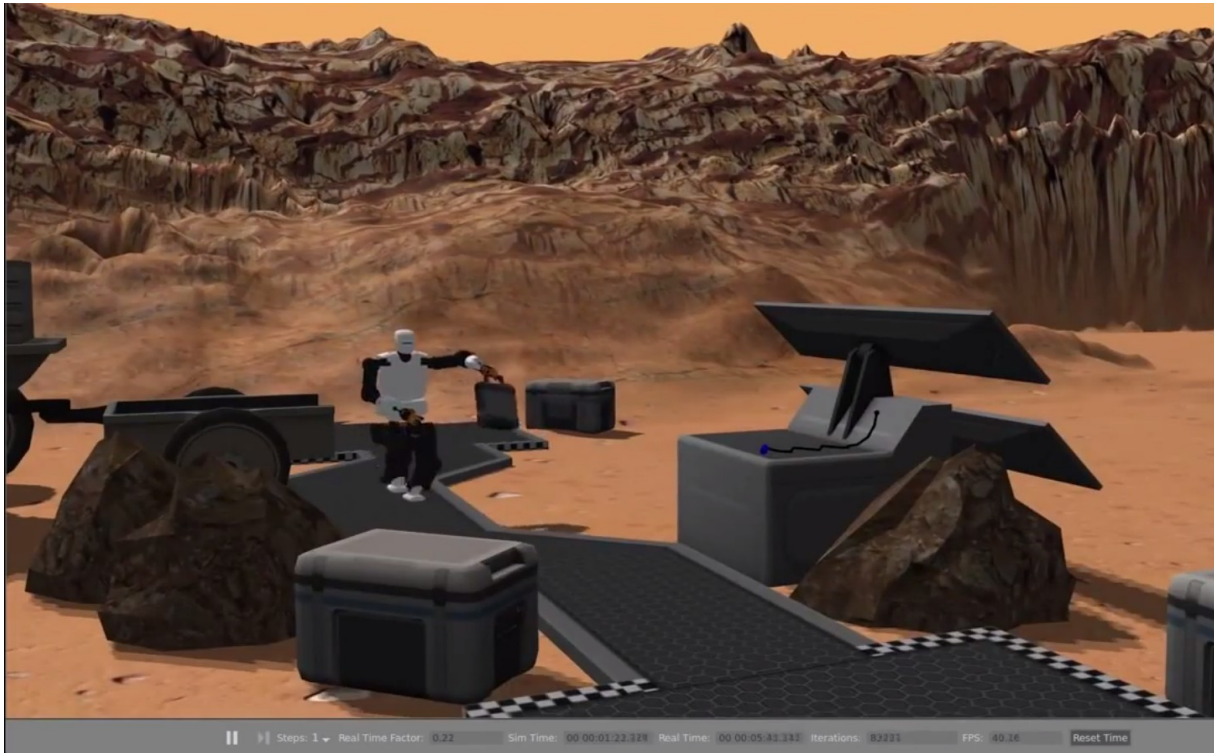
TALOS Robotics Challenge (work in progress)







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Thank you ROS community!!!

www.pal-robotics.com